

# **STARLOG**

## **Temperature Probes**

**Model 6507**

**Model 6535**



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# 1. INTRODUCTION

This supplement provides information about temperature probes, in particular, the probes listed below. Some of the following information relates to any type of thermistor probe allowing a wide range of thermistors to be used with the STARLOG Data Logger.

This supplement includes descriptions and operating instructions for:

- Model 6507 Thermistor Temperature Probes
- Model 6535 Linear Temperature Probe (LM34)

## 1.1. Thermistor Probes

These Negative Temperature Coefficient (NTC) thermistors are high quality, precision curve matched elements, available for a wide range of temperatures. Used in conjunction with thermistor reference resistors (Model 6104), these probes are interchangeable and retain factory calibration for two years or more.

## 1.2. Linear Temperature Probe

The linear temperature probe is used for measuring temperatures between  $-17.8^{\circ}\text{C}$  and  $100^{\circ}\text{C}$ . The output signal is a DC voltage which is directly proportional to the temperature. This is especially useful for use with the Model 6004-2 STARLOGGER which can only display linear formulae on its LCD.

## 1.3. Other Probes Available

UNIDATA also provide glass sealed probes for projects such as monitoring acidic liquids as found in batteries, special size probes to measure leaf temperatures, humidity probes and pH probes. Contact your nearest distributor for details of these probes.

## 2. USING A PROBE IN A STARLOG SCHEME

UNIDATA's Temperature Probes are designed for automatic monitoring and collection of temperature data in a STARLOG Data Logging System. When the probes are connected to a STARLOG Data Logger, data sensed by the probes is logged and stored according to a program you define using the STARLOG Software Package.

The STARLOG Software Package runs on a computer compatible with IBM systems (PC/XT/AT, PS/2). You can generate a data logging program – called a Scheme – then load the Scheme into a Data Logger. To learn how to use this program see the STARLOG Users Manual (supplement 6203 or 6245).

This section provides you with information you will find helpful in creating and executing a Temperature Monitoring Scheme using the current version of STARLOG Software, Version 3.

### 2.1. Which Data Logger To Use

You can use any STARLOG Data Logger with these probes, however, please take the following comments into consideration.

While the Model 6507 Thermistor Probes can be used with any STARLOG Data Logger, the 6507D is recommended to be used only with the STARLOGGER (Model 6004) or Macro Data Logger (Model 7000). You will want to ensure that the scaling formula is correct.

The Linear Temperature Probe (Model 6535A) is recommended mainly for use with the STARLOGGER and Macro Data Logger. This is due to the better resolution available with these loggers when you use high resolution channels.

### 2.2. Adding an Instrument

Use the **Instruments** window in the **Scheme Editor** to add the temperature probe to the Scheme.

The list of temperature probes includes many variations. Each variation is listed separately in the list. Models no longer available also appear in the list, in case you already use one of the older models. In some cases, you may receive a Temperature Probe so new that it doesn't appear in the list yet.

If the probe you have doesn't appear in the list, you will want to add it using the **Instrument Editor** and assign the transducer details listed on page 4.

There are several listings for the Model 6507 Thermistor Probes (a few appear on the next page). By choosing the appropriate Probe from the list, appropriate default scaling and input channels are used. The Model number indicates which reference resistor is used and whether high or low resolution channels are used.

**6507A**                      **Temperature (Red Thermistor 15K ref)**  
**6507A-10**                **Temperature (Red Thermistor 10K ref)**  
**6507A-47**                **Temperature (Red Thermistor 47K ref)**

### Model Number Designations

6507

10

P (early version software)

P uses 0 to 2550 mV input range.  
M uses 0 to 5000 mV input range.

10/47 means 10k/47k reference resistor  
absence of number means 15k

A/B/C means red/yellow/violet thermistor

The Linear Temperature Probe appears later in the list:

### **6535A** Linear Temperature Probe

When you add a Temperature Probe to a Scheme, the default settings are:

Channel	Title	Description	Input Range	Formula
a0	Therm	Red Therm 15k	0 to 2550 mV	red15
A0*	Therm	Red Therm 15k	0 to 5000 mV	hired15
a0 or A0*	Temp	Linear Temperature Probe	0 to 2120 mV	-17.8 to 100

\* A0 is referred to as h0 in earlier versions of STARLOG Software.

The connection details in Section 4 assume you are using these defaults.

To change any of these settings, edit a transducer using the **Instruments** window.

Transducer default details are:

```

[■]----- Transducer 1 -----
Description: Red Thermistor (15k ref.)
Output: Analog Voltage ( [↓] Min: 0           Max: 2550
Scale: Formula           [↓] a: 1           b: 0
Formula: red             [↓]
Channel: a0
Title: Temp
Units: deg C
Using: ###.#
                                [OK] [Cancel]
    
```

*Red Thermistor Probe (using low resolution input range)*

```

[■]----- Transducer 1 -----
Description: Red Thermistor (15k ref.)
Output: Analog Voltage ( [↓] Min: 0           Max: 5000
Scale: Formula           [↓] a: 0           b: 0
Formula: hired           [↓]
Channel: A0
Title: Temp
Units: deg C
Using: ###.#
                                [OK] [Cancel]
    
```

*Red Thermistor Probe (using high resolution input range)*

```

[■]----- Transducer 1 -----
Description: Temperature (linear)
Output: Analog Voltage ( [↓] Min: 0           Max: 2120
Scale: FullScale a..b   [↓] a: -17.8       b: 100
Formula: none           [↓]
Channel: A0
Title: Temp
Units: deg C
Using: ##.#
                                [OK] [Cancel]
    
```

*LM34 Temperature Probe (using high resolution input range)*

### **2.3. Using a Portable Data Logger**

If you are using a Portable Data Logger, ensure that the Scan Rate Switch is set correctly (the factory default is 5 seconds). The switch setting should be the same as the Scan Rate set in the **Program** window.

### **2.4. Using a High Resolution Channel**

To take advantage of the high resolution available with STARLOGGERS and the Macro Logger, use one of the high resolution analog channels, A0–A15. (In earlier versions of STARLOG Software these are called, h0–h15.)

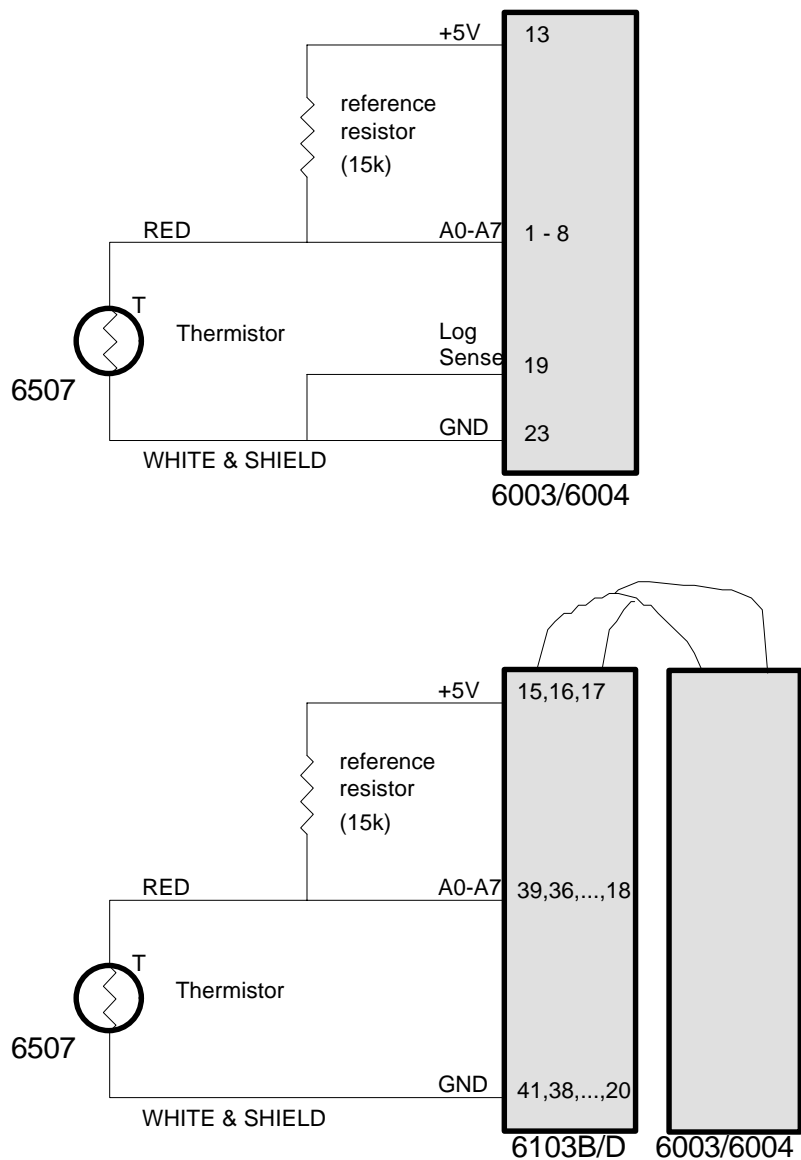
<b>Data Logger</b>	<b>Resolution</b>
Model 6004 and Model 7000	<0.2°C resolution
Model 6003	<0.6°C resolution

If you want to use a high resolution channel instead of a default low resolution channel, ensure that you edit the transducer's details, changing both the input channel and the scaling formula (see previous page).

### 3. INSTALLATION

#### 3.1. Thermistor Probes

The thermistor probe connects directly to a STARLOGGER, Portable or Macro Data Logger's Analog channels. The connection is not polarised so either thermistor lead can be connected to the signal input. The thermistor acts as a passive voltage divider (potentiometer) and therefore must be referenced to the logger power via a precision reference resistor (usually 15kΩ). This reference is connected from the Analog +ve input to the logger power (+5V).



Refer to the Field Termination & Signal Conditioning Modules supplement (6208) or Macro Field Termination Strip (supplement 6234) for details of how to connect a reference resistor to a FTS.

## 4. CONNECTIONS

### 4.1. Thermistor Temperature Probes (Model 6507)

Thermistor Probe		STARLOGGER & PDL		Macro Data Logger	
Colour	Function	Pin	Term	Pin	Term
Red*	Analog +ve	1	39	20	39
White & shield	Common	23	41	1	40

Either lead can be connected to the signal input (see section 3.1). The signal input must be referenced to Data Logger power via a precision reference resistor. This reference is connected from the signal input lead to power (PDL pin 13, MDL pin 18).

### 4.2. Linear Temperature Probe (Model 6535)

Linear Temperature Probe		STARLOGGER & PDL		Macro Data Logger	
Colour	Function	Pin	Term	Pin	Term
Red	+5V DC	13	17	18	49
Yellow	Analog +ve	1	39	20	39
Green	Ground	23	41	1	40



resulting simultaneous equations solved. (NOTE: these values are found in published manufacturers' data tables, not by experiment).

The thermistor correction is based on a 'Steinhart-Hart' equation [ $1/T = A + B \ln R + C (\ln R)^3$ ]. A simplified equation is used which provides correction accuracy of 0.02°C over 100°C ranges. The simplified Steinhart-Hart equation to solve is:-

$$T = (B / (\ln(R) - A)) - C$$

### 5.2.1. Solving the Steinhart-Hart Equation (THERMCON.BAS)

The following BASIC program requires three sets of Temperature/Resistance values (from a manufacturer's data sheet). The temperatures must be separated by an equal temperature gap (i.e. -10°C, 10°C, 30°C) and should cover (as close as possible) the range of temperatures to be measured.

```
10 PRINT "Thermistor constants A, B & C"
20 PRINT "T=(B/(LN(ohms)-A))-C"
30 PRINT:PRINT "Enter temp. in deg C, resistance in ohms"
40 INPUT "High temp., resistance";TZ,Z
45 INPUT "Mid temp., resistance";TY,Y
50 INPUT "Low temp.,resistance";TX,X
60 IF (TZ-TY)(TY-TX) THEN PRINT "Temperatures not equal distance":END
70 T=(TZ-TY)
75 TX=TX+273.15
80 A=(LN(Y)*LN(X*Z))
85 A=A-2*LN(X)*LN(Z)
90 B=LN(X*Z)-2*(LN(X)+LN(Z)-LN(Y))
95 A=A/B
100 PRINT "A=";A
105 B=T/((1/(LN(Y)-A))-(1/(LN(X)-A)))
110 PRINT "B=";B
115 C=(B/(LN(X)-A))-TX
120 PRINT "C=";C
130 END
```

## 6. INSTRUMENT TESTING

To test the Temperature Probe when connected to a STARLOG Data Logger, you can connect the Logger to a computer running STARLOG Software Version 3. The steps below explain how to use the **Control Panel** option, **Scheme Test Mode**.

1. Connect the Temperature Probe to the Data Logger (see section 3: Installation).
2. Connect the Logger to the Computer.
3. Using the **Scheme Editor** , create a Temperature Monitoring Scheme using the instrument you are about to test.
4. Then, open the **Control Panel**.
5. **Program the Logger** with this Scheme.
6. Select **Scheme Test Mode** to test the scheme you just generated.
7. The first Test Window you see includes general information for a Scheme and displays Data Logger memory addresses used in the current Scheme.

The temperature probe, when connected to PDL pin 1, sends data to address 16 (the place in Data Logger memory where information for low resolution analog channel 0 is found).

Check the data which appears in address 16 .

## 7. SPECIFICATIONS

### 7.1. Model 6507A/B/C Thermistor Probes

---

Accuracy:	$\pm 0.2^{\circ}\text{C}$ , pre-calibrated
Stability:	$\pm 0.15^{\circ}\text{C}$ change over 1000 hours (0–60°C)
Ranges:	9 ranges from -28.7 to 162°C (see section 1.1)
Resolution:	(see Thermistor Range Table)
Depth:	Tested to a pressure of 400 metres of water
Output Signal:	1 analog, 0 – 2.55 V DC (PDL, STARLOGGER) 0 – 5 V DC (MACRO)
Power:	5V DC, 0.5mA from Logger
Cable:	2 wire shield, 10 metres supplied
Material:	Stainless steel, epoxy sealed
Dimensions:	4mm diameter, 50mm long

### 7.2. Model 6507D Thermistor Probe

---

As above, except the following:

Accuracy:	$\pm 0.1^{\circ}\text{C}$ , pre-calibrated
Stability:	$\pm 0.08^{\circ}\text{C}$ change over 1000 hours (0–60°C)
Cable:	Model 6600A order length required, maximum 50 metres
Dimensions:	12mm diameter, 120mm long

### 7.3. Linear Temperature Probe (Model 6535A)

---

Accuracy:	$\pm 0.6^{\circ}\text{C}$ , pre-calibrated
Stability:	$\pm 0.09^{\circ}\text{F}$ over 1000 hours
Range:	-17.8 to 100°C
Resolution:	Macro Data Logger (12-bit) 0.07°C STARLOGGER (10 bit) 0.14°C STARLOGGER (8-bit) 0.6°C
Output Signal:	1 analog, 0 – 2120 mV DC (18 mV/°C)
Power:	5V DC, 150µA from Logger
Cable:	4 core shield, 10 metres supplied

Material: Stainless steel  
Dimensions: 100mm x 6.5mm diameter

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## APPENDIX A THERMISTOR RANGE TABLES

### Thermistor Range Table

The following tables show temperature ranges applicable if you are using the Model 6004 STARLOGGER or the Model 6003 Portable Data Logger.

Range in °C to 0.5° resolution (1° resolution)

Reference Resistor	Model 6507A RED	Model 6507B YELLOW	Model 6507C VIOLET
10kΩ	-1.2 to 45 (65)	24.1 to 74 (95)	81.2 to 133 (162)
15kΩ	-8.9 to 35 (54)	15.1 to 62 (82)	70.2 to 119 (146)
47kΩ	-28.7 to 10 (26)	-7.5 to 32 (50)	43 to 83 (106)

For example, using the table above, the 6507A probe, with a reference resistor of 15kΩ, has a range of -8.9 to 35°C at a resolution of 0.5°C and 35 to 54°C at a resolution of 1°C.

Ohms at	RED	YELLOW	VIOLET
25°C	3,000	10,000	100,000
60°C	746.4	2,488	22,590

### Thermistor Resolution Tables for STARLOGGER

Resolutions are twice that of the MACRO Data Logger (see tables on next page.) For instance, the Yellow Thermistor with a 10kW reference resistor connected to a STARLOGGER provides a resolution of: 0.086° at 60°C.

Note that thermistor temperature range is not as shown in the MACRO's tables, but is limited as shown above.

## Thermistor Resolution Tables for MACRO Data Logger

**For Low Temperatures**

Temperature	HIRED10	HIRED15	HIRED47
80°C	0.215°	0.314°	0.955°
60°C	0.105°	0.151°	0.444°
25°C	0.031°	0.040°	0.099°
0°C	0.019°	0.020°	0.034°
-30°C	0.029°	0.023°	0.016°

**For Ambient Temperatures**

Temperature	HIYEL10	HIYEL15	HIYEL47
80°C	0.076°	0.106°	0.600°
60°C	0.043°	0.056°	0.143°
25°C	0.022°	0.023°	0.038°
0°C	0.027°	0.022°	0.020°
-30°C	0.078°	0.055°	0.024°

**For High Temperatures**

Temperature	HIVIO10	HIVIO15	HIVIO47
80°C	0.028°	0.029°	0.046°
60°C	0.030°	0.027°	0.029°
25°C	0.063°	0.046°	0.024°
0°C	0.165°	0.113°	0.043°
-30°C	0.741°	0.492°	0.163°

As the above tables show, the Yellow Thermistor with a 10kΩ reference connected to a MACRO Data Logger will provide the best resolution over the full operating range (-20 to 80°C).