

# Microfire LLC Mod-NTC Datasheet

## Release Information

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## Release History

Release	Date	Description
1.0.0	4/20/2023	Initial

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## About the Mod-NTC Module

A module for interfacing with 10K NTC temperature sensors. It has been designed to be flexible and simple to incorporate into new or existing electrical designs.

- Resolution 0.125°C
- [I<sup>2</sup>C](#) with software definable address
  - Default address 0x0C
  - 10kHz, 100 kHz, 400 kHz, 1 MHz compatible
- 25 mm wide x 15 mm high x 0.8mm thick
  - Material type: FR-4 TG155
  - DIP and castellated edges

## Mechanical Specification

The Mod-NTC module is a single-sided 25x15 mm 0.8 mm thick PCB with dual castellated/through-hole pins around the east and west edges. It is designed to be usable as a surface mount module as well as in Dual Inline Package (DIP) type format, with the 12 pins on a 2.54mm pitch grid with 0.9mm holes.

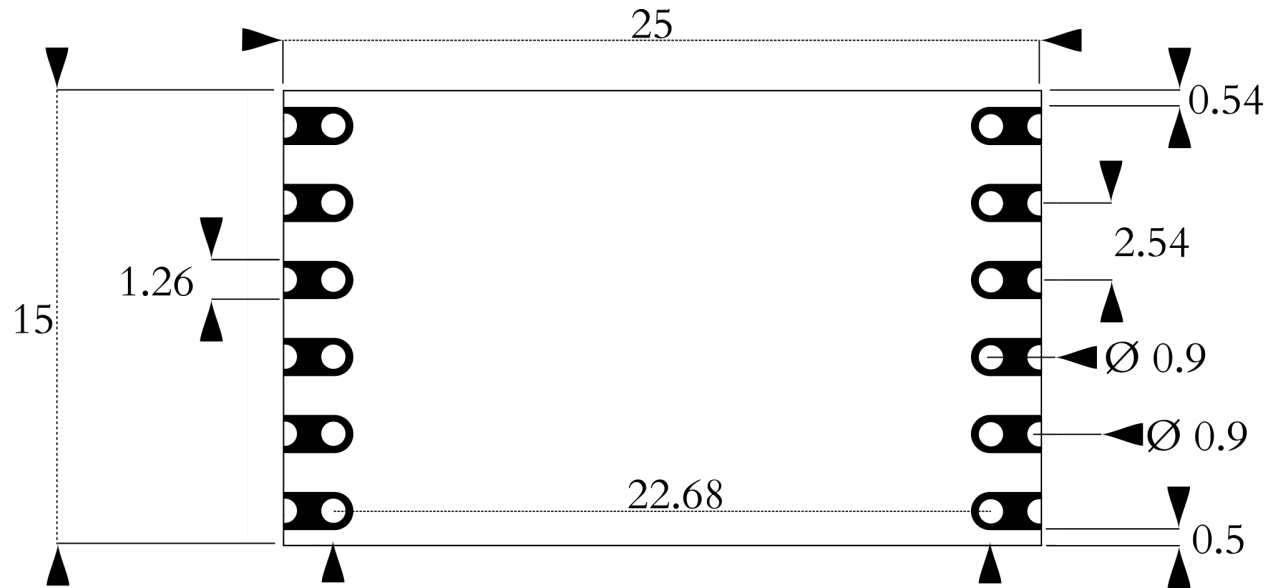


Figure 1. Physical dimensions of the module.

## Pinout

The pinout of the module has been designed to provide as many interface options as possible.



Figure 2. Pinout of the module.

**Pin 1:** Probe 1 input. Provides a connection to either wire of the NTC.

**Pin 2:** Probe 2 input. Provides a connection to the other wire of the NTC.

**Pin 3:** Not used in this module.

**Pin 4:** Not used in this module.

**Pin 5:** Not used in this module.

**Pin 6:** Not used in this module.

**Pin 7:** Not used in this module.

**Pin 8:** Not used in this module.

**Pin 9:** I<sup>2</sup>C SCL. Clock line for I2C interface.

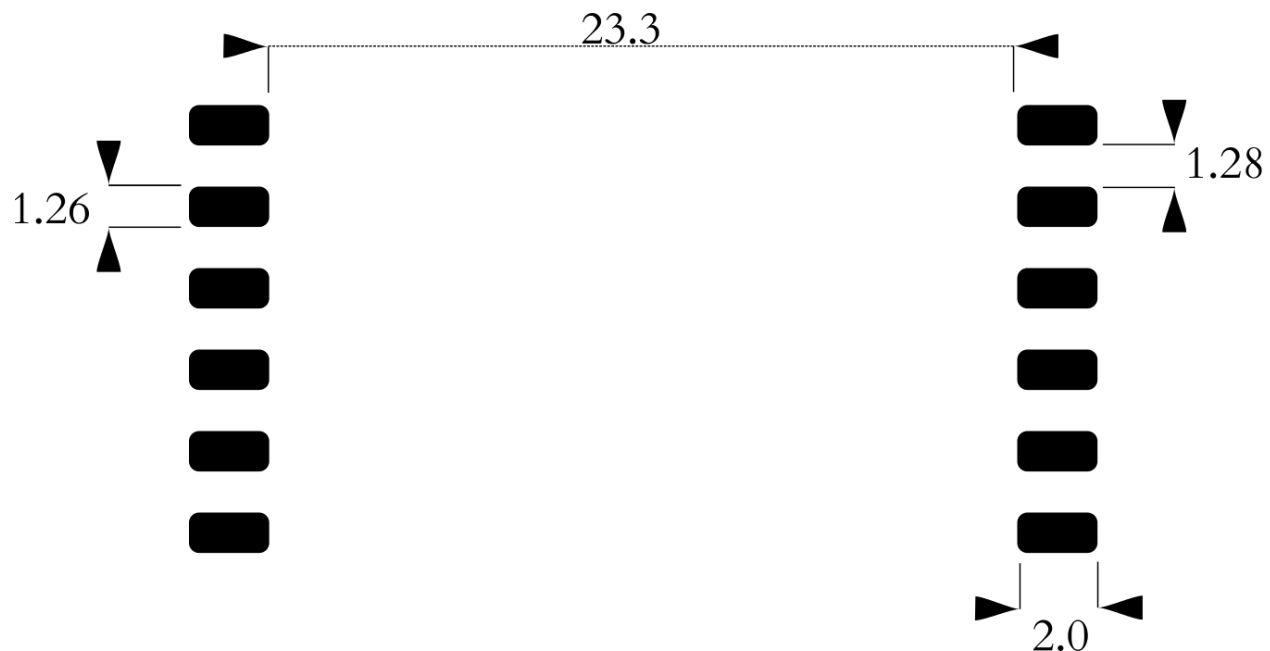
**Pin 10:** I<sup>2</sup>C SDA. Data line for I2C interface.

**Pin 11:** VIN. 3.3-volt power supply.

**Pin 12:** Ground. Ground for the module.

## Surface Mounting

The following figure shows the recommended footprint for mounting the module through reflow processes. It provides for a Class 1 connection (*IPC-A-610G § 8.3.4 Castellated Terminations*).



It is recommended that the stencil be 8 mils in thickness to ensure enough solder paste can flow into the castellations.

The module is assembled with [Chip Quik SMD291SNL50T3](#) (Sn96.5/Ag3.0/Cu0.5) solder paste, a lead-free paste with a 249-degree Celsius peak reflow temperature. Reflowing the module multiple times can cause malfunction, to avoid the issue, if it is possible, use a lower melting-point temperature solder paste.

## Operating Conditions

### Temperature:

- **Absolute:**
  - **Maximum:** 85 C
  - **Minimum:** -40 C
- **Recommended:**
  - **Maximum:** 50 C
  - **Minimum:** 10 C

When approaching the absolute temperature ratings, it should be noted that the module's temperature will begin to affect measurements, the extent of which will need to be characterized to the specific environment the module will be deployed in.

### Voltage:



- **Absolute Maximum:** 5.5 volts
- **Absolute Minimum:** 1.8 volts (3.3 volts is required for proper operation)

# Electrical Specification

## Power Supply

The module requires 3.3 volts for proper operation. It can be supplied with less and still communicate through the various peripheral interfaces, but this will not allow the analog circuitry to operate properly. Voltage should not exceed 5.5 volts.

There is no reverse polarity protection on the module.

## Power Isolation

Isolation is not required for this module.

## Power Consumption

All modules are designed to be low-power. Power usage has been characterized at two points, idle and active sensor measurement.

- Current use is typically 0.15 mA

## I<sup>2</sup>C Interface

The module supports speeds of 10kHz, 100 kHz, 400 kHz, and 1 MHz at 3.3 volts.

The I<sup>2</sup>C interface uses the following pins:

- **Pin 9 SCL:** serial clock
- **Pin 10 SDA:** data

## Additional Circuitry

The module has no pullup resistors on the I<sup>2</sup>C bus. For reliable communication, appropriate resistors must be chosen for the SDA and SCL lines.

## I<sup>2</sup>C Address

The default address is 0x0C by default. It can be changed through firmware.

## I<sup>2</sup>C Write

Writing is done by sending a start condition followed by the module's address with the write bit set. The master device then sends data 8 bytes at a time. The first byte received is considered to be the register address. Successive writes will automatically increment the register address by one byte. Transmission is finished with a stop condition.

## I<sup>2</sup>C Read

Reading is done by sending a start condition followed by the module's address with the read bit set. The master sets the register to read from, then requests data. The device then sends the appropriate number of bytes as determined by the register being read.

# Design Incorporation

Adding the module is a straightforward process.

## Power

A suitable power supply must be supplied. Ideal solutions will provide a low-ripple, low-EMI, 3.3 volt supply.

## Ground

The module operates at the same ground potential as what **Pin 11: Ground** is connected to, so a low-impedance connection is needed.

## Probe Connection

An NTC probe that is compatible with the module consists of two wires. This is most commonly provided for with a BNC, SMA, or U.FL connector.

## Considerations

- **Pin 1:** Probe 1 input and **Pin 2:** Probe 2 input pins should be on their own island plane pour or otherwise isolated by no pour surrounding them.
- **Pin 1:** Probe 1 input and **Pin 2:** Probe 2 input pins should be as short as possible.
- If the PCB is 4 or more layers, consider routing **Pin 1 and Pin 2** traces on internal layers to protect the probe input signal from interference.
- Avoid routing other traces near **Pin 1** and **Pin 2**.
- Flux residue on **Pin 1, Pin 2** and at the probe connection must be removed. This is ideally accomplished by using a “no-clean” solder paste, and/or through mechanical means such as an ultrasonic bath.

## Unused Pins

Any unused pins should be left unconnected to any other trace or net.

# Temperature Measurements

## Measurement Details

An NTC (Negative Temperature Coefficient) is a thermistor, a resistor whose resistance changes with temperature. The resistance of NTC will decrease as the temperature increases. The amount the resistance decreases can be related to a constant, commonly referred to as beta, or  $\beta$ .

## NTC Types

NTCs come in various configurations, materials, and specifications. Mod-NTC is intended for room temperature ranges using 10K sensors. The 10K specification signifies the sensor will read 10,000 Ohms at 25 degrees Celsius.

## Calibration

NTC sensors typically come with a value called beta. The beta value is used in a formula to convert the NTC's output to a temperature value.

## Steinhart-Hart Coefficients

Some NTC probes will come with Steinhart-Hart coefficients. They are typically presented as three numbers: A, B, and C. The formula to use the coefficients with Mod-NTC is simple. Call the following function, passing [resistance](#).

```
float SH_calculation(float _resistance)
{
    float logRt = log(_resistance);
    float _tempK, _tempC, _tempF;
    _tempK = (1.0 / (A + B * logRt + C * logRt * logRt * logRt));
    _tempC = _tempK - 273.15;
    _tempF = _tempC * 1.8 + 32;

    return _tempC;
}
```



## I<sup>2</sup>C Interface

The module's I<sup>2</sup>C interface operates similarly to many common I<sup>2</sup>C sensors. There are several registers that hold values such as temperature or version information. The registers are used to pass information both to the module and the controlling device. Tasks are performed by writing a specified value to a certain register.

## Registers

All registers are either 1 byte or a float which is 4 bytes formatted as an IEEE 754 32-bit floating point, little-endian. The firmware will allow the registers to be read and written.

### Register Listing

Register Name	Value	Type	Description
HW_VERSION_REGISTER	0	byte	Hardware version
FW_VERSION_REGISTER	1	byte	Firmware version
TASK_REGISTER	2	byte	Task register
STATUS_REGISTER	3	byte	Status of measurement
BETA_REGISTER	4	float	Beta value for connected sensor
TEMP_C_REGISTER	8	float	Measured temperature in Celsius
TEMP_K_REGISTER	12	float	Measured temperature in Kelvin
TEMP_F_REGISTER	16	float	Measured temperature in Fahrenheit
RESISTANCE_REGISTER	20	float	Resistance of the temperature sensor in ohms
BUFFER_REGISTER	24	float	Buffer used for passing information

## Tasks

When a particular value is written to TASK\_REGISTER, it starts an operation within the module.

Temperature measurement is performed when MEASURE\_TEMP\_TASK is written to the TASK\_REGISTER register. To read the resulting measurement, you would read the TEMP\_C\_REGISTER, TEMP\_F\_REGISTER, TEMP\_K\_REGISTER or RESISTANCE\_REGISTER register.

### Task Listing

Task Name	Duration	Value	Description
MEASURE_TEMP_TASK	150 ms	40	Temperature measurement
BETA_TASK	1 ms	20	Beta change
I2C_TASK	1 ms	2	I <sup>2</sup> C address change



## MEASURE\_TEMP\_TASK - Temperature Measurement

Starts a temperature measurement.

## Required Registers

Register	Description
None	

## Response Parameters

Parameter	Description
<b>TEMP_C_REGISTER</b>	The solution-under-test's temperature in degrees Celsius.
<b>TEMP_F_REGISTER</b>	The solution-under-test's temperature in degrees Fahrenheit.
<b>TEMP_K_REGISTER</b>	The solution-under-test's temperature in Kelvin.
<b>RESISTANCE_REGISTER</b>	The resistance in ohms as measured from the temperature sensor.
<b>STATUS_REGISTER</b>	<p>An error code for the measurement. Can be one of the following:</p> <p>0: no error 1: no probe 2: system error</p>

## BETA\_TASK - I<sup>2</sup>C address change

Changes the device's beta value.

### Required Registers

Register	Description
BUFFER_REGISTER	Used to temporarily store the new beta value.

### Response Registers

Register	Description
None	

## I2C\_TASK - I<sup>2</sup>C address change

Changes the device's I<sup>2</sup>C address.

### Required Registers

Register	Description
BUFFER_REGISTER	Used to temporarily store the new I <sup>2</sup> C address.

### Response Registers

Register	Description
None	



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### Modules

Mod-EC  
Mod-pH  
Mod-ORP  
Mod-ISO  
Mod-NTC

### Development Boards

Isolated Dev Board  
Mod-EVAL  
Mod-EVAL\_ISO

### Probes

Industrial pH Probe  
Industrial EC Probe  
Industrial ORP Probe  
Lab pH Probe  
Lab EC Probe  
Lab ORP Probe



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