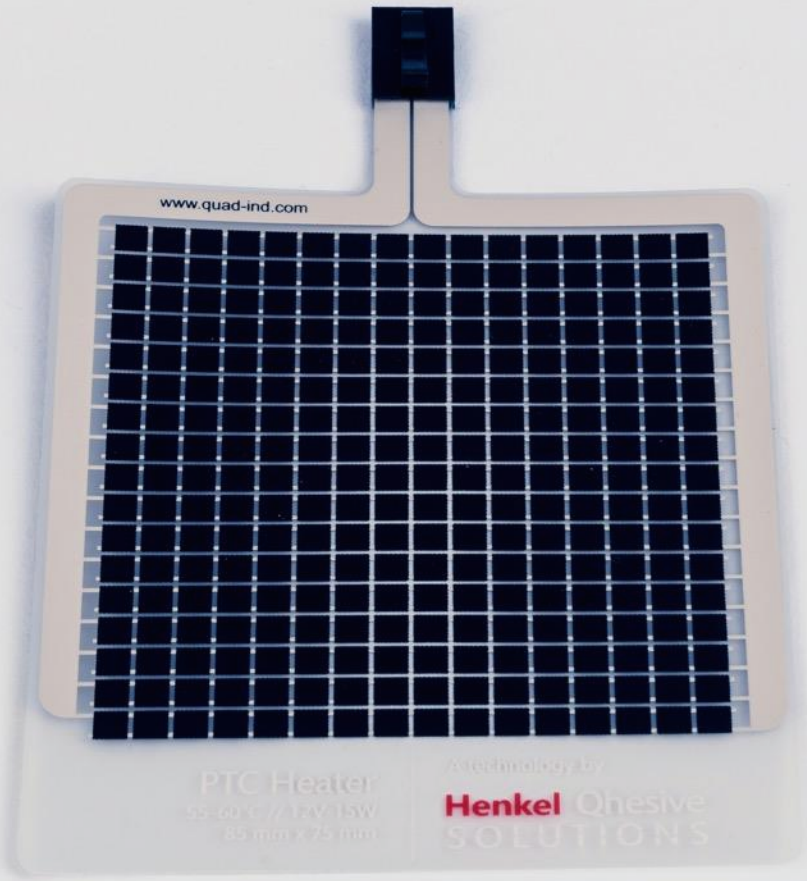


TECHNICAL INFORMATION SHEET:

POSITIVE TEMPERATURE COEFFICIENT [PTC] HEATER

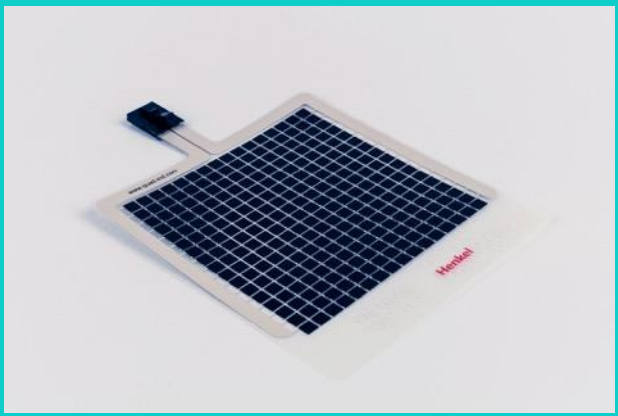
BY QUAD INDUSTRIES

Henkel Qhesive SOLUTIONS

TECHNICAL INFORMATION SHEET

POSITIVE TEMPERATURE COEFFICIENT HEATER BY QUAD INDUSTRIES

Self-regulating, uniform PTC Heater INKxperience enabled by Loctite ® printed electronics inks.



The PTC heater by Henkel Qhesive Solutions is enabled by a printed electronics heating pad and hardware. The printed PTC heating pad heats up rapidly, is self-regulating and provides uniform surface heating at a temperature of around 55 °C. The PTC heating design was developed by Henkel Qhesive Solutions in collaboration with Quad Industries. The PTC heater is constructed by printing a combination Loctite PTC, silver and dielectric ink onto a polyethylene terephthalate (PET) substrate. Printed designs determine system sensitivity due to the physically thin sensor format. The PTC heating pad is designed to be powered by 12 volts.

Features

- **Easy installation**
- **Physically thin sensor format**
- **Self-regulating temperature (55-60 °C)**
- **Rapid and uniform heating**
- **Design freedom**
- **Environmentally very stable and long**

Operating Mode

The primary use case of this sensor is to provide conformal surface heating by PTC self-regulation. The heating pad instantly heats up once connected to a 12V power supply. Heat can be sensed by touching the pad. The PTC heater dashboard on the Raspberry Pi will display the current increase until the self-regulation temperature (55 to 60 °C) is reached. At this point the current will drop.

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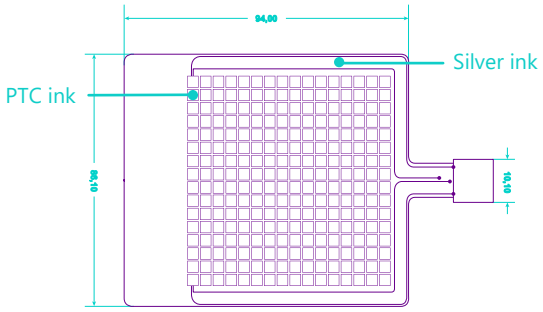
POSITIVE TEMPERATURE COEFFICIENT HEATER BY QUAD INDUSTRIES

Product Nomenclature

The PTC heater INKxperience is composed of two main physical components, the electronic 'hardware' and printed 'PTC heater'. We refer to the Printed Circuit Board [PCB] and plastic enclosure as the 'hardware' and breakout board.



Sensor

The PTC heater is composed of squares of carbon based on PTC ink, silver ink busbars and a protective dielectric coating. The heater has high force female contacts (Ctct_MHFC025-T35) and a Memcon housing (MHL-04) as a connector. The silver ink is applied for power distribution and the PTC ink squares allow for the uniform, self-regulating heat distribution across the surface of the heater. PTC ink and silver ink are indicated with green arrows above.

Technical Summary	
Hardware and Enclosure Dimensions	60 x 40 x 18 mm
Heater Dimensions	94 x 86.1 mm
Hardware and Enclosure Weight	52 g
Operating Temperature Range	From 55 to 60°C
Sensitivity	Current sensing sensitivity: +-20 mA
Resolution	Current sensing resolution: 50 mA
Activation Method	Application of current
Operating Voltage	Hardware: 5 V Heater: 12 V
Housing	LOCTITE® 3D 3843™
Mounting	n/a
Sensor Connector	Memcon (MHL-04)
Sensor Materials	Loctite ECI 8001, Loctite ECI 1010, Loctite EDAG PF-455BC
Sensor Function	Self-regulating, uniform heating

Sensor Limitations	Hardware Limitations
The PTC Heater is designed to work at the recommended voltage. Higher voltage will generate hot spots and may lead to permanent degradation of the part. Limited power supply limits the heating power.	The hardware is designed to work with the given setup. When modifying the PCB function and safety cannot be guaranteed.

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POSITIVE TEMPERATURE COEFFICIENT HEATER BY QUAD INDUSTRIES

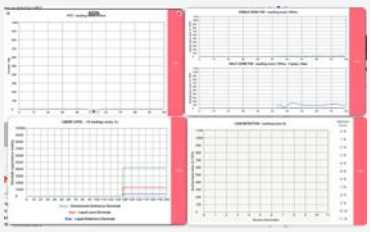
Data Output

The sensor data can be read out via the Raspberry Pi or the web app. Each sensor breakout board outputs data over USB serial. USB driver installation information is available here. The PTC Heater breakout board outputs 1 signal over serial USB and the output format is 1 integer per line, representing the current draw in milliamps. The breakout board is based on Seeduino Xiao with the serial protocol settings being: 115200 baud rate, no parity, 1 stop bit.

Data Read Out & Saving via Raspberry Pi

The included main board (Raspberry Pi) allows for immediate testing and data read out. Once you have connected the Raspberry Pi to a power source, one or more sensors can be connected at the same time. With a power supply in place the Henkel Qhesive Solutions dashboard will boot.

From the dashboard you can select the sensor technology you would like to use, for example the leak detection sensor. Detected sensors are highlighted in green while not connected sensors are grayed out. Once the leak detection sensor is connected, tap on the respective application to see the data readout in real time. Tap on exit to return to the menu.



The Raspberry Pi supports automatic saving of data on a USB stick. With the Sensor INKxperience Kit you will receive a USB stick with the required filesystem: FAT32. Once the USB stick is plugged in, a dialog window will open. Please select "Cancel".

While the USB drive is plugged in, every data reading session will save a new file on the drive. Filenames are in the form (SENSOR_NAME)_(timestamp).txt.
Each line in the file contains a timestamp (milliseconds since session start) and the analog data value read from the sensor. A data reading session starts when you tap an available sensor and ends when you tap "Exit".

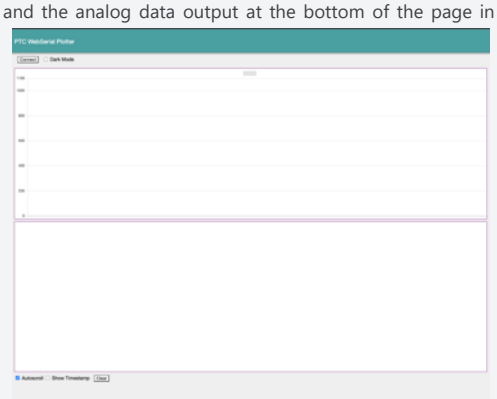
To shutdown the Raspberry Pi, unplug the power supply.

Data Read Out & Saving via Web App

The web app allows you to read data from the sensor breakout boards by directly connecting them to your computer, without needing to use the included Raspberry Pi. Supported browsers Chrome and Microsoft Edge.

After connecting a breakout board to an available USB port, go to Qhesive WebSerial Plotter (inkxperiencekit.com) and click on the type of sensor for which you want to see data. Next, click on "Connect" and select the correct board name from the popup window.

For each sensor you can see the data graphically at the top of the page and the analog data output at the bottom of the page in real time.



To save the raw data read during the session, click the download button of the web app and save the file to your chosen location. Each line in the file contains a timestamp and the raw data read by the sensor.

TECHNICAL INFORMATION SHEET

POSITIVE TEMPERATURE COEFFICIENT HEATER BY QUAD INDUSTRIES

Getting Started - Use Case

1

Connect the PTC Heater to the breakout board. Apply power to the Raspberry Pi, by using the power cable. Connect the connector cable to the breakout board and the Raspberry Pi.

2

Once the screen of the Raspberry Pi has lit up and the Henkel Qhesive Solutions dashboard is visible, select the "PTC Heater" application and wait until the screen for data read out opens.

3

Connect the PTC heater with it's power cable. On the screen of the Raspberry-Pi you will see how the graph displaying the current rapidly increases until the self-regulation temperature of 55 to 60°C is reached.

4

Take an ice cube from your freezer and place on the heater surface. You will see how the Heater slowly melts the ice cube, while the heater graph showing the current stays stable.

5

In case you have a heat camera at hand, you can review the uniform heat distribution and the change taking place once the ice has been added to the surface.

6

To save the collected data throughout future experiments you can plug in a USB stick [Filesystem FAT32] to the Raspberry Pi. The raw data from your test setup will be saved automatically on the USB stick. Each sensor breakout board outputs data over USB Serial. Further information on how to output an save data can be found on page 4 of this document.

7

You are ready to start your ideation! For questions regarding the setup please contact:

printed.electronics@henkel.com

Check out our video tutorial on how to get the leak detection sensor INKxperience started:

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POSITIVE TEMPERATURE COEFFICIENT HEATER BY QUAD INDUSTRIES

Legal Disclaimer

This product is a B2B product, intended for research and technical feasibility validation only. For installation and application follow the recommended processes carefully.
All pieces were selected by Henkel. The printed sensors were sourced and produced by Quad Industries and LAIIER. The later including also compatible hardware components. All remaining hardware components were sourced by IOX GmbH. The Loctite hardware cases are intended for protection only. All hardware cases can be opened for review of hardware components.

CAUTION: Please keep out of reach of children.

LAIIER makes wireless connected printed sensors that install like tape and detect leaks, occupancy, and more. They are building a Surface to Cloud™ Industrial IoT solution that is uniquely easy to install and scale in the smart building and smart facility. Their Surface to Cloud Industrial IoT sensor platform addresses critical use cases in the smart building, starting with liquid leaks, liquid level, moisture detection, and much more. LAIIER's solution prevents damage to structures, conserves precious resources, and reduces the release of hazardous chemicals into the environment.

Quad Industries has been at the forefront of printed electronics for more than 25 years, which makes them a reliable partner in the development and manufacturing of user interfaces and control panels for both consumer and industrial applications. In recent years, they have extended our activities in the domain of printed electronics, using their extensive knowledge to develop and manufacture printed, flexible sensor solutions. Their headquarters and production facilities in Europe are certified to the internationally recognized ISO 9001:2015 Quality Management Systems (QMS) standard. The QMS for Quad is the sum of all the processes, resources, properties, and cultural values that support the goal of customer satisfaction and productivity of the organization.

Leading companies have innovative IoT concepts but are challenged when it comes to turning them into reality. IOX LAB helps them and creates prototypes exceptionally fast: In 30 days from idea to prototype. To make this possible, the start-up uses IoT technologies as sensors, motors, 3D printing and artificial intelligence. The team covers the full stack of IoT. Make things, not slides: ioxlab.de

Summary of components

Component	Subcomponents	Certifications
FSR Sensor Breakout Board	PCB: • Seeeduino • Current sensor INA219 • Resistance • Solder	PCB: • Standard IPC-4101 • Flammability class V0 Seeeduino: • Certifications: CE & FCC Connectors: • Recognized E60389 • Certified LR20812 • 2R75087 Resistance: • RoHS 2011/65/EU • Solder: • Lead-free • 96.5% Sn, 3.0% Ag, 0.5% Cu
Leak Detection Breakout Board	PCB by LAIIER (Bare Conductive Ltd): SKU-8502 - Severn Evaluation Kit (containing Bravo Board PCB)	European Declaration of Conformity (08/02/2023) by Bare Conductive Ltd.: The EMC Directive 2014/30/EU and RoHS 3 Regulation (EU 2015/863). The components contained within the listed PCB boards are compliant with the • RoHS 3 Regulation (EU 2015/863) and • EMC Directive 2014/30/EU • Standards EN 55032:2015+A11:2020 and EN 55035:2017
Non-Contact Liquid Level Breakout Board	PCB by LAIIER (Bare Conductive Ltd): SKU-8403 - Trent Evaluation Kit (containing Alfa Board PCB)	

FROM PRINT TO UNBOX.
FROM IDEATION TO PROTOTYPE.
FROM TESTING TO ACCELERATION.

FOR FURTHER INFORMATION:

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Henkel Qhesive
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