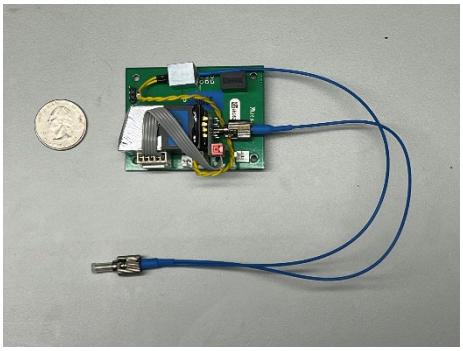
FOTEMP MINI
OEM Signal Conditioner
User Manual

Document: 98-0PTC-26
Revision A dated 08-Sept-2022



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Revision History

Revision	Date	Notes
A	08-Sept-2022	Initial Release

Specifications are subject to change without notice

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1. Product Description

The FOTEMP MINI (aka FTM) is a small form factor (SFF) OEM PCB interface module designed for low cost insertion of high performance GaAs-based fiber optic temperature sensing technology into OEM applications where common electrical temperature sensors and thermocouples cannot be used. The SFF profile is ideal for embedded medical, life science and energy applications such as:

- MRI, requires immunity to magnetic fields
- CT, requires non-metallic design and minimal contrast
- Switchgear and Transformers, requires electrical isolation and immunity to electrical fields

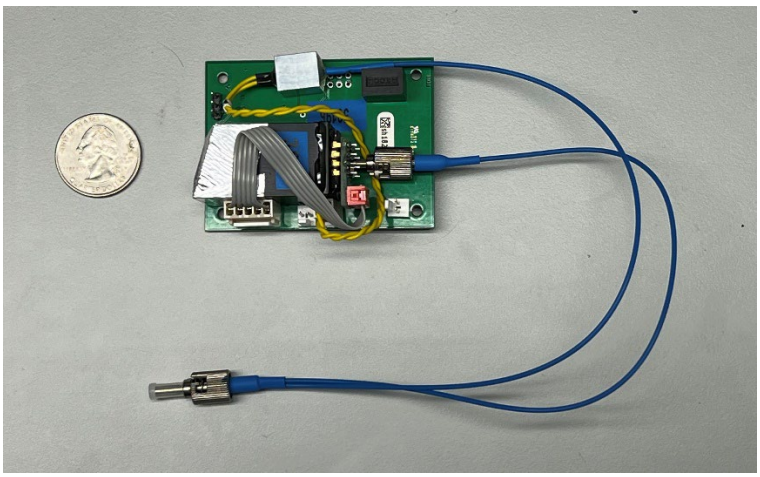

Figure 1. The SFF Weidmann FOTEMP MINI OEM Signal Conditioner

The FOTEMP MINI is compatible with all TS series high precision GaAs fiber optic temperature probes. The sensors are entirely non-metallic and electrically passive, providing immunity to EMI, RFI, MR, microwaves and radiation is required.

Features

- Smallest form factor, single channel solution
- Purposely designed for embedded instrument applications
- 3.3V-TTL interface for direct connection to Microcontroller UART serial port
- Easy to interface ASCII protocol
- Operates from 7-12V power
- 0.1°K resolution
- Operating temperature: -20°C to +60°C
- Measurement range: -200°C to +300°C (depends on TS sensor used and Calibration option)

Applications

- For embedded instrument applications
- EMI, RFI and microwave environments
- High voltage environments
- Harsh and hazardous environments
- Nuclear environments
- Aerospace applications
- Process monitoring
- Medical and imaging applications (MRI)

2. Initial Preparation

2.1 Unpacking and Inspection

Since the FOTEMP MINI is an electronic printed circuit board, the user should use ESD protection when handling the module. THE FOTEMP MINI is shipped in an ESD protective pouch.

When received, the shipping carton should contain the following items listed below. Account for and inspect each item before the carton is discarded. In the event of a damaged instrument, contact your near Weidmann Technologies representative. Please retain the shipping container in case reshipment is required.

2.2 Damage in Shipment

If you receive a damaged instrument, you should:

- Report the damage to your shipper immediately.
- Inform local Weidmann Technologies representative or HQ.
- Save all shipping cartons.

Failure to follow this procedure may affect your claim for compensation.

2.3 Standard Contents

FOTEMP MINI OEM Signal Conditioner:

- FOTEMP MINI board with ST Pigtail (use ESD protection when handling)
- ST Bulkhead Adapter
- Weidmann Technologies (Factory) Calibration Report
- Micronor Sensors One-Point Calibration Report (if ordered with different TS sensor than used for Factory Calibration)
- FOTEMP Resource USB Memory Stick containing copy of Technical Documentation and FOTEMP-Assistant Software

TS series GaAs Fiber (Optic Temperature Probe)

- TS model as ordered and paired (calibrated) with above FOTEMP MINI

2.4 Warranty Information

Warranty

WEIDMANN TECHNOLOGIES warrants this product to be free from defects in material and workmanship for a period of 1 (one) year from date of shipment. During the warranty period we will, at our option, either repair or replace any product that proves to be defective.

To exercise this warranty, write or call your WEIDMANN TECHNOLOGIES local representative or WEIDMANN TECNOLOGIES headquarters. You will be given prompt assistance and return instructions. Send the instrument, transportation prepaid, to the indicated service facility. Repairs will be made and the instrument returned transportation prepaid. Repaired products are warranted for the balance of the original warranty period, or at least 90 days.

Limitations of Warranty

This warranty does not apply to defects resulting from unauthorized modification or misuse of any product or part. This warranty also does not apply to Fiber Optic Connector interfaces, fuses or AC line cords. This warranty is in lieu of all other warranties, expressed or implied, including any implied warranty of merchantability of fitness for a particular use. Neither WEIDMANN TECHNOLOGIES nor MICRONOR SENSORS shall not be liable for any indirect, special or consequent damages.

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3. Installation and Operation

3.1 Mounting the Unit

As shown in Figure 1 below, there are two versions of the FOTEMP MINI OEM Controller which differ by which side the various internal and external pin connectors are mounted.

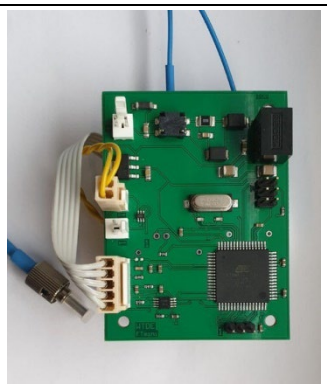
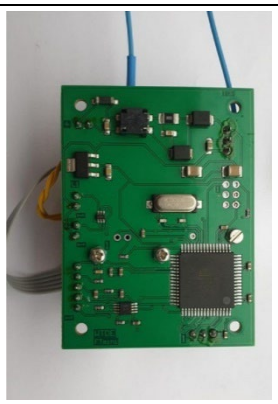
FOTEMP MINI **Version "1"**	FOTEMP MINI **Version "2"**
	
Pin connectors for Power Supply and Serial Port are located on front of board.	Pin connectors for Power Supply and Serial Port are located on back (trace) side.

Figure 2. How to identify Versions 1 and 2 of the FOTEMP MINI Signal Conditioner

In either case, the mounting holes are in the same location as shown in Figure 3. Use appropriately sized stand offs and allow adequate clearance for all wiring and components.

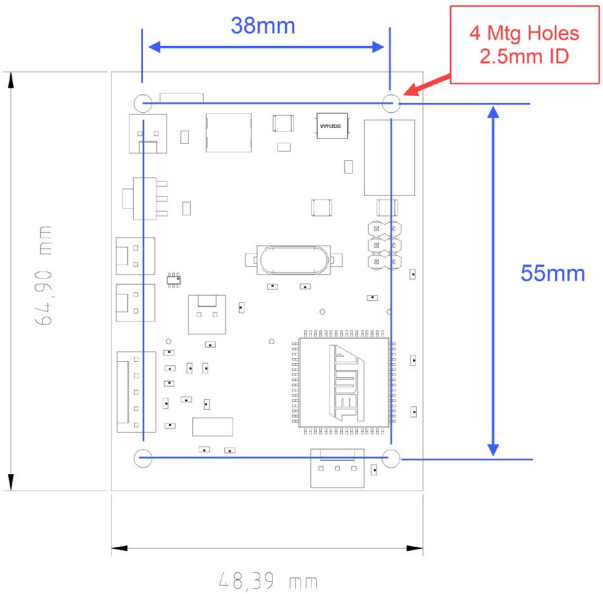


Figure 3. Location of FOTEMP MINI Mounting Holes

3.2 Electrical Connections to the Unit

As shown in Figure 4, the FOTEMP MINI requires only Power Supply (7-12V DC) and Serial Interface connections.

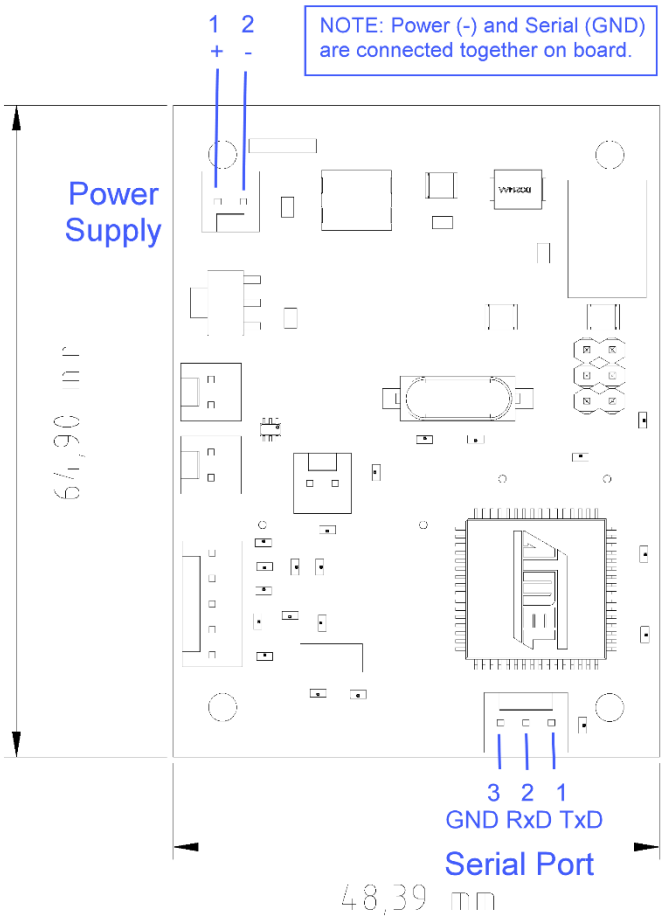
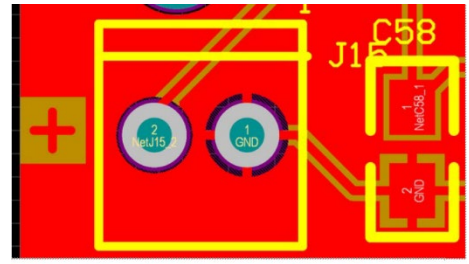
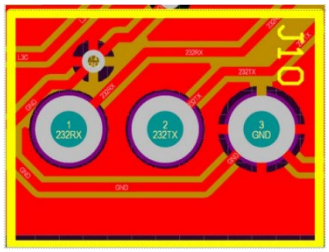
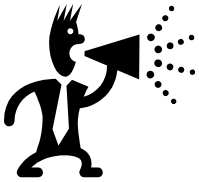
Electrical Connections viewed from Component Side	Electrical Connections Viewed from Back (Trace) Side
	 Power Supply Pins (1-"-", 2-"+")  UART-Pins (1-RXD, 2-TXD, 3-GND)

Figure 4. Location of Power Supply and Serial Interface Connections



IMPORTANT NOTE
Your Microcontroller's (MC) UART or Serial Interface should be set for 57'600 baudrate, 8 bits data, 1 stop bit, no parity, no flow control.
MC RxD input connects to the FTMINI TXD output
MC TxD output connects to the FTMINI RxD input.

3.3 Connecting the TS Temperature Probe

The FOTEMP MINI optical interface is via an ST Pigtail. There are two fibers terminated internally in the ST plug. Use the supplied MR320A ST Bulkhead Adapter to connect TS sensor probe to the FOTEMP MINI signal conditioner.

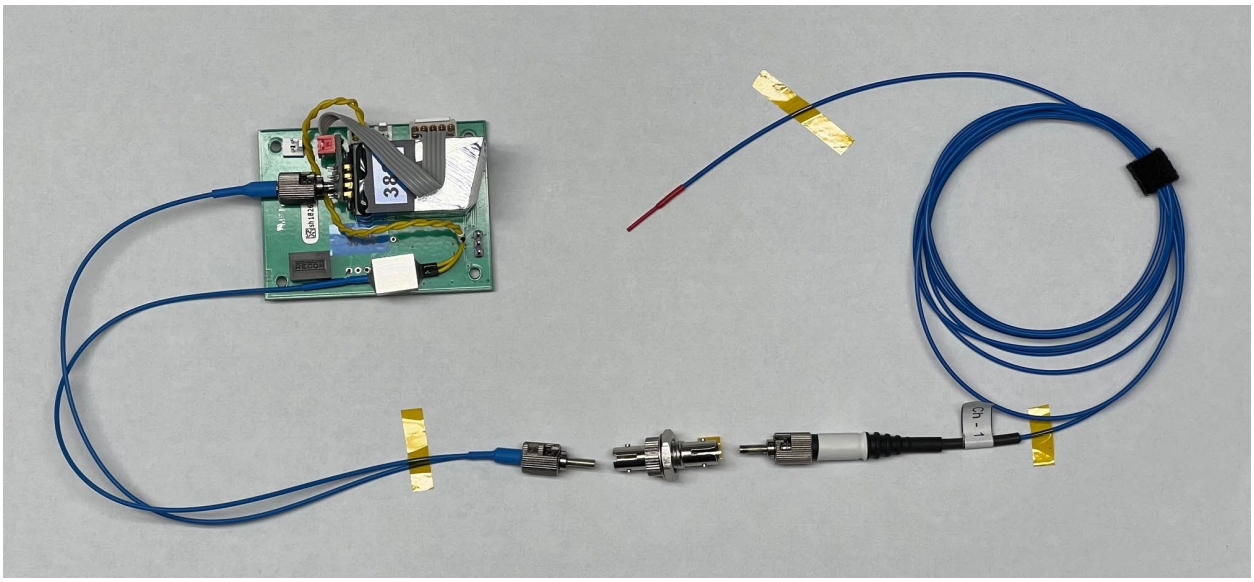
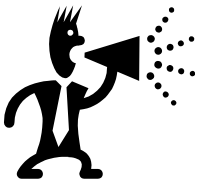


Figure 5. How TS Probe is connected to FOTEMP MINI

The proper technique for making ST connection to the FOTEMP MINI :

1. Align key of ST plug with matching key slot of ST adapter.
2. Gently guide the ferrule into the adapter.
3. Twist and engage bayonet pin lock



IMPORTANT NOTE
Never force the ST Plug into the ST Receptacle. Otherwise you might damage the ST plug and alignment sleeve in the ST adapter.

3.4 System Start-Up

Apply DC power only after all connections have been made.

4. Serial Communications

4.1 Introduction to UART Operation and Data Frame

The FOTEMP MINI is designed for embedding into the user's design via a simple 3-wire UART-based half-duplex serial interface.

UART stands for **universal asynchronous receiver / transmitte**r and defines a protocol, or set of rules, for exchanging serial data between two devices. UART is very simple and only uses two wires between transmitter and receiver to transmit and receive in both directions. Both ends also have a ground connection. Communication in UART can be **simplex** (data is sent in one direction only), **half-duplex** (each side speaks but only one at a time), or **full-duplex** (both sides can transmit simultaneously). Data in UART is transmitted in the form of frames.

As shown in Figure 6, the FOTEMP system's UART data frame consists of one start bit, 8 bits data, one stop bit, no parity and no flow control – clocked at 57'600 baudrate.

Figure 6. UART Data Frame used by FOTEMP System

One of the big advantages of UART is that it is asynchronous – the transmitter and receiver do not share a common clock signal. Although this greatly simplifies the protocol, it does place certain requirements on the transmitter and receiver. Since they do not share a clock, both ends must transmit at the same, pre-arranged speed in order to have the same bit timing. The most common UART baud rates in use today are 4800, 9600, 19.2K, 57.6K, and 115.2K. The FOTEMP system transmits at 57,600 baud.

4.2 FOTEMP ASCII Serial Protocol

The FOTEMP Signal Conditioners use a standard ASCII protocol across its Serial (TTL and RS232) and USB interfaces. The detailed command and response protocol are described in Micronor Sensors Application Note AN123. In summary, the FOTEMP MINI recognizes the following commands:

Read Command	Description	Sample Command	Sample Response	Notes
04	Current temperature of all channels	?04<cr> **or** ?04 1<cr>	#04 312<cr><lf> *00<cr><lf>	Reads temperature 31.2°C
0F	Current channels of the device	?0F<cr>	#0F4 1<cr><lf> *00<cr><lf>	FTMINI has only 1 channel
40	Model name	?40<cr>	#40 46 54 4D 49 4E 49<cr><lf> *00<cr><lf>	Hex equivalent of FTMINI
41	Serial number	?41<cr>	#41 30 30 36 30 31 39 36<cr><lf> *00<cr><lf>	Hex equivalent of S/N 0050196
42	Firmware version	?42<cr>	#41 33 2E 30 33 31<cr><lf> *00<cr><lf>	Hex equivalent of Version 3.031
75	Temperature Offset	?75 1<cr>	#75 0000<cr><lf> *00<cr><lf> #75 0001E<cr><lf> *00<cr><lf>	Convert hexadecimal value to decimal value in tenth of Kelvin, +0.0 K 0x001E converts to 30 (base10), +3.0 K

Write Command	Description	Sample Command	Notes
75	Temperature Offset In tenth of Kelvin (added to current temperature offset of the channel) NOTE: Offset readings are stored in 2's Complement Binary format. Convert binary value to decimal value in tenths of Kelvin, i.e. +1.0 K =0x000A -1.0 K =0xFFF6	Assume internal offset value is +1.0 K :75 1 000A<cr>	 Internal offset becomes +2.0 K. ?75 1<cr> **returns** #75 0014<cr><lf> which converts to offet value +2.0K

Table 1. FOTEMP ASCII Command List

4.3 Communicating via FOTEMP-Assistant

In this example, a DTECH USB to TTL Serial Adapter (Prolific PL2303TA chipset) was used. https://www.amazon.com/gp/product/B08BLKBK1K/ref=ppx_yo_dt_b_search_asin_title?ie=UTF8&psc=1

Serial port connections:

- White (TXD) to FTMINI RxD
- Green (RXD) to FTMINI TxD
- Black (GND) to FTMINI GND

As shown in Figure 7, access Windows Device Manager to note the COMx virtual com port assignment under Ports (COM & LPT). Click on the COMx port assigned to your device (COM4 in this example) and set the FOTEMP-compatible Port Settings as follows:

- Bits Per Second=57600
- Data bits=8
- Parity=None
- Stop Bits=1
- Flow Control=None

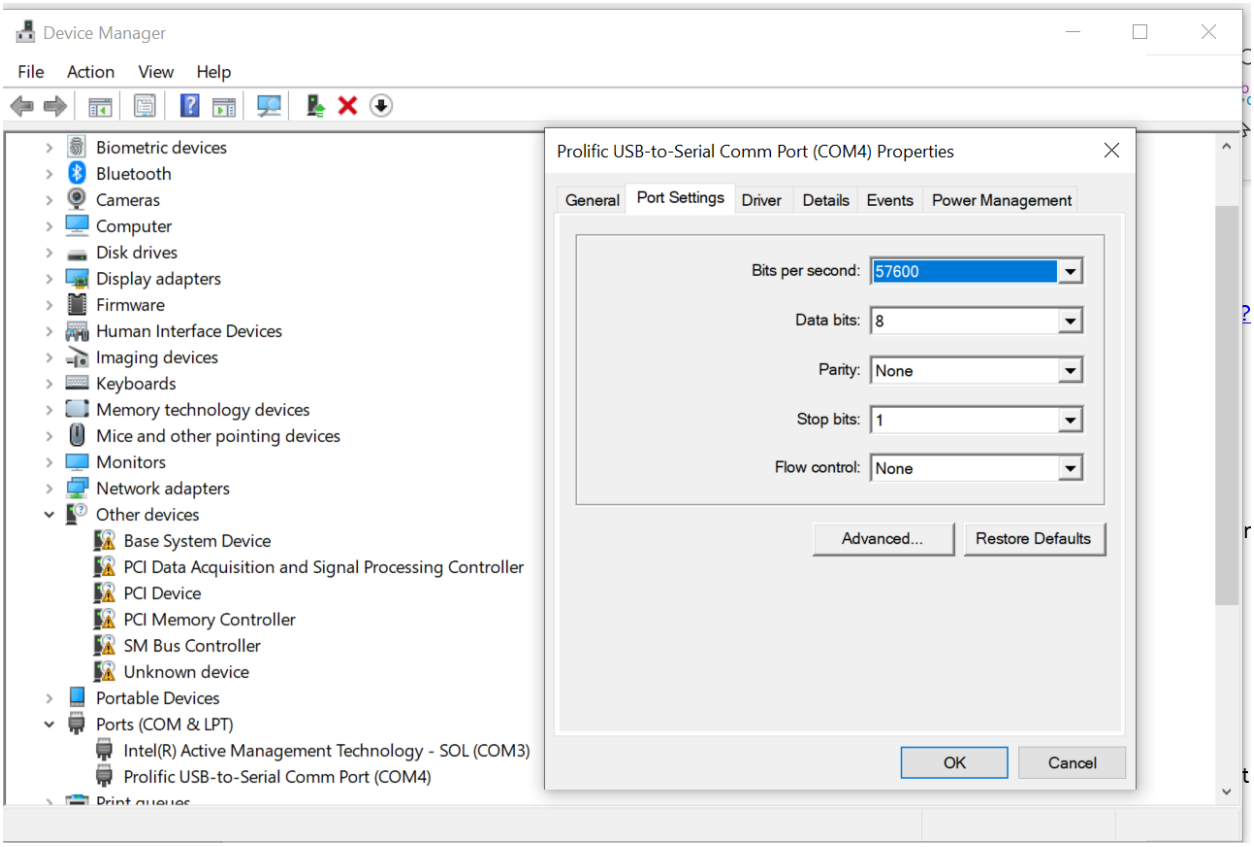


Figure 7. Setting Serial Port Settings via Device Manager

Run FOTEMP-Assistant V2.3.0.22 or later (consult separate FOTEMP-Assistant V2 manual). Select [Devices/Search/Search ASCII Devices] and FOTEMP ASSISTANT will start reading the FOTEMP MINI.

For One-Point Calibration of replacement TS sensor, select [Devices/Settings] and Device COMx. Adjust Offset value field until FOTEMP MINI displays same reading as your designated TC Reference.

4.4 Direct Serial Communications via PuTTY Terminal Emulator

In this example, a DTECH USB to TTL Serial Adapter (Prolific PL2303TA chipset) was used. https://www.amazon.com/gp/product/B08BLKBK1K/ref=ppx_yo_dt_b_search_asin_title?ie=UTF8&psc=1

PuTTY terminal emulator (shareware) can be download here: https://www.chiark.greenend.org.uk/~sgtatham/putty/latest.html

Serial port connections:

- White (TXD) to FTMINI RxD
- Green (RXD) to FTMINI TxD
- Black (GND) to FTMINI GND

As shown in Figure 7, access Windows Device Manager to note the COMx virtual com port assignment under Ports (COM & LPT). Click on the COMx port assigned to your device (COM4 in this example) and set the FOTEMP-compatible Port Settings as follows:

- 57,600 bits per second (baudrate)
- 8 Data bits
- No Parity
- 1 Stop bit
- No Flow control

Run PuTTY and open a Session with the following parameters:

- Session menu – select Serial mode, enter COMx port and Speed=57600.
- Terminal menu – set Local Echo=Force ON, Local Line Editing=Force ON
- Connection/Serial Menu – set Data Bits=8, Stop Bits=1, Parity=none, Flow Control=none
- Go back to Session menu and name and save Session for future sessions
- Click on [Open] to start session

Reference the ASCII commands summarized in Table 1 and discussed in more detail in Application Note AN123. As an example, enter “?04<cr> to read the current temperature.

Example:
See Figure 8 for example of ASCII command dialog with FOTEMP MINI using PuTTY terminal emulator. Converted responses are shown to the left.

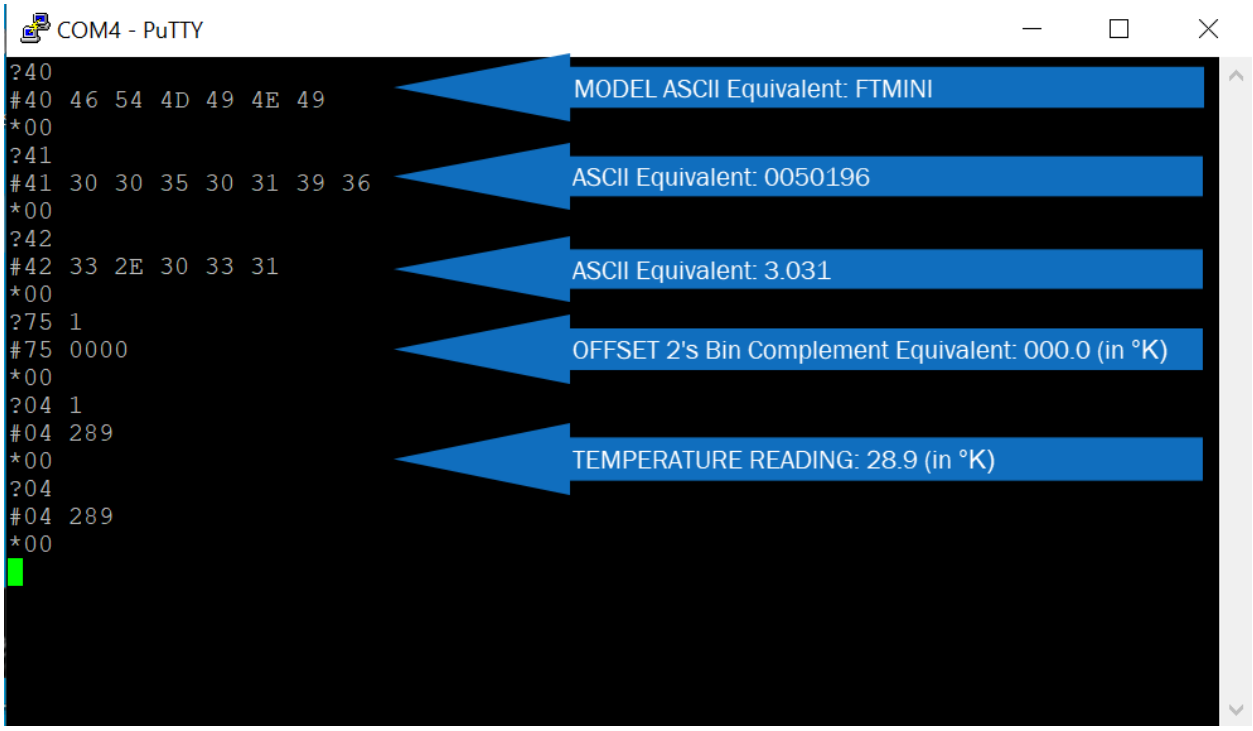


Figure 8. Example of FOTEMP MINI Serial Communications Dialog using PuTTY

4.5 Sample Arduino Program

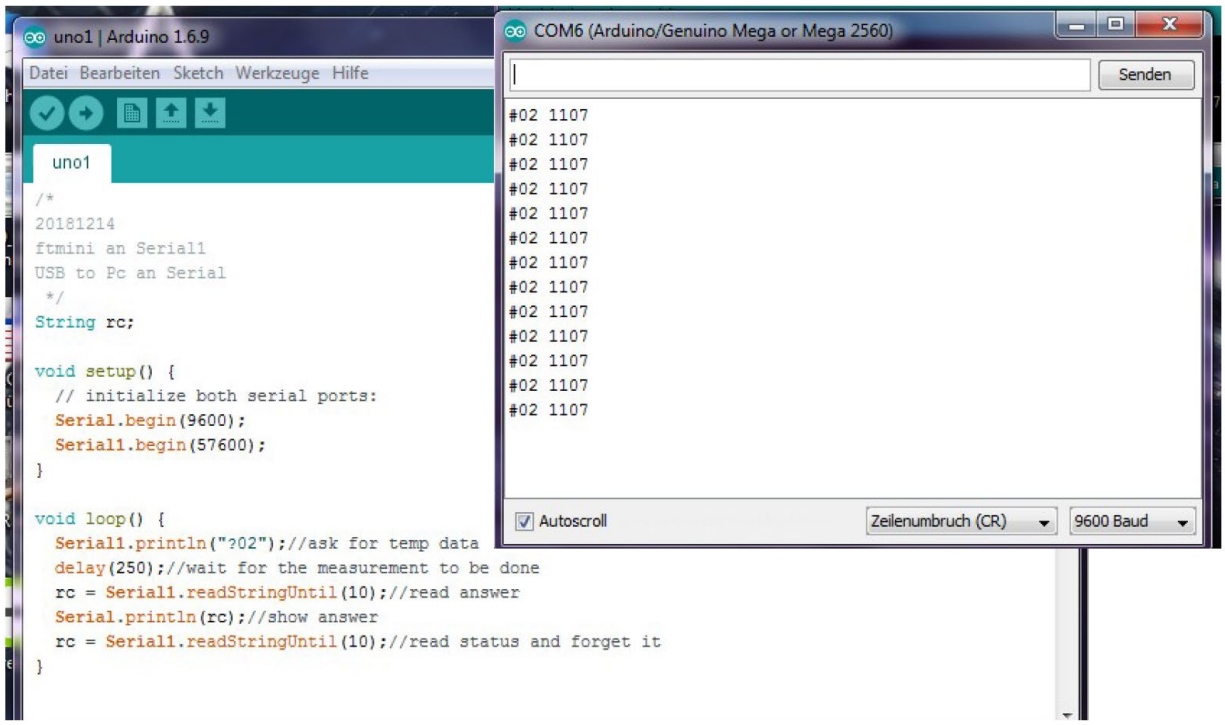


Figure 9. Sample Arduino Program

5. FOTEMP MINI Specifications

Temperature Measurement	
No. of Channels	1
Measuring Range	-200°C to +300°C, depending on Calibration option and TS sensor used
Resolution	0.1°K
Accuracy	± 0.2°K (1 sigma) when used with TS sensor used during Factory Calibration ± 0.5°K (1 sigma) when used with TS sensor used for One-Point Calibration
Calibration Options (as ordered)	A Calibration (standard) = -40°C to +200°C B Calibration (high temperature) = -40°C to +300°C C Calibration (extended temperature) = 200°C to +300°C
Measuring Rate	250ms
Electrical Interfaces	
Serial Interface	3.3V TTL UART – Rx, Tx, GND 57'600 Baud, 1 Start bit, 8 Data bits, 1 stop bit, no parity
Serial Protocol	Stancard Optocon ASCII protocol as described in Application Note AN123
Power Supply	+7 to +12VDC, <700mA
Optical Interface	**Eye Safe**
Interface	ST-PC Simplex, Compatible with all TS series GaAs FO temperature probes 200/220/245 Polyimide-Coated Step Index Fiber, VIS-IR, Low OH
Source Type	Broadband white light
Maximum Optical Link Length	Up to 2000m NOTE: Actual distance depends on total link loss – fiber, connectors and splices
Environmental Performance	
Temperature/Humidity Operating Storage Humidity	 -20° to +60°C -20° to +70°C 25% to 95% RH (non-condensing)
Ingress Protection	IP00 (None)
Physical Attributes	**Physical Attributes**
Dimensions	48.4mm L x 64.9mm W x 32.6mm H
Unit Weight	140g (22 oz.)

Specifications subject to change without notice

6. FOTEMP MINI Theory of Operation

As shown in Figure 10, the FOTEMP MINI operates on the same theory of operation as the FOTEMP signal conditioners.

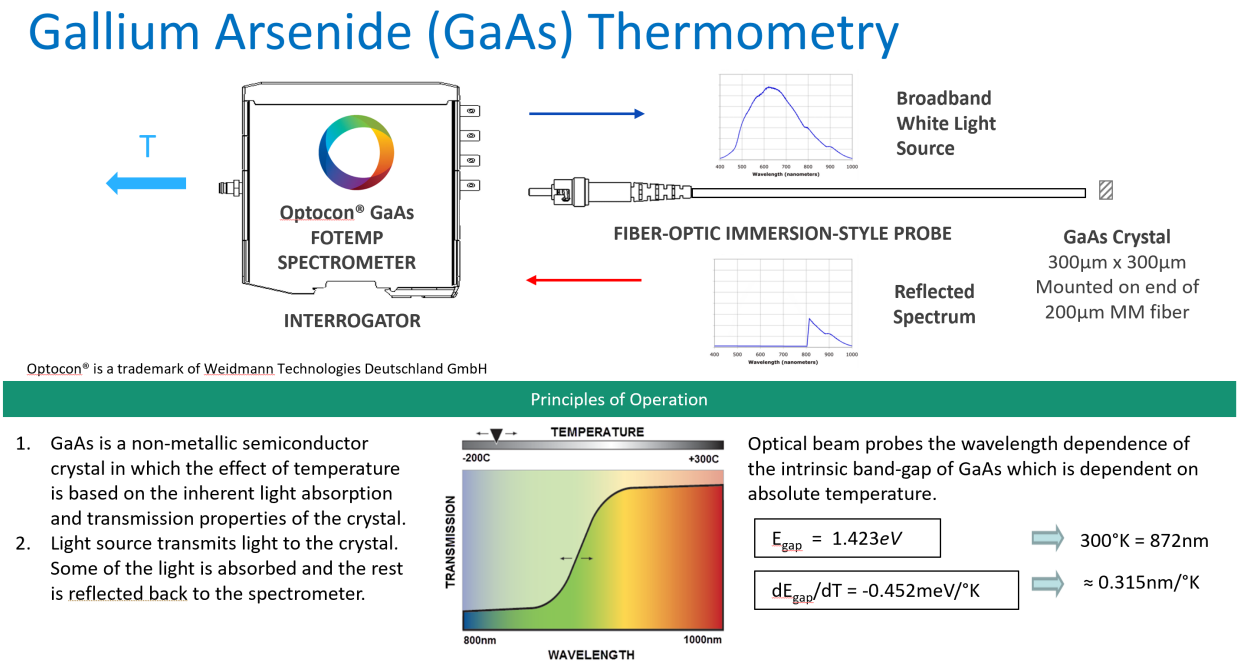


Figure 10. FOTEMP MINI Theory of Operation

As shown in Figure 11, GaAs-based fiber optic temperature probes and FOTEMP signal conditioners are deployed wherever conventional convention thermocouples cannot be used.

Environment	K-Type Thermocouple	GaAs
Benign, Short Distance <30m	✓	✓
Benign, Long Distance	✗	✓
High Temperature > 300°C	✓	✗
Low Temperature < -40°C	✗	✓
EMI/RFI	✗	✓
Magnetic Fields	✗	● (Requires offset factor for >1 Tesla)
High Voltage	✗	✓
RF Fields	✗	✓
RF or Conductive Heating	✗	✓
Microwave Oven	✗	✓
Radiation (Nuclear)	● Requires Radiation Compensation	✓

✓ Recommended
● Provisional
✗ Not Recommended

Figure 11. Advantages of GaAs Fiber Optic Thermometry versus Thermocouples

7. FOTEMP MINI Reference Drawing