## Features

- Push data to remote server or log directly to SD Card
- LTE CAT-M1 and CAT-NB cellular bands
- Advanced triggering options
- HTTP/MQTT push APIs
- Up to two general purpose 0-10V analog inputs
- Up to four RTD or strain gauge measurements
- Up to six thermocouple inputs
- Negative common-mode range handling for grounded thermocouples (±2.4V)
- Supports all major thermocouple types (B, E, J, K, N, R, S, T)
- Regulated 14.4V output to power external sensors.
- Wide supply voltage range (4.8-30V)
- Ideal for battery powered installations
- Integrated GPS (GNSS) Receiver

## Applications

- Remote battery/solar powered installations
- Automotive data acquisition (EGT, etc)
- Electrical contact resistance measurement
- Remote strain-gauge/load-cell monitoring
- Industrial and Chemical process measurement
- Research instrumentation

## Description

The FDQ-99900 MI-8 is a compact, 24-bit data acquisition system (DAQ) designed to measure up to ten external sensors then log values locally to an SD card or push data to the cloud over a cellular data connection. Advanced triggering functionality allows the MI-8 to conserve storage space and network data by only transmitting events of interest.

The low power consumption and wide operating temperature range are designed to allow outdoor and remote installations. The MI-8 is available


with and without an enclosure to support custom packaging solutions. For example, the enclosure-less (OEM) configuration is often mounted into an IP-67 rated NEMA enclosure along with supporting sensors and hardware.

## Cellular Network Communication

The MI-8 supports LTE CAT-M1 and CAT-NB1/NB2 cellular communication and is compatible with most north American carriers. SIM card installation by FusionDAQ is available. Contact Sales@FusionDAQ.com for more information

| Specification | CAT-M1 | CAT-NB1/NB2 |
|---|---|---|
| Supported Bands | 1, 2, 3, 4, 5, 8, 12, 13, **14**, 18, 19, 20, 25, 26, **27**, 28, 66, 85 | 1, 2, 3, 4, 5, 8, 12, 13, 18, 19, 20, 25, 26, 28, 66, **71**, 85 |
| Downlink | 300 kbps | 20 kbps |
| Uplink | 300 kbps | 10.3 kbps |
| Modulation Type | QPSK / 16QAM | BPSK / QPSK |

Current date and time are determined from the cellular network or satellite position fix. The MI-8 does not contain a real-time clock or backup battery to maintain time when powered off. Data logging is disabled at power up until date and time can be determined.

## GNSS (GPS) Position

The MI-8 combines data from the GPS, GLONASS, Galileo, and BeiDou Global Navigation Satellite Systems (GNSS) to determine position. An initial position fix is generally available within 30 seconds of power-up when the antenna has a clear view of the sky. The initial fix may require several minutes if the antenna does not receive a high-quality signal.

| Specification | Value |
|---|---|
| Tracking Sensitivity | -159 dBm (GPS) / -156 dBm (GLONASS) |
| Cold-start sensitivity | -148.5 dBm |
| Accuracy (Open Sky) | 0.74 m (CEP50) |
| Receiver Type | 16-channel, C/A Code |
| GNSS L1 Frequency | 1575.42 ±1.023 MHz |
| GLONASS Frequency | 1597.5 – 1605.8 MHz |
| BeiDou Frequency | 1559.05 – 1563.14 MHz |
| Galileo L1 Frequency | 1575.42 ±1.023 MHz |

Due to hardware design, the cellular modem and GNSS receiver may not be used at the same time. The cellular connection is interrupted any time the GNSS receiver is active and the GNSS receiver is unable to resolve position when the cellular modem is active. The MI-8 will automatically switch between the two radios each time a new position fix or network notification is required. The interval between GNSS position measurements is configurable.

## Input Configurations

The electric inputs to MI-8 are multiplexed. Some pins are able to measure both thermocouples and RTD sensors while others only support 0-10V single ended analog inputs. All MI-8 devices support thermocouple, RTD, and single ended analog inputs in several specific configurations:

| Number of Thermocouples | Number of Resistive sensors | Number of 0-10V analog inputs |
|---|---|---|
| 6 | 0 | 2 |
| 0 | 4 | 1 |
| 3 | 2 | 1 |

Resistive sensors (RTD, strain-gauges, etc) are measured using two, three, or 4-wire (kelvin) electrical connections. Standard configuration MI-8 devices may measure resistances up to 4000 Ohms which is sufficient to measure PT100 & PT1000 RTD sensors and most 120, 350, and 1000 Ohm nominal strain-gauges. Other configurations are possible which allow the MI-8 to accurately measure less than an Ohm or measure up to thousands of Ohms. Contact Sales@FusionDAQ.com for more information.

## Auxiliary Inputs

The OEM (no enclosure) version of the MI-8 includes three additional low voltage analog inputs and three digital inputs. All six inputs may be logged and used in trigger expressions. For example, a digital input may be connected to a micro switch and used to capture strain gauge data any time the switch is closed.

## Advanced Triggering

Triggers are algebraic expressions which are used to determine when data should be logged to the SD card or pushed over the cellular network. Any physical (temperature/voltage measurements) or internal (GPS position, supply voltage, ambient temperature) measurement may be used in an expression. Some examples of possible expressions include:

| Condition | Description |
|---|---|
| "1" | Always true. Use this condition to log data anytime the MI-8 is powered |
| "an0 > 2.5" | Trigger active any time the voltage on the an0 input is greater than 2.5 Volts. |
| "(tc0 > 35.0) \| (tc1 > 22.0)" | Trigger is active whenever either the thermocouple 0 (tc0) temperature is greater than 35°C or thermocouple 1 (tc1) is greater than 22°C |
| (35.919<lat) & (lat<36.378) & (-115.369<lon) & (lon<-114.921) | Trigger is active whenever the MI-8 is in Las Vegas, Nevada |

## Measurment Channels

The following channels may be logged, pushed over the cellular connection, and may be used in trigger expressions:

| Channel Name | Description | Unit |
|---|---|---|
| *tc0* | Thermocouple channel 0 | °C |
| *tc1* | Thermocouple channel 1 | °C |
| *tc2* | Thermocouple channel 2 | °C |
| *tc3* | Thermocouple channel 3 | °C |
| *tc4* | Thermocouple channel 4 | °C |
| *tc5* | Thermocouple channel 5 | °C |
| *ambient* | Ambient temperature of DAQ | °C |
| *an0* | Auxiliary analog input 0 | V |
| *an1* | Auxiliary analog input 1 | V |
| *an2* | Internal header analog input 2 | V |
| *an3* | Internal header analog input 3 | V |
| *an4* | Internal header analog input 4 | V |
| *vbat* | MI-8 supply voltage | V |
| *rtd0* | RTD sensor temperature 0 | °C |
| *rtd1* | RTD sensor temperature 1 | °C |
| *rtd2* | RTD sensor temperature 2 | °C |
| *rtd3* | RTD sensor temperature 3 | °C |
| *res0* | Resistance input 0 (rtd0) | Ω |
| *res1* | Resistance input 1 (rtd1) | Ω |
| *res2* | Resistance input 2 (rtd2) | Ω |
| *res3* | Resistance input 3 (rtd3) | Ω |
| *lat* | GPS latitude | ° (decimal) |
| *lon* | GPS longitude | ° (decimal) |
| *di0* | Internal header digital input 0 | none |
| *di1* | Internal header digital input 1 | none |
| *di2* | Internal header digital input 2 | none |
| *rssi* | Cellular signal strength | dBm |

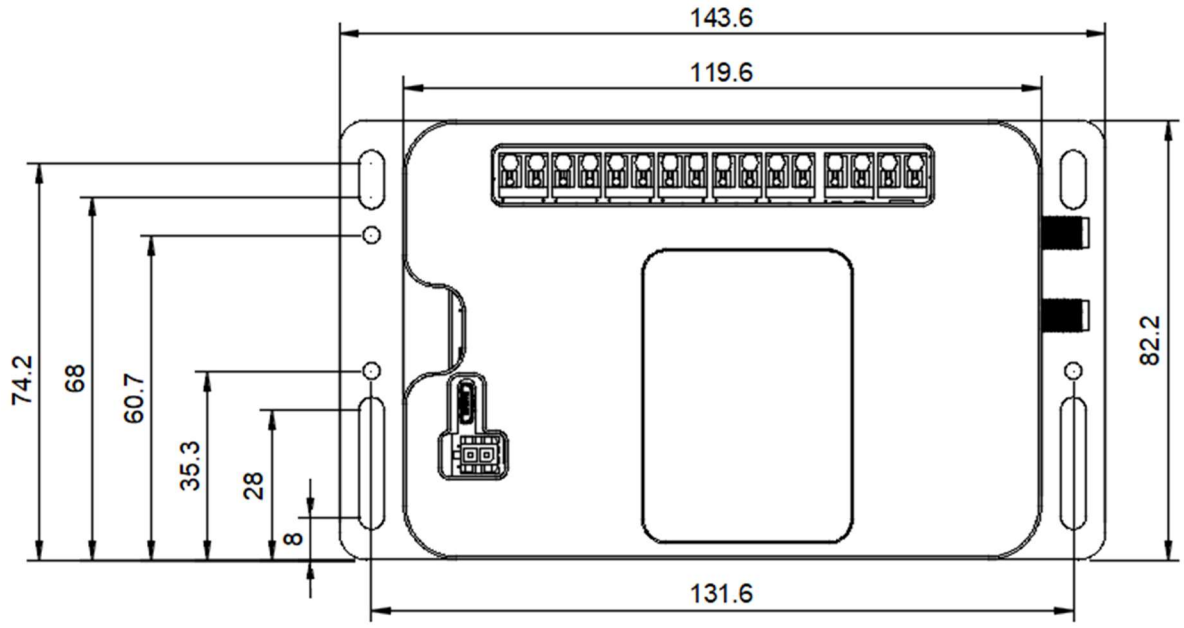
## Electrical Limits and Specifications

| Name | Description | Min | Nominal | Max | Unit |
|---|---|---|---|---|---|
| $V_{Supply}$ | Supply Voltage | 4.8 | - | 30 | V |
| $T_{Ambient}$ | Ambient Temperature | -40 | - | 85 | C |
| $I_{Supply}$ | Supply Current $V_{Supply}$ = 5.0 V<br>$V_{Supply}$ = 12.0 V<br>$V_{Supply}$ = 24.0 V | | | | mA |
| $P_{Supply}$ | Supply Power | | | | mW |
| $P_{Standby}$ | Power consumption while in standby | | | | mW |
| $V_{CommonMode}$ | Common mode voltage which may be applied to DAQ analog input pins | -2.4 | - | 2.4 | V |
| $V_{Sense}$ | Maximum voltage which may be measured by analog differential DAQ input pins | -4.8 | - | 4.8 | V |
| $V_{SenseLimit}$ | Maximum voltage which may be applied to DAQ differential analog inputs without causing physical damage | -6.4 | | 6.4 | V |
| $V_{SDCard}$ | SD Card supply voltage | | 3.3 | | V |
| $V_{SIM}$ | SIM card supply voltage | 1.75 | 1.8 | 1.95 | V |
| $V_{LNA}$ | GPS active antenna (LNA) supply voltage | | 3.8 | | V |
| $Z_{GPS}$ | GPS Antenna Impedance | | 50 | | Ω |
| $Z_{Cellular}$ | Cellular Antenna Impedance | | 50 | | Ω |
| $I_{SenseLimit}$ | | -15 | | 15 | mA |
| $R_{Sense}$ | Resistance input measurement range | 0.12 | - | 4000 | Ω |
| $R_{Input}$ | Analog input equivalent series resistance | 489 | 499 | 509 | Ω |
| $V_{Aux}$ | Voltage limits which may be applied to the digital and analog inputs on the internal auxiliary connector | 0 | - | 3.3 | V |
| $I_{AuxLoad}$ | Maximum current draw form internal auxiliary connector digital outputs | 0 | - | 15 | mA |

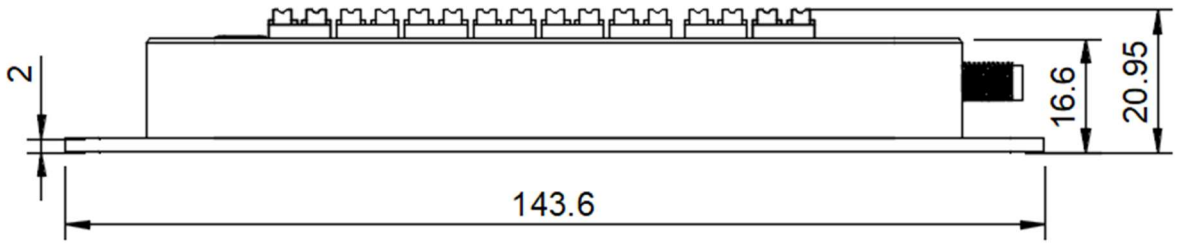
| | | | | | |
|---|---|---|---|---|---|
| $I_{AuxSupply}$ | Maximum current draw from auxiliary connector 3.3V supply | 0 | - | 100 | mA |
| $V_{PowerOut}$ | Voltage of external sensor power supply | 13.9 | 14.5 | 15.0 | V |
| $I_{PowerOut}$ | Maximum current draw from external sensor power supply | 0 | - | 150 | mA |
| $t_{sample}$ | Minimum sample period | 100 | - | - | ms |

## Appendix 1: Mech Drawing (Top View)

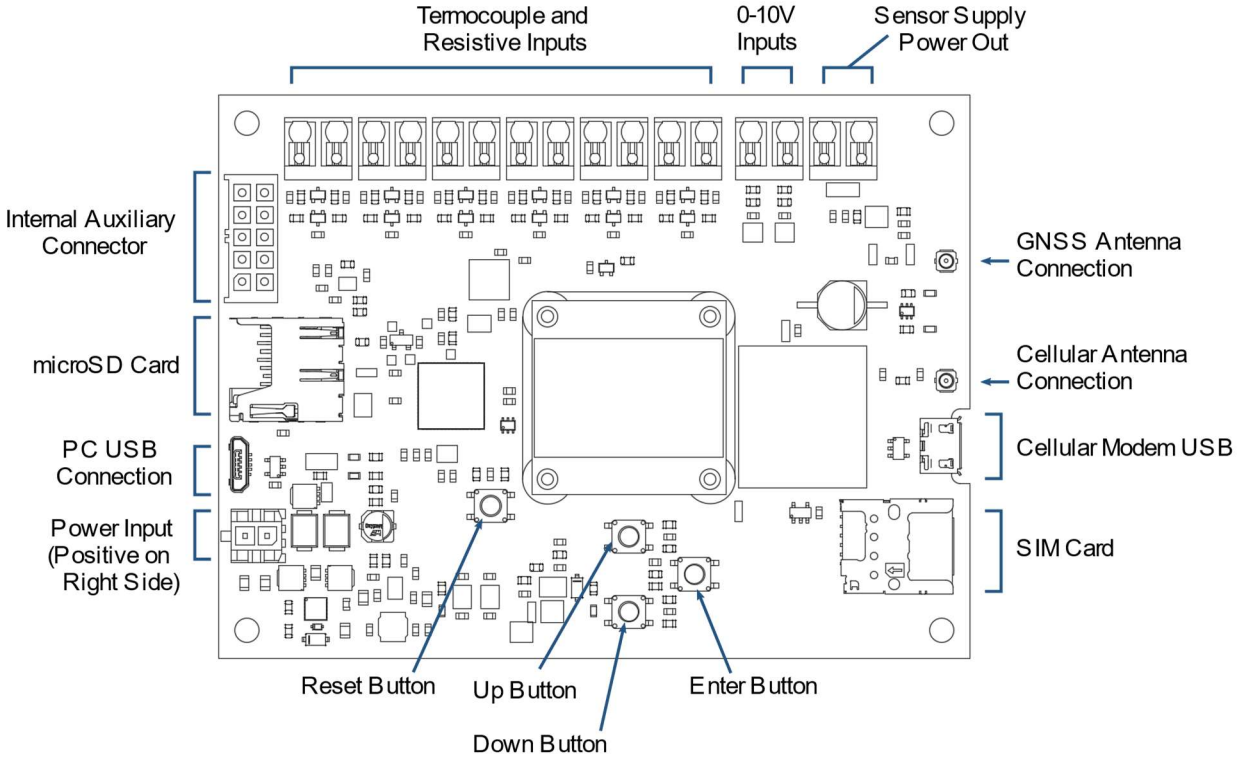
All Dimensions in millimeters




## Appendix 2: Mech Drawing (Side View)



## **Appendix** 3: Circuit board layout – OEM packaging




## Revision History

| Date | Author | Notes |
|---|---|---|
| 6/1/2022 | J. Leonard | Original release |