# Remote Connection of the MPS™ Family of Sensors

## Introduction

The MPS family of sensors--including the MPS Flammable Gas Sensor, MPS Methane Gas Sensor and MPS Refrigerant Gas Sensor--are designed to be mounted within the same assembly as the electronic system that controls the communication and power delivery to the sensor. There are some applications where it may be desirable to mount the MPS sensor at a separate location than the control electronics. This application note describes the requirements and limits in order to use the MPS sensor in this type of remote-mounted configuration.

All variations of the MPS family of sensors share the same basic electronic design and electrical interface characteristics. Therefore this application note is applicable to the three versions of MPS Sensors named above.

This application note describes only the electrical considerations related to remotely mounting the MPS sensor. Mechanical mounting considerations and protection of the MPS sensor from damage are the responsibility of the system integrator.

## Considerations

There are several areas of concern that need to be addressed when interfacing with the MPS sensor via a connecting cable to remotely mounted electronic systems. These include:

1. Voltage drop of the supply voltage to the sensor.
2. Electrical signal degradation due to resistance, capacitance and inductance in the connecting cable.
3. Signal crosstalk between Tx and Rx that may adversely affect communication.
4. Voltage drop in the connecting cable that may adversely affect gas concentration readings from the analog output (if using a sensor configured for analog instead of digital output).
5. Effect of safety barrier devices that may need to be placed between the MPS sensor and the control electronics in safety applications.
6. Connectors used in the interconnect cable between the MPS sensor and control electronics.

## Cable Recommendations

NevadaNano recommends the following configuration for an interconnecting cable between the MPS sensor and control electronics:

**Cable:** Cat 5/5E, 8 conductor, 4 twisted pairs, unshielded
**Characteristic Impedance:** 100 Ω
**DC Loop Resistance:** ≤ 0.188 Ω/meter
**Capacitance:** 52 pF/meter
**Inductance:** 525 nH/meter
**Maximum cable length (MPS sensor to control electronics):** 20 meters
**Connectors:** Vendor choice, recommended RJ-45
**Wiring interconnect method:** EIA/TIA 568B

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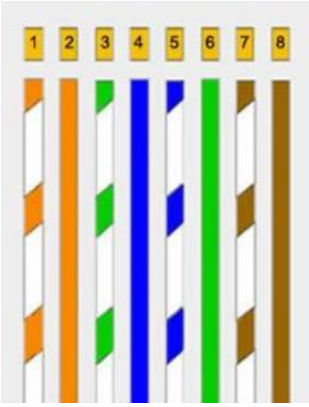


| EIA/TIA 568B to MPS signal mapping: | | | |
|---|---|---|---|
| MPS Signal Name | Wire 1 Color | Wire 2 Color | Wire 3 Color |
| GND | Green/White | Blue/White | Brown/White |
| +V | Orange | Orange/White | |
| Tx Data | Blue | | |
| Rx Data | Brown | | |
| Analog Out | Green | | |

This signal map has the following advantages:

- The +V is carried in 2 wires, resulting in lower voltage drop due to the parallel resistance of the two conductors
- Each signal wire has a corresponding wire of the pair connected to ground potential. The MPS interface signals are single ended, not differential, therefore providing an associated ground surrounding each signal, will reduce cross-talk between signals.

Utilizing Cat 5 / 5E cable with a known standard connector termination allows a commonly available, affordable, pre-configured, off-the-shelf solution to be used with good results. The following pictures show representative electrical signal characteristics between a representative MPS sensor and an example host system (the USB to serial converter contained in the NevadaNano MPS Sensor Evaluation Unit PCB in this example). The cable used is CAT 5E, and is 20 meters in length.

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Command / Response message to the MPS.

Zoom In of Rx data (Command) at the MPS.

Zoom In of Tx data (Command) from the Host.


Command / Response message to the MPS.

Zoom In of Tx data (Response) from the MPS.

Zoom In of Rx data (Response) at the Host.

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## Supply Voltage Considerations

The MPS sensor minimum operating voltage is 3.135V (3.3V minus 5%). It is imperative that the operating voltage AT THE SENSOR not drop below this level or fault conditions will be reported. Therefore when implementing a system with a remotely mounted sensor, the voltage drop of the cable and connectors need to be taken into account and the source power supply adjusted upward to compensate for the voltage drop in the cable and connectors.

When the MPS sensor is operating over a 20-meter cable, the expected voltage drop is approximately 160 mV (80 mV on V+ and 80 mV on GND return). Therefore, the power supply should source a minimum of 3.46V to account for the voltage drop in the cable.

The maximum operating voltage of the MPS sensor is 5.25V. The voltage AT THE SENSOR should not exceed this value or damage to the sensor may occur.

## Analog Out Considerations

The MPS sensor provides an analog output as an option. The analog output from the sensor is configured at the factory to support various output voltage levels. When using the MPS sensor with a cable, the voltage drop of the wire carrying the analog output signal needs to be taken into account. For example, the gas concentration reported needs to be adjusted to account for voltage drop along the cable.

## Safety Barrier Considerations

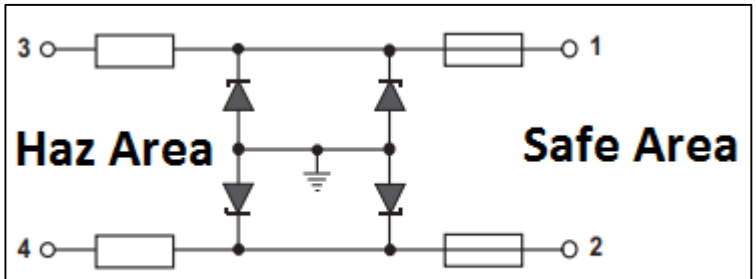
When using the MPS sensor in a hazardous location application, the use of safety barrier isolation devices is often required. In applications where the MPS sensor is co-located with the control electronics, the safety barrier is placed between the control electonics on the “hazardous” side and the monitoring/reporting systems on the “safe” side, with the MPS connected to the control electronics, either directly or via a cable as described.

If the the MPS sensor is connected by a cable and the application requires the control electronics to be placed on the “safe” side (if the 20-meter maximum cable length restriction can be maintained), then the safety barrier must be placed between the MPS and the control electronics.

A safety barrier, such as an MTL-7758+, can be used to isolate the MPS placed on the “hazardous” side from the control electronics placed on the “safe” side.The MTL7758+ has the following characteristics:

- All models are certified ‘ia’ for all zones and ‘IIC’ for all explosive atmospheres
- Safety Description
  - 7.5 Volts
  - 10 W
  - 750 mA
  - Polarity positive
- Application
  - Gas Detection in Hazardous Areas

- Max end to end resistance
  - 17 Ω
- Working voltage at 10 µA
  - 6.0 Volts
- Vmax
  - 7.3 Volts
- Fuse Rating
  - 200 mA




Representative schematic of the MTL7758+ safety barrier.

When using the MTL-7758+, note that two barrier devices are required as three signals need to be protected, the V+, Tx and Rx.

The added 17-ohm resistance present in the MTL 7758+ means that the V+ supply to the MPS sensor needs to be further increased to 3.82 V minimum to account for an approximate 360-mV drop in the barrier device and the approximate 160-mV drop in the 20-meter CAT 5 cable.

## Conclusion

While the MPS sensor devices were designed for direct connection to control systems, it is possible to remotely mount the sensor and reliably communicate over short distances of cable if the considerations presented in this document are followed.

Applications requiring cable distances greater than 20 meters are beyond the scope of this document. Circuit designs utilizing differential transceivers with appropriate termination circuits to drive long cable distances can be constructed to address longer distances. Additional power conditioning would be needed to ensure the MPS sensor receives the required voltage and current to ensure proper operation. These designs would require HazLoc certification if used in safety applications in hazardous areas.