Electronic Compass Sensors
Rev. 1.1 Jan. 2002

TCM2 Series
TCM2-20 ®
TCM2-50 ®
TCM2-80 ®
TCMVR Series
TCMVR-20 ®
TCMVR-50 ®
V2X Series
V2X ®
V2XG ®

® registered trademarks of Precision Navigation Inc.
**TCM 2 Series**

The TCM2 is the first quantum step forward in electronic compass technology since the conventional fluxgate magnetometer's introduction in the 1930's.

---

**Magneto-Inductive Magnetic Sensor Technology**

The TCM2's magnetic sensor is not a fluxgate, but a patented new technology that outperforms all other magnetic sensors in its class. Magneto-Inductive magnetic sensors change inductance with different applied magnetic field strengths. This variable inductance property has been used to create very sensitive magnetic sensors that are low in cost and power. These sensors are the clear choice for a wide variety of applications.

**Electronic Gimbaling**

Unlike mechanically gimbaled 2-axis fluxgates, the TCM2 has no mechanical moving parts. The use of 3 single-axis magnetometers and a 2-axis tilt sensor allows the TCM2 to be gimbaled electronically. Electronic gimbaling is a solid-state solution to compass tilt compensation that eliminates all moving parts and mechanical impediments to performance. This advanced electronic gimbaling allows for tilt ranges of up to ±80º and provides superior performance over the entire tilt range in real world conditions.

**Full 3-Axis Magnetometer and 2-Axis Tilt Sensor**

In addition to compass heading, the TCM2 also supplies highly accurate pitch, roll, magnetic field data and temperature information, allowing the TCM2 to replace several sensors within a system.

**Accurate in Any Environment**

Ferrous metals in host systems often magnetize over time, misdirecting magnetic compass readings. In addition, some systems also generate soft iron distortions. Soft iron can either misdirect or magnify existing magnetic fields, making calibration extremely difficult. The TCM2 uses advanced electronics and correction algorithms to counter the effects of hard and soft iron, enabling it to maintain a high degree of accuracy even in the most demanding environments.

**Designed to Work in the Real World**

The TCM2's advanced technology allows you to design your system to cope with the challenges of your application. Plus, the command set is designed with flexibility and adaptability in mind: many of the parameters are user-programmable.
TCM2-20

TCM2 electronic compass sensor module with tilt compensation of ±20º

**Heading Information**
- Accuracy when level: ±0.5º RMS
- Accuracy when tilted: ±1º RMS
- Resolution: 0.1º
- Repeatability: ±0.1º

**Tilt Information**
- Accuracy: ±0.2º
- Resolution: 0.1º
- Repeatability: ±0.2º
- Range: ±20º

**Magnetic Field Information**
- Accuracy: ±0.2 µT
- Resolution: 0.01 µT
- Repeatability: ±0.2 µT
- Range: ±80 µT

**Temperature Information (sensor is uncalibrated)**
- Accuracy after calibration: ±1ºC, ±2ºF
- Resolution: 1ºC, 2ºF
- Range: -20ºC to 70ºC

**Power Requirements**
- Supply Voltage: +5 VDC regulated or 6 to 18 VDC unregulated
- Current: Standard mode 15-20 mA (depending on user configuration), Low-Power mode 7-13 mA (depending on user configuration), Sleep mode 2.5 mA

**Physical Measurements**
- Dimensions: 2.50” x 2.00” x 1.25”
- Weight: 1.6 ounces

**Environmental Characteristics**
- Operating Temperature: -20ºC to 70ºC
- Storage Temperature: -30ºC to 90ºC

**Interfaces**
- Digital: RS232C, NMEA0183
- Analog: 0-5 V linear, 19.53 mV resolution (256 discrete levels), 0-5 V quadrature (sine and cosine)
TCM2-50

TCM2 electronic compass sensor module with tilt compensation of ±50º

### Heading Information
- **Accuracy when level**: ±1.0º RMS
- **Accuracy when tilted**: ±1.5º RMS
- **Resolution**: 0.1º
- **Repeatability**: ±0.3º

### Tilt Information
- **Accuracy**: ±0.4º
- **Resolution**: 0.3º
- **Repeatability**: ±0.3º
- **Range**: ±50º

### Magnetic Field Information
- **Accuracy**: ±0.2 µT
- **Resolution**: 0.01 µT
- **Repeatability**: ±0.2 µT
- **Range**: ±80 µT

### Temperature Information (sensor is uncalibrated)
- **Accuracy after calibration**: ±1ºC, ±2ºF
- **Resolution**: 1ºC, 2ºF
- **Range**: -20ºC to 70ºC

### Power Requirements
- **Supply Voltage**: +5 VDC regulated or 6 to 18 VDC unregulated
- **Current**: Standard mode 15-20 mA (depending on user configuration), Low-Power mode 7-13 mA (depending on user configuration), Sleep mode 2.5 mA

### Physical Measurements
- **Dimensions**: 2.50” x 2.00” x 1.25”
- **Weight**: 1.6 ounces

### Environmental Characteristics
- **Operating Temperature**: -20ºC to 70ºC
- **Storage Temperature**: -30ºC to 90ºC

### Interfaces
- **Digital**: RS232C, NMEA0183
- **Analog**: 0-5 V linear, 19.53 mV resolution (256 discrete levels), 0-5 V quadrature (sine and cosine)
TCM2-80

TCM2 electronic compass sensor module with tilt compensation of ±80°

**Heading Information**
- Accuracy when tilted 0° to ±55°: ±2.5 RMS
- Accuracy when tilted ±56° to ±80°: ±3.5° RMS
- Resolution: 0.1°
- Repeatability: ±0.6°

**Tilt Information**
- Accuracy: ±0.5°
- Resolution: 0.5°
- Repeatability: ±0.75°
- Range: ±80°

**Magnetic Field Information**
- Accuracy: ±0.2 μT
- Resolution: 0.01 μT
- Repeatability: ±0.2 μT
- Range: ±80 μT

**Temperature Information (sensor is uncalibrated)**
- Accuracy after calibration: ±1°C, ±2°F
- Resolution: 1°C, 2°F
- Range: -20°C to 70°C

**Power Requirements**
- Supply Voltage: +5 VDC regulated
- Current: Standard mode 15-20 mA, Low-Power mode 7-13 mA, Sleep mode 2.5 mA (depending on user configuration)

**Physical Measurements**
- Dimensions: 2.50” x 2.00” x 1.25”
- Weight: 1.6 ounces

**Environmental Characteristics**
- Operating Temperature: -20°C to 70°C
- Storage Temperature: -30°C to 90°C

**Interfaces**
- Digital: RS232C, NMEA0183
- Analog: 0-5 V linear, 19.53 mV resolution (256 discrete levels), 0-5 V quadrature (sine and cosine)
TCMVR Series

The TCMVR is a sophisticated, affordable, low-power electronic compass module that outputs compass heading, pitch, and roll readings via RS232 to a host system. It is based on a proprietary triaxial magnetometer system and a biaxial electrolytic inclinometer, and contains no moving parts. The TCMVR provides an advanced hard-iron calibration system and tolerates rugged environments.

Magneto-Inductive Magnetic Sensor Technology

The TCMVR's magnetic sensor is not a fluxgate, but a patented new technology that outperforms all other magnetic sensors in its class. Magneto-Inductive magnetic sensors change inductance with different applied magnetic field strengths. This variable inductance property has been used to create very sensitive magnetic sensors that are low in cost and power. These sensors are the clear choice for a wide variety of applications.

Electronic Gimbaling

Unlike mechanically gimbaled 2-axis fluxgates, the TCMVR has no mechanical moving parts. The use of 3 single-axis magnetometers and a 2-axis tilt sensor allows the TCMVR to be gimbaled electronically. Electronic gimbaling is a solid-state solution to compass tilt compensation that eliminates all moving parts and mechanical impediments to performance. This advanced electronic gimbaling allows for tilt ranges of up to ±50° and provides superior performance over the entire tilt range in real world conditions.

Full 3-Axis Magnetometer and 2-Axis Tilt Sensor

In addition to compass heading, the TCMVR also supplies highly accurate pitch, roll, magnetic field data and temperature information, allowing the TCMVR to replace several sensors within a system.

Accurate in Any Environment

Ferrous metals in host systems often magnetize over time, misdirecting magnetic compass readings. In addition, some systems also generate soft iron distortions. Soft iron can either misdirect or magnify existing magnetic fields, making calibration extremely difficult. The TCMVR uses advanced electronics and correction algorithms to counter the effects of hard and soft iron, enabling it to maintain a high degree of accuracy even in the most demanding environments.

Designed to Work in the Real World

The TCMVR's advanced technology allows you to design your system to cope with the challenges of your application. Plus, the command set is designed with flexibility and adaptability in mind: many of the parameters are user-programmable.
**TCMVR-20**

TCM2 electronic compass sensor module with tilt compensation of ±20°

### Heading Information
- **Accuracy when level**: ±2.0° RMS
- **Accuracy when tilted**: ±3.0° RMS
- **Resolution**: ±0.1°
- **Repeatability**: ±0.5°

### Tilt Information
- **Accuracy**: ±1.0°
- **Resolution**: ±0.1°
- **Repeatability**: ±0.5°
- **Range**: ±20°

### Power Requirements
- **Supply Voltage**: +5 VDC regulated or 6 to 18 VDC unregulated
- **Current**
  - Standard mode 15-20 mA (depending on user configuration)
  - Low-Power mode 7-13 mA (depending on user configuration)
  - Sleep mode 2.5 mA

### Physical Measurements
- **Dimensions**: 2.50” x 2.00” x 1.25”
- **Weight**: 1.6 ounces

### Environmental Characteristics
- **Operating Temperature**: -20°C to 70°C
- **Storage Temperature**: -30°C to 90°C

### Interfaces
- **Digital**: RS232C, NMEA0183
- **Analog**: 0-5 V linear, 19.53 mV resolution (256 discrete levels),
  0-5 V quadrature (sine and cosine)
TCMVR-50

TCMVR electronic compass sensor module with tilt compensation of ±50º

**Heading Information**
- Accuracy when level: ±3.0º RMS
- Accuracy when tilted: ±5.0º RMS
- Resolution: ±0.1º
- Repeatability: ±1.0º

**Tilt Information**
- Accuracy: ±2.0º
- Resolution: ±0.3º
- Repeatability: ±1.0º
- Range: ±50º

**Power Requirements**
- Supply Voltage: +5 VDC regulated or 6 to 18 VDC unregulated
- Current:
  - Standard mode: 15-20 mA (depending on user configuration),
  - Low-Power mode: 7-13 mA (depending on user configuration),
  - Sleep mode: 2.5 mA

**Physical Measurements**
- Dimensions: 2.50” x 2.00” x 1.25”
- Weight: 1.6 ounces

**Environmental Characteristics**
- Operating Temperature: -20ºC to 70ºC
- Storage Temperature: -30ºC to 90ºC

**Interfaces**
- Digital: RS232C, NMEA0183
- Analog: 0-5 V linear, 19.53 mV resolution (256 discrete levels), 0-5 V quadrature (sine and cosine)
V2X Series

V2X

The Vector 2X is a low-cost solution for direction or magnetic sensing requirements. The Vector 2X consumes less power, is smaller in size, and is much less expensive than traditional compasses or magnetic sensors. It is a complete compass or magnetic sensor module that integrates easily into any system.

Magneto-Inductive Magnetic Sensor Technology

The Vector 2X uses two Magneto-Inductive sensors to sense magnetic fields. Magneto-Inductive sensors change inductance with different applied magnetic field strengths. This variable inductance property has been used to create very sensitive magnetic sensors that are low in cost and power. These advantages have made Magneto-Inductive sensors the choice for use as compasses in a wide variety of applications.

Applications

The Vector 2X is designed for applications that require an accurate but inexpensive compass or magnetic sensor. Compass applications for the Vector 2X include car navigation, backup azimuth for GPS, vehicle tracking, and vehicle location. The module can also be used as a magnetic sensor for vehicle detection, seismic surveying, and metal detection.

Accurate in Any Environment

Ferrous metals in host systems often magnetize over time, misdirecting magnetic compass readings. The Vector 2X has a built-in hard iron calibration algorithm that compensates for the magnetic fields generated by a host system. The simple calibration process makes it possible to accurately use the Vector 2X in environments with nearby metal or electronics.

Outputs

The Vector 2X is a 2-axis magnetometer that outputs either compass heading or uncalibrated magnetic field data. This information is output via a 3-wire serial format (compatible with Motorola SPI and National Microwire) at either 2.5 or 5 times per second. The modules are pin selectable between BCD and Binary output format.

Differences Between the Vector 2X and 2XG

The Vector 2X uses two strapped-down magnetic sensors and is designed for use as a compass in level environments or as a magnetic sensor in any environment. The Vector 2XG has two mechanically gimbaled magnetic sensors, allowing it to be used as a compass in environments that are not always level. The mechanical gimbals increase the headroom on the Vector 2XG, but the footprint is the same matchbook size as the Vector 2X.
Performance Characteristics

**Heading Information**
- Accuracy: ±2º RMS
- Resolution: 1º
- Repeatability: ±2º RMS

**Uncalibrated Magnetic Field Information**
- Resolution: 25 counts per µT
- Repeatability: ±15 counts
- Dynamic Range: ±200 µT
- Tilt Range: None

**Magnetic Field Information after Typical Calibration**
- Dynamic Range: ±90 µT
- Accuracy: ±1 µT
- Dynamic Range: ±200 µT
- Accuracy: ±5 µT

**Physical and Environmental Characteristics**
- Dimensions: 1.50” x 1.43” x 0.39”
- Weight: 0.4 oz.
- Temperature:
  - Operating: -20º to 70ºC
  - Storage: -30º to 90ºC

**Power Requirements**
- Power Supply: Single 5 volt supply; 2.5 volt for power down
- Power Draw:
  - Master Mode: 6.0 mA operating, 110 µA power down
  - Slave Mode: 4 mA operating, 50 µA power down
The Vector 2XG is a low-cost solution for direction or magnetic sensing requirements. The Vector 2XG consumes less power, is smaller in size, and is much less expensive than traditional compasses or magnetic sensors. It is a complete compass or magnetic sensor module that integrates easily into any system.

Magneto-Inductive Magnetic Sensor Technology

The Vector 2XG uses two Magneto-Inductive sensors to sense magnetic fields. Magneto-Inductive sensors change inductance with different applied magnetic field strengths. This variable inductance property has been used to create very sensitive magnetic sensors that are low in cost and power. These advantages have made Magneto-Inductive sensors the choice for use as compasses in a wide variety of applications.

Applications

The Vector 2XG is designed for applications that require an accurate but inexpensive compass or magnetic sensor. Compass applications for the Vector 2XG include car navigation, backup azimuth for GPS, vehicle tracking, and vehicle location. The module can also be used as a magnetic sensor for vehicle detection, seismic surveying, and metal detection.

Accurate in Any Environment

Ferrous metals in host systems often magnetize over time, misdirecting magnetic compass readings. The Vector 2XG has a built-in hard iron calibration algorithm that compensates for the magnetic fields generated by a host system. The simple calibration process makes it possible to accurately use the Vector 2XG in environments with nearby metal or electronics.

Outputs

The Vector 2XG is a 2-axis magnetometer that outputs either compass heading or uncalibrated magnetic field data. This information is output via a 3-wire serial format (compatible with Motorola SPI and National Microwire) at either 2.5 or 5 times per second. The modules are pin selectable between BCD and Binary output format.

Differences Between the Vector 2X and 2XG

The Vector 2X uses two strapped-down magnetic sensors and is designed for use as a compass in level environments or as a magnetic sensor in any environment. The Vector 2XG has two mechanically gimbaled magnetic sensors, allowing it to be used as a compass in environments that are not always level. The mechanical gimbals increase the headroom on the Vector 2XG, but the footprint is the same matchbook size as the Vector 2X.
Performance Characteristics

**Heading Information**
- Accuracy: ±2° RMS
- Resolution: 1°
- Repeatability: ±2° RMS

**Uncalibrated Magnetic Field Information**
- Resolution: 25 counts per µT
- Repeatability: ±15 counts
- Dynamic Range: ±200 µT
- Tilt Range: ±15°

**Magnetic Field Information after Typical Calibration**
- Dynamic Range: ±90 µT
- Accuracy: ±1 µT
- Dynamic Range: ±200 µT
- Accuracy: ±5 µT

**Physical and Environmental Characteristics**
- Dimensions: 1.50” x 1.43” x 1.00”
- Weight: 0.7 oz.
- Operating Temperature: -20º to 70ºC
- Storage Temperature: -30º to 90ºC

**Power Requirements**
- Power Supply: Single 5 volt supply; 2.5 volt for power down

Power Draw
- Master Mode: 6.0 mA operating
  - 110 µA power down
- Slave Mode: 4 mA operating
  - 30 µA power down