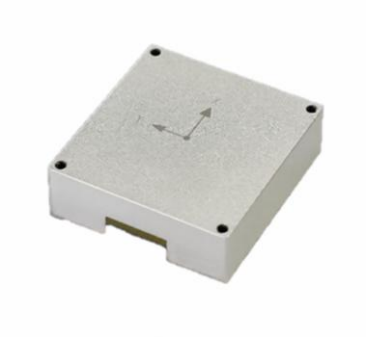
SensorsX
SX-MIEHC Series

High Performance MEMS IMU

Motion & Inertial | MEMS Inertial Measurement Unit (IMU)



±450 °/s Gyroscope Range (X, Y, Z)	**±20 g** Accelerometer Range (X, Y, Z)	**0.3 °/h** Gyro Bias Instability (Version E)
SPI Interface (output up to 2000 Hz)	**−40 to +85 °C** Working Temp. (−40 to +185 °F)	**3.3 V DC / <1 W** Voltage / Power Consumption

■ PRODUCT OVERVIEW

The SX-MIEHC Series is a MEMS inertial measurement unit (IMU) integrating a three-axis gyroscope and a three-axis accelerometer. It provides calibrated angular rate and acceleration data through an SPI interface, with temperature compensation, sensor misalignment compensation, and nonlinearity correction. The series is intended for integration into navigation, attitude measurement, robotics, and platform stabilization systems.
Four performance versions—B, C, D, and E—are available. Versions B, C, and D offer optional three-axis magnetometers and digital barometers, while Version E provides gyroscope and accelerometer measurements only. The output data rate is 2,000 Hz for Versions B/C/D and 1,000 Hz for Version E.



■ KEY FEATURES

◆ Three-Axis Gyroscope with ±450 °/s Measurement Range	◆ Three-Axis Accelerometer with ±20 g Measurement Range
◆ Optional 10-Axis Configuration with Three-Axis Magnetometer and Barometer (Versions B, C, and D Only)	◆ High-Speed SPI Interface with Output Rates up to 2,000 Hz
◆ Temperature Compensation Across −40 to +85 °C	◆ Compact 47 × 44 × 14 mm Design

■ TYPICAL APPLICATIONS

Application Fields

- Attitude Measurement and Control
- Platform Stabilization and Control
- Industrial Automation and Machinery
- Robotics and Motion Control

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Model Configuration

Model	Gyroscope (Standard)	Accelerometer (Standard)	Magnetometer (Optional)	Barometer (Optional)
SX-MIEHC Version B	✓	✓	Optional	Optional
SX-MIEHC Version C	✓	✓	Optional	Optional
SX-MIEHC Version D	✓	✓	Optional	Optional
SX-MIEHC Version E	✓	✓	None	None

■ PERFORMANCE SPECIFICATIONS

Parameter	Version B	Version C	Version D	Version E	Unit
Measuring Range: X, Y, Z	±450	±450	±450	±450	°/s
Bias Instability	2	0.8	0.5	0.3	°/h
Random Walk	0.08	0.03	0.03	0.03	°/√hr
Scale Factor Nonlinearity	300	300	300	300	ppm
Orthogonality	200	100	100	100	ppm
Bandwidth	400	268	268	268	Hz
Accelerometer					
Measuring Range: X, Y, Z	±20	±20	±20	±20	g
Bias Instability	50	20	20	15	μg
Random Walk	0.05	0.05	0.03	0.02	m/s/√hr
Scale Factor Nonlinearity	250	250	150	150	ppm
Orthogonality	200	200	100	100	ppm
Bandwidth	400	268	268	268	Hz
Magnetometer (Optional)					
Measuring Range	±8			/	Gauss
Resolution	0.2			/	mG
Noise Density	50			/	μG
Barometer (Optional)					
Measuring Range	300 ~ 1,100 (4.35 ~ 15.95 psi)			/	mbar
Tolerance	4.5 (0.065 psi)			/	mbar

■ ELECTRICAL SPECIFICATIONS

Power	
Voltage	3.3 V DC
Power Consumption	<1 W
Output Signal	
Interface	SPI
Output Frequency	2,000 Hz (Version B / C / D); 1,000 Hz (Version E)
Electrical Connection	
Main Connector	24-pin, 1.00 mm pitch (see Wiring Diagram)
Mating Connector	SAMTEC CLM-112-02 or equivalent

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■ ENVIRONMENTAL SPECIFICATIONS

Temperature	
Working Temperature	−40 to +85 °C (−40 to +185 °F)
Storage Temperature	−55 to +105 °C (−67 to +221 °F)
Temperature Compensation Range	−40 to +85 °C (−40 to +185 °F)
Mechanical & Environmental	
Vibration	6.06 g (20–2,000 Hz)
Shock	1,500 g / 0.5 ms
Weight & Size	
Size	47 × 44 × 14 mm (1.85 × 1.73 × 0.55 in)
Weight	<40 g (<1.41 oz)

■ COMMUNICATION PROTOCOLS

SPI Interface

The SX-MIEHC series is a self-contained inertial sensing system. When a valid power source is connected, it will automatically start. After completing the initialization process, it starts sampling, processing, and loading the calibrated sensor data into the output register, which can be accessed through the SPI port. SPI ports are usually connected to compatible ports of embedded processors. The connection diagram is shown in the following figure. Four SPI signals support synchronous serial data transmission. By default, DIO2 serves as a data-ready signal. It goes high when new data is available in the output register.

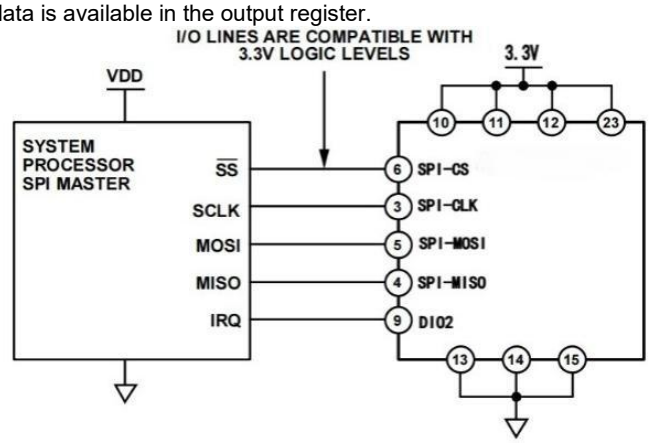


Figure 1 Electrical Connection Diagram

Universal Host Processor SPI Settings

Processor Settings	Description
Host	SX-MIEHC series used as a slave
SCLK < 10 MHz	Maximum serial clock rate
SPI Mode 3	CPOL=1 (polarity), and CPHA=1 (phase)
MSB-First Mode	Bit sequence
16-Bit Mode	Shift register/data length

If the previous command is a read request, the SPI port supports full duplex communication, which allows the external processor to write DIN when reading a DOUT (see Figure 2). This figure provides bit coding guidelines on DIN and DOUT.

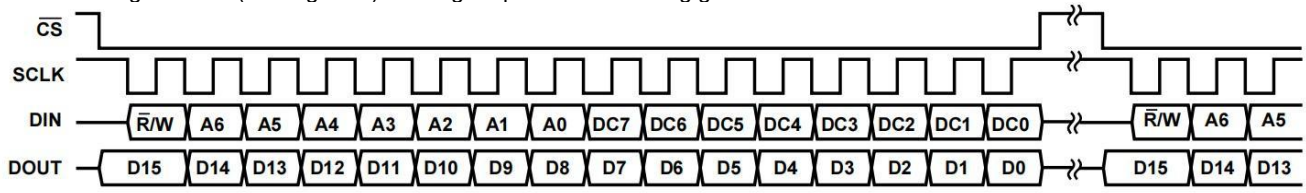


Figure 2 SPI communication bit sequence

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Read Sensor Data

The SX-MIEHC series automatically starts and activates page 0 for data register access. After accessing another page, return to page 0 by writing 0x00 to the PAGE_ID register (DIN = 0x8000). Reading a single register requires two 16-bit SPI transfer cycles.
The first SPI transfer sends the register read request as illustrated in Figure 2. The requested register data is returned on DOUT during the subsequent SPI transfer. The first bit of the DIN command is 0, followed by the register address bits. The final eight bits are don't-care bits; however, a complete 16-clock SPI transfer is required.
Figure 3 illustrates two consecutive register reads: DIN = 0x1A00 requests Z_GYRO_OUT, followed by DIN = 0x1800 requesting Z_GYRO_LOW.

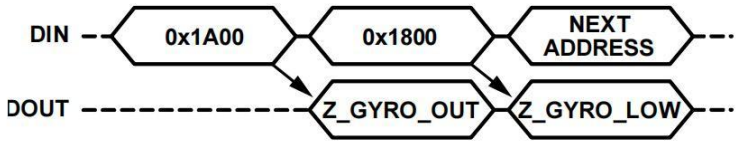


Figure 3 Example of SPI Register Reads

User Register Memory Mapping (N/A indicates not applicable)

R/W	PAGE_ID	Address	Default	Register Description
R/W	0x00	0x00	0x00	Page identification
R	0x00	0x0E	N/A	temperature
R	0x00	0x10	N/A	X-axis gyroscope output, low bit word
R	0x00	0x12	N/A	X-axis gyroscope output, high bit word
R	0x00	0x14	N/A	Y-axis gyroscope output, low bit word
R	0x00	0x16	N/A	Y-axis gyroscope output, high bit word
R	0x00	0x18	N/A	Z-axis gyroscope output, low bit word
R	0x00	0x1A	N/A	Z-axis gyroscope output, high bit word
R	0x00	0x1C	N/A	X-axis accelerometer output, low bit word
R	0x00	0x1E	N/A	X-axis accelerometer output, high bit word
R	0x00	0x20	N/A	Y-axis accelerometer output, low bit word
R	0x00	0x22	N/A	Y-axis accelerometer output, high bit word
R	0x00	0x24	N/A	Z-axis accelerometer output, low bit word
R	0x00	0x26	N/A	Z-axis accelerometer output, high bit word
R	0x00	0x28	N/A	X-axis magnetometer, high bit word
R	0x00	0x2A	N/A	Y-axis magnetometer, high bit word
R	0x00	0x2C	N/A	Z-axis magnetometer, high bit word
R	0x00	0x2E	N/A	Barometer output, low bit word
R	0x00	0x30	N/A	Barometer output, high bit word
R/W	0x03	0x00	0x00	Page identification
R/W	0x03	0x06	0x000D	Control, I/O pins, function definitions
R/W	0x03	0x08	0x00X0	Control, I/O pins, universal
R/W	0x04	0x00	0x00	Page identification
R	0x04	0x20	N/A	serial number

Data Format

The gyroscope, accelerometer, and barometer output data are represented in 32-bit two's complement format. Each output uses two registers to support this resolution. Figure 4 provides an example of how each register supports each inertial measurement. In this case, X_GYRO_OUT is the most significant word (high 16 bits), while X_GYRO_LOW is the least significant word (low 16 bits). In many cases, using the most significant word register alone provides sufficient resolution to preserve key performance indicators.

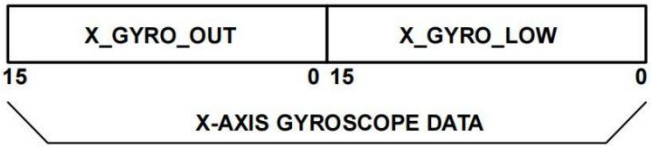


Figure 4 Example of gyroscope output format, DEC_RATE>0

Current temperature = 25 + TEMP_OUT × 0.00565 (°C); in °F: 77 + TEMP_OUT × 0.01017

Quantity		_OUT register	_LOW register
X-axis gyroscope	Resolution	1LSB = 0.02 °/s	The weight of MSB is 0.01 °/s, and the weight of subsequent data is half of the last data
	Calculation	0.02 × X_GYRO_OUT	0.01 × MSB + 0.005 × …

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Quantity		_OUT register	_LOW register
X-axis accelerometer	Resolution	1LSB = 0.8 mg	The weight of MSB is 0.4 mg, and the weight of subsequent data is half of the last data
	Calculation	0.8 × X_ACCL_OUT	0.4 × MSB + 0.2 × …
X-axis magnetometer	Resolution	1LSB = 0.1 mGauss	—
	Calculation	0.1 × X_MAGN_OUT	—
Pressure	Resolution	1LSB = 40 μbar	The weight of MSB is 20 μbar, and the weight of subsequent data is half of the last data
	Calculation	40 × BAROM_OUT	20 × MSB + 10 × …

SPI Code Example

Note:This example includes magnetometer and barometer channels. Adapt the register reads to the sensors fitted to the selected configuration.

```
#define LSB_GYRO              0.02f      //1LSB = 0.02 °/s
#define LSB_ACC               0.8f       //1LSB = 0.8 mg
#define LSB_MAG               0.1f       //1LSB = 0.1 mgauss
#define LSB_BAR               40.0f      //1LSB = 40ubar
#define LSB_TEMP              0.00565f   //1LSB = 0.00565 °C
struct sensor_data
{
    float gyro_x; // °/s
    float gyro_y; // °/s
    float gyro_z; // °/s
    float acc_x; // g
    float acc_y; // g
    float acc_z; // g
    float mag_x; // gauss
    float mag_y; // gauss
    float mag_z; // gauss
    float barom; // bar
    float temp;            // °C
}sensor_data_imu;

void spi_rw_buf_16bits(uint16_t *tx_buf, uint16_t *rx_buf, uint16_t len)
{
    spi_cs_enable(&spi_imu);
    spi_transmit_receive(&spi_imu, tx_buf, rx_buf, len);
    spi_cs_disable(&spi_imu);
}

uint16_t read_id(void)
{
    uint16_t tx_buf[3] = {0x8000, 0x7E00, 0x0000};
    uint16_t rx_buf[3] = {0};

    spi_rw_buf_16bits(tx_buf, rx_buf, 3);

    return rx_buf[2];
}

void set_decimation_rate(uint16_t divisor)
{
    uint16_t tx_buf[4] = {0};
    uint16_t rx_buf[4] = {0};
    uint16_t data_temp[2] = {0};

    divisor = divisor - 1;
    data_temp[0] = divisor & 0x00FF;
    data_temp[1] = divisor >> 8;

    while(1)
    {
        tx_buf[0] = 0x8003; //page3
        tx_buf[1] = 0x0c00;   //read
        tx_buf[2] = 0x0000; //dummy
        spi_rw_buf_16bits(tx_buf, rx_buf, 4);

        if(rx_buf[2]==divisor)
        {
            tx_buf[0] = 0x8000; //page0
            spi_rw_buf_16bits(tx_buf, rx_buf, 1);
            return;
        }

        tx_buf[0] = 0x8c00 | data_temp[0];
        tx_buf[1] = 0x8d00 | data_temp[1];
        spi_rw_buf_16bits(tx_buf, rx_buf, 2);
    }
}

uint32_t sensor_init(void)
{
    uint16_t id = read_id();

    if(id != 0x4068)
    {
        return 0;
    }
```


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```
    set_decimation_rate(1);        //set ODR

    return 1;
}

void get_imu_data()
{
    int16_t rx_data[20];

    uint16_t tx_data[20] =
    {
        0x8000, //page0
        0x0e00, //temp_out
        0x1000, //gx_low
        0x1200, //gx_out
        0x1400, //gy_low
        0x1600, //gy_out
        0x1800, //gz_low
        0x1a00, //gz_out
        0x1c00, //ax_low
        0x1e00, //ax_out
        0x2000, //ay_low
        0x2200, //ay_out
        0x2400, //az_low
        0x2600, //az_out
        0x2800, //mx_out
        0x2a00, //my_out
        0x2c00, //mz_out
        0x2e00, //barom_low
        0x3000, //barom_out
        0x0000 //dummy
    };

    spi_rw_buf_16bits(tx_data, (uint16_t*)rx_data, 20);

    sensor_data_imu.temp = rx_data[2]*LSB_TEMP + 25.0f;
    sensor_data_imu.gyro_x = rx_data[4]*LSB_GYRO + (uint16_t)rx_data[3]*LSB_GYRO/65536.0f;
    sensor_data_imu.gyro_y = rx_data[6]*LSB_GYRO + (uint16_t)rx_data[5]*LSB_GYRO/65536.0f;
    sensor_data_imu.gyro_z = rx_data[8]*LSB_GYRO + (uint16_t)rx_data[7]*LSB_GYRO/65536.0f;
    sensor_data_imu.acc_x = (rx_data[10]*LSB_ACC + (uint16_t)rx_data[9]*LSB_ACC/65536.0f) / 1000.0f;
    sensor_data_imu.acc_y = (rx_data[12]*LSB_ACC + (uint16_t)rx_data[11]*LSB_ACC/65536.0f) / 1000.0f;
    sensor_data_imu.acc_z = (rx_data[14]*LSB_ACC + (uint16_t)rx_data[13]*LSB_ACC/65536.0f) / 1000.0f;
    sensor_data_imu.mag_x = (rx_data[15]*LSB_MAG) / 1000.0f;
    sensor_data_imu.mag_y = (rx_data[16]*LSB_MAG) / 1000.0f;
    sensor_data_imu.mag_z = (rx_data[17]*LSB_MAG) / 1000.0f;
    sensor_data_imu.barom = (rx_data[19]*LSB_BAR + (uint16_t)rx_data[18]*LSB_BAR/65536.0f) /1000000.0f;
}
```

Precautions

- SPI Configuration: The interface operates in SPI Mode 3.

The SPI interface supports 16-bit transfers only; 32-bit transfers are not supported.

- Signed Data Representation (Two's Complement)

For signed 16-bit data, negative values are represented in two's complement format. For example, 0xFD88 is interpreted as follows: 0xFD88 → 64904 → 64904 − 65536 (2^{16}) = −632.

- The IMU features automatic calibration at power-on. Ensure that the IMU is stationary during the 5 seconds before power-on. To disable this function, please contact SensorsX for configuration support.

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■ MECHANICAL DIMENSIONS

Overall dimensions: 47.0 (L) × 44.0 (W) × 14.0 (H) mm (excluding mounting holes and connectors), as shown below.

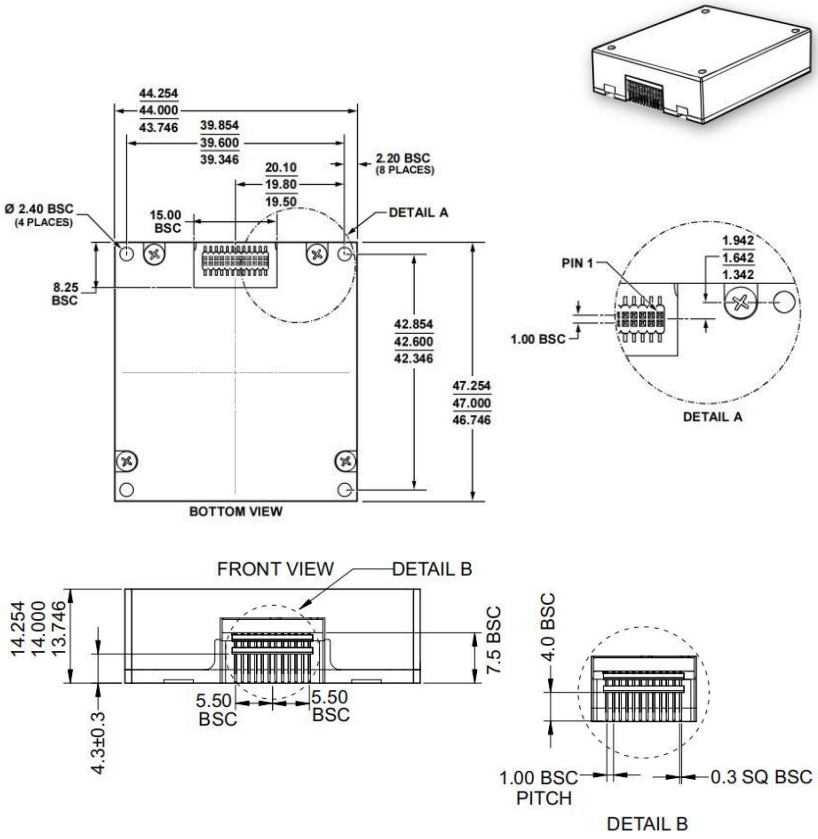


Figure 5 Mechanical dimensions (unit: mm)

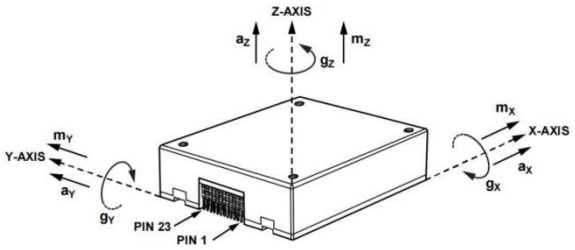


Figure 6 Definition of axes

Key Dimensions

Dimensions — mm (in)	
Length	47.000 ± 0.254 mm (1.850 ± 0.010 in)
Width	44.000 ± 0.254 mm (1.732 ± 0.010 in)
Height	14.000 ± 0.254 mm (0.551 ± 0.010 in)
Mounting Hole Spacing	39.600 × 42.600 mm (1.559 × 1.677 in)
Mounting Holes	Ø2.40 BSC, 4 places (Ø0.094 in)
Connector Pitch	1.00 mm BSC (0.039 in); pin 0.3 mm SQ (0.012 in)
Connector Height from Base	4.3 ± 0.3 mm (0.169 ± 0.012 in)

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■ WIRING DIAGRAM

Electrical Interface — Pin Configuration

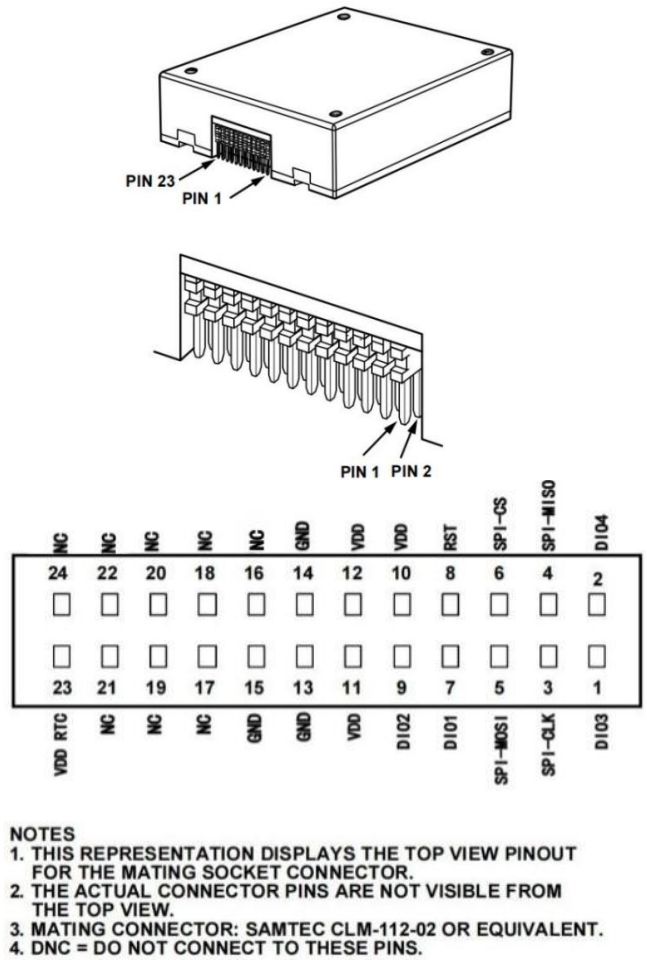


Figure 7 Pin configuration

Pin Definitions of Main Connector

Pin Number	Name	Type	Description
10, 11, 12	VDD	power supply	3.3 V
13, 14, 15	GND	power ground	
7	DIO1	input/output	Universal IO, configurable
9	DIO2	input/output	Universal IO, configurable
1	DIO3	input/output	Universal IO, configurable
2	DIO4	input/output	Universal IO, configurable
3	SPI-CLK	input	Fixed SPI slave mode
4	SPI-MISO	output	Fixed SPI slave mode
5	SPI-MOSI	input	Fixed SPI slave mode
6	SPI-CS	input	Fixed SPI slave mode
8	RST	input	reset
23	VDD RTC	power	None
16, 17, 18, 19, 20, 21, 22, 24	NC	reserved	DNC

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■ ORDERING INFORMATION

Complete model number example: SX-MIEHC-045020gC83

Angular Rate Measurement Range	
0450	±450 °/s
Acceleration Measurement Range	
20g	±20 g
Performance Version	
B	Version B
C	Version C
D	Version D
E	Version E
Magnetometer Measurement Range	
0	Without
8	±8 Gauss (available for Versions B, C, and D only)
Barometer Measurement Range	
0	Without
3	300–1,100 mbar (available for Versions B, C, and D only)
Customization Options	
D	Custom Configuration — specify requirements when ordering

Example: SX-MIEHC-045020gC83D specifies an SX-MIEHC Series IMU with a ±450 °/s gyroscope measurement range, a ±20 g accelerometer measurement range, Version C accuracy, an optional ±8 Gauss magnetometer, a 300–1,100 mbar barometer, and a custom configuration. Magnetometer option 8 and barometer option 3 are available for Versions B, C, and D only.

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