

MEMSENSE

**Driver Installation
IMU Data Console
IMU Demo**

Documentation
Revision 1

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1 Driver Installation

Depending on the protocol you specified when ordering your IMU, you will install either RS422 or I2C drivers. If you ordered a uIMU, only the RS422 protocol is available whereas both RS422 and I2C are available for the nIMU. Regardless of whether you are installing I2C or RS422 drivers, the installation process is identical.

1.1 Identifying Protocol

You can identify the device protocol from the part number on the white sticker affixed to the device. If you have a uIMU the part number will be similar to IM05-0300C050A35R, whereas a nIMU will be similar to NA02-0300F050C. The last letter in the part number dictates the protocol your device is configured for: R = RS422 and C = I2C. Once you know the protocol your IMU uses you can download the correct drivers from MEMSense' website at: <http://www.memsense.com/support/downloads.asp>.

1.2 Installation

Installing the drivers is very simple. Once you have downloaded and unzipped the driver files, you should see a file called PreInstaller.exe, as shown below:

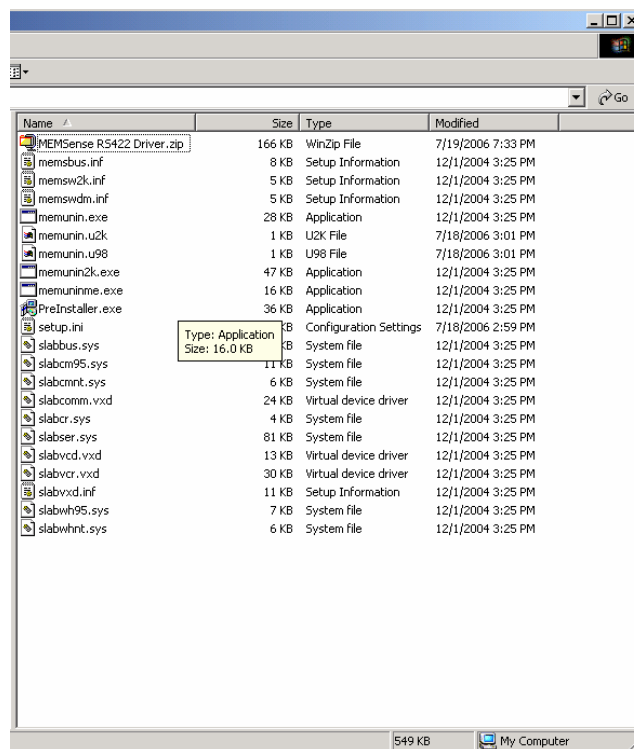


Figure 1: Extracted RS422 driver files.

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Double-click PreInstaller.exe to start the driver install process on your computer. You will see the dialog shown in Figure 2 which allows you to select where the files are installed, or accept the default location. Select 'Install' when you're ready to start the install. The I2C driver dialog will be nearly identical except that it informs the user that I2C drivers are being installed.

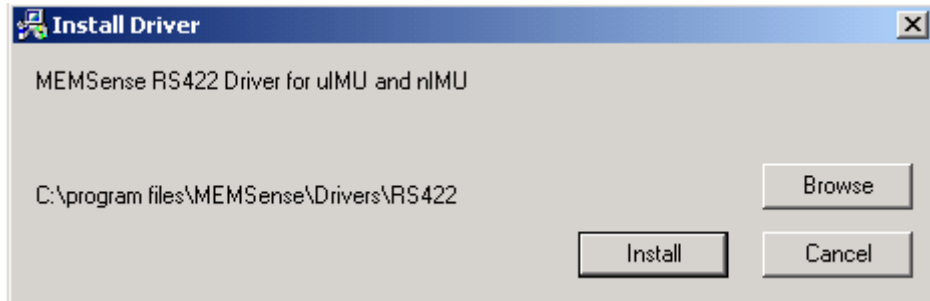


Figure 2: Driver install dialog.

When the installation is complete you will see a dialog indicating success, as shown in Figure 3.

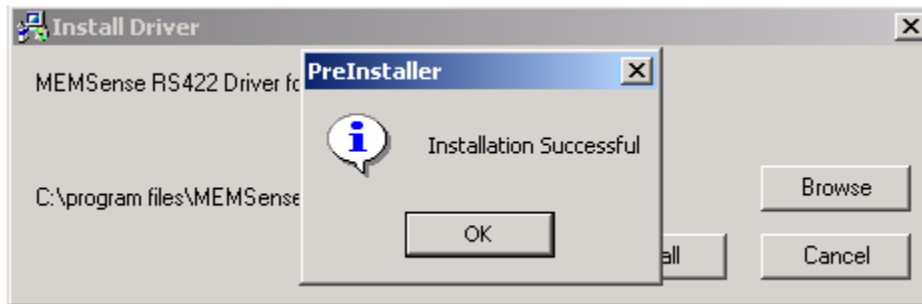


Figure 3: Successful driver installation.

Note for I2C driver installations:

If the I2C files have already been installed on your computer, and you run PreInstaller.exe a second time, you will get an error very similar to that shown in Figure 4. The solution is to simply delete the already existing directory that contains the I2C driver files which, as shown in Figure 4, are located at C:\Program Files\MEMSense\Drivers\I2C. Once the files are deleted, simply run PreInstaller.exe again.

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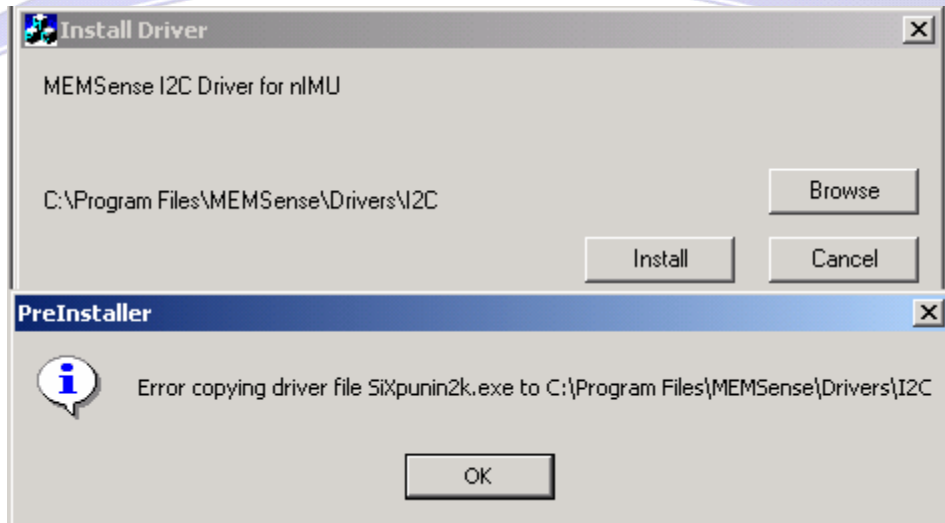


Figure 4: I2C driver installation failure.

1.3 Hardware Setup

Connecting your IMU to your computer is done as follows:

1. Verify the power supply is set to 8.3 Volts.
 - a. Ensure the USB board is not connected to the power supply.
 - b. Turn on power supply.
 - c. Rotate the voltage dial until 8.3V is displayed as shown in Figure 5. If the voltage will not increase to 8.3V, rotate the current dial to the half-way point, then adjust the voltage up/down to 8.3V.
 - d. Turn off the power supply.



Figure 5: Correct output from power supply before connecting to IMU.

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2. Connect the USB interface board to the power supply. Make sure the USB board leads connect to the matching color posts on the power supply.
3. Connect the IMU to the USB interface board.
4. Connect the USB interface board to your computer (directly, or via USB extension).
5. Turn on the power supply and readjust the voltage to 8.3 Volts. Your final connections should appear as in figure 6. Note that the current display shows approximately 0.15 Amps/150 milliamps; your current draw may vary by as much as +/-30 milliamps.



Figure 6: Power supply, IMU and USB interface board connectivity.

1.4 Found New Hardware Wizard

Once the driver files are installed, and the hardware is connected, Windows will now be able to identify your MEMSense IMU via the Hardware Wizard. Note that the Hardware Wizard will only run the first time you connect the IMU/USB Interface board to your computer. You will see the 'Found New Hardware Wizard' dialog appear, as shown in Figures 7.0 through 7.6. Simply accept the default options and click through via the 'Next' buttons. The dialog sequence will be similar – but not necessarily identical – to those shown below. Eventually, the Wizard will complete indicating it has successfully installed the drivers. You are now able to communicate with the IMU, and can install applications such as the MEMSense IMU Data Console or MEMSense IMU Demo.



Figure 7.0: New Hardware Wizard dialog

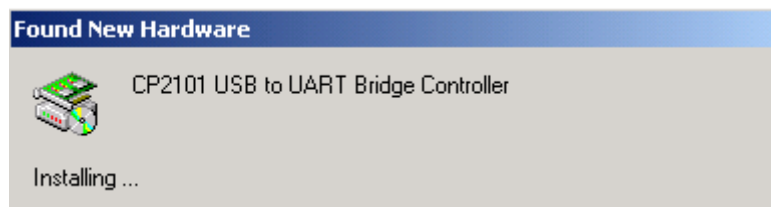


Figure 7.1: New Hardware Wizard dialog



Figure 7.3: New Hardware Wizard



Figure 7.4: New Hardware Wizard

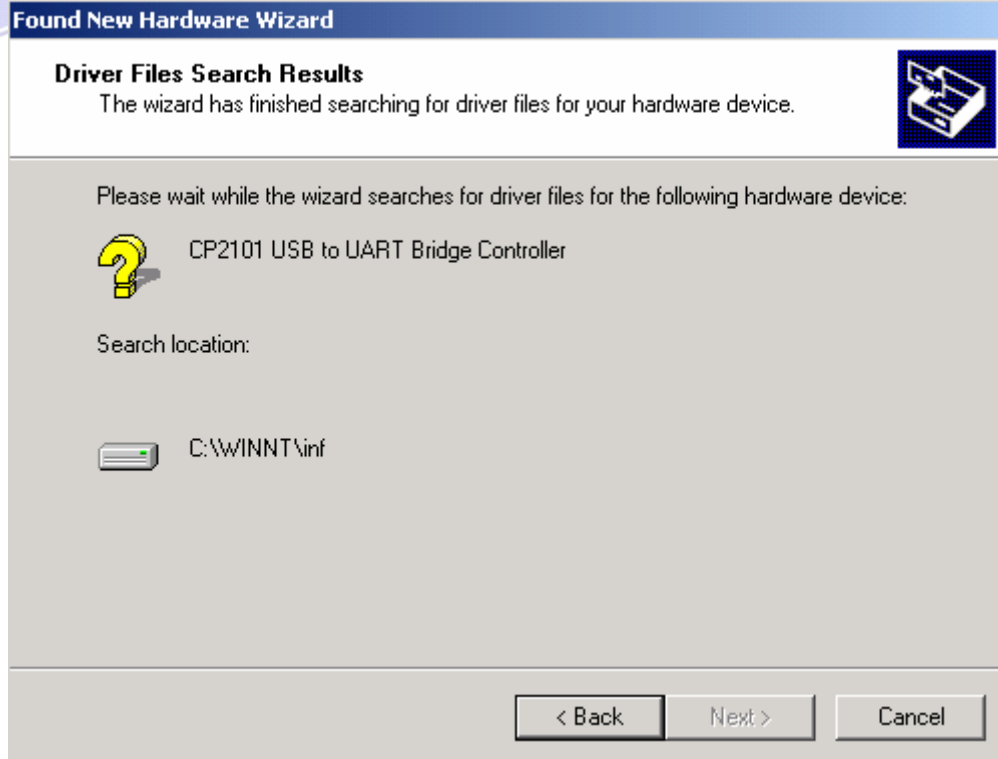


Figure 7.5: New Hardware Wizard

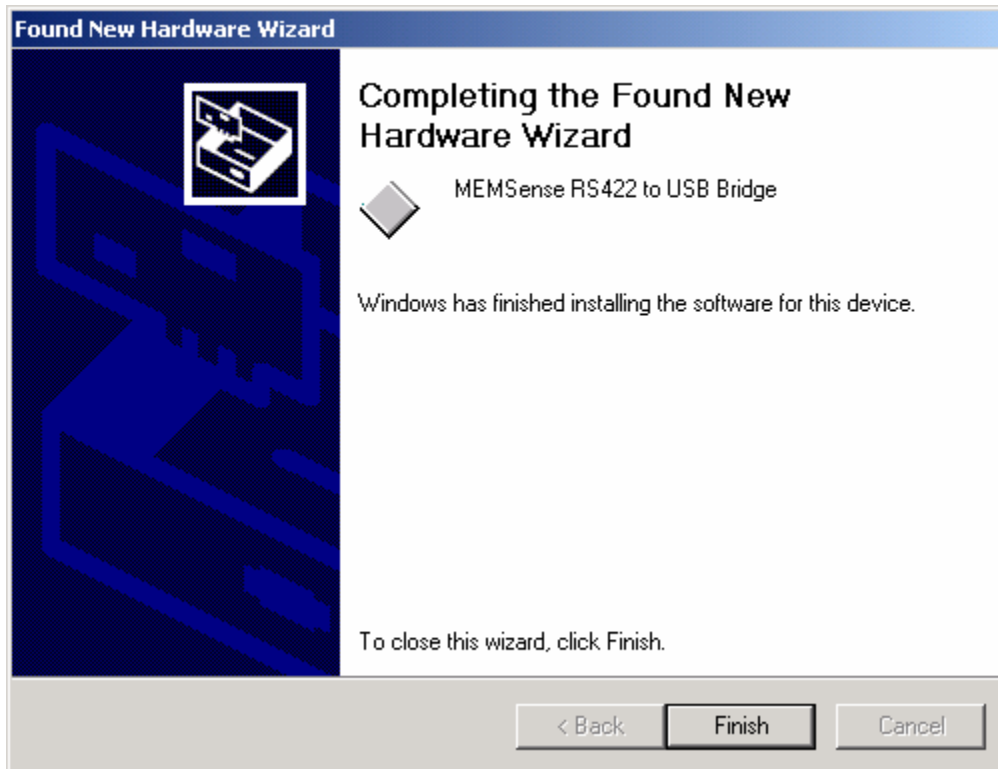


Figure 7.6: New Hardware Wizard

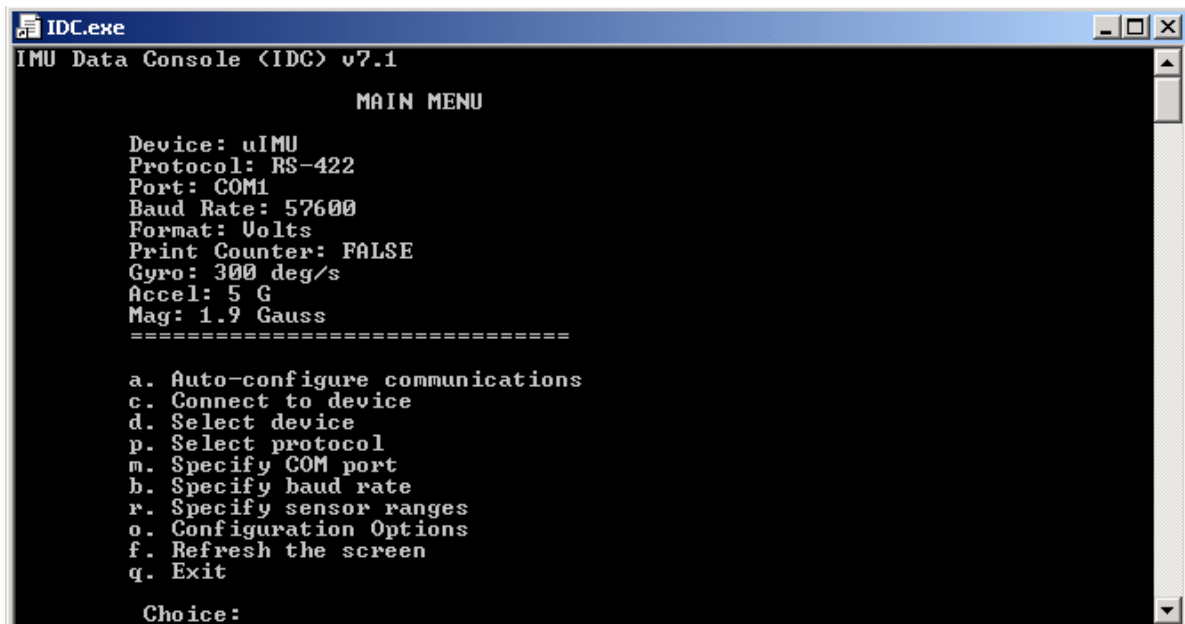
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2 Application Installation and Usage

2.1 IMU Data Console (IDC)

The IMU Data Console is a console-based, menu-driven application that recognizes both the nIMU and uIMU, and allows basic display and collection using either the RS422 or I2C protocols. Although a relatively simple application, it enable quick, easy verification of device functionality and data collection.

The IDC can be downloaded from the MEMSense support website at: <http://www.memsense.com/support/downloads.asp>, under the Data Acquisition link. Once downloaded complete the installation by double-clicking on the file and following the installer wizard. Once complete you may start the IDC by going to Start/Program Files/MEMSense/IMU Data Console/IDC.exe, and should display as the Main Menu in a DOS window as shown in Figure 8:



```
IMU Data Console <IDC> v7.1

                MAIN MENU

Device: uIMU
Protocol: RS-422
Port: COM1
Baud Rate: 57600
Format: Volts
Print Counter: FALSE
Gyro: 300 deg/s
Accel: 5 G
Mag: 1.9 Gauss
=====
a. Auto-configure communications
c. Connect to device
d. Select device
p. Select protocol
m. Specify COM port
b. Specify baud rate
r. Specify sensor ranges
o. Configuration Options
f. Refresh the screen
q. Exit

Choice:
```

Figure 8: IMU Data Console Main Menu

The basic layout of the Main Menu shows current settings at the top half of the window, with the various menu options available to the user at the bottom. The current settings dictate how the application will communicate with the device (e.g. baud rate, COM port, etc.), how data is printed to screen (e.g. volts, units, etc.), whether to print data to screen, the IMU the application thinks it's communicating with, and the various sensor ranges (e.g. gyro: 300 deg/s). It's important these items are configured correctly or the IDC may not be able to communicate with the IMU or correctly display data. Fortunately, it's a simple process to configure each of these options.

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2.1.1 Establishing Communication

The easiest way to initially configure the application is by selecting 'Auto-configure' from the menu by hitting 'a' on the keyboard. This will display a different screen that will attempt to setup communications with the IMU by automatically looking for data across all communications ports, as shown in figure 9. There are three stages to identifying the device:

1. Find the correct port/baud rate pair to establish basic communication.
2. If data is present on the port, look for the synchronization bytes to align with a packet boundary (see your respective IMU documentation for additional information on packet structure).
3. Once aligned on a packet boundary, read in the data header to identify the type of IMU.

Successfully completing each of the above stages ensures communication with your IMU, with success indicated at the bottom of the screen. If, however, the IDC is unable to identify the device, run the configuration process again, check your hardware connections and/or reinstall the drivers.

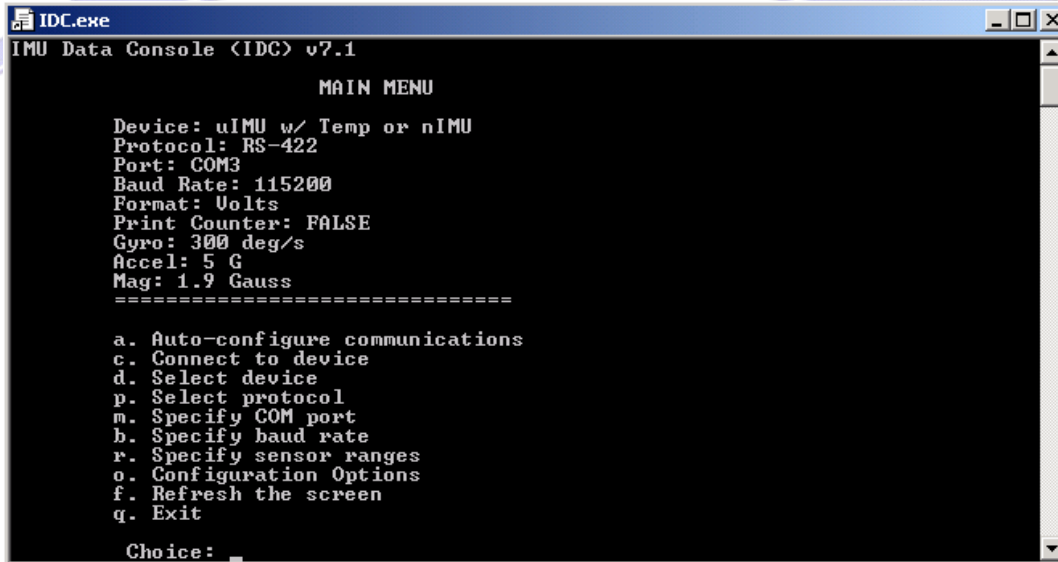
```
Starting auto configuration....
Searching serial ports...
  Attempting to open COM1 @ 57600 bps.....SUCCESS!
    Searching for synch bytes.....failed
  Attempting to open COM1 @ 115200 bps.....SUCCESS!
    Searching for synch bytes.....failed
  Attempting to open COM2 @ 57600 bps.....SUCCESS!
    Searching for synch bytes.....failed
  Attempting to open COM2 @ 115200 bps.....SUCCESS!
    Searching for synch bytes.....failed
  Attempting to open COM3 @ 57600 bps.....SUCCESS!
    Searching for synch bytes.....failed
  Attempting to open COM3 @ 115200 bps.....SUCCESS!
    Searching for synch bytes.....FOUND!
    Reading in header information.....done

Successfully identified device: uIMU w/ Temp or nIMU
Successfully identified protocol: RS-422
Press any key to continue...
```

Figure 9: Auto configuration display

Once communication with the IMU has been established, you will be returned back to the Main Menu with corrected communications settings displayed at the top of the screen, as shown in Figure 10.

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```
IDC.exe
IMU Data Console <IDC> v7.1

                MAIN MENU

Device: uIMU w/ Temp or nIMU
Protocol: RS-422
Port: COM3
Baud Rate: 115200
Format: Volts
Print Counter: FALSE
Gyro: 300 deg/s
Accel: 5 G
Mag: 1.9 Gauss
=====

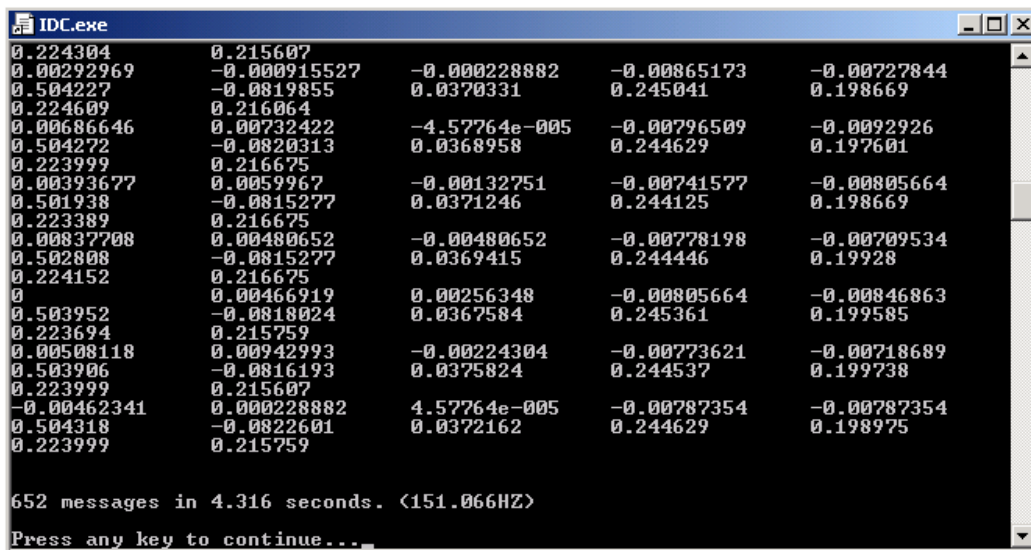
a. Auto-configure communications
c. Connect to device
d. Select device
p. Select protocol
m. Specify COM port
b. Specify baud rate
r. Specify sensor ranges
o. Configuration Options
f. Refresh the screen
q. Exit

Choice: _
```

Figure 10: Correct communications settings.

2.1.2 Displaying Data

To display data it's now a simple matter of connecting to the IMU through menu option 'c' – Connect to device. Data will stream to the screen and defaults to displaying every twentieth packet as shown in Figure 11; this rate can be modified from the main menu, if you wish. Also note that the data format defaults to volts, not units; again, this can be changed from the main menu. To stop display data to screen simply hit any keyboard key which will then display the number of messages/packets received during the time streaming was enabled, and calculates the device sample rate (151.066 Hz in figure 11). Hitting another key will return the application to the Main Menu.



```
IDC.exe
0.224304          0.215607
0.00292969      -0.000915527    -0.000228882    -0.00865173     -0.00727844
0.504227        -0.0819855      0.0370331      0.245041        0.198669
0.224609        0.216064
0.00686646     0.00732422     -4.57764e-005  -0.00796509     -0.0092926
0.504272        -0.0820313     0.0368958      0.244629        0.197601
0.223999        0.216675
0.00393677     0.0059967      -0.00132751    -0.00741577     -0.00805664
0.501938        -0.0815277     0.0371246      0.244125        0.198669
0.223389        0.216675
0.00837708     0.00480652     -0.00480652    -0.00778198     -0.00709534
0.502808        -0.0815277     0.0369415      0.244446        0.19928
0.224152        0.216675
0              0.00466919     0.00256348     -0.00805664     -0.00846863
0.503952        -0.0818024     0.0367584      0.245361        0.199585
0.223694        0.215759
0.00508118     0.00942993     -0.00224304    -0.00773621     -0.00718689
0.503906        -0.0816193     0.0375824      0.244537        0.199738
0.223999        0.215607
-0.00462341    0.000228882    4.57764e-005  -0.00787354     -0.00787354
0.504318        -0.0822601     0.0372162      0.244629        0.198975
0.223999        0.215759

652 messages in 4.316 seconds. <151.066HZ>
Press any key to continue...
```

Figure 11: Streaming IMU data to console.

2.1.3 Data Columns

The data columns displayed will vary slightly between the nIMU and uIMU, but will match their respective IMU documentation. If displaying in volts or units the orders for each device are as shown in Figure 12.

Column	Sensor
1	Gyro X
2	Gyro Y
3	Gyro Z
4	Accel X
5	Accel Y
6	Accel Z
7	Mag X
8	Mag Y
9	Mag Z

Column	Sensor
1	Gyro X
2	Gyro Y
3	Gyro Z
4	Accel X
5	Accel Y
6	Accel Z
7	Mag X
8	Mag Y
9	Mag Z
10	Hi-G Accel X
11	Hi-G Accel Y

Column	Sensor
1	Gyro X
2	Gyro Y
3	Gyro Z
4	Accel X
5	Accel Y
6	Accel Z
7	Mag X
8	Mag Y
9	Mag Z
10	Gyro Temp X
11	Gyro Temp Y
12	Gyro Temp Z

Figure 12: Order of IDC data columns for each MEMSense IMU.

If displaying the data format in bytes, each 8-bit/byte value of the sensor data is displayed in hexadecimal format in the order of Most Significant Byte (MSB) to Least Significant Byte (LSB), as documented in the respective device manual. If displaying the data formatted in counts, the sensor MSB/LSB are combined and displayed as a 16-bit, hexadecimal value.

2.1.4 Configuration Options

A number of options can be configured by the user, including: data format, console data interval, saving data to file and whether to print the counter. These items are accessed from the Main Menu via Configuration Options, and are covered in the following sections.

2.1.5 Data Format

Four formats are available - bytes, counts, volts and units – with the default being volts. Formats were covered in detail in Section 2.1.2, but it's important to note two additional items, however:

- The selected format also governs how data is written to file
- If the data format is 'units', the ranges of the gyro, accelerometer and magnetometer must be set to values that match the IMU ranges (see Section 2.1.9). If not, the calculated sensor values will likely be incorrect.

2.1.6 Toggle Console Data

This option enables/disables printing of data to the console. Default is enabled.

2.1.7 Set Console Data Interval

Specifies the interval at which data is printed to the console. If every value is to be printed, specify a value of '1'. The default is to display every 20th sample.

2.1.8 Output File Name

By specifying the output filename, data is printed to file. If the file does not previously exist it is created. If the file exists and data is present, the data is truncated (erased), not appended to. The default is to not save to file until the user specifies a filename.

2.1.9 Toggle Print Counter

The nIMU sends a counter as part of the packet (see nIMU documentation, Section 3,2). Enabling this option forces the counter to be printed both to console and file. By default this option is disabled. This option has no effect when displaying uIMU data.

2.1.10 Sensor Ranges

The IDC sensor ranges must be set to match the IMU sensor ranges if data is to be displayed in Units format. Failure to correctly set the ranges will very likely result in incorrect and/or corrupted data. Setting the sensor ranges is done from 'Specify Sensor Ranges' – option 'r' – from the Main Menu. You will be presented with ranges for the gyros, accelerometers and magnetometers. Simply step across each sensor and set the correct value. Note that the magnetometer need not be set – all MEMSense IMU magnetometers are set to 1.9 Gauss, which is the IDC default.

2.2 IMU Demo

IMU Demo is designed primarily to demonstrate the effectiveness of the MEMSense Kalman filter at reducing angular drift. IMUDemo does this by displaying a 3-dimensional cube on the screen that, in real-time, matches the rotational direction and rates of the attached MEMSense IMU. Saving raw and filtered data to file is available, as well.

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2.2.1 Installation

IMUDemo can be downloaded from the MEMSense support website at: <http://www.memsense.com/support/downloads.asp>, under the Filter Demo link. Once downloaded complete the installation by double-clicking on the file and following the installer wizard. Once complete you may start IMUDemo by going to Start/Program Files/MEMSense/IMU Demo/IMUDemo.exe, and should see the application as shown in Figure 13:

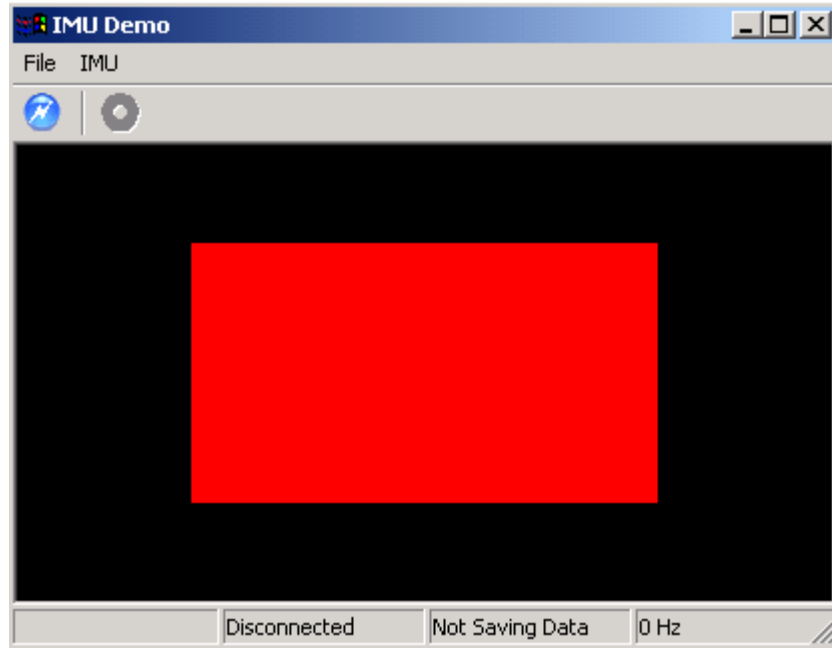


Figure 13: IMUDemo application.

2.2.2 Establishing Communication

IMUDemo is configured by clicking the blue, lightning-bolt icon - positioning the cursor over this icon should also display the help-text 'Connect to device' – displaying the Connection Wizard, as shown in Figure 14.

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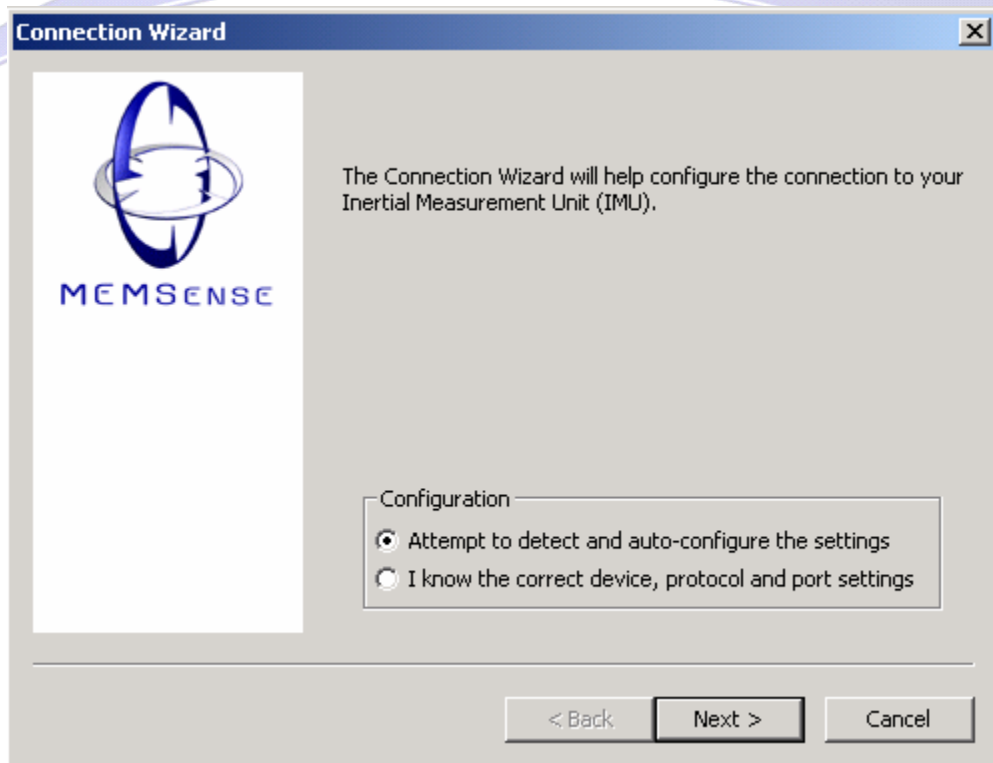


Figure 14: Connection wizard.

Accept the default option to auto-configure the device, and hit 'Next'. This will display the configuration screen, shown in Figure 15. Click the 'Configure' button to begin the configuration process. Device configuration will attempt to setup communications with the IMU by automatically looking for data across all communications ports. There are three stages to identifying the device:

1. Find the correct port/baud rate pair to establish basic communication.
2. If data is present on the port, look for the synchronization bytes to align with a packet boundary (see your respective IMU documentation for additional information on packet structure).
3. Once aligned on a packet boundary, read in the data header to identify the type of IMU.

Successfully completing each of the above stages ensures communication with your IMU, with success indicated at the bottom of the panel. If, however, IMUDemo is unable to identify the device, run the configuration process again, check your hardware connections and/or reinstall the drivers.

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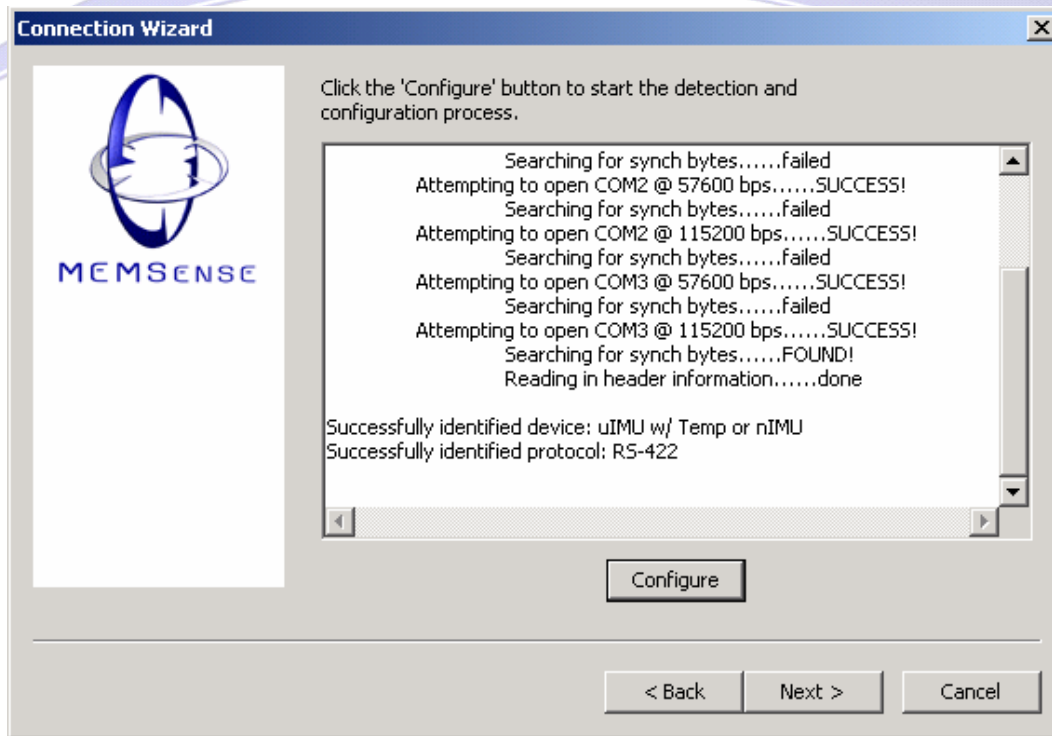


Figure 15: IMU successfully identified by Connection Wizard.

Once the device and protocol have been identified, click 'Next' to proceed to the IMU sensor range configuration screen, shown in Figure 16.

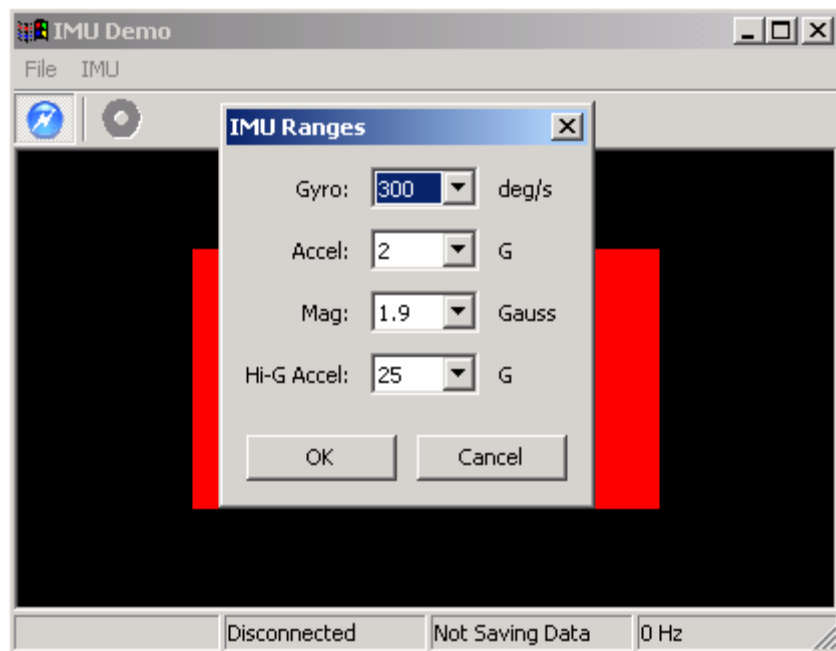


Figure 16: IMU sensor range configuration.

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Set the sensor configuration such that it matches your IMU. Note that the magnetometer setting only allows 1.9 Gauss, and the Hi-G Accel option is only used if a uIMU with a hi-g accelerometer is connected; it is ignored for all other devices. Once the ranges have been set, hit 'OK' and IMUDemo will continue with determination of the sample rate, followed by activation of the cube rotation. At this point data is being collected from the IMU, processed through the Kalman filter, and the cube updated to simulate the position and motion of the IMU.

2.2.3 Saving Data to File

Once communication is established with the IMU, the second blue toolbar icon – the Record icon – will be enabled which allows saving of data to file; note that placing the cursor over the icon displays the help text 'Collect data'. Clicking this icon will bring up the dialog shown in Figure 17.

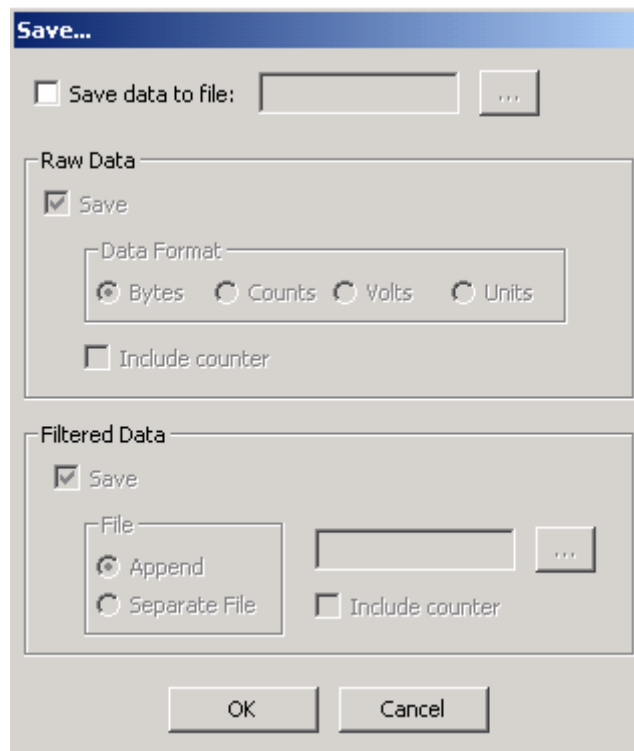


Figure 17: Save data dialog.

To configure saving data place check the 'Save data to file:' checkbox, which enables the various dialog elements, as shown in Figure 18. Also note that the dialog is separated into two sections: raw data and filtered data. This allows the user the flexibility to decide what data to save, the format, and how whether the raw and filtered data should be separated out to different files or appended within a single file. As shown in Figure 18, the raw data is being saved to the file 'raw.txt' formatted in units, whereas the filtered data is separated out to a second file called 'filtered.txt', and includes the IMU counter value

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(NOTE: the counter is only valid for MEMSense nIMU; it is ignored if connected to a uIMU). When finished setting the various options click 'OK' to begin saving data. Note that IMUDemo displays 'Saving Data' in the lower-right corner of the display. To stop data collection simply deselect the Record toolbar icon, noting that IMUDemo now shows 'Not Saving Data' in the lower right corner of the display.

Finally, to terminate communication with the IMU, simply deselect the Connect toolbar icon.

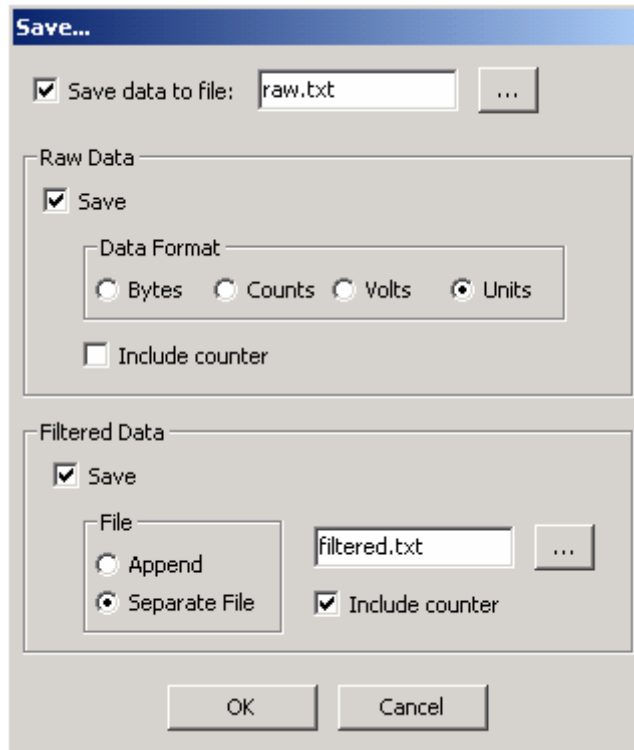


Figure 18: Save data configuration dialog

2.2.4 Data Columns

The following are three possible output formats from IMUDemo. Each format includes the counter values, but the counter values are a user-selectable option from the data output dialog. If the counter values are not selected for output, simply remove the counter values from the following lists.

1. Raw file output, including counter. The output 'type' is dependent upon the user-selected options and the IMU; columns 12, 13 and 14 may or may not be present based on IMU type. May be any of bytes, counts, volts or units. Bytes is represented as 8-bit hex values, counts are 16-bit hex values, and units are sensor dependent (i.e. gyro will be rad/s, accel is G's, and magnetometer is Gauss).

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Column	Output
1.	counter(counts)
2.	counter(seconds)
3.	gyro(x)
4.	gyro(y)
5.	gyro(z)
6.	accel(x)
7.	accel(y)
8.	accel(z)
9.	mag(x)
10.	mag(y)
11.	mag(z)
12/13/14	Dependent upon IMU

2. Filtered output, including counter

Column	Output
1.	counter(counts)
2.	counter(seconds)
3.	corrected gyro(x) rad/s
4.	corrected gyro(y) rad/s
5.	corrected gyro(z) rad/s
6.	quaternion(w)
7.	quaternion(x)
8.	quaternion(y)
9.	quaternion(z)
10.	bias(x) rad/s
11.	bias(y) rad/s
12.	bias(z) rad/s
13.	euler(yaw) rad
14.	euler(pitch) rad
15.	euler(roll) rad

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3. Combined Raw and Filtered outputs, with counter. Note that columns 12, 13 and 14 may or may not be present, dependent upon the IMU type.

Column	Output
1.	counter(counts)
2.	counter(seconds)
3.	gyro(x) rad/s
4.	gyro(y) rad/s
5.	gyro(z) rad/s
6.	accel(x) G's
7.	accel(y) G's
8.	accel(z) G's
9.	mag(x) Gauss
10.	mag(y) Gauss
11.	mag(z) Gauss
12/13/14	Dependent upon IMU
15.	corrected gyro(x) rad/s
16.	corrected gyro(y) rad/s
17.	corrected gyro(z) rad/s
18.	quaternion(w)
19.	quaternion(x)
20.	quaternion(y)
21.	quaternion(z)
22.	bias(x) rad/s
23.	bias(y) rad/s
24.	bias(z) rad/s
25.	euler(yaw) rad
26.	euler(pitch) rad
27.	euler(roll) rad