AC0091-001, rev B



WF Smartphone Sensor Toolkit User Manual





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Support information

Technical support and Product information

https://www.wireflow.se/product/wf-smartphone-sensor-toolkit/ support@wireflow.se

WireFlow headquarters

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Introduction

The WireFlow Smartphone Sensor Toolkit is a LabVIEW add-on that enables Android smartphone sensor data to be acquired and utilized in LabVIEW. The sensor data that can be acquired depends on which smartphone is used, since different smartphone models have different sensors.

Supported sensors

The smartphones coordinate system is defined according to the following image.



Figure 1. Smartphone coordinate system according to Android. Source: Android [1]

The toolkit currently offers 15 different sensors to choose from. These are listed in the table below.

Sensor	Data out	Description	Units of measure
Accelerometer	ReadData[0]	Acceleration force along X axis	m/s ²
	ReadData[1]	Acceleration force along Y axis	
	ReadData[2]	Acceleration force along Z axis	-
Linear acceleration	ReadData[0]	Acceleration force along X axis (excl. gravity)	m/s ²
	ReadData[1]	Acceleration force along Y axis (excl. gravity)	-
	ReadData[2]	Acceleration force along X axis (excl. gravity)	-
Gyroscope	ReadData[0]	Rate of rotation around X axis	rad/s
	ReadData[1]	Rate of rotation around Y axis	-
	ReadData[2]	Rate of rotation around Z axis	-
Gyroscope uncalibrated	ReadData[0]	Rate of rotation around X axis (without drift compensation)	rad/s
	ReadData[1]	Rate of rotation around Y axis	1



		(without drift compensation)	
	ReadData[2]	Rate of rotation around Z axis	
		(without drift compensation)	
	ReadData[3]	Estimated drift around X axis	
	ReadData[4]	Estimated drift around Y axis	
	ReadData[5]	Estimated drift around Z axis	
Rotation vector	ReadData[0]	Rotation vector component	unitless
		along X axis (X*sin(θ/2))	
	ReadData[1]	Rotation vector component	
		along Y axis (Y*sin(Θ/2))	
	ReadData[2]	Rotation vector component	
		along Z axis (Z*sin(Θ/2))	
Gravity	ReadData[0]	Force of gravity along X axis	m/s ²
	ReadData[1]	Force of gravity along X axis	
	ReadData[2]	Force of gravity along X axis	-
Magnetic field	ReadData[0]	Geomagnetic field strength	μT
		along X axis	
	ReadData[1]	Geomagnetic field strength	-
		along Y axis	
	ReadData[2]	Geomagnetic field strength	
		along Z axis	
Magnetic field	ReadData[0]	Geomagnetic field strength	μT
uncalibrated		(without hard iron calibration)	
		along X axis	
	ReadData[1]	Geomagnetic field strength	
		(without hard iron calibration)	
		along Y axis	
	ReadData[2]	Geomagnetic field strength	
		(without hard iron calibration)	
		along Z axis	_
	ReadData[3]	Iron bias estimation along X	
		axis	_
	ReadData[4]	Iron bias estimation along Y	
		axis	_
	ReadData[5]	Iron bias estimation along Z	
		axis	
Game rotation	ReadData[0]	Rotation vector component	unitless
vector ¹		along X axis (X*sin(θ /2))	_
	ReadData[1]	Rotation vector component	
		along Y axis (Y*sin(θ /2))	_
	ReadData[2]	Rotation vector component	
		along Z axis (Z*sin(θ /2))	
Geomagnetic	ReadData[0]	Rotation vector component	unitless
rotation vector ²		along X axis (X*sin(θ /2))	
	ReadData[1]	Rotation vector component	
		along Y axis (Y*sin(θ /2))	_
	ReadData[2]	Rotation vector component	
		along Z axis (Z*sin(θ /2))	
Proximity ³	ReadData[0]	Distance from object	cm
Ambient	ReadData[0]	Ambient air temperature	°C



temperature			
Light	ReadData[0]	Illuminance	lx
Pressure	ReadData[0]	Ambient air pressure	hPa or mbar
Relative humidity	ReadData[0]	Ambient relative humidity	%
GPS position	ReadData[0]	Lattitude	° (degrees)
	ReadData[1]	Longitude	° (degrees)
	ReadData[2]	Altitude	m (meters)
GPS time ⁴	ReadData[0]	ms since 1:00 AM, 1 Jan 1970	Unix time

¹ The game rotation vector sensor is identical to the rotation vector sensor, except it does not use the geomagnetic field. Therefore the Y axis does not point north, but instead to some other reference. That reference is allowed to drift by the same order of magnitude as the gyroscope drifts around the Z axis.

² The geomagnetic rotation vector sensor is similar to the rotation vector sensor, but it uses a magnetometer instead of a gyroscope. The accuracy of this sensor is lower than the normal rotation vector sensor, but the power consumption is reduced.

³Some proximity sensors provide only binary values representing near and far.

⁴To convert to LabVIEW time, multiply output value value with 0.001 and add with timestamp from 1:00 AM 1 Jan 1970, then convert calculated value to timestamp. Look in example ReadFromMultipleSensors.vi to see how it's done.



Download & Install

Requirements

The following software needs to be installed before installing the toolkit:

- JKI VI Package Manager (VIPM) version 2014 or later
- LabVIEW version 2014 or later

If you are planning to connect to the smartphone via USB instead of TCP (WiFi) you also need to install <u>NI-VISA</u> with USB passport support.

In addition to the required software an Android based Smartphone is required to get sensor data.

Installing the toolkit (VI Package)

To be able to install the toolkit, you will need the VI Package Manager (VIPM) from JKI to be installed. Once this is installed, you have two options:

- Search for "WF Smartphone Sensor Toolkit" in the VIPM search field and double-click to open the search result.
- Double-click the Smartphone Sensor Toolkit .vip file, if you have already downloaded it from wireflow.se.

Choose whichever option is most convenient and you should see the following window.

IKI VIPM - WE Smartpho	ne Sensor Toolkit	Σ
Help		
ackage Information Select an action	to perform on the package.	
2015 -		
Install	WE Smartphone Sensor Toolkit v1 0 0 41 hr WirsElow	
Show in Palettes	Author: WireFlow Copyright: Copyright (c) 2018, WireFlow Compatible LabVIEW Versions: >= 2014.	
	Compatible OS Versions: Windows.	
Show Examples	Description: Toolkit for reading smartphone sensor data to LabVIEW.	
*Browse All Versions		

Press *Install* and follow the instructions provided by the VI package manager to complete the installation.



For USB: Install USB driver

(If you're not planning to connect to your smartphone via USB, and you're planning to connect via TCP instead, you can skip this step.)

The required drivers could be found in *<LabVIEW>\vi.lib\addons\WireFlow_WF Smartphone Sensor Toolkit\Drivers* or on the <u>product page</u> on the WireFlow website. This folder contains multiple vendor/model specific drivers. If your Android smartphone isn't listed among the drivers, please read and follow the instructions in: <u>No USB Driver for your device?</u>.

Open the folder with the name corresponding to your smartphone and locate the inf-file (vendor + model). Also locate the generic Android Accessory device driver.

- SensorToolkitUSBDriver_Vendor/ModelSpecificName.inf
- SensorToolkitUSBDriver_AndroidAccessoryDevice.inf

Right-click and choose "Install" for <u>both</u> drivers.

📙 🛃 🔜 = C:_SVN	AC Products\AC0105 Android USB Driver Generator\bi	uilds\SensorToolkitUSBDriver_H	luaweiMat	-		×
File Home Share	View					~ 🕐
← → ~ ↑ 📙 « A0	C0105 Android USB Driver Generator → builds → Sen	sorToolkitUSBDriver_HuaweiM	ate9Pro v さ	Search SensorTool	kitUSBD	. ρ
	Name		Date modified	Туре	Size	
T QUICK access	SensorToolkitUSBDriver_HuaweiMate9Pro.inf		2017-10-25 17:49	Setup Information		2 KB
a OneDrive	sensortoolkitusbdriver_huaweimate9pro.cat	Open		Security Catalog		7 KB
This PC	SensorToolkitUSBDriver_Android Accessory De	Install		Setup Information		2 KB
	sensortoolkitusbdriver_android accessory devi	Print		Security Catalog		7 KB
Network		Edit with HHD Hex Edito	r Neo			
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		Restore previous version	s			
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		Cut				
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		Create shortcut				
		Delete				
		Rename				
Aitems 1 item selected	<	Properties			F	>
+ items i i item selected	LIV KD					

If the installation is successful, the following window will appear:

The operation completed successfully.
ОК



Try connecting your device now to verify that it works. Choose to connect as an MTP Device from your smartphone. Verify that your device enumerates correctly in Windows by opening Windows Device Manager where your device should be listed under NI-VISA USB Devices, or by opening NI Measurement & Automation Explorer where your device should be listed as an USB device under Devices and Interfaces.

Device Manager	—	×
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🗸 📇 WireFlow-Fhilip		
> 👖 Audio inputs and outputs		
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> 🗑 Biometric devices		
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> 💻 Computer		
> 🚽 ControlVault Device		
> 👝 Disk drives		
> 🏣 Display adapters		
> 🔐 DVD/CD-ROM drives		
> 📔 Firmware		
> 🛺 Human Interface Devices		
> 🏣 Intel(R) Dynamic Platform and Thermal Framework		
> 🖵 Intel® Power Sharing Manager		
> 🔀 Intel® Wireless Gigabit Drivers		
> 🔤 Keyboards		
> 🥅 Memory technology devices		
> 📗 Mice and other pointing devices		
> 🛄 Monitors		
> 🚅 Network adapters		
VIEVISA USB Devices		
WF USB Driver for HuaweiMate9Pro		
> 🔮 Other devices		
> 💭 Ports (COM & LPT)		
> 🚍 Print queues		
> Processors		
> Proximity devices		
> If Security devices		
Smart card readers		
Software devices		
Sound, video and game controllers		
> Storage controllers		
> The System devices		
Universal Serial Bus controllers		

If your device isn't listed as a NI-VISA USB Device after performing these steps, please see <u>Device not listed as a NI-VISA USB Device?</u>.

Install Android Application

The WF Smartphone Sensor Toolkit Android application can be downloaded and installed from within the Google Play Store in your Android smartphone.

Link to app: <u>Google Play Store</u>

Or search in the Google Play Store for "WireFlow Smartphone Sensor Toolkit".





Toolkit VIs

The toolkit consists of eight VIs which can be seen in the figure below.

WF Smartphone S	ensor Toolkit	
↑ Q Search	🔧 Customize 🔻	
<mark>ទីពេទ១៤</mark> ក្នុងស្នា Init	Close	GetConnectio
StartSensor	StopSensor	ReadSensor
StartMultipleS	StopMultipleS	

Figure 2. WF Smartphone Sensor Toolkit VIs.

Each VI is described more in detail below.

Init.vi

Initializes the class object and starts the asynchronous background process that communicates between the smartphone and the LabVIEW API. Lastly, it looks for a connection with the smartphone.

System sampling time (100ms) sets the sampling time for all sensors the user chooses to start.

timeout (1000 ms) defines how long the application will look for a connection to the smartphone.

Com selects between USB and TCP connection type.

IP address must contain the IP address of the smartphone if Com is set to TCP.



Close.vi

This VI sends a message to the smartphone, telling it to stop all sensors that have been previously started. After sending the message, the VI terminates the background process which closes the connection with the smartphone. Finally it closes all open references, releases all notifiers and destroys all user events.





GetConnectionStatus.vi

Returns the connection status between the smartphone and the Sensor Toolkit.



Connection Status states:

INIT - Initializing driver.NO DEVICE - Not connected to smartphone.CONNECTED - Ready to send commands to and read data from smartphone.

StartSensor.vi

Sends a message to the smartphone to start sending the selected **Sensor type**'s values to LabVIEW. Receiving the values requires the use of the **ReadSensor.vi** with the same **Sensor type** as input parameter.



StartMultipleSensors.vi

Starts multiple sensors, for more details see StartSensor.vi documentation.



StopSensor.vi

Sends a message to the smartphone that stops the selected **Sensor type**.





StopMultipleSensors.vi

Stops multiple sensors, for more details see StopSensor.vi documentation.



ReadSensor.vi

Reads the selected sensors value upon notification triggered by the background process. Depending on chosen sensor, the output **Data read** might be represented in array sizes between 1-6.



timeout (100 ms) determines how long it's acceptable to wait for a reading to be received.



Basic usage/Examples

When everything is downloaded and installed (see <u>Download & Install</u>) you can start acquiring sensor data from your smartphone.

Quick start USB

It's recommended that you first try one of our example VIs to see that everything works. Start by opening LabVIEW (\geq 2014) and, in the top menu, choose *Help*>>*Find Examples...*

	Show Context Holp	Ctrl+ H	
TTTTTTT NATIONAL INST	Lock Context Help	Ctrl+Shift+L	
🔛 ab)	LabV/EW/Holp	Ctrl. 2	Search C
	Explain Error	Curri	
C	Find Examples		Onon Existing
C	Find Instrument Drivers		Open Existing
	Web Resources		
Recent Project T	About MINDSTORMS Module		Files
Blank Project	MINDSTORMS Module Help		
	NI-Embedded CAN for RIO		
	WireFlow	•	
	Activate LabVIEW Components		
	Activate Add-ons		
	Check for Updates		
	Customer Experience Improvement	Program	
	Patents		
Find Driver	About LabVIEW		Welcome to LabVIEW
Connect to devi	ces and expand the Particip	ate in the discussion forums or	Learn to use LabVIEW and upgrade
functionality of L	LabVIEW. request	technical support.	from previous versions.

In the new window that appears, type "wireflow", press Search and choose to open the VI named ReadSingleSensor_USB.vi.

🥬 NI Example Finder				- 🗆	×
Browse Search	D	ouble-click an example to open it.		Information	
Enter kerword(s)		^ 21 examples match your search criteria	^ ^ ^	Description:	^
wireflow	- II.	Fingerprint_Doorlock_Example.vi		This example demonstrates in a	
	- II.	KeyCheckPrinciple.vi		simple manner now to connect,	
Search		Basic - License Validation Asymmetric Key_wireflow.vi		single sensor on the smartphone.	
Double-click keyword(s)		Basic - License Validation_wireflow.vi	•	copyright (c) 2010, menor	
WireFlow	`	Basic - Remote Challenge Response Exchange_wireflow.vi	Ð		
		Basic - Session Key Usage_wireflow.vi	Description		
		Basic - User Authentication_wireflow.vi			
		Basic - Using DataFields_wireflow.vi			
		Intermediate - Key Validation and Features_wireflow.vi	Ð		
		Intermediate - Remote Validation_wireflow	.vi 💽		
		Intermediate - Separated Authentication_wireflow.vi	Ð		~
		Intermediate - Using Key-Pair functionallity_wireflow.vi	Ð	Requirements	
		KeyCheckPrinciple.vi	•		
	/	ReadFromMultipleSensors_TCP.vi	▶		
		ReadFromMultipleSensors_USB.vi	⊳		
	_	ReadSingleSensor_TCP.vi	•		
Visit ni.com		ReadSingleSensor_USB.vi			
for more examples		Rotate 3D Object_TCP.vi			
		WF3132_cDAQ-ModeSelection.vi	•		
Hardware		Rotate 3D Object_USB.vi	•		
Find hardware	\sim		~	1	
Limit results to hardware		А	dd to Favorites	Setup Help Clos	se



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	Sensor						<u>a</u>	Sensor data			-
2 5	Acceler	ometer					0	0			
	Tip! Select a	sensor tha	at exists in y	/our				0			
	Accelerome	ter sensor	or a Gyroso	ope sen	sor.			0			
								0			
								0			
								0			
						error out					
						status 🖌	code				
			STOP			source					
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Now, plug in your smartphone to your PC. At this point, it might be a good idea to see that the device enumerates itself as a NI-VISA USB Device in Windows Device Manager or to find it in NI Measurement & Automation Explorer under Device and Interfaces. If it doesn't, check out <u>Device not listed as a NI-VISA USB Device?</u>.

When you run the VI, the Android application will start and ask you to connect to the device, press OK.





The Android application should now start and activate the selected sensor on your device (should be the Accelerometer if you started the VI without selecting another sensor).

Rotate your device in different ways and look at the sensor data indicator on the LabVIEW front panel to see the values change.

Quick start TCP

It's recommended that you first try one of our example VIs to see that everything works. Start by opening LabVIEW (\geq 2014) and, in the top menu, choose *Help>>Find Examples...*

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	Show Context Help	Ctrl+H	
TERTER NATIONAL INST	Lock Context Help	Ctrl+Shift+L	
Lab\	LabVIEW Help Explain Error	Ctrl+?	- Search Q
C	Find Examples		Open Existing
C	Find Instrument Drivers		Open Existing
Recent Project T	Web Kesources		- Files -
Blank Project	About MINDSTORMS Module		
and the post	MINDSTORMS Module Help NI-Embedded CAN for BIO		
	WireFlow	•	
	Activate LabVIEW Components		-
	Activate Add-ons		
	Check for Updates		
	Customer Experience Improvemen	it Program	_
	Patents		
Find Driver	About LabVIEW		Welcome to LabVIEW
Connect to dev functionality of	ces and expand the Partic LabVIEW. reque	cipate in the discussion forums o est technical support.	r Learn to use LabVIEW and upgrade from previous versions.

In the new window that appears, type "wireflow", press Search and choose to open the VI named ReadSingleSensor_TCP.vi.





◇ ❷ 🛑 🛛			8
nstructions 1. Make sure that the "WireFlow Sensor Toolkit" android appli 2. Start the "WireFlow Sensor Toolkit" android application, whi 3. Enter the IP address of the smartphone in the IP address strii 4. Select the sensor you would like to start in the dropdown m 5. Run this example application 5. Run this example application	cation is instal ich displays th ng control of t enu of this exa	led on your smartphone e IP address of the smart his example imple	(see user mar phone
IP address		Sensor data	
192.168.0.165	0	0	
Sensor		0	
Accelerometer		0	
Tip! Select a sensor that exists in your smartphone. Most smartphones have a		0	
Accelerometer sensor or a Gyroscope sensor.		0	
		0	
st STOP	or out atus code ource	^	

Start the Android application. The IP address of the smartphone is displayed in the app.



Enter the IP address of the smartphone in the IP Address string control in the LabVIEW VI. Run the VI.



Rotate your device in different ways and look at the sensor data indicator on the LabVIEW front panel to see the values change.

Other examples

Other examples that are available are the *ReadFromMultipleSensors_USB.vi/ ReadFromMultipleSensors_TCP.vi* that starts all the sensors that are available both in the toolkit and in your smartphone, and the *Rotate 3D Object_USB.vi/ Rotate 3D Object_TCP.vi* that shows a 3D object that rotates according to the Rotation Vector in your smartphone.

Using the toolkit

The toolkit consists of a few functions (VIs) that are required to be able to acquire sensor data in LabVIEW. Let's look at a simple example.



The *Init.vi* starts the sensor toolkit session. This needs to be executed first for the background service that communicates with the smartphone to start. The first numeric input is the sensor sampling time, which will be used for all sensors that are started. The second numeric input (in this example 3000 ms) is a timeout constant that tells how long the toolkit session should look for a connection with your smartphone before continuing/exiting. You also need to choose a connection type, USB or TCP with the input named Com. If you're using TCP, you also must input the IP-address to the target you want to connect to (the smartphone).

The *StartSensor.vi* starts the selected sensor in the toolkit and in the smartphone.

The *ReadSensor.vi* reads the incoming sensor data from the started sensor(s). The output format is always a 1D array of floating point values, but the array size differs depending on what kind of sensor is read (see, <u>Supported sensors</u>).

The *StopSensor.vi* stops the selected sensor in both the toolkit and in the smartphone.



The *Close.vi* closes the sensor toolkit session. This always needs to be executed lastly for the background process that communicates with the smartphone to shut down correctly.

Error codes

The Sensor Toolkit API has a number of custom error codes that is used to describe the reason for a failure to connect- or read a sensor etc.

Error code	Description
6601	SensorAPI not initialized
6602	SensorAP already initialized
6603	Failed to initialize SensorAPI
6604	No connection to phone
6605	No reply from Android device
6606	Sensor is already started
6607	Specified sensor is not started
6609	Sensor doesn't exist on this Android device
6610	Invalid command
6611	Invalid sampling time

Technical support and FAQ

FAQ

Q: Is the toolkit available for iOS devices? A: No.

Q: Can I set individual sampling frequencies for individual sensors? A: No.

Q: Which TCP port is used? A: 6000



Device not listed as a NI-VISA USB Device?

If your device has been connected to the PC before installing this driver, it is highly possible that the device is listed under another category in device manager, e.g. Portable Devices. If that's the case, right click your device in the device manager and choose "Update driver".

File Action View Help		
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> 📓 DVD/CD-ROM drives		
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Next, choose "Browse my computer for driver software".



Next, choose "Let me pick from a list of available drivers on my computer."

		×
~	Update Drivers - HuaweiMate9Pro	
	Browse for drivers on your computer	
	Search for drivers in this location:	
	C:\Users\WireFlow\Documents	
	\square Include subfolders \rightarrow Let me pick from a list of available drivers on my computer	
	This list will show available drivers compatible with the device, and all drivers in the same category as the device.	
	Next Can	cel

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Find the driver named "WF USB Driver For *Vendor/ModelSpecificName*", choose it and click "Next".



The driver should now be installed for the device and the following window will appear,



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If everything went ok, the device should now show up in the device manager under NI-VISA USB Devices as in the following image,



No USB Driver for your device?

If your USB driver isn't listed among the downloaded drivers, please execute the following steps.

- 1. Connect your smartphone to your PC.
- 2. Open up "Device Manager" in Windows.
- 3. Find your device in the list, right-click it and choose "Properties".



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- 4. Press the "Details"-tab and choose "Hardware IDs" in the drop-down menu.



5. Right-click somewhere in the window and "Select All", right-click on one of the IDs and select "Copy".

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6. Send an email to <u>support@wireflow.se</u> with the title "Smartphone Sensor Toolkit, New Driver" and paste the Hardware IDs in the email. WireFlow will then reply as soon as possible with a new driver for your device

Device not showing at all in Windows Device Manager?

This might occur for a number of reasons. The most likely one is probably that the smartphone is connected in *charge only-mode*. This can be solved by changing the connection option in your smartphone to MTP (Media Transfer Protocol) mode. If this still doesn't solve the problem, try connecting the smartphone using a different USB-cord.



References

 [1] N/A, "Sensors Overview | Android Developers," [Online]. Available: https://developer.android.com/guide/topics/sensors/sensors_overview.html. [Accessed 25 October 2017].