Intel® Wireless Gigabit VR

User Guide

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Contents

1 Introduction 7
1.1 Scope 7
1.2 References 7
1.3 Terminology 7
1.4 VR usage model 8
2 HW Setup 10
2.1 WGA 10
2.1.1 WGA components 10
The WGA system includes the following components (see Figure 2-1): 10
2.1.2 WGA assembly 10
1. Open the PC cover and insert the WGA to one of the free PCIe slots. Close the PC cover. 10
2. Connect the antenna box to the SMA connector on the external panel 10
3. Position the PC in a clear gaming area of up to 7x7m, without line-of-sight obstacles... 10
4. Position the Antenna box at a height of 0.75-1.25m , directed towards center of the room 10
2.1.3 PC Requirements 11
2.1.4 Platforms limitations…?? 12
2.2 HMDA 12
2.2.1 HMDA components 12
The HMDA FW is burnt to flash by the OEM during production line process (See Ref 7 for more details). The FW is updated with new versions over the air by the WGA. (see 4.3) 12
3 Software Install (WGA) 13
Intel WiGig software has two installation options: 13
3.1 WiGig installation without Intel CU 13
3.2 WiGig installation with Intel CU 14
3.2.1 WiGig installation (with Intel CU) 14
3.2.2 WiGig uninstall (with Intel CU) 15
3.3 Flow for running VR 15
4 WiGig Application User Manual 16
4.1 Launch the Intel® Wireless VR Dashboard 16
4.2 CU functionalities 16
4.2.1 First time connection 16
4.2.2 Automatic connections for existing profile 19
4.2.3 Disconnect from the HMDA 20
4.2.4 WiGig Radio Off 20
4.2.5 HMDA settings 21
When selecting the “Wireless Headset Settings” the window in Figure 3-12 pops up. 22
4.2.6 About information 22
4.2.7 Connection Quality Indication (CQI) 22
4.3 HMDA FW Update 23
4.3.1 FWU errors 24
4.4 Notification messages in CU 25
4.4.1 Device status Errors 25
4.4.2 Device RF state Errors 27
5 LEDs and Buttons/GPIOs 29
5.1 LEDs 29
5.2 Buttons/GPIOs 29
6 WiGig events in Windows Event Viewer (TBD) 31

6.1 WiGig Event Properties 31
6.2 WiGig Event Data 31
6.3 Accessing WiGig Events Log 31
7 End User Logging Utility (EULU) 33

Figures

Figure 1-1 WiGig VR usage model 9
Figure 2-1 – WGA components 10
Figure 2-2 - WGA setup 11
Figure 3-1 - End User License Agreement dialog box 14
Figure 3-2 - Success message 14
Figure 3-3 - Uninstall window 15
Figure 3-4 - SteamVR Ready 15
Figure 3-5 - SteamVR Not Ready 15
Figure 4-1 - OOB window 16
Figure 4-2 - Intel® Wireless VR First Time Connection 17
Figure 4-3 - HMD connected message 17
Figure 4-4 – Scanning 18
Figure 4-5 - Connect New VR Headset 18
Figure 4-6 New connection timeout message 19
Figure 4-7 - Scanning 19
Figure 4-8 - Wireless Radio Off 20
Figure 4-9 - Confirm Radio Off 20
Figure 4-10 - Radio Off status 21
Figure 4-11 - Wireless Radio On 21
Figure 4-12 - CU settings menu 21
Figure 4-13 - Wireless Headset Settings 22
Figure 4-14 - ABout window 22
Figure 4-15 - Connection Quality Indication 23
Figure 4-16 - HMDA SW Update progress 23
Figure 4-17 - HMDA SW Update complete 24
Figure 4-18 - SW Update Error during FWU process 24
Figure 4-19 - SW Update Error due to SW incompatibility 25
Figure 4-20 - Driver disabled error message 25
Figure 4-21 - RFEM not connected error message 26
Figure 4-22 Antenna Setup instructions 26

Tables

Table 1-1 References 7
Table 5-1 CQI levels 23
Table 5-2 Error code cases – device status 27
Table 5-3 Error code cases – RF state error 27
Table 6-1 LEDs behavior 29
Table 6-2 Signals behavior 29
Table 7-1 List of groups for Task Category parameter in WiGig Events 31

Revision History

Revision	Description	Date
1.0	Initial release	February, 2018

1 Introduction

1.1 Scope

This document is targeted for OEMs to get familiar with the Intel® WiGig VR solution components. It provides flows for setup, installation and configuration. In case further troubleshooting is required please refer to Ref 9.

1.2 References

Table 1-1 References

	Document name	Description
Ref 1	*571416_Intel_WiGig-W11100_VR_PnP_EPS_Rev1.1*	*WGig VR PnP External Product Specifications (EPS)*
Ref 2	*571415_Intel_WiGig_13110_VR_MpP_SNK_EPS_Rev 1.1*	*WiGig VR Maple Peak SNK External Product Specifications (EPS)*
Ref 3	*557232_WiGig_R-FEM_External_Product_Specification_Rev3.0*	*WiGig R-FEM2 External Product Specifications (EPS)*
Ref 4	*563709_Intel_Wireless_Gigabit_Antenna_M10101R_RFEM3_EPS_Rev0.7*	*WiGig R-FEM3 External Product Specifications (EPS)*
Ref 5	*571610_Intel_WiGig-W11100_VR_PnP_PDG_Rev0_8*	*WiGig VR PnP Platform Design Guidelines*
Ref 5	*571636_Intel_WiGig_13110_VR_MpP_SNK_PDG_Rev 0_8*	*WiGig VR MpP SNK Platform Design Guidelines*
Ref 6	*572100_Intel_WiGig_VR_PTG_Rev1_0*	*Intel WiGig VR Platform Testing Guidelines*
Ref 8	*Intel_WiGig_SDK_API (part of the SW package)*	*API for WiGig driver SDK*
Ref 9	*First Aid Debug Kit*	

1.3 Terminology

Acronym	Description
VR-PnP	Intel® Wireless Gigabit W11100 Pine Peak WiGig-only module. Includes WiGig MAC/BB chip solution for VR-Client side.
VR-SNK	Intel® Wireless Gigabit Sink-M 13110 VR WiGig-only module. Includes WiGig MAC/BB chip solution for VR-SNK side.
R-FEM2	Intel® Wireless Gigabit Antenna-M 10042R
R-FEM3	Intel® Wireless Gigabit Antenna-M 10101R
LOS	Line of sight
NLOS	Non line of sight (single reflection)

Acronym	Description
TPT	Throughput
MA-USB	Media agnostic USB – WiGig USB PAL
SNK	Sink; receiver in A/V applications
HDMI	High definition multimedia interface
SKU	Stock keeping unit
VR	Virtual reality
HMD	Head-mounted display
HID	Human interface device
GPU	Graphics processing unit
IMU	Inertial measurement unit
WGA-P	WiGig gaming add-on
HMDA	HMD add-on, refering to WiGig solution for VR HMD side
WGE	WiGig gaming embedded, referring to the WiGig solution, embedded in VR PC laptops

1.4 VR usage model

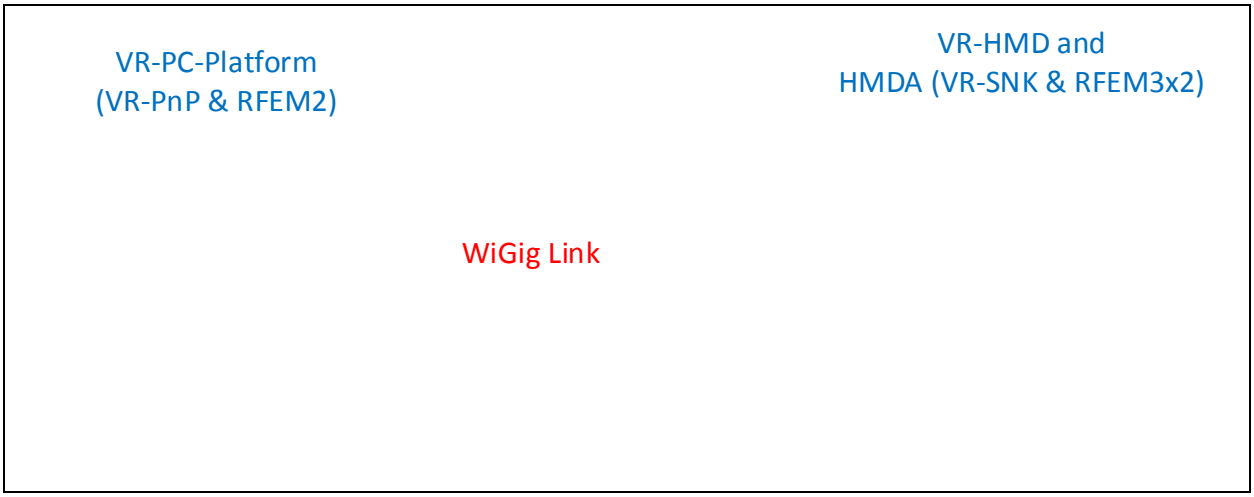
The Virtual Reality (VR) tethered system is composed of a head-mounted display (HMD) that is cable-connected to a PC or Laptop. In such system, HMD user is limited to specific movement-types and distance due to the cable connection with the PC.

The VR-SNK product, together with the VR-PnP WiGig peer product (see Ref1 and Ref**2**), allows wireless tethering of the VR system. By communicating all video, audio and control content over a WiGig link, the HMD becomes a stand-alone component, providing freedom of movement and the best user experience. WiGig video latencies and ultra-short USB latencies, combined with superior video quality and low power consumption, allow for a wired-like gaming experience. A high-throughput USB back-channel allows for connection of state-of-the-art human interface devices (HIDs), such as motion detectors and HD cameras, without any quality degradation.

Figure 1-1 presents WiGig VR usage model setup. The components at each side are:

- VR-PC-Platform side, which is a client-side WiGig system, based on VR-PnP and R-FEM2 products. See more details in Table 1-1 1.
- VR-HMD side, connected to HMDA (HMD add on). HMDA is an SNK-side WiGig system, based on VR-SNK and R-FEM3 products. See more details in Table 1-1 2.

Figure 1-1 WiGig VR usage model



2 HW Setup

2.1 WGA

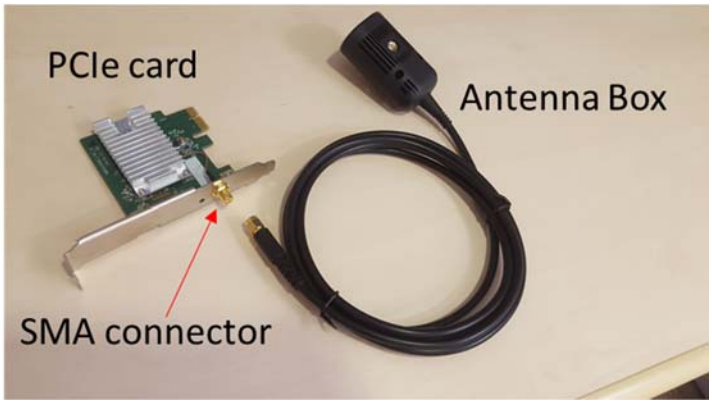
WGA is WIGig Gaming add-on, installed on the PC side. WiGig application is installed on the PC to control the connection with the HMDA side. See 3 for more details.

2.1.1 WGA components

The WGA system includes the following components (see Figure 2-1):

- VR PC desktop platform – a VR-compatible platform
- PCIe card (with PnP module soldered-down)
- Antenna box – a standalone box connected over a ~2m coax cable to an SMA connector exposed by PCIe-WGA's external panel

Figure 2-1 – WGA components



2.1.2 WGA assembly

1. Open the PC cover and insert the WGA to one of the free PCIe slots. Close the PC cover.
2. Connect the antenna box to the SMA connector on the external panel
3. Position the PC in a clear gaming area of up to 7x7m, without line-of-sight obstacles
4. Position the Antenna box at a height of 0.75-1.25m , directed towards center of the room
5. You can check the device manager for "Network Controller" with the Hardware ID as in Figure 2-2, to make sure card is inserted correctly. (Note that after SW installation you should see WiGig driver, see Figure 3-1)

Figure 2-2 - Device manager - PCIe card device

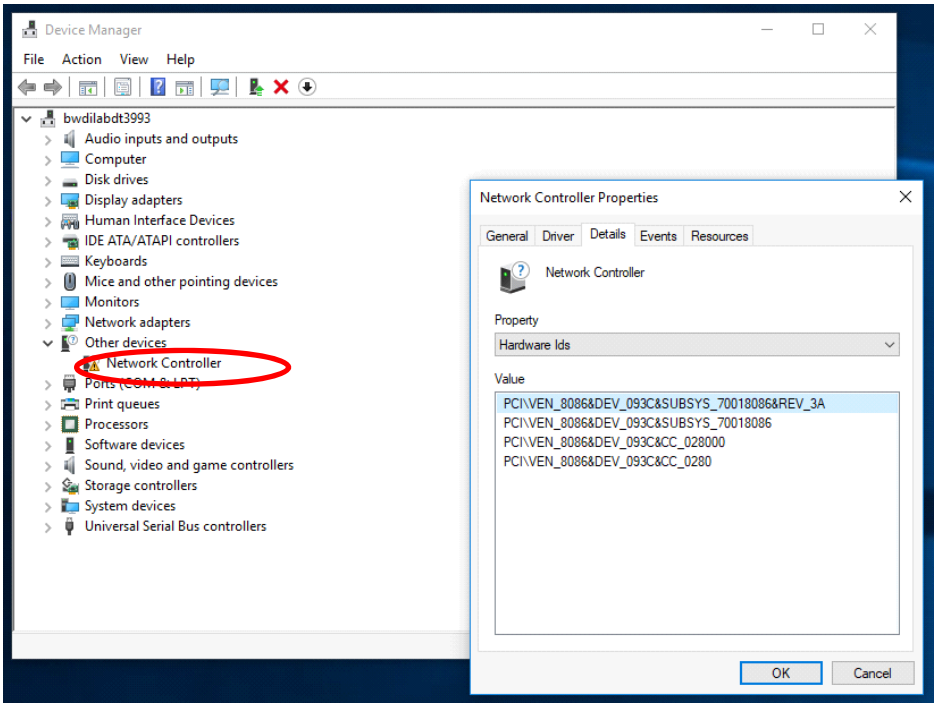


Figure 2-3 - WGA setup – SMA connector, Antenna box mounted on table

2.1.3 PC Requirements

- In order to run VR content smoothly there is minimum system requirements as below:

- CPU –
- GPU –
- OS – Win 7 or Win10 64bit..

2.1.4 Platforms limitations…??

AMD – only on PCH..

….

…

2.2 HMDA

The HMDA is a wireless HMD adapter, integrated on the HMD by the OEM, that allows untethering the HMD from the PC.

2.2.1 HMDA components

- MpL-SNK VR module
- 2 x RFEM3 modules connected over coax cable to MpL-SNK

The HMDA FW is burnt to flash by the OEM during production line process (See Ref 7 for more details). The FW is updated with new versions over the air by the WGA. (see 4.3)

3 Software Install (WGA)

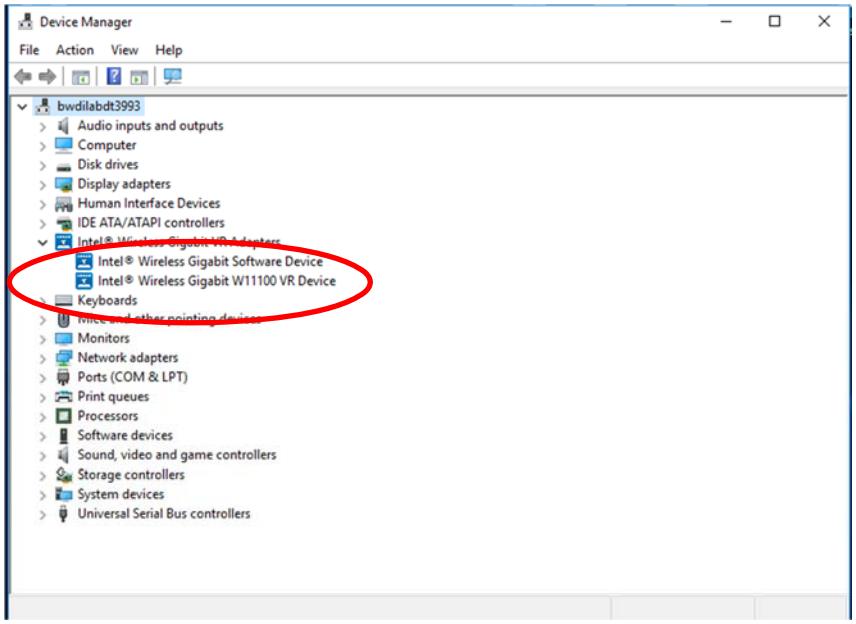
The SW package should be provided by the OEM for installation on the PC side (WGA). This package includes OEM drivers, WiGig driver and encoder driver . The PCIe card must be installed (see 2.1.2) before the SW installation, otherwise WiGig driver installation will fail.

Intel WiGig software has two installation options:

- Installer that includes Intel CU (Connection Utility) application
- Installer that installs only WiGig driver without Intel CU. For this option the OEM needs to develop its proprietary application which is integrated to WiGig SDK API

After installation check the Device Manager for "Intel Wireless Gigabit VR Adapters" as in Figure 3-1.

Figure 3-1 - WiGig driver in Device Manager



3.1 WiGig installation without Intel CU

If the OEM choose to develop their own CU application it requires an integration with Intel SDK (see Ref 8 for more details). OEM package for the end user should include OEM CU and Intel WiGig driver. WiGig driver should be installed by (OEM) calling to setup.exe from NOCU_VR layout\Win7Plus\.

For silent installation the following command should be used:

"SetUp.exe -silent -norestart -l C:\WiGig\InstallationLogs\WiGig_VR_NB_Setup_exe.txt"

For silent uninstall the following command should be used:

"SetUp.exe -silent -uninstall -norestart -l C:\WiGig\InstallationLogs\WiGig_VR_NB_Setup_exe.txt"

*Note that all CU features and user manual under 4 are related to Intel CU only and does not apply to OEM CU. Please refer to the OEM for guidelines on their CU.

3.2 WiGig installation with Intel CU

3.2.1 WiGig installation (with Intel CU)

1. Go to G_VR Layout\Win7Plus\ and run Setup.exe.

Figure 3-2 - End User License Agreement dialog box

2. Check the "*I have reviewed and agree to the EULA*" box, and click *Install*. This will install the operational WiGig software for the WGA side.
3. When the application is successfully installed, Click *Finish*, see Figure 3-3.

Figure 3-3 - Success message

4. After installation you will be able to launch the Intel® Wireless VR Dashboard application from the desktop shortcut or by searching the PC programs.

3.2.2 WiGig uninstall (with Intel CU)

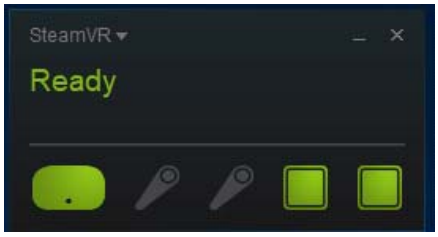
When uninstalling the Intel CU the user can select whether to keep the previous settings or discard them, i.e. HMDA profile and settings (see more details about profiles in 4.2.2 and about HMDA settings in 4.2.5)

Figure 3-4 - Uninstall window

3.3 Flow for running VR

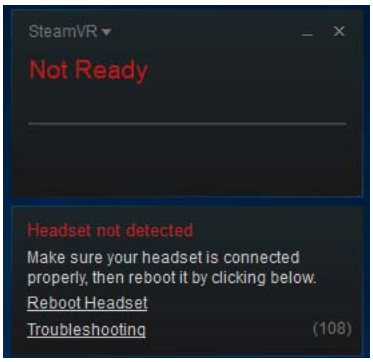
- Install SteamVR (please refer to SteamVR website)
- Install OEM package as described above
- Create a WiGig connection – see in 4.2.1 for WiGig connection creation through Intel CU
- Open SteamVR – It should recognize the HMD and show Figure 3-5

Figure 3-5 - SteamVR Ready



- If SteamVR is opened prior to the WiGig connection the HMD will not be detected and Figure 3-6 will be shown.

Figure 3-6 - SteamVR Not Ready



4 WiGig Application User Manual

Note that this Chapter is only relevant if the SW was installed including Intel CU, as described in paragraph 2.2. OEM CU will have different GUI and may or may not have similar functionalities. Please refer to the OEM for instructions on its proprietary application.

4.1 Launch the Intel® Wireless VR Dashboard

To invoke the Intel® Wireless VR dashboard, double-click the icon on the desktop, or search for this application under the PC programs.

4.2 CU functionalities

The Intel® Wireless VR is a dedicated application that runs on the PC (WGA side) and allows the user to find, connect to, and configure an HMDA.

The CU application has a menu, status bar for a general WiGig status and a notification bar for more information on the status. (See examples in below figures)

LEDs on the HMDA device provide additional feedback about the HMDA status.

The Function button on the HMDA device is used for controlling flows such as pairing and power down indication. A recovery button is used to restore factory FW in case of an issue in current running FW. (See 5 for more details on LEDs and Buttons)

4.2.1 First time connection

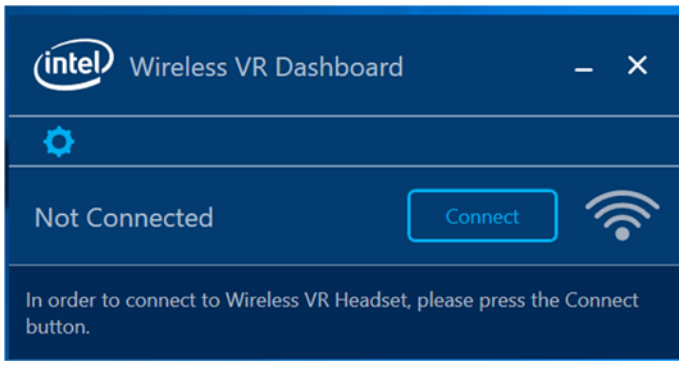
Every time that the WGA is connected to the HMDA, the CU application saves the HMDA profile to be able to connect to it automatically in the following connections (see more details in 4.2.2). When connecting to an HMDA for the first time, a pairing process will be initiated during connection.

4.2.1.1 Out-of-Box / No Profile flows

When the CU is launched for the first time, or when no profile is saved in the CU, the connection flow will be as follows:

1. Power on HMDA, verify functional LED is ON, displaying slow blinking green light (1 blinks/sec).
2. The CU will show “Not Connected” status and a “Connect” button, as can be seen in Figure 3-2.

Figure 4-1 - OOB window

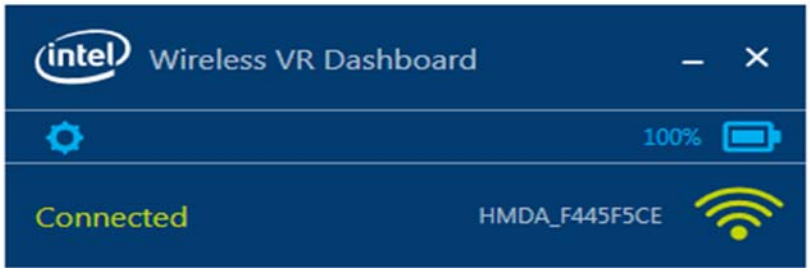


3. Press “Connect” in order to connect to an HMDA in the PC range (as written in the notification bar). A pairing is required since no HMDA profile is saved on the WGA side. The following screen will pop-up, see figure 3-4.

Figure 4-2 - Intel® Wireless VR First Time Connection

4. The HMDA LED will be fast blinking green light. Press your HMDA function button to confirm the connection.
5. Note that all HMDAs in range may blink, but only the one that its button is pressed will be connected.
6. After a successful pairing the status in the CU will be changed to Connected as in **Error! Reference source not found.** and the HMDA LED will become constant green.

Figure 4-3 - HMD connected message

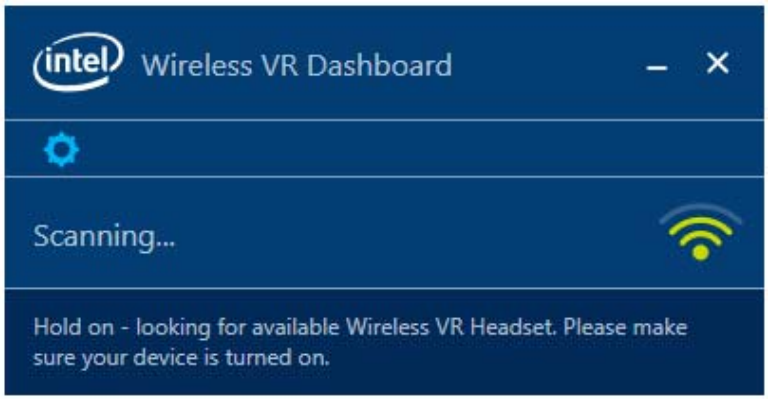


Congratulations! You’ve made your first wireless VR connection.

4.2.1.2 Add New Device

If the CU has a saved HMDA profile it will search for it and the CU will show “Scanning” as in Figure 4-4

Figure 4-4 – Scanning

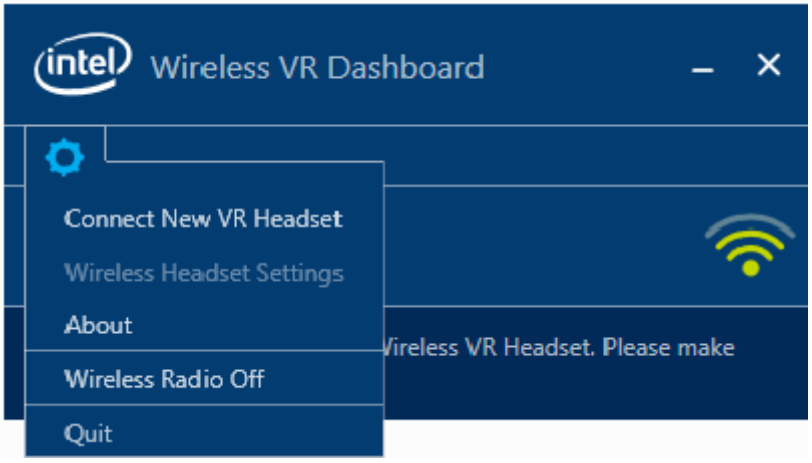


In case the saved HMDA is not in range, or if the user wants to connect to another HMDA, the user should press the Gear icon and select “Connect New VR Headset” (See **Error! Reference source not found.**). Since only one HMDA profile is saved in the WGA, this operation will delete the saved profile and search for HMDAs in range.

Similarly, if an HMDA is already connected and the user wishes to connect to another HMDA, he/she should press the Gear icon and select “Connect New VR headset”. This will disconnect the current HMDA and will start a connection process. The process will proceed as described in 16 similar to first time connection.

Note that the profile of the disconnected HMDA will be deleted and a new pairing will be required on next connection.

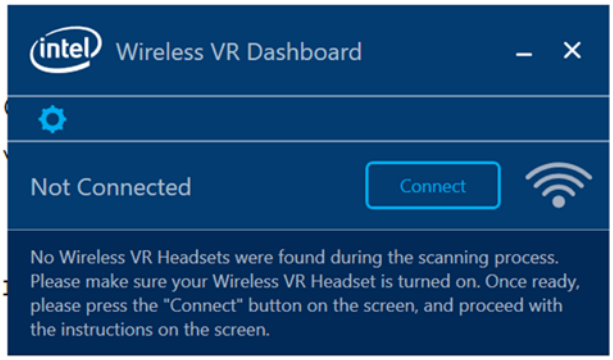
Figure 4-5 - Connect New VR Headset



4.2.1.2.1 Add new device timeout

If there is no HMDA in range, or no one pressed the HMDA button to connect, within a predefined time (currently defined as 2 minutes), the connection attempt will stop, the CU status will be set to “Not connected” and the text as seen in Figure 4-6 will be in the notification bar.

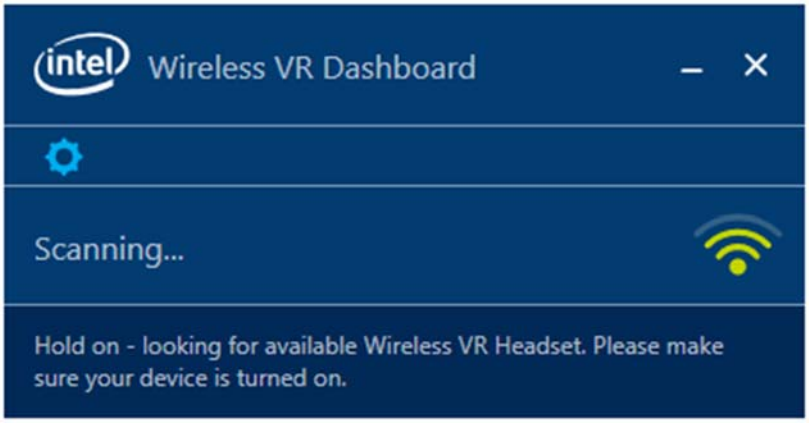
Figure 4-6 New connection timeout message



4.2.2 Automatic connections for existing profile

After first connection of the WGA with an HMDA, a profile will be created for this specific HMDA and the next time the CU is opened it will search for this specific HMDA and will connect to it automatically. When launching the CU with a saved HMDA the following screen will be seen:

Figure 4-7 - Scanning



If the saved HMDA is in range it will connect to it automatically. This automatic connection will occur either when opening the CU (and HMDA is in range) or when the HMDA is entering the range of the WGA (and CU is open).

4.2.2.1 Automatic connection in Sx

When the WGA enters Sx power state while connected to the HMDA, the WiGig will be disconnected and no video will be seen. When the WGA gets back to S0 mode the connection between HMDA and WGA is restored automatically.

4.2.3 Disconnect from the HMDA

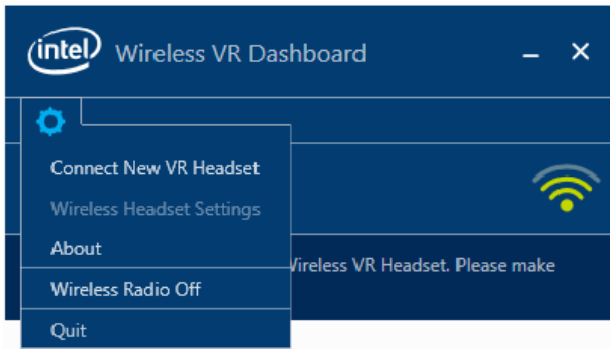
There is no specific command that disconnect the HMDA from the WGA but there are several ways to achieve disconnection:

1. Taking the HMDA out of range of the WGA will eventually cause a link loss and a disconnection. Getting in range again will auto-connect the HMDA, unless the profile was deleted.
2. Power off the HMDA will cause a WiGig disconnection
3. Closing the CU will disconnect the WiGig connection
4. "Add new device" menu will disconnect the current connection (in order to start a new connection)

4.2.4 WiGig Radio Off

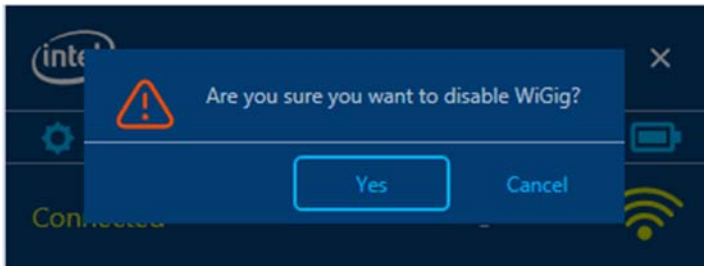
1. To turn the WiGig radio Off click on the Gear icon and select "Wireless Radio Off".

Figure 4-8 - Wireless Radio Off



2. When the popup-menu in **Error! Reference source not found.** appears select yes.

Figure 4-9 - Confirm Radio Off

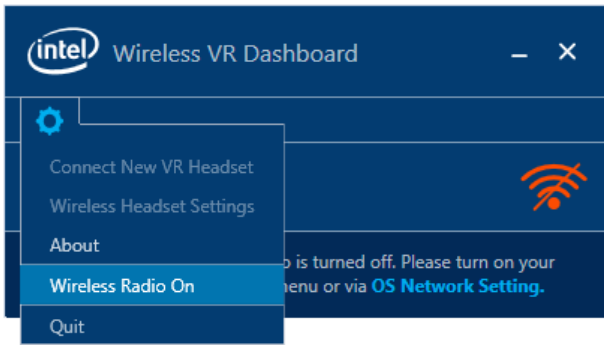


3. When WiGig Radio is Off, you cannot find and connect to a wireless HMDAs; The CU shows "Not ready" as in Figure 4-10**Error! Reference source not found.**. Turn WiGig radio Off minimizes the power consumption of the WiGig radio in the WGA side.

Figure 4-10 - Radio Off status

4. When the radio is off, the menu in the Gear icon will be changed as in Figure 4-11

Figure 4-11 - Wireless Radio On



5. Press “Wireless Radio On” to Turn the radio On again.

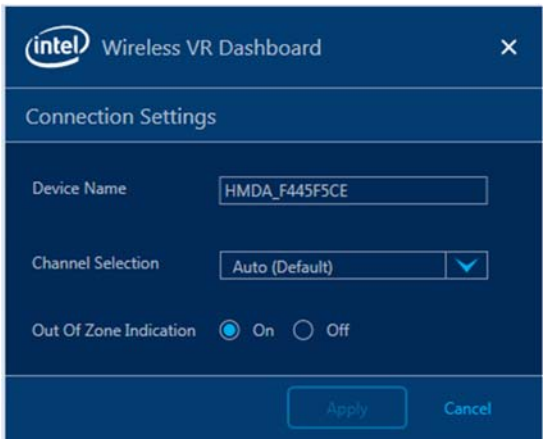
4.2.5 HMDA settings

While the WGA is connected to an HMDA you can configure the HMDA with few settings through the CU. Click the Gear icon and select “Wireless Headset Settings”, see **Error! Reference source not found.Error! Reference source not found.**.

Figure 4-12 - CU settings menu

When selecting the “Wireless Headset Settings” the window in **Error! Reference source not found.** pops up.

Figure 4-13 - Wireless Headset Settings



- Device name – Set the name of the HMDA. This is the name that is seen in the CU when this HMDA is connected. The name will be seen for this HMDA for connection with any WGA.
- Channel Selection – default option is Auto – Allows WiGig driver to decide on the channel to use after connecting to the WGA. Other options are Channel 1, Channel 2 or Channel 3 – this option set a fixed channel for this connection. It is helpful when working in dense environment to allow work on different channels for adjacent setups.
- Out Of Zone Indication – In extreme conditions, when the video quality is bad for a certain time, the HMD will show a bluish screen instead of the bad video. This feature can be disabled or enabled using this radio button in the HMDA settings.

4.2.6 About information

A general information such as WiGig and DL SW version can be seen under the Gear icon “About” menu. See **Error! Reference source not found.**.

Figure 4-14 - ABout window

The Help link in the ‘About’ page is directed to WiGig page under Intel Customer Support website.

4.2.7 Connection Quality Indication (CQI)

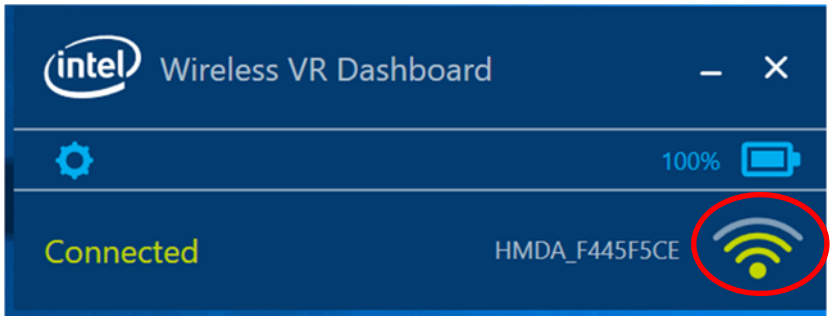
When the PC and HMDA are connected there is an indication of the Channel Quality in the CU (red circle in **Error! Reference source not found.**.

There are 5 levels of the connection quality that are represented by 4 bars as defined in the below table.

Table 4-1 CQI levels

Connection Quality Indication (# of Bars)	High-level Interpretation
4	Best
3	Good
2	Average
1	Poor
0	Insufficient

Figure 4-15 - Connection Quality Indication



4.3 HMDA FW Update

HMDA (VR-SNK) flash memory has 2 slots:

- Factory slot – In the production line the FW is burnt to this slot.
- Current slot – when upgrading the SW Over-The-Air (OTA) it is burnt to the current slot.

During connection process of the WGA and HMDA, if the SW versions of the WGA and HMDA are not identical, the version at the WGA side will be burnt to the HMDA side OTA, which will cause either upgrade or downgrade of the HMDA SW.

Figure 4-16 - HMDA SW Update progress

During the software update process the HMDA LED will be fast blinking Red.

Once the update process is complete, the HMDA SW is reset, and when reset complete, the WGA will automatically re-connect

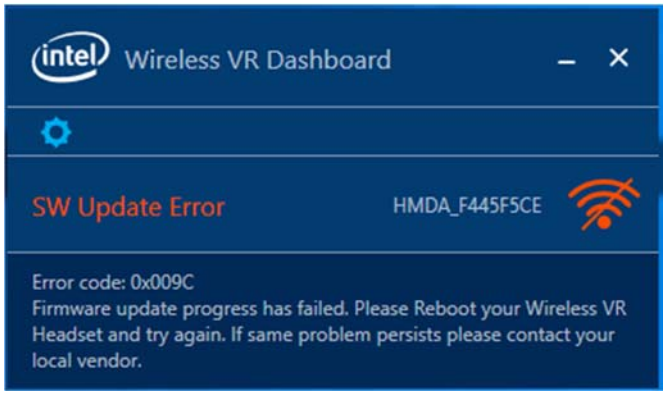
Figure 4-17 - HMDA SW Update complete

4.3.1 FWU errors

4.3.1.1 SW update progress error

In case of an error that occurred during the SW update process the Error in **Error! Reference source not found.** will be seen in the CU status bar:

Figure 4-18 - SW Update Error during FWU process



4.3.1.2 SW incompatibility error

In some cases there is incompatibility between the SW in the WGA and HMDA which does not allow a FWU. In such case the Error in **Error! Reference source not found.** will be shown and the user will have to install a different SW on the WGA side.

Figure 4-19 - SW Update Error due to SW incompatibility

4.4 Notification messages in CU

In cases of errors or possible limitations, the status bar in the CU (bottom of the CU window) will show a text describing the error and a potential workaround.

See some examples below and a full list in Table 4-2 and Table 4-3

4.4.1 Device status Errors

4.4.1.1 Driver Disabled

When the WiGig driver is disabled, the below Error will be seen. In order to fix this issue the driver should be enabled and a link to the Device Manager is provided.

Figure 4-20 - Driver disabled error message

4.4.1.2 RFEM not connected

When the RFEM of the WGA is not connected (e.g. the user unplugged the antenna) the below error message will be seen. Instructions for Antenna Setup (see figures below) are provided to help the user fix the problem.

Figure 4-21 - RFEM not connected error message

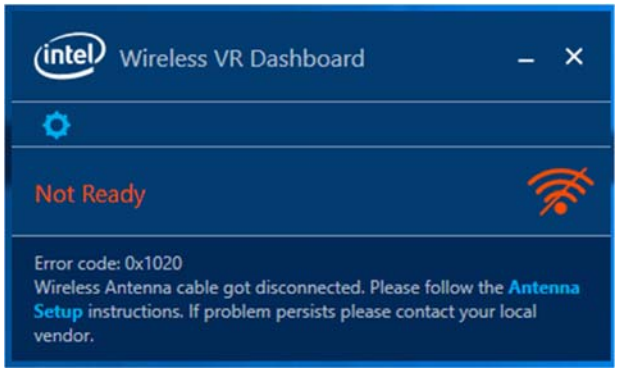


Figure 4-22 Antenna Setup instructions

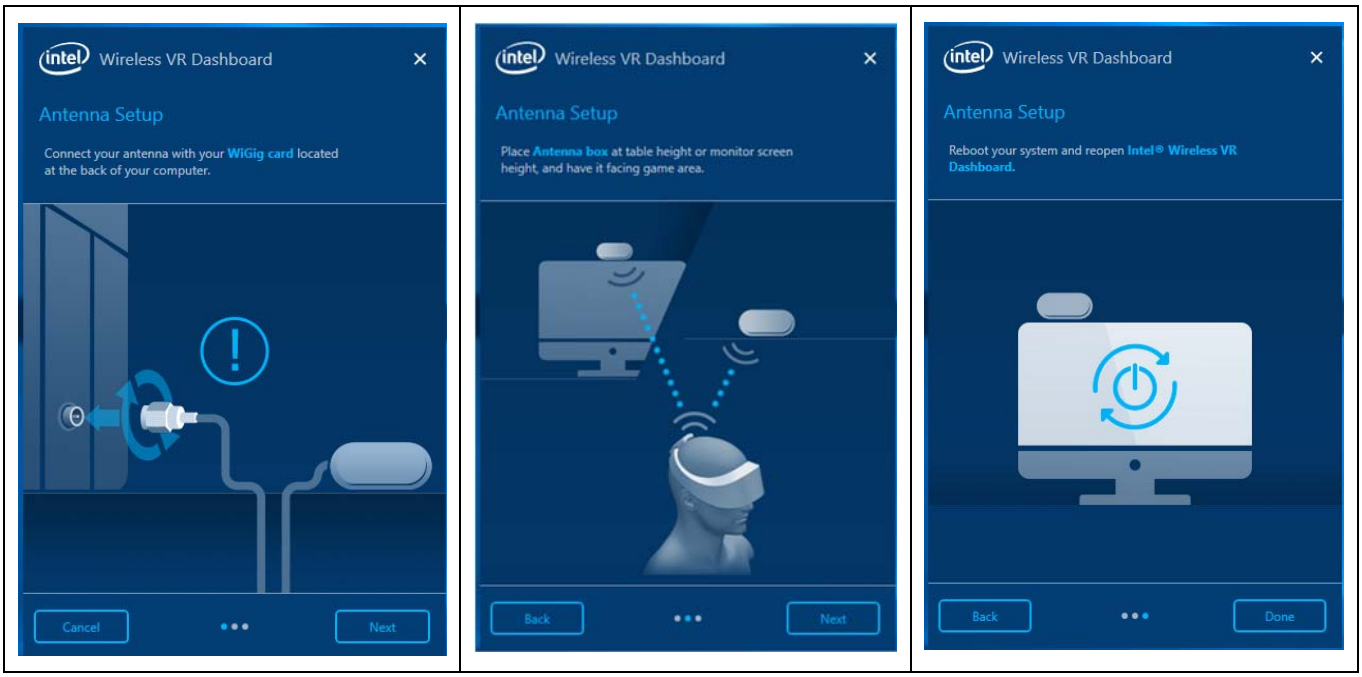


Table 4-2 Error code cases – device status

Item	Error Code	Description	Notification Text
1	0x1000	Device driver is disabled	Error code: 0x1000 It seems that your Wireless VR device driver was disabled. To enable it, please open Device Manager
2	0x1014	RFEM Gen Malfunction	Error code: 0x1014 Wireless Antenna cable got disconnected. Please follow the Antenna Setup instructions. If problem persists please contact your local vendor
3	0x1020	RFEM not connected	Error code: 0x1020 Wireless Antenna cable got disconnected. Please follow the Antenna Setup instructions. If problem persists please contact your local vendor.
4	0x1022	HW not detected	Error code: 0x1022 It seems that your Wireless VR Adapter is not properly connected to PCI interface. Please ensure that device is connected to PCI interface and try rebooting your computer. If problem persists please contact your local vendor.
5	0x1100	Generic Error	Error code: 0x1100 It seems that your Wireless connection experienced an unexpected error, please wait few minutes while we try to restore connection. If problem persist, please reboot your PC and your Wireless VR Headset. For further assistance please visit Help at intel.com

4.4.2 Device RF state Errors

Table 4-3 Error code cases – RF state error

Item	Error Description	Notification Text
1	Airplane Mode is enabled	WiGig has been disabled by Airplane Mode. You must enable Intel WiGig to find and connect to

		Wireless Headsets. To enable WiGig, turn Airplane Mode off.
2	RF Off due to Critical Temperature	Please wait few minute and reboot your Wireless VR Headset (should be changed)
3	WiGig disabled due to physical switch	WiGig has been disabled by a physical switch on your computer. You must enable Intel WiGig to find and connect to wireless Headsets. To enable WiGig, turn the physical switch back on.
4	WiGig disabled by SW	It seems that your Wireless Radio is turned off. Please turn on your Wireless Radio via the settings menu or via OS Network Setting.

5 LEDs and Buttons/GPIOs

WiGig VR-SNK provides two LED signals: Red and Green for status indication for the user. It also provides Two GPIO Input signals that allow the user to control the WiGig flows. OEM is responsible to implement the final UX based on these LEDs and signals. See REF 2 for more details.

5.1 LEDs

The following table provides details on the different states and LEDs behavior.

Table 5-1 LEDs behavior

System State	LED	Behavior
Discovery	Green	Slow Blink (1 blink/second)
Waiting PBC	Green	Fast Blink (4 blinks/second)
Connected	Green	Constant On
Errors: • CT-Kill • FW Upgrade Error	Red	Constant On
FW Upgrade	Red	Fast Blink (4 Hz)

5.2 Buttons/GPIOs

There are 2 Input GPIO signals for the HMDA – Function signal and Recovery signal.

It is the OEM responsibility to define the UX for the buttons controlling these signals. The signals behavior is defined as below:

Table 5-2 Signals behavior

Signal	Pulse	Behavior
Function GPIO	Short	When in “Wait for PBC” state, it will trigger connection establishment
Function GPIO	Long	Power Down Indication – provides an indication that WiGig will be powered down within X secs. This allows the

		WiGig driver to complete all flows and have a safe power down.
Recovery GPIO	~2 secs high pulse during power cycle	HMDA FW is restored to factory slot, profile and HMDA settings are deleted

There is an additional GPIO which is defined as Output and allows the WiGig driver to indicate it is not connected. This allows OEM to implement HMDA power save.

For more details on all signals please see REF 2.

6 WiGig events in Windows Event Viewer (TBD for WiGig VR)

WiGig SW provides logging information to Windows Event Viewer, both for local PC and for the connected WiGig HMDA. This information appears in Windows Event Viewer under *Applications and Services Logs -> Intel® WiGig.*

6.1 WiGig Event Properties

The events are distinguished by the following list of properties:

- Log Name: Intel® WiGiG
- Level: can be
  - Information – Events with this level provides informative data of WiGig flow.
  - Error - Event with this level provides data for erroneous WiGig flow.
- Source: can be
  - iWiGig-Local – Events logged from local WGA side
  - iWiGig-Remote – Events logged from remote HMDA side, that is, WiGig connected to the WGA
- Event ID: Will be always 256
- Task Category: The index for this parameter may belong to the groups listed in Table 6-1. TBD

Table 6-1 List of groups for Task Category parameter in WiGig Events

	***Task Category* index range**	**Group type**
1	0-199	TBD
2	200-299	TBD
3	300-399	TBD
4	600-699	TBD

6.2 WiGig Event Data

The data per each event provides the following information:

- TBD.

6.3 Accessing WiGig Events Log

The steps to access the WiGig Events log are

1. Open the Windows Event Viewer.
2. On the left-hand pane, Go to *Applications and Services Logs->Intel® WiGig*.

   The middle pane displays the list of WiGig events.
3. The user can click on each event and see its specific details on the bottom pane.

4. By right-clicking on *Applications and Services Logs->Intel® WiGig* (on the left-hand pane), user may save the WiGig Events log or perform other operations as allowed by the Event Viewer.

7 End User Logging Utility (EULU)