User Manual

SIRIUS User Manual
ETF-SIR-O5001

Version 1.0
Jan 2025

ETTIFOS®

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1 Introduction

SIRIUS is an all-in-one solution supporting the functional testing and performance analysis of LTE-V2X sidelink (PC5) communication as well as rapid prototyping advanced V2X use cases, such as extended sensor sharing, advanced driving, and vehicle platooning.

Users are able to:

- Develop their own LTE-V2X applications using APIs provided by SIRIUS.
- Run and verify user applications using the LTE-V2X sidelink protocol and modem provided by SIRIUS.
- Analyze and monitor real-time performance of LTE-V2X sidelink communication using EDM, a Diagnostic Monitoring (DM) SW tool that interworks with SIRIUS.

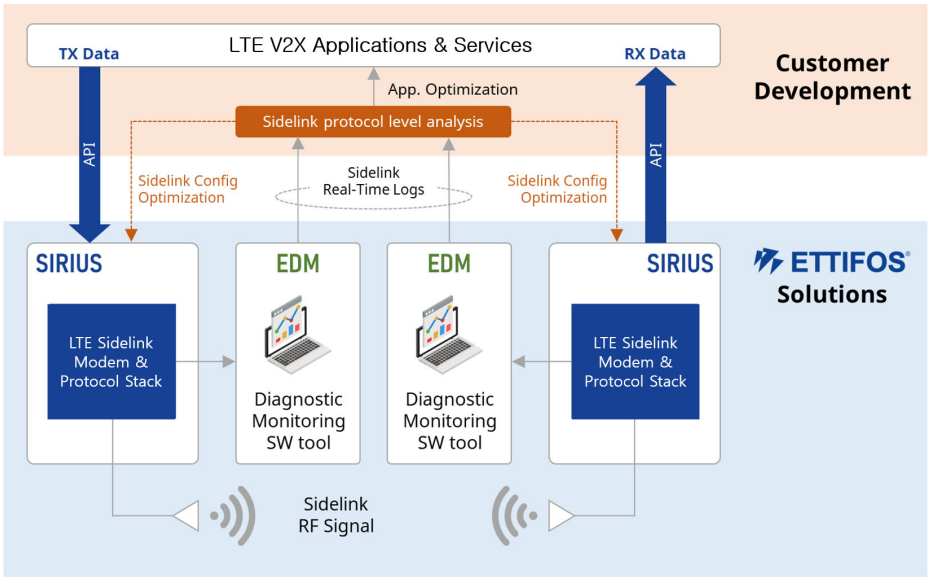


Figure 1-1: User application development and performance analysis using SIRIUS

SIRIUS is not only suitable for lab tests, but also for field tests and on-road driving tests to evaluate various LTE-V2X use cases as illustrated in Figure 1-2.

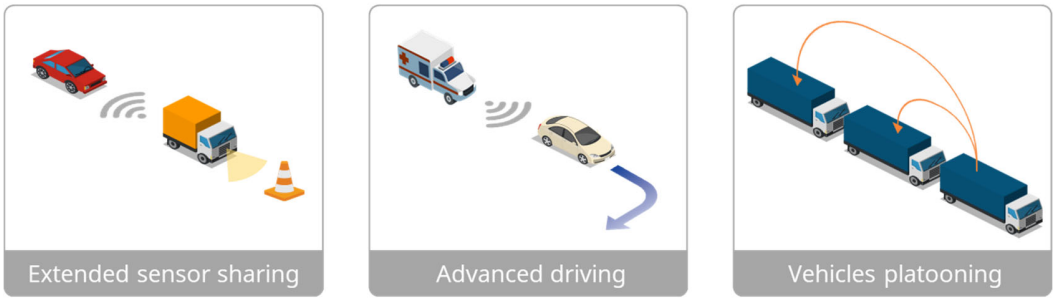


Figure 1-2: Various LTE-V2X use cases supported by SIRIUS

This document describes the first step to start, configure, and run SIRIUS.

1.1 Additional documents

For advanced use of SIRIUS, please refer to the following documents available at https://ettifos.atlassian.net/servicedesk/customer/portals:

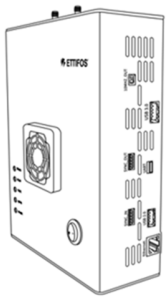
- Technical specifications
- SDK user manual
- EDM (Ettifos Diagnostic Monitoring) user guide

1.2 Unpack SIRIUS

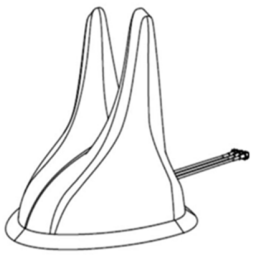
The package contains parts as below.

Table 1-1 SIRIUS package parts

Part	Type	Quantity
SIRIUS	-	1
V2X & GPS antenna	SMA(Reverse)	1
Ethernet cable	UTP Cat5e	1
Power cord	AC	1
Stand	-	2
Screw	-	4
Screwdriver	-	1

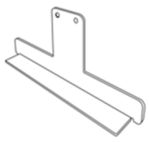


SIRIUS X1



V2X & GPS ANT X1

Ethernet Cable X1



Stand X2

Screw X4

Screwdriver X1

1.3 User application development

SIRIUS provides Software Development Kit API to reduce effort in developing user applications. Please refer to the SIRIUS SDK API User Manual for further information.

1.4 Monitoring and logging

1.4.1 Connection and use of EDM

Directly connect the Ethernet port in the right-side panel of SIRIUS to an EDM-installed computer.
Execute EDM and the start window below will pop up on your screen.
Please refer to the EDM User Manual for further information.

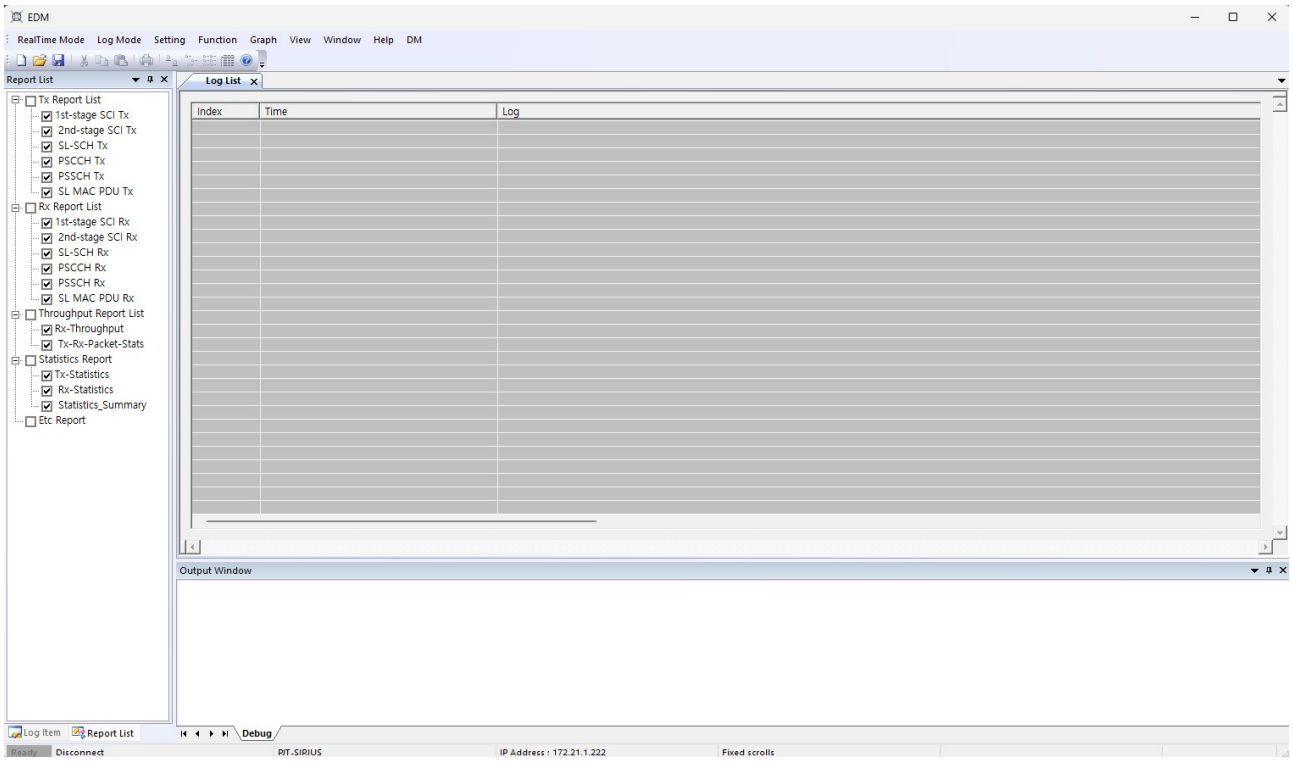


Figure 1-3 Start window of EDM

2 Hardware setup

2.1 Hardware overview

2.1.1 Front panel with LEDs

The status LEDs are located on the front panel of SIRIUS.

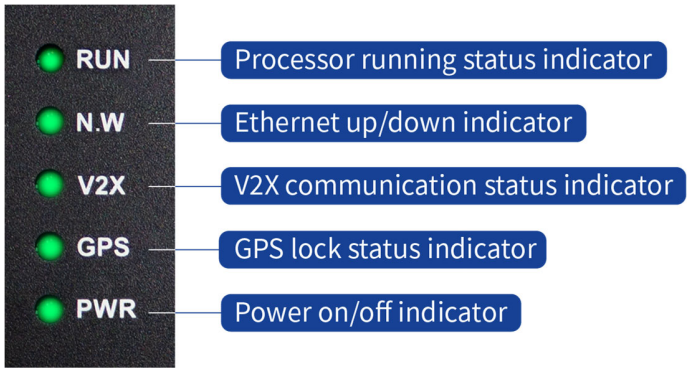


Figure 2-1 Status LEDs for SIRIUS

Table 2-1 LED descriptions

LED	Description	
RUN	Blink Green	Processor is normally operating.
	Solid Green	Processor is abnormal.
N.W	Solid Green	Ethernet is up.
	Off	Ethernet is down.
V2X	Solid Green	LTE-V2X Tx/Rx is ready.
	Solid Yellow	LTE-V2X Tx/Rx is not ready.
	Off	LTE-V2X main software is not executed.
GPS	Solid Green	GPS signal is locked.
	Solid Yellow	GPS signal is unlocked.
PWR	Solid Green	Power is on.
	Off	Power is off.

2.1.2 Top panel with antenna ports

The antenna ports are on the top panel of SIRIUS.

Figure 2-2 Antenna ports for SIRIUS

Table 2-2 Antenna descriptions

Antenna port	Type	Description
ANT-1	SMA female(Reverse)	V2X antenna port #1
ANT-2	SMA female(Reverse)	V2X antenna port #2
GPS	SMA female	GPS antenna port

NOTICE: Make sure not to overload the RF input and keep within the maximum allowed signal level of -10 dBm.

2.1.3 Right-side panel with I/O interfaces

The right-side panel of SIRIUS provides I/O interfaces, and a switch is on the front panel and power connectors are on the bottom panel of SIRIUS.

Figure 2-3 I/O interfaces for SIRIUS

Table 2-3 I/O interface descriptions

Interface	Type	Description
UART	USB-C	Debug port for serial debug (115200n8)
USB	USB 2.0	USB host port
USB	USB 3.0	External interface supporting USB 3.0
Ethernet	RJ-45	Ethernet port to connect user computers and switches (1GbE)
ON/OFF	Rocker	Power on/off switch
POWER	DC Jack Molex	DC Jack 5.5mm x 2.5mm Molex 5557-04

2.1.4 Dimensions

The dimensions of SIRIUS (W x H x D) are 165 x 212 x 64.5 mm.

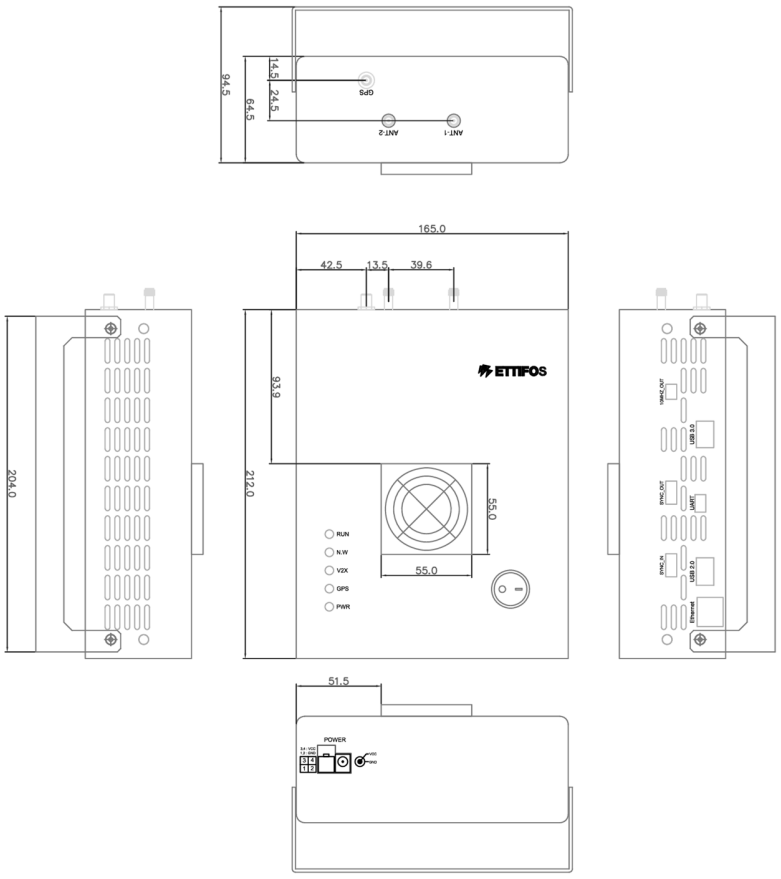


Figure 2-4 Dimensions of SIRIUS

2.2 Power supply

- Plug the AC/DC power adapter provided with SIRIUS in the POWER connector and place the ON/OFF power switch in the position “1”.
- The POWER LED will light up solid green when SIRIUS is powered on.

2.3 GPS antenna connection

- Connect the GPS antenna cable to the GPS antenna port in the top panel.
- The GPS LED will light up solid yellow when the GPS is not locked and turn into solid green once the GPS is locked.

2.4 V2X antenna connection

- Connect the V2X antennas provided with SIRIUS to the ANT-1 and ANT-2 antenna port in the top panel.
- V2X antenna connections are not port sensitive.

3 Configuration

3.1 Access to SIRIUS

3.1.1 SSH connection (via Ethernet)

- Directly connect the Ethernet port in the right-side panel of SIRIUS to a computer.
- Access SIRIUS via ssh application with the default IP address and the default port number 45345. (ID: sirius, Password: alphacma)
- The default IP address is 192.168.70.xxx, where xxx matches last 3 digits on the serial number.
- The NETWORK LED will light up solid green when the connection is working.

ID: sirius
Password: alphacma
	`> ssh -p 45345 sirius@[IP Address]`
	`sirius@192.168.70.1's password:`
	`telechips-tcc8050-main:~$`

- To change the IP settings of SIRIUS:
  ① Open '80-wired.network' file and change 'Address' and 'Gateway' (Line 22 to 23) values to new ones you want.
  ② Restart SIRIUS with 'sudo reboot' or hard reset(Power off & on) for the changes take effect.

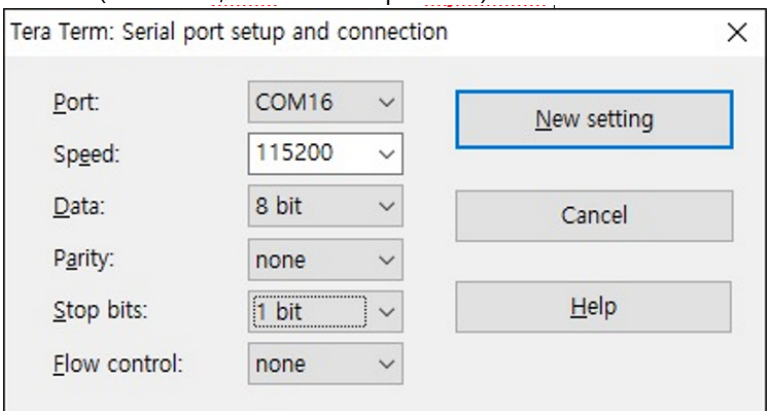
```
$ vi /lib/systemd/network/80-wired.network
…
# Press 'i' to enter insert mode
20
21 [Network]
22 Address=192.168.70.2/24
23 Gateway=192.168.70.1
…
# Press ':wq!' to save the changes and quit
:wq!

# Restart with 'sudo reboot'
$ sudo reboot
```

3.1.2 UART Serial connection (via USB-C)

- Directly connect the UART port in the right-side panel of SIRIUS to a computer.
- (In case when it's recognized as unknown device on Windows Device Manager) Download CP210x USB to UART Bridge VCP driver at CP210x USB to UART Bridge VCP Drivers - Silicon Labs (silabs.com), and install it by doing 'driver update' in Windows Device Manager.
- Once installed, check the COM port which corresponds to Interface 1 in 'Port(COM & LPT)' of Device Manager as below.

- Access SIRIUS via terminal program (such as Tera Term and Putty) with the COM port and baud rate 115200. (ID: sirius, Password: alphacma)



3.2 Configurable parameters

The user configurable parameters of SIRIUS are listed in Table 3-1.

Table 3-1 User configurable SIRIUS parameters

Category	Parameter name	Type	Unit	Range
Device Info	MAC Address	-	-	-
	IP Address	-	-	-
RF Config	Tx power	integer	dBm	{0, ..., 20}, TBD for 23
SL Frequency Config	Carrier Frequency	enum	MHz	{5860, 5865, 5870, 5875, 5880, 5885, 5890, 5895, 5900, 5905, 5910, 5915, 5920}
	Channel Bandwidth	enum	MHz	{10, 20, 40}
	Subcarrier Spacing	enum	kHz	{15, 30, 60}
SL BWP Config	sl-StartSymbol	integer	OFDM symbol	{0}, TBD for {0, ..., 7}
	sl-LengthSymbols	integer	OFDM symbol	{14}, TBD for {7, ..., 14}
Resource Pool Config	sl-SubchannelSize	integer	PRB	{10, 12, 15, 20, 25, 50, 75, 100}
	sl-NumSubchannel	integer	Subchannel	{1, ..., 27}
	sl-StartRB-Subchannel	integer	PRB	{0, ..., 265}
	sl-ResourceReservePeriodList[1]	integer	msec	{0, 1, 2, ..., 99, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000}
PSCCH Config	sl-TimeResourcePSCCH	integer	OFDM symbol	{2, 3}
	sl-FrequencyResourcePSCCH	integer	PRB	{10, 12, 15, 20, 25}
PSSCH Config	MCS table	enum	-	{qam64, qam256, qam64LowSE}
	MCS index	integer	-	• {0, ..., 28} for qam64 and qam64LowSE

[1] Maximum 16 elements of *ResourceReservePeriod* can be configured.

				• {0, …, 27} for qam256
	sl_MaxTxTransNumPSSCH_r16	integer	-	{1, 2, 4}
PSFCH Config	sl-PSFCH-Period	integer	-	{0, 1}, TBD for {0, 1, 2, 4}
	sl-MinTimeGapPSFCH	integer	-	{3}, TBD for {2, 3}
HARQ Config	HARQ FeedbackEnable	enum	-	{0, 1}
Antenna Config	Antenna configuration mode	integer	-	{1, …, 4}, TBD for 5

3.3 Configuration guide

3.3.1 UCFG commands

SIRIUS supports user configuration for the user to set various parameters for test purpose. Users can get the current configuration status as well using UCFG commands. UCFG is one of Linux applications, hence, UCFG commands are executable in Linux shell. The previous way supported via Telnet access is no longer supported from Phase2 SW (Package version V2.x.x.x.x).

Table 3-2 UCFG commands supported for SIRIUS configuration

Command	Description
help	Show available commands
exit	Exit from current mode
history	Show a list of previously run commands
ucfg save	Save User Configuration
ucfg revert	Revert to default User Configuration
ucfg set dev mac	Set MAC address
ucfg set dev ip	Set IP address
ucfg set rf pow	Set RF Tx power
Ucfg set freq	Set Frequency, Channel Bandwidth, Subcarrier Spacing
ucfg set bwp sym	Set BWP sl-StartSymbol & sl-LengthSymbols
ucfg set rp sc	Set Resource Pool sl-SubchannelSize, sl-NumSubchannel, sl-StartRB-Subchannel
ucfg set rp prd	Set Resource Reserve Period List
ucfg set pscch	Set PSCCH sl-TimeResourcePSCCH, sl-FrequencyResourcePSCCH
ucfg set pssch	Set PSSCH MCS table, MCS index, The maximum of PSSCH transmission
ucfg set psfch	Set PSFCH Period, Minimum Time Gap
ucfg set harq	Set HARQ Enable/Disable
ucfg set ant cfg	Set Antenna configuration
ucfg get	Get User Configuration
ucfg get dev	Get Device Configuration
ucfg get dev mac	Get MAC address
ucfg get dev ip	Get IP address
ucfg get rf	Get RF Configuration
ucfg get rf pow	Get RF Tx power
ucfg get freq	Get Frequency Information
ucfg get bwp	Get BWP Configuration
ucfg get bwp sym	Get BWP sl-StartSymbol & sl-LengthSymbols

ucfg get rp	Get Resource Pool Configuration
ucfg get rp sc	Get sl-SubchannelSize, sl-NumSubchannel, sl-StartRB-Subchannel
ucfg get rp prd	Get Resource Reserve Period List
ucfg get pscch	Get PSCCH sl-TimeResourcePSCCH, sl-FrequencyResourcePSCCH
ucfg get pssch	Get PSSCH MCS table, MCS index
ucfg get psfch	Get PSFCH Period, Minimum Time Gap
ucfg get harq	Get HARQ Enable/Disable
ucfg get ant cfg	Get Antenna configuration

(† : To be supported in the next release)

3.3.2 CLI usage

3.3.2.1 Show configuration

```
ucfg set <item> <param>
Set <item> the value <param>

ucfg get [<item>]
Get the value of <item>. If the item is not existed, show all configurations
```

3.3.2.2 Management

```
ucfg save
       Save current user configuration values in user_config.txt
       Renames previous user_config.txt to user_config.bak

ucfg revert
       Initialize current user configuration values to default values defined in
       Preconfiguration
```

3.3.2.3 Device information

- MAC address

```
ucfg set dev mac <addr#1> <addr#2> <addr#3> <addr#4> <addr#5> <addr#6>
       <addr>: MAC Address (8bits * 6)

       Set the MAC address of LTE-V2X device

ucfg get dev mac
       MAC Address: 0-0-0-0-0-0
```

- IP address for IP-based V2X service

```
ucfg set dev ip <addr#1> <addr#2> <addr#3> <addr#4> [<addr#5> <addr#6> <addr#7> <addr#8>]
       <addr>: IP Address, IPv4 - (8bits * 4), IPv6 - (16bits * 8)

ucfg get dev ip
       IPv6 Address: 0:0:0:0:0:0
```

3.3.2.4 Radio Frequency (RF) configuration

- RF transmit power

```
ucfg set rf pow  <power>
       <power>: Tx power, unit is dBm, 0 ~ 23, step is 2

       Set the transmission power of RF path

ucfg get rf pow
      Tx Power: 20dBm
```

3.3.2.5 Sidelink Frequency configuration

- Carrier frequency & Channel Bandwidth & Subcarrier Spacing

```
ucfg set freq <freq> <bw> <scs>
       <freq>: Frequency(MHz), 5860, 5865, 5870, 5875, 5880, 5885, 5890, 5895, 5900, 5905,
                               5910, 5915, 5920
       <bandwidth>: Bandwidth, 10, 20, 40
       <scs>: Subcarrier Spacing(KHz), 15, 30, 60

ucfg get freq
      SL Frequency Info
      ├ Frequency : 5680MHz
      ├ Bandwidth : 20MHz
      ├ SubcarrierSpacing : 15kHz
```

3.3.2.6 Sidelink Bandwidth Part (BWP) configuration

- OFDM symbol resources in a slot

```
ucfg set bwp sym <start> <length>
       <start>: sl-StartSymbol,       [0-7],  else - no config
       <length>: sl-LenghtSymbol,         [7-14], else - no config

       Note: Only start 0, length 14 symbols are supported in this version.

ucfg get bwp sym
      Symbol: Start-0, Length-14
```

3.3.2.7 Resource pool configuration

- Subchannel parameters

```
ucfg set rp sc <size> <number> <start>
       <size> : sl-SubcahnnelSize,      [10, 12, 15, 20, 25, 50, 75, 100], else - no config
       <number> : sl-numSubchannel,     [1-27], else - no config
       <start> : sl-StartRB-Subchannel, [0-265], else - no config

ucfg get rp sc
      Subchannel of Resource Pool
      ├ SubchannelSize : 15
      ├ NumSubchannel : 7
      └ StartRB-Subchannel : 0
```

- Resource reservation period list

```
ucfg set rp prd <value#1> [<value#2> ...[<value#16>]]
       <value>: sl-ResourceReservePeriod(msec), 0 ~ 100, 200, 300, 400, 500, ..., 1000

      Note: <value1> must be 0, 100 must be included.

ucfg get rp prd
      Resource Reserve Period List : 2
       [0] : 0
       [1] : 100
```

3.3.2.8 PSCCH configuration

- Time and frequency resource of PSCCH

```
ucfg set pscch <time> <frequency>
       <time>: sl-TimeResourcePSCCH,      [2, 3],                else - no config
       <frequency>: sl-FrequencyResourcePSSCHl,  [10, 12, 15, 20, 25], else - no config

ucfg get pscch
      PSCCH Config
      ├ TimeResourcePSCCH : 2
      └ FrequencyResourcePSCCH : 10
```

3.3.2.9 PSSCH configuration

■ MCS table and MCS index

```
ucfg set pssch <table> <index> [<max>]
       <table>: MCS table, 0-qam64, 1-qam256, 2-qam64LowSE, else - no config
       <index>: MCS index, [0, …, 28] for qam64 and qam64LowSE,
                           [0, …, 27] for qam256,
                           else - no config
       <max>: sl_MaxTxTransNumPSSCH_r16, 1, 2, 4, 0 - no config
              Total transmission count including 1st transmission and retransmission.

ucfg get pssch
      PSSCH Config
      ├ MCS table : QAM256
      └ MCS index : 20
      └ MaxTxTransNum : 4
```

3.3.2.10 PSFCH configuration

■ PSFCH Period and Minimum Time Gap

```
ucfg set psfch <period> <min>
       <period>: sl-PSFCH-Period,     0, 1, 2, 4,              else - no config
       <min>: sl-MinTimeGapPsfch,     2, 3, else - no config

ucfg get psfch
      PSFCH Config
      ├ Period : 0
      └ MinTimeGap : 3
```

3.3.2.11 HARQ configuration

■ HARQ Feedback Enable/Disable

```
ucfg set harq <enable>
       <enable>: FeedbackEnable, 0 - disable, 1 - enable

       Set enable/disable of HARQ Feedback.

ucfg get harq
      HARQ Config : Feedback Disable(0)
```

3.3.2.12 Antenna configuration

■ Antenna configuration mode

```
ucfg set ant cfg <mode>
       <mode>: Mode of Antenna Configuration, 1~5
                    1: Ant1 TX/RX
                    2: Ant2 TX/RX
                    3: Ant1 Tx, 2Rx
                    4: Ant2 Tx, 2Rx
                    5: 2Tx, 2Rx (2 Tx is not supported now)

ucfg get ant cfg
 Antenna Configuration: 3
```

3.3.3 HARQ Retransmission

Basically, HARQ retransmission is performed when a transmitter confirmed that a receiver failed to receive complete packets. And the transmitter can judge whether the receiver successfully receives the packets by checking HARQ feedback sent by the receiver. However, not all transactions send HARQ feedback to transmitter. In that case, if a transmitter performs retransmissions despite no HARQ feedback, it's called 'Blind Retransmission'. On the other hand, if a sender performs retransmission based on HARQ feedback from receiver, it's called 'HARQ Feedback Based Retransmission'. Figure 3-1 shows how HARQ feedback-based retransmission works. If a transmitter receives ACK as HARQ feedback while retransmitting, retransmission can be stopped.

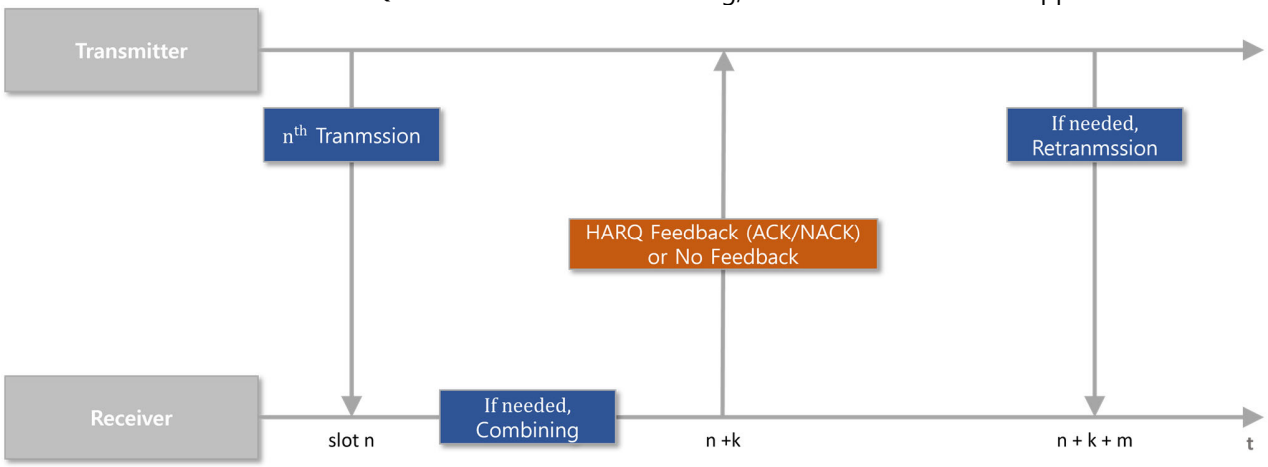


Figure 3-1 HARQ Feedback Based Retransmission

3.3.3.1 UCFG setting for Blind Retransmission

Blind retransmission can be used for the purpose of coverage expansion, reception reliability, etc. The following is the UCFG setting required for enabling HARQ blind retransmission.

```
ucfg set pssch 1 17 4
ucfg set psfch 0 3
ucfg set harq 1
```

3.3.3.2 UCFG setting for HARQ Feedback Based Retransmission

The following is the UCFG setting required for enabling HARQ feedback-based retransmission.

```
ucfg set pssch 1 17 4
ucfg set psfch 1 3
ucfg set harq 1
```

4 Troubleshooting

4.1 Troubleshoot with the LEDs

- POWER LED is off
  - Make sure that the ON/OFF switch on the right-side panel is the "1" position.
  - Make sure that the power cord is correctly connected to POWER connector of SIRIUS and that the power supply unit is correctly connected to a power outlet.
  - Make sure that you are using the proper power adapter that Ettifos supplied for SIRIUS.

- GPS LED remains solid yellow
  - Make sure that GPS antenna are correctly connected to the GPS antenna port.
  - Make sure that the GPS signals are available in your testing environment. GPS signals are may not available indoors or underground.

- V2X LED remains solid yellow
  - Make sure that GPS Led lights up solid green.
  - Make sure that the user application is implemented properly with the guidelines described in SIRIUS SDK user manual.

- NETWORK LED is off
  - Make sure that the network interface configuration is correct with the *ifconfig* command and check that the ethernet interface (*eth0*) is activated.

- RUN LED remains solid green
  - Make sure that Linux kernel is normally running on the SIRIUS processor.

4.2 Troubleshoot with SIRIUS connection

- You cannot access SIRIUS
  - Make sure that the IP address of the user computer and SIRIUS are configured correctly.
  - Make sure that *ping* works between the user computer and SIRIUS.
  - Make sure that firewall on the user computer does not block access to SIRIUS.

4.3 Troubleshoot with RF signal

- No RF signal is transmitted
  - Make sure that V2X antennas are correctly connected to the V2X-1 and V2X-2 antenna ports.
  - Make sure that the requested transmission data size is less or equal than the supported size by the configured RF parameters (bandwidth, subcarrier spacing, subchannels)

5 FCC Statement

Regulatory Compliance

C-V2X OBU

IMPORTANT NOTE:

FCC RF exposure statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance. This transmitter must be at least 20 cm from the user and must not be co-located or operating in conjunction with any other antenna or transmitter.

The FCC ID of the product is: 2BHJL-ETF-SIR-O5001

OBU firmware prevents the end user from adjusting power or channel settings that could result in a violation of FCC rules.

The end user is warned that any un-authorized adjustment to OBU firmware could result in a violation of FCC rules. Firmware update may only be performed by or under the immediate supervision and responsibility of a person certified as technically qualified to perform transmitter maintenance by Ettifos Co.

Any modifications made to this product, including the use of unauthorized antennas could result in violation of the FCC regulations and is strictly prohibited.

This product is operated under FCC license, please contact Ettifos Co. regarding all licensing requirements to ensure ongoing regulatory compliance during use.

Caution

Any changes or modifications (including the antenna) made to this device that are not expressly approved by the manufacturer may void the user's authority to operate the equipment.

Antenna Information

Antenna Type: External dipole array antenna (RP-SMA)

Antenna Max Gain: 8 dBi

FCC Compliance Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions : (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC Interference Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help

Our aim is to provide customers with timely and comprehensive service.
For any assistance, please contact our company headquarters:

Ettifos Co.
Suite 405, 41 Beolmal-ro 50beon-gil
Bundang-gu, Seongnam-si, Gyeonggi-do
Republic of Korea
Tel: +82 31 8039 5000
Email: pr@ettifos.com

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