

WAVE RSE User' s Manual

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.

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

This equipment complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. This equipment is a handheld device and should be maintained with a minimum safety distance of 20cm from the antenna. This transmitter must not be co-located or operated in conjunction with any other antenna or transmitter.

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1. Overview

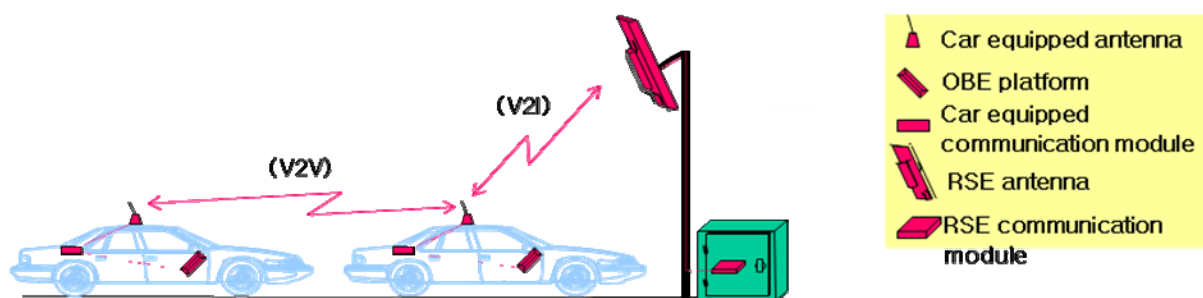
1.1 Purpose

The user manual is used to comprehend how the WAVE RSE(Road Side Equipment) is functioning and how to operate it to execute the tasks by using RSE. It includes the explanation of WAVE RSE related technical terminologies and some procedures to operate RSE.

1.2 Definition of WAVE

The “WAVE” stands for “Wireless Access in Vehicle Environments” and this technology supports both V2V(Vehicle to Vehicle) and V2I(Vehicle to Infrastructure) communication. The WAVE technology is a global standard, IEEE 802.11p and 1609.1~12, which is used for ITS(Intelligent Transport System) service, especially for the vehicle safety control.

The basic configuration of WAVE system consists of RSE(Road Side Equipment) and OBE(On Board Equipment). The RSE is located on the road and OBE is located in the car. The name of wireless communication protocol between RSE and OBE or OBE's is the WAVE. Apparent differentiation from the existing wireless technology is that it provides reliable high speed broadband communication with the lowest packet latency even when the car is moving faster than 200Km/h.



Picture 1. Basic Configuration of WAVE system

The WAVE standard is based on the 5,860~5,920MHz frequency band. IEEE 802.11p defines the physical layer and MAC layer for the wireless communication. IEEE 1609.1~12 defines upper multi-channel layer, networking, authorization & security layer and applicable service layer. Basically WAVE communication supports high speed mobility, very short time link access time and very low latency for the packet transmission. And these characteristics such as 27Mbps data transmission under faster than 200Km/h mobility environment, long distance radio coverage up to 1Km, very low latency less than 100msec and very short time link access time less than 1msec are the differentiation. The WAVE communication supports both V2V and V2I with these differentiated performance specifications.

ITEMS	Performance
Velocity	Max. 200 Km/h
Radio Coverage	Max. 1 Km
Data Rate	12Mbps, Max. 27Mbps
Packet Error Rate	0.1(10%)
Packet Latency Time	Less than 100msec
Link Access Time	Less than 1msec
Communication	Vehicle to Vehicle(V2V) Vehicle to Infrastructure(V2I)

[Table 1] WAVE Performance Specifications

The Wireless link budget is specified in IEEE 802.11p. WAVE RSE specification versus that for wireless LAN is described in Table 2. The WAVE RF frequency band is secured for only ITS services and the propagation power can be increased up to 44.8 dBm(around 30W) for the public service usage. The original channel bandwidth 20MHz is changed to 10MHz and it is robust against the propagation delay spread and the timing because the symbol time for the transmitted signal is extended twice. Therefore, as one of the advantages, the physical layer for IEEE 802.11p is designed to support high speed mobility and wide area coverage considering vehicle driving environment.

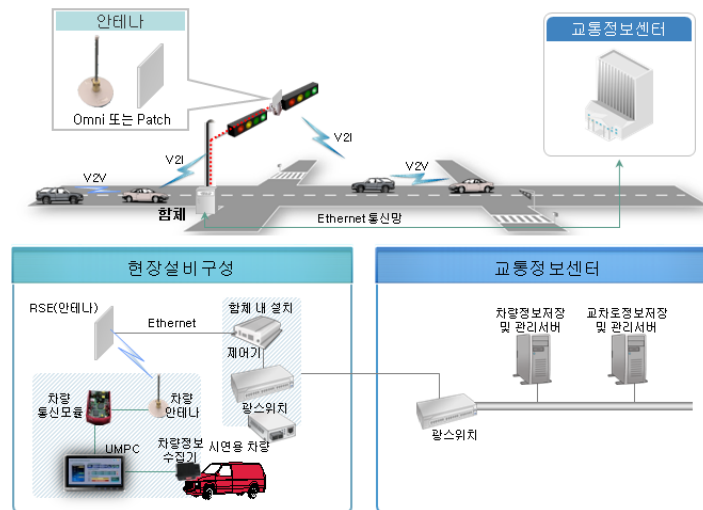
Standard	MAC	IEEE1609.4
	LLC	IEEE1609.3
	PHY	IEEE802.11P
RF	Frequency	5,860 ~ 5,920MHz
	TX Power	28.8dBm(max)
	RX Sensitivity	-85dBm
	Stability	±10ppm max
Antenna	Gain	≥ 8dBi
Date	Date Rate	3 ~ 27 Mbps
	Velocity	200Kph max
	Modulation	QPSK / 16QAM / 32QAM / 64QAM OFDM
Time	Link Acces	≤ 100msec
	Packet Latency	≤ 100msec
Distance	Communication	≒ 1 Km
	Area	
System	Power Source	DC 12V
	GPS	Sirf3
	V2V	Vehicle to vehicle Communication
	V2I	Vehicle to Infrastructure Communication
	Interface	Ethernet, USB, UART

[Table 2] WAVE RSE Specification vs. Wireless LAN

IEEE 802.11p MAC layer is same as that for the wireless LAN. But to minimize the packet latency it is designed for the multi-channel switching ,which has a control channel and the traffic channel to

transceive the safety and traffic message without the congestion. And to reduce the link access time it can be access the link right after receiving the RSE information by removing the authorization ,the security and the association for the link access.

1.3 WAVE Network Configuration

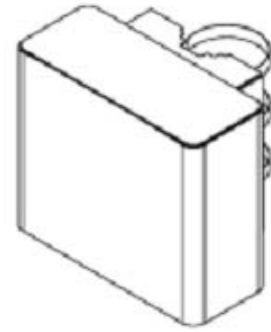
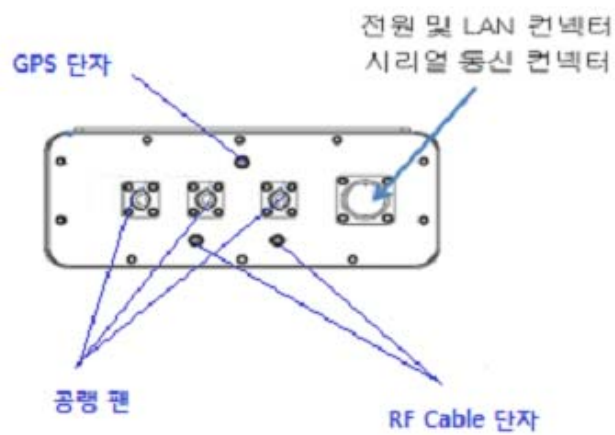


[Picture 2] WAVE Network Configuration

The WAVE based network requires the following equipments

- ▶ ITS service server(vehicle related information management)
- ▶ WAVE RSE
- ▶ WAVE OBE
- ▶ UMPC
- ▶ OBD2
- ▶ Antenna(OBE, RSE)
- ▶ Optical switch and local HUB
- ▶ Intersection Safety Equipment

2. WAVE RSE System Configuration



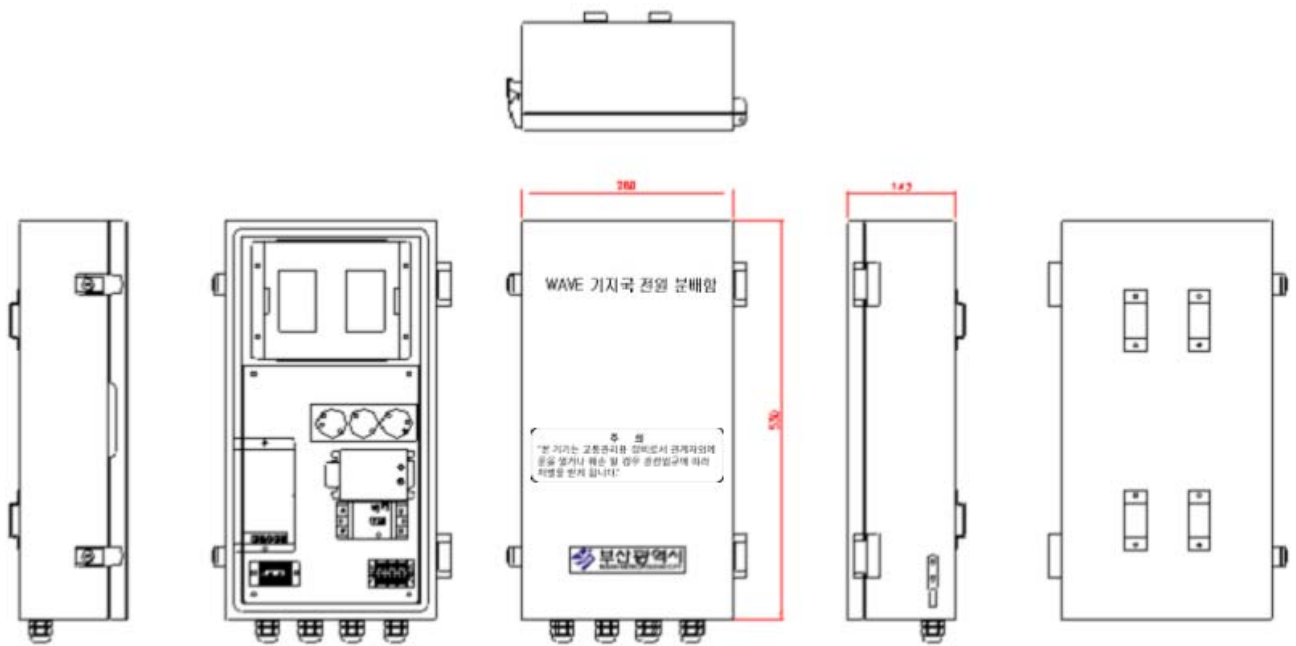
GPS 단자: GPS terminal

전원 및 LAN 컨넥터: power and LAN connector

공랭팬: Air cooling fan

RF cable 단자: RF cable terminal

[Picture 3] WAVE RSE Exterior Shape



[Picture 4] WAVE RSE Power Unit

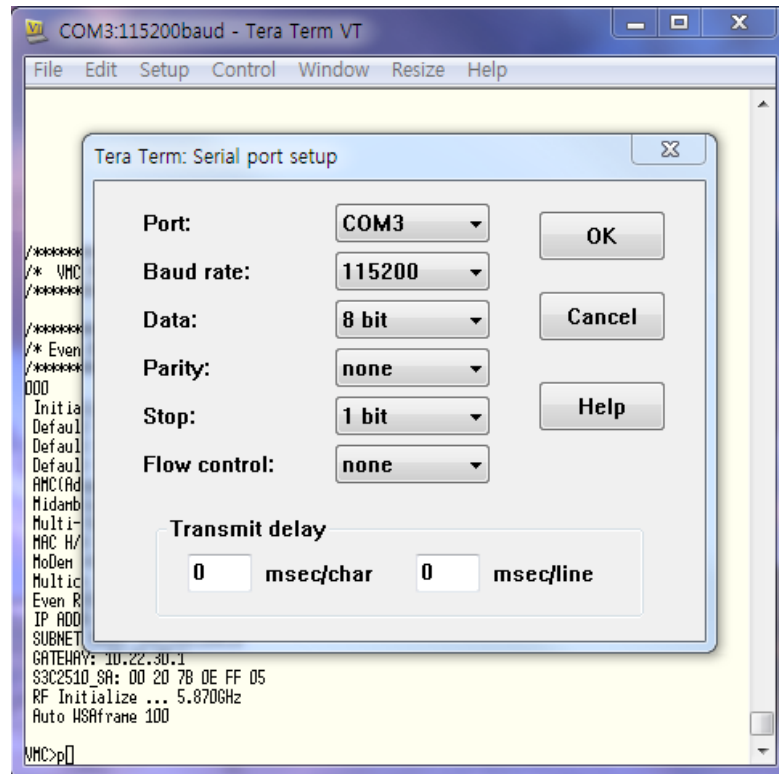
WAVE 기지국 전원 분배함: WAVE RSE Power Distributor Case

3. WAVE RSE Software Installation

After installing RSE hardware, follow the below steps to upgrade the software.

3.1 WAVE RSE Environment Set Up

- ① Open the WAVE RSE power unit and connect the Ethernet port coming from 10pin connector to RJ45 from the notebook
- ② Connect another port(serial), which converts the port to the serial port, to the gender and hook up USB to Serial cable to USB port on the notebook PC.
- ③ Execute the terminal program named “Tera Term”. And click “Setup” on the top menu and select “Serial Port” after that.
- ④ Push “OK” button after setting up the baud rate 115200. Click “Setup” menu and select “Save setup”, and click save button to set up the environment.



- ⑤ If the step3 & 4 is already set up, just go step 6 directly.
- ⑥ Power on the WAVE RSE
- ⑦ If WAVE RSE works correctly, the following screen appears on Tera Term.

```

COM3:115200baud - Tera Term VT
File Edit Setup Control Window Resize Help

/*****/
/* VMC PROGRAM Ver Oct 27 2010 20:56:39
/*****/

/*****/
/* Even RSE : ETH MODE : SINGLE-HOP
/*****/

000
Initialize... START
Default Power : 5
Default Datarate : 12
Default MAC Priority[0x76AB] : 1
AMC(Adaptive Modulation And Coding) OFF !!
Midamble Insertion OFF !!
Multi-Channel Operation OFF !!
MAC H/W Ver : 20100727
MoDem H/W Ver : 805
Multich TimeSet : CCH_inv[27]ms, SCH_Inv[67]ms, Guard_Inv[3]ms
Even RSE : CCH[5.850GHz], SCH[5.840GHz]
IP ADDR: 10.22.30.201
SUBNET MASK: 255.255.255.0
GATEWAY: 10.22.30.1
S3C2510_SA: 00 20 7B 0E FF 05
RF Initialize ... 5.870GHz
Auto WSAframe 100

VMC>

```

⑧ Refer to the below interpretation.

```

/*****/
/* VMC PROGRAM Ver Oct 27 2010 20:56:39                ← WAVE RSE Program Version Date
/*****/

/*****/
/* Even RSE : ETH MODE : SINGLE-HOP                    ← The program is working on WAVE RSE mode
/*****/

000
Initialize... START
Default Power : 5                                     ← RF Power is 5
Default Datarate : 12                                 ← Data rate is 12
Default MAC Priority[0x76AB] : 1
AMC(Adaptive Modulation And Coding) OFF !!
Midamble Insertion OFF !!
Multi-Channel Operation OFF !!
MAC H/W Ver : 20100727
MoDem H/W Ver : 805
Multich TimeSet : CCH_inv[27]ms, SCH_Inv[67]ms, Guard_Inv[3]ms
Even RSE : CCH[5.850GHz], SCH[5.840GHz]
IP ADDR: 10.22.30.201                                ← WAVE RSE IP Address
SUBNET MASK: 255.255.255.0
GATEWAY: 10.22.30.1                                  ← Gateway IP Address
S3C2510_SA: 00 20 7B 0E FF 05
RF Initialize ... 5,860MHz~5,920MHz                    ← current WAVE RSE frequency band
Auto WSAframe 100

```

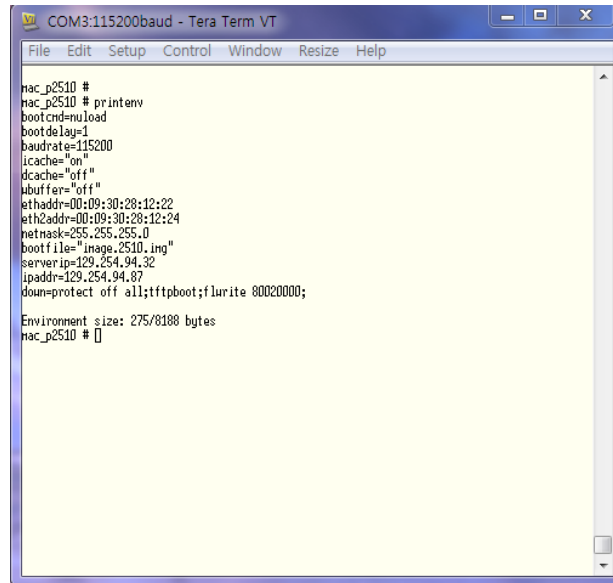
3.2 Software Upgrade

- ① When the screen is being shown up after power on WAVE RSE, hit the “Enter” key a couple of times and below screen is shown up after getting in the boot loader mode.
- ② Put the command “printenv” on the prompt and hit the “Enter” key to get the notebook IP address and image file name to bring the software image.

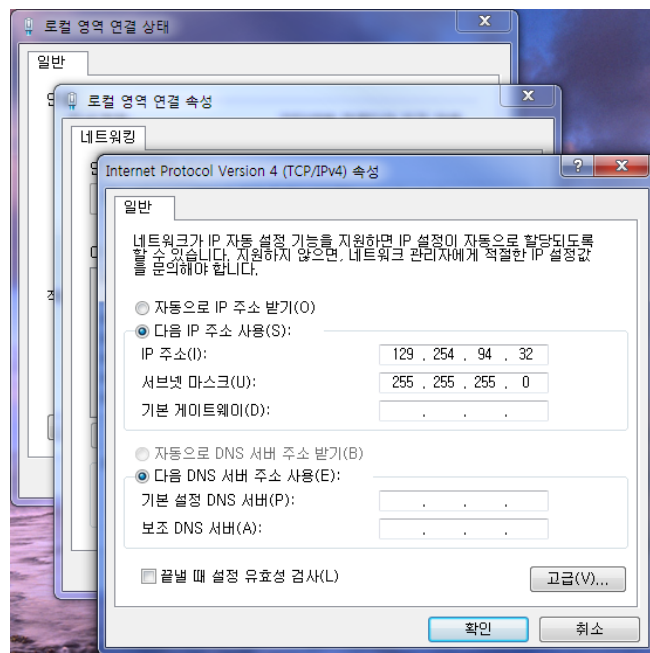
```
COM3:115200baud - Tera Term VT
File Edit Setup Control Window Resize Help

#####
#
# ARMboot for VMC RSE/DBU - V1.1(Mar 31 2010 - 15:12:45)
#
#####
#
# #####
#
# #####
#
# #####
#
# #####
#
# #####
#
#####
#
# ETRI (Electronics and Telecommunications Research Institute)
# Vehicle Networking Research Team
#
# Editor : Kyeong-Soo Han
#
#####

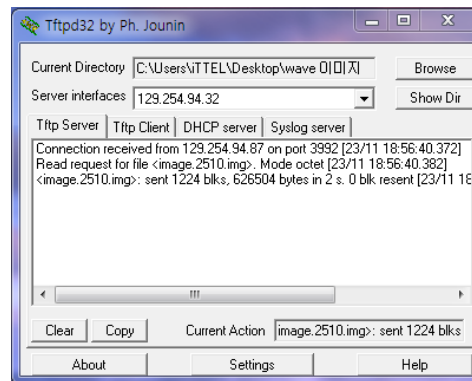
code size : 00700000 -> 00720848
IRQ Stack: 00729848
FIQ Stack: 00731848
DRAM Configuration:
Bank #0: 00000000 64 MB
Flash: 4 MB
cp15 register : 00001078
Instruction Cache is ON
cp15 register : 00001078
Data (write-through) Cache is OFF
Write Buffer Control register : 00000000
Write Buffer is OFF
Hit any key to stop autoboot: 0
mac_p2510 #
mac_p2510 #
mac_p2510 #
mac_p2510 #
```



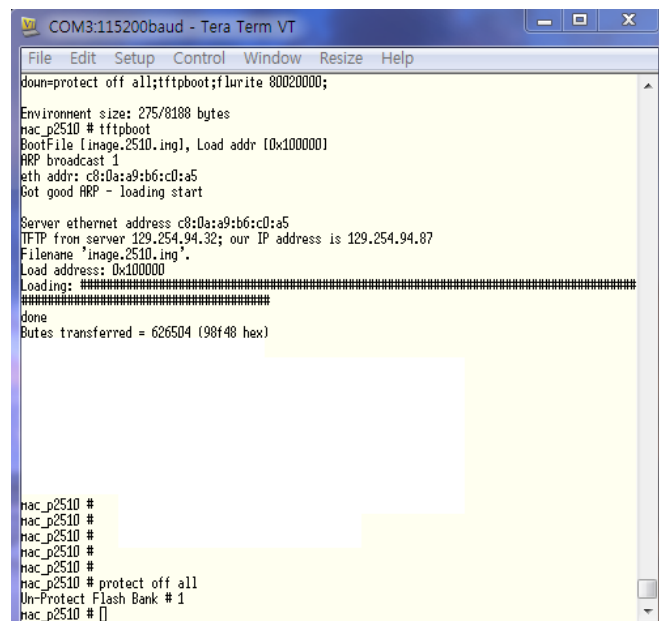
- ③ Set up the notebook ip 129.254.94.32 ,which is set up as the server ip based on related information.



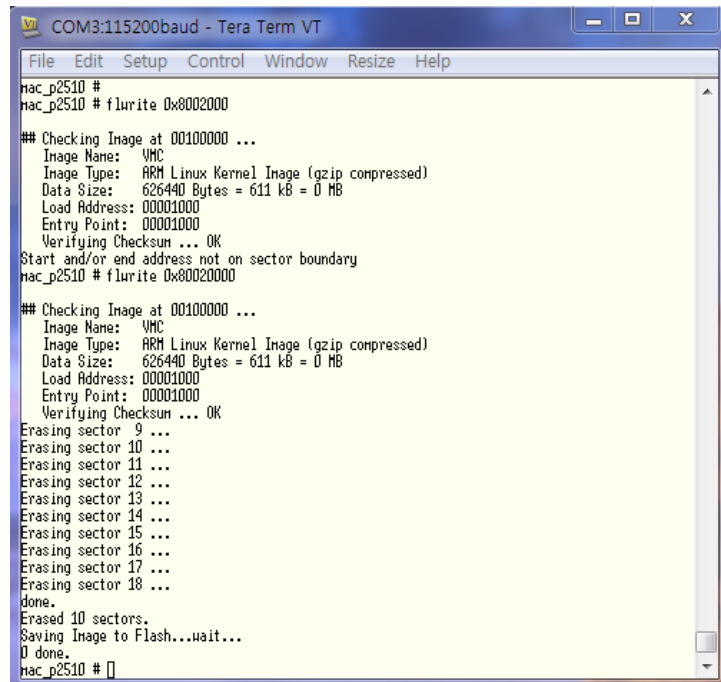
④ Execute tftpd32 to download the related image which includes “image.2510.img” file, WAVE RSE software image. If tftpd32 is executed after successfully setting up the notebook ip, server interface is set up as “129.254.94.32”.



⑤ Put the “tftpboot” command in the Tera Term window and hit the “Enter” key after tftpd32 execution to download the software execution file “image.2510.img” which is executes as below screen. And hit the “Enter” key after putting the command “protect off all” in the Tera Term window.



⑥ Put the command “flwrite” in the Tera Term window to load the image execution file on the address 0x80020000.



```
COM3:115200baud - Tera Term VT
File Edit Setup Control Window Resize Help
mac_p2510 #
mac_p2510 # flurite 0x80020000

## Checking Image at 00100000 ...
  Image Name: VMC
  Image Type: ARM Linux Kernel Image (gzip compressed)
  Data Size: 626440 Bytes = 611 kB = 0 MB
  Load Address: 00001000
  Entry Point: 00001000
  Verifying Checksum ... OK
Start and/or end address not on sector boundary
mac_p2510 # flurite 0x80020000

## Checking Image at 00100000 ...
  Image Name: VMC
  Image Type: ARM Linux Kernel Image (gzip compressed)
  Data Size: 626440 Bytes = 611 kB = 0 MB
  Load Address: 00001000
  Entry Point: 00001000
  Verifying Checksum ... OK
Erasing sector 9 ...
Erasing sector 10 ...
Erasing sector 11 ...
Erasing sector 12 ...
Erasing sector 13 ...
Erasing sector 14 ...
Erasing sector 15 ...
Erasing sector 16 ...
Erasing sector 17 ...
Erasing sector 18 ...
done.
Erased 10 sectors.
Saving Image to Flash...wait...
0 done.
mac_p2510 #
```

⑦ If above screen is shown up, the image execution file is successfully loaded in the address 0x80020000.

⑧ Power off and reboot the WAVE RSE to finalize the software upgrade.