Wi-SUN Module FAN1.0 compliant

BP35C5 Sample Script Manual

Version 1.0.1

Overview

This instruction manual explains the sample script, which is a file that describes the macro of the terminal emulator "Tera Term". By executing this, a Wi-SUN FAN mesh network can be created.

1. Table of Contents

2. Overview

This document explains how to execute a sample script to build a mesh network.
Refer to command manual for the details of data communication and others.

2.1. Document structure

The structure of this document is as follows.

1. Preparation
   - Downloading and extracting of sample script
   - Connection of Tera Term
   - Startup of BP35C5
   - Confirmation of MAC address
   - Change of MAC address in sample script

2. Execution of sample script
   - Running the script
   - Checking the network connection
   - Checking the routing information
   - Checking the communication status by using ping

3. Confirmation of automatic routing
   - Stopping the router on the route
   - Checking the automatic routing
   - Checking the communication status by using ping

2.2. List of sample scripts

Filename	Outline
fan_setup_mesh_1.ttl	Initialization script of Border Router
fan_setup_mesh_2.ttl	Initialization script of Router2
fan_setup_mesh_3.ttl	Initialization script of Router3
fan_setup_mesh_4.ttl	Initialization script of Router4

2.3. Usage environment

Operating materials and supply

- Windows PC 1 or more
- Tera Term version 4.87 or later

BP35C5-T01	4 pcs
BP359C	4 pcs

Refer to the Start-up Manual of Wi-SUN support page on ROHM website on how to build environment when using an evaluation board.

Page URL of BP35C5:
https://www.rohm.co.jp/products/wireless-communication/specified-low-power-radio-modules/bp35c5-product/documents

Firmware

Firmware	Operating macro script
FAN (ver.1.0.52 or above)	fan_setup_mesh_1.ttl fan_setup_mesh_2.ttl fan_setup_mesh_3.ttl fan_setup_mesh_4.ttl

Example of system configuration (in case of using evaluation board)

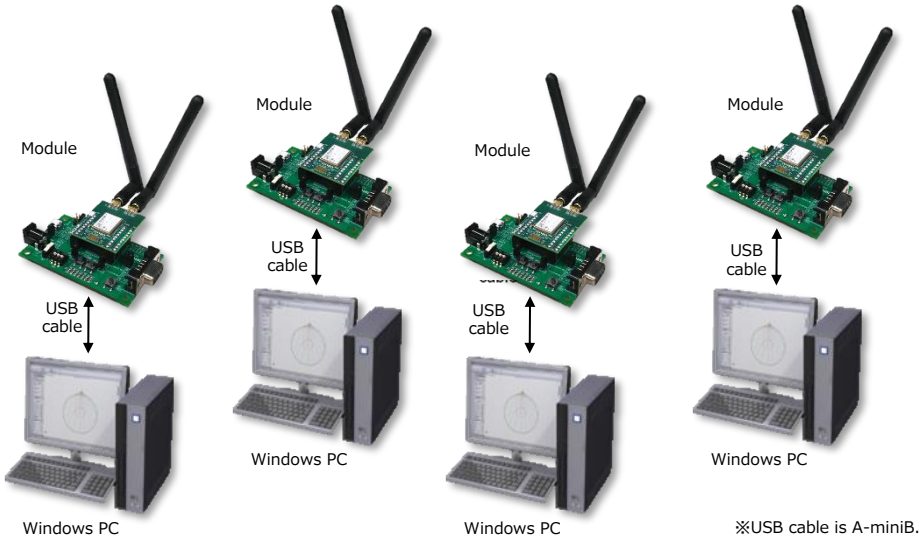

Figure 1. System Configuration Example of 4 PCs

Four modules can also be connected to a single PC for communication.

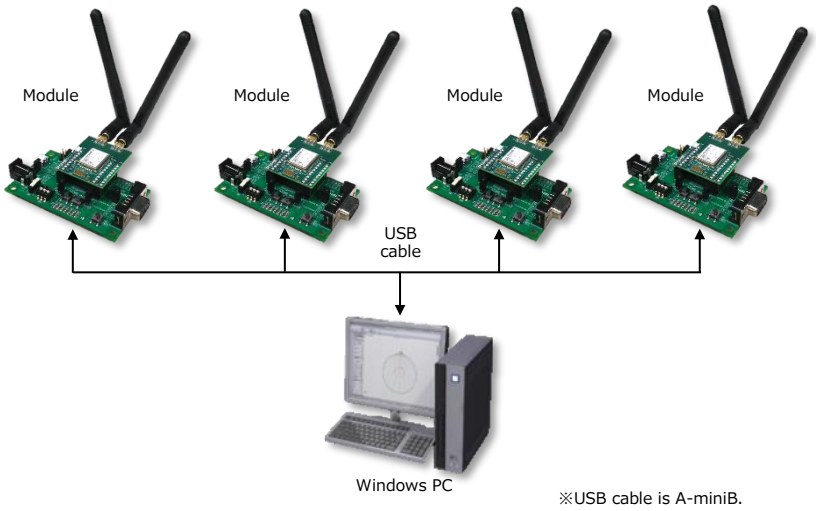

Figure 2. System Configuration Example of 1 PC

3. Overview of Operation

Wi-SUN FAN (Field Area Network) is a mesh networking protocol that consists of a parent repeater called Border Router, a repeater called Router, and a terminal called Leaf. It can cover a wide range because of its relay function (hopping function). Further, it is a networking protocol suitable for social infrastructure because it has also the ability to avoid radio interference by automatic routing (ability to automatically switch routes).

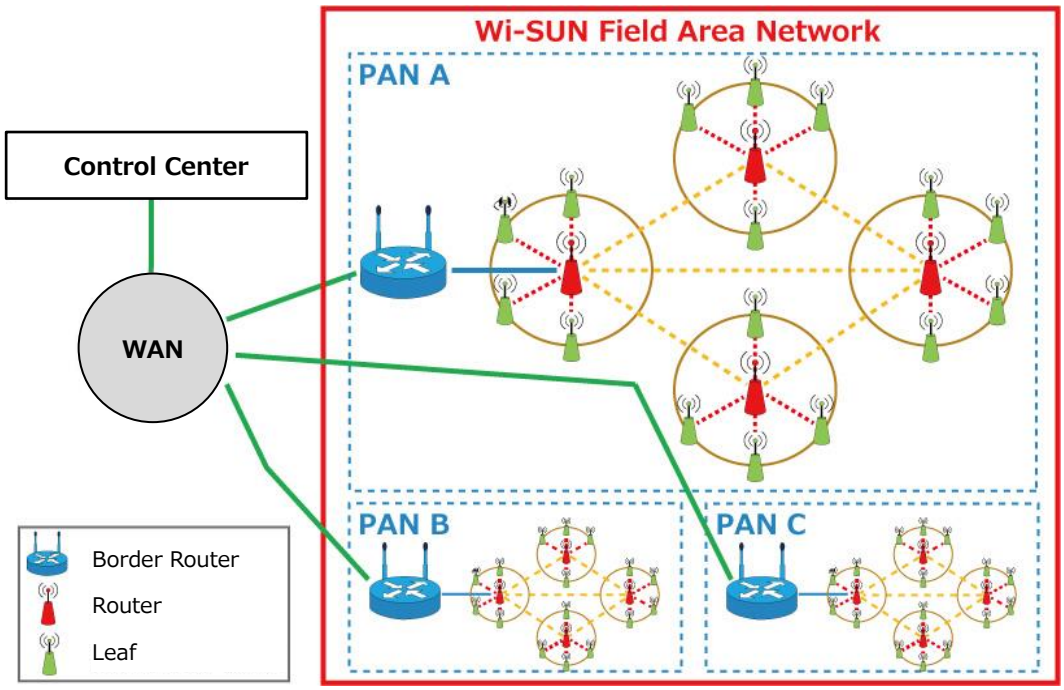

Figure 3. FAN Networking Diagram

In order to understand the relay and automatic routing with minimum configuration, a small scale mesh networking using one Border Router station and 3 Router stations is shown in Figure 4

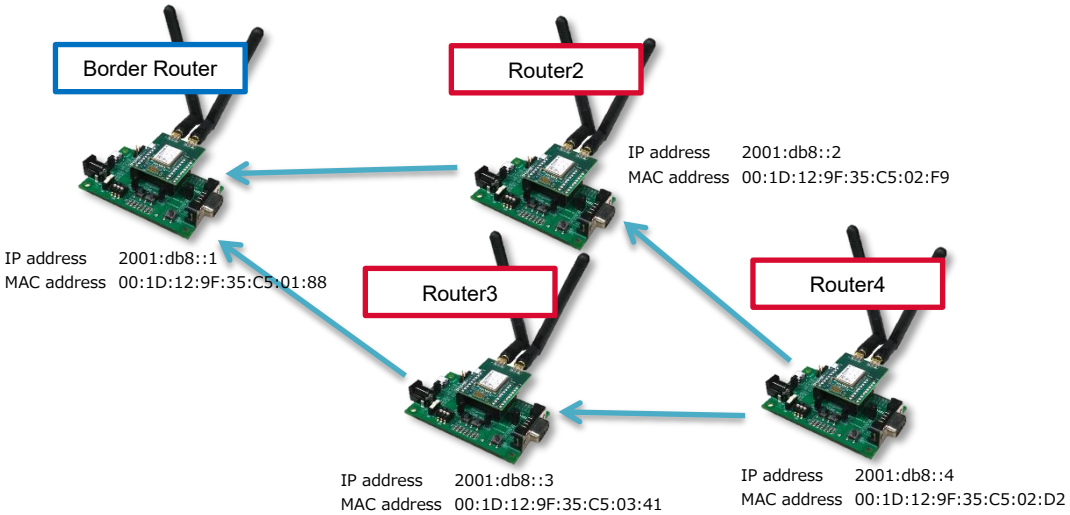

Figure 4. Mesh Networking Configuration Diagram

4. Operating Procedure

4.1. Preparation

Download the sample script from the Wi-SUN support page on ROHM's homepage.

Unzip the downloaded zip file.

Start Tera Term as shown in Figure 5, and set each of the 4 BP35C5 units to communicate with the PC. Refer to the Startup Manual posted on ROHM Wi-SUN page on how to connect with Tera Term, settings of Tera Term, and how to write the firmware.

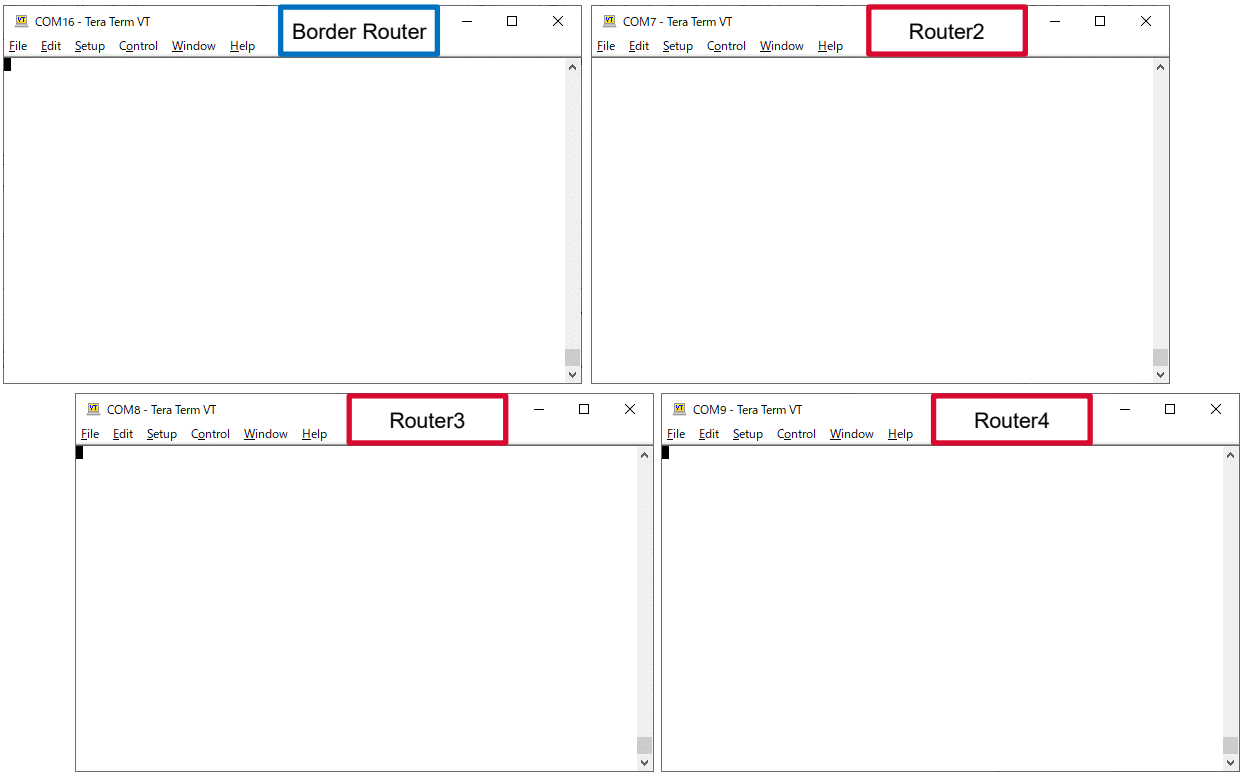

Figure 5. Four BP35C5 Units Connected to Tera Term

Upon shipment, the following message is displayed once the power of BP35C5 is turned on.
(The message "NBRS: added new neighbor <001d12xxxxxxxxxx>" will show a few moments after startup..)

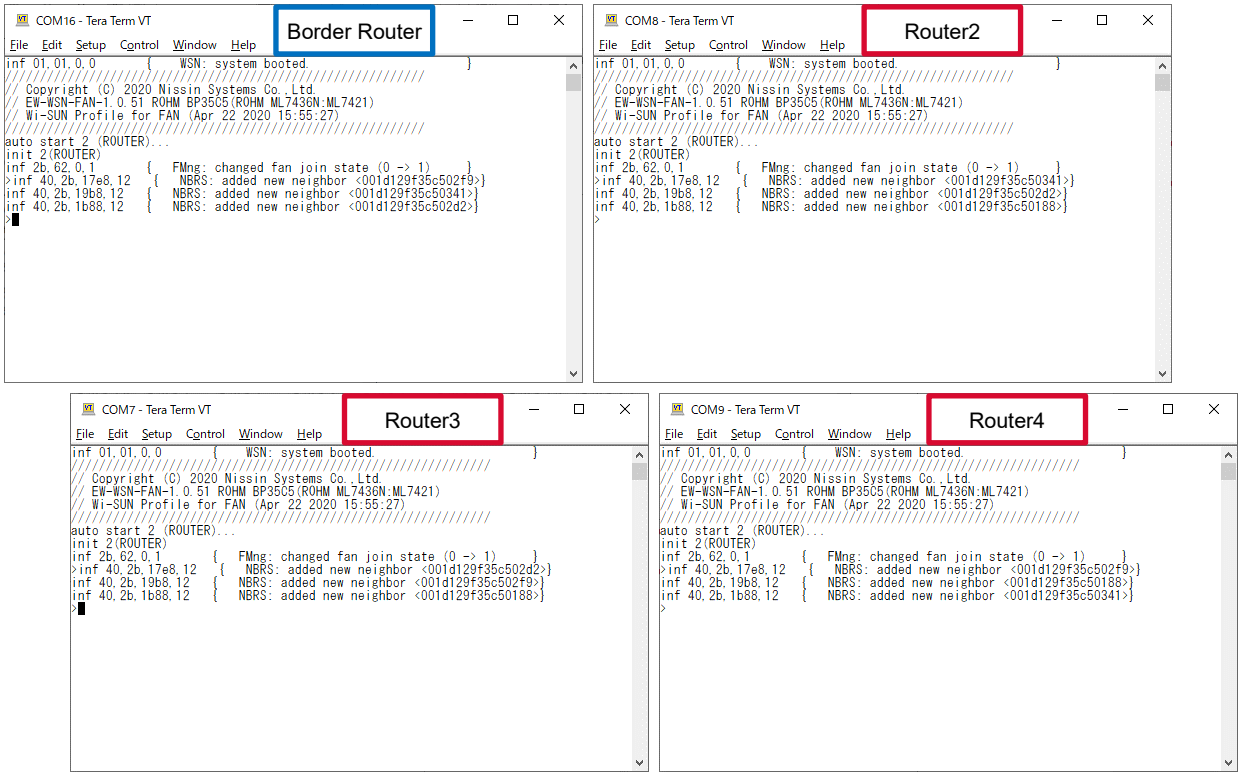

Figure 6. When the Power of BP35C5 is ON

Next, check the MAC address of each station.

There are two reasons why the MAC address of each station should be checked.

- To set which IP address is leased to which station in the DHCPv6 server embedded in Border Router.
- To set the MAC address filter (the details of MAC address filter will be discussed later).

MAC address can be checked with "mac" command. (It is also mentioned on the label of module body.)

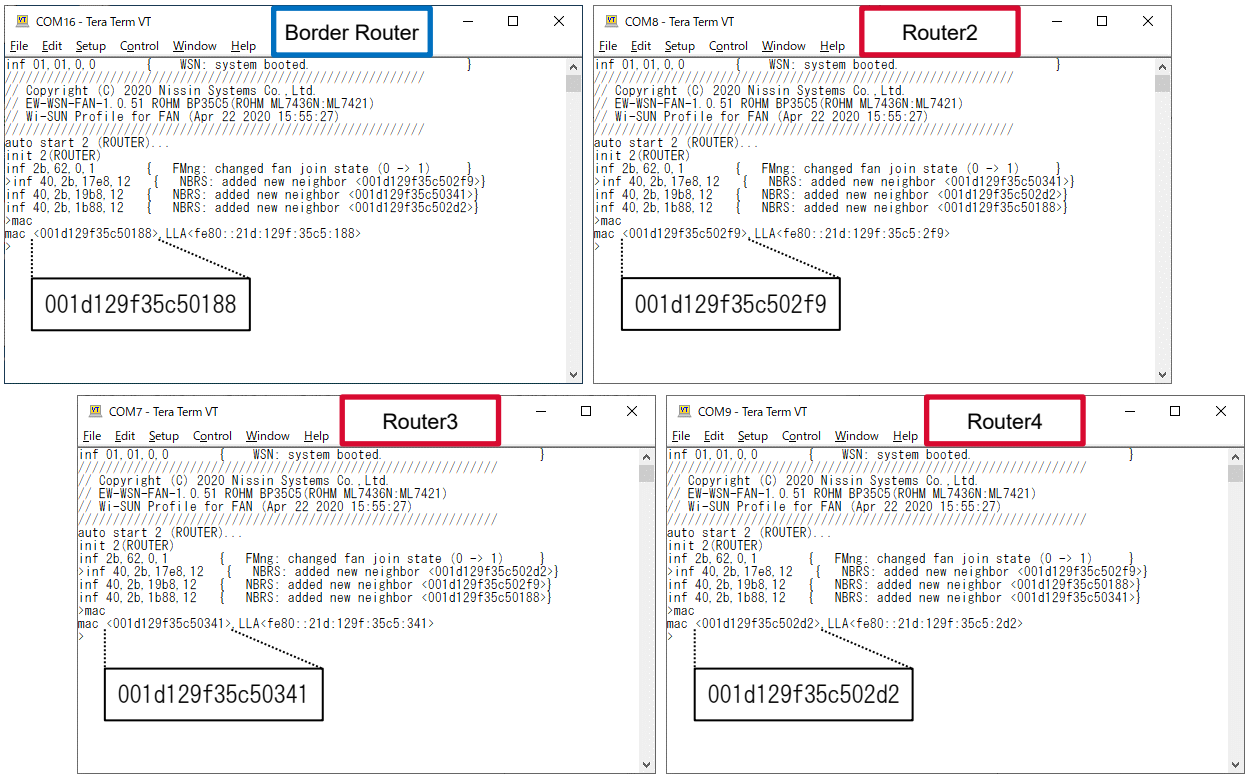

Figure 7. Checking of MAC Address by Command

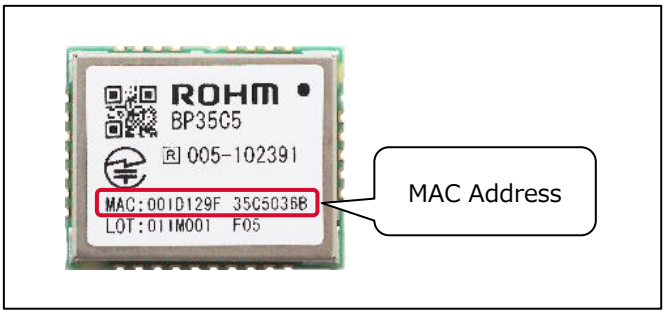

Figure 8. Checking of MAC Address by Label

In sample script, Border Router and Router4, and Router2 and Router3 are assumed to operate in a condition where their radio waves are unable to reach each other as shown in Figure 9.

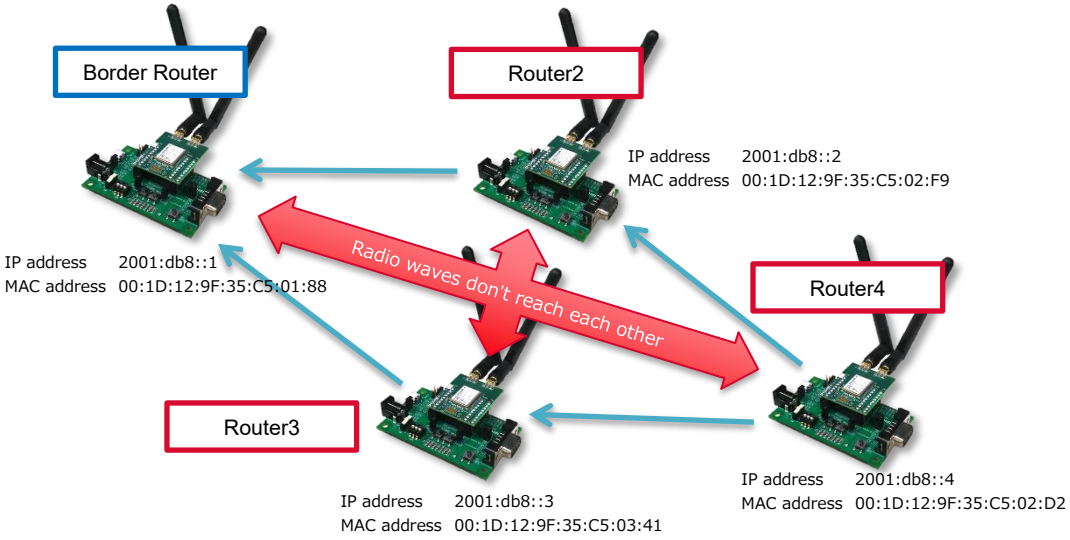

Figure 9. Mesh Networking of Sample Script

However, if it is placed on a desk as shown in Figure 9, the radio waves actually reach all stations and building a mesh network with the expected route may not be possible. In some cases, all routers may connect directly to Border Router. For that reason, in the sample script, the MAC address filtering (*1) is used to intentionally set the distance so that radio waves do not reach each other.

(*1) MAC Address Filtering
The MAC address filtering is a function that limits the received frames by MAC address.
With "macf" command, *deny* and *allow* can be set for the received frame.
In sample script, it is set to permit only the MAC address of the stations allowed to receive ("macf allow MAC address") after setting it once to reject the reception of all MAC addresses ("macf deny") in order to create a condition where the radio waves do not reach due to distance.

As shown below, use text editor (example: Notepad) to rewrite the MAC address of default script with MAC address of your BP35C5.

fan_setup_mesh_1.ttl

```
send 'init 0' #13
wait '>'

send 'mode 0' #13
wait '>'

send 'clear' #13
wait '>'

send 'reset' #13
wait 'init'
wait '>'

;---------------------------------------
; MAC Address Filtering
```

```
;---------------------------------------
send 'macf deny' #13
wait '>'

send 'macf allow 001d129f35c502f9' #13          ← Rewrite in MAC address of Router2
wait '>'

send 'macf allow 001d129f35c50341' #13          ← Rewrite in MAC address of Router3
wait '>'

send 'mode 1' #13
wait '>'

send 'chan 33 59' #13
wait '>'

send 'ip 2001:db8::1/48' #13
wait '>'

;---------------------------------------
; DHCPv6 Setting
;---------------------------------------
send 'leaseip 001d129f35c502f9 2001:db8::2' #13          ← Rewrite in MAC address of Router2
wait '>'

send 'leaseip 001d129f35c50341 2001:db8::3' #13          ← Rewrite in MAC address of Router3
wait '>'

send 'leaseip 001d129f35c502d2 2001:db8::4' #13          ← Rewrite in MAC address of Router4
wait '>'

send 'atstart 1' #13
wait '>'

send 'save' #13
wait '>'

send 'reset' #13
wait 'init'
```

n_setup_mesh_2.ttl

```
send 'init 0' #13
wait '>'

send 'mode 0' #13
wait '>'

send 'clear' #13
wait '>'

send 'reset' #13
wait 'init'
wait '>'

;---------------------------------------
; MAC Address Filtering
;---------------------------------------
send 'macf deny' #13
wait '>'

send 'macf allow 001d129f35c50188' #13          ← Rewrite in MAC address of Border Router
wait '>'
```

```
send 'macf allow 001d129f35c502d2' #13          ← Rewrite in MAC address of Router4
wait '>'

send 'mode 1' #13
wait '>'

send 'chan 33 59' #13
wait '>'

send 'atstart 2' #13
wait '>'

send 'save' #13
wait '>'

send 'reset' #13
wait 'init'
```

fan_setup_mesh_3.ttl

```
send 'init 0' #13
wait '>'

send 'mode 0' #13
wait '>'

send 'clear' #13
wait '>'
send 'reset' #13
wait 'init'
wait '>'

;--------------------------------------
; MAC Address Filtering
;--------------------------------------
send 'macf deny' #13
wait '>'

send 'macf allow 001d129f35c50188' #13          ← Rewrite in MAC address of Border Router
wait '>'

send 'macf allow 001d129f35c502d2' #13          ← Rewrite in MAC address of Router4
wait '>'

send 'mode 1' #13
wait '>'

send 'chan 33 59' #13
wait '>'

send 'atstart 2' #13
wait '>'

send 'save' #13
wait '>'

send 'reset' #13
wait 'init'
```

fan_setup_mesh_4.ttl

```
send 'init 0' #13
wait '>'
```

```
send 'mode 0' #13
wait '>'

send 'clear' #13
wait '>'

send 'reset' #13
wait 'init'
wait '>'

;--------------------------------------
; MAC Address Filtering
;--------------------------------------
send 'macf deny' #13
wait '>'

send 'macf allow 001d129f35c502f9' #13          ← Rewrite in MAC address of Router2
wait '>'

send 'macf allow 001d129f35c50341' #13          ← Rewrite in MAC address of Router3
wait '>'

send 'mode 1' #13
wait '>'

send 'chan 33 59' #13
wait '>'

send 'atstart 2' #13
wait '>'

send 'save' #13
wait '>'

send 'reset' #13
wait 'init'
wait '>'
```

The above concludes the preparation. Then, execute the script.

4.2. Execution of script

As mentioned, the next step is to run the edited script.

Tera Term has a function to run macros. This section explains how to execute macros

Select [Control] → [Macro] from the Tera Term menu connected to each station, specify the script file of that station, and execute the macros in order.

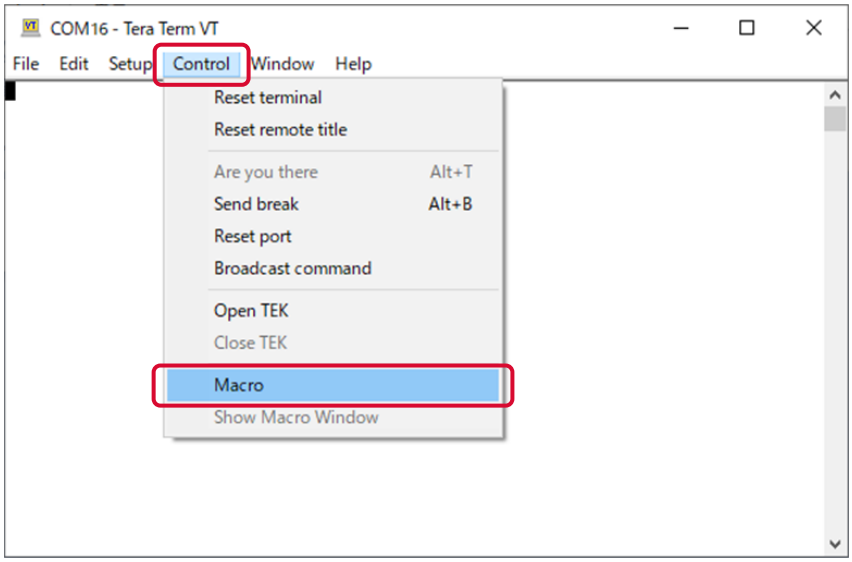

Figure 10. Execution of Tera Term Macros

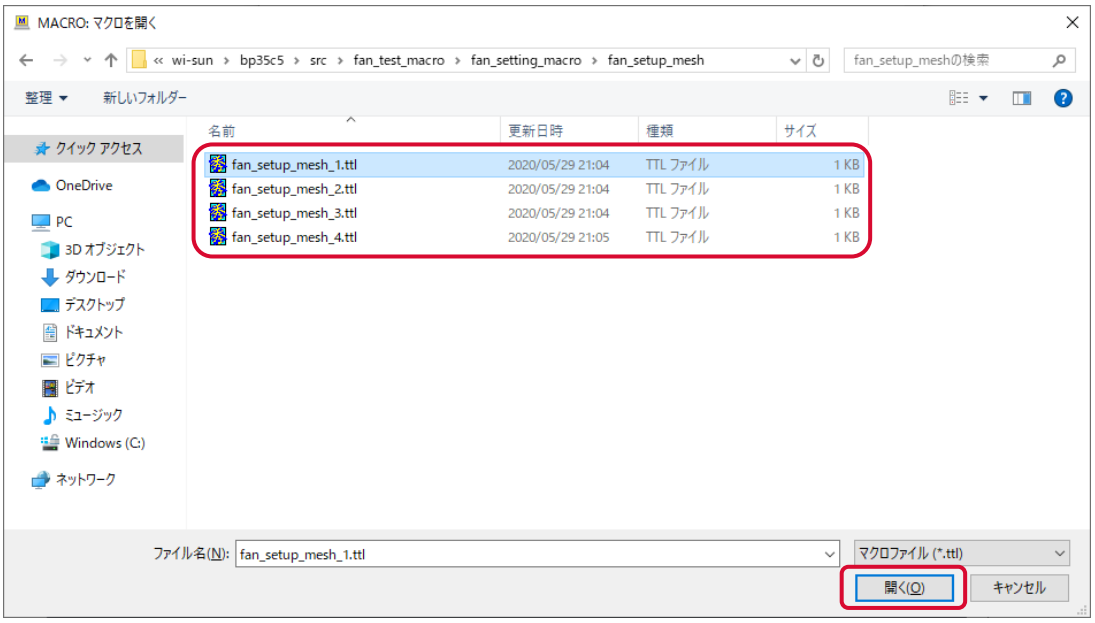

Figure 11. Selection of Script

When the script is run, the settings are automatically saved and all stations will reboot and be connected after approximately 2 minutes.

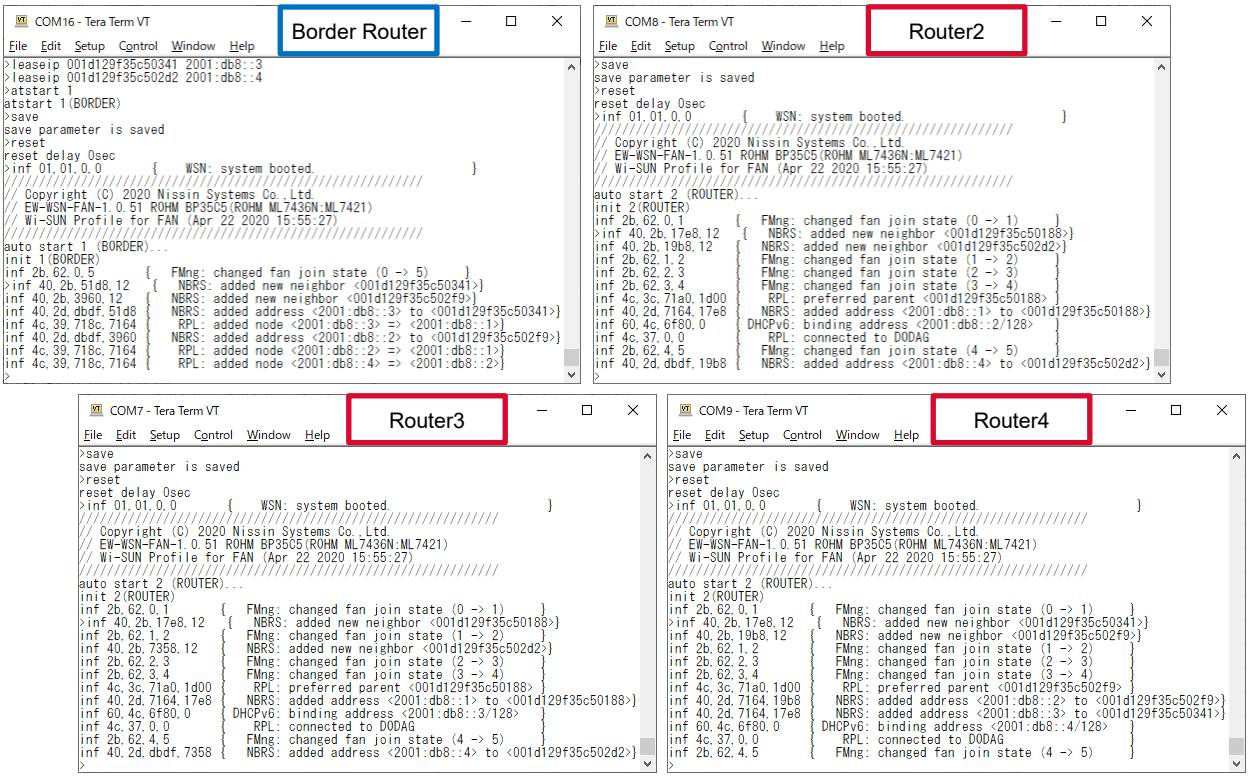

Figure 12. Mesh Networking Connected Status

When the router is connected, the following message is displayed.

```
inf 2b,62,4,5      {   FMng: changed fan join state (4 -> 5)     }
```

This message means that the FAN connection status has changed.

The connection status is represented by a number.

No.	Name	Details
0	INIT	Initial status
1	SELECT-PAN	Selecting PAN to connect
2	AUTHENTICATE	Authenticating
3	WAIT-PANCFG	Waiting for frame from upper router encrypted by authentication
4	ROUTING	Initialization of network layer including RPL routing settings
5	OPERATIONAL	Available connection/communication

After confirming that all routers are connected, then check the routing information.
To view the routing information, execute the "rplsr" command on the Border Router.

```
>rplsr
rplsr - Routing links (3 in total):
rplsr -- 2001:db8::3 to 2001:db8::1 (lifetime: 7164 seconds)
rplsr -- 2001:db8::2 to 2001:db8::1 (lifetime: 7185 seconds)
rplsr -- 2001:db8::4 to 2001:db8::2 (lifetime: 7154 seconds)
>
```

This shows the connection of Router3 and Router2 to Border Router, and Router4 connection to Router2 (Router4 may also be connected to Router3).
The current connection status is shown in Figure 13.

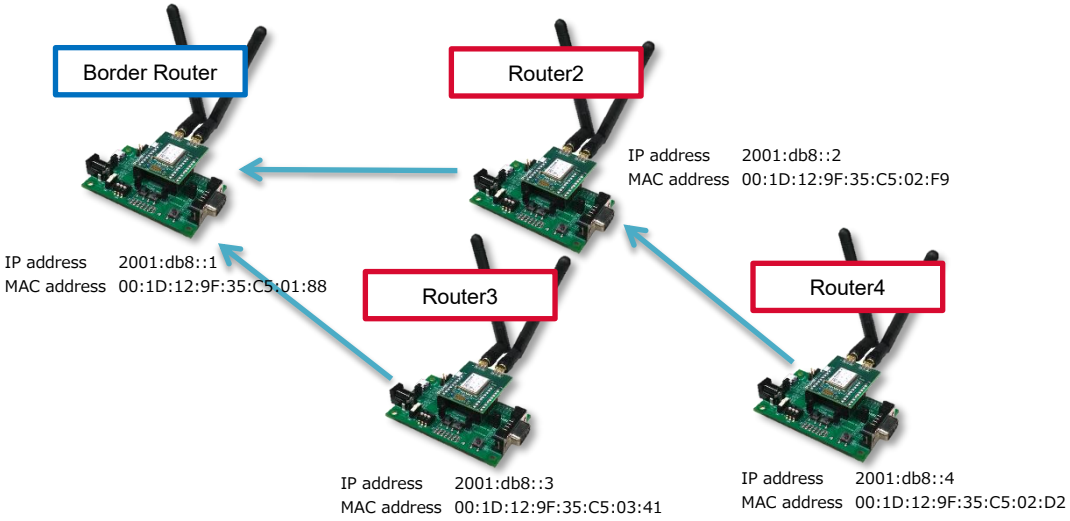

Figure 13. Mesh Networking Connection

To check the communication, run ping from Border Router to Router4.
If communication is possible, "0.0% loss" is displayed in the Border Router, while "rcvd echo request" is outputted in the Router4 as shown below.

Border Router

```
>ping 2001:db8::4
ping <2001:db8::4> (seq=1 sz=32bytes time=0.270sec) 1/1
1 transmitted, 1 received, 0.0% loss (min=0.270/max=0.270/avr=0.270 sec)
>
```

Router4

```
inf 44,32,1,20      { icmpEch: rcvd echo request (seq=1 len=32)   }
>
```

4.3. Checking of automatic routing

The automatic routing will be checked from here.

The current communication route is Router4 → Router2 → Border Router. However, even if Router2 goes down at this time, it will automatically switch to Router3, and checks that the communication will restart.

Then, turn off the power of Router2 and disconnect the route.

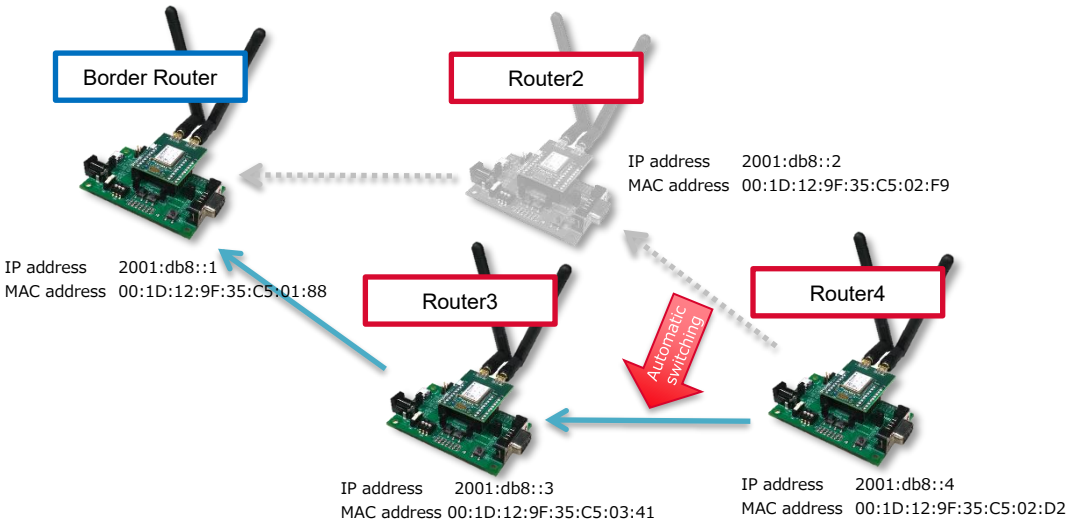

Figure 14 : Automatic Routing State

Even if Router2 goes down, it will not switch immediately.

If ping is run in that state, it will show "100.0% loss" denoting that there is no longer return of response.

Border Router

```
>ping 2001:db8::4
1 transmitted, 0 received, 100.0% loss (min=0.000/max=0.000/avr=0.000 sec)
>
```

The route will be updated automatically after waiting for a while. Then, the following will appear.

Border Router

```
inf 4c,3a,718c,7164 {    RPL: update node <2001:db8::4> => <2001:db8::3>}
```

Router4

```
inf 4c,3c,72c8,1d00 {    RPL: preferred parent <001d129f35c50341> }
```

This shows that Router4 is connected via Router3.

When the routing information is checked here, it will look like as below.

Border Router

```
>rplsr
rplsr - Routing links (3 in total):
rplsr -- 2001:db8::3 to 2001:db8::1 (lifetime: 7151 seconds)
rplsr -- 2001:db8::2 to 2001:db8::1 (lifetime: 6512 seconds)
rplsr -- 2001:db8::4 to 2001:db8::3 (lifetime: 7177 seconds)
>
```

This shows that Router4 is being connected via Router3.

Then, run ping again to check if the communication is successful or not.

Border Router

```
>ping 2001:db8::4
ping <2001:db8::4> (seq=1 sz=32bytes time=0.190sec) 1/1
1 transmitted, 1 received, 0.0% loss (min=0.190/max=0.190/avr=0.190 sec)
>
```

Router4

```
inf 44,32,1,20      { icmpEch: rcvd echo request (seq=1 len=32)   }
>
```

The above confirmed that the route was automatically switched, and the line was restored.

In addition to ping, TCP or UDP can also be used as a procedure to check the communication.

For example, the procedure to send the character string "Wi-SUN FAN" to IP address 2001:db8::4 is discussed below.

```
tcps  2001:db8::4 57692d53554e20464a4e   ← How to send TCP in binary
udpst 2001:db8::4 "Wi-SUN FAN"           ← How to send UDP as character string
udps  2001:db8::4 57692d53554e20464a4e   ← How to send UDP in binary
```

Although the port number can be designated, it was omitted in this example. The default port number is 3610 (ECHONET-Lite).

5. Notes

5.1. Wireless connection

1. There are times when wireless communication is unstable depending on the radio wave environment and communication environment, ROHM does not guarantee 100% data transfer, and shall not be responsible for any data loss.
2. UDP does not provide for arrival of packets in chunks and does not guarantee the arrival of data.
3. Perform a thorough validation of this product with the customer before incorporating it for full-scale operation.
4. ROHM shall not be liable for any damage or malfunction caused by data interception, loss, theft, plagiarism or leakage to a third party.

5.2. Sample script

The sample script used in this manual is a simulation of mesh networking communication, and does not guarantee actual mesh networking communication.

5.3. Changes

This instruction manual and the sample scripts used are subject to change without notice.

5.4. Firmware

5.4.1. License of firmware

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5.4.2. Firmware version

1. The firmware version written in this product is the latest at the time of manufacture.
2. The latest firmware may not be available depending on the timing of shipping.
3. The firmware version will be changed without prior notice. ROHM Co., Ltd. shall not take any responsibility for any damage caused to the customer by the change
4. The written firmware version cannot be identified by the appearance of this product.
5. Refer to the Startup Manual on how to rewrite the firmware.

5.4.3. How to confirm the firmware version

The firmware version can be checked by executing the "vers" command after startup.

5.5. Startup time of this product

In resetting this product, wait at least 6 seconds before accessing the product after releasing the reset.

6. Revision History

Ver.	Date	Details
1.0.0	2020/06/08	Initial version
1.0.1	2022/02/01	Removed description about the 'tcpst'

Notes

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