

FRH-SD07TU (US Version)
FRH-SD07TB (EU Version)
Ultra Low Power Consumption
Wireless Modem with Serial Interface
Instruction Manual

I Notice

This device complies with part 15 of the FCC rules and with ETS 300 440 of the European Telecommunication Standard Institute (ETSI). 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.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Any unauthorized changes or modifications to this device not expressly approved by Futaba Corporation could void the user's authority to operate the device and possibly result in damage to the equipment and/or cause serious or fatal injuries to the operator or nearby personnel.

This device is intended to be installed and used in accordance with the instructions contained in this manual. Failure to comply with these instructions could void the user's authority to operate the device and possibly result in damage to the equipment and/or cause serious or fatal injuries to the operator or nearby personnel.

[Especially for users in Europe]

FRH-SD07TB, European version can be used in the following countries: Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Norway, Portugal, Spain, Sweden, Switzerland, The Netherlands and United Kingdom (the Czech Republic and Hungary with limitation, see below).

In France and Spain, usable frequency is limited by its country's regulatory authority. See p.35 **FREQUENCY GROUPING** for the frequency usage limitation.

Belgium does not authorize FRH-SD07TB itself. FRH-SD07TB must be fitted into the final product, then tested to Radio, EMC and safety requirements. A notification will be only accepted for the final product then.

Users in the Czech Republic and Hungary can use FRH-SD07TB modem, but it has some limitation for operation. Please contact local regulatory authority to obtain details before attempt to use FRH-SD07TB modem in that countries.

II Important Safety Information

The list of dangers, warnings and cautions in this section contain important information that will help ensure safe operation of the system. Please read carefully and understand all of these items. All installers, operators and maintenance personnel should read and understand this information before installation, use, or maintenance of the FRH-SD07TU/TB system.

The FRH-SD07TU/TB system by itself is not inherently dangerous. **HOWEVER, WHEN THE FRH-SD07TU/TB IS CONNECTED TO OTHER EQUIPMENT FOR THE PURPOSE OF CONTROL, SAFETY AND ALL POSSIBLE ASSOCIATED DANGERS MUST ALWAYS BE GIVEN THE UTMOST CONSIDERATION DURING SYSTEM INTEGRATION, DESIGN, INSTALLATION, AND USE.**

The FRH-SD07TU/TB system may be used in virtually unlimited applications. Many of these associated systems can, by themselves, pose a mechanical, electrical or other hazard to operators and other persons or equipment. To address all possible applications and associated safety hazards in this manual would be impossible. The warnings below and throughout this manual give information that will allow safe installation and use the modem system applications. If you have questions regarding the safety of your specific application, please contact the appropriate people for help. Your Futaba sales representative, representatives of the equipment being controlled, and the technical support staff at local branch of Futaba Corporation are among those who can provide assistance with your safety concerns.

The following warnings are included in the lists that follow but warrant repetition here:

In installations where the FRH-SD07TU/TB system is used to control motion or operation of potentially dangerous equipment, it is imperative for safety that all operators and installers be thoroughly trained in the normal function of that equipment before attempting to control it remotely with the FRH-SD07TU/TB system.

To help ensure safe operation of the equipment, the FRH-SD07TU/TB system must be connected so that it will operate in a fail-safe way. In other words, the equipment being controlled should stop or return to its safest state in the absence of a control signal or total loss of RF transmission from the FRH-SD07TU/TB system. Our system uses one of the most reliable methods available to transmit data using radio signals. Many factors can affect a radio signal that may block it or interfere enough to disrupt regular transmission. Because of this, equipment motion or dangerous electrical current, for example, that continues during a loss-of-signal condition could be very dangerous.

Four symbols are used in the margin of the following section and throughout the manual to indicate the level of hazard or information listed.

The symbols are defined as follows:



Indicates a hazard that *will* cause severe personal injury, death, or substantial property damage if the warning is ignored.



Indicates a hazard that *can* cause severe personal injury, death, or substantial property damage if the warning is ignored.



Indicates a hazard that will or can cause minor personal injury, or property damage if the warning is ignored.



Indicates installation, operation, or maintenance information that is important but not hazard-related.

Please read the following safety information carefully. Some of these notices are duplicated throughout the manual, in areas of associated content, for your benefit.

II.1 General Safety Hazards and Notes



Improper installation and/or operation of the FRH-SD07TU/TB system can cause serious or fatal injuries to the operator or nearby persons and cause damage to the FRH-SD07TU/TB system, and any equipment it is used to control. Please read and understand this manual completely and the manual of all equipment being controlled before attempting to operate or install this system.



Always keep this manual at a location readily accessible to anyone operating the system and related equipment. Ensure that all operators have read and understood this manual, especially all safety and operation procedures contained in it. Please refer to the section in this manual titled **How to Obtain Help** for the contact that can supply additional manuals or answers to questions not covered in this manual. If this product is passed on to a different user, be sure that this manual accompanies the product.

⚠ WARNING

Be certain that the installer of this equipment reads and understands the instruction manual of *the equipment that is being connecting to* before attempting this installation.

⚠ DANGER

The FRH-SD07TU/TB modem should **NOT** be used in a manner in which failure of the product or loss of the radio signal could cause damage to the equipment being controlled, or to anything in the area in which such equipment is located. All integrated control systems should be designed for “fail-safe” operation so that a temporary or permanent loss of signal will not endanger any person, critical process, or equipment (refer to the beginning of the safety section for further explanation). The system design should ensure that the equipment being controlled will default to its safest state in the event of signal loss.

⚠ CAUTION

The FRH-SD07TU/TB modem contains no user serviceable parts. If the unit requires service, contact your sales representative or local branch of Futaba Corporation per instructions the section titled **How To Obtain Help**. Do not disassemble or attempt to repair the FRH-SD07TU/TB yourself. Doing so could void your warranty and may void the user’s authority to operate the device.

⚠ WARNING

Contact Futaba before using the FRH-SD07TU/TB modem in safety critical applications such as medical equipment, aircraft, hazardous materials handling, etc.

II.II Installation Safety Hazards and Notes

⚠ CAUTION

When mounting the FRH-SD07TU/TB modem, use M2 (ISO) screws that project 2 to 3 mm into the modem. Screws that project further into the modem (3.5mm MAX) may permanently damage the internal components and/or cause the FRH-SD07TU/TB modem to malfunction.

⚠ WARNING

Use only the proper regulated DC voltage supplied to the FRH-SD07TU/TB modem. Use of any other voltage may permanently damage the modem and/or cause the modem to malfunction and create a shock or fire hazard.

⚠ WARNING

Be certain that all AC power outlets used the power adapters have been properly installed, grounded, and fused. An electrical shock

hazard may exist if this unit is powered by a faulty power outlet or source. If such a situation is discovered, immediately discontinue use until the power source and outlet have been properly installed, grounded, and fused by an electrician or other authorized person.

⚠ WARNING

Be sure to wire the power and serial connections correctly. Incorrect wiring can damage the system, cause it to malfunction and/or create a shock and fire hazard.

⚠ WARNING

Ensure that the FRH-SD07TU/TB modem power and the power to the equipment to be controlled is turned off before connecting or disconnecting the cable between them. This will help prevent accidental damage to the system and unexpected operation and/or injury.

⚠ WARNING

Be sure the FRH-SD07TU/TB modem power, the power to the equipment that is being connecting to it, and the DC power source are all turned off before wiring and connecting the power cable.

⚠ WARNING

Be sure that the supplied power is within the specified range (2.7 to 3.3 VDC). Voltages outside the specified range may damage the FRH-SD07TU/TB modem.

⚠ WARNING

Be sure that the power source has sufficient current capacity. Insufficient current may cause the unit to malfunction.

⚠ WARNING

Securely attach the antenna cable, and serial communication connector to the FRH-SD07TU/TB modem and equipment/power source to which it is connected. Failure to do so could cause an unexpected system failure.

II.III Antenna Installation Hazards and Notes

⚠ WARNING

Be sure to keep all systems and antennas clear of power lines. Permanent equipment damage and severe shock injury or death can occur if the system contacts power lines.

⚠ WARNING

Contact Futaba before connecting any antenna not provided by Futaba specifically for the FRH-SD07TU/TB modem. Attaching any non-authorized antenna may be in violation of FCC regulations.

NOTE

When using two antennas with a single FRH-SD07TU/TB modem for diversity reception, mount the antennas as far apart as possible (6 cm minimum). If the antennas are too close, the diversity advantage will not be achieved.

⚠ WARNING

Before each use, verify that the antenna (and antenna cable, if used) is securely attached and in good condition. A loose antenna or cable may severely reduce the operating range of the system.

NOTE

When installing the FRH-SD07TU/TB modem in a mobile unit such as an Automated Guided Vehicle (AGV), Futaba recommends to use the diversity reception feature as a remedy for multipath fading problems. For diversity reception, install the two antennas as far apart as possible in order to gain maximum benefit (6 cm minimum).

NOTE

The FRH-SD07TU/TB operates at frequencies in the 2.4 GHz band. These frequencies are more directional than lower frequencies and are easily reflected. If there are metal structures nearby, the effective range may be shortened or the directional properties may be further narrowed. To help avoid this, mount the antenna as far away as possible from surrounding metallic structures.

NOTE

Multipath problems occur easily at frequencies in the 2.4 GHz band. When multipath problems are present, moving the antenna as little as 10 cm may result in improved communication or, conversely, worsened or complete loss of communication. Futaba recommends that the mounting position of the antenna be determined *after* testing and verifying optimal communication conditions. Negative multipath effects can also be overcome with antenna diversity. See p.12 **DIVERSITY ANTENNA SETUP** and the related register settings for more details regarding antenna diversity function.

⚠ CAUTION

When installing multiple FRH-SD07TU/TB modem systems that will use different frequency groups in the same area, modem's antennas of different frequency groups must be mounted at least 6 feet (2 meters) apart. Failure to do so may severely reduce the modem operating range.

NOTE

Please contact Futaba for information about antenna separation when using the FRH-SD07TU/TB and other wireless products in the same area.

II.IV Environmental Safety Hazards and Notes

WARNING

If the FRH-SD07TB/TU modem has been stored at a temperature beyond the specified operating temperature range for the system, it may not function properly. Allow it to return to normal temperatures before use. Refer to **APPENDIX A – TECHNICAL SPECIFICATIONS** for the actual operating temperature range.

WARNING

The FRH-SD07TB/TU modem is a precision electronic device with a rugged design that is intended for industrial applications. However, do not install it where it will encounter excessive vibrations. In some cases, isolation mounts may be used to isolate the modem from the equipment's vibration. Excessive vibration can permanently damage the modem and/or cause it to malfunction.

WARNING

Do not operate the FRH-SD07TB/TU modem in environments where it will be subjected to excessive moisture (such as rain or water spray), dust, oil, or other foreign matter (such as metal particles). Doing so may permanently damage the modem and/or cause it to malfunction. If it does become wet or contaminated, correct the situation, verify proper operation and have any problems corrected before using it to control other equipment. If necessary, the modem can be mounted inside a protective or waterproof enclosure. If the enclosure is metallic, the antenna must be mounted externally or the effective operating range will be severely limited.

WARNING

The FRH-SD07TU/TB is designed for indoor use. When using it outdoors, the modem should be mounted in a waterproof enclosure and the ambient temperature range should be checked to insure that it is within the modem's specifications. Always use the modem within its specified environmental ranges.

II.V Other Notice

NOTE

Italicized gothic word used in this manual shows functional and technical term especially important for the FRH-SD07TU/TB modem.

Operational Safety Hazards and Notes

⚠ WARNING

Before each use of the FRH-SD07TU/TB modem, ensure that the area where the equipment will be operated is clear of people or obstacles that may affect its safe operation.

⚠ WARNING

Before each use of the FRH-SD07TB/TU modem, verify that both the equipment being controlled and the modem are in proper operating condition.

⚠ CAUTION

When rewriting the FRH-SD07TB/TU modem's memory registers, do not turn the modem's power off until the modem returns a "P0" response. If the power is interrupted before a P0 response is returned, the memory contents may be lost or corrupted and the modem operation will be unpredictable. If the memory contents are lost or corrupted, they may be restored to original default settings by reinitializing them. (See p.44 **Memory REGISTER INITIALIZATION** for more details.)

⚠ WARNING

Do not attempt to operate remotely controlled equipment outside the communication range of the FRH-SD07TU/TB system. Doing so could cause loss of control of the equipment.

⚠ WARNING

Without implementing proper serial communication flow control settings, the baud rate between the modem and its terminal equipment (wire linked) can exceed the wireless link data rate and cause the modem buffer to overflow. This can result in malfunction of the systems being controlled and/or data corruption. Ensure that the appropriate flow control settings are being used for your upper layer application protocol.

III System Identification

For future reference, please take a moment to fill in the information below. This information will help us respond as quickly as possible should your FRH-SD07TU/TB modem ever need repair or replacement.

Model Name and Number: FRH-SD07TU or FRH-SD07TB

Serial Number: _____

Date of Purchase: _____

Distributor Name: _____

Distributor Address: _____

Distributor Phone Number: _____

IV Limited Warranty

FUTABA WARRANTS ONLY THAT THE INDUSTRIAL RADIO CONTROL SYSTEM GOODS OR PRODUCTS FURNISHED HERewith SHALL BE FREE FROM DEFECTS IN MATERIAL AND WORKMANSHIP UNDER NORMAL CONDITIONS OF USE AND SERVICE FOR A PERIOD OF ONE (1) YEAR FROM THE DATE OF SALE TO THE PURCHASER WHO IS THE FIRST BUYER OF THE GOODS FOR USE OR CONSUMPTION AND NOT FOR RESALE OTHER THAN AS A COMPONENT OF ANOTHER PRODUCT MANUFACTURED FOR SALE BY SUCH PURCHASER ("CONSUMER"). FUTABA'S LIABILITY, WHETHER BASED ON BREACH OF WARRANTY OR NEGLIGENCE, SHALL BE LIMITED, AT FUTABA'S ELECTION, TO REPLACEMENT OR REPAIR OF ANY SUCH NONCONFORMING GOODS, F.O.B. FUTABA'S U.S.A. PLANT, OR, AT FUTABA'S ELECTION, CREDIT FOR THE NET PURCHASE PRICE OF SUCH GOODS. ALL CLAIMS HEREUNDER MUST BE MADE IN WRITING DURING THE WARRANTY PERIOD, AND FUTABA SHALL HAVE THE RIGHT PRIOR TO ANY RETURN OF GOODS TO INSPECT ANY GOODS CLAIMED TO BE NONCONFORMING, AND IN ANY EVENT RESERVES THE RIGHT TO REJECT CLAIMS NOT COVERED BY WARRANTY. THIS LIMITED WARRANTY CONSTITUTES FUTABA'S SOLE WARRANTY. **FUTABA MAKES NO OTHER WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, AND EXPRESSLY DISCLAIMS ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.** FUTABA'S WARRANTY SHALL NOT APPLY IF, AMONG OTHER LIMITATIONS CONTAINED HEREIN OR FURNISHED WITH THE PRODUCT, BUYER, OR CONSUMER, OR ANY USER OF THE PRODUCT (A) ALTERS SUCH PRODUCT, OR (B) REPLACES ANY PART OF SUCH PRODUCT WITH ANY PART OR PARTS NOT FURNISHED BY FUTABA FOR THAT PURPOSE, OR IF, AMONG SUCH OTHER LIMITATIONS, PRODUCT FAILS TO OPERATE PROPERLY OR IS DAMAGED DUE TO ATTACHMENTS OR COMPONENTS THAT ARE NOT FURNISHED BY FUTABA FOR USE WITH OR REPAIR OF THE PRODUCT UNLESS SUCH USE IS AUTHORIZED IN WRITING IN ADVANCE BY FUTABA.

THIS LIMITED WARRANTY EXTENDS ONLY TO THE CONSUMER AND IS NOT ASSIGNABLE OR TRANSFERABLE. This limited warranty shall not apply to fuses, lamps, batteries, or other items that are expendable by nature, unless otherwise expressly provided.

This limited warranty does not cover any defect or damage to any of the goods caused by or attributable to force, accident, misuse, abuse, faulty installation, improper maintenance, improper electrical current, failure to install or operate in accordance with Futaba's written instructions, repair or alteration by unauthorized persons, or leaking batteries. **THE GOODS ARE SENSITIVE ELECTRONIC DEVICES REQUIRING SPECIAL HANDLING, AND THIS LIMITED WARRANTY DOES NOT APPLY TO PRODUCTS NOT HANDLED IN ACCORDANCE WITH INSTRUCTIONS SET FORTH IN THE MANUAL.**

THIS LIMITED WARRANTY DOES NOT COVER INDUSTRIAL RADIO CONTROL PRODUCTS PURCHASED OR USED OUTSIDE OF THE UNITED STATES WITHOUT FUTABA'S PRIOR APPROVAL.

V Returns

Futaba's authorization must be obtained prior to return of any item for warranty or other repair or replacement or credit and will reflect Futaba's warranty service procedure. Consumer's warranty rights are governed by the terms of Futaba's Limited Warranty, as above described. Products returned for warranty repair or replacement or credit must be carefully and securely packed for return, preferably in the original carton or equivalent. The Consumer must also include in the carton a legible copy of the bill of sale or invoice which shows the date of sale and the original Buyer's and Consumer's names, and also a letter which gives the Consumer's return address and contact telephone number, the model and serial numbers of the product(s) returned, and a brief explanation of the problem or claimed defect. Any returned products that are replaced by Futaba shall become the property of Futaba. If after inspection Futaba determines the defect is not covered by its limited warranty, Futaba will notify Consumer of its determination and will not undertake any repairs or product replacement until Consumer agrees to pay for all necessary parts and materials, labor (to be charged at Futaba's standard repair rate then in effect), and other expenses including all shipping charges and insurance. Futaba reserves the right to retain possession of any product returned by Consumer because of defects not covered by Futaba's warranty until Futaba receives Consumer's agreement as above noted or, if Consumer wants the product returned without repair or replacement, Consumer reimburses Futaba for all shipping and handling charges incurred by Futaba. Issuance of credit for returned items shall be made at Futaba's unfettered discretion. Consumer will not be entitled to return defective goods for cash refunds. Consumer must inspect goods immediately and no rejection or revocation of acceptance shall be permitted more than ten (10) days after delivery to, or first use by, Consumer of the goods, whichever occurs first.

VI Patents – Copyrights – Trademarks – Proprietary Rights

If this product was manufactured according to designs or processes specified by Consumer, Consumer shall indemnify and save Futaba, its affiliates, officers, agents, and employees, harmless from any expense, loss, attorneys' fees, costs, damages, or liability which may be incurred as a result of actual or alleged infringement of patent, copyright, or trademark rights. Furnishing of these products does not convey a license, implied or otherwise, under any patent, copyright, or trademark right in which Futaba has an interest, nor does it convey rights to trade secrets or any other proprietary information of Futaba.

VII Limitation of Damages and Action

IN NO EVENT SHALL FUTABA BE LIABLE TO CONSUMER, OR ANY OTHER PERSON FOR ANY INCIDENTAL, CONSEQUENTIAL, OR SPECIAL DAMAGES RESULTING FROM THE USE OF OR INABILITY TO USE THIS PRODUCT,

WHETHER ARISING FROM BREACH OF WARRANTY OR NEGLIGENCE OF FUTABA, OR OTHERWISE. Any action hereunder must be commenced within one (1) year of accrual of cause of action or be barred and forever waived. No modification or alteration of Futaba's Limited Warranty or any other provision of this paragraph or the above paragraphs shall result from Futaba's acknowledgment of any purchase order, shipment of goods, or other affirmative action by Futaba toward performance following receipt of any purchase order, shipping order, or other form containing provisions, terms, or conditions in addition to or in conflict or inconsistent with any such provisions.

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SECTION

1

INTRODUCTION

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1.1 Special Features

The following list highlights some of the special features of the FRH-SD07TU/TB. For more complete system specifications please refer to p.165 **SPECIFICATIONS**.

- Approved under FCC Part 15.247 rules (TU version) and under the European ETS 300 440 standard (TB version) -- no special user license required
- Operating range greater than 1000 feet, line-of-sight -- configurable as a repeater for extended range of application service area
- Ultra low power consumption. 35mA (Maximum) is achieved at the full-rate operation mode retaining almost same function and performance in the conventional FRH series radio.
- Newly developed doze waiting reception, *ULTRA (Ultra Low-power Transient Radio Access) mode* is implemented to the modem. It enables 2mA current consumption (average) in the mode.
- 2.4 GHz Direct Sequence Spread Spectrum (DSSS) communication system provides unsurpassed immunity to interference and RF noise
- *Diversity receiving function* is employed, which is practically invulnerable to multipath fading
- Fast switching Time-Division-Duplex (TDD) provides virtual full-duplex communication between terminal equipments at rates up to 115.2 kbps
- 54 user selectable frequencies allow up to 54 independent networks to operate simultaneously in the same area
- Single fixed frequency communication or multi-access communication (automatic selection of an vacant frequency from a defined group of frequencies) allows the user to select the best frequency use for the application
- Supports 1:1, 1:n, and n:m wireless network topology
- Serial communication interface allows direct connection to a micro controller chip. By converting its level by the external interface circuit, conformable to RS232C, RS422 and RS485
- Small size allows easy integration with many systems (1.97" x 1.18" x 0.31" / 50 x 30 x 8 mm)
- Supply voltage range is DC voltage in 2.7 to 3.3 V DC
- Communication can be made with other FRH series modems such as 03TU, 04TU and 06TU.

1.2 How To Obtain Help

Please contact your local sales representative or local branch of Futaba Corporation at the address shown below for help with the following:

- Application information regarding the FRH-SD07TU/TB or other Futaba products
- Technical assistance or training
- Answers to safety questions and issues
- Additional manuals or other documentation
- Repair or service
- Comments regarding the product or this manual

Japan
Futaba Corporation
Radio Control Equipment Group
1080 Yabutsuka, Chosei,
Chiba, 299-4395 JAPAN
Tel: +81 (475) 32-6173, Fax: +81(475) 32-6179
Internet: www.futaba.co.jp

United States
Futaba Corporation of America
Industrial Radio Control Department
1605 Penny Lane
Schaumburg, IL 60173
Tel: +1(847) 884-1444, Fax: +1(847) 884-1635
Internet: www.futaba.com

Europe
PENDING

When requesting repairs, please provide as much detail as possible regarding the failure and its cause or symptoms. Doing so will help our service department find the problem quickly, resulting in a shorter repair time.

CAUTION

The FRH-SD07TU/TB modem contains no user serviceable parts. If the unit requires service, contact your sales representative or local branch of Futaba Corporation as per instructed in this section. Do not disassemble or attempt to repair the modem yourself. Doing so could void your warranty and may void the user's authority to operate the device.

1.3 Starter Kit

The FRH-SD07TU/TB sales policy is a bulk shipment. However, we prepared the starter kit for an engineering evaluation and test. Below is the content of the starter kit. A content of the kit is subject to change without notice.

<u>Part Description</u>	<u>Part Number</u>	<u>Quantity</u>
FRH-SD07TU Wireless Modem	FRHSD07T02	1
or		
FRH-SD07TB Wireless Modem	FRHSD07T03	1
RS232C Interface Board		1
Communication Cable	1M38A14901	1
Simple Flat Antenna	1M38A15001	1
Startup Floppy Disk		1

1.4 Optional Parts

In addition to the basic system, the following accessories are available (Please refer to **APPENDIX A and B** for more detailed information).

<u>Description</u>	<u>Part Number</u>
Communication Cable	1M38A14901
Simple Flat Antenna	1M38A15001

For information on obtaining spare parts or accessories, contact your local branch of Futaba Corporation or the distributor from whom the system was purchased.

1.5 Physical Description

Please review the following section and take a moment to familiarize yourself with the FRH-SD07TU/TB wireless modem.

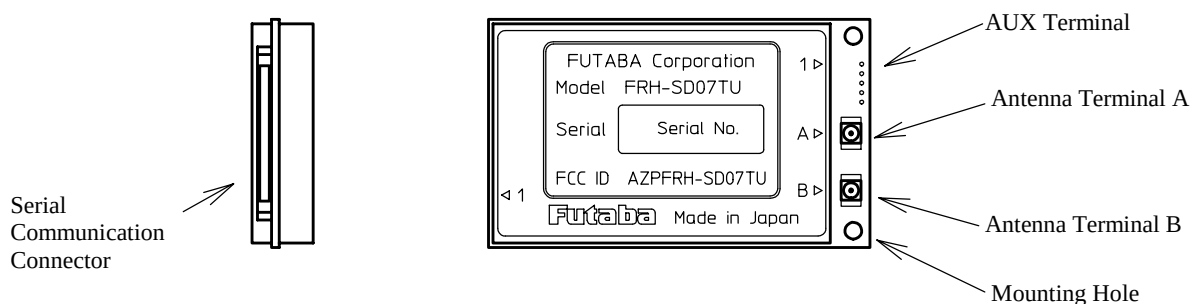


Figure 1-1: Upper View (TU example)

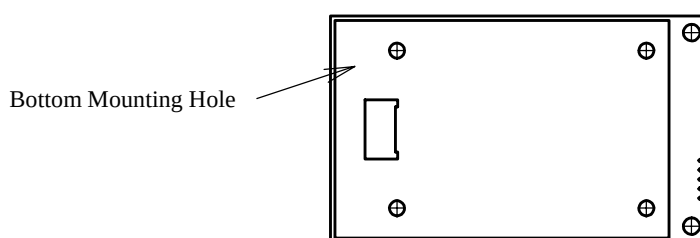


Figure 1-2: Bottom View

(1) Serial Communication Connector

This is a connector to communicate to external terminal equipment (DTE; Data Terminal Equipment) and connect serial communication cable. Also controlling functions such as *hardware reset* and *RS232C/RS485 selecting* pins are available. Signal is CMOS level. Add level conversion circuit when level conversion is required.

(2) Antenna Terminal A

Connect Antenna. Install antennas provided by Futaba. If you install single antenna, Antenna should be installed to this Terminal A.

(3) Antenna Terminal B

This terminal is for *diversity reception* function. Install second antenna to the terminal B.

(4) AUX Interface Terminal

This terminal is used as auxiliary for the operation. Monitoring statuses such as internal operation, transmission/receiving operation and antenna diversity switching are available.

(5) Mounting Hole

The holes are used to install the modem to mounting terminal or bracket. Since screw can be installed from the front surface, it is easy to install the modem. However, only two holes are available, it should be fixed by guide structure on the other side of the unit to prevent vibration problem.

(6) Bottom Mounting Hole

The four holes are used to install the modem. Please use this holes instead of above explained holes if tightened mounting is required. The hole has M2 taps. Use M2 (ISO) screws that project 2 to 3 mm into the modem. 3.5mm is MAXIMUM LIMIT. Screwing torque is 2.5 kg cm MAXIMUM.

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2

SYSTEM INSTALLATION

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2.1 Wireless Modem Installation

2.1.1 Mounting Method 1

A method to mount the modem directly on a surface using the mounting holes at the side of the modem's print circuit board. When using this method, provide a guide on the opposite side, because two holes are not sufficient to securely mount the modem.

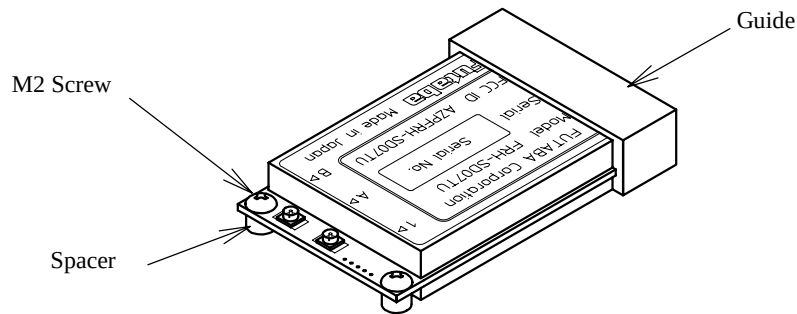


Figure 2–1: Mounting Method 1

2.1.2 Mounting Method 2

To mount the modem using the holes on a flat horizontal surface, which are 3.5mm deep for M2 screws. When using this method, use M2 screws which project the hole 2 to 3mm deep. The screw tightening torque is below 2.5kg cm. Mount the modem on a flat plane and be careful that there is no torsion applied. For the position of the mounting holes, see p.167

DIMENSIONS.

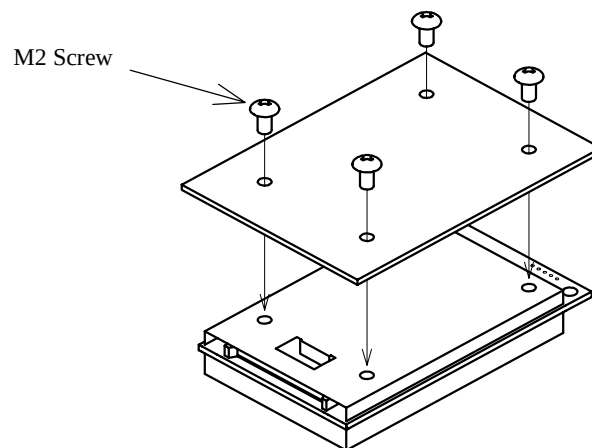


Figure 2–2: Mounting Method 2

⚠ WARNING

Be careful not to allow water, oil, dust and other foreign particles (especially metal particles) to enter inside, which may damage the unit.

⚠ WARNING

Since the FRH-SD07TU/TB modem is a precision electronic device, install it at a place free of excessive shock and vibration to prevent the unit from damage.

⚠ WARNING

The FRH-SD07TU/TB is designed to be used inside the room. In case of using it outdoor, be sure to use it within the extent limited by the environmental specification, and check the ambient temperature and the state of water-proof.

2.2 Communication Cable Connection

Use the serial communication cable prepared by Futaba to connect the FRH-SD07TU/TB modem to the external terminal equipment. For the connection of the modem, see p.144 **PIN ASSIGNMENT.**

The signal level of the FRH-SD07TU/TB is CMOS. If the interface of the equipment to be connected is RS232C or RS485, the level conversion circuit is required. For the example of the level conversion circuit, see p.148 **CONVERSION CIRCUIT.**

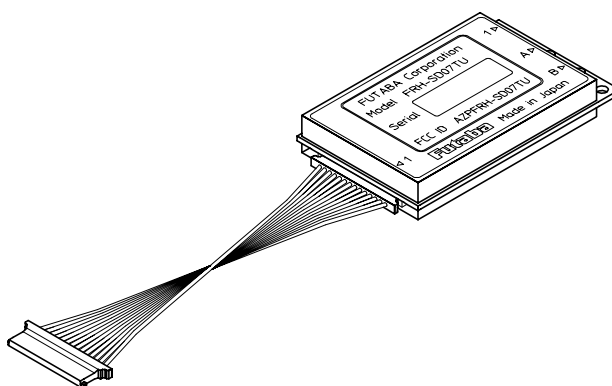


Figure 2–3: Connection of Communication Cable

⚠ WARNING

Be certain that the installer of this equipment reads and understands the instruction manual of the equipment that is being connected to before attempting this installation.

⚠ WARNING

Ensure that the FRH-SD07TU/TB modem power and the power to the equipment to be controlled is turned off before connecting or disconnecting the cable between them. This will help prevent

accidental damage to the system and unexpected operation and/or injury.

⚠ CAUTION

In addition to this manual, read the operation manual of a PC (Personal Computer) and PLC (Programmable Logic Controller) to be connected.

⚠ WARNING

Be sure to wire the cable connections correctly. Incorrect wiring can damage the system, causing it to malfunction and/or create a shock and fire hazard. Also insert the cable firmly to the connector. Since no lock system is provided with the connector of this equipment, never stretch the cable or pull it up by hands.

2.3 Power Supply Precautions

Since FRH-SD07TU/TB contains a very-high-frequency sensitive analog circuit, the modem is susceptible to be affected the variation of the power source and noises from the digital circuit. Therefore, when embedding the modem into the system, it is necessary to supply power to the modem from a different (independent) power supply IC chip other than those used in the digital circuits. Check the noise level from the power source line is enough below than the practical level in the following way.

- Prepare 2 units of FRH-SD07TU/TB mounted in the system
- Set the frequency of each modem to the same and fixed frequency as below.
Example: @FRQ:H00 CR/LF
- Set the number of *retransmission count* of the modem on the sender side to 0.
Example: @RNO000 CR/LF
- Issue the @TXT command several hundreds times. If almost all *responses* are “P0” (communication success), there is no problem.
- If “N1” *response* (communication failure) returns many times, there may be a noise problem in the power source.
- However, there is a possibility of causing communication failure due to a trouble in the radio communication channel (multipath). For correct judgment, it is recommended to repeat the above checking several times.

NOTE

For the operation of commands explained, refer p.79 **COMMAND SET DESCRIPTION**.

2.4 Antenna Connection

At least one antenna must be connected to Antenna Connector A on each FRH-SD07TU/TB modem in use. In the environment where multipath fading exists with reliable communication requirements, a second antenna can be installed to Antenna Connector B for the *diversity reception* function to improve reception performance.

⚠ WARNING

Be sure to keep all systems and antennas clear of power lines. Permanent equipment damage and severe shock injury or death can occur if the system contacts power lines.

NOTE

Please contact Futaba before attempting to install any third party antenna equipment.

NOTE

Please contact Futaba for information about antenna separation when using the FRH-SD07TU/TB and other wireless products in the same area.

2.4.1 Single Antenna Setup

Always use Antenna Connector A when installing a single antenna. Antenna Connector B cannot be used to transmit and is only used to attach a second receive antenna when the antenna diversity function is enabled.

Refer to the figures below for details about the actual mounting and connecting methods.

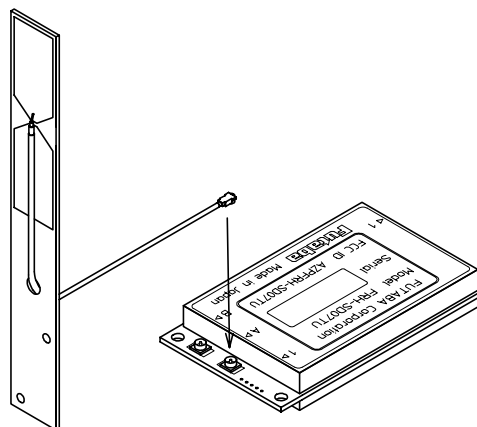


Figure 2–5: Connecting the Antenna

2.4.2 Diversity Antenna Setup

In certain situations, reception can be improved by using the integrated *antenna diversity* feature. This is accomplished by using two separate antennas and enabling the diversity function in REG19 (see p.59 **MEMORY REGISTER DESCRIPTION**).

CAUTION

When using two antennas with a single modem for *diversity reception*, mount the antennas as far apart as possible (at least 6 cm). If the antennas are too close, the *diversity* advantage will not be achieved.

CAUTION

Before connecting the connector, make sure that no dirt and foreign particles are attached.

Refer to the figures below for details about the actual mounting and connecting methods.

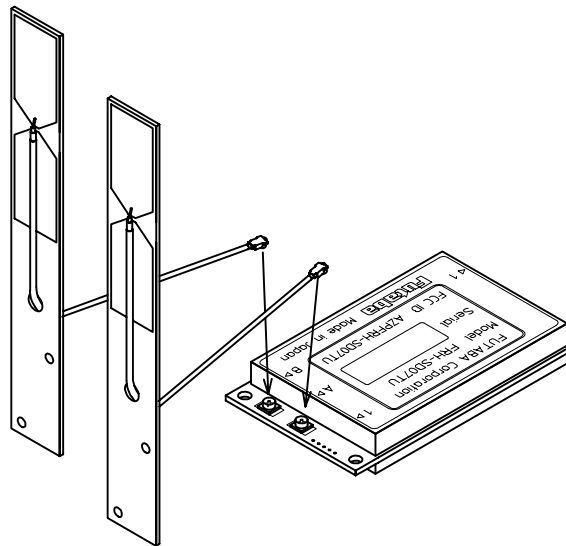


Figure 2–6: Connecting Two Antennas

2.5 Other Installation Precautions

2.5.1 Modem Installation Precautions

WARNING

Securely attach the antenna cable, and *serial communication connector* to the FRH-SD07TU/TB modem and equipment/power source to which it is connected. Failure to not do so could cause an unexpected system failure.

⚠ WARNING

The FRH-SD07TU/TB modem is a precision electronic device. Its rugged design is intended for industrial applications. However, do not install it where it will encounter excessive vibrations. In some cases, isolation mounts may be used to isolate the modem from the equipment vibration. Excessive vibration could permanently damage the modem and/or cause it to malfunction.

⚠ WARNING

If the FRH-SD07TU/TB modem has been stored at a temperature beyond the specified operating temperature range for the system, it may not function properly. Allow it to return to normal temperatures before use. Refer to p.165 **SPECIFICATION** for the actual operating temperature range.

⚠ WARNING

Do not operate the FRH-SD07TU/TB modem in environments where it will be subjected to excessive moisture (such as rain or water spray), dust, oil or other foreign matter (such as metal particles). Doing so may permanently damage the modem and/or cause it to malfunction. If it does become wet or contaminated, correct the situation, verify proper operation and have any problems corrected before using it to control other equipment. If necessary, the modem can be mounted inside a protective or waterproof enclosure. If the enclosure is metallic, the antenna must be mounted externally or the effective operating range will be severely limited.

⚠ WARNING

The FRH-SD07TU/TB is designed for indoor use. When using it outdoors, the modem should be mounted in a waterproof enclosure and the ambient temperature range should be checked to insure that it is within the modem's specifications. Always use the modem within its specified environmental ranges.

2.5.2 Antenna Installation Precautions

⚠ WARNING

Before each use, verify that the antenna (and antenna cable, if used) is securely attached and in good condition. A loose antenna or cable may severely reduce the operating range of the system.

⚠ WARNING

Avoid mounting the antenna near large metallic objects or inside metal enclosures. Such objects can severely reduce the operating range of the system.

NOTE

When installing the FRH-SD07TU/TB modem in a mobile unit such as an Automated Guided Vehicle (AGV), Futaba recommends using

the *diversity reception* feature as a remedy for to multipath fading problems. For *diversity reception*, install the two antennas as far apart as possible in order to gain maximum benefit (Actual recommendation is 30 cm, 6 cm at least).

⚠ CAUTION

FUTABA standard antenna is made by Printed Circuit Board. It is not fabricated for severe use. Please use antenna without any unexpected force (bent or broken). Mount the antenna in a location where it will be least likely to be damaged by contact with other objects or equipment.

⚠ CAUTION

The FRH-SD07TU/TB operates at frequencies in the 2.4 GHz band. These frequencies are much directional than lower frequencies and are easily reflected. If there are metal structures nearby, the effective range may be shortened or the directional properties may be further narrowed. To help avoid this, mount the antenna as far away as possible from surrounding metallic structures.

⚠ CAUTION

Multipath problems occur easily at 2.4 GHz frequencies. When multipath problems are present, moving the antenna as little as 10 cm may result in improved communication or, conversely, a further diminished or total loss of communication. Futaba recommends that the mounting position of the antenna be determined *after* testing and verifying optimal communication conditions. Negative multipath effects can also be overcome with *antenna diversity*. See p.12 **DIVERSITY ANTENNA SETUP** and the related register settings for more details regarding *antenna diversity*.

2.5.3 Multiple FRH Modems Installation Precautions

⚠ CAUTION

When installing multiple FRH (series) modem systems that will use different *frequency groups* in the same area, modem's antennas of different *frequency groups* must be mounted at least 6 feet (2 meters) apart. Failure to do so may severely reduce the modem operating range.

NOTE

Please contact Futaba for information about antenna separation when using the FRH-SD07TU/TB and other wireless products in the same area.

2.5.4 ID Code Setting Recommendation

Futaba recommend user to set unique ID code to prevent unexpected interference (jamming) between individual FRH systems working in the same area.

The protocol on RF channel employed in FRH series modem is Futaba's original protocol. Therefore, there is no concern undesired connection to other radio systems, such as wireless LAN. On the other hand, it has a possibility that unexpected, undesired radio connection between Futaba's FRH series modems which work as different radio systems.

To prevent this undesired radio connection, ID code (REG04 and REG05) can be used. Since the FRH radio modems which set different ID code can not communicate each other, it is possible to prevent an undesired connection.

Set same ID code to the modems work in the same radio system. Set appropriate and individual ID code for the system, do not use simple code such as 1111H, not to coincide to other system's setting.

Refer to p.157 **PREVENTING UNDESIRED RADIO CONNECTION** in this manual for details.

SECTION

3

SYSTEM OPERATION

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3.1 Operation Modes

FRH-SD07TU/TB modem can operate in one of four primary operation modes. Select the mode that best suits your specific application. The default setting is Mode 3. Mode 1 and 2 are the modes perform on the other FRH series modem.

Mode	Protocol	Function
3	packet transmission	Modem
4		Repeater
5		Modem
6	direct transmission	

Table 3–1: FRH Operation Modes

3.1.1 Mode 3 – Packet Transmission Mode

- In Mode 3, the FRH-SD07TU/TB modem communicates in *packet transmission mode*. Communication parameters are set using the *memory registers*.
- Mode 3 is generally used for 1:n and n:m wireless network topology and for applications in which the volume of data is relatively small and changing the *destination station* occurs frequently.

3.1.2 Mode 4 – Repeater Mode

- In Mode 4, the FRH-SD07TU/TB modem operates as a *repeater* in *packet transmission mode*. All modem and communication parameters are controlled through the modem's internal *memory registers*.
- Mode 4 is used to extend the effective communication range in a topology using Mode 3.

3.1.3 Mode 5 – Headerless Packet Transmission Normal Mode

- Mode 5, a special mode in *packet transmission mode*, is used by no transmission command required in Mode 3 and enable transmission only by the direct data input.
- Mode 5 is generally used for 1:n wireless network topology and for applications in which the volume of data is relatively small and changing the *destination station* from among the receiver modems occurs infrequently. Since no transmission command is required, the development of upper layer application program becomes easier.
- The operation method of Mode 5 is quite different from that of Mode 3 and Mode 4. For details, refer to p.118 **HEADERLESS PACKET TRANSMISSION MODE**.

3.1.4 Mode 6 – Direct Transmission Mode

- Mode 6 is a mode to transmit input data not as the data-bit but as the signal level indicating high or low state.
- Mode 6 features a short transmission delay of about 500 us due to no need to assemble data to the wireless packet.
- Mode 6 is particularly suitable for, an upper layer application where fast response is required.
- The operation method of Mode 6 is quite different from that of Mode 3 through Mode 5. For details, refer to p.127 **DIRECT TRANSMISSION MODE**.

3.2 Packet Transmission Mode

Packet transmission mode operates as half-duplex communication and requires explicit commands to control the modem transmissions. Because this mode allows the addressing of different *destination* receiver modems by embedding the address in the data packets, it is best suited for 1:n and n:m topology applications.

In *packet transmission mode*, the FRH-SD07TU/TB modem normally waits in a *ready-to-receive state*.

When a transmission command is issued to the sender modem from its terminal equipment, the modem searches for a clear frequency channel and, when found, transmits the message to the intended *destination* receiver modem.

Packet transmission mode also allows expansion of the effective wireless communication range by using an additional FRH (series) modem configured as a *repeater*.

3.2.1 Packet Transmission Mode Protocol

In *packet transmission mode*, after a data packet is transmitted from the sender modem (station) to a *destination station*, the *destination station* acknowledges successful communication by returning an *acknowledgement (ACK) packet* to the sender modem. The sender modem waits for the *ACK packet* and when it is received, indicates that the transmission was successful. If it does not receive an *ACK packet*, it will continue to retransmit the data packet until it does receive an *ACK packet* or until the *retransmission count* (REG11 or RNO command setting) reaches the preset limit. If the sender modem receives an *ACK packet* anytime during the retransmission attempts, it returns a “*successive completion response*” (P0) code to its terminal equipment. If the modem does not receive an *ACK packet*, it returns a “*transmission failed*” (N1) code to its terminal equipment.

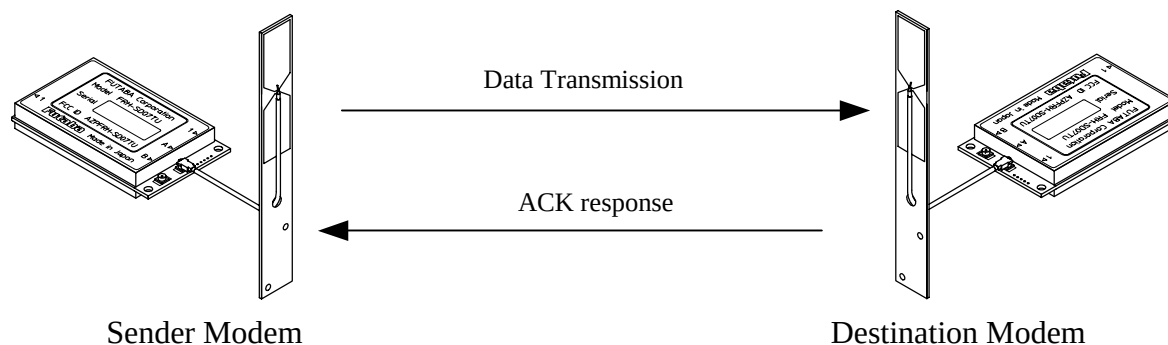


Figure 3–2: Packet Transmission and ACK response

3.2.2 Broadcast Transmission Protocol

Broadcast transmission (sending the same data to multiple modems simultaneously) is possible in *packet transmission mode* by setting 255 as the *destination address* (REG02). However, because *ACK packet* are not returned when executing the *broadcast transmission*, the sender modem does not receive confirmation of the “successful reception” of the transmitted data from any of the receiver modems.

In *broadcast transmission*, the sender modem transmit the data packet the number of times equal to the preset *retransmission count* (REG11 or RNO command setting) plus one and then it outputs a *successive completion response* (P0) to its terminal equipment. When the remote receiver modems receive the transmitted data successfully, they output the data to their terminal equipments normally and do not return *ACK packet*. Once a valid data packet has been received correctly by a receiver modem, rest of data received during any subsequent retransmissions are discarded and not output to its terminal equipment.

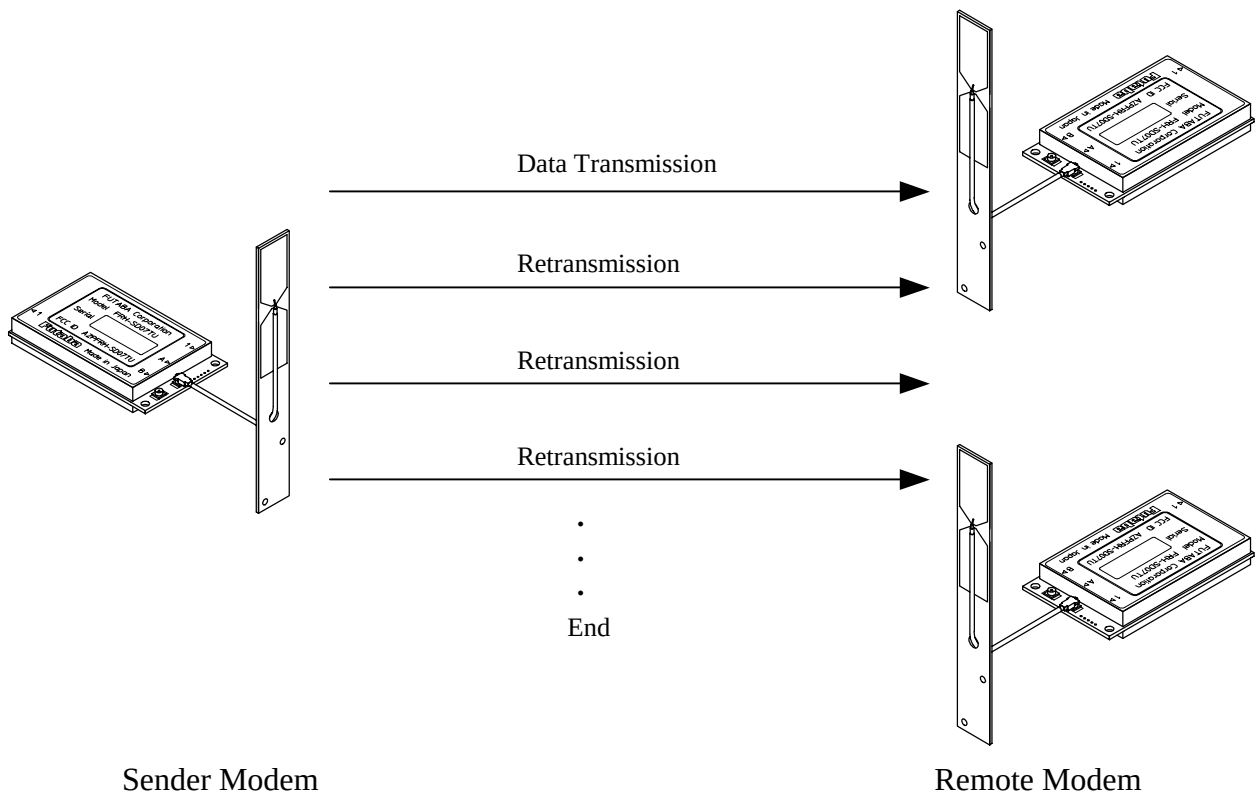


Figure 3–3: Broadcast Transmission

3.2.3 Transmit Command and Receive Header

Four transmit commands can be used in *packet transmission mode* (mode 3). Both *text* and *binary* data can be sent *directly* from modem-to-modem or sent through a third FRH (series) modem configured as a *repeater*. The receiver modem automatically determines the transmitted data format and communication path from the information in the received packet header. Refer to the table below for a list of the transmit commands and the corresponding header component.

Transmit Command	Receive Header	Function
TXT	RXT	Text data transmission
TBN	RBN	Binary data transmission
TXR	RXR	Text data transmission via repeater
TBR	RBR	Binary data transmission via repeater

Table 3–5: Transmit Commands and Receive Headers

The following list shows each command's syntax as issued at the sender terminal equipment and the response displayed at the receiver terminal equipment when the packet is received.

1. Direct Text Data Transmission

transmit: @TXT [destination address]{source address}[message]

receive: RXT [source address][message] CR/LF

2. Direct Binary Data Transmission

transmit: @TBN[destination address]{source address}[message length][message] CR/LF

receive: RBN [source address][message length][message] CR/LF

3. Text Data Transmission through Repeater

transmit: @TXR [repeater address][destination address]{source address} [message] CR/LF

receive: RXR [repeater address][source address][message] CR/LF

4. Binary Data Transmission through Repeater

transmit: @TBR [repeater address][destination address]{source address}
[message length][message] CR/LF

receive: RBR [repeater address][source address][message length][message] CR/LF

where {source address} is optional, used in *RS485 mode* set by serial communication cable 12 pin.

The following list defines the parameters and symbols used in the commands above:

@ = command header

CR/LF = carriage return + line feed

destination address = address of modem to receive the message (000 to 239)

source address = address of modem sent the message (000 to 239)
repeater address = address of the repeater modem (000 to 239)
message length = number of bytes in message
message = information data (255 bytes or less)

⚠ CAUTION

Since there are significant notes for issuing the transmit command, be sure to read p.158 **OPERATION IMPORTANT NOTICE**.

⚠ CAUTION

In the *text data transmission*, the message is considered to be terminated when the CR/LF code appears in it. No data after that will be transmitted. When the CR/LF code contains in a message, use the *binary data transmission* command.

⚠ CAUTION

When the *command header* contains in a message data, the data after that are recognized as the command, resulting in *command error*. When the *command header* contains in a message data, it is necessary to set the memory register REG15, *Command Recognition Interval*.

3.2.4 Extended Receiving

The *extended receiving function* (mode 3 and 5) can be used to prevent the degradation of transmission delay or failure caused by a collision of two transmission packet where two modems perform transmission at the same time in the *contention topology* application. The collision results retransmission of the same packet or packet transmission failure. Set with the *memory register* REG19: bit 3 to enable this function.

3.2.4.1 Operation of Extended Receiving

In the transmission originate sequence, the message packet arrived during *carrier sensing* in the sequence is not received all but *carrier sensing* continues. But in the *extended receiving*, the message packet arrived during *carrier sensing* is received and the modem returns *ACK packet*. After returning *ACK*, *carrier sensing* resume.

The following is the operation of packet transmissions which is invoked both of the two modems simultaneously while the *extended receiving function* is valid.

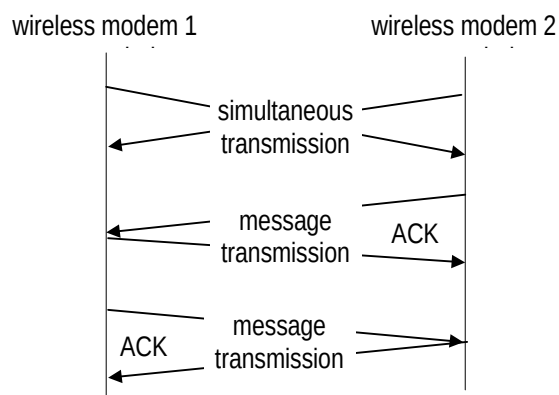


Fig. 3–5: Operation of Extended Receiving

1. Modems 1 and 2 transmit messages packet at the same time.
2. Both modems wait for *ACK* but the status becomes time-out.
3. Both modems start *random wait* after the transmission, and the modem first completes the *random wait* starts *carrier sensing* and retransmits the message. (in this case, modem 2)
4. Modem 1 receives the retransmitted message during *carrier sensing* state (performs the *extend receiving*), return *ACK* after receiving the message.
5. Modem 1 does *carrier sensing* again and transmits the message.
6. Modem 2 returns *ACK* to complete transmission.

3.2.4.2 Caution for Extended Receiving

As understood from the figure above, the modem 1 outputs to the terminal equipment as follows.

P1 CR/LF	<i>response</i> of transmission command acceptance
RXT002 CR/LF	message output
P0 CR/LF	<i>response</i> of successive transmission

Therefore, it is necessary to design an upper layer application protocol with a consideration that the message is output between the *command responses* “P1” and “P0”. Except the *headerless packet transmission mode*, such consideration is not necessary because there is no “P1” and “P0” *response*.

3.2.5 Communication Time in Packet Transmission Mode

3.2.5.1 Transmission sequence

The transmission sequence in the *packet transmission mode* (mode 3,4 and 5) and time required for each transmission are described as follows:

1. Issue the transmission command

The input time of the transmission command is determined by the serial communication parameter between the terminal equipment and the modem. Relating parameters are as follows.

- a. transmitting rate (300 bps to 115200 bps)
- b. data length (7 or 8 bits)
- c. parity bit (with or without)
- d. stop bit length (1 or 2 bits)
- e. start bit length (1 bit constant)

Example: In the case of the transmitting rate of 9600 bps, 1 start bit and 1 stop bit, data length of 8 bits and without parity, the time required for sending 1 byte is 1.04 ms, as 104 us is required for 1 bit.

To transmit 10 bytes message data by the TXT command, the command syntax is @TXT001ABCDEFGHIJ CR/LF of 19 bytes, requiring 19.8 ms.

2. Carrier sensing

The sensing time to confirm whether another modem is transmitting or not. If a carrier is detected during *carrier sensing*, again another *carrier sensing* will take place after *random wait* time.

3. Wireless transmission

The wireless transmission time depends on the message byte data length (1 to 255). It can be expressed in the following equation.

$$7.084 \text{ ms} + \text{message byte} \times 0.154 \text{ ms}$$

4. Waiting for ACK packet

The time for waiting *ACK packet* after the end of wireless transmission. It takes 5 ms for the direct transmission to the *destination station* and “wireless transmission time + 17.2 ms” for the transmission through *repeater*. If the preamble of the *ACK packet* cannot be received within this period, it results transmission failure. When the *retransmission count* (REG11 or RNO command setting) does not reach 0, *carrier sensing* starts after the *random wait* time. When the *retransmission counter* reaches 0, the transmission ends with the “N1” *response* of transmission failure.

5. Transmission of ACK (NAK)

The time for transmitting the response packet from the receiver modem. *ACK packet* is

to notify the sender the successful receiving. *NAK packet* is to notify the receive failure which the *repeater* returns to the sender modem when no respond from the *destination station*, in case the transmission is through the *repeater*. In both cases, it takes 7.084 ms.

6. Random wait

When a carrier is detected in *carrier sensing* or data are retransmitted due to transmission failure, *carrier sensing* starts after the randomly set wait period for to prevent the collision of packets. It takes 0, 3, 6 or 10 ms, *random wait* time

7. Output of received data

Time to output the received data to the terminal equipment. This time depends on the serial communication parameter between the terminal equipment and the modem, as in the case of above **ISSUE THE TRANSMISSION COMMAND.**

3.2.5.2 Communication time

An example of the communication time for transmitting 10 bytes message with 1 stop bit and without parity, where the communication parameter is 19200 bps and the data length is 8 bits, is shown below.

Case 1: Successive finish of the TXT command

This case is the most basic communication example.

Time		Terminal 1	Modem 1	Modem 2	Terminal 2	Time
10ms	Issue transmission command					
3ms	carrier sensing					
9ms	Transmission				Receiving	
7ms	receive ACK				ACK transmission	10ms
2ms	response				received data output	
Total						
31ms						

Case 2: Finish by one-time retransmission of the TXT command

This example is a case of one-time retransmission. Since no *ACK* is received, the modem retransmits the data. In the retransmission routine, *random wait* for 10 ms to prevent the collision of packets and *carrier sensing* starts again. The subsequent communication is the same as the Case 1.

Time	Terminal 1	Modem 1	Modem 2	Terminal 2	Time
10ms	Issue transmission command				
3ms	carrier sensing				
9ms	Transmission				
5ms	wait for ACK (no response)				
10ms	random wait				
3ms	carrier sensing				
9ms	Transmission			Receiving	
7ms	receive ACK			ACK transmission received data output	10ms
2ms	Response				
Total 58ms					

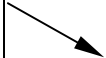
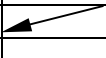
Case 3: Successive finish of the TXR command

This example is the transmission through the *repeater*. In the transmission through the *repeater*, it takes twice longer for the wireless communication because of the data is transferred by the *repeater*.

Time	Terminal 1	Modem 1	Repeater	Modem 2	Terminal 2	Time
11ms	Issue transmission command					
3ms	carrier sensing					
9ms	Transmission to the repeater					
9ms	Transmission from the repeater				Receiving	
7ms	ACK received by the repeater				ACK transmission received data output	11ms
7ms	receive ACK from the repeater					
4ms	Response					
Total 50ms						

Case 4: Successive finish of broadcasting the TXT command

This example shows the case of *broadcast transmission*. In the *broadcast transmission*, data are retransmitted by the specified times. If the receiver modem has once received it, the retransmitted data will not be output to the terminal equipment.

Time	Terminal 1	Modem 1	Modem 2	Terminal 2	Time
10ms	Issue transmission command				
3ms	carrier sensing				
9ms	Transmission			Receiving	
5ms	wait time			output received data	10ms
10ms	random wait				
3ms	carrier sensing				
9ms	Transmission			Receiving	
5ms	wait time			No output since the data is the same data	
10ms	random wait				
3ms	carrier sensing				
9ms	wireless transmission			wireless receiving	
5ms	wait time			No output since the data is the same	
2ms	response				
Total 83ms					

3.2.6 Precautions in Packet Transmission Mode

3.2.6.1 No ACK Response

In *packet transmission mode* (mode 3), succession of communication is confirmed when the sender modem receives an acknowledgment (*ACK packet*) from the receiver modem. If the *ACK packet* is not successfully obtained from the receiver modem, even though the data was successfully received, the sender modem concludes (incorrectly) that the data transmission sequence was failed and outputs *transmission failure response* (N1) to its terminal equipment. The following text describes what will occur in such situations:

When the *ACK packet* is lost and the *retransmission count* (REG11 or RNO command setting) is set to 0:

- Tx modem: sends packet
- Rx modem: transmits *ACK* and outputs the received data to its terminal equipment
- Tx modem: outputs the *transmission failure response* (N1) to its terminal equipment (since no *ACK* was received) and takes no more action.

When the *ACK packet* is lost and the *retransmission count* set to 1 or greater:

- Tx modem: sends packet
- Rx modem: transmits *ACK* and outputs the received data to its terminal equipment.
- Tx modem: retransmits same packet until *ACK* is received or until it finishes retransmission of the packet the number of times the *retransmission count* plus one
- Rx modem: for each subsequent data packet successfully received, transmits an *ACK* but does not forward the again-received-data to its terminal equipment
- Tx modem: if an *ACK* is received after any retransmission attempt, a *successive completion response* (P0) returns to its terminal equipment; otherwise, the *transmission failure response* (N1) returns

Problems with *ACK packet* not being received can usually be resolved by increasing the number of *retransmission count* setting. However, if in the situation above, inconsistency of data stream perception between sender and receiver terminal equipments will occur. This problem can not be resolved in the modem inside, prepare the solver in the upper layer application protocol.

3.2.6.2 Throughput Degradations in Frequency Grouping

If the *retransmission count* is not set sufficiently high when using the *frequency group function* in the *packet transmission mode* (modes 3 and 5), receive throughput will drop and the probability of transmission failure will increase. To help alleviate these potential performance problems when using the *frequency group function*, set the *retransmission count* to a value equal to or larger than the square of the number of frequencies being used.

Receive throughput will drop since the frequency between the sender modem and receiver modem is not identical in some case (because multiple frequencies are used). When using the *frequency group function*, receiver modems are in the *ready-to-receive state* and is sequentially changing frequencies. A sender modem, that has data to be transmitted, also transmits its packet sequentially with changing frequencies until it receives *ACK* from the receiver modem or until it reaches the *retransmission count* plus one. Because the receiving modem changes frequencies at a slower rate than the transmitting modem, the both frequency channels will eventually align. And the data packet will be successfully transmitted. To make frequency alignment in both mode, the *retransmission count* should be set high enough. But sometimes, it takes a time to make this alignment.

The use of the *frequency group function* is effective when specific frequencies are interfered, but will result a degradation of data throughput. Accordingly, it is recommended to use the *fixed frequency mode* for applications that require high data throughput in the *packet transmission mode*. (In this case, the communication may be susceptible to interference or multipath fading)

3.2.6.3 Collision Avoidance in RS485 Interface

When multiple modems are connected on RS485 wire-line, the received data or the *command responses* of the modem may collide on the line. Reasons of such collision are that multi-dropped multiple modems receive packet at the same time and output to RS485 line, or, multiple modems accept *global addressing command* and output its response at the same time.

When there is a possibility of the RS485 line collision, avoid it by taking following remedy.

- 1) Set each of the multi-dropped modem's *Interval between packets* (REG07) value to different value. Difference between each set value shall be larger than 1 byte transmission duration (from the start bit to the stop bit) which determined by the RS485 line baud rate.
- 2) Set the *Collision avoidance function* (REG23:bit 1) of all modems to 1.
- 3) Set *Regular interval output for RS485 collision avoidance* (REG23:bit 2) to 1 of the modem which *Interval between RS485 packets* (REG07) is set to the longest

The above remedy is set to the multiple modems that are multi-dropped, the modem which set REG07 interval to the longest outputs regularly CR code [0DH] when all modem has no data to output. This enables timing synchronization of all of the modems to start measuring the interval time between RS485 data packets to packet.

This results that data will not be output from multiple modems at the same time since the *interval between RS485 packets* (REG07) of each modem is set to different values. Also the modem can detects another station's RS485 data transmission status since the interval difference is set more than 1 byte time. Eventually, this can avoid collision on the RS485 line since the modem can wait for their turn to output RS485 data.

3.2.6.4 Retransmit Count in Broadcast Transmission

In the *broadcast transmission*, the modem does transmit packet up to the *retransmission count* (REG11 or RNO command setting). If the upper layer application protocol is designed, such that the receiver side terminal equipment immediately return the response to the sender, the reply is sent back during retransmission is in progress. In this case, the reply packet cannot be received during the retransmission. It is necessary to set the *retransmission count* to a suitable value in the case.

3.3 Power Down Mode

The FRH-SD07TU/TB has three power down modes. Select the mode according to the power supply operating conditions such as battery powered application.

(1) Active Mode

This mode is not the power down mode but always capable of transmitting and receiving data. The modem is in the active mode when the power is turned on.

The current consumption is 35 mA maximum in this mode.

(2) ULTRA Mode

ULTRA (Ultra Low Power Transient Radio Access) mode is the doze mode. When set to the *ULTRA mode*, the modem transits to the intermittent receive state to wait the *wakeup request packet*. On receipt of the *wakeup request packet* to be requested *wakeup* from other modem, the modem returns to the *Active mode* to operate normal communication operation. This mode is effective, by extending the operation duration time, in the operation using the power source with limited capacity, such as dry-batteries or solar-batteries.

The average current consumption is about 2 mA in this mode.

(3) RF Block Power Down Mode

This mode shuts down the power supply of the RF circuit block, where only the control (logic) circuit is activating. Since the control circuit is in operation, the setting of *memory registers* are retained. When the modem returns to the *Active mode*, it can continue its operation since the register value is retained. Furthermore, functions such as referencing and setting memory registers can be used in this mode.

This mode is invoked by the following commands.

ROF command:	to become the <i>RF block power down mode</i>
RON command:	to return to the <i>Active mode</i>

The current consumption is about 5 mA in this mode.

(4) Shutdown Mode

This mode not only shuts down the power source of the RF circuit block but also stops the control (logic) circuit operation. The current consumption becomes minimum. Since the control circuit does not operate in this mode, the modem will be in the reset state when it returns to the *Active mode*. That is, all parameters, tentatively change modem operation like FRQ command, will be initiated. On the other hand, *memory register* parameters set by the REG command is effective.

This *Shutdown mode* is the same state as the *system reset* and can be used as the '*forced reset*' from the terminal equipment. Reset duration (initializing) time when power is turned on is about 220 ms. However, returning from this mode can accept commands in about 75 ms. Set with Pin 11 (/SHUT) of the serial communication interface.

To set Pin 11 to 'L': to the *Shutdown mode*

To set Pin 11 to 'H': to return to the *Active mode*

If the modem transits to the *Shutdown mode* from the *ULTRA mode*, it will return to the *ULTRA mode* again when the *Shutdown mode* is released.
The current consumption is about 70uA in this mode.

3.4 Frequency Grouping

3.4.1 Frequency Band

The FRH-SD07TU/TB has 54 individual frequencies between 2420 MHz and 2479 MHz with 1 MHz / 2MHz separation in each frequency. One system can select/operate 24 frequencies in the 54 frequencies. See the table below for the exact frequency assignments.

3.4.2 Frequency Allocation

24 Frequency are assigned each frequency band (01, 02 and three 2 MHz separation) with 1 MHz or 2 MHz separation. If 1 MHz adjacent frequency separation is utilized in a same area, the possibility of adjacent channel interference exists because the difference of reception signal level between the desired signal and undesired leakage from the adjacent channel. Specially, if *fixed (single) frequency operation*, more than 2 MHz separation operation is recommended. **Both France and Spain are band limited, please use 02 Band for operation.*

Freq. No.	Freq. (MHz)				
	2433-79MHz	01 Band	02 Band*	2420-66MHz	2423-69MHz
0	2433	2426	2450	2420	2423
1	2435	2427	2451	2422	2425
2	2437	2428	2452	2424	2427
3	2439	2429	2453	2426	2429
4	2441	2430	2454	2428	2431
5	2443	2431	2455	2430	2433
6	2445	2432	2456	2432	2435
7	2447	2433	2457	2434	2437
8	2449	2434	2458	2436	2439
9	2451	2435	2459	2438	2441
10	2453	2436	2460	2440	2443
11	2455	2437	2461	2442	2445
12	2457	2438	2462	2444	2447
13	2459	2439	2463	2446	2449
14	2461	2440	2464	2448	2451
15	2463	2441	2465	2450	2453
16	2465	2442	2466	2452	2455
17	2467	2443	2467	2454	2457
18	2469	2444	2468	2456	2459
19	2471	2445	2469	2458	2461
20	2473	2446	2470	2460	2463
21	2475	2447	2471	2462	2465
22	2477	2448	2472	2464	2467
23	2479	2449	2473	2466	2469

Table 3–6: Frequency Table

3.4.3 Frequency Group Operation

The FRH-SD07TU/TB can operate on a *fixed frequency* or on any frequency in a set of *frequency group*.

Multiple FRH (series) systems can be use different *frequency groups* and operate in the same area without mutual interference between the systems. When the RF environment is relatively clean, wireless channel links can be made on a fixed, clear frequency (no interference) by using *Grouping Method H*. In less than ideal RF environments, it is better to use multiple frequencies method in the *frequency group (Grouping Method A through G, multi-Access function)*. Since the modem searches clear frequency in the group, it overcomes multipath fading and interference problems and establishes wireless communications.

On the down side, wireless link establishment delays will become longer when using the *frequency group function (multi-access function)* because the additional time is required for searching the channels in the group with transmitting and receiving the packet on the both end of the modem. The average connection delay will increase and the number of systems that can operate independently in the same area will decrease as the number of frequencies per group increases. Select the best *grouping method* for your application.

3.4.4 Grouping Methods

The *frequency grouping method* and *group number* are set using *memory register REG06*.

The following eight *frequency grouping methods* are available:

Method	Number of Groups	Group Numbers	Frequencies per Group
A	1	0	24
B	2	0 to 1	12
C	3	0 to 2	8
D	4	0 to 3	6
E	6	0 to 5	4
F	8	0 to 7	3
G	12	0 to 11	2
H	24	0 to 23	1

Table 3–7: Frequency Grouping Methods and Group Numbers

- In *Grouping Method A, multi-access function* uses all 24 frequencies.
- Frequencies are fixed in *Grouping Method H*, because only one frequency is available in each group.

3.4.5 Grouping Method Details

Group	Frequency Numbers
0	All frequencies from 0 to 23

Table 3–8: Grouping Method A (1 group; 24 frequencies)

Group	Frequency Numbers
0	0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22
1	1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23

Table 3–9: Grouping Method B (2 groups; 12 frequencies each)

Group	Frequency Numbers
0	0, 3, 6, 9, 12, 15, 18, 21
1	1, 4, 7, 10, 13, 16, 19, 22
2	2, 5, 8, 11, 14, 17, 20, 23

Table 3–10: Grouping Method C (3 groups; 8 frequencies each)

Group	Frequency Numbers
0	0, 4, 8, 12, 16, 20
1	1, 5, 9, 13, 17, 21
2	2, 6, 10, 14, 18, 22
3	3, 7, 11, 15, 19, 23

Table 3–11: Grouping Method D (4 groups; 6 frequencies each)

Group	Frequency Numbers
0	0, 6, 12, 18
1	1, 7, 13, 19
2	2, 8, 14, 20
3	3, 9, 15, 21
4	4, 10, 16, 22
5	5, 11, 17, 23

Table 3–12: Grouping Method E (6 groups; 4 frequencies each)

Group	Frequency Numbers	Group	Frequency Numbers
0	0, 8, 16	4	4, 12, 20
1	1, 9, 17	5	5, 13, 21
2	2, 10, 18	6	6, 14, 22
3	3, 11, 19	7	7, 15, 23

Table 3–13: Grouping Method F (8 groups; 3 frequencies each)

Group	Frequency Numbers	Group	Frequency Numbers
0	0, 12	6	6, 18
1	1, 13	7	7, 19
2	2, 14	8	8, 20
3	3, 15	9	9, 21
4	4, 16	10	10, 22
5	5, 17	11	11, 23

Table 3–14: Grouping Method G (12 groups; 2 frequencies each)

Group	Frequency Numbers	Group	Frequency Numbers
0	0	12	12
1	1	13	13
2	2	14	14
3	3	15	15
4	4	16	16
5	5	17	17
6	6	18	18
7	7	19	19
8	8	20	20
9	9	21	21
10	10	22	22
11	11	23	23

Table 3–15: Grouping Method H (fixed frequency mode)

NOTE

The initial value of the *memory register* is Group 0 of the *Grouping Method F*. (3 frequencies of 8 group modes)

NOTE

To test the communication initially, use the *Grouping Method H (fixed frequency mode)* at first. Operation at *frequency grouping* mode makes the communication quality robust against multipath fading and interference, but sometimes leads to degrade throughput or transmission failure.

SECTION

4

FUNCTION CONTROL METHODS

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4.1 Function Control Methods

4.1.1 Serial Interface Setting

For connecting the FRH-SD07TU/TB modem with an external terminal equipment, RS232C is appropriate for 1 to 1 topology. And set the *RS485 mode* to make RS485 multi-dropping topology for multiple equipment connection. Interface configuration can be made with Pin 12 (/RS485ENB) of the *serial communication connector*.

To configure the *RS485 mode*, pull down Pin 12 with 10k ohm register. In this case, do NOT connect this pin DIRECTLY to the GND. This is because in *RS485 mode*, this pin will be as an output pin, after the initialization completes, to control the output buffer of the RS485 driver IC chip. As for the RS232C interface, no connection is required because it is pulled up inside.

Since the interface level of the FRH-SD07TU/TB modem is CMOS, the level conversion circuit must be provided outside for connecting it with the RS232C or RS485 interface. For an example of the level conversion circuit, see p.148 **CONVERSION CIRCUIT**.

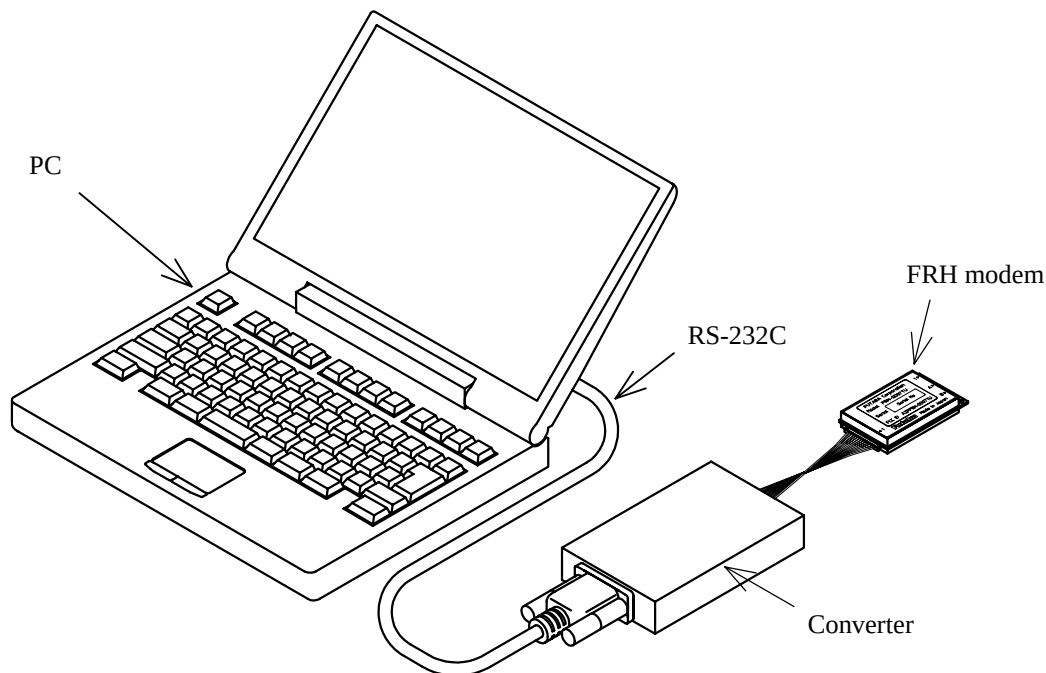


Figure 4-1: Connection Example to PC

4.1.2 Terminal Software Setup for Memory Register Control

Communication or terminal software is necessary to set the *memory registers*. Nearly any PC communication software can be used. Launch the communication software and set the terminal's communication parameters as shown below. Refer to your specific communication software instructions how to set these parameters.

bit rate:	9600 bps
data length:	8 bits
stop bits:	1 bit
parity bit:	none
flow control:	none
local echo:	yes
terminator:	carriage return + line feed

These settings correspond to the initial, default *memory register* value of the FRH-SD07TU/TB modem. When changing *memory registers* REG20 and REG21 for communication parameters, remember to also update your communication software settings.

Check for proper communication between the terminal equipment and the modem after setting these parameters. To do this, turn the modem power on and, with the communication software running, enter “@ARG CR/LF ” at the terminal prompt. If functioning properly, the modem should return the value of all 28 *memory registers* to the terminal screen.

4.1.3 Memory Register Setting

Memory registers set the operation mode and communication parameters of the modem and retain them in memory. All of the settings of the modem are made by these *memory registers*.

Since the *memory register* is based on rewritable non volatile memories, these memories can be readily rewritten by external terminal equipment such as PC and their contents will be kept even after the power is turned off. This non volatile memory can be rewritten about 1 million times.

4.1.3.1 Memory Register Referencing and Setting

Memory registers are referenced and set with the REG command. (For more information, refer to REG section at p.79 **COMMAND SET DESCRIPTION**)

Example procedure:

1. To view the current value of register 00, enter: @REG00 CR/LF
2. Modem responds with 00H CR/LF (REG00 is assumed to be 00H in this case and varies in each setting case)
3. To set register REG00 to 0FH, enter: @REG00:0FH CR/LF
4. Modem responds with “P0” CR/LF

5. Enter “@RST CR/LF” or cycle the modem power, to activate new values

@ = command header (specify following characters are command)

CR/LF = Terminator (carriage return + line feed)

⚠ CAUTION

When rewriting the modem's *memory registers*, do not turn the modem's power off until the modem returns “P0” *response*. If the power is interrupted before “P0” is returned, the memory contents may be lost or corrupted and the modem operation will be unpredictable.

⚠ CAUTION

If the memory contents are lost or corrupted, they can be restored to original default settings by reinitializing them. (See the section below titled p.44 **MEMORY REGISTER INITIALIZATION**)

NOTE

Input character arrays of commands quickly and sequentially. Too slow input (taking more than 5 seconds in the initial setting) results in *command error*.

4.1.3.2 Memory Register Initialization

The *memory registers* can be restored to the *factory default* values at any time by using one of the following two methods.

1) Memory Register Initialization by hardware:

Use either methods stated below, in which the modem attempts to read Pin 13 (/DefParam) of the *serial communication connector* at the startup and starts initializing the *memory registers* when it is “L”.

Method 1. Set “L” level to Pin 13 (/DefParam) of the *serial communication connector* with the power turned off. When the power is re-supplied, the *memory registers* are initialized and the modem starts operation in the *factory default* state.

Method 2. Set “L” level to Pin 13 (/DefParam) of the *serial communication connector* while the power turned on. In this state, force “L” to Pin 11 (/SHUT) of the *serial communication connector* more than 1ms, then return the level to “H”. The modem once becomes the *Shutdown mode* and returns to *Active mode*. Since this sequence is the same as the *reset*, the *memory registers* are initialized and the modem starts operation in the *factory default* state.

2) Memory Register Initialization by Command:

1. With the modem power is on and the communication software running, enter “@INI CR/LF ” at the terminal prompt.
2. The modem responds with “P0” *response* and immediately begins to operate using the initialized *factory default* state.

** CAUTION**

While initializing the *memory registers*, do not turn the modem's power off. It take about 1 sec. to initialize the *memory registers*.

4.1.4 Command Control

Some FRH-SD07TU/TB parameters can be changed by issuing commands from the terminal equipment. Various applications can be supported with the flexibility that command control offers.

Command Entry

- When a command is issued to the modem from the terminal equipment, a *command header* (one byte character) should be used the modem to acknowledge the command from ordinary data. The *command header* is initially set to “@” (40H) but can be changed to another character by changing the value stored in the *memory register* REG10.
- Commands must use all upper case letters (A to Z). The modem does not recognize lower case letters (a to z) in commands.
- A two byte terminator (carriage return (0DH) + line feed (0AH)) is used to terminate a command. “CR/LF” shows the terminator in this manual. PC can send this two byte character with pressing ENTER key once using a communication software. But some setting is necessary in the software.
- The modem immediately executes a command once it’s recognized. If the command requires a *response*, the modem returns the *response* to the terminal equipment when its internal processing is completed.

The following is an example of a command entry and *response*:

```
@BCL CR/LF :command issued from the terminal equipment  
P0 CR/LF   : successive completion response is returned
```

4.2 Communication Methods

The FRH-SD07TU/TB can support wide range of network configurations, from simple networks that are simply connected in 1:1 topology to complex n:m networks topology that use an upper layer application protocol to control the modem with commands.

This section shows several specific configuration examples to help illustrate the settings for each basic communication topology. The actual settings of the *memory registers* for your specific application may differ from these examples.



There are important notes using transmit commands. Be sure to read p.158 **OPERATION IMPORTANT NOTICE**.

4.2.1 Communication Example (1:1 – Mode 3)

The most basic communication topology of FRH-SD07TU/TB is the 1:1 communication in the communication mode 3 (*packet transmission mode*). In this mode, message data are transmitted using *transmit commands* like @TXT. As the terminal equipment, personal computers (PC) can be used. In here, we assume that the RS232C interface is used.

4.2.1.1 Modem Setup (1:1 – Mode 3)

Both two modem can operate without changing any parameter settings.

4.2.1.2 Terminal Software Setup (1:1 – Mode 3)

Invoke terminal software and setup the terminal software as follows: (refer your software instructions for setup details)

bit rate:	9600 bps
data length:	8 bits
stop bits:	1 bit
parity bit:	none
flow control:	none
local echo:	yes
terminator:	carriage return + line feed

This setting corresponds to the *factory default* state of the modem. When REG20 and REG21 are changed, change the terminal software setup accordingly.

Check for proper communication between the terminal equipment and the modem after setting these parameters. To do this, turn the modem power on and with the communication software running, enter “@ARG CR/LF” at the terminal prompt. If functioning properly, the modem should return the value of all 28 *memory registers* to the terminal screen.

4.2.1.3 Communication (1:1 – Mode 3)

In *packet transmission mode*, data is transmitted by using the *transmit commands* (TXT, TBN, etc.).

1. Master Station transmits a message to Slave Station.

command: @TXT001HELLO CR/LF

2. Master Station returns the *response* to the terminal equipment.

response: P1 CR/LF

3. Slave Station receives the message, verifies that the message is addressed to it, outputs the data to its terminal equipment, and returns an *ACK packet* to Master Station.

output: RXT000HELLO CR/LF

4. Master station receives the *ACK* and responds to the terminal equipment “*Successive Completion*” response.

response: P0 CR/LF

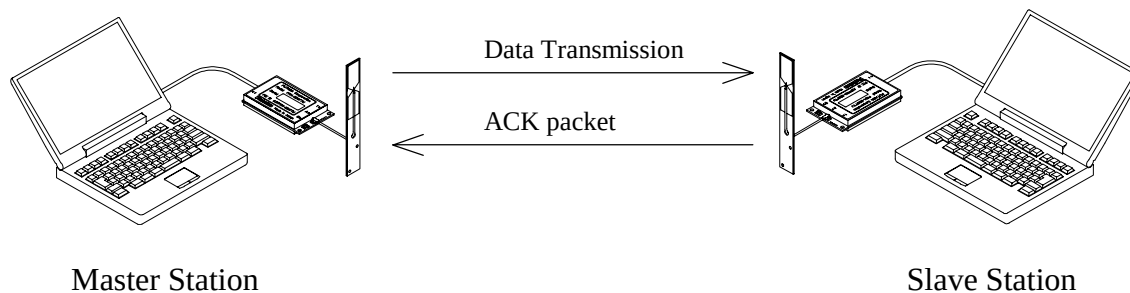


Figure 4–2: Communication Configuration (1:1 – Mode 3)

4.2.2 Communication Example (1:n – Mode 3)

This section describes an example of 1:n communication in *packet transmission mode* (Mode 3). In multiple station topology, each station's *memory register* setting must be unique *local station address* (REG00). In this mode, all transmissions are made using the *transmit commands* (TXT, TBN, etc.). The following example assumes that there are one master and three slave stations.

4.2.2.1 Terminal Software Setup (1:n – Mode 3)

Set the terminal software as follows: (refer your software instructions for setup details)

bit rate:	9600 bps
data length:	8 bits
stop bits:	1 bit
parity bit:	none
flow control:	none
local echo:	yes
terminator:	carriage return + line feed

This setting corresponds to the *factory default* state of the modem. When REG20 and REG21 are changed, change the terminal software setup accordingly.

Check for proper communication between the terminal equipment and the modem after setting these parameters. To do this, turn the modem power on and with the communication software running, enter “@ARG CR/LF” at the terminal prompt. If functioning properly, the modem should return the value of all 28 *memory registers* to the terminal screen.

4.2.2.2 Modem Setup (1:n – Mode 3)

1. Set the local station addresses (REG00) as follows:

Master Station	000
Slave Station 1	001
Slave Station 2	002
Slave Station 3	003

2. Set Bit 0 of REG18 to “1” (to perform “*destination address checking*”)
3. Leave all other memory registers at the *factory default* settings.

4.2.2.3 Communication (1:n – Mode 3)

In *packet transmission mode*, data is transmitted by using the *transmit commands* (TXT, TBN, etc.).

1. Master Station transmits a message to Slave Station 1.

command: @TXT001HELLO CR/LF

2. Slave Station 1 receives the message, verifies that the message is addressed to it, outputs the data to its terminal equipment, and returns an *ACK packet* to Master Station.

output: RXT000HELLO CR/LF

3. Slave Stations 2 and 3 also receive the message, but since the *destination address* does not match theirs, they discard the data and do not output it to their respective terminal equipments.

4. Master Station receives the *ACK* from Slave Station 1.

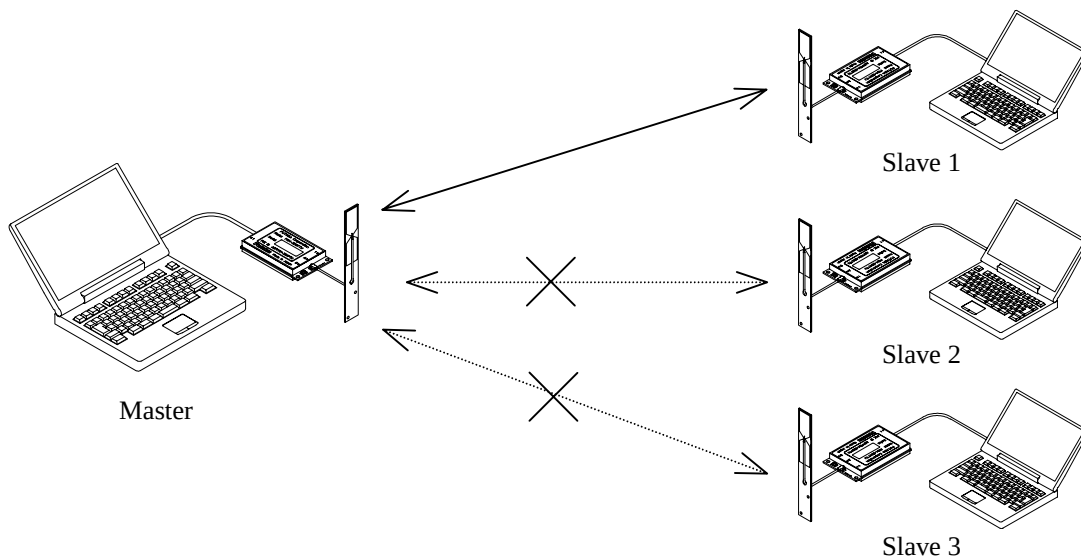


Figure 4–3: Communication Configuration (1:n – Mode 3)

4.2.3 Communication Example (n:m – Mode 3)

RS485 mode is suitable for assigning several master modems in a wide area using RS485 multi-drop communication topology. In this example; 3 master modems and 2 slave modem case is explained. The slave modem can keep on radio communication while moving, by automatically changing the communication to master modems (*roaming function*).

4.2.3.1 Terminal Software Setup

Example:

Set the terminal software as follows: (refer your software instructions for setup details)

```

bit rate:      9600 bps
data length:   8 bits
stop bit:      1 bit
parity bit:    none
flow control:  none
local echo:    yes
terminator:    carriage return + line feed

```

This setting corresponds to the *factory default* state of the modem. When REG20 and REG21 are changed, change the terminal software setup accordingly.

Check for proper communication between the terminal equipment and the modem after setting these parameters. To do this, turn the modem power on and with the communication software running, enter “@ARG CR/LF” at the terminal prompt. If functioning properly, the modem should return the value of all 28 *memory registers* to the terminal screen.

4.2.3.2 Modem Setup

Example:

(1) Master (Base) Station Setup

1. Pull down Pin 12 (/RS485ENB) at about 10 k ohm register. (*RS485 mode*) At this time, do NOT connect this pin DIRECTLY to GND.
2. Set the *local station address* of the modem as follows. (REG00 or REG01)

	REG00	REG01
Master modem 1	001	240
Master modem 2	002	240
Master modem 3	002	240

3. Set REG18:bit 0 to 1. (to perform *Destination Address Checking*)
4. Allocate the frequency No. 0, 8, 16 in the *fixed frequency* mode (REG06), which corresponds to Group 0 of *Grouping Method F*.

Master modem 1 E0H (Frequency No. 0, fixed)

- Master modem 2 E8H (Frequency No. 8, fixed)
- Master modem 3 EFH (Frequency No. 16, fixed)
- 5. Set REG19:bit 1 to 1 (to perform *Regularly transmit radio beacon without transmission request*).
- 6. Use the default value for other *memory registers*.

(2) Slave (Mobile) Station Setup

1. Since the slave modem is in the RS232C mode, it is not necessary to pull down Pin 12 of the *serial communication connector*
2. Set the *local station address* (REG00) of the modem as follows.
 - Slave modem 1 101
 - Slave modem 2 102
3. Set REG18:bit 0 to 1 (to perform *Destination Address Checking*).
4. Set the *frequency group* (REG06) to A0H (group 0 of *Grouping Method F*) to make it correspond to the frequency of the maser modems.
5. Set REG19:bit 2 to 1 (to be *Wait-to-receive mode by fixing frequency while the correlation detection is made*).
6. Use the default value for other *memory registers*.

4.2.3.3 Communication

Example:

1. If there is Slave Station 2 near Master Station 1, Slave Station 2 receives the *radio beacon* of Master Station 1 and its frequency is fixed at No. 0.
2. @TXT240HELLO CR/LF : Issue the transmit command to Slave Station 2. Be noted that the address is 240 (*global addressed destination*).
3. Since slave stations transmit data to master stations as the *global addressed destination*, slave station need not aware which master station responds. Only the master station who has the same frequency receives and responds. (In this case, Master Station 1.)
4. RXT102240HELLO CR/LF : Master Station 1 outputs data to PC.
5. When Slave Station 2 enters into the area of Master Station 2, it receives the *radio beacon* from Master Station 2 and its frequency is fixed at No.8.
6. @TXT102240MAIL CR/LF : Issue the transmit command to master stations. Be noted that the sender address is 240, *global addressing*.
7. Global addressed master stations are transmit data to slave station. Using the *global addressing*, that is, three master stations transmit the same data at the same time. Accordingly, it is not necessary to aware where slave station is. Only the slave station who has the same address receives the data. (In this case, Slave Station 2.)

8. RXT240MAIL CR/LF : Slave Station 2 outputs the received data to the terminal equipment.

As described above, the slave station can communicate in wide area without considering where it is.

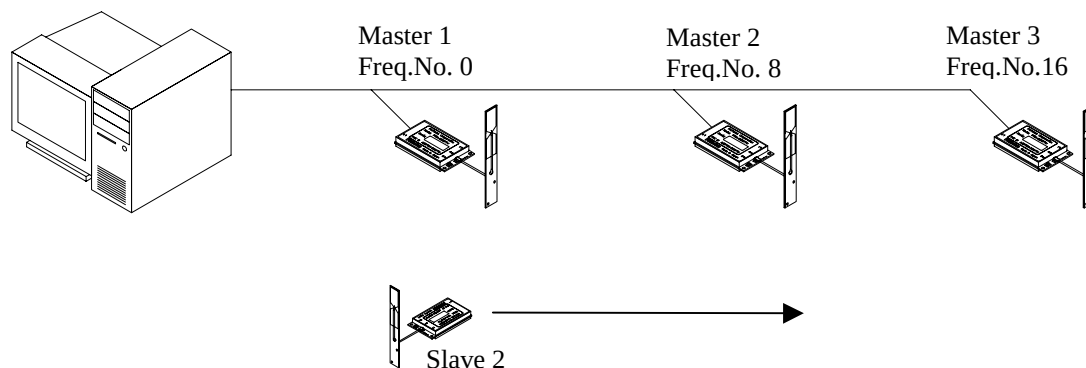


Fig. 4-8: n:m Communication (Roaming)

4.2.4 Repeater Example (Mode 4)

The FRH-SD07TU/TB can be used as a *repeater* to extend the wireless communication range or eliminate null zones caused by obstructions. The following example uses one *repeater* and two modems.

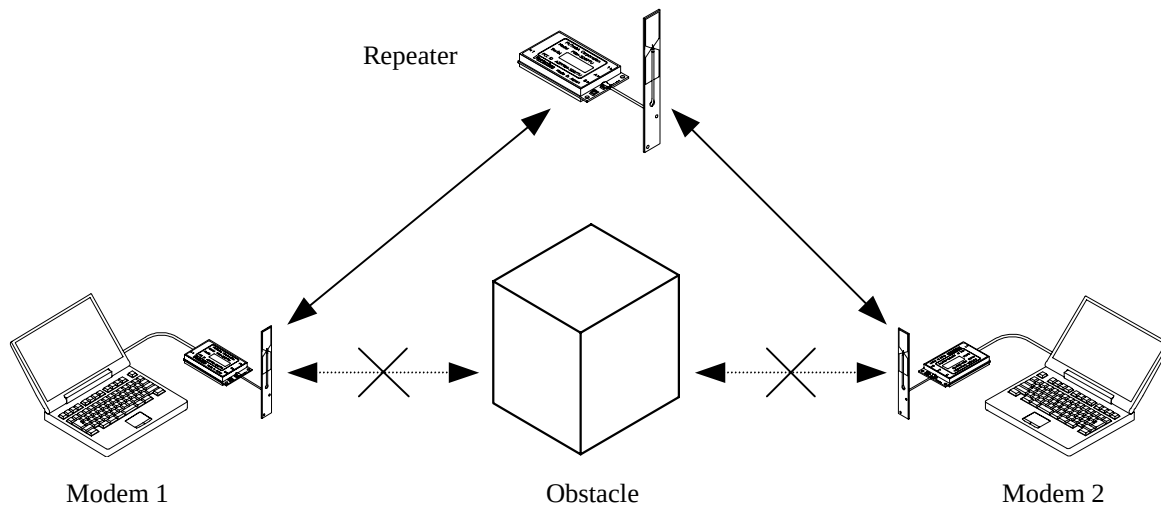


Figure 3–10: Repeater

4.2.4.1 Communication Through a Repeater (Mode 4)

- When two modems cannot reliably communicate because of excessive distance or obstructions, a third modem can act as a *repeater*. The *repeater* is placed in a position where it can communicate with both modems.
- Although PC or terminal equipment is used to configure the modem as a *repeater*, it is not necessary to connect PC or terminal to the *repeater* once it is configured and functioning normally. The *repeater* can operate in a stand-alone mode.
- Multiple *repeaters* can be used in a network, but stations can only communicate to other stations through one *repeater*. Communication through two or more *repeaters* is not possible.
- When communicating through a *repeater*, the *repeater transmit commands* (TXR, TBR, and RTY) must be used.
- When using a *repeater*, all modems in the radio-network must be set to the same *fixed frequency*.
- Communication through the *repeater* approximately doubles the communication time delay.

4.2.4.2 Terminal Software Setup (Mode 4)

Set the terminal software as follows: (refer your software instructions for setup details)

bit rate: 9600 bps
data length: 8 bits
stop bits: 1 bit
parity bit: none
flow control: none
local echo: yes
terminator: carriage return + line feed

This setting corresponds to the *factory default* state of the modem. When REG20 and REG21 are changed, change the terminal software setup accordingly.

Check for proper communication between the terminal equipment and the modem after setting these parameters. To do this, turn the modem power on and with the communication software running, enter “@ARG CR/LF” at the terminal prompt. If functioning properly, the modem should return the value of all 28 *memory registers* to the terminal screen.

4.2.4.3 Modem Setup (Mode 4)

1. Set the *local station address* of the modem (REG00) as follows.
Wireless Modem 1: 001
Wireless Modem 2: 002
2. Set REG06 (*Frequency Grouping*) at the *fixed Frequency* No. 0 of *Grouping Method H*.
3. Set REG18:bit 0 to 1 (to perform *Destination Address Checking*).
4. Set REG19:bit 0 to 0 (to use as a modem).
5. Use the default value for other *memory registers*.

4.2.4.4 Repeater Setup (Mode 4)

1. Set REG00 (the *local address* of the *repeater*) to 000.
2. Set REG06 at the *fixed frequency* No. 0 of *Grouping Method H*.
3. Set REG18:bit 0 to 1 (to perform *Destination Address Checking*).
4. Set REG19:bit 0 to 1 (to use as a *repeater*).
5. Use the default value for other *memory registers*.

4.2.4.5 Communication (Mode 4)

To communicate using the *repeater*, use the *repeater transmit commands*. The below describes the operation of each modem when a simple message is sent.

1. Message is sent from Modem 1 (001) to Modem 2 (002) through *Repeater* (000).
command: @TXR000002HELLO CR/LF
2. Modem 1 transmits the message to the *repeater*. *Repeater* receives the message, verifies that the message is for its address, then retransmits the unaltered message to Modem 2.
3. Modem 2 receives the message and verifies that the message is addressed to itself, then it outputs the message to its terminal equipment and returns an *ACK packet* through the *repeater*.
output: RXR000001HELLO CR/LF
4. *Repeater* receives the *ACK*, verifies its address then retransmits the *ACK* without changing it to Modem 1.
5. Modem 1 receives the *ACK* and output the *response* to the terminal equipment.
output: P0 CR/LF



Do not use the modem set as the *repeater* for other commands than listed below to avoid operation error.

ARG: to reference memory registers

INI: to initialize all memory registers

REG: to reference and set memory registers

RST: to reset

VER: to read out a version

4.2.5 Other Communication Configurations

Many other communication topology can be configured with the FRH-SD07TU/TB modem. The following section briefly describes a few of them.

4.2.5.1 n:n Communication

The modem can execute the N:N communication where all modems are in the equality relation.

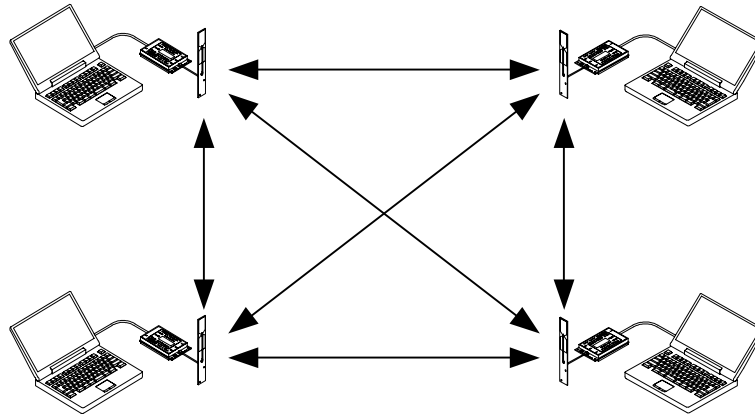


Figure 3–12: n:n Communication

4.2.5.2 Packet Transmission Mode 1:n:m Connection

One master modem can transmit data to multiple groups of slaves by using multiple *repeaters*. The master and slaves can also be communicated directly to each other, without passing the *repeater*.

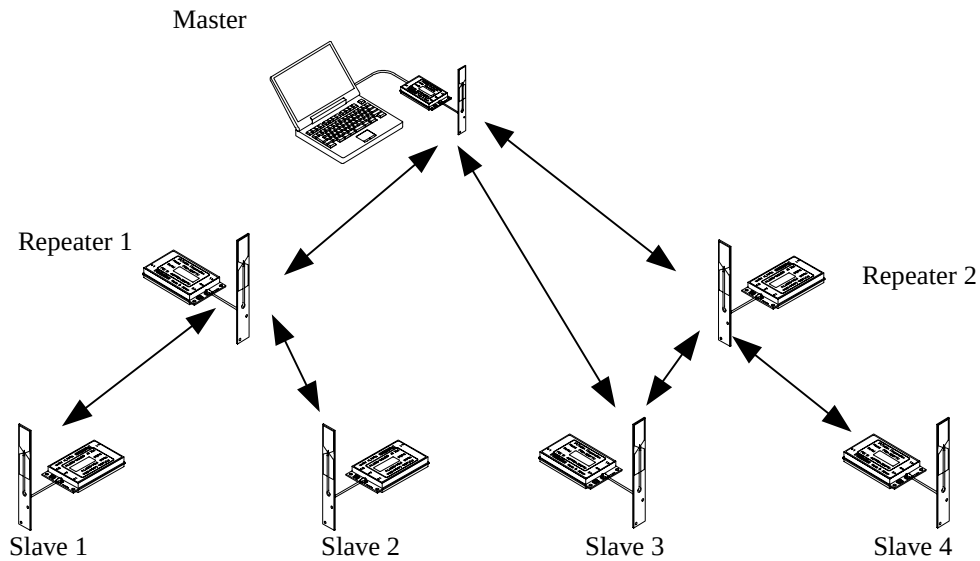


Figure 3–13: Packet Transmission Mode 1:n:m

SECTION

5

MEMORY REGISTER DESCRIPTION

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5.1 Memory Register Description

The FRH-SD07TU/TB modem contains 28 *memory registers* which are used to control and store communication parameters and operation mode settings. After rewriting new register settings, the power must be cycled, a hardware reset asserted, or a software RST command is issued to validate the new settings.

Functions of some *memory registers* vary depending on the *operation mode*. This chapter describes the communication modes 3 and 4. For communication modes 5 and 6, refer to p.117 **ADVANCED APPLICATION**.

The following table briefly lists each register, register function and default value:

Register	Function	Default Value	Meaning
REG00	Local Station Address	00H	address 0
REG01	Local Station Global Address	F0H	address 240
REG02	Destination Address	00H	address 0
REG03	Special Setting	F0H	F0H
REG04	ID Code 1	00H	address 0
REG05	ID Code 2	00H	address 0
REG06	Frequency Group	A0H	see text
REG07	Packet Interval	05H	5 ms
REG08	Reserved	11H	11H
REG09	Reserved	13H	13H
REG10	Command Header	40H	character @
REG11	Retransmission Count	32H	50 count
REG12	Roaming Threshold	B4H	-180dBm
REG13	Reserved	1EH	1EH
REG14	Receive Data Output Interval	00H	0 ms
REG15	Command Recognition Interval	00H	0 s
REG16	Command Input Timeout	32H	32H
REG17	Reserved	32H	32H
REG18	Communication Setting 1	8CH	see text
REG19	Communication Setting 2	00H	see text
REG20	Serial Interface Setting 1	05H	see text
REG21	Serial Interface Setting 2	09H	see text
REG22	Serial Interface Setting 3	00H	see text
REG23	Serial Interface Setting 4	00H	see text
REG24	Miscellaneous Settings	C0H	see text
REG25	ULTRA Mode Settings	40H	see text
REG26	Reserved	00H	
REG27	Frequency Band Settings	00H	see text

Table 5–1: Memory Registers

Suffix ‘H’ of each default value denotes HEX radix expression in the value.

REG00: Local Station Address**[default value: 00H]**

- Sets the *local station address*. Valid values are 000 to 239. (240 addresses)
- This value is inserted in the “*source address*” field in the transmitted packet header.
- If the *address check function* is enabled (REG18) in the receiving modem, the modem can receive the packet which header contains *destination address* information identical to REG00.
- In the *RS485 mode*, this register is used as *485 mode local station address*.

REG01: Local Station Global Address (RS485)**[default value: F0H]**

- Sets the *local station global address* of the modem. Valid values are 240 to 254. (15 addresses)
- When plural modems are connected by RS485 multi-dropping topology, commands can be issued to multiple modems simultaneously by setting all connected modems to the *same global address*. This is the *global addressing*.
- This *global addressing* allows to handle multiple multi-dropped modems as if they were one modem.

REG02: Destination Address**[default value: 00H]**

- This address is used in the *headerless packet transmission mode* (communication modes 5). For details, refer to p.118 **HEADERLESS PACKET TRANSMISSION MODE**.
- Use the default value for the transmission mode 3 or 4.

REG03: Special Setting**[default value: F0H]**

- Sets special operation modes such as *headerless packet transmission mode* or *direct transmission mode*. Refer to p.117 **ADVANCED APPLICATION**.
- Use the default value for the transmission mode 3 or 4.

REG04: ID Code 1**[default value: 00H]**

- Used with ID code 2 (REG05), set the ID code. Valid values are 000 to 255. Together with ID code 2, up to 61,440 ID codes can be set.
- The ID code identifies the group of the modems works in the same group. The ID code is used to prevent erroneous connection with other systems and for communication security.

- Before transmission, *radio data packets* are scrambled using a pseudo-random data sequence generated with this ID code as the seed. During reception, the original data is restored by de-scrambling it with the pseudo-random data sequence. The modems with different ID codes cannot communicate with each other.

REG05: ID Code 2**[default value: 00H]**

- Used with ID code 1 (REG04), set the ID code. Valid values are 000 to 239. Together with ID code 1, up to 61,440 ID codes can be set.
- Do not set the value 240 and above. If excess value is set, the modem ignores the REG04 and REG05 value and assigns REG04 to 255 and REG05 to 239.
- In case plural modems are used as a single system, always set the same ID code for all modems and *repeaters*.

REG06: Frequency Group**[default value: A0H]**

- Refer to p.35 **FREQUENCY GROUPING** in Section 3, for a detailed description of the frequency operation modes.

Bits 7 – 5: Grouping of frequency

Grouping	Setting	Bit 7	Bit 6	Bit 5
A	24 freq. × 1 group	0	0	0
B	12 freq. × 2 group	0	0	1
C	8 freq. × 3 group	0	1	0
D	6 freq. × 4 group	0	1	1
E	4 freq. × 6 group	1	0	0
F	3 freq. × 8 group	1	0	1
G	2 freq. × 12 group	1	1	0
H	1 freq. × 24 group	1	1	1

Table 5–2: Grouping of Frequency

- Set the *grouping method* for the 24 available frequencies. The number of available frequencies per group is allocated to perform *multi-access* in the frequencies of group.
- The *multi-access function* is performed within a *frequency group*.
- When more frequencies per group are made available for *multi-access function*, the system will gain an advantage in overcoming interference and fading, but average time required to establish a connection will increase because more frequencies are scanned.

Bits 4 – 0: Group Number

Group No.	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	0
1	0	0	0	0	1
2	0	0	0	1	0
3	0	0	0	1	1
4	0	0	1	0	0
⋮	⋮	⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮	⋮	⋮
19	1	0	0	1	1
20	1	0	1	0	0
21	1	0	1	0	1
22	1	0	1	1	0
23	1	0	1	1	1

Table 5–3: Frequency Group Settings

- The *frequency group number* is set. Valid *group numbers* for setting vary depending on the *frequency grouping method*.

REG07: RS485 Packet Interval**[default value: 05H]**

- In the *packet transmission mode* with the *RS485 mode* is used, sets the *interval* between response and/or received data which output from the modem to RS485 line.
- Be able to set 0 to 254 ms at increment of 1 ms. 255ms is not allowed. The default value is 5 ms.
- Set this *interval* to a larger value than the *receiving interval* set by REG14.
- Suitable setting of this *interval* avoids the data collision possibility of RS485 line. For details, refer to p.31 **COLLISION AVOIDANCE IN RS485 INTERFACE**.

REG08: Reserved**[default value: 11H]**

- The FRH-SD07TU/TB does not use this register. Keep the default value as it is.

REG09: Reserved**[default value: 13H]**

- The FRH-SD07TU/TB does not use this register. Keep the default value as it is.

REG10: Command Header**[default value: 40H]**

- Sets the character that identifies the start of a command.
- The default is character “@” (40H).

- When this character is input from the terminal equipment after no character is received for the *command recognition interval* (REG15) or longer, subsequent input character is recognized as a command for the modem.

REG11: Retransmission Count**[default value: 32H]**

- Sets the maximum *number of packet retransmission* attempts. Valid values are 000 to 254. 255 is not allowed.
- When retransmission exceeds the *retransmission count* (*retransmission count* plus one for *broadcast transmission*), the modem outputs an *error response* to the terminal equipment.

REG12: Roaming Threshold**[default value: B4H]**

- At the time to set the *frequency roaming* (REG19:bit 2 is 1), set the *receiving strength threshold of the radio beacon* which starts scanning frequency.
- Set the value of the desired *radio beacon strength threshold* represented in dBm excluding the minus sign, e.g., set to “80” to search the next master station when the *radio beacon strength* becomes below –80 dBm.

REG13: Reserved**[default value: 1EH]**

- The FRH-SD07TU/TB does not use this register. Keep the default value as it is.

REG14: Receive Data Output Interval**[default value: 00H]**

- Sets the minimum *time interval between characters* (time from the stop bit of one character to the start bit of the next character) when outputting data from the modem to the terminal equipment.
- Valid values are 000 to 255, representing milliseconds in 1 ms increments.
- Since the modem transmit data to other end modem in packet form, minimal interval between the character output to the terminal equipment does not guaranteed. Characters are continuously sent to the terminal equipment until the modem’s buffer becomes empty. When the data cannot be received by the terminal equipment, set this *interval* longer.

REG15: Command Recognition Interval**[default value: 00H]**

- When a message data contains a *command header* character (in case of binary data or data in two-byte Chinese characters), data following the *command header* character will be interpreted as a command, the message does not transmit properly.

- Sets the necessary vacant duration *time interval* to discriminate between ordinary data character and a *command header* character. Input a command after a longer interval than *time interval* setting.
- Valid values are 0.1 to 25.4 sec., representing tenths of seconds in 0.1 second increments. (Set an integer value equal to ten times the number of seconds desired.)
- When set to 000, the *command header* is recognized at any time, and when set to 255, all *command header* character are ignored.

REG16: Command Input Timeout**[default value: 32H]**

- Sets the character *input timeout interval for command input*. It is used as the *timeout* between the *command header* and the character following it and between each character of the command.
- At the timeout, the modem operation transits from *command-input-wait-state* to *ordinary-data-wait-state*.
- Valid values are 000 to 255, representing tenths of seconds in 0.1 second increments. (Set an integer value equal to ten times the number of seconds desired.)
- A setting of 000 disables this *timeout function*.

REG17: Reserved**[default value: 32H]**

- The FRH-SD07TU/TB does not use this register. Keep the default value as it is.

REG18: Communication Setting 1**[default value: 8CH]****Bits 7 – 2: Reserved**

- The FRH-SD07TU/TB does not use this register. Keep the default value as it is.

Bit 1: Source address check

0	Inhibit source address checking (default value)
1	Activate source address checking

Table 5–4: Source Address Check Settings

- When the *source address checking* is active and the *source address* in the received *packet header* does not match the *destination address setting* (REG02), the data is discarded (data cannot be received).

Bit 0: Destination address check

0	Inhibit destination address checking on receipt (default)
1	Activate destination address checking on receipt

Table 5–5: Destination address check

- When the *destination address checking* is active and the *destination address* in the received *packet header* does not match the received modem's *local station address* (REG00), the data is discarded (data cannot be received).

REG19: Communication Setting 2**[default value: 00H]****Bit 7: Reserved**

- The FRH-SD07TU/TB does not use this register. Keep the default value as it is.

Bit 6: Diversity Reception

0	Disable diversity reception (default value)
1	Enable diversity reception

Table 5–6: Diversity Reception Settings

- Enable/disable *diversity reception*.
- To enable *diversity reception*, set this bit to 1 and connect an antenna to Antenna Terminal B.
- Enabling *diversity reception* with only one antenna connected may *degrade* the reception performance.

Bit 5: Broadcast Transmission Reception

0	Enable broadcast transmission reception (default value)
1	Disable broadcast transmission reception

Table 5–7: Broadcast Reception Settings

- Enable/disable reception of *broadcast transmission* in *packet transmission mode* (Mode 3 and 5).

Bit 4: Antenna selection

0	Receiving antenna is fixed to A (default value)
1	Receiving antenna is fixed to B

Table 5–8: Antenna Selection

- At the *non-diversity reception*, decide the antenna terminal for the *receiving antenna fixing*.
- Selection of 1 fixes the receiving antenna to the terminal B. When the *high gain antenna* connecting to the terminal B is used for reception, this setting would achieve better performance than the *diversity reception* in some case.

Bit 3: Extended reception

0	Disable extended reception (default value)
1	Enable extended reception

Table 5–9: Extended reception

- *Contention type communication* in *packet transmission mode* (including the *headerless packet transmission mode*) may cause repetitive retransmission when two modems are in transmission state in identical timing. This results in the decrease of response rate or the transmission failure.
- This *extend reception function* solves such problems as above. The data packet received during *carrier sensing* are received first by interrupting the on-going transmission operation. For further detail, refer to p.24 **EXTEND RECEIVING**.

Bit 2: Receiving frequency change

0	Regularly change frequency within a group while waiting (default value)
1	Fix the frequency to wait while data can be regularly received.

Table 5–10: Receiving frequency change

- Set the changing method of receiving frequency in *packet transmission mode*. Sets *roaming function* with combining bit 1.

Bit 1: Beacon transmission

0	No transmission until transmission command is requested (default)
1	Enable regular beacon transmission.

Table 5–11: Beacon Transmission

- Enable or disable *beacon transmission* in *packet transmission mode*.
- Set *roaming function* with combining bit 2.

Bit 0: Operation Mode

0	Operates in normal modem mode
1	Operates as a repeater

Table 5–12: Operation Mode Settings

- Sets the modem to operate either as a normal *modem* or as a *repeater*. Effective only in *packet transmission mode* (Mode 3, 4 and 5).

REG20: RS-232C Setting 1**[default value: 05H]****Bit 7: Data Length**

0	8 bit data bytes (default value)
1	7 bit data bytes

Table 5–13: Data Length Settings

Bit 6: Parity Bit

0	No parity bit (default value)
1	Parity bit

Table 5–14: Parity Settings

Bit 5: Even/Odd Parity

0	Even parity (default value)
1	Odd parity

Table 5–15: Odd/Even Parity Settings

- Invalid when bit 6 is set to 0, without parity.

Bit 4: Stop Bit

0	1 stop bit (default value)
1	2 stop bits

Table 5–16: Stop Bit Settings

Bits 3 – 0: Baud rate setting

Bit 3	Bit 2	Bit 1	Bit 0	Setting
0	0	0	0	300 bps
0	0	0	1	600 bps
0	0	1	0	1200 bps
0	0	1	1	2400 bps
0	1	0	0	4800 bps
0	1	0	1	9600 bps (default)
0	1	1	0	19200 bps
0	1	1	1	38400 bps
1	0	0	0	50000 bps
1	0	0	1	62500 bps
1	0	1	0	83333 bps
1	0	1	1	100000 bps
1	1	0	0	57600 bps
1	1	0	1	115200 bps
1	1	1	0	Reserved
1	1	1	1	Reserved

Table 5–17: Baud Rate

- Because of the limitation of internal processing speed in the processor, character output throughput is limited up to 60 us interval. When baud rate 83333 bps and faster is selected, the throughput which expected from its baud rate can not be obtained.

REG21: RS-232C Setting 2**[default value: 09H]****Bits 7 – 2: Reserved**

- The FRH-SD07TU/TB does not use this register. Keep the default value as it is.

Bit 1: Flow Control

0	No flow control (default value)
1	Hardware flow control

Table 5–18 Software/Hardware Flow Control Settings

- Selects the flow control method. This setting must match the connected terminal equipment's setting.
- *Hardware flow control* uses the two *control lines RTS* and *CTS*. When using *hardware flow control*, be sure that *RTS* and *CTS* lines are properly wired.
- When using with the RS485 interface, be sure to set to 0.

Bit 0: Reserved

- The FRH-SD07TU/TB does not use this register. Keep the default value as it is.

REG22: RS-232C Setting 3**[default value: 00H]****Bit 7: Enable and Disable Reception**

0	Enable reception at the initial state (default value)
1	Disable reception at the initial state

Table 5–19: Enable/Disable Reception

- Select enable or disable reception at the initial state in the *packet transmission mode*.
- The initial state is in *reception enable*. Depending on an usage of the modem, the initial state of the modem may be better in the *reception disable* state. In such a case, use this setting.
- Issue the REN command to enable reception.

Bit 6: Reserved

- The FRH-SD07TU/TB does not use this register. Keep the default value as it is.

Bits 5 – 4: DCD (Data Carrier Detect)

Bit 5	Bit 4	Setting
0	0	Ignore DCD input; DCD output always ON (default value)
0	1	Reserved
1	0	Remote modem's DCD (IN) is transferred to local modem DCD (OUT). (DCD Output = OFF at reset state)
1	1	Remote modem's DCD (IN) is transferred to local modem DCD (OUT) (DCD Output = ON at reset state)

Table 5–20: DCD Settings

- When connecting to the telephone line modem, set the FRH-SD07TU/TB modem to transfer the *DCD* input of the remote modem to the *DCD* output of the local modem.
- Operation on *Direct Transmission Mode* differs. Please refer to p.127 **DIRECT TRANSMISSION MODE**.

Bits 3 – 2: DTR/DSR

Bit 3	Bit 2	Setting
0	0	Ignore DTR input; DSR output always ON (default value)
0	1	Reserved
1	0	Remote modem DTR is transferred on local modem CTS (CTS = OFF at reset state)
1	1	Remote DTR is transferred on local modem CTS (CTS = ON at reset state)

Table 5–21: DTR/DSR Control Settings

- When connecting to the telephone line modem, set the FRH-SD07TU/TB modem to allow to transmit the *DTR* input of the remote modem to the *DSR* output of the local modem.
- Operation on *Direct Transmission Mode* differs. Please refer to p.127 **DIRECT TRANSMISSION MODE**.

Bits 0 – 1: RTS/CTS

Bit 1	Bit 0	Settings
0	0	Ignore RTS input; CTS output always ON
0	1	Reserved
1	0	Remote modem RTS is output on local modem CTS (CTS = OFF at reset)
1	1	Remote modem RTS is output on local modem CTS (CTS = ON at reset)

Table 5–22: RTS/CTS Control Settings

- When *hardware flow control* is enabled (REG21), this setting is ignored.
- Operation on *Direct Transmission Mode* differs. Please refer to p.127 **DIRECT TRANSMISSION MODE**.

REG23: Miscellaneous Settings**[default value: 00H]****Bit 7 – 5: reserved**

- The FRH-SD07TU/TB does not use this register. Keep the default value as it is.

Bit 4 : CR/LF addition/deletion

- Especially used for the *headerless packet transmission mode* only. Refer to p.124 **MEMORY REGISTER SETTING, IN HEADERLESS PACKET TRANSMISSION MODE.**

Bit 3: reserved

- The FRH-SD07TU/TB does not use this register. Keep the default value as it is.

Bit 2: RS485 collision avoidance regular interval output

0	No C/R code output for collision avoidance (default value)
1	Regularly output C/R code for collision avoidance

Table 5–23: C/R Code Regular Interval Output

- Sets whether the *collision avoidance function* is used or not, together with bit 1.
- When this bit is set to 1, *responses* or data will be output to RS485 line if there are such *responses* or data exist in the buffer at the timeout of the *RS485 Packet Interval* (REG07). If there are no such *responses* or data exist in the buffer, the C/R code (0Dh) is compulsorily output.
- The effective use of this function helps to shift the output timing of multi-dropped modems on RS485 line. Eventually it avoids the data collision on the RS485 line.
- To use this function, set REG23:bit 1 of all RS485 multi-dropped modems to 1. And set all the *RS485 Packet Interval* (REG07) to different values more than 1.5 bytes each. Further set this bit of the modem, the *RS485 Packet Interval* is set to the longest, to 1.

Bit 1: RS485 collision avoidance

0	Invalid collision avoidance function (default value)
1	Use collision avoidance function

Table 5–24: Collision Avoidance Function

- Sets to decide whether to use the *collision avoidance function* or not, together with bit 2.
- When modem tried to output a *response* or the received data, the modem outputs only if RS485 line is available at the timeout of *RS485 Packets Interval* (REG07). When RS485 line is not available at the timeout, the modem waits for a line becomes available and starts re-measurement of its *packet interval*.
- Set to 1 makes it unable to output neither *response* nor the received data, unless other modem(s) outputs any data to the RS485 line and *interval time* measuring becomes effect.
- Bit 2 is used for the purpose of resolving this problem.

Bit 0: Global addressing command response

0	No P0 response to global addressing command (default value)
1	Respond P0 response to global addressing command

Table 5–25: Global addressing command response

- Set to decide whether to return “P0” *response* (including “P1” for the *transmit command*) to the terminal equipment for the *global addressing command* (commands for Addresses 240 to 254).
- When the *global addressing command* is issued to plural modems, which are multi-dropped and have the same *global address* on RS485 line, there is a possibility causing data *collision* on the RS485 line. Unless the *RS485 Packet Interval* is properly set. This is because all modems return the “P0” (or P1) *response* to the terminal equipment simultaneously on *default memory setting*. Such potential problem can be avoided by limiting the modem to output the *response* to the *global addressing command* is only one.

REG24: Special Mode Settings**[default value: C0H]****Bit 7 – 6: reserved**

- The FRH-SD07TU/TB does not use this register. Keep the default value as it is.

Bit 5: Delay time of transmission and reception (Direct transmission mode)

0	Same delay time as the conventional series modem (default value)
1	Sets short delay time

Table 5–26: Setting of delay time of transmission and reception

- Sets the delay time of the *direct transmission mode* using REG03 together. For details, refer to p.127 **DIRECT TRANSMISSION MODE**

Bit 4: DCD output (Direct transmission mode)

0	DCD outputs in the same way as the conventional series modem. (default value)
1	DCD acts as the synchronous clock output.

Table 5–27: Output of DCD direct transmission mode setting

- Sets the *direct transmission mode* using REG03 together. For details, refer to p.127 **DIRECT TRANSMISSION MODE**.

Bit 3 – 0: reserved

- The FRH-SD07TU/TB does not use this register. Keep the default value as it is.

REG25: ULTRA Mode Settings**[default value: 40H]****Bit 7: ULTRA mode setting**

0	Disable ULTRA mode (default value)
1	Enable ULTRA mode

Table 5–28: ULTRA mode setting

Bit 6: ULTRA mode control frequency channel setting

0	No control channel is used
1	Use control channel (default value)

Table 5–29: Control frequency channel setting

- Sets the frequency to be wait-to-receive in the *ULTRA mode*. When the *control frequency* is assigned, the lowest frequency of the *frequency group* is used as the *control frequency*. For details, refer to p.141 **CONTROL FREQUENCY**.

Bit 5 – 0: reserved

- The FRH-SD07TU/TB does not use this register. Keep the default value as it is.

REG26: Reserved**[default value: 00H]**

- The FRH-SD07TU/TB does not use this register. Keep the default value as it is.

REG27: Frequency Band Settings**[default value: 01H]****Bit 7 – 6: reserved**

- The FRH-SD07TU/TB does not use this register. Keep the default value as it is.

Bit 5 – 4: Output clock rate of AUX terminal

Bit 5	Bit 4	Setting
0	0	No clock output (default value)
0	1	100KHz
1	0	1.14MHz
1	1	8MHz

Table 5–30: Setting of output clock rate of AUX terminal

- Sets the operation *clock rate* of the output signal of the *AUX terminal* for the status monitor use. Some of the status data contains high speed one-shot signals, which requires high speed clock to properly catch. Because of higher current consumption when higher clock rate, this parameter controls the *clock rate* to decrease current consumption.
- For the function of the *AUX terminal*, refer to p.151 **AUXILIARY INTERFACE**.

Bit 3 – 0: Frequency band setting

Bit 3	Bit 2	Bit 1	Bit 0	Setting
0	0	0	0	Invalid (forced to 0001)
0	0	0	1	2433-2479MHz (default value)
0	0	1	0	Do not set (Invalid)
0	0	1	1	01 Band
0	1	0	0	02 Band
0	1	0	1	2420-2466MHz 2MHz Separation
0	1	1	0	2423-2469MHz 2MHz Separation
0	1	1	1	Reserved
1	-	-	-	

Table 5–31: Frequency band setting

- For the *frequency band*, refer to p.35 **FREQUENCY BAND**.
- For the FRH-SD07TB users in France and Spain, frequency usage is restricted to 02 Band because of its country's regulatory authority. Also please refer p.35 **FREQUENCY BAND** for its details.

SECTION

6

COMMAND SET DESCRIPTION

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6.1 Command Set Description

This section provides a description of each command available in the FRH command set. The table below lists each command and its applicability in each operation mode.

	Command	Function	Command to Mode Availability			
			3	4	5	6
1	ARG	Reference All Memory Registers	○	○	○	○
2	BCL	Clear Transmit and Receive Buffers	○	—	○	—
3	BIV	Reference and Set Beacon Interval	○	—	○	—
4	BST	Read Buffer Status	○	—	○	—
5	DAS	Reference and Set the Destination Address	—	—	○	—
6	DBM	Read Signal Strength	○	—	○	—
7	FRQ	Reference and Set Frequency Group	○	—	○	○
8	INI	Initialize All Memory Registers	○	○	○	○
9	ODA	Disable Received Data Output	○	—	○	—
10	OEN	Enable Received Data Output	○	—	○	—
11	PAS	Reference and Set Repeater Address	—	—	○	—
12	POF	Transmit Directly to Receiver	—	—	○	—
13	PON	Transmit through Repeater	—	—	○	—
14	RBC	Clear Receive Buffer	○	—	○	—
15	RDA	Disable Wireless Reception	○	—	○	—
16	REG	Reference and Set Memory Registers	○	○	○	○
17	REN	Enable Wireless Reception	○	—	○	—
18	RID	Display Received Serial ID	○	—	○	—
19	RLR	Release ULTRA Mode Through Repeater	○	—	○	—
20	RLU	Release ULTRA Mode (Direct)	○	—	○	—
21	RNO	Reference and Set Retransmission Count	○	—	○	—
22	ROF	RF Circuit Block Power Down	○	○	○	○
23	RON	RF Circuit Block Power Up	○	○	○	○
24	RPT	Retransmit Message	○	—	○	—
25	RST	Reset	○	○	○	○
26	RTY	Retransmit Message Through Repeater	○	—	—	—
27	STS	Read Status	○	—	○	—
28	TBC	Clear Transmit Buffer	○	—	○	—
29	TBN	Transmit Binary Data	○	—	—	—
30	TBR	Transmit Binary Data Through Repeater	○	—	—	—
31	TID	Display Local Station Serial ID	○	○	—	—
32	TXR	Transmit Text Data Through Repeater	○	—	—	—
33	TXT	Transmit Text Data	○	—	—	—
34	VER	Reference Version Information	○	○	○	○

○ = available
 — = unavailable or invalid

Table 6–1: Command to Mode Availability

The symbols used in this section have the following meaning:

- > : Input character from the terminal equipment to the modem
- < : Output from the modem to the terminal equipment
- @ : *Command header*
- CR/LF : *Terminator* (carriage return + line feed)
- [] : Required input parameter/s Be sure to input.
- () : Optional input parameter/s May be omitted
- { } : *485 mode local station address* (REG00). Be sure to input at *485 mode*

In the *Syntax* and *Response* segments of the following command descriptions the *terminator* symbol (CR/LF) has been omitted for clarity.

ARG**Reference All Memory Registers**

Syntax

ARG{Local Station Address}

Local Station Address : *local station address* for 485 mode (000 to 239).

Response

All settings are indicated (REG00 to REG27)

N0: *command error* (Except 485 mode)

Function

Recalls the contents of all 28 *memory registers*.

Example

>@ARG CR/LF : Recall the contents of all the *memory registers*

<REG00 : 01H CR/LF : Consecutive output of register contents

<REG01 : F0H CR/LF : Register values output in hexadecimal codes

<REG02 : 02H CR/LF

<REG03 : F1H CR/LF

|
|

<REG22 : 00H CR/LF

<REG23 : 00H CR/LF

BCL**Clear Transmit and Receive Buffers**

Syntax

BCL{Local Station Address}

Local Station Address : *local station address* for 485 mode (000 to 254).

Response

P0 : command accepted

N0 : *command error* (Except 485 mode)

Function

On *headerless packet mode* (mode 5), clears the contents of the transmit and receive buffers of the modem.

Example

>@BCL CR/LF : clear the buffer contents

<P0 CR/LF : command accepted

Notes

Use the TBC or RBC command to clear *only* the contents of either transmit or receive buffers.

BIV**Reference and Set Beacon Intervals****Syntax**

BIV(Interval) {; Local Station Address}

Interval : Specifies 000 to 065, in 10msec increment.

Local Station Address : *local station address* for *485 mode* (000 to 239).

Response

xxx : current set value (reference)
 P0 : command accepted (setting)
 N0 : *command error* (Except 485 mode)

Function

Set the interval of the *radio beacon transmission/receiving function*. Refer to p.51

COMMUNICATION EXAMPLE (N:M-MODE 3).

The current value can be referred by issuing the command only. In case of setting, input the desired value for setting.

In the *radio beacon transmission function* status (REG19:bit 1=1), the *beacon transmission interval* can be set. In the *beacon receiving function* status (REG19:bit 2=1), the *beacon receiving interval* can be set.

BIV command is used for temporarily changing the *interval*. The default values are fixed at 500 ms for the *receiving interval* and 150 ms for the *transmission interval*. The default value is reloaded at the power on or reset operation.

Example

```
>@BIV025 CR/LF      : Set the receiving (transmission) interval at 250 ms
<P0 CR/LF           : command accepted
>@BIV CR/LF         : Refer the current value
<025 CR/LF          : 025 (25 0ms) returns
```

Notes

Values set by the BIV command will be lost by turning the power on or resetting.

Generally, this parameter is no need to modifying. Use with the default value.

DAS**Reference and Set Destination Address**

Syntax

DAS(set destination address)

set destination address : the desired *destination address* (000 to 239)

Response

xxx : current value (reference)
P0 : command accepted (setting)
N0 : *command error*

Function

References or sets the *destination address* of the modem connection established with in the *headerless transmission mode* (mode 5)

The current DAS value can be referenced by entering the command with no parameter.

The DAS command is used for temporary modifying *destination address*. Change the value of REG02 to change the default value.

Example

```
>@DAS002 CR/LF : set the destination address to 002  
<P0 CR/LF : command accepted  
>@DAS CR/LF : reference the destination address  
<002 CR/LF : current value output (002)
```

Notes

This command cannot be used in *packet transmission mode*.

The *local station address* (REG00) must be set to communicate with the remote modem. Communication cannot be established unless the *addresses* coincide with each other.

This command is not allowed to use in *485 mode*.

DBM**Read Signal Strength**

Syntax

DBM{Local Station Address}

Local Station Address : *local station address* for 485 mode (000 to 239).

Response

-xxxdBm : signal strength

N0 : *command error* (Except 485 mode)

Function

Reads the *received signal strength* and outputs the value in dBm.

Higher values represent stronger *signal strength* and better receiving conditions.

Example

>@DBM CR/LF : read *signal strength*

<-78dBm CR/LF : signal strength is -78dBm.

Notes

The range available for measurement is -40 dBm to -100 dBm. Since the *signal strength* indication has a slight error in its value, use this result for your 'rule of a thumb' reference.

This command outputs the *strength* of last *received packet*.

FRQ**Reference and Set Frequency Group****Syntax**

FRQ(:frequency group){Local Station Address}

frequency group : combination of *frequency grouping method* (A to H) and *group number* (00 to 23). See p.35 **FREQUENCY GROUPING** more details.

Local Station Address : *local station address* for *485 mode* (000 to 239 for reference, 000 to 254 for setting).

Response

xxx : current value
 P0 : command accepted
 N0 : *command error* (Except *485 mode*)

Function

References or sets the *frequency grouping method* and *group number*.

The current set value is referenced by omitting the “:frequency group” parameter

This command is for temporary use only. To change the default value, change the settings of REG06.

Example

>@FRQ CR/LF : reference the current *grouping method* and *frequency number*
 <F00 CR/LF : output current value (*grouping method* F: *group number* 00)
 >@FRQ:E03 CR/LF : set *grouping method* to E (6 groups) and *group number* to 3.
 <P0 CR/LF : command accepted

Table 5–2: Grouping Methods and Numbers

Method	Number of Groups	Available Group Number Settings	Frequencies per Group
A	1	0	24
B	2	0 to 1	12
C	3	0 to 2	8
D	4	0 to 3	6
E	6	0 to 5	4
F	8	0 to 7	3
G	12	0 to 11	2
H	24	0 to 23	1

Notes

Do not change this setting while the modem is being transmitted.

The maximum number of *frequency groups* available depends upon the selected *grouping method*.

INI**Initialize All Memory Registers**

Syntax

INI{Local Station Address}

Local Station Address : *local station address* for *485 mode* (000 to 254).

Response

P0 : command accepted
N0 : *command error* (Except *485 mode*)

Function

Sets the all contents of the *memory registers* to the factory default values.

Example

>@INI CR/LF : initialize all memory registers
<P0 CR/LF : command accepted

Notes

Custom settings of all *memory registers* are lost when this command is executed.

If the *global address* (240 to 254) is designated while RS485 multi-drop connection is being made in the *RS485 mode*, the *local station address* of all modems will be initialized to 000. Exercise care when issuing this command.

For a list of the *factory default values*, see the section titled p.59 **MEMORY REGISTER DESCRIPTION.**

ODA**Disable Received Data Output**

Syntax

ODA{Local Station Address}

Local Station Address : *local station address* for *485 mode* (000 to 254).

Response

P0 : command accepted

N0 : *command error* (Except *485 mode*)

Function

Disables output of any data received via the wireless link to the terminal equipment.

Data received, while output is disabled, is stored in the receive buffer.

When the modem's power is turned on (or a reset), the modem is in the state to *enable* the *received data output*.

Example

>@ODA CR/LF : *disable* the output of received wireless data
<P0 CR/LF : command accepted

(Data is not output during this period even if received.)

>@OEN CR/LF : *enable* the output of received wireless data.
<P0 CR/LF : command accepted
<RXT002HELLO CR/LF : outputs data stored in the receive buffer
<RXT003MAIL CR/LF :

OEN**Enable Received Data Output**

Syntax

OEN{Local Station Address}

Local Station Address : *local station address* for 485 mode (000 to 254).

Response

P0 : command accepted

N0 : *command error* (Except 485 mode)

Function

Enables output of any data received via the wireless link to the terminal equipment.

This command enables serial data output after it has been disabled with the ODA command.

When the modem's power is turned on (or a reset), the modem is in the state to *enable* the *received data output*.

Example

>@ODA CR/LF : *disable* serial output of received wireless data
<P0 CR/LF : command accepted

(Data is not output during this period even if received.)

>@OEN CR/LF : *enable* serial output of received wireless data.
<P0 CR/LF : command accepted
<RXT002HELLO CR/LF : outputs data stored in receive buffer
<RXT003MAIL CR/LF : and any new data received

PAS**Reference and Set Repeater Address**

Syntax

PAS (Repeater Address)

Repeater Address : *repeater address* to pass through

Response

xxx : current address (reference)
P0 : command accepted (setting)
N0 : *command error*

Function

In the *headerless packet transmission mode* (mode 5), references and sets the *repeater address* to pass through

When no *repeater address* is set, the current setting can be referenced.

This command is used to temporarily change *repeater address*. To change the default value, change REG13.

Example

>@PAS CR/LF : references the current *repeater address*
<000 CR/LF : current *repeater address* is 000
<P0 CR/LF : command accepted
< @PAS002 CR/LF : sets the *repeater address* to 002
<P0 CR/LF : command accepted

Notes

This command is not allowed to be used in *485 mode*.

POF**Transmit Directly to Receiver**

Syntax

POF

Response

P0 : command accepted

N0 : *command error***Function**

In the *headerless packet transmission mode* (mode 5), transmits directly to receiver without passing through the *repeater*.

This command is used for temporary change of the path. To change the default value, change bit 5 of REG18.

Example

>@PON CR/LF	: sets the transmission path through <i>repeater</i>
<P0 CR/LF	: command accepted
< @POF CR/LF	: sets to direct transmission to receiver modem
<P0 CR/LF	: command accepted

Notes

This command is not allowed to be used in *485 mode*.

PON**Transmit through Repeater**

Syntax

PON

Response

P0 : command accepted

N0 : *command error***Function**

In the *headerless packet transmission mode* (mode 5), transmits through *repeater*.

This command is used for temporary change of path. To change the default value, change bit 5 of REG18.

Example

```
>@PON CR/LF      : sets the transmission path through repeater  
<P0 CR/LF        : command accepted  
< @POF CR/LF     : sets to direct transmission to receiver modem  
<P0 CR/LF        : command accepted
```

Notes

This command is not allowed to be used in *485 mode*.

RBC**Clear Receive Buffer**

Syntax

RBC{Local Station Address}

Local Station Address : *local station address* for 485 mode (000 to 254).

Response

P0 : command accepted

N0 : *command error* (Except *485 mode*)

Function

On *headerless packet mode* (mode 5), clears the contents of the receive buffer.

Example

>@RBC CR/LF : clear the contents of the receive buffer

<P0 CR/LF : command accepted

Notes

To clear both transmit and receive buffers, use the BCL command.

RDA**Disable Wireless Reception**

Syntax

RDA{Local Station Address}

Local Station Address : *local station address* for 485 mode (000 to 254).

Response

P0 : command accepted

N0 : *command error* (Except 485 mode)

Function

Disables wireless reception in the packet transmission mode.

The status when the modem is powered ON or reset follows bit 7 of REG22.

Example

>@RDA CR/LF : *disable wireless reception*

<P0 CR/LF : command accepted

>@REN CR/LF : *enable wireless reception*

<P0 CR/LF : command accepted

REG**Reference and Set Memory Register****Syntax**

REG[register number]([: value) {;Local Station Address}

register number	: <i>register</i> number to be set (00 to 23)
value	: value to be set. Input 2 hexadecimal digits (0 through 9 and A through F) followed by the number radix designator H.
Local Station Address	: <i>local station address</i> for <i>485 mode</i> (000 to 239 for reference, 000 to 254 for setting).

Response

xxH	: current value (reference)
P0	: command accepted (setting)
N0	: <i>command error</i> (Except <i>485 mode</i>)
N6	: memory register write error

Function

References or sets *memory registers*.

The current *register* value is referenced by omitting the “value” parameter.

Example

>@REG00 CR/LF	: reference the contents of <i>register</i> 00
<01H CR/LF	: displays current value
>@REG00 : 02H CR/LF	: set value of <i>memory register</i> 00 to 02H (hexadecimal)
<P0 CR/LF	: command accepted

Notes

The *register* can be rewritten sequentially. However, to make its parameter valid after rewriting it, re-supply the power, reset the modem using the *Shutdown mode* pin (Pin 11 of the *serial communication connector*) or use RST command.

While rewriting the *memory register*, do not turn off the power until *response* is output. Otherwise, the *memory registers* content may be collapsed.

When the *response* of the *memory register write error* is output, set the values after initializing the *memory register*.

REN**Reception Enable**

Syntax

REN{Local Station Address}

Local Station Address : *local station address* for 485 mode (000 to 254).

Response

P0 : command accepted

N0 : *command error* (Except 485 mode)

Function

Enables wireless reception in the *packet transmission mode*.

The status when the modem is powered ON or reset follows bit 7 of REG22.

Use this command to *enable wireless reception* after reception is disabled with the RDA command.

Example

>@RDA CR/LF : *disable wireless reception*

<P0 CR/LF : command accepted

>@REN CR/LF : *enable wireless reception.*

<P0 CR/LF : command accepted

RID**Display Received Serial ID**

Syntax

RID{Local Station Address}

Local Station Address : *local station address* for *485 mode* (000 to 239).

Response

XXXXXXXXXXXX : displays the received *serial ID code* (12 digits)
N0 : *command error* (Except *485 mode*)

Function

Outputs the *serial ID code* in the received packet and displays it.

The *serial ID code* consists of 12 digits; upper three digits are 0 and the lower 9 digits are the *product serial number* of the transmitted-end modem.

Be noted that the *serial ID code* of the packet received last is displayed. When packets are received from multiple stations and their data are stored in the receiving buffer, those data may not be correspond to the *serial ID code* readout with RID command.

To use it more securely, it is recommended to readout the *local serial ID code* with TID command and pad it (either all or a part of it) in the transmitting packet.

When no packet is received, "All Zero" is displayed as the result of this command execution.

The *serial ID code* is no relation with *ID code* setting of REG04 and 05.

Example

>@RID CR/LF : requests the received remote station's *serial ID code*
<XXXXXXXXXXXX CR/LF : outputs the received remote station's *serial ID code*

RLR**Release ULTRA Mode Through Repeater****Syntax**

RLR [repeater address] [destination address]{Local Station Address}

repeater address : address of *repeater* to pass through (000 to 239)
 destination address : address of *destination station* (000 to 239, set to 255 for *broadcast ULTRA mode release*)
 Local Station Address : *local station address* for *485 mode* (000 to 254).

Response

P1 : command accepted. Transmitting, the request to release the *ULTRA mode* through the *repeater*.
 P0 : *Broadcast ULTRA mode release request transmission* complete
 N0 : *command error* (Except *485 mode*)
 N1 : *ULTRA mode release request transmission* complete

Function

Makes the *destination station(s)* in the *ULTRA (Ultra Low-power Transient Radio Access) mode* return to the *Active mode* by transmitting *ULTRA wakeup request packet* from the *repeater*. Local modem just send the request to the *repeater*.

At the command completion, “N1” *response* is output from in any case (P1 to *broadcast* case). To confirm that the *destination station* returns to the *Active mode*, attempt communication with the *destination station* using TXR command.

Example

>@RLR100001 CR/LF : transmitting to Station 001 the request to release the *ULTRA mode* from the *repeater* 100.
 <P1 CR/LF : transmitting the *Wakeup transmission request* signal
 <N1 CR/LF : *request* signal transmission completes (unknown whether succeeded or failed)
 >@RLR100255 CR/LF : transmits the *broadcast request* signal to release the *ULTRA mode*
 <P1 CR/LF : transmitting the *request* signal
 <P0 CR/LF : *request* signal transmission completes (unknown whether succeeded or failed)

RLU**Release ULTRA Mode (Direct)****Syntax**

RLU [destination address]{Local Station Address}

destination address : address of *destination station* (000 to 239, set to 255 for all station) to *ULTRA mode* release

Local Station Address : *local station address* for *485 mode* (000 to 254).

Response

P0 : *ULTRA mode* successfully released
 P1 : command received.
 transmitting the *Wakeup request packet* of the *ULTRA mode*
 N0 : *command error* (Except *485 mode*)
 N1 : failed in releasing the *ULTRA mode* (no response from the *destination station*)

Function

Makes the *destination station(s)* in the *ULTRA (Ultra Low-power Transient Radio Access) mode* return to the *Active mode* by transmitting *Wakeup request packet*, *ULTRA mode* release signal.

In case of all station's *ULTRA mode* release (*broadcast*), the modem outputs "P0" *response* in any case. To confirm that the *destination station* returns to the *Active mode*, attempt communication with the *destination station* using TXT command.

When the *destination station*, its REG 25:bit 7 is set to 1 which allows the *ULTRA mode* operation, but operating in the *Active mode*, will return "*release success ACK*" when it receives the *Wakeup request packet*, *ULTRA mode* release signal. Therefore, the *response* to the RLU command is "P0".

Example

```
>@RLU001 CR/LF      : transmitting to Station 001 Wakeup request packet,
                     : the request to release the ULTRA mode
<P1 CR/LF           : transmitting the Wakeup request packet
<N1 CR/LF           : release failed
>@RLU002 CR/LF      : transmits to Station 001 the Wakeup request packet
<P1 CR/LF           : transmitting the Wakeup request packet
<P0 CR/LF           : release succeeded
>@RLU255 CR/LF      : transmits to all stations Wakeup request packet
<P1 CR/LF           : transmitting the Wakeup request packet
<P0 CR/LF           : transmission of Wakeup request packet completes
                     : (unknown whether it is succeeded or failed)
```

RNO Reference and Set Retransmission Count

Syntax

RNO (retransmission count) {; Local Station Address}

retransmission count : maximum *number of retransmissions* (000 to 255)
Local Station Address : *local station address* for *485 mode* (000 to 239 for reference, 000 to 254 for setting).

Response

xxx : current set value
P0 : command accepted
N0 : *command error* (Except *485 mode*)

Function

This command references or sets the *number of retransmissions (retransmission count)* to attempt before making decision as transmission failure.

The current value can be referenced by issuing the command with no parameter.

RNO command is used to temporarily change the *retransmission count*. To change the default value, change the setting of REG11.

Example

>@RNO CR/LF : reference the *retransmission count*
<050 CR/LF : output the current set value (50 times)
>@RNO010 CR/LF : set the *retransmission count* to 10 times
<P0 CR/LF : command accepted

ROF**RF Circuit Block Power Down**

Syntax

ROF{Local Station Address}

Local Station Address : *local station address* for *485 mode* (000 to 254).

Response

P0 : command accepted

N0 : *command error* (Except *485 mode*)

Function

Turn off the power of *RF circuit block* and stops RF operation.

This function is used to save the current consumption when no transmit/receive are required. The current consumption in this mode is about 5 mA.

Example

>@ROF CR/LF : turn off *RF circuit block*
<P0 CR/LF : command accepted

>@RON CR/LF : turn on *RF circuit block*
<P0 CR/LF : command accepted

RON**RF Circuit Block Power Up**

Syntax

ROF{Local Station Address}

Local Station Address : *local station address* for 485 mode (000 to 254).

Response

P0 : command accepted

N0 : *command error* (Except 485 mode)

Function

Turn on the power of *RF circuit block* and activates RF operation.

Use this command to activate *RF circuit block* after its *power down state* set by the ROF command.

The status when the modem is powered ON or reset, the *RF circuit block* is in the operation state.

Example

>@ROF CR/LF : turn off *RF circuit block*

<P0 CR/LF : command accepted

>@RON CR/LF : turn on *RF circuit block*

<P0 CR/LF : command accepted

RPT

Retransmit Message

Syntax

RPT [destination address]{Local Station Address}

destination address : address of *destination station* (000 to 239)
set 240 to 254 for *global addressed destination*
set 255 for *broadcast transmission*

Local Station Address : *local station address* for 485 mode (000 to 254).

Response

P0	: data transmission succeeded
P1	: command accepted, data being transmitted.
P2	: data packet reached to <i>repeater</i>
N0	: <i>command error</i> (Except <i>485 mode</i>)
N1	: data transmission failed -- no response from <i>destination station</i>
N2	: data transmission failed -- <i>destination station</i> is in the <i>reception disabled state</i>
N3	: data transmission failed -- <i>destination station</i> cannot receive because its receive buffer is full

Function

Retransmits the last message.

Use this command to retransmit the same data or transmit the same data to a different station.

For *broadcasting* messages to multiple modems, set the *destination address* to 255. In this case, the modem *retransmit* the message the number of times of the *Retransmission count* plus 1, and then it will return “P0”.

Example

```
>@TXT002HELLO CR/LF      : transmit "HELLO" from station 001 to station 002
<P1 CR/LF                 : data being transmitted
<N1 CR/LF                 : transmission failed.
>@RPT002 CR/LF           : retransmit "HELLO" from station 001 to station 002
<P1 CR/LF                 : data being transmitted
<P0 CR/LF                 : data transmission succeeded
>@RPT003 CR/LF           : transmit "HELLO" from station 001 to station 003
<P1 CR/LF                 : data being transmitted
<P0 CR/LF                 : data transmission succeeded
```

Notes

Follow the last transmit command's form of transmission, text or binary, or whether passing through *repeater* or not.

In case of *broadcast transmission*, the receiving result of the *destination station* cannot be confirmed at the sender end.

Before invoking this command, execute any transmit command of `TXR`, `TBN`, or `TBR`.

There are important notes using transmit commands. Be sure to read p.158

OPERATION IMPORTANT NOTICE.

RST**Reset**

Syntax

RST{Local Station Address}

Local Station Address : *local station address* for 485 mode (000 to 254).

Response

P0 : command accepted
N0 : *command error* (Except 485 mode)

Function

Resets the modem to restore the power on state.

When any *memory register* is rewritten with REG command before issuing this command, the value rewritten becomes valid and active. Temporary settings like DAS and FRQ command become invalid and the *memory register* settings is loaded.

Example

>@RST CR/LF : reset the modem
<P0 CR/LF : command accepted

Note

When a serial communication parameter in *memory register* is changed with REG command, the *response* of “P0” returns according to the changed setting parameter, which may cause communication error. In such a case, set the communication parameter of the terminal equipment in correspondence with the new setting immediately after the issuance of RST command.

RTY**Retransmit Message Through Repeater****Syntax**

RTY [repeater address] {Local Station Address}

repeater address : address of *repeater* to pass through for message transmission (000 to 239)

Local Station Address : *local station address* for *485 mode* (000 to 254).

Response

P0 : data transmission succeeded
 P1 : command accepted, data being transmitted.
 P2 : data packet reached to *repeater*
 N0 : *command error* (Except *485 mode*)
 N1 : data transmission failed -- no response from *destination station*
 N2 : data transmission failed -- *destination station* is in the *reception disabled state*
 N3 : data transmission failed -- *destination station* cannot receive because its receive buffer is full

Functions

Retransmits the previous message to the same *destination station* through a *repeater*.

In case the *global addressing command* is issued to plural modems connected by RS485 multi-dropping interface, the transmission stops when any modem outputs "P0", "N2" or "N3" *response* to the RS485 line.

Example

```
>@TXT002HELLO CR/LF : transmit "HELLO" from station 001 to station 002
<P1 CR/LF           : command received, data transmitted
<N1 CR/LF           : transmission failed
>@RTY100 CR/LF      : retransmit "HELLO" from station 001 to station 002
                     through repeater 100
<P1 CR/LF           : data being transmitted
<P2 CR/LF           : data packet reached to repeater
<P0 CR/LF           : data transmission succeeded
```

Notes

Before invoking this command, execute any transmit command of TXT, TXR, TBN, or TBR.

In case of *broadcast transmission*, the receiving result of the *destination station* cannot be confirmed at the sender end.

There are important notes using transmit commands. Be sure to read p.158 **OPERATION IMPORTANT NOTICE.**

STS

Read Status

Syntax

STS{Local Station Address}

Local Station Address : *local station address* for 485 mode (000 to 239).

Response

xxxxxxx : modem's current status (x = 0 or 1)
N0 : *command error* (Except 485 mode)

Function

Reads the modem *status register*. (Represented with an 8-bit binary number.)

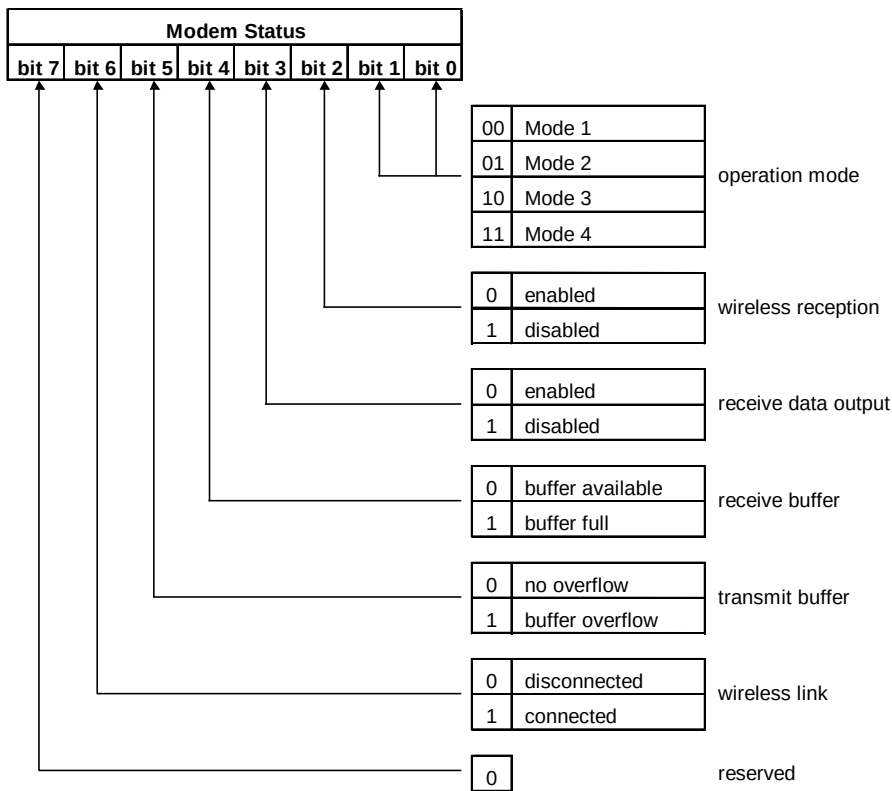


Figure 6–2: Modem Status Bit Description

Example

>@STS CR/LF : read the current status
<00001010 CR/LF : Operation Mode 3, *receive data output disabled*

Notes

Bit 6, the *wireless link status*, this bit does not valid in the modem.

TBC**Clear Transmit Buffer**

Syntax

TBC{Local Station Address}

Local Station Address : *local station address* for *485 mode* (000 to 254).

Response

P0 : command accepted

N0 : *command error* (Except *485 mode*)

Function

In the *headerless packet mode* (mode 5), clear the contents of the transmit buffer.

Example

>TBC CR/LF : clear the contents of the transmit buffer

<P0 CR/LF : command accepted

Notes

Use the BCL command to clear both the transmit and receive buffers.

TBN

Transmit Binary Data

Syntax

TBN[destination address][message byte length]{Local Station Address}[message]

Destination address : address of the *broadcast transmission* (000 to 239)
set 240 to 254 for *global addressed destination*
set 255 for *broadcast transmission*

Message byte length : message length (001 to 255)

Local Station Address : *local station address* for 485 mode (000 to 254).

Message byte : arbitrary binary data (255 or less)

Response

P0 : data transmission succeeded

P1 : command accepted, data being transmitted

N0 : *command error* (Except 485 mode)

N1 : data transmission failed -- no *response* from *destination station*

N2 : data transmission failed -- *destination station* is in the *reception disabled* state

N3 : data transmission failed -- *destination station* cannot receive because its receive buffer is full

Function

Transmits binary data in the *packet transmission mode*.

Any *message length* between 1 to 255 bytes is accepted.

The modem counts the number of message characters and transmits the message.

For *broadcasting* messages to multiple modems, set the *destination address* to 255.

In this case, the modem *retransmits* the message the number of times of the

Retransmission count plus 1, and then it will return “P0”.

In case the *global addressing command* is issued to plural modems connected by RS485 multi-dropping interface, the transmission stops when any modem outputs “P0”, “N2” or “N3” *response* to the RS485 line.

Example

```
>TBN002005HELLO CR/LF      : transmit "HELLO" from station 001 to station 002
```

<P1 CR/LF : data being transmitted

<P0 CR/LF : data transmission succeeded.

>@TBN003004MAIL CR/LF : retransmit "MAIL" from station 001 to station 003

<P1 CR/LF : data being transmitted

<N1 CR/LF : transmission failed, no *response* from *destination station*

Notes

Set the *message length* to 255 byte or less. The *message length* exceeding 255 byte will be *command error*.

Message must be terminated with 2 byte (CR/LF) character, others will be *command error*.

In *broadcast transmission*, the receiving result of the *destination station* cannot be confirmed at the sender side.

There are important notes using transmit commands. Be sure to read p.158

OPERATION IMPORTANT NOTICE.

TBR

Transmit Binary Data through Repeater

Syntax

TBR [repeater address] [destination address] [message byte length]{Local Station Address}[message]

Repeater address : *repeater* address to pass through (000 to 239)

Destination address : address of *destination station* (000 to 239)
set 240 to 254 for *global addressed destination*
set 255 for *broadcast transmission*

Message byte length : message byte length (001 to 255)

Local Station Address : *local station address for 485 mode (000 to 254).*

Message byte : arbitrary binary data (255 or less)

Response

```
P0          : data transmission succeeded
```

P1 : command accepted, data being transmitted

P2 : data packet reached to *repeater*

N0 : *command error* (Except 485 mode)

N1 : data transmission failed -- no *response* from *destination station*

N2 : data transmission failed -- *destination station* is in the *reception disabled* state

N3 : data transmission failed -- *destination station* cannot receive because its receive buffer is full

Function

In the *packet transmission mode*, transmits binary data through *repeater*.

Any *message length* between 1 to 255 bytes is accepted.

The modem counts the number of message characters and transmits the message.

For *broadcasting* messages to multiple modems, set the *destination address* to 255.

In this case, the modem *retransmits* the message the number of times of the *Retransmission count* plus 1, and then it will return “P0”.

In case the *global addressing command* is issued to plural modems connected by RS485 multi-dropping interface, the transmission stops when any modem outputs “P0”, “N2” or “N3” *response* to the RS485 line.

Example

>TBR100002005HELLO CR/LF : transmit "HELLO" from station 001 to station 002

<P1 CR/LF : data being transmitted

<P2 CR/LF : data packet reached to *repeater*

<P0 CR/LF : data transmission succeeded

Notes

Set the *message length* to 255 byte or less. The *message length* exceeding 255 byte will be *command error*.

Message must be terminated with 2 byte (CR/LF) character, others will be *command error*.

In *broadcast transmission*, the receiving result of the *destination station* cannot be confirmed at the sender side.

There are important notes using transmit commands. Be sure to read p.158

OPERATION IMPORTANT NOTICE.

TID**Display Local Station Serial ID**

Syntax

TID{Local Station Address}

Local Station Address : *local station address* for 485 mode (000 to 239).

Response

XXXXXXXXXXXX : displays the *local serial ID code* (12 digits)

N0 : *command error* (Except 485 mode)

Function

Readout the *local serial ID code* of the modem and display it. This command corresponds to RID command.

The *local serial ID code* consists of 12 digits; upper three digits are 0 and the lower 9 digits are the *product serial number* of the modem.

Be noted the usage of RID command, the *serial ID code* of the packet received last is displayed. When packets are received from multiple stations and their data are stored in the receiving buffer, those data may not correspond to the *serial ID code* readout with the RID command.

To use it more securely, it is recommended to readout the *local serial ID code* with the TID command and pad it (either all or a part of it) in the transmitting packet.

The *serial ID code* is no relation with *ID code* setting of REG04 and 05.

Example

>@TID CR/LF : requests the modem's *local serial ID code*

<XXXXXXXXXXXX CR/LF : outputs the modem's *local serial ID code*

TXR**Transmit Text Data through Repeater****Syntax**

TXR [repeater address] [destination address]{Local Station Address}[message]
 repeater address : address of *repeater* to pass through (000 to 239)
 destination address : address of *destination station* (000 to 239)
 set 240 to 254 for *global addressed destination*
 set 255 for *broadcast transmission*
 Local Station Address : *local station address* for *485 mode* (000 to 254).
 message : any text data (255 or less)

Response

P0 : data transmission succeeded
 P1 : command accepted, data being transmitted
 P2 : data packet reached to *repeater*
 N0 : *command error* (Except *485 mode*)
 N1 : data transmission failed -- no *response* from the *destination station*
 N2 : data transmission failed -- *destination station* is in the *reception disabled state*
 N3 : data transmission failed -- *destination station* cannot receive because its receive buffer is full.

Function

Transmits text data in the *packet transmission mode* through *repeater*.

Any *message length* between 1 to 255 bytes is accepted. The completion of data input is recognized by the *terminator*.

For *broadcasting* messages to multiple modems, set the *destination address* to 255. In this case, the modem *retransmits* the message the number of times of the *Retransmission count* plus 1, and then it will return "P0".

In case the *global addressing command* is issued to plural modems connected by RS485 multi-dropping interface, the transmission stops when any modem outputs "P0", "N2" or "N3" *response* to the RS485 line.

Example

```
>@TXR100002HELLO CR/LF : transmits HELLO from station 001 to station 002 through
                        repeater 100
<P1 CR/LF               : data being transmitted
<P2 CR/LF               : data packet reached to repeater
<P0 CR/LF               : data transmission succeeded
```

Notes

Set the *message length* to 255 byte or less. The *message length* exceeding 255 byte will be *command error*.

When the same character as the *terminator* (CR/LF) is contained in a message, the modem distinguishes it as the end of a command and ignore the subsequent data. In such a case, use TBR command.

In *broadcast transmission*, the receiving result of the *destination station* cannot be confirmed at the sender side.

There are important notes using transmit commands. Be sure to read p.158

OPERATION IMPORTANT NOTICE.

TXT**Transmit Text Data****Syntax**

TXT [destination address]{Local Station Address}[message]
 destination address : address of *destination station* (000 to 239)
 set 240 to 254 for *global addressed destination*
 set 255 for *broadcast transmission*
 Local Station Address : *local station address* for *485 mode* (000 to 254).
 message : any text data (255 or less)

Response

P0 : data transmission succeeded
 P1 : command accepted, data being transmitted
 N0 : *command error* (Except *485 mode*)
 N1 : data transmission failed - no *response* from the *destination station*
 N2 : data transmission failed - *destination station* is in the *reception disabled state*
 N3 : data transmission failed – *destination station* cannot receive because its receive buffer is full.

Function

Transmits text data in the *packet transmission mode*.

Any message length between 1 to 255 bytes is accepted. The completion of data input is recognized by the *terminator* (CR/LF).

For *broadcasting* messages to multiple modems, set the *destination address* to 255. In this case, the modem will *retransmit* the message the number of times of the *Retransmission count* plus 1, and then it will return “P0”.

In case the *global addressing command* is issued to plural modems connected by RS485 multi-dropping interface, the transmission stops when any modem outputs “P0”, “N2” or “N3” *response* to the RS485 line.

Example

```
>@TXT002HELLO CR/LF : transmits HELLO from station 001 to station 002
<P1 CR/LF           : data being transmitted
<P0 CR/LF           : data transmission succeeded
>@TXT003MAIL CR/LF  : transmits MAIL from station 001 to station 003
<P1 CR/LF           : data being transmitted
<N1 CR/LF           : transmission failed. no response from destination station
```

Notes

Set the *message length* to 255 byte or less. The *message length* exceeding 255 byte will be *command error*.

When the same character as the *terminator* (CR/LF) is contained in a message, the modem distinguishes it as the end of a command and ignores the subsequent data.

In such a case, use TBN command.

In *broadcast transmission*, the receiving result of the *destination station* cannot be confirmed at the sender side.

There are important notes using transmit commands. Be sure to read p.158

OPERATION IMPORTANT NOTICE.

VER**Reference Version Information**

Syntax

VER{Local Station Address}

Local Station Address : *local station address* for 485 mode (000 to 239).

Response

Hardware system version Ver x.nn

or

N0 : *command error* (Except 485 mode)

Function

Reads the modem's hardware system version.

Example

>@VER CR/LF	: read the version information
<Ver 1.00 CR/LF	: this modem firmware is version 1.00

SECTION

7

ADVANCED APPLICATIONS

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7.1 Headerless Packet Transmission Mode

7.1.1 Operation in the headerless packet transmission mode

The *headerless packet transmission mode* (mode 5) is a specific transmission mode to set transmission data without the *packet header*, employing the protocol of the *packet transmission mode*. Parameters such as *receiver* or *repeater addresses* are set either by the *memory register* or by the command. A transmission data packet is automatically terminated by the specific character (*terminator*). *Command responses* (P1, P0) are not output.

In the *headerless packet transmission mode*, since the transmission data is no longer to be issued as the transmission command. At the end to end of the wired link, existing upper layer application protocol can be used without awareness of the wireless link protocol.

This mode can communicate with the normal *packet transmission mode* (mode 3 and 4) interactively.

This mode cannot be used in the *RS485 mode*.

7.1.1.1 Format of the headerless packet transmission mode

In the *headerless packet transmission mode*, no *response* (P1, P0) following the transmission command is output. Instead of outputting the *receive header* or the CR/LF code, the specific characters (*terminator*) is output which separates data to a transmission packet at the sender end.

Since the transmission packet contains the sender's address, data format (*text or binary mode*) and the *repeater address*, the *headerless packet transmission mode* is compatible with the normal *packet transmission mode* and the interactive communication can be performed between them.

The transmission and receiving formats in the *headerless packet transmission mode* are as follows.

1. *Packet transmission mode* (for the reference below)
Sender: @TXT002HELLO CR/LF -> Receiver: RXT001HELLO CR/LF
2. *Headerless packet transmission mode* (when *terminator* is CR/LF)
Sender: @HELLO CR/LF -> Receiver: HELLO CR/LF
3. When the receiver is in the *packet transmission mode* (text mode)
Sender: @HELLO CR/LF -> Receiver: RXT001HELLO CR/LF
4. When the receiver is in the *packet transmission mode* (binary mode)
Sender: @HELLO CR/LF -> Receiver: RBN001HELLO CR/LF CR/LF

5. When sender is in the *packet transmission mode*
 Sender: @TXT002HELLO CR/LF -> Receiver: HELLO

NOTE

When the receiver is in the *packet transmission mode*, be careful about the terminator. For details, refer to REG23 of p.59 **MEMORY REGISTER DESCRIPTION**.

NOTE

The difference between the *text mode* and the *binary mode* does not matter in the *headerless transmission mode*.

7.1.1.2 Commands for the headerless packet mode

The same command as used in the *packet transmission mode* can be used, but the following commands which attempted transmission cannot be used.

TXT, TXR, TBN, TBR, RPT, RTY.

In the *headerless packet transmission mode*, no command for transmission is required. But the internal processing is the same as that in the normal *packet transmission mode*.

Therefore, the parsing process of the transmission data array is the same as that of the *command*. Accordingly, the *command input timeout* is valid (Note: which is fixed to 5 sec. in the *headerless packet transmission mode*).

7.1.1.3 Repeater in the headerless packet mode

The *repeater* also can be used in the *headerless packet transmission mode*. The *repeater address* is set with the *memory register* or the PAS command. The *repeater* itself no needs to be in the *headerless packet transmission mode*.

Set REG18:bit 5 whether the *repeater* is used or not. The address of the *repeater* is set using REG13 or command.

Command to ON/OFF via the *repeater*.

Command for setting the *repeater* address.

PON command, POF command

PAS command

7.1.1.4 Broadcast transmission

In the *headerless packet transmission mode*, the *broadcast transmission* to multiple modems can be performed by setting the *destination address* to 255. However, the sender side cannot confirm whether the transmitted data are successfully received by all receivers or not, because there is no *ACK packet* returned from the receiver modem. In the *broadcast transmission*, the sender side transmits a data packet number of times that *retransmission count* plus one. When successfully the data packet is received, the receiver modem outputs the data packet to the terminal equipment without responding by *ACK packet*. The retransmission-packet-data after the successful receipt is considered as the same packet and is not output to the terminal equipment.

NOTE

There are important notes using transmit commands. Be sure to read p.158 **OPERATION IMPORTANT NOTICE**.

7.1.2 Invoke transmission in headerless packet

In the *headerless packet transmission mode*, detection of the *terminator* is a recognition of the end of the packet, and transmission starts. Though the *terminator* is set to CR/LF as the default, any desired 1 byte or 2 byte characters can be set as the *terminator*. For details, refer to the p.124 **MEMORY REGISTER SETTING, HEADERLESS TRANSMISSION MODE**.

The *message data length* transmittable at one time (one packet) is 255 bytes maximum. The message data over 255 is recognized as the *command error* (“N0” response is returned). When transmission starts, *CTS* goes OFF instead of outputting the *response* “P1”. And instead of the *response* “P0” to complete data transmission, *CTS* goes ON. So, input the subsequent transmission data after confirming that *CTS* goes ON, because *CTS* is OFF during the transmission process.

The *receiver's address* is set with the *memory register* or command. *Broadcasting* to multiple-modems is possible by setting the *receiver's address* to 255. However, the sender end cannot confirm whether the transmitted data are successfully received by all receivers or not, because there is no *ACK packet* returned from the receiver modem. In the *broadcast transmission*, the sender transmits data packet number of times that the *retransmission count* plus one. When successfully receiving data packet, the receiver modem outputs the data packet to the terminal equipment without responding by *ACK packet*. The retransmission packet data after the successful receipt is considered as the same packet and is discarded.

NOTE

In the *headerless packet transmission mode*, no *response* (P0 or N1) is output to convey the transmission result. When resulting any transmission failure, correction should be made in the upper layer application protocol in the terminal equipment.

NOTE

In the *headerless packet transmission mode*, the *terminator* is included in the transmission data. Be noted that the *data length*, including the *terminator*, is limited up to 255 bytes.

NOTE

In the *headerless packet transmission mode*, continuous transmission is impossible because this mode is fundamentally the *packet transmission mode*. Since *CTS* is OFF during transmission, be sure to input the subsequent transmission data after confirming that *CTS* goes to ON.

NOTE

In the *broadcast transmission*, retransmission is made until it reaches the *retransmission count*. In some upper layer application protocol, which immediately reply from the receiver side during

sender's retransmission, would replies during retransmission. This case packet returned from the receiver side cannot be received. In such a case, the *retransmission count* must be set to the appropriate value.

7.1.3 Example of operation

The following is an example of 3 modems communicating each other through the *repeater*.

7.1.3.1 Terminal software setup

Procedure 1

Set all the terminal software as follows.

bit rate:	9600 bps
data length:	8 bits
stop bits:	1 bit
parity bit:	none
flow control:	hardware control (RTS/CTS)
local echo:	yes
terminator:	carriage return +line feed

Procedure 2

Check for proper communication between the terminal equipment and modems after connecting them. Enter “@ARG CR/LF” at the terminal equipment. If functioning properly, the set value of all 28 memory registers will be displayed on your terminal screen.

7.1.3.2 Modem setup

Procedure 1. Set REG00 (*local station address*) and REG02 (*destination address*) as follows.

modem 1:	REG00=000	REG02=001
modem 2:	REG00=001	REG02=000
modem 3:	REG00=002	REG02=000

Procedure 2. Set REG03 to FFH (enable *headerless packet transmission mode*).

Procedure 3. Set the frequency to the *fixed frequency* No.0 (*Frequency group H*)

Procedure 4. Set REG13 to 010 (*repeater address*).

Procedure 5. Set REG18:bit 0 to 1 (enable the *destination address checking*).

Procedure 6. Set REG18:bit 5 to 1 (transmit through the *repeater*).

The other registers shall remain at the default value.

7.1.3.3 Repeater setups

Procedure 1. Set REG00 (*local station address*) to 010.

Procedure 2. Set REG06 (frequency) to the fixed frequency No.0 (*Frequency group H*)

Procedure 3. Set REG18:bit 0 to 1 (enable the destination address check).

Procedure 4. Set REG19:bit 0 to 1 (to use the modem as the *repeater*).
The other *memory registers* shall remain at the default value.

7.1.3.4 Communication

1. A message is transmitted from the modem 1 to the modem 2 through the *repeater*.
 >HELLO CR/LF
2. The modem 2 outputs the received message to the terminal equipment.
 >HELLO CR/LF
3. The modem 1 changes the *destination address* to 002 (modem 3) using the DAS command.
 >@DAS002 CR/LF Change the *destination address* to 002
 <P0 CR/LF Subsequent message will be transmitted to 002.
4. The modem 1 transmits the message to the modem 3.
 >MAIL CR/LF
5. The modem 3 outputs the message to the terminal equipment.
 <MAIL CR/LF

7.1.4 Memory Register Settings

The basic setup is the same as that of normal *packet transmission mode* (mode 3 and 4). In the *headerless packet mode*, the following settings should be added.

REG02: Destination Address**Default value: 00H**

Set the address of the modem to transmit data as the *destination address*. Setting to 000 to 239 is available (240 addresses).

This value is padded to the transmission data packet to transmit to the *destination address*.

When *address checking function* (REG18) is valid, set the address of the receiving modem to this register. DAS command can change this *destination address*.

REG03: Operation Mode Setting**Default value: F0H**

Set the operation mode to the *headerless packet transmission mode* (FFH).

REG13: Repeater Address**Default value: 1EH**

When a *repeater* is used, set the *repeater address* to pass through.

REG16: Terminator Setup 1**Default value: 32H**

Set an arbitrary 1 byte *terminator*. In case of a *2-byte terminator*, set the first byte character of the *terminator*.

The command input timeout is fixed to 5 sec.

REG17: Terminator Setup 2**Default value: 32H**

Set another arbitrary 1 byte *terminator*. In case of a *2-byte terminator*, set the last character of the *terminator*.

REG18: Communication Setting 1**[default value: 8CH]**

Bits 7 – 6: Reserved

- The FRH-SD07TU/TB does not use this register. Keep the default value as it is.

Bit 5: Transmission path select

0	transmit directly to destination (default value)
1	transmit indirectly via repeater

Table 7–3: Transmission path selection

- To transmit a packet data through the *repeater*, set the *repeater address* to REG13.

Bit 4 Transmission format

0	transmit in the test form (default value)
1	transmit in the binary form

Table 7–4 Transmission format

- Selects the *transmission format*. When data are transmitted to the *destination station* which is set to the normal *packet transmission mode*, output text format (RXT, RBN) from the receiver modem (*destination station*) differs depend on this setting.
- This setting does not effect in the receiver modem set as *headerless packet transmission mode*.

Bits 3 – 2 Terminator Setting

bit 3	bit 2	setting
0	0	two kinds of arbitrary 1 byte code (REG16, REG17)
0	1	arbitrary 1 byte code (REG16) + a wild card (any character)
1	0	arbitrary 2 byte code (REG16 + REG17)
1	1	carriage return (CR) + line feed (LF) (default value)

Table 7–5 Terminator setting

- Sets the *terminator* to identify the breakpoint of a packet. The modem transmits data considering this character as the breakpoint of a packet.
- In case of using an arbitrary terminator, set it to REG16 and 17.

Bit 1: Source address check

- The same function as the basic function.

Bit 0: Destination address check

- The same function as the basic function.

REG23: Interface Setting 4**[default value: 00H]**

The same function as the basic function, except bit 4.

Bit 4 : CR/LF addition/deletion

0	does not add CR/LF code to the received data (default value)
1	adds CR/LF code to the received data

Table 7–6: Addition of CR/LF code
(setting at the headerless packet transmission mode)

- In the *headerless packet transmission mode*, setting is made whether the CR/LF character is added to the received data or not.
- In the communication between the modems set to the *headerless packet mode*, this setting is invalid because the *terminator* is originally added to the transmit data. However, when a packet is received from the modem in the *normal packet transmission mode*, there is no addition of the CR/LF *terminator*. In this case, set this bit to 1. Then the received packet is output with the CR/LF character is added.
-

0	adds the CR/LF to the received data (default value)
1	does not add the CR/LF to the received data

Table 7–7: Deletion of CR/LF character
(setting at the packet transmission mode)

- In the *packet transmission mode*, setting is made whether the CR/LF character is added to the received data or not.
- At the receiver modem (set to the normal *packet transmission mode*), the sender (set to the *headerless packet transmission mode*) side *terminator* (CR/LF character as default) plus *packet transmission mode terminator* (CR/LF) are output. To avoid such redundant outputs, set this bit of the modem in the normal *packet transmission mode* to 1.

7.2 Direct Transmission Mode

7.2.1 Operation in the direct transmission mode

In the *direct transmission mode*, data are transmitted by sampling the *TxD* pin of the *serial communication connector* at the rate of 51.9 k sample/sec, featuring the less delay time of about 500 us.

Difference from the *packet transmission mode* is, this mode has no functions to identify *addresses* or check *error*. Transmission is simultaneously made to the receiver stations which operating in the same frequency, like a *broadcast transmission*. In the *asynchronous communication*, the rate up to about 19.2 kbps is available.

By setting REG24:bit 5, the modem is able to reduce the time to start data transmission down to 3.5 ms, which is 13.5 ms by the conventional FRH type modems' mode.

NOTE

In this mode, since no data error is checked, *data error* may arise when the radio channel condition is not good. Error correction should be performed with the upper layer application protocol.

NOTE

When the adjacent frequency channels are used in the same area, be noted there is a possibility of interference between the frequencies each other.

NOTE

When plural channels (more than 3 frequencies) are operating in the same area, be noted there is a possibility that the signals interfere each other because the limited performance of the receiver RF circuit.

7.2.2 Transmission in direct transmission mode

The sender modem transmits data with sampling the level of the *TxD* pin at 51.9 kHz (a cycle of 19.25 us) speed. The receiver modem outputs the received data to the *RxD* pin as they are.

Sample on the sender side is performed at the constant period independently to the level change of its *TxD* pin. Accordingly, the level change faster than sampling rate can not be captured and transmitted. Further, on the receiver side, the pulse width will change due to the variation of the sampling rate on the sender side. Therefore, it is recommended to transmit data in the speed which allows its level change is at least several times of the sampling period.

Transmission and receive are controlled by the *control line*. Setting the *RTS* pin to Lo level is to transmission. The starting transmission is detected at the falling edge of *RTS*. Hence, at the reset state, set the *RTS* pin to Hi level to be in reception mode. And after confirming the Lo level of *DSR*, fall down *RTS* and start transmission.

It is possible to change frequencies during operation by using commands.

The *direct transmission mode* features less delay time between the input of the transmit data and the output of the receive data, i.e. about 500 us.

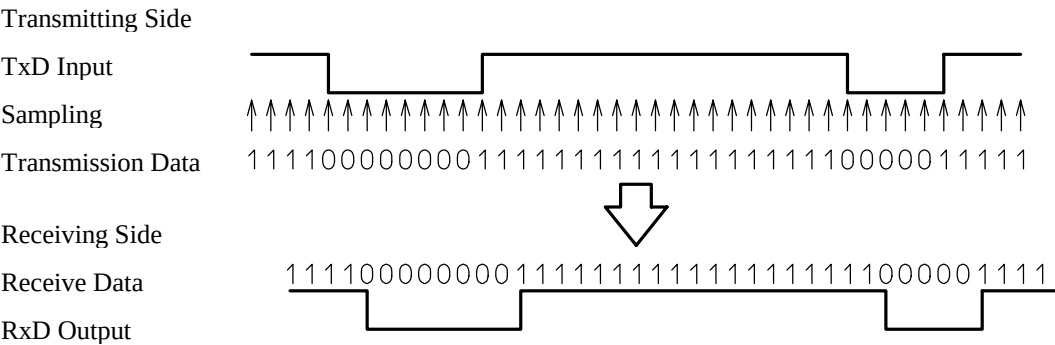


Figure 7–1: Transmission on Direct Transmission Mode

NOTE

If the other end modem is the conventional type, such as FRH-SD03TU, logic level is reverse that of FRH-SD07TU/TB. When FRH-SD07TU/TB transmits [1], the conventional type modem receives [0].

7.2.3 Memory Register Settings

In the *direct transmission mode*, set the following parameters. Keep other parameters as being the factory default values.

REG03: Operation Mode Setting

Default value: F0H

Set the operation mode to the *direct transmission mode* (01H).

REG06: Frequency Setting

Default value: A0H

Set the frequency in operation. It is the same function as the basic function. *Fixed frequency mode* is preferred to use in the *direct transmission mode*.

REG19: Communication Setting 2

[default value: 00H]

Only bit 6 is used. Use other bits than bit 6 as they are default values.

Bit 6: Diversity reception

- The same function as the basic function is valid.

REG20: RS-232C Setting 1

[default value: 05H]

- Set the *communication parameter* to be used to accept command. The same function as the basic function is valid.
- Since *TxD* is sampled at 51.9 kHz, there is no relation between this setting and the actual communication speed.

REG24: Special Mode Settings

[default value: C0H]

Bit 7 – 6: reserved

- The *direct transmission mode* does not use this register. Keep the default value as it is.

Bit 5: Delay time of transmission and reception (direct communication mode)

0	same delay time of the conventional type (13.5 ms, default value)
1	shorter delay time (3.5 ms)

Table 7–8: Setting of delay time of transmission and reception
in the direct communication mode

- Set this parameter to the same value for both modems being communicated. Different settings may cause undefined data output.

Bit 4: : DCD output (direct communication mode)

0	DCD output is the same of the conventional type (default value)
1	DCD output is the synchronous clock

Table 7–9: : Setting of DCD output in the direct communication mode

Bit 3 – 0: reserved

- The *direct transmission mode* does not use this register. Keep the default value as it is.

7.2.4 Function of each terminal pin

Functions of the pin of the *serial communication connector* in the *direct communication mode* are as listed below.

TxD (input) :	Inputs the transmit data.
RxD (output) :	Outputs the receive data.
RTS (input) :	Controls the transmission and reception. Sets to ON (Lo level) to make the modem to transmit.
CTS (output) :	Indicates the modem is ready-to-transmit. When <i>RTS</i> is ON (Lo level), the this pin goes ON (Lo level).
DCD (input) :	Not used.
DCD (output) :	Indicates that the modem is receiving valid data. While data being received, this pin is ON (Lo level)
REG24 :	Sets REG24:bit 4 to output the synchronous clock.
DTR (input) :	Switched the <i>transmission</i> mode to/from the <i>command accept</i> mode. In the normal state, set to ON (Lo level). When issuing a command, set to OFF (Hi level).
DSR (output) :	Indicates that the modem can operate. When initializing completes, after the input of <i>RESET</i> , this pin becomes ON (Lo level).
GND (input) :	Ground signal

7.2.5 Timing

7.2.5.1 Timing chart of transmission and reception

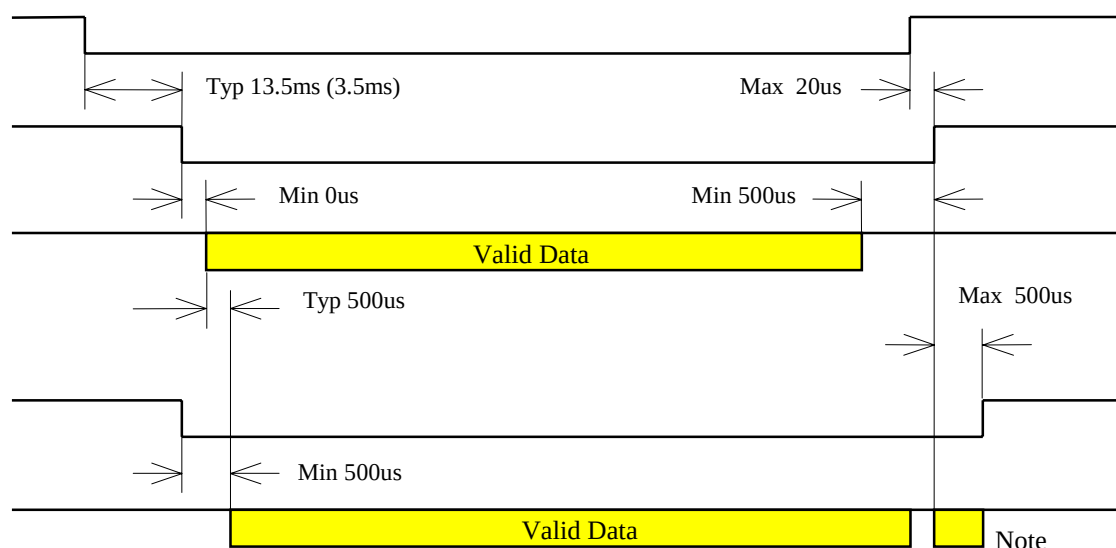


Figure 7–2: Timing chart of transmission and reception

NOTE

In the state where *DCD* (output) is OFF (Hi level, i.e. receiving no data), *RxD* is tied to OFF (High level).

NOTE

DCD (output) may become ON (Lo level) due to incoming noise.

NOTE

At this timing, undefined data may be output.

7.2.5.2 Timing chart of command accept

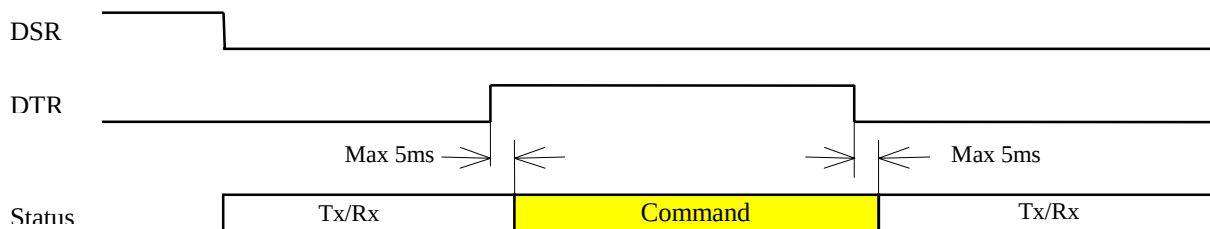


Figure 7–3: Timing chart of command accept

1. After transmitting the *serial ID code*, *DSR* becomes ON (Lo level) and the modem becomes the state of ready-to-transmit (to-accept commands).
2. The *serial ID code* is transmitted after the decision that the channel is vacant by the carrier sensing. When other modem is in transmission continuously on the same channel, the *serial ID code* cannot be transmitted, and *DSR* pin does not go to ON (Lo level) until channel goes vacant. In such a case, *DCD* (output) will stay ON (Lo level) state.
3. Since the transmission time of the *serial ID code* is short, it does not output as the receive data.
4. *Communication parameters* such as the baud rate in the *command accept* state, that follow the setting of REG20.

7.2.5.3 Timing chart of synchronous clock

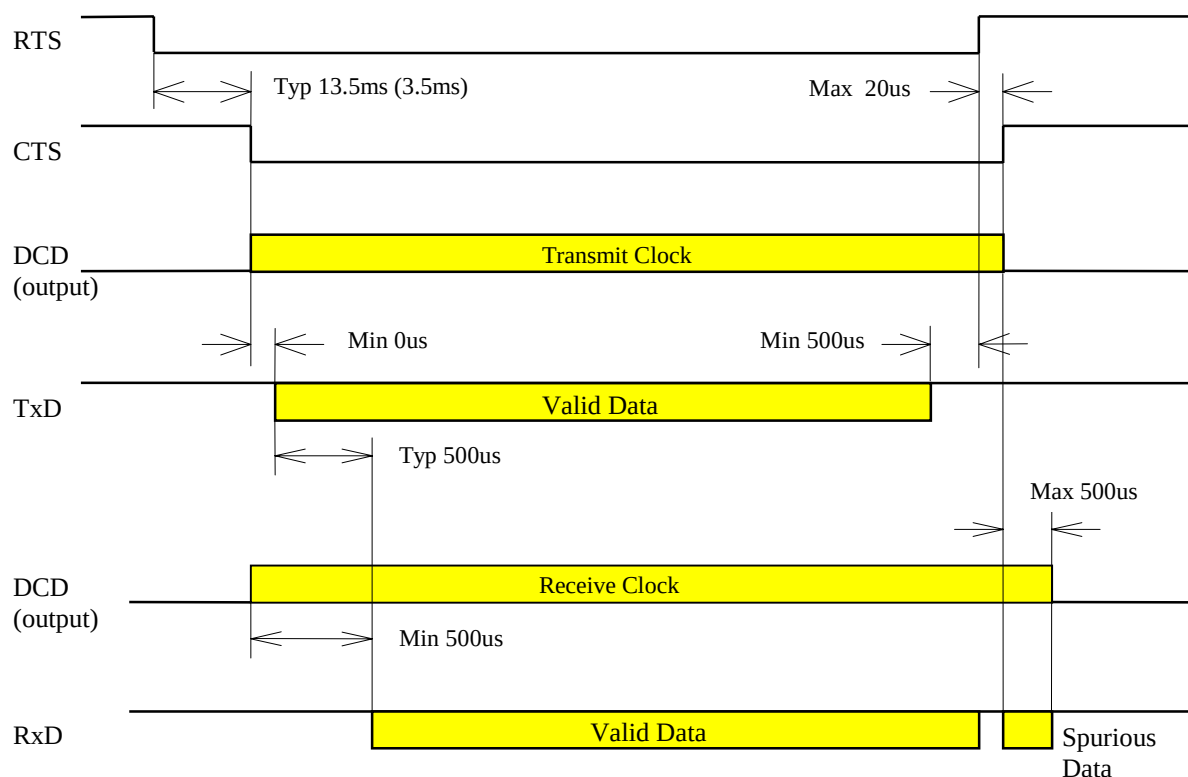


Figure 7-4: timing chart of synchronizing clock

1. On the sender side, after *RTS* goes to ON (Lo level), the *transmission synchronous clock* outputs from *DCD* (output) at the same timing when *CTS* goes to ON (Lo level).
2. On the receiver side, the *reception synchronous clock* outputs from *DCD* (output) after the modem received a valid data. The clock may output due to incoming noise.

Timing of the transmission synchronous clock and data

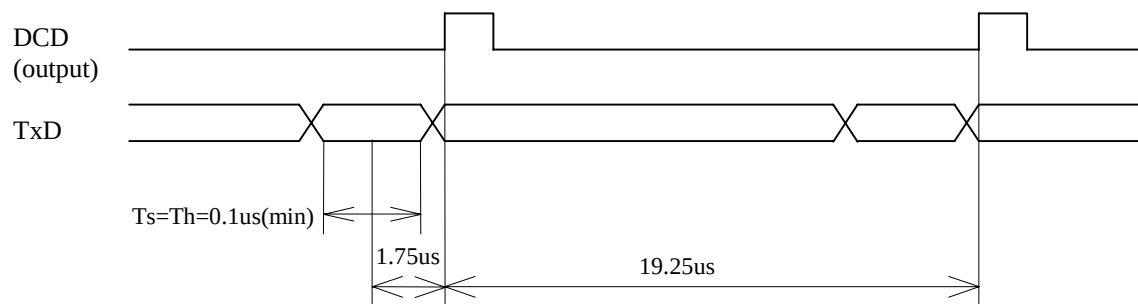


Figure 7-5: Timing of the transmission synchronous clock

TxD is sampled in 1.75 μs before the rising edge of *DCD* (output). Detect the rising edge (or falling edge) of *DCD* (output) to change the *TxD* level. H level duration of the clock in the *DCD* output is 1.75 μs .

Timing of the receive synchronous clock and data

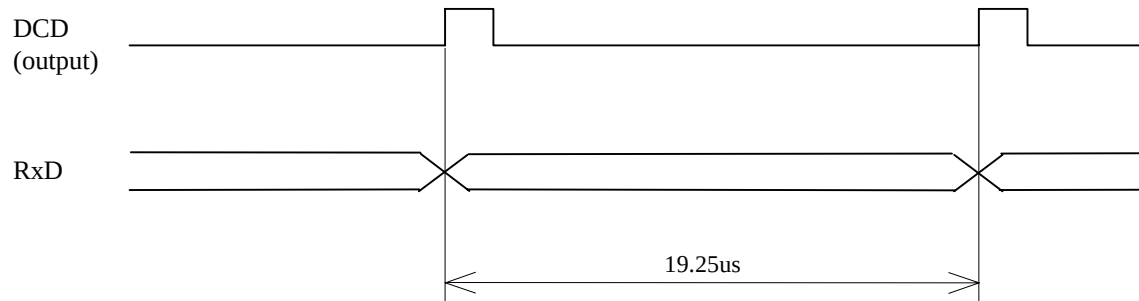


Figure 7–6: Timing of the receive synchronous clock

RxD level changes synchronize with the rising edge of the *DCD* output. H level duration of the clock in the *DCD* output is 875 ns.

7.3 ULTRA Mode

7.3.1 What is ULTRA mode

The *ULTRA (Ultra Low Power Transient Radio Access) mode* is the doze mode. The modem operates in the intermittent receive state at the average current consumption of about 1/20 of the *Active mode*. The *ULTRA mode* is suitable for an application where the modem does not originate transmission but only responds when it receives a call from other station. Even current consumption is as low as 35 mA in the *Active mode*, the *ULTRA mode* consumes only 2 mA (average). Therefore, dramatic extension of the operating duration time is achieved in the battery powered operation. It is particularly effective for portable applications where battery powered.

While the modem is in the *ULTRA mode*, the modem does not receive the *normal packet*, it only receives the, special, *wakeup request packet*.

7.3.2 Operation in ULTRA mode

7.3.2.1 Memory register setup

For to use the *ULTRA mode*, set *memory registers* as follows.

REG25 :	Set bit 7 to 1 (enable <i>ULTRA mode</i>)
REG25 :	Set bit 6, when necessary (1: with <i>control frequency</i> , 0:without <i>control frequency</i>)
REG06 :	Set it, when necessary. (to set the <i>frequency group</i>)

The FRQ command setting gives no effect on the *ULTRA mode* operation. In the *ULTRA mode*, REG06 is referenced for *frequency operation*.

For the *control frequency*, refer to the detailed description on p.141 **CONTROL FREQUENCY**.

Transition to/from ULTRA mode

The *DTR* pin of the communication connector is used to transit to the *ULTRA mode* and return to the *Active mode*. The logic level of the input pin of the FRH-SD07TU/TB is described below. If the RS232 transceiver IC chip is connected, be noted that its logic level inverts from the following description.

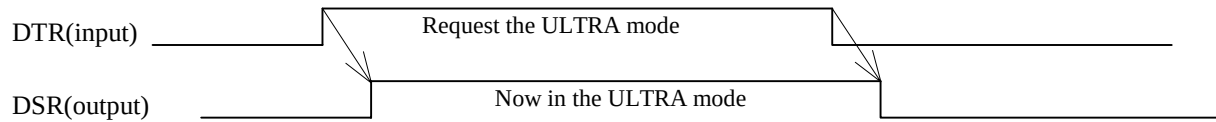


Figure 7–7: Transition to ULTRA mode

To transit to the *ULTRA mode*, set the *DTR* pin to Hi level. The modem detects the rising edge of *DTR* pin and transits to the *ULTRA mode*. For returning to the *Active mode*, set the *DTR* pin to the Lo level.

Since the *DSR* pin is used to monitor the *ULTRA mode* state, it can confirm the completion of both transition to the *ULTRA mode* and returning to the *Active mode*.

It is possible to make the modem in the *ULTRA mode* return to the *Active mode* through the radio link. Details are described in the following sections.

7.3.2.2 Wakeup request packet

The *wakeup request packet* is a special packet to make the designated modem return to the *Active mode* through the radio link.

In the *ULTRA mode*, the modem cannot receive normal packets but only receive the, special, *wakeup request packet*. When receiving the *wakeup request packet*, the modem wakes up and returns to *Active mode* in the following sequence. With upper layer application software, the status of the modem can be monitored using *DSR* pin.

To transit to the *ULTRA mode* again, once set *DTR* pin to Lo level and again set to the Hi level. At the rising edge of *DTR*, the modem transits to the *ULTRA mode*. While the modem is wakeup state and make it to transit to the *ULTRA mode*, it should be performed by the upper layer application software.

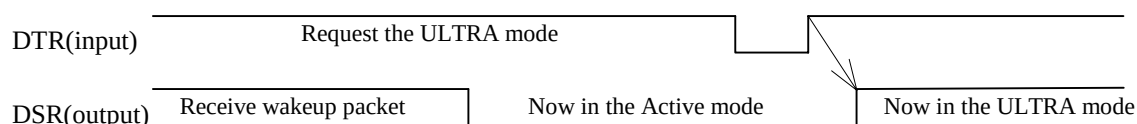


Figure 7–8: Wakeup

7.3.2.3 Operation in wakeup state

During the wakeup state (*Active mode*), the operation of the modem is identical to the normal operation (i.e. the *ULTRA mode* is not set to the *memory register*), and all commands are available for operation.

7.3.2.4 Operation in the ULTRA mode

The modem in the *ULTRA mode* intermittently operates at the period of 150 ms. For 8 ms out of 150 ms, the modem is in activation state, and at the rest of the time it is in the operation-full-stop state including clock signal.

The frequency, when the *control frequency* is used, it is fixed to the lowest of the group. On the other hand, when the *control frequency* is not used, the frequency scans all frequency in the group a dwell time of 150 ms/frequency.

7.3.2.5 Use of ULTRA mode together with shutdown state

The *Shutdown mode* and *ULTRA mode* can be utilized simultaneously. Force the /SHUT pin (Pin 11 of the *serial communication connector*) to the Lo level completely stops the operation of FRH-SD07TU/TB, consuming the least current. When longer time for waking-up is affordable, the current consumption can be more reduced by intermittently goes to the *ULTRA mode* from the *Shutdown mode*, e.g. at a cycle of 1 sec.

Since the *wakeup request packet* cannot be received when the modem is in the *Shutdown mode*, it is necessary to issue the RLU command several times.

Even the modem is during the *Shutdown mode*, the *DSR* pin shows the state of the *ULTRA mode*.

7.3.3 Wakeup command

For these commands, refer to Chapter 6.

7.3.3.1 Direct wakeup : RLU command

Transmit Command

Use the RLU command to wakeup the modem in the *ULTRA mode*.

Command format: @RLU [Destination address]CR/LF

[Destination address] designates the *destination* (which is in the *ULTRA mode*) address (the set value of REG00 of the receiving station in the *ULTRA mode*). *Broadcasting wakeup request packet* (address 255) is also available. When the command is accepted, “P1” response is output and the *wakeup request packet* is transmitted.

Wakeup ACK and response

The modem in the *ULTRA mode*, which received the *wakeup request packet*, always checks destination address regardless of the status of REG19:bit 0. Accordingly, the modem does not wakeup unless addresses correspond to each other.

When the modem receives *wakeup request packet* and being *Active mode*, its modem returns *ACK packet* which inform the modem has been returning to *Active mode*, unless the *Broadcasting wakeup* (destination address: 255) is designated.

The sender modem receives *ACK* from the destination station, it outputs “P0” response following the “P1” response. In case of being unable to wakeup, *ACK* not received, or wrong destination address, “N1” response will output which follows “P1” response. When REG25:bit 7 is set to be the *ULTRA mode enable*, the modem returns *ACK* to the wakeup request packet even the modem is in the wakeup state (*Active mode*). Therefore, “P1” response will output after the “P0” response when the RLU command is issued for the *destination station* in the *Active mode*.

Broadcast wakeup

When 255 is designated to [destination address] field, all receiver station does not return *ACK packet* even these are being waken-up. So, as the command response, “P0” is output always following “P1” output, after the defined *number of retransmission count*. In this case, it is not assured whether the stations returns to the *Active mode* or not. It is recommended to issue TXT command (to attempt communication) and such to the *destination station*, for to confirm whether *ACK packet* is obtained or not from the *destination station*.

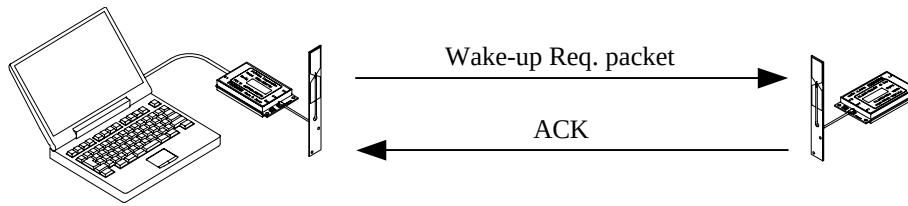


Figure 7–9: Wakeup using RLU command

7.3.3.2 Wakeup through repeater : RLR command

Transmit command

Use the RLR command to wakeup the modem in the *ULTRA mode*, through the *repeater*.

Command format : @RLR[repeater address] [destination address]CR/LF

[repeater address] designates the *repeater* to transmit the *wakeup request*.
 [destination address] designate the station address (the set value of REG00) to be waken-up.
Broadcasting wakeup (address 255) is also available. On accepting this command, the modem returns “P1” *response* and starts transmitting *wakeup transmission request packet* to the *repeater*. And this packet makes the *repeater* to transmit the *wakeup request packet* to the *destination(s)*.

The transmission of wakeup request packet

The sender station transmits the *wakeup transmission request* to the *repeater*, its *request* making the *repeater* to transmit the *wakeup request packet* to the *destination(s)*. The *wakeup transmission request* is repeated to transmit at the cycle of 200 ms by the *retransmission count* designated by REG11 or RNO command.

At the *repeater*, the *destination address checking function* set by REG18:bit 0 is valid. Accordingly, when the function is set to be valid, the *repeater* does not receive the *wakeup transmission request* unless the *repeater* address matches.

When the *repeater* receives the *wakeup transmission request*, it transmits the *wakeup request packet* to the *destination station* designated by [destination address] for 160 ms duration. Though *ACK packet* is returned from the *destination station*, the *repeater* ignores it and does not return *ACK packet* to the sender station. Therefore, even when the single station is designated by the [destination address], the sender station cannot confirm whether the *destination station* wakes-up or not. It is necessary to issue TXR command (to attempt communication) and such to the *destination station*, for to confirm whether *response* is obtained or not from the *destination station*.

Wakeup ACK and response

As described above, no wakeup *ACK* is returned from the *repeater* when the RLR command is issued. To the RLR command, “N1” *response* is always output which follows “P1” *response* except *Broadcasting wakeup*.

Note when the repeater is used

The utilization is the same as that of the normal *repeater* function. But, the *frequency setting* of REG06, should be set the *fixed frequency (Grouping Method H)* mode when the *repeater* is used. In this case, of course, the *control frequency* setting of REG25:bit 6 is invalid.

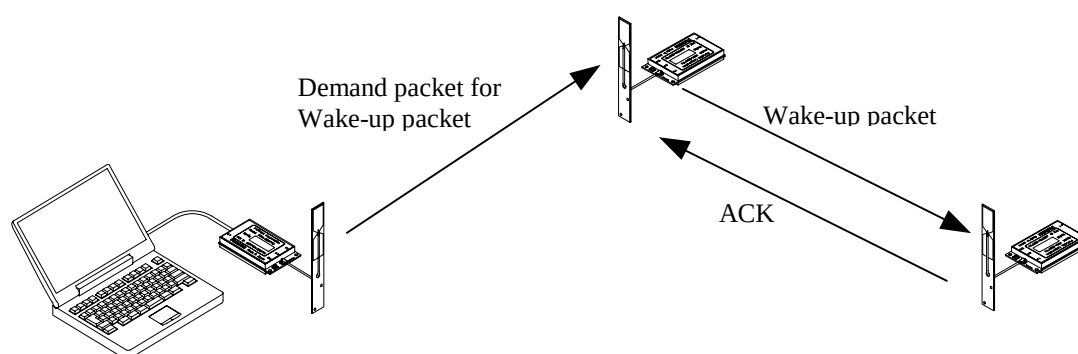


Figure 7–10: Wakeup using RLR command

7.3.4 Control frequency

7.3.4.1 What is the control frequency

When operating at frequencies in the *group mode*, the modem requires longer time to establish the radio link connection because the modem in *ULTRA mode* is in receiving state while changing frequencies. Therefore, to obtain high speed wakeup in the *ULTRA mode*, the system can specify the *control frequency*. When the *control frequency* is designated, the modem is always in the wait-to-receive state on the *control frequency*, which reduces the time to receive the wakeup request packet.

The *control frequency* is set with REG25:bit 6 as follows.

REG25:6 1: *control frequency* designated 0: no *control frequency* designated

7.3.4.2 Control frequency allocation

The *control frequency* is allocated the lowest frequency of the frequency group. As being the exclusive channel for wakeup, the *control frequency* cannot be used in the normal data communication. This means that usable frequencies of the *frequency group* become less by

one. The following explanation is based on the default setting of the *frequency grouping* (REG06 = A0H).

Control frequency	: Frequency No. 0
Communication frequency	: Frequency Nos. 8, 16 (usable frequency for communication becomes 2 from 3)

In the operation using the *fixed frequency (Grouping Method H)*, only one frequency can be used and the setting of the *control frequency* becomes invalid.

7.3.4.3 Extent of control frequency used

When a *frequency group* using more than 4 frequencies is set, the wakeup sequence speed becomes faster if the *control frequency* is set. This is due to the timing to scan the frequency between transmitter and receiver.

7.3.4.4 Transmission count of wakeup request packet

If multiple frequencies are used in the *frequency group mode*, the *wakeup request packet* transmission count on a single frequency is as follows.

- 2 consecutive transmission using the control frequency (320 ms)
- 4 consecutive transmission count without using the control frequency (640 ms)

Using the *control frequency* ends transmission with 2 transmission counts. But without using the *control frequency*, transmission continues for more counts by the number of frequencies of the *frequency group* x 2 with scanning frequencies in the group. For example, when 3 frequencies are used (*Grouping Method F*), transmission is performed up to 24 times ($4 \times 3 \times 2 = 24$) with scanning frequencies. Compared to the mode the *control frequency* is used, the mode without the *control frequency* takes much more time to transmit the wakeup request packet.

Be noted that the *retransmission count* set by REG11 is not applied in the case using frequencies in the *group mode*.

SECTION

8

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8.1 Interface

8.1.1 Pin Assignment

The figure below shows the pin location of the *serial communication connector*, following the DCE (Data Communication Equipment) specification.

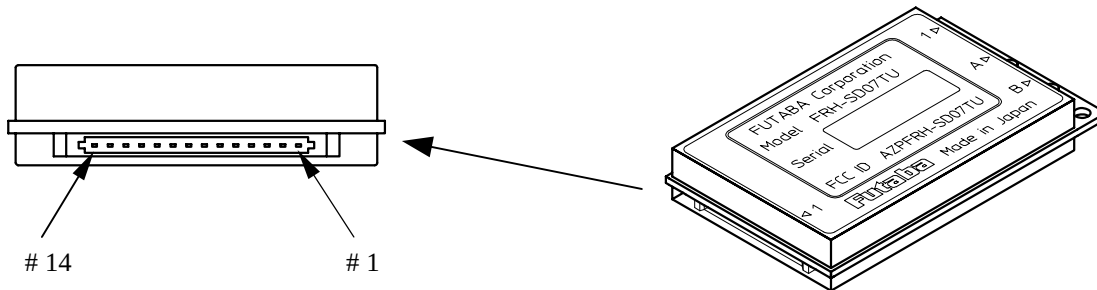


Figure A-1: Serial Communication Connector Location

Pin	Name	Abbreviation	I/O	Function
1	Carrier Detect Out	DCDO	output	carrier detect output
2	Receive Data	RxD	output	received data output (since modem is DCE interface)
3	Transmit Data	TxD	input	transmit data input (since modem is DCE interface)
4	Data Terminal Ready	DTR	input	terminal ready
5	Signal Ground	GND	–	signal ground
6	Data Set Ready	DSR	output	modem ready
7	Request To Send	RTS	input	receive stop/resume request
8	Clear To Send	CTS	output	transmit stop/resume request
9	Carrier Detect In	DCDI	input	ring indicator input
10	Power Supply	VCC	–	2.7V to 3.3V DC
11	Modem Shutdown	/SHUT	input	Shutdown mode. Do not leave this pin OPEN
12	RS485 Enable	485ENB	in/out	RS485bus Tx Enable at 485mode
13	Load Default Parameter	/DefParam	input	Load default parameter when low
14	Reserved	Reserved	–	Reserved

Table A-1: Pin Descriptions

1. The *serial communication connector*'s pin of the modem is defined as the DCE specification, where transmission indicates input and reception indicates output.
2. Pin 12 is for tri-state control for RS485 driver (CMOS - RS485 level converter) which will be externally mounted. When the power is turned on or reset, this pin is configured as an input pin to read the operation mode in the interface. When it is pulled down, the operation becomes the *RS485 mode*, and when it is pulled up (or leave open) the operation becomes the *RS232C mode*. Since this pin becomes to configure the output pin after reading the operation mode at the initialize state, never connect it directly to VCC or GND. This pin is internally pulled up with 470 k ohm.
3. Pin 13 is internally pulled up with 100 k ohm.
4. The input pin tolerates 5 V input (5 V tolerant specification). When the user's system is of 5 V, it is possible to interface with a such system.
5. Pin 11 can be used as the *hardware reset*. Since the input pin is at high impedance, never fail to tie the input level.
6. It is no problem if Pins 12, 13 and 14 are leaved open.
7. Since the interface is CMOS structure circuit, it is recommended to take a remedy against ESD problem (e.g. surge absorber; VRD series, made by Ishizuka Denki).

8.1.2 Interface Electrical Specification

(1) Supply voltage

Absolute maximum rating:	-0.3 V to 4 V
Operation supply voltage:	2.7 V to 3.3 V

(2) Input circuit

Input circuit structure:	CMOS input
Absolute maximum input voltage:	+7V (input circuit is 5V tolerant)
Absolute maximum input voltage (-)	-0.3V
Input voltage of signal 'H':	1 V minimum, 2.3 V maximum
Input voltage of signal 'L':	0.5 V minimum, 1.7 V maximum

* Hysteresis input (Schmidt) for the input circuit.

Input leakage current:	+/-1uA maximum
------------------------	----------------

(3) Output circuit

Output circuit structure:	CMOS output
Output voltage of signal 'H':	supply voltage -0.4 V min. (@1.8 mA)
Input voltage of signal 'L':	0.4 V max. (@1.8mA)
Absolute maximum current:	2 mA

(4) signal specification

Mark:	'H' level
Space:	'L' level

8.1.3 Modem Initialization Time

The time required for the FRH-SD07TU/TB to be able to receive signals from the serial interface (internal initialization time) is described below. After the initialization time completes, feed the signals.

- (1) The internal initialization time after the power supply is about 220 ms.
- (2) The internal initialization time after the *hardware reset (Shutdown mode)* by setting Pin 11 (/SHUT) to Lo level (force this pin with Lo level longer than 1ms), is about 75 ms after returning its level to Hi.

8.1.4 Electrical Static Discharge Remedy

Since the interface of the FRH-SD07TU/TB is connected directly to the CMOS circuit, the connection wiring is expected to be short wires. Therefore, the equipments for connection is expected to be an embedded equipment where is mainly inside of the system.

When very long distance wire communication cable is used, RS422 or RS485 level conversion is recommended.

Additionally, To secure more stable operation, it is recommended to take a remedy against ESD problem (e.g. surge absorber; VRD series, made by Ishizuka Denki).

8.1.5 Connection to PC

Since the interface of the FRH-SD07TU/TB is connected directly to the CMOS circuit, the signal level conversion circuit is required to connect it to the DTE (Data Terminal Equipment) such as PC. For the level conversion circuit, refer to the following section. (The power supply of 2.7 V to 3.3 V for the modem is also needed).

8.1.6 Line Noise Remedy

As being constructed with a highly sensitive RF analog circuit, the FRH-SD07TU/TB is quite susceptible to noises. To secure more stable operation, serially provide the dumping resistor at several 100 ohm to each signal line.

8.1.7 Shutdown Mode/Hardware Reset

Pin 11 of the *serial communication connector* can be used to the *Shutdown mode* or *hardware reset*. Even when the *Shutdown mode* is not used, this pin should be controlled by the terminal equipment to make the modem to reset.

The modem does not get to system hung-up, however for an emergency, *hardware reset* should be controlled to make it possible like a watch dog timer. When no *response* is returned (modem hung-up) within the specified time due to an accidental error, a higher reliable system can be configured.

8.1.8 Power Supply to the Modem

Since FRH-SD07TU/TB contains a very-high-frequency sensitive analog circuit, the modem is susceptible to be affected the variation of the power source and noises from the terminal equipment's digital circuit. Therefore, when embedding the modem in the system, it is necessary to supply power to the modem from the different (independent) power supply IC chip other than those used in the digital circuits.

Also adding the line filter is important. Example is, use series 100 uH (must be enough low ESR; Equivalent Series Register) inductor with shunted 100 uF capacitor. However, this value is depend on user's system environment. Please choice appropriate value for an application.

8.2 Conversion Circuit

Examples of the level conversion circuit are shown as a reference, which is just for the confirmation of system operation. This example does not guarantee the operation under users' actual operation environment.

8.2.1 RS-232C Level Converter

Wire the *control line* when necessary. Tie down unused input pin(s) to GND and leave the 485ENB pin open.

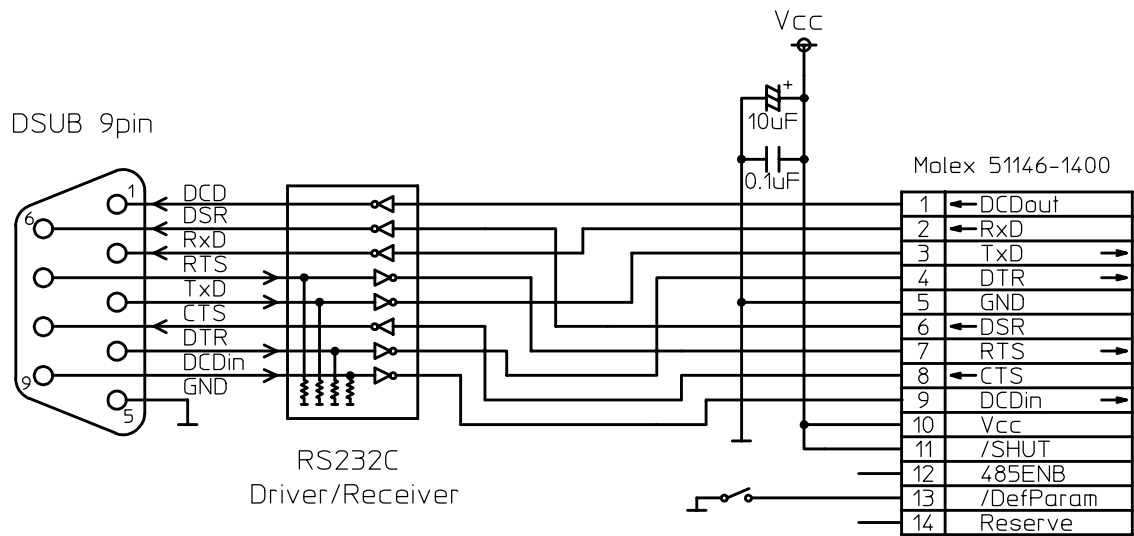


Figure B-1: RS-232C Level Conversion Circuit

8.2.2 RS422 Level Converter

Wire the output terminator (100 ohm) of the RS422 line driver, the input terminator (100 ohm) of the receiver, the input pull-up (1k ohm) and the input pull-down (1k ohm), when necessary.

Provide a surge absorber (e.g. Z2012 made by Ishizuka Denshi) when long RS422 line is used or there is much noisy environment, etc.

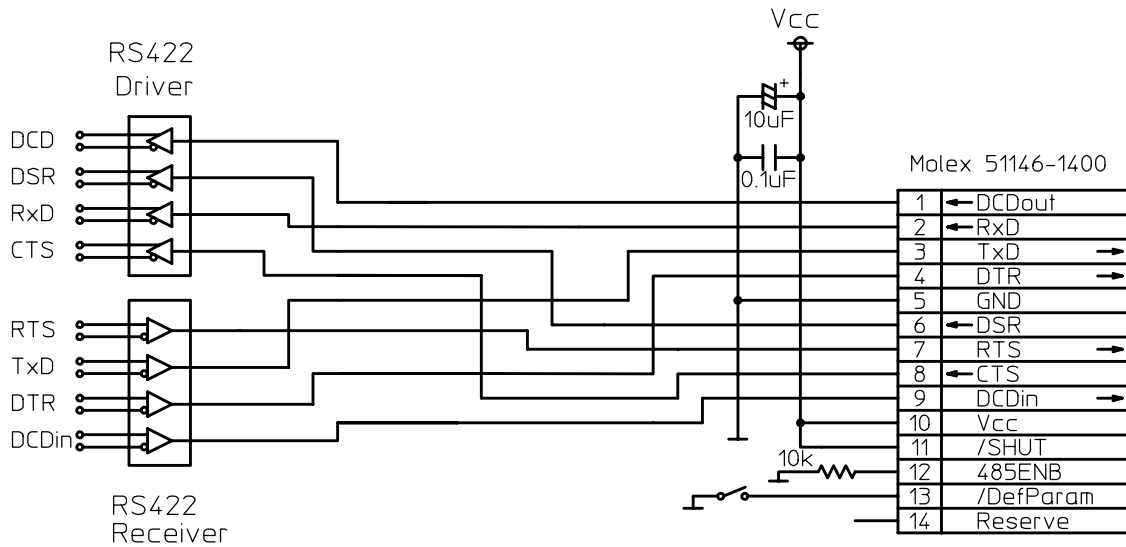


Figure B-2: RS422 Level Conversion Circuit

8.2.3 RS485 Level Converter

Wire the terminator of the RS485 bus (100 ohm), the input pull-up (1k ohm) and the input pull-down (1k ohm), when necessary.

When long RS485 line is used or there is much noise, provide the surge absorber (e.g. Z2012 made by Ishizuka Denshi) according to the situation.

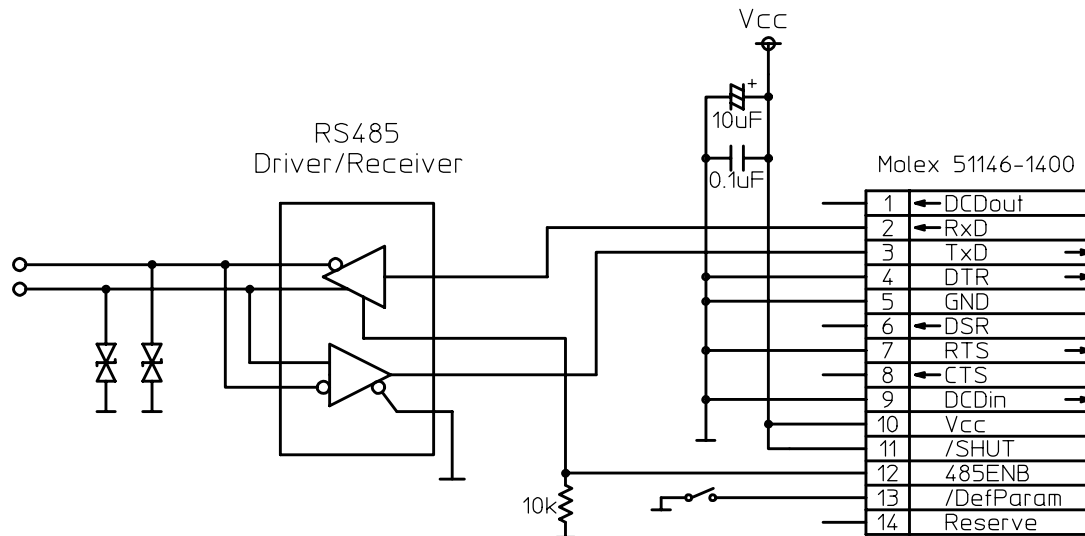


Figure B-3: RS485 Level Conversion Circuit

8.3 Specification of the Connectors

(1) Serial Communication connector

Connector: MOLEX 53780-1490 (14 pins)

Mating Plug: MOLEX 51146-1400

(2) Antenna connector

RF connector: HIROSE U.FL-R-SMT

▲CAUTION

The antenna connector is guaranteed for 30 times of plugging in/out.

▲CAUTION

When plugging out the antenna connector, use the specially prepared tool of E.FL-LP-N, provided by HIROSE (HIROSE Product No. CL331-0441-9).

8.4 Auxiliary Interface

8.4.1 What is Auxiliary Interface

A via-hole for a 5-pin connector for auxiliary functions is available, which you can use according to the user's requirement. Pin 3 to 5 can be used to monitor the internal status using the 3-wire serial communication. Board-in connector which can be inserted into the via-hole is listed below.

For electric specification, see p.145 **INTERFACE ELECTRIC SPECIFICATION**.

Connector : MOLEX 51022-0500 (5 pins) terminal used: 50061 (Board-in type)

Pin	Name	Function
1	/TxOn	'L' at transmission
2	Div/-Main	Selects the receiving antenna, 'H' on the diversity side.
3	Status-Data	Outputs the serial data to monitor the internal status.
4	Status-Clock	Outputs the serial clock to monitor the internal status.
5	Status-Load	Output the serial load-enable to monitor the internal status.

Table C–1: Auxiliary Interface Pin Descriptions

8.4.2 Serial Communication Setting

The clock rate of the serial signal output from the AUX interface can be changed with the *memory register*, REG27:bit 5 and 4. The serial signal is not output by the default setting. the status monitor circuit operates at the clock rate set by *memory register* and the serial-clock of the AUX interface pin 4 is output at a half of the set rate.

Among monitoring status, there are high-speed one-shot signals. Which require high speed serial-clock to sufficiently sample and output the status. Since higher clock rate results higher current consumption, its rate can be controlled by the following parameters. To realize the operation at lowest current consumption, use the default parameter which does not output any serial clock.

REG 27		Setting
Bit 5	Bit 4	
0	0	No clock output (default)
0	1	100 KHz
1	0	1.14 MHz
1	1	8 MHz

Table C–2: Clock rate of status monitor circuit

8.4.3 Output Format

Signals are output in the following format.

One frame consists of 12 bits. The first 4 bits indicates which data frame is output from the status monitor circuit (frame address), and the following 8 bits are the actual status signal. Frames are repeatedly output from Address 0 to 4. Both the frame address and status signal are the MSB first output.

As shown in the next paragraph of **OUTPUT TIMING**, these data are the clock synchronous serial output, which is latched by rising edge of the *LOAD* signal at the end of each frame.

First bit												Last bit
A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	
Frame Address (4bits)				Status signal bits (8bits)								

Figure C–1: Output Format

8.4.4 Output Timing

Signals are output in the following timing, where T_c represents the clock rate set by REG27. *DATA* line will be latched at the rising edge of *CLOCK* line, and 1 frame will be captured by the rising edge of *LOAD* line.

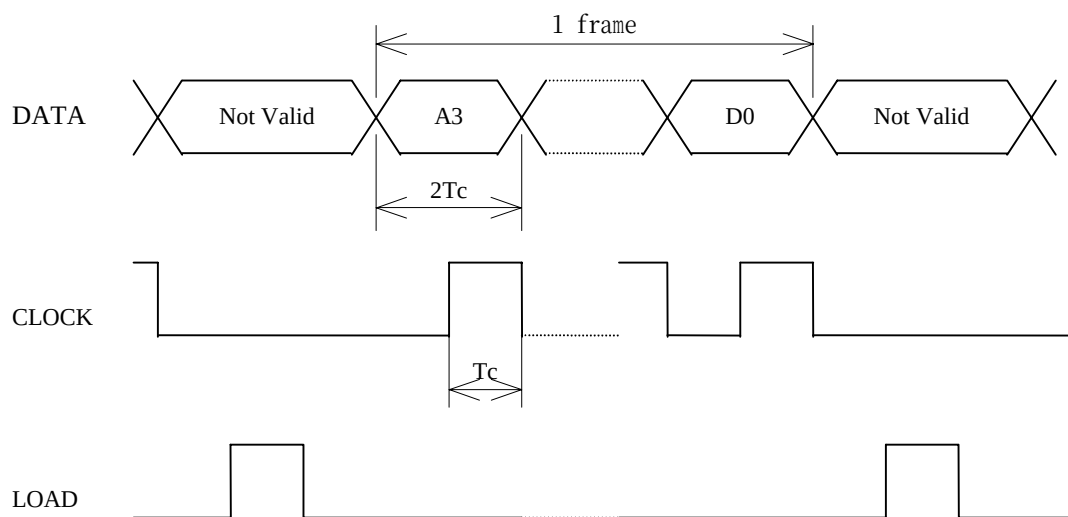


Figure C-2: Output Timing

8.4.5 Output Status Data

The status data having the following contents are output.

		Frame address	Status signal bit number		
		Signal name	Contents	Note	
0	D7	CorrelationDetect	Hi while correlation is detecting		
	D6	FrameSyncDetect	Hi when frame-sync is detected, Lo when correlation is lost		
	D5	TransparentLinkEstablished	Not used		
	D4	OperateInUltraMode	Hi while operating in ULTRA mode		
	D3	FreqChangeExecuting	Hi while frequency is changing		
	D2	OperatingTransmissionCommand	Hi while transmission command is executing		
	D1	TrxCtrlSeqIsPacketIdle	Hi while no TX/RX operation is executing		
	D0	SystemErrorState	Hi when system error occurred		
1	D7	ReceiveSuccess	Hi when receive success	ONE	
	D6	ReceiveMyAckSuccess	Hi when ACK receive success	ONE	
	D5	Receive1packetError	Hi when received but error occurred	ONE	
	D4	DetectJabberPacket	Hi while wakeup packet is receiving		
	D3	TransmissionSequenceResultCode(2)	Refer to note[1]		
	D2	TransmissionSequenceResultCode(1)			
	D1	TransmissionSequenceResultCode(0)			
	D0	0			
2	D7	RxBuflerFull	Hi while the receive buffer is full		
	D6	RxBuflerDataExist	Hi while a data is existing in the receive buffer		
	D5	TxBuflerFull	Hi while the transmission buffer is full (mode 7)		
	D4	TxBuflerDataExist	Hi while operating in mode 7		
	D3	TxBuflerOverflow	Hi while the transmission buffer is overflowing (mode 7)		
	D2	TxDaExistInTransAndFdaHdrless	Hi while a data is existing in the transmission buffer		
	D1-0	0			
3	D7	RxDteDataOutputEnable	Hi while the serial port is enabled to output		
	D6	RadioDataReceiveEnable	Hi while the radio is enabled to receive		
	D5	RsReceivedDataReceptionEnable	Hi while the serial port is enabled to receive		
	D4	OperatingFreqChannelRegister(4)	Frequency channel number in operating (0~23)		
	D3	OperatingFreqChannelRegister(3)			
	D2	OperatingFreqChannelRegister(2)			
	D1	OperatingFreqChannelRegister(1)			
	D0	OperatingFreqChannelRegister(0)			
4	D7-5	0	Reserved		
	D4	TopOperationState(4)			
	D3	TopOperationState(3)			
	D2	TopOperationState(2)			
	D1	TopOperationState(1)			
	D0	TopOperationState(0)			

Table C-3: Status Data

Note [1] Transmission Sequence Result Code (2-0)

Indicates the result of the transmit commands, e.g. TBR and TXT, which last executed.

Bit2: 'H' when packet reaches to the *repeater* by the transmit commands passing through the *repeater*.

Bit1,0 are as shown below.

- 00 Packet reaches the *receiver station*.
- 01 No ACK is returned from the *receiver station*.
- 10 The *receiver station* is in the receive prohibited status.
- 11 The *receiver station's* receive buffer is full.

“ONE” in the note indicates the one-shot signal of 20 usec.

8.4.6 Example Circuit Schematic to Receive internal Status

The following schematic shows a circuit which can receive the status serial signal. Addresses to read-out are selected with the switches and the internal status are displayed with LED.

CAUTION

The location of the connector in the following schematic is different from that of the AUX interface of the FRH-SD07TU/TB. Be noted that these pin numbers represent in the schematic are on the sample circuit board (includes the power terminal).



8.5 Preventing Undesired Radio Connection

Futaba recommend user to set unique ID code to prevent unexpected interference (jamming) between individual FRH systems working in the same area.

8.5.1 What is Interfere Problem

The “Interference” described here is

8.5.2 What is ID Code

ID code is 16 bit word set by REG04 and REG05. The FRH series radio transmits data with code-scramble. Scramble data is made by the seed using this ID code. On the receiver side, de-scramble is performed to restore original data using the same ID code (set on the receiver side *memory register*) as the seed. Therefore, communication can not be established if both sender and receiver modems do not set an identical ID code.

By setting this ID code, the interference problem can be decreased. But because of the FRH modem employs carrier sense function, the function that the modem can not start transmission during carrier is sensing (where other FRH modem station is in transmission) is not affected by this ID code setting. Please do not misunderstand the purpose of this ID code interference measure.

8.5.3 ID Code Setting

ID code can be defined by users. FRH-SD07TU/TB modem can set from 0000H to EFFFH 16 bit code, set by upper 8 bit to REG05 and lower 8 bit to REG04. This 16 bit value should be choose as random as possible, to make good performance for this interference problem.

However, still there has a possibility that the other system using same ID exists nearby, this countermeasure can not to be perfect such a situation. Please understand this measure is for to decrease the interference problem.

It is important to set “random” value for ID code. But if to obtain the value is difficult to image, use below equations to define the ID code for you. Use the product serial number which randomly selected from your FRH-SD07TU/TB modems you own.

Product serial number is 9 digits; divide these as [AA][BB][C][DDD][E].

$$\text{REG05} = \{[(\text{AA} \bmod 10) + 11] \times \text{BB}\} - 1$$

$$\text{REG04} = \text{DDD} \bmod 256$$

MOD is the modulo operator.

[Example]

If product serial number is 020809468, AA=2, BB=8, DDD=946. Therefore,

$$\text{REG05} = \{[(2 \bmod 10) + 11] \times 8\} - 1 = 103 \quad \rightarrow \quad 67\text{H}$$

$$\text{REG06} = 946 \bmod 256 = 178 \quad \rightarrow \quad \text{B2H}$$

8.6 OPERATION IMPORTANT NOTICE

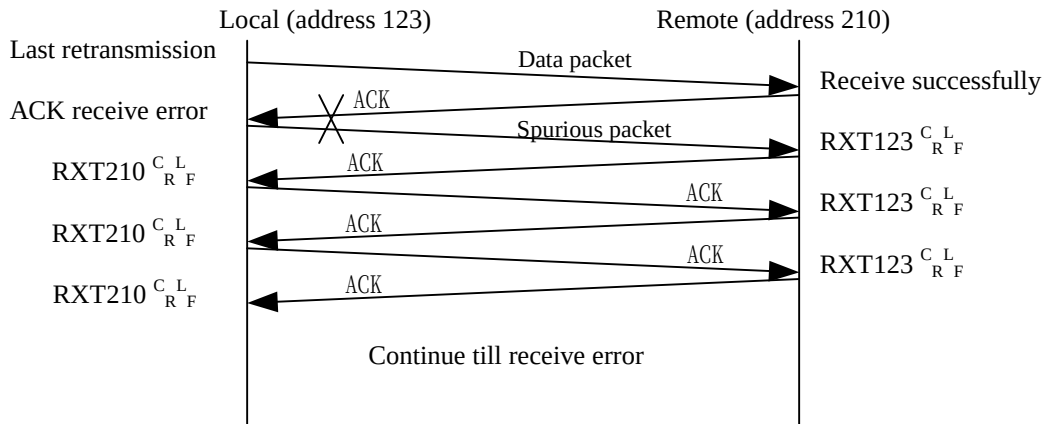
Problems were found in the current version of FRH-SD07TU/TB (Version 1.00). Before using this product, refer to the preventive measures described below.

8.6.1 Problem 1 (Spurious Packet Transmission)

8.6.1.1 Problem Description

At the final retransmission, when the sender modem transmits final packets due to transmit error, *ACK packet* reception is started but its reception was failed, rarely the sender modem which received *ACK packet* starts the repetitive “*spurious packet*” transmission. This *spurious packet* format is same as that of *ACK packet*. In the receiver (remote) modem, this *spurious packet* is recognized as the *normal packet* and starts receiving. And from remote modem, it returns *ACK* to the sender modem. Again sender modem recognize this *ACK packet* as a *normal packet* and returns *ACK* to the remote modem.

This sequence repeats until radio communication becomes error or next transmission command (such as TXT or TBN) is issued. This problem tends to occurs in a *retransmission count* is set to 0.



When this problem occurs, both sender and remote modem repetitively output vacant packet data (only header information) to the both terminal equipment.

[Example]

@TXT000AAA CR/LF

N1 CR/LF

RXT012 CR/LF (*Spurious packet*)

The probability of this problem occurs, it becomes large, when the *retransmission count* (which set by RNO command or REG11) is set to small.

8.6.1.2 Preventive countermeasure

If terminal equipment (or upper layer software) detects the *spurious packet* (header information only), then discard this packet, and issue RST command or force /SHUT pin (11pin) of the *serial communication connector* to low. The operation results modem to reset. Once either side modem is being reset, this repetitive *spurious packet* stops and the modem returns to normal operation mode.

8.6.2 Problem 2 (Transmission Command Error)

8.6.2.1 Its problem description

In the mode 3 and 5 (*packet transmission mode* and *headerless packet transmission mode*), when the TBN, TBR, TXR and TXT commands (*or headerless transmission command*) are issued, wrong data are output to the receiver modem's terminal equipment under the following condition.

As shown in the example, when the transmit command becomes error, the *command error* response is returned.

[Example 1]

@TXT000AAAAAAAAA.....AAA
(excessive bytes due to the input maximum of 256 byte)

N0 CR/LF

[Example 2]

@TXT000ABCDE (becomes 'time out' at this point)

N0 CR/LF

If the next transmit command is issued at this stage and this command is successfully accepted and performed, the wrong data (the contents of the last transmission-command data) are send as the radio packet and output to the receiver end terminal equipment. The contents of the "accepted, the next" transmission command data will not be transmitted. (Refer the following example.)

@TXT000ABCDE (becomes 'time out' at this point)

N0 CR/LF

@TXT000KLMN CR/LF

P1 CR/LF

P0 CR/LF

@RXT000ABCD CR/LF (KLMN will be output.)

8.6.2.2 Preventive countermeasure

In the normal case, these problems will not arise because packets are assembled by the upper layer software in the micro processor of the user system. To secure the operation, take the preventive measure as described below.

If the transmit command causes *command error* and “N0” *response* is returned, initialize the transmit command with the RST command.

@TXT000ABCDE (becomes ‘time out’ at this point)

N0 CR/LF

@RST CR/LF

P0 CR/LF

This measure cannot be used in the *headerless packet transmission mode* (mode 5), because no “N0” *response* is output.

8.7 Q & A

Q: Can the modem be used in factories and other “radio unfriendly” environments?

A: Because electric discharge tools, inverters, and similar machines do not generate much noise in the 2.4 GHz band, the modem can generally be used without problems in these environments. Problematic noise sources are microwave ovens and other wireless equipment that operate on the same frequencies as the modem. Install the modems as far away as possible from RF noise sources. If possible, avoid using the interfering equipment at the same time the modems will be in use.

Q: I want to use the modem for machine control. Are there any precautions that require consideration?

A: In normal wireless communication, the modems check each received data packet for errors and request packet retransmission if an error is detected. And also there occurs no data error in the normal use. However, there is still a possibility of causing some troubles which interfere communication when RF channel is used. It is necessary to design your system to keep your machine out of such a communication trouble.

Q: Frequencies in the 2.4 GHz band are especially susceptible to multipath fading. What are possible remedies for this?

A: Spatial and frequency diversity are two effective multipath remedies. By connecting the receiving antenna to the diversity antenna terminal B for FRH-SD07TU/TB, diversity reception is possible.

Because the modem can use 24 frequency channels, frequency diversity is also possible by setting up an appropriate *frequency grouping method* and allowing the modem to automatically search and select clear frequencies.

Q: My terminal software is set correctly, but I cannot successfully communicate over the wire link. What’s wrong?

A: Several conditions can cause this. Check each of the following symptoms and correct as described.

1. “N0” *response* is immediately returned when entering a command.
This indicates a *command error* and could be related to typing error or entering commands in lower case. Make sure commands are entered using capital characters and with syntax exactly as shown in the manual.
2. “N0” *response* is returned after about 5 seconds.
This can be caused by not sending a carriage return *and* line feed together as the command terminator (CR/LF).
This may also occur if the terminal software’s data length and modem’s data length settings are different. Verify the settings and try again.

3. Partial loss of characters on the terminal screen.
Check the terminal equipment communication speed and make sure that it is set to the same setting as the modem.

Q: Multiple slave modems are being used in *packet transmission mode*, but ACK packets are not being returned. Why?

A: If the *destination address checking function* is disabled (REG18:bit 0), the *ACK packet* being returned from multiple slave modems are interfering with each other. Enable the *destination address check function* using this *memory register*.

Q: The modem is being used in *packet transmission mode* and transmission failures are being returned (response N1). How can I correct this?

A: Verify that the master and slave modems are using the same *frequency grouping method*. The higher the number of frequencies per group, the more time it will take for the modems to connect because transmit and receive modes must scan the frequencies in the group until they align on one frequency. Try the following:

1. Increase the *retransmission count* (REG11).
2. Operate the modems in the *fixed frequency mode (Grouping Method H)*.
If it is possible in the application (little or no RF interference), it is recommended that the modems be operated in *fixed frequency* mode to shorten communication times.

Q: The transmitting modem outputs a transmission failed response (N1), but data was received normally at the receiving modem. Why?

A: The *ACK packet* sent by the receiving modem was not be received by the transmitting modem for some reason. Refer to the section in p.30 **PRECAUTIONS IN PACKET TRANSMISSION MODE**.

Possible solutions are:

1. Increase the *retransmission count* (REG11).
2. Enable *antenna diversity reception function*.

8.8 Troubleshooting

Refer to the following table for troubleshooting other problems.

Phenomenon	Check	Disposition
Can't establish wireless connection	Is the Antenna connector connected firmly?	Connect the antenna connector
	Is there any microwave oven or other SS radio around the modem?	Keep modem distant from obstacle
	Is the distance between two modems too far?	Reduce the distance till wireless connection is made
	Is the frequency of all modems matched together?	Let REG06 the same setting
Can't communicate with terminal	Is the communication cable connected firmly?	Connect the communication cable
	Are the communication settings (i.e. baud rate, parity bit) matched together?	Let the communication settings match together

Table 8–1: Troubleshooting

8.9 Specification

8.9.1 Radio Characteristics

Engineering standard	FCC Part 15.247, ETS 300 440 approved (no user license required)
RF power output	5mW/MHz max.
Modulation	Direct sequence spread spectrum
Communication scheme	Single communication
Frequency band	2420.0 to 2479.0 MHz
Frequency channel	54 channels (27 channels available for simultaneous communication in one area)
Channel management	Fixed mode or group mode Fixed mode: communication by fixing 1 arbitrary frequency from 54 freq. Group mode: multi-access within a group of plural frequencies
Data barer rate	51.9 kbps
Oscillation	PLL synthesizer
Antenna diversity	2 branch reception diversity
Service area	In an indoor environment: 60m radius, depending on the environment In an outdoor environment: more than 300m (line-of-sight)
RF connector	Hirose U.FL-R-SMT
In/out of connector	30 times max. using E.FL-LP-N extractor (for exclusive use)

8.9.2 Communication Control

Radio link control	Command control
Error checking	CRC-CCITT (16 bit)
Error handling	ARQ (Automatic Retransmission Request)
Multi-access function	Connect on clearest channel from selected frequency group

8.9.3 Data Terminal Interface

Physical interface	Molex 53780-1400 (14 pins) Mating connector: 51146-1400
Interface specification	Serial communication Input CMOS level (5V tolerant with hysteresis) Output CMOS level
Communication	Full-duplex or half-duplex system
Synchronization	Asynchronous
Transmit/receive buffer	Approx. 3 k bytes in total
Baud rate	300 / 600 / 1200 / 2400 / 4800 / 9600 / 19200 / 38400 / 50000 / 62500 / 83333 / 100000 / 57600 / 115200 bps
Flow control	Hardware flow
Data length	7 or 8 bit
Stop bit	1 or 2 bit
Parity	Even, odd, or none

8.9.4 Power Supplying

Supply voltage	2.7 to 3.3Vdc
Current consumption	35 mA or less in the active mode 5 mA or less in the RF stop mode 2 mA in average in the ULTRA mode 70uA or less in the shutdown mode

8.9.5 Environmental

Operating temperature	-20 to +50 °C
Storage temperature	-20 to +60 °C
Operating humidity	90%RH max. (no condensation)
Storage humidity	90%RH max. (no condensation)
Vibration resistance	JIS-C-0040 (50m/s ² , 10 to 150 Hz, 15 cycles)
Shock resistance	JIS-C-0041 (500m/s ²) (JIS specification is Japanese Industry Standard)

8.9.6 Miscellaneous

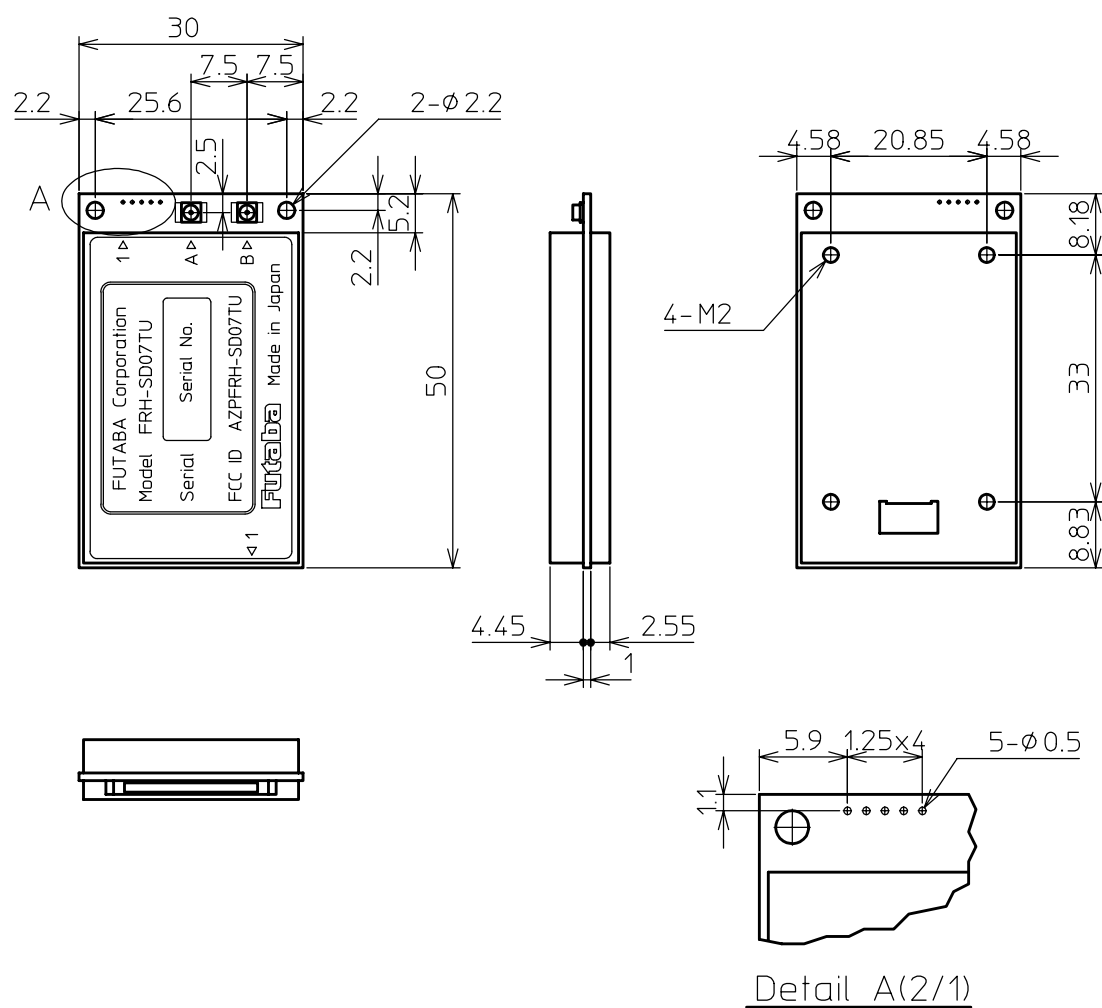
AUX terminal	Outputs the transmission status, diversity status and internal status applicable connector: MOLEX 51022-055 (5 pins), terminal used: 50061
Memory register	Rewritable times: approx. 1 million times
Case	Ni plated copper plate
Outer dimensions	30 (W) × 50 (D) × 8 (H) mm
Weight	Aprox. 14g

† Operating distances depend on the conditions such as obstructions and electrical interference. Under ideal, line-of-sight conditions, reliable operating distances greater than specified may be achieved. Optional, directional antennas can significantly increase the operating range.

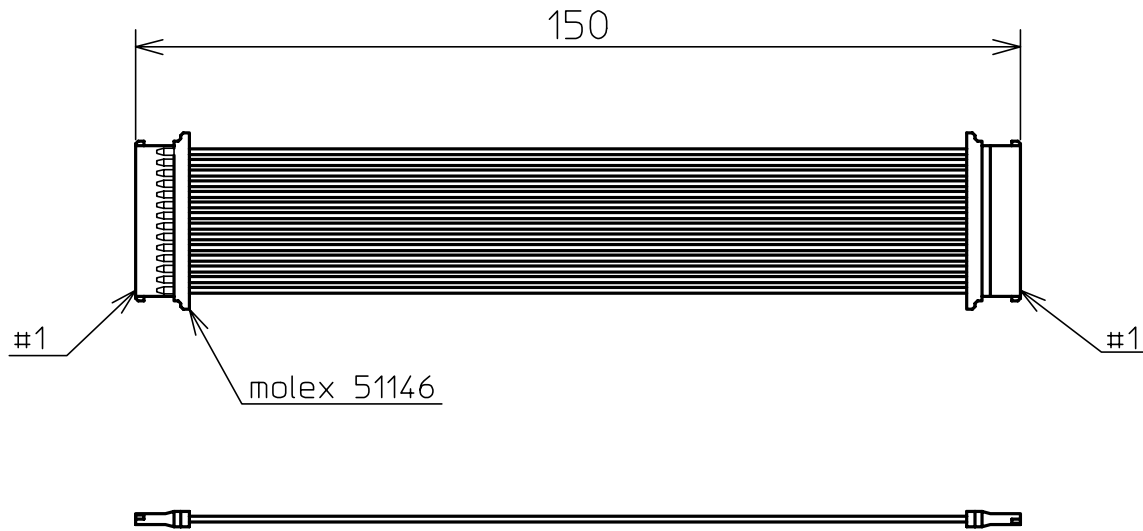
* Specifications and appearance are subject to change without prior notice.

8.10 Dimensions

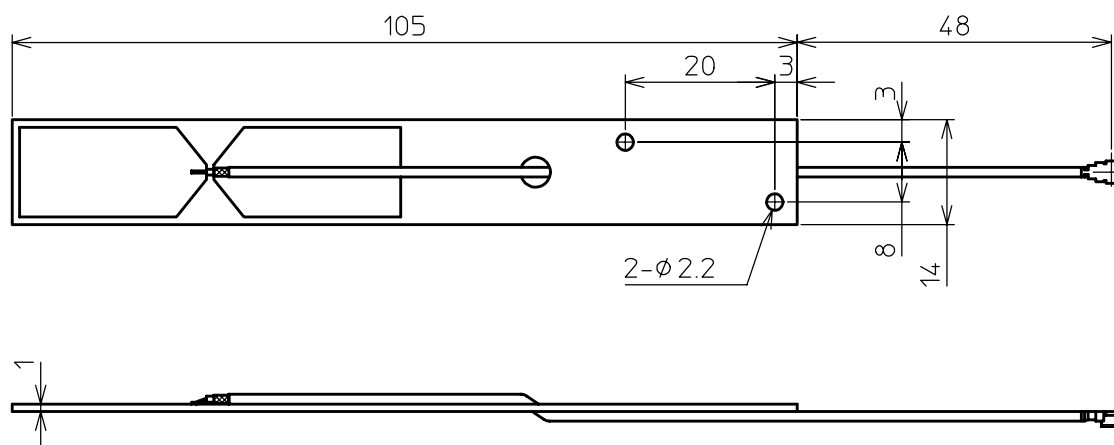
8.10.1 FRH-SD07TU/TB



8.10.2 Communication Cable



8.10.3 Flat Printed Antenna



8.11 Glossary of Terms

1:1, 1:n, n:m

Ratios indicating communication topology node architecture. The ratio 1:1 indicates a system with only two nodes communicating with each other. The ratio 1:n indicates a system with one “master” node communicating with a variable number of “slave” nodes (also referred to as point-to-multipoint). The ratio n:m indicates a variable number of nodes communicating with a variable number of other nodes.

ACK/NAK

In the *packet transmission mode*, a specific response is sent to the transmitting modem to confirm the successful receipt of data, which is called *ACK*. In the transmission through the *repeater*, the *repeater* sent a specific response to the transmitting modem to convey that no *ACK* is returned from the destination modem by the *repeater*, which is called *NAK*.

Antenna Diversity

A method commonly employed to improve the signal strength of received signals. This method uses two independent antennas that receive signals differing in phase and amplitude resulting a difference in the two antenna positions. Either the two signals are summed or the strongest is accepted.

ARQ, or Automatic Retransmission Request

The method of checking transmitted data, used on virtually all high-speed data communications systems. The sender encodes an error-detection field based on the contents of the message and the receiver recalculates the field and compares it with the one it received. If they match, an “*ACK*” (acknowledgement) is transmitted to the sender. If they do not match, in some case, a “*NAK*” (negative acknowledgment) is returned and the sender retransmits the message.

Asynchronous Communication

In this operation, the transmitting and receiving modems confirm the start and end of 1-byte data with the signal level (start bit and stop bit). As being simpler than the synchronous system which requires to send the clock signal in addition to data, this system is widely prevailing as the communication system of PCs. RS-232C interface is originally the standard of the electric signal level, but actually it is called as the asynchronous operation.

Bit

A contraction of the term “*binary data*”. A bit is the smallest unit of digital information and is typically represented by a zero or one.

bps, or bits per second

The number of bits transferred per second.

Break Signal

One of a signal control signal. The data line (*TxD/RxD*) remains in the “Lo” state for more than 1 byte (may be for several 100 ms). When data are sent in the

asynchronous communication, a start bit and a stop bit are attached to separate a byte data. For example, even if the data is “11111111”, there are the “Hi” state and the “Lo” state for each byte. However, the break signal keeps the “Lo” state for more than 1 byte (generally, for more than 3 bytes).

In the Modes 1 and 2 (in other FRH series employs), the break signal can be used as the *command header*.

Byte

Originally from the expression “by eights” it represented a group of 8 bits. Today a byte still represents a set of bits but of lengths specific to the computer or device being used and can vary from 4 to 16 bits or more. Common byte lengths are from 7 to 12 bits.

Carrier sensing

In the *packet transmission mode*, frequencies are checked before transmission to prevent the coincident transmission caused by multiple modems communicating in the contention mode. This type of checking is called *carrier sensing*. As the generally used term, *carrier sensing* means to check frequencies whether radio wave exists or not. But with FRH-SD07TU/TB, *carrier sensing* function is enabled by the *correlation sensing*, which is the specific feature of spread spectrum communication.

Command connection mode

This is one of the connection methods in the data transparent mode, the transmitting modem designates the receiving address with the command to request connection. After receiving the response from the receiving modem, the communication link is established. Disconnection is also enabled by command. Communication switching among multiple modems is possible.

Constant Connection Mode

In *Constant Connection Mode*, two FRH modems maintain a constant wireless link whether or not regular data packets are being transmitted. *Also see Automatic Connection Mode.*

CTS, or Clear To Send

In a standard RS-232C interface, this is an output for DTE devices and an input for DCE devices. This signal is typically used to control flow from the DTE to the DCE device.

Data Transparent Mode

Operation in which digital transmission between terminal equipments occurs without the user or equipment being aware of any special intermediate processing or equipment. This mode allows easy installation and compatibility of the FRH with many systems and with no special hardware or software requirements. Data packets are automatically assembled, transmitted and received without the need for specific commands as are used in *packet transmission mode*. Also see p.18 **PACKET TRANSMISSION MODE**.

dB, or Decibel

A unit of measure for the power or strength of a signal. Given as the ratio of two signal levels.

dBi

A decibel unit for measuring antenna gain. A unit of measurement of the gain relative to an isotropic antenna, or one that radiates equal power in all directions.

dBm

Abbreviation for *decibels above 1 mW*, a unit for specifying input signal power – 1.0 mW across 600 ohms, or 0.775 V RMS (root mean square).

DCD, or Data Carrier Detect

In a standard RS-232C interface, this is an input for DTE devices and an output for DCE devices. It indicates that the local DCE is receiving a carrier signal from the remote DCE.

DCE, or Data Communications Equipment

A device that typically provides the interface between the DTE (Data Terminal Equipment) and a network or another communication node. Examples of DCE devices include modems, network interface cards, and routers.

Direct Sequence

A form of modulation (commonly used in spread spectrum communications) wherein a code sequence is used to directly modulate a carrier, usually by phase-shift keying. The FRH-SD07TU/TB is a Direct Sequence Spread Spectrum system. *Also see Frequency Hopping and Spread Spectrum.*

DSR, or Data Set Ready

In a standard RS-232C interface, this is an output for DTE devices and an input for DCE devices.

DTE, or Data Terminal Equipment

A PC, PLC, printer or other device that provides and accepts digital signals. Connects to DCE devices (modem, network card, etc.).

DTR, or Data Terminal Ready

In a standard RS-232C interface, this is an output for DTE devices and an input for DCE devices. It indicates that the DTE is powered on and ready to communicate. It can also be used for hardware flow control.

Extended receiving function

In case of the contention-type communication in the packet transmission mode, retransmission repeats when data are coincidentally transmitted between two or several modems at the same time, resulting in the remarkable degradation of response. The extended receiving function solves this problem. With the normal receiving function, when the modem receives data during carrier sensing, it starts repeating carrier sensing before the data is fully received. The data received during carrier sensing is discarded. On the other hand, when the extended receiving function

is enabled, the modem properly receives the data received during carrier sensing and accepts to send the data to the terminal equipment. Then, the modem returns *ACK* and resumes carrier sensing to continue transmission.

Fading

A gradual change in signal strength. *Fade in* refers to an increase in strength and *fade out* refers to a decrease in signal strength.

Fade Margin

A margin of signal strength above the level required for communication under “normal” conditions that will provide sufficient power for communication under expected adverse conditions.

Flow Control

Hardware Flow Control:

The data flow is controlled by using RTS and CTS *control lines* of the RS-232C interface. The FRH-SD07TU/TB outputs the received radio packet data when the RTS input is ON and stops outputting the received radio packet data when the RTS input is OFF. When the transmission buffer is near to overflow, the FRH-SD07TU/TB switches the CTS output OFF and requests the terminal equipment to stop data output. When the buffer becomes the receivable state, the FRH-SD07TU/TB switches the CTS output ON to permit data output.

Software Flow Control:

One type of flow control of serial link, which controls data flow by transmitting and receiving the specific control characters as data. Connection is very simple as no flow *control line* is required. But be careful when you send or receive the binary data because the control character cannot be distinguished from ordinary data.

The FRH-SD07TU/TB stops the output of the received radio packet data when it receives the XOFF character (13H) and resumes the output of the received radio packet data when it receives the XON character (11H). When the transmission buffer is near to overflow, the FRH-SD07TU/TB outputs the XOFF character to request to stop data input. When the buffer becomes the receivable state, the FRH-SD07T outputs the XON character to receive the input of data.

Frequency group

The FRH-SD07TU/TB modem can use 24 different frequency channels. These 24 channels can be used independently or by grouping several frequencies and allowing the FRH modem to automatically selecting a frequency from within the group. Mode 1 uses eight groups of three frequencies each. The frequency group configuration of Modes 2, 3, and 4 can be changed using the associated memory registers. Separate FRH systems can be set to different frequency groups and used in the same area without interfering with each other.

Frequency Hopping

A spread spectrum technique in which the transmitter and receiver or transceivers in a system change frequencies rapidly and in synchronization. In this way, the data signal

is spread over a broad RF band through the continual frequency “hopping”. *Also see Direct Sequence and Spread Spectrum.*

Full-Duplex

A type of two-way communication in which both stations can send *and* receive signals or data at the same time. A telephone is an example of a full-duplex communication device. *Also see Half-Duplex.*

Half-Duplex

A type of two-way communication in which both stations can send and receive signals or data but not at the same time. When one unit is sending the other unit can only receive. A CB radio is an example of a half-duplex communication device. The FRH-SD07TU/TB essentially uses half-duplex transmission techniques but *simulates* full-duplex communication by causing both units to switch very rapidly between transmit and receive modes. This is also referred to as Time-Division-Duplex (TDD). *Also see Full-Duplex.*

Headerless Packet Transmission Mode

The headerless packet transmission mode is a special mode of the packet transmission mode, where data are directly input with no transmission command, as a header, required in the packet transmission mode. Basically, this mode is the packet transmission mode, therefore communication is possible with the modems in the packet transmission mode. Due to its high data transparency, the application software is quite simple or unnecessary. Suitable for the multi-terminal communication.

Multi-access

Automatic selection of an idle or clear FRH frequency from a defined group of frequencies.

Broadcast/Multicast

This is a mode in which one FRH modem transmits the same message to multiple receiving FRH modems simultaneously.

Multipath (Fading)

Multipath refers to the reception of the same RF signal from multiple paths such as reception of the direct antenna-to-antenna signal and reception of a secondary signal reflected from surrounding structures. This phenomena can cause signal fading due to interference between the RF signals arriving from multiple paths.

Packet

A finite bundle of binary data assembled in a specific way for transmission. It consists of the data to be transmitted and certain control information such as destination and origination address, packet length, synchronizing bits, error detection and correction bits, etc.

Packet Transmission Mode

The FRH-SD07TU/TB can use one of two primary modes: *data transparent mode* and *packet transmission mode*. In packet transmission mode, fixed length segments of data, consisting of information data and other control data, are assembled and

transmitted as a single unit or *packet* of data. Each transmission is controlled with explicit transmit commands.

Polling- and Contention-type Communication

The polling is a type of communication, where the slave station can communicate only when it receives the polling request of message data from the master station. The contention is another type of communication, where any station may transmit if the channel is free; if the channel is in use, the queue of contention request may be maintained in the predetermined sequence.

Repeater

Equipment that receives weak signals and retransmits the same data in stronger signals. Used to extend range or overcome obstacles and horizon constraints in RF communication systems. An FRH-SD07TU/TB can be configured as a repeater to effectively double the normal range between two FRH modems or to allow communication around obstacles that would otherwise block line-of-sight transmission.

Response

One of the values to express the communication speed, indicating the time delay required by the transmitted data to reach the receiving modem. The smaller the value becomes, the quicker the response requiring the machine control application. However, it must be noted that the response is not always quick when the throughput is large.

RS-232C

Also referred to as RS-232C and currently EIA-232E, RS-232C is a set of standards specifying electrical, functional and mechanical interfaces for communicating between computers, terminal equipments and modems (DTE and DCE).

RTS, or Request To Send

In the standard RS-232C interface, this is an output for DTE devices and an input for DCE devices. This signal is typically used to control flow from the DCE to the DTE device.

Spread Spectrum

A modulation technique that spreads data over an RF bandwidth wider than would normally be required by the content of the original data stream. This technique provides high levels of communication reliability and security. In the modulation system generally used for radio, the bandwidth is about the same as the frequency of the data signal. But in the spread spectrum system, the bandwidth is much wider than the frequency of the data signal (tens to several thousands times), in other word, the spectrum of the data signal can be spread in a broad range, thus this system is called the spread spectrum (SS).

i.e. Frequency Hopping and Direct Sequence. *See also Direct Sequence and Frequency Hopping.*

There are two main types of spread spectrum techniques: one is called the direct sequence (DS) system where the modulated data signal is modulated to further spread, another is the frequency hopping (FH) where the frequency of the modulated data signal is changed rapidly. The FRH-SD07T modem uses the direct sequence system.

Direct Sequence (DS): A form of modulation (commonly used in spread spectrum communications) wherein a code sequence is used to directly modulate a carrier, usually by phase-shift keying (PSK). The FRH-SD07TU/TB is a Direct Sequence Spread Spectrum system. *Also see Frequency Hopping and Spread Spectrum.*

Frequency Hopping (FH): A spread spectrum technique in which the transmitter and receiver or transceivers in a system change frequencies rapidly and in synchronization. In this way, the data signal is spread over a broad RF band through the continual frequency “hopping”.

TDD, or Time-Division-Duplex

See Half-Duplex.

Throughput

One of the values indicating the capacity of the communication link; amount of data available for transmission or receiving per unit time. In the transmission of large amount of data, with the increase of data, the transmission time becomes shorter. Since the FRH modem transmits data in packet, the throughput varies according to the ratio of data contained in a packet.

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