LMR400*

User manual

Version 1.0
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*Other names for marketing purposes are AW400Tx, AW400Jv

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PREFACE

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1. Other names for marketing purposes are AW400Tx, AW400Jv

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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.

Note: Any changes or modifications to the equipment not expressly approved by the party responsible for compliance could void your authority to operate such equipment.

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This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Réglement sur le matériel brouilleur du Canada.

Glossary

µC	Micro Controller
AGC	Automatic Gain Control
ALC	Automatic Output Power Level Control
AWGN	Additive White Gaussian Noise
BER	Bit Error Rate
BERT	Bit Error Rate Test
CLI	Command Line Interface
CMOS	Complementary Metal-Oxide Semiconductor
CRC	Cyclic Redundancy Code
CTS	Clear To Send
CW	Continues Wave
DBPSK	Differential Binary Phase Shift Keying
DC	Direct Current
DCD	Data Carrier Detect
DQPSK	Differential Quadrature Phase Shift Keying
DSP	Digital Signal Processing
DSR	Data Set Ready
DTE	Data Terminal Equipment
DTR	Data Terminal Ready
ETSI	European Telecommunications Standardization Institute
FCC	Federal Communications Commission
FEC	Forward Error Correction
FIFO	First-Input-First-Output
FSK	Frequency Shift Keying
GMSK	Minimum Shift Keying with Gaussian filtering
GUI	Graphical User Interface
HPA	High Power Amplifier
I/O	Input/Output
IF	Intermediate Frequency
LED	Light Emitting Diode
LLC	Logic Link Control
LNA	Low Noise Amplifier
MAC	Media Access Control
MSK	Minimum-shift keying
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
PA	Power Amplifier
PCB	Printed Circuit Board

PDA	Personal Digital Assistant
PLL	Phase-Lock Loop
PMP	Point-to-Multipoint
PSK	Phase Shift Keying
PTP	Point-to-Point
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RSSI	Received Signal Strength Indication
RTK	Real-time Kinematics
RTS	Request To Send
RX	Receive(r)
SCADA	Supervisor Control and Data Acquisition
SRAM	Static Random Access Memory
TDD	Time Division Duplex
TDM	Time Division Multiplexing
TDMA	Time Division Multiple Access
TPC	Turbo Product Codes
TPO	Transmitter Output Power
TTL	Transistor-Transistor-Logic
TX	Transmit(ter)
UART	Universal Asynchronous Receiver/Transmitter
UHF	Ultra High Frequency (300-3000 MHz)
UIM	User Identify Module
VSWR	Voltage Standing Wave Ratio
FIRMWARE	A software program or a set of instructions embedded on a hardware device
SOFTWARE	Computer program for communication with a hardware device

Related Information

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PRODUCT FEATURES

1.1. Introduction

LMR400 DSP based integrated UHF Modem is the single board OEM wireless transceiver intended for SCADA, outdoor telemetry applications and transmission / receiving of differential corrections and additional information by terrestrial radio channels between two GNSS receivers.

LMR400 is a half duplex, UHF Radio Transceiver developed to be integrated in a new JAVAD GNSS Receiver (TRIUMPH). It takes incoming data from a JAVAD GNSS receiver through the standard asynchronous serial port (CMOS/ TTL compatible), modulates it with GMSK, FSK, PSK or most spectrum efficient QAM modulation and transmits it at RF power output levels from 15 dBm up to 30 dBm operating in UHF frequency band (406.1 to 470 MHz).

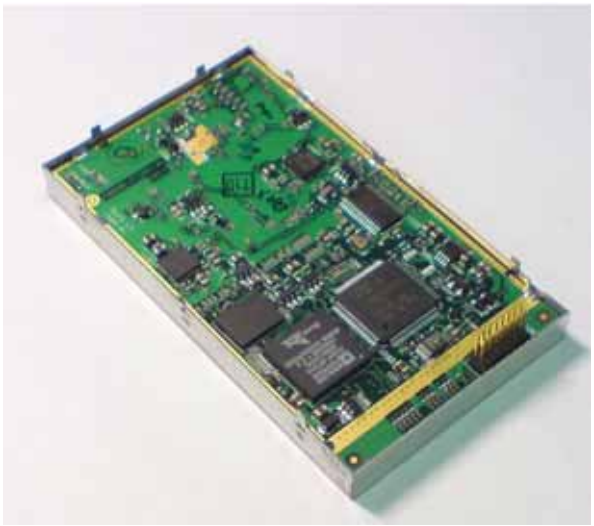

Figure 1-1. LMR400

The UHF transceiver is also capable of receiving RF signals through a 50 Ohm impedance external antenna port. These signals are demodulated and output to the JAVAD GNSS receiver. LMR400 delivers a reliable radio link at up to 38.4 kbps over the air for the 25 kHz channel spacing, 19.2 kbps for 12.5 kHz, and 9.6 kbps for 6.25 kHz.

The module requires a regulated DC voltage power supply 4.2 V ± 5 %.

The delivered product is a wireless system, which includes:

- LMR400 – UHF Radio Transceiver;
- “JRadio” – Windows based Unit Configuration and Maintenance Software Application running on a IBM PC compatible computer and connecting to the device over RS-232 interface.

The unit’s user settings can be changed through the built-in Command Line interface (CLI), or through JRadio. The system built-in diagnostic features provide the information required to monitor and maintain user’s communications link. The output transmit power, receive signal strength (RSSI), antenna/feed line condition, and data decode performance will be transmitted online without application interruption.

The product is designed for maximum performance and reliability even in the harshest environments. Plug and play at its best, robust, withstanding the most adverse of conditions.

1.2. Operating at Ultra High Frequency Band

LMR400 operates in UHF frequency band covering both licensed and unlicensed frequencies. The following are its key benefits:

1. Operating in UHF frequency band will provide a non-line of sight connection.
2. User selectable operation mode (licensed or unlicensed mode) is a feature, which makes JAVAD GNSS’s radio modems suitable for both licensed and unlicensed markets.
3. Relatively low cost associated with installation equipment compared to the licensed wireless bands, since no capital is required to purchase spectrum rights.
4. User-selectable channel spacing (25/12.5/6.25 kHz) is a feature, which makes LMR400 modems attractive for distributors and system integrators.

1.3. Modulation Technique

The design will be based on high-level modulation techniques which include:

	6.25 kHz	12.5 kHz	25 kHz
DBPSK – Differential Binary Phase Shift Keying	2.4 kbps	4.8 kbps	9.6 kbps
DQPSK – Differential Quadrature Phase Shift Keying	4.8 kbps	9.6 kbps	19.2 kbps
D8PSK – Eight Phase Shift Keying	7.2 kbps	14.4 kbps	28.8 kbps
D16QAM – Sixteen Quadrature Amplitude Modulation	9.6 kbps	19.2 kbps	38.4 kbps
GMSK – Minimal Shift Keying with Gaussian Filtering	N\A*	4.8 kbps	9.6 kbps

*. N/A – Not Applicable

The following are its key benefits:

1. Provides an excellent spectral efficiency (up to 2.3 bps/Hz for D16QAM), it is better than any product available on the market.
2. Forward Error Correction scheme (FEC) is based on Hamming Code known as a Perfect Code. Although Hamming Code is not very powerful, it is easy to implement and does not require much DSP resources.
3. More powerful Reed-Solomon FEC coding scheme improves the tolerance to interference and ensures the highest link quality at distances range higher than 15 miles (24 km) and roaming speeds of up to 60 mph (96 km/h).

1.4. Network Topologies

LMR400 is developed to support Point-to-Point link (PTP) using Time Division Duplex (TDD) protocol and Point-to-Multipoint (PMP) network topology using Time Division Multiple Access (TDMA) protocol.

The media access contention between wireless nodes in PMP network (Remotes) can be resolved by an external controller (TRIUMPH GNSS Receiver) located on base station (Base). The CONNECT command is intended to establish the link with a specific Remote.

The RTS and CTS data flow control lines (Request-To-Send and Clear-To-Send) can be used on Remote side to support TDMA protocol implementation.

1.5. Operating Modes

The operating modes for LMR400 can be set through the CLI, or through JRadio. The following operating modes are available for LMR400:

1. Simplex operating modes (Simplex Base, Remote and Repeater) are developed primarily for GNSS applications.
2. Half Duplex Base, Remote and Repeater are the alternative to Simplex operating modes that are implemented based on half-duplex TDD protocol with dynamic bandwidth allocation.
3. Sleep mode has automatic transmitter activation by an internal real-time clock, or by an external controller through the data interface control lines (RTS).
4. The programmable automatic channel scanning of the Preferred Channels is an alternative mode to the operation on the fixed Frequency Channel. In this mode, the Base is looking for a “free of use” frequency channel while a Remote is looking for a Base to interact with.
5. Test mode supports the radio installation using Built-in test tools.

1.6. Management Tools

The built-in management tools along with JRadio running on PC compatible computer provide the following benefits:

1. Easy user’s interface for system configuration and monitoring using well developed CLI or intuitive GUI.
2. An ability to test the link using built-in test utilities without expensive external test equipment such as spectrum analyzer and BER test analyzer.
3. An ability to monitor status, alarms and radio performance through the intuitive GUI.
4. LMR400 firmware upgrades and improvements can be downloaded to the units over serial link locally or over-the-air remotely.

Note: Downloading over-the-air remotely is not requested by JAVAD GNSS for first release.

1.7. Security

The system will provide wireless media access protection as well as data encryption. The following are its key features and benefits:

1. The Key Sequence generated by Pseudo-random generator scrambles the fully formatted frame (including Frame's CRC). This provides the wireless media access protection.
2. User selectable Frequency Hopping Pattern provides another level of the wireless media access protection.

At the same time it allows operators to increase the number of links deployed in the same location.

Chapter 2

General Description

2.1. Hardware Platform

UHF module electronic hardware consists of Zero-IF RF Front-End and Digital Section based on BlackFin DSP micro processor. Both are located on a single PCB board.

LMR400 radio modem utilizes ultra-wide dynamic range RF front-end developed specifically to provide the adjacent channel power ratio and adjacent channel selectivity levels required by FCC Part 90 standards.

Digital Section is responsible for:

- Baseband modulation/demodulation;
- MAC Protocol performance;
- Serial Data Interface Control Logic (RTS and CTS).
- System Initialization and configuration including initialization of configurable devices in the RF frontend.

Both factory and user specific configuration parameters will be stored in the flash memory. However, only user specific parameters can be changed on the field. The factory configuration includes maximum allowed output power (500mW – unlicensed and 1 W – licensed), six-byte unique serial number, and unit specific calibration tables.

2.2. Physical Interfaces

2.2.1. Serial Data/Command Interface

The serial asynchronous interface allows connection to external serial devices. It is shared between user data and unit's command/status information. All commonly supported baud rates, parity and bit configurations are available up to 115.2 kbps for UART.

2.2.2. RF Interface

RF interface is a 50-ohm impedance matched standard MMCX connector as required by regulation. The RF interface can operate without damage to the unit under DC short and open conditions.

The RF interface is protected against static discharge (15 kV air discharge, 8 kV contact discharge) and unloaded output.

Switching from UHF module to cell module operation mode and vice versa is provided on RF interface in case if they share the same antenna.

2.2.3. Antennas

Antenna type depends on the site requirements, and may be directional or omni-directional. The antenna must have a 50-ohm impedance matched interface with VSWR 2.0:1 or better.

The Base transceiver is recommended to be mounted on an antenna mast that elevates the antenna a minimum of 40 feet above the average level of the terrain to support 15 miles distance range.

2.2.4. Power Interface

The power interface allows connection to an unregulated DC power source. The DC power source (thirdparty or user supplied) must provide peak 7.5 W of DC power 4.2 V ± 5 %.

Chapter 3

COMMAND LINE INTERFACE

The built-in user-friendly Command Line Interface (CLI) allows user to perform a full configuration of the unit and read the statistics and alarm status. It is the most powerful tool to configure the unit. It makes changes to all possible settings that system will not be able to determine automatically.

The CLI commands allow user to configure and reconfigure the unit's settings. The user configuration parameters that could be changed through the CLI are:

- Data Port Settings
  - Baud Rate
  - Data Bits (8, 7)
  - Parity (Odd, Even, None)
  - Flow control (None or RTS/CTS)
- Alarm Settings
- Radio Operation Modes

  See "Network Topologies" on page 15 for details.
- Sleep modes
  - On/Off
  - Activate by internal real-time clock
  - Activate through RTS/CTS lines
  - Activate by external sense lines
  - Activate by any combination of the parameters mentioned before

Note: The unit's configuration that is set or modified through the CLI will be lost after unit's reboot, unless the saving operation is used to store a new setting in the unit's configuration file.

The CLI commands also provide filing operations, which include:

- Downloading
  - Unit's Configuration files
  - Software Images
- Uploading Unit's Configuration files

- Saving into the configuration files the configuration parameters modified through the CLI.

3.1. Command Line Interface Convention

The following convention is implemented in AW400Tx Command Line Interface (CLI):

- The Carriage Return/Line Feed (CR/LF, 0x0D/0x0A) is a command delimiter.
- The Carriage Return/Line Feed (CR/LF, 0x0D/0x0A) is a reply delimiter followed by the "CLI>" prompt if Echo option is On.
- The Carriage Return/Line Feed (CR/LF, 0x0D/0x0A) is a reply delimiter if Echo option is Off (default option).
- The 2-digit number followed by "@" in the unit's reply indicates the error code (refer to Table 1 for description), if Echo Off is selected, otherwise the error message is displayed.
- A successfully performed command is replied by @00 code, if Echo Off is selected, otherwise the set value is replied.
- A command with the certain [Parameter Name] and blank [Parameter List] displays the current settings for a given parameter.
- To set the mode ordered by CLI commands as permanent User Setting (the setting automatically selected for the boot-up unit) the SAVE command must be asserted.

Table 1. Command Line Interface Error Codes

Error Code	Short Description
0x01	Command Syntax Error. A command followed by "/?" displays a command usage.
0x02	The parameter has a format error. A command with the certain [Parameter Name] followed by "/?" displays the format and range of the variable.
0x03	The parameter is out of allowed range. A command with the certain [Parameter Name] followed by "/?" displays the format and range of the variable.
0x04	The command is not valid for specific radio model. To display the list of available commands, the HELP command must be used (see "Software Switching to Maintenance Mode").
0x05	Unspecified Error

3.1.1. Software Switching to Maintenance Mode

Software Switching to Maintenance Mode can be utilized if Data/Maintenance Port (DP/MP) control line is set to High Z (or 3.3v) level. To switch to Maintenance mode the special byte-sequences with special meanings are used:

- Escape-Sequence: “+++”or “++++” with 20 ms guard time before and after the command characters
- Escape-Acknowledge: “@00<CR><LF>”

20 ms toggling on CTS control line needed to acknowledge switching from Data to Maintenance mode and vice versa. In Maintenance mode, the unit’s serial port must keep CTS line always active (see also “MPORT” on page 27).

Note: “++++”used for Topcon products only.

Happy Flow

1. In data-mode the unit starts looking for the Escape-sequence if there is no data from DTE for more than 20 ms (Start Guard Time).
2. If the unit detects the Escape-Sequence:
   - The transmitter continues sending over the air the data received from DTE before Escape-Sequence and buffers the data from DTE;
   - The Receiver immediately stops forwarding to DTE the data received over the air and buffers it instead.
3. The radio unit waits for 20 ms and then sends Escape-Acknowledge to DTE if there is no data from DTE during 20 ms of Stop Guard Time.
4. The unit goes to Maintenance mode and discards Escape-Sequence from input buffer. The modem is immediately ready to receive commands. At the same time it continues buffering the data received over the air since step 2.

Escape-Sequence in Data

During its waiting in step 3, the unit receives data from DTE:

- The unit sends buffered Escape-Sequence from DTE to the air;
- The unit sends all buffered data received from the air since step 2 to DTE and stays in data-mode (i.e. transmits data received from DTE over the air – including the just received, unexpected, data and forwards data received over the air to DTE.)

3.1.2. Hardware Switching to Maintenance Mode

As alternative to Software Switching, the switching through the MP/DP control line can be used (this control line can be also used as Data Terminal Ready, DTR). To set Maintenance mode, the

DTE must assert DTR signal active (0v level). By falling edge of DTR signal the unit goes to Maintenance mode and then sends Escape-Acknowledge to DTE („@00<CR><LF>“).

20 ms toggling on CTS control line followed by Escape-Acknowledge response is needed to acknowledge switching from Data to Maintenance mode and vice versa. In Maintenance Mode, the unit’s serial port must keep Clear to Send (CTS) line always active (see also “MPORT” on page 27).

Note: The powered up radio modem by default goes to Data Mode regardless of DTR control line polarity.

3.1.3. Switching to Data Mode

- DTE sends the CLI command „DATAMODE<CR><LF>“to the unit.
- Unit answers with Escape-Acknowledge („@00<CR><LF>“) and immediately goes to datamode, so that the DTE can start sending data as soon as the Escape-Acknowledge has been received.
- If no valid CLI commands received from DTE within 1 minute, the unit will automatically switch back to data-mode.

Note: The data received over the air could be lost due to Rx buffer overflow if the unit stays in Maintenance mode longer then 15 second.

3.2. Networking Commands

3.2.1. CONNECT

To connect the radio unit through the local maintenance serial port or to establish the link with the remote unit in the Point-to-Multipoint network, the CONNECT command must be used.

CONNECT [Unit_Numb] [/?]

Where the Unit_Numb is an assigned decimal number for the unit to be connected. To get the complete unit list, the CONNECT command must be used with no parameter. The list of units in the Point-to-Point link with the connection established with remote unit is shown in Figure 3-1:

Unit	Serial Number	Connect
BS	003578659922	
1	003574459923	C

Figure 3-1. Connection List

To connect to the Base unit, through the remote unit, the parameter (Unit_Numb) must be equal to 0. To connect the local unit (Base or Remote), the parameter (Unit_Numb) must be equal to 0xFF.

3.2.2. LINK

The LINK command is responsible for configuring radio's operation mode. It has six parameters listed below.

LINK [Parameter Name] [Parameters List] [/?]

Parameter Name	Parameter List
PROT	1 – "Simplex Receiver", a default setting for Remote units 2 – "Simplex Transmitter" 3 – "Half Duplex" specific for remote units (Reserved for future use) 4 – "Half Duplex" specific for base unit (Reserved for future use) 5 – "Full Duplex" specific for remote units (Reserved for future use) 6 – "Full Duplex" specific for base unit (Reserved for future use) 7 – "TRMB Receiver" (used with GMSK modulation, not supported) 8 – "TRMB Transmitter" (used with GMSK modulation, not supported) 9 – Reserved for future use 10 – "Repeater" (ArWest Proprietary protocol) 11 – "TRMB Repeater" (used with GMSK modulation, not supported) 12 – "Transparent w/EOT" Receiver (used with GMSK modulation, not supported) 13 – "Transparent w/EOT" Transmitter (used with GMSK modulation, not supported)
RTR	0 – No Retransmission in the wireless cluster 1 – There is Repeater
MOD	1 – DBPSK 2 – DQPSK, a default settings 3 – D8PSK 4 – D16QAM 5 – GMSK 6 – 4FSK
PWRB / PWRW	0 – Automatic Transmit Power control, a default setting for Remote units (15 – 30) / (30 – 1000) – RF output Power in dBm / mW
CHAN	Selects the frequency channel, CN = (1 – ((Maximum_frequency – Minimum_frequency) / 6.25 + 1)). The CN = 0 is reserved to set the Frequency Automatic scanning mode. The LINK CHAN 0 command also forces the radio modem to continue scanning starting from the channel currently selected by automatic scanning algorithm. In Automatic scanning mode, to check the frequency channel currently used or scanned, the STATE command must be used (see section 6.5.2).
FHOP	(1 – 32) – Frequency Hoping Pattern number
SCRAM	0 – No Scrambling (a default setting) (1 – 255) – Seed for Pseudo-Random Sequence Generator

Parameter Name	Parameter List
ENROL	Enrolls the secondary units into the wireless cluster. The enrolled unit's 6-digit serial numbers are delimited by commas SN1, SN2, SN3 ... SN31, SN32. The number of units in the cluster does not exceed 32. The SN = 0 is reserved to clear the list of enrolled remote units. (Reserved for future use)
FEC	0 – Disable Forward Error Correction (FEC), a default setting 1 – Enable Reed-Solomon encoding
SPACE	Sets channel spacing (see section 3.2.2): 0 – 25kHz, a default setting 1 – 12.5kHz 2 – 6.25kHz
MAP	Retrieves the map of allowed frequency channels. Each entry in the retrieved channel map delimited by "<CR><LF>" consists of three configuration parameters separated by commas – Channel Number (CN = 1 to ((Maximum_frequency – Minimum_frequency) / 6.25 + 1)), channel spacing (0 –25kHz, 1 – 12.5kHz, 2 – 6.25kHz), and maximum allowed output power level in dBm (15 to 30). Escape-Acknowledge („@00<CR><LF>") sequence is used as end-delimiter of the retrieved channel map. The number of entries in the channel map does not exceed 32.

Note:

- LINK FHOP XX and LINK CHAN 0 commands can be processed only if Frequency Map is defined.
- The boot-up radio modem operating in automatic scanning mode must start frequency scanning from first channel in the frequency map.
- The remote unit will restart the frequency scanning process if there is no receive signal on the automatically selected channel.
- The mode defined by RTR parameter is not valid for remote units.
- The frequency defined by CHAN parameter is not valid if Frequency Hoping mode is selected.
- In the Frequency Hoping mode, the Frequency Pattern generator must generate the random numbers smaller than the number of frequencies listed in the unit's frequency list.
- By default, there are no enrolled remote units in the network list.
- The ENROL parameter is not valid for Remote units.
- Automatic Transmit Power control (PWRB/PWRW 0) is not valid setting for Base unit.
- The radio link with GMSK modulation uses a Non-ArWest protocol only.
- "Full-duplex" protocol is a specific case of half-duplex MAC protocol when 50% of bandwidth in the PTP link is allocated to remote unit.

3.3. Serial Interfacing Commands

3.3.1. DPORT

The DPORT is an object that responsible for data port interface configurations like Bit Rate, Flow Control,etc.

DPORT [Parameter Name] [Parameters List] [/?]

Parameter Name	Parameter List
RATE	0 – Maintenance Port baud rate, a default setting 1 – 1200 baud 2 – 2400 baud 3 – 4800 baud 4 – 9600 baud 5 – 14400 baud 6 – 19200 baud 7 – 38400 baud 8 – 57600 baud 9 – 115200 baud, a default setting
BITS	Set number of bits in one byte (8 or 7) 8 is a default setting
PARITY	0 – None, a default setting 1 – Odd 2 – Even
FLOW	0 – None, a default setting 1 – Not used 2 – HW (RTS/CTS) 3 – RS-485 TX Enable High 4 – RS-485 TX Enable Low

3.3.2. MPORT

The MPORT is an object that responsible for maintenance serial port interface configurations such as data rate and number of bits in a byte.

MPORT [Parameter Name] [Parameters List] [/?]

Parameter Name	Parameter List
RATE	0 – Auto. 1 – 1200 baud 2 – 2400 baud 3 – 4800 baud 4 – 9600 baud 5 – 14400 baud 6 – 19200 baud 7 – 38400 baud 8 – 57600 baud 9 – 115200 baud, a default setting

Note:
- MPORT operates using 8 bits in one byte fixed (not configurable).
- The radio modem with none-dedicated maintenance serial port must keep CTS line always active in MPORT mode (DP/MP is low).

3.4. Special Commands

3.4.1. ALARM

The ALARM command is intended to set up the alarm indication mode and alarm control lines' behavior.

ALARM [Parameter Name] [Parameters List] [/?]

Parameter Name	Parameter List
TTL1	0 – TTL_OUT1 = logic "1" 1 – TTL_OUT1 = TTL_IN, received from remote unit (default settings)
TTL2	0 – TTL_OUT2 = logic "1" 1 – TTL_OUT2 = TTL_IN2, received from remote unit (default settings) 2 – TTL_OUT2 = SYNC Loss 3 – TTL_OUT2 = BER > BERTH or SYNC Loss
BERTH	1– BER Threshold >10 –3 (default threshold level for BER) 2 – BER Threshold BER >10 –2

Note: The BERTH 1 / 2 is optional for TTL2 = 3 condition, otherwise the BERT alarm is off

3.4.2. BOOT

The BOOT command is intended to reboot the unit using selected user settings. Two options are available, to use the default user settings defined by dealer or to use the settings defined by end-user

BOOT [Parameter Name] [Parameters List] [/?]

Parameter Name	Parameter List
CFG	0 – selects the default user settings 1 – selects user modified settings

The BOOT command with no parameters selects the user settings defined by the prior "parameterized" BOOT commands.

3.4.3. HELP

The HELP command types the list of all available commands:

HELP – Display this usage
BOOT – Reboot the unit
LINK – RF Link Operation Mode
DPORT – Data Port Configuration
MPORT – Maintenance Port Configuration
ALARM – Alarm Indication and Alarm Control Configuration
SLEEP – Sleep Mode Configuration
CONNECT – Connect to Specified Unit
STATE – Display Status and Statistics
SAVE – Save Current Configuration into Configuration File
INFO – Display Product ID along with Hardware/Software Versions
DATAMODE – Exit Maintenance Mode
[COMMAND] /? – Display Command Usage

3.4.4. SAVE

The SAVE command is intended to store the unit's currently used configuration into the User Configuration file. The configuration stored in the User Configuration file will be activated by automatically after unit's reboot.

3.4.5. SLEEP

The SLEEP command determines the sleep mode parameters. The sleeping LMR400 can be activated by real-time CLK, DTR/RTS lines, and command received through TTL inputs. The user can select one, two, or all three conditions.

SLEEP [Parameter Name] [Parameters List] [/?]

Parameter Name	Parameter List
CLK	0 – Do not activate by internal real-time clock (1 – 255) – Activate by internal real-time clock after 100 to 25500 msec of sleeping
HW	0 – Do not activate through DTR/RTS lines 1 – Activate through DTR/RTS lines
TTL	0 – Do not activate by external sense lines 1 – Activate by external sense lines
GTS	0 – Disable Sleep mode (default) (1 – 255) – Go to sleep mode if there is no activity in 10 to 2550 msec

3.5. Diagnostics and Identification Commands

3.5.1. INFO

The INFO command is used to retrieve the Radio ID along with its Hardware version, the loaded realtime software version/revision and BootLoader's version/revision.

INFO [Parameter Name] [Parameters List] [/?]

Parameter Name	Parameter List
ID	Product ID
SN	Six bytes Serial Number (SN)
HW	1.0 – hardware version in numeric "Major.Minor" format
SW	Ver. 1.0 Rev. A – displays software's version in numeric "Major.Minor" format and revision in numeric format (range from 01 to 99) for engineering releases and alphabetic format (A to Z) for manufacturing releases
BL	Ver. 1.0 Rev. A – displays BootLoader's version in numeric "Major.Minor"format and revision in numeric format (range from 01 to 99) for engineering releases and alphabetic format (A to Z) for manufacturing releases

The INFO command without Parameter Name indicates all values as shown in Figure 3-2:

Product ID = 6
S/N = 000000 020303
Hardware = Ver. 1.0
Software = Ver. 1.0 Rev. B
BootLoader = Ver. 1.0 Rev. A

Figure 3-2. INFO Command Display

3.5.2. STATE

The STATE command is used to check the state of the wireless link, the unit in the link, and the alarm control lines. To specify a radio unit (local or remote), the CONNECT command must be used in prior of STATE command using.

STATE [Parameter Name] [Parameters List] [/?]

Parameter Name	Parameter List
TTL1	0/1 – State of TTL_IN1 line
TTL2	0/1 – State of TTL_IN2 line
RSSI	-52 to -116 dBm – Indicates the Receive Signal Strength in dBm
BER	1.0E-6 to 9.9E-3 – Indicates the BER level
FREQ	403.000000 to 470.000000 MHz – Displays the central frequency of the operating channel
CHAN	1 to 9601 – Displays the selected or currently scanned frequency channel
TEMP	-30°C to 100°C – Displays the temperature inside of enclosure
SYNC	1 – Indicates the established link, 0 – if link is not established yet
PWRB	Indicates unit's output power level in dBm (see "CONNECT" on page 24)

Note: The indicated receive signal strength (RSSI) is equal to -147 dBm if there is no signal received from transmitter.

Chapter 4

TECHNICAL SPECIFICATIONS

LMR400 DSP based integrated UHF Modem is the single board OEM wireless transceiver intended for SCADA, outdoor telemetry applications and transmission /receiving of differential corrections and additional information by terrestrial radio channels between two GNSS receivers.

The UHF module provides half-duplex communication with transmitter output power of 1 W (+30 dBm) in the frequency band 406-470 MHz with channel spacing 25 / 12,5 / 6,25 kHz. It supports the following modulation methods: GMSK, DBPSK, DQPSK, D8PSK, D16QAM.

4.1. Technical Specifications

4.1.1. Radio Transceiver

Component	Details
Frequency Range	406.1 - 470 MHz (USA) 406.1-430; 450-470 MHz (Canada)
Channel Spacing	25/12.5/6.25 kHz
Carrier Frequency Stability	±1 ppm, compiles with FCC 2.1055, 90.213
Modulation	GMSK/DBPSK/DQPSK/D8PSK/D16QAM
Communication Mode	Half duplex, simplex

4.1.2. Radio Transmitter

Component	Details
Transmitter Output Power	+15... +30 dBm in 1 dB step / 50 Ω Complies with FCC 2.1046
Carrier Frequency Stability	+1 dB / -2 dB
Occupied Bandwidth	Complies with FCC 2.1049, 90.209
Emission masks	Complies with FCC 90.210
Spurious Radiation	Complies with FCC 2.1053, 90.210

4.1.3. Radio Receiver

Component	Details
Receiver Sensitivity for DBPSK (@ BER 1x 10^{-4}, over temperature -30 ^{o}C to +50 ^{o}C)	-113 dBm for 25 kHz Channel Spacing, -114 dBm for 12.5 kHz Channel Spacing, -114 dBm for 6.25 kHz Channel Spacing
Receiver Sensitivity for DQPSK (@ BER 1x 10-4, over temperature-30 ^{o}C to +50 ^{o}C)	-110 dBm for 25 kHz Channel Spacing -111 dBm for 12.5 kHz Channel Spacing -111 dBm for 6.25 kHz Channel Spacing

Component	Details
Receiver Dynamic Range	-119 to -52 dBm
Adjacent Channel Selectivity	70 dB for 25 kHz Channel Spacing 60 dB for 12.5 kHz Channel Spacing 50 dB for 6.25 kHz Channel Spacing

4.1.4. Modem

Component	Details
Interface	DSP UART (serial port)
Interface Connector	16-lead Connector
Data Speed of Serial Interface	9600 - 115200 bps
Data Rate of Radio Interface (25 kHz Channel Spacing)	9600 bps – DBPSK/GMSK 19200 bps – DQPSK 28800 bps – D8PSK 38400 bps – D16QAM
Data Rate Radio Interface (12.5 kHz Channel Spacing)	4800 bps – DBPSK/GMSK 9600 bps – DQPSK 14400 bps – D8PSK 19200 bps – D16QAM
Data Rate Radio Interface (6.25 kHz Channel Spacing)	2400 bps – DBPSK 4800 bps – DQPSK 7200 bps – D8PSK 9600 bps – D16QAM
Forward Error Correction (FEC)	Reed-Solomon Error Correction
Data scrambling	Yes

4.1.5. General

Component	Details
Input Voltage	4.2 V ± 5 %
Power Consumption (average)	4 W – transmit with 50% duty cycle (1 W TPO) 1 W – receive mode
Operation Temperature	-30°C - +50°C
Storage Temperature	-40°C - +80°C
Dimensions	L: 81 mm x W: 46 mm x H: 7 / 13 mm
Weight	32 g

Features:

- DSP-Modem
- Multi-Modulation Technologies
- Zero-IF Technologies
- 406.1-470 MHz Frequency Range
- Up to 115200 bps Data Rate
- Embedded Firmware Compensation for Operation at Extremely Low at High Temperatures
- Compact Design

4.2. External Connectors

Main Connector (J100): 16-Lead Header Connector COMM CON INC P/N 3913-16G2.

PIN #	Signal Designator	Signal name	Deascription	I/O	Comments
1	GND	GND	Ground	-	-
2	DSP UART RX	TXD	Transmit Data	TTL Input	Serial Data Input
3	DSP UART TX	RXD	Receive Data	TTL Output	Serial Data Output
4	DPORT-5	DTR	-	TTL Input	-
5	DPORT-1	CTS	Clear to Send	TTL Output	(0v) = Transmit buffer not full, (3.0v) = Transmit buffer full

PIN #	Signal Designator	Signal name	Deascription	I/O	Comments
6	TTLI-1	SLEEP	Sleeps/wakes radio Receive only	TTL Input	(3.0v) = Sleep Radio, (0v) = Wake Radio
7	DPORT-3	MDM_GRN	LED control line used by remotes to indicate that the remote has successfully acquired the signal from base station to indicate	TTL Output	(0v) = Carrier detected (synchronized) (3.0v) = No carrier detected (not synchronized)
8	DPORT-4	RTS	Request to Send, gates the flow of receive data from the radio to the user on or off	TTL Input	(0v) = Receive data (RxD) enabled (3.0v) = Receive data (RxD) disabled
9	DPORT-2	DSR	-	TTL Output	-
10	RES CONT	RESCONT	Reset Control	TTL Input	-
11	TTLO-1	V_CTRL	Voltage Control Line	TTL Output	(0v) = 4.2V DC (3.0v) = 3.6V DC
12	TTLO-2	MDM_RED	LED control line usrd to indicate	TTL Output	(0v) = Transmission (3.0v) = No Transmission
13	GND	GND	Ground	-	-
14	TTLI-2	ANT_DET	Antenna detector input line	TTL Input	(0v) = No Antenna Detected (3.0v) = Antenna Detected
15	VCC36	PWR	Power Supply	External	4.2/3.6 V
16	VCC36	PWR	Power Supply	External	4.2/3.6 V

4.3. RF Connectors

J500 is Antenna Input / Output Connector: MMCX RIGHT ANGLE PCB JACK, EMERSON JOHNSON P/N 135-3701-311.

SAFETY WARNINGS

General Warnings

Note: To comply with RF exposure requirements, maintain at least 20 cm between the user and the UHF radio modem.

Warning: *The LMR400 is designed for intended for SCADA, outdoor telemetry applications and transmission / receiving of differential corrections and additional information by terrestrial radio channels between two GNSS receivers. This product should never be used:*

– Without the user thoroughly understanding this manual.

– After disabling safety systems or altering the product.

– With unauthorized accessories.

– Without proper safeguards at the measuring site.

– Contrary to applicable laws, rules, and regulations.

Danger: **THE LMR400 SHOULD NEVER BE USED IN DANGEROUS ENVIRONMENTS.**

Usage Warnings

If this product has been dropped, altered, transported or shipped without proper packaging, or otherwise treated without care, erroneous measurements may occur.

Note: Do not connect or disconnect equipment with wet hands, you are at risk of electric shock if you do!

The owner should periodically test this product to ensure it provides accurate measurements.

Inform JAVAD GNSS immediately if this product does not function properly.

Only allow authorized JAVAD GNSS warranty service centers to service or repair this product.

UHF Radio Usage

Many countries require a license for radio users (such as the United States). Be sure you comply with all local laws while operating a UHF radio.

Surveying in RTK mode has made UHF the most popular choice for communications between base and rover receivers. Know the strengths and weaknesses of this technology to get the best use out of your receiver.

The quality and strength of the UHF signals translates into range for UHF communications.

The system's range will greatly depend on the local conditions. Topography, local communications and even meteorological conditions play a major role in the possible range of RTK communications.

If needed, use a scanner to find clear channels for communication.

WARRANTY TERMS

JAVAD GNSS electronic equipment are guaranteed against defective material and workmanship under normal use and application consistent with this Manual. The equipment is guaranteed for the period indicated, on the warranty card accompanying the product, starting from the date that the product is sold to the original purchaser by JAVAD GNSS' Authorized Dealers[1].

During the warranty period, JAVAD GNSS will, at its option, repair or replace this product at no additional charge. Repair parts and replacement products will be furnished on an exchange basis and will be either reconditioned or new. This limited warranty does not include service to repair damage to the product resulting from an accident, disaster, misuses, abuse or modification of the product.

Warranty service may be obtained from an authorized JAVAD GNSS warranty service dealer. If this product is delivered by mail, purchaser agrees to insure the product or assume the risk of loss or damage in transit, to prepay shipping charges to the warranty service location and to use the original shipping container or equivalent. A letter should accompany the package furnishing a description of the problem and/or defect.

The purchaser's sole remedy shall be replacement as provided above. In no event shall JAVAD GNSS be liable for any damages or other claim including any claim for lost profits, lost savings or other incidental or consequential damages arising out of the use of, or inability to use, the product.

1. The warranty against defects in JAVAD GNSS battery, charger, or cable is 90 days.

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