RM12

Wideband SDM & ALE – 48 kHz

NAV DIVISION

DATASHEET

ALE 4G, 3G & 2G (48 kHz) | WBHF MODEM (48 kHz)

Functions and Applications

- **Streaming Modem:** MIL-STD-188-110D & STANAG 5069
- **Automatic Link Establishment Controller:** MIL-STD-188-141D & STANAG 4538 (FLSU)
- **Packet Modem:** STANAG 4538 (xDL)

Features and Benefits

- **Automatic Link Establishment Controller**
  - Waveforms: MIL-STD-188-141D: WALE (Fast & Deep)
  - 4G ALE/WALE Link Setup:
    - Adaptive: selects bandwidth and frequency offset based on observed channel conditions
    - Spectral Sensing to dynamically avoid interference
    - User Traffic Type is negotiated during Link Setup (LSU)
    - Inter-operation with 2G ALE & 3G ALE controllers
  - WALE Protocol:
    - WALE Address: 16-bit PDU and 16-bit Network number
    - Synchronous and asynchronous link setup
    - Point-to-Point, Point-to-Multipoint and Broadcast links
    - Automatic channel selection for calling channels
    - Wideband traffic channel negotiation: 2-way and 3-way; with override
    - Orderwire messages: Text and Binary
  - Utility Protocols:
    - Time-of-Day distribution
- **External Interfaces**
  - DTE Port: Synchronous (EIA-530)
  - ETHERNET LAN Ports: Control, Data & VITA-49
  - Radio Audio & Control: 48 kHz Baseband, 2xRS-232
- **Deployment**
  - 19" Rack Mount for Strategic Use
  - Mobile Platform (Ship, Aircraft)
  - Shore Station (Split-Site Architecture)
- **High-Build Quality**
  - Environmental Spec: MIL-STD-810H and MIL-STD-461G
  - Wide Operational Temperature Range
- **High Reliability:**
  - High MTBF: > 40 000 hours
- **Extended Product Life-Cycle:**
  - Product Availability: > 15 years
  - Availability of Spares: > 20 years
  - Long Term Configuration Management
- **Front Panel:** Operator Interface

Product Overview

Navies and coast guards need relatively high-speed Beyond Line-of-Sight (BLOS) data communication, spanning long distances over water, without being reliant on satellite networks. High Frequency (HF) backbone networks and other terrestrial HF radio networks provide strategic communications to government, disaster relief agencies and industries, without relying on vulnerable fixed-line network infrastructure.

The RM12 offers standards-based HF data modem waveforms, in particular, the 48 kHz wideband HF modem as defined in MIL-STD-188-110D and STANAG 5069. Please refer to the RM12 “WBHF MODEM (48 kHz)” datasheet.

4G ALE, 3G ALE & 2G ALE Controller

The RM12 provides Wideband Automatic Link Establishment (4G ALE / WALE), based on MIL-STD-188-141D, up to 48 kHz bandwidth. It includes second generation ALE (2G) and third generation ALE (3G) as per MIL-STD-188-141A/B and STANAG 4538 (FLSU only).

The WALE controller provides fast or robust link setups by dynamically adapting the bandwidth and frequency offset of wideband channels to avoid interference and optimize throughput.

The WALE link setup controller also provides inter-operation with 2G ALE and 3G ALE (FLSU). WALE supports (as does 3G ALE) both synchronous and asynchronous modes.

ALE Waveforms

The 4G ALE (WALE) system uses waveforms derived from the WB waveforms for its transmissions, and draws ideas from both 2G ALE and 3G ALE for its protocols. The WALE waveforms operate in 3 kHz and provide two modes for sending Protocol Data Units (PDUs) – the “Fast” WALE waveform (intended for very fast link setup in voice-quality channels) and the “Deep” WALE waveform (designed for operation in the most challenging channels, including SNR < 0 dB).

The choice between Fast or Deep WALE can be made on a call-by-call basis as receivers listen to both types of WALE calls, as well as 2G ALE and 3G ALE calls for simultaneous operation with existing narrowband circuits.

Linking Protection

Linking protection (LP) is intended to prevent unauthorized attempts to interact with automated radios. LP protects the linking function, including related addressing and control information. 3G ALE uses the SODARK algorithm, while 4G ALE/WALE uses the HALFLOOP algorithm with a 96-bit encryption block size.

REACHING BEYOND BOUNDARIES

Link Quality Analysis

The RM12 offers a comprehensive 4G ALE Link Quality Analysis (LQA) solution which incorporates lessons learnt from field experience with the LQA solutions offered in 2G ALE and 3G ALE. Optimisations for fixed installations versus mobile platforms are possible through configuration options.

Interference measurements are recorded for local and remote sub-channels in addition to local and remote SNR measurements obtained from PDUs. To aid Automatic Channel Selection (ACS) in accounting for changing channel conditions throughout the day, recordings also include the date and time. Control over the weights used when averaging historical measurements, as well as the resolution of time-slots, are available.

Radio Equipment & Control

4G ALE/WALE is intended to be useful for a wide range of applications, including legacy systems without WBHF modems. For interoperability over such a range of systems, WALE includes an exchange of Equipment Capability (EC) codes during the link setup procedure which defines the maximum radio bandwidth of the radio in use.

The MIL-STD-188-110D approach is to use 3 kHz or wider contiguous bandwidth for the transfer of data traffic. The wideband modem waveforms defined in the standard use channel bandwidths from 3 to 48 kHz. Interference from other radio users could reduce the available channel bandwidth.

WALE includes Listen-Before-Transmitting (LBT) and Listen-Before-Responding (LBR) methods to sense the radio interference environment during link establishment. A suitable WBHF waveform will then be chosen to occupy the portion of an allocated channel bandwidth that was confirmed available at link setup time (Figure 1).

As shown, the Tx and Rx traffic positions and bandwidths can differ, depending on the interference experienced at the Tx or Rx radio circuits.

Text & Binary Messaging

4G ALE/WALE offers text messaging similar to the 2G ALE Automatic Message Display (AMD) and binary message capability. The WALE message words can each carry up to 8 bytes of a message.

Multi-word messages use a Word Countdown field, which is decremented in each message word sent. Message words can be appended to any of the Link Setup PDUs. After a link is set up, messages are appended to a One-Way Message Header utility PDU so that the source and destination addresses are present on each message.

WALE OTA Example

Over-The-Air (OTA) transmissions and receptions are relative to the dial frequency (as specified in MIL-STD-188-141D Change Note 1).

Figure 1 shows a 48 kHz capable radio, using a 42 kHz channel, with a 3 kHz WALE Waveform offset by 1.8 kHz from the Dial frequency, a 12 kHz traffic Tx waveform offset by -7.5 kHz from the WALE waveform, and a 9 kHz traffic Rx waveform offset by +12 kHz from the WALE waveform.

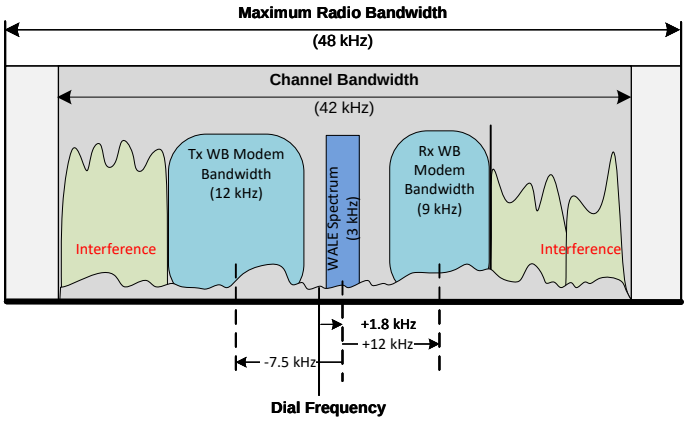

Figure 1: WALE link setup and traffic channel selection example

4G/WALE Feature Set

MIL-STD-188-141D Appendix G – 4G ALE/WALE	
WALE Protocol	WALE protocols use a 96-bit Protocol Data Unit (PDU). Synchronous and asynchronous link Setup. 2-way (LSU Request, followed by LSU Confirm) and 1-way (LSU Request). Point-to-Point, Point-to-Multipoint and Broadcast link setup. Channel quality estimation by means of wideband occupancy detection and LQA (LBT and LBR exchanges). Excellent performance in degraded HF channels by means of robust waveforms. Automatic channel selection for calling channels. Wideband traffic channel negotiation: 2-way and 3-way; with override. 4G Text and Binary Message PDUs. Utility Protocols – Time of day distribution and Time Broadcast
WALE Addresses	User process and PDU addressing are supported. • WALE PDU addresses are 16-bit binary numbers for individual nodes and multipoint groups. In addition, support for 16-bit network numbers for NATO applications and used as part of the linking protection process is provided. • WALE user process addresses are 3 to 15 printable ASCII characters (not sent OTA).
WALE Waveforms	Two WALE waveforms (3 kHz in bandwidth) are used: • The "Fast" WALE waveform is intended for very fast link setup in voice-quality channels. • The "Deep" WALE waveform is designed for operation in the most challenging channels, including SNR < 0 dB. • Both "Fast" and "Deep" WALE waveforms include half rate, constraint length 9 (CL-9) FEC, block interleaving and 8-PSK modulation.
Scanning Operation	Scanning entails listening for calls and sounding transmissions. Asynchronous scanning: No time synchronization is assumed. System dwells on each channel for the minimum dwell time. Synchronous scanning: Time synchronization is required. System dwell periods are synchronized to the start of a GPS epoch. Support for multiple dwell times: • Mixed 3G / 4G Networks. Scans at 3G ALE speed, with a synchronous dwell time of 1.35 s. • 4G Network with support for both Fast & Deep WALE. Synchronous dwell time is 675 ms. • 4G Network with support for Fast WALE only. Synchronous dwell time is 450 ms.
Channel Records/ Occupancy Detection	Up to 255 channel records containing information for a channel (e.g. frequency, bandwidth, occupancy records). Occupancy detection (used during LBT and LBR) based on integrated energy detection for the wideband channel.
Linking Protection	HALFLOOP Linking Protection, 128-bit key. HALFLOOP-96 (WALE PDUs)

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