VEChat Protocol Reference

Third-Party Developer Guide

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VEChat is an amateur radio packet chat application using AX.25 over AFSK audio modulation. This document describes the message formats, framing, and protocol conventions needed to build a compatible third-party application.

All VEChat traffic uses AX.25 UI frames addressed to the destination callsign "VECHAT". The info field carries UTF-8 text (or zlib-compressed text) with a structured payload format.

1. Message Payload Format

The AX.25 info field carries a UTF-8 text payload (or its zlib-compressed form). The payload uses colon (:) as the field separator. All VEChat messages begin with a 10-digit message ID derived from the Unix epoch timestamp.

1.1 Message ID

The message ID is the Unix epoch time in seconds, zero-padded to exactly 10 decimal digits. For example, epoch 1735000000 becomes the string "1735000000". The parser identifies messages by checking whether the text before the first colon is exactly 10 decimal digits.

1.2 Message Types

Message Type	Wire Format	Example
Broadcast	id:text	1735000000:Hello net!
Direct (unicast)	id:u:callsign:text	1735000000:u:VE3ABC:Hi
Group	id:g:group:text	1735000000:g:EMCOMM:Net msg
Ping	id:p:	1735000000:p:
ACK	ack:id	ack:1735000000

Any message type (except ACK) can optionally include a grid locator by inserting l:grid: immediately after the message ID. For example, a broadcast with grid: "1735000000:l:FN31pr:Hello net!". The l: prefix always comes before u:, g:, or p:.

1.3 Type Prefixes

Prefix	Meaning	What Follows
l	Grid locator	Maidenhead grid (4 or 6 chars)
u	Unicast (direct)	Target callsign
g	Group	Group name
p	Ping (presence)	Nothing (empty)

1.4 Parsing Rules

The parser processes the info field text in this order:

- If the string starts with "ack:" and the remainder is all digits, it is an ACK frame.
- If the text before the first colon is exactly 10 decimal digits, it is a message ID. The text after the ID is parsed for optional prefixes: l: (grid), then p: (ping), u: (direct), or g: (group). Remaining text is the message body.
- Anything else is ignored (unrecognized format).

1.5 Grid Locator

An optional Maidenhead grid locator (4 or 6 characters, e.g. "FN31" or "FN31pr") can be included using the l: prefix immediately after the message ID. It indicates the sender's geographic grid square.

2. ACK and Reliability

2.1 Direct Message ACKs

Direct (unicast) messages are the only type that uses ACK-based reliability. When a station receives a direct message addressed to its callsign (u:mycall:), it immediately responds with an ACK frame: "ack:<messageId>".

The sender retries unacknowledged direct messages up to 3 times at intervals of 10s, 15s, and 30s. After all retries, a final wait of 10s is applied before marking the message as failed.

2.2 Broadcast / Group / Ping Reliability

Broadcasts, group messages, and pings use a simpler approach: each is sent twice with a 5-second gap. The receiver deduplicates by (source callsign + message ID), maintaining a rolling set of up to 100 seen IDs per callsign.

2.3 Ping ACK Behavior

Pings also receive an automatic ACK, but with two important differences from direct message ACKs:

- Rate limiting: only one ACK per source callsign every 10 minutes (600 seconds). This prevents excessive traffic when multiple stations are pinging.
- Delayed response: the ACK is sent after a 10-second delay to allow the sender's second ping copy (sent 5s after the first) to finish transmitting.

3. AX.25 Frame Format

3.1 Frame Layout

```
[ Destination address  7 bytes ]
[ Source address       7 bytes ]
[ Control field        1 byte  ]  = 0x03 (UI frame)
[ PID field            1 byte  ]  = 0xF0 or 0x21
[ Info field           N bytes ]  = payload (UTF-8 or zlib)
[ FCS / CRC            2 bytes ]  = CRC-CCITT
```

VEChat uses AX.25 UI (Unnumbered Information) frames exclusively. No digipeater path is included in transmitted frames. Received frames with repeater addresses are accepted (the parser skips over them).

3.2 Address Encoding

Each address field is 7 bytes. Bytes 0-5 contain the callsign characters, each ASCII code shifted left by 1 bit. Shorter callsigns are padded with spaces (0x40 = ' ' << 1). Byte 6 is the SSID byte: ('0' + ssid) << 1. Bit 0 of byte 6 of the last address field is set to 1 as the end-of-address marker.

3.3 VECHAT Destination

ALL VEChat traffic is addressed to the fixed AX.25 destination callsign "VECHAT" (no SSID). This is the primary channel identifier. Any packet with a different destination is ignored by the VEChat message handler.

3.4 Control and PID

Field	Value	Meaning
Control	0x03	AX.25 UI frame
PID	0xF0	Uncompressed UTF-8 payload
PID	0x21	zlib-compressed payload

3.5 CRC

CRC-CCITT initialized to 0xFFFF. Covers all bytes from the destination address through the info field. The 2-byte FCS is appended in little-endian order (low byte first, ones-complement of the CRC). The decoder also attempts single-bit error correction via bit-flipping before discarding a frame.

3.6 Maximum Frame Size

The maximum AX.25 frame is 512 bytes. In practice, FX.25 RS data block capacity limits the HDLC-framed content to 239 bytes, yielding roughly 200-220 bytes of raw AX.25 frame content.

4. Payload Compression

When compression is enabled, the payload string is compressed using zlib (deflate). The compressed form is only used if it is strictly smaller than the UTF-8 original. Short messages (ACKs, pings) rarely benefit from compression and are sent uncompressed.

TX: encode payload to UTF-8, attempt zlib compress. If smaller, use PID 0x21; otherwise PID 0xF0.

RX: frames with PID 0x21 are always zlib-decompressed, regardless of local settings. Frames that fail decompression are silently discarded.

5. FX.25 Forward Error Correction

FX.25 wraps AX.25 frames with a Reed-Solomon codeblock for error recovery. It is the default TX mode in VEChat.

5.1 FX.25 Frame Layout

```
[ Correlation Tag   8 bytes ] 64-bit LE tag identifying RS params
[ Data block        N bytes ] HDLC-framed AX.25 + 0x7E padding
[ RS Parity bytes   P bytes ] Reed-Solomon parity
```

Total FX.25 frame size = 8 + codeblock_size bytes (max 263 bytes).

5.2 Correlation Tags

11 tags are defined, selected by data length. VEChat prefers 32-parity codes for best error correction. Tags are stored and transmitted little-endian.

Tag	64-bit Value (hex)	Data	Parity	Block
0x01	B74DB7DF8A532F3E	239	16	255
0x02	26FF60A600CC8FDE	128	16	144
0x03	C7DC0508F3D9B09E	64	16	80
0x04	8F056EB4369660EE	32	16	48
0x05	6E260B1AC5835FAE	223	32	255
0x06	FF94DC634F1CFF4E	128	32	160
0x07	1EB7B9CDBC09C00E	64	32	96
0x08	DBF869BD2DBB1776	32	32	64
0x09	3ADB0C13DEAE2836	191	64	255
0x0A	AB69DB6A543188D6	128	64	192
0x0B	4A4ABEC4A724B796	64	64	128

5.3 Data Block Content

The data block contains the AX.25 frame HDLC-framed (opening 0x7E flag + bit-stuffed data + CRC + closing 0x7E flag), padded with 0x7E bytes to fill the data block capacity. This ensures a standard AX.25 decoder can still decode the embedded HDLC frame.

5.4 Reed-Solomon Codec

GF(2^8), primitive polynomial 0x11D. Corrects up to parity_bytes/2 byte errors. The receiver detects correlation tags within Hamming distance 5.

6. HDLC Framing and NRZI Encoding

6.1 NRZI

Bit encoding uses NRZI (Non-Return-to-Zero Inverted): a 1-bit means no tone change; a 0-bit means toggle between mark and space frequencies. Note: FX.25 outer data uses NRZI but no bit-stuffing.

6.2 Bit Stuffing

For standard AX.25 (non-FX.25): after five consecutive 1-bits, a 0-bit is inserted. The demodulator removes stuffed zeros. FX.25 outer transmission has no bit-stuffing; only the inner HDLC within the data block uses it.

6.3 Frame Delimiting

Flag byte: 0x7E (01111110). Sent without bit-stuffing as preamble and postamble. Bit order is LSB first (standard AX.25).

7. AFSK Modulation

7.1 1200 Baud (VHF/UHF)

Parameter	Value
Standard	Bell 202
Bit rate	1200 baud
Mark frequency	1200 Hz
Space frequency	2200 Hz
TX sample rate	48000 Hz
RX sample rate	22050 Hz
Default preamble	25 flags (~167 ms)
Default postamble	5 flags (~33 ms)

7.2 300 Baud (HF)

Parameter	Value
Bit rate	300 baud
Mark frequency	1600 Hz
Space frequency	1800 Hz
TX sample rate	48000 Hz
RX sample rate	22050 Hz
Default preamble	10 flags (~267 ms)
Default postamble	3 flags (~80 ms)

7.3 Modulation Details

Pure sinusoidal AFSK with continuous phase across tone transitions (no phase discontinuity at frequency changes). Demodulation uses a quadrature correlator (mark/space energy comparison) with clock recovery.