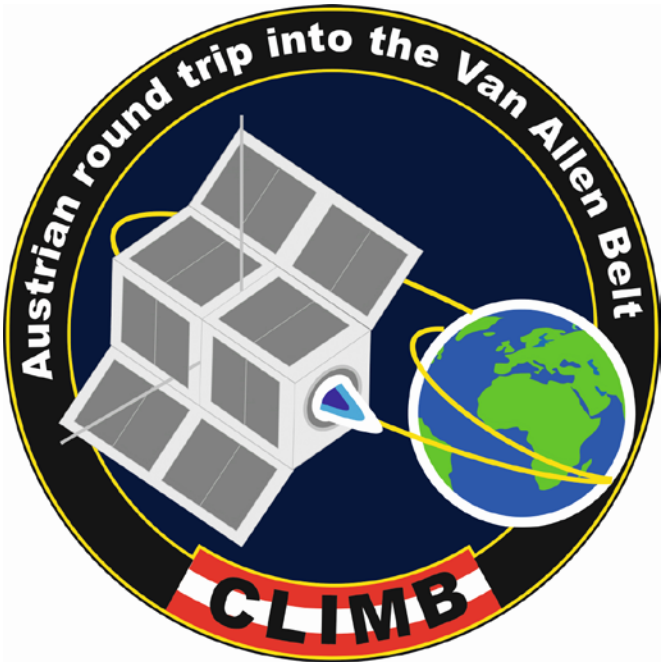


Manual for Radio-Amateurs

for receiving and decoding
S-Band (2400-2450 MHz) telemetry data of the
CLIMB satellite

This document is a preliminary version
and may be changed without notice!

DOCUMENT CHANGE RECORD	
Project: CLIMB- Communication	
Change Status Log:	
V0.1, 11. 2. 2020, MT	Document created from previous documents

Abbreviations

ADCS	Attitude Control System
AID	Address Identifier
CALL	Call Sign (Ham Radio Call Sign) of the satellite
CRC	Cyclic Redundancy Checksum
E-Beacon	EPS-Beacon
EPS	Electrical Power System
FEC	Forward Error Correction (RS Code)
GPS	Global Positioning System
GS	Ground Station
IARU	International Amateur Radio Union
ILEOP	Initial Launch and Early Orbit Phase
LEOP	Launch and Early Orbit Phase
MCC	Mission Control Center
OBC	Onboard Computer
O-Beacon	OBC-Beacon
PCB	Printed Circuit Board
PID	Protocol Identifier
RS	Reed Solomon
RSSI	Received Signal Strength Indication
RTC	Real Time Clock
S-Beacon	STACIE-Δ-Beacon
SDC	Space Data Center
Side-P	Side Panels
STG-A	Space Tech Group Austria
STACIE-Δ	Space Telemetry And Command Interface UHF
TRX	Transceive, Transceiver
TX	Transmit, Transmitter
TT-32	Thomas Turetschek 32 byte protocol
WOD	Whole Orbit Data

1. Radio Engineering Parameter of CLIMB (S-Band)

The satellite CLIMB is a 3U CubeSat with an S-Band TRX module. This communication module is called STACIE-Σ. The antenna is a 5dBi gain patch antenna with RHCP polarisation.

Downlink Frequency	(2400-2450 MHz)
TX power max	33dBm, 2W
Modulation	GFSK
Polarisation	RHCP
Protocol	TT-32

2. TT-32 Protocol

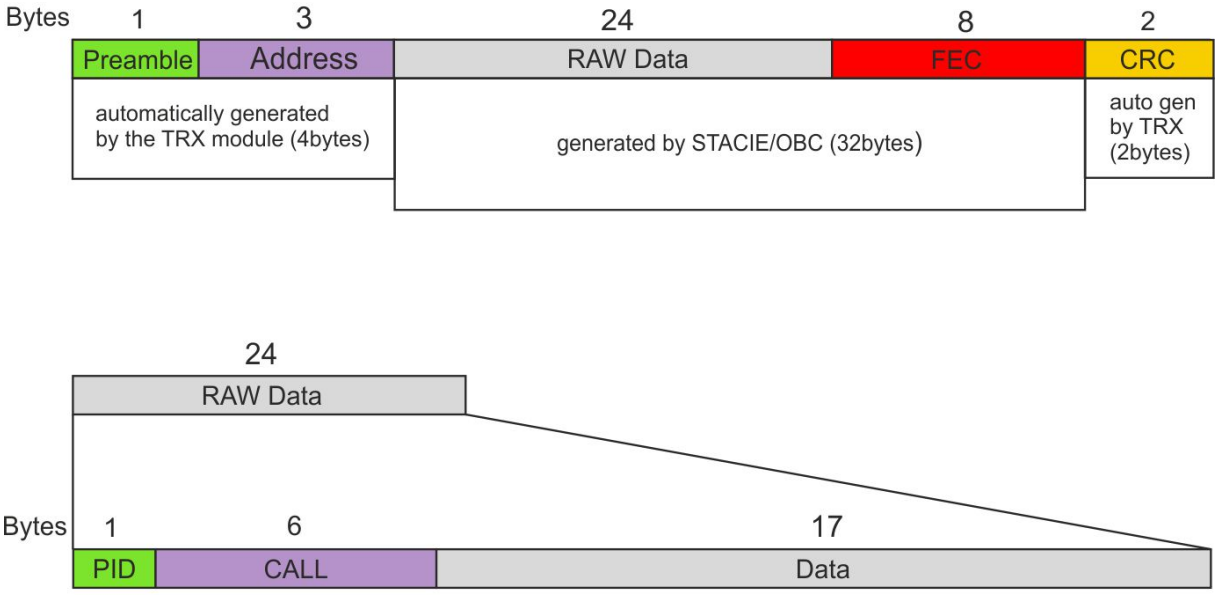
The TT-64 protocol regulates the data transfer between the satellite and the GS in both directions (air interface). The TT-32 protocol supports the time division multiplex method (semi duplex communication).

A complete data packet consists of a 38 bytes string, whereas 6 bytes are created automatically by the TRX module of the communication interface STACIE-Σ for synchronizing and receiver tuning, addressing and for the CRC. The remaining 32 bytes are data bytes. The last 8 bytes are used for the FEC.

2.1 Down-Link

From the 46 bytes of data, 1 byte must be the PID and 6 bytes the CALL. The CALL is the official call sign of the satellite.

38 bytes total packet length
32 bytes data packet length



Preamble:	uses for receiver tuning, consists of alternating 0 and 1
Address:	Byte 1+2 synchronizes the bit stream, Byte 3 addresses the receiver
CRC:	cyclic redundancy checksum
FEC:	RS code, can fix up to 8 errors
PID:	Protocol identifier, to distinguish between different protocols (subsystem address)
CALL:	Call Sign of the satellite

2.2 PID Regulation

The PID regulates if the OBC or STACIE-Σ is the responsible subsystem of the data packet, the direction of the packet and an assignment to a special beacon.
With the PIDs it is possible to distinguish between the different beacons and route them to the beacon dependent decoding operations.

Assigned PIDs

Content	hex	binary

2.3 CALL

The assigned call sign of the satellite PEGASUS is

Symbol						
Hex						
Binary						

2.4 FEC and CRC

In principle there is no need to use FEC and CRC for receiving and decoding the beacons. Anyway, if CRC and FEC are not used by the decoding operation, there is no indication of errors in the raw data.

CRC
The Cyclic Redundancy Checksum (CRC) is a standard
CRC16 Checksum

FEC
The Forward Error Correction (FEC) is a Reed Solomon (RS) code with the following Specifications:
RS(n=64,k=48)
Generator-polynomial-coefficients:
[79,44,81,100,49,183,56,17,232,187,126,104,31,103,52,118]
It is possible to repair 8 errors per 64bit packet.