AIRCRAFT
ELECTRONICS

KRT2 Series

Remote RS232 Protocol

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Document Control – Record of Revisions

Rev.	Date	By	Summary
000	27 May 2020	EJ	Initial release – derived from TQ document # KRT2.A-IFD.MCU-RTI Version 20
001	29 Sep 2020	EJ	Removed <mNr> line from Section 2.4 Set New Standby Frequency and Channel Name
002	07 Dec 2020	T.Lehwald	Sect. 2.1 Improved description Sect. 2.4 Example correction Replace “main module” by “radio module”
003	11 May 2021	T.Lehwald	Chapter 1: Fix wrong Stop Bits Chapter 2.3: Fix wrong XOR checksum for example message

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Introduction

This document contains the interface specifications for the RS232 serial connection between the KRT2-F/S/S2/L/P transceiver (herein “radio module”) and a remote control unit (herein “remote module”) e.g. the KRT2-D remote head module.

1. Remote Interface Overview

The data format for the serial communication is as follows:

- Baud rate 9600
- Data bits 8
- Stop bits 1
- Parity none
- Handshake none

2. Bidirectional Command Messages

The following command messages are bidirectional; they may be originated from the radio module and transmitted to the remote module, or vice versa. Messages from the radio module to the remote module can be generated, transmitted, and complied with by the remote module at any time regardless of the state of the remote connection confirmation flag (as described below). However, messages running the opposite direction (remote module to radio module) may only be transmitted and complied with by the radio module only if the remote connection confirmation flag is active.

2.1 Remote Connection Confirmation

Starting with initial power-up, the radio module pings an ASCII “S” (0x53) over the RS232 connection and repeats every few seconds. If the remote module answers this query with any ASCII character within 60ms, the radio module recognizes the connection as active and activates a yellow “r” flag on the display to mark the remote connection as established.

This is immediately followed by sending the current device status of the main module (see *2.3 Set New Active Frequency and Channel Name*, *2.6 Set Receiver Volume, Receiver Squelch, and VOX squelch, MIC selection*, *2.7 Configure PTT Buttons*, *2.8 Set Intercom Volume*, *2.9 Set External Audio Input Volume*, *2.10 Set Sidetone Level*).

Sending of radio module device status and settings will happen only once immediately after confirming the ping “S” query for synchronization. If the connection is lost, the radio module tries again to re-establish the connection.

The same procedure aforementioned may also be used in the other direction wherein the remote queries the radio module every few seconds for trying to establish a connection. If this becomes success the remote connection is marked active with the "r" symbol in the display too. Local changes at the radio module will be send to the remote module.

Note:

Even if the connection to a remote module is not established, the remote module can send control commands (not all commands supported in this case) to the radio module to force changes. But in contrast to an established connection, local changes at the radio module (i.e. exchange passive and active frequency by button push, volume changes and so on) will not be send to the remote module!

2.2 Exchange Active and Standby

This command exchanges the data (frequency and channel name, if any) in the active field with the data in the standby field. In a non-remote setting, this task is normally accomplished by pressing the flip-flop button.

0x02	STX
0x43	class code “C” – exchange active/standby

The receiving module responds by replying with ACK (0x06).

2.3 Set New Active Frequency and Channel Name

This command directly inputs a new frequency and channel name into the active field.

0x02	STX
0x55	class code “U” – input new active frequency and name
<MHz>	desired MHz frequency (118~136)
<kHz>	desired kHz channel (0~198); see Section 2.13)
<n0> ... <n7>	desired channel name, 8 *alphanumeric* ASCII characters
<checksum>	checksum = <MHz> xor <kHz> (bitwise)

Example Message:

0x02	STX
0x55	command: input new active frequency and name
0x77	0d119 = 119MHz
0x82	0d130 = channel 130 = 650kHz
0x47	“G”
0x47	“G”
0x47	“G”
0x20	[space]
0x41	“A”
0x54	“T”
0x49	“I”
0x53	“S”
0xF5	checksum ... 0x77 xor 0x82

Meaning:

Input new active frequency/name ... 119.650MHz “GGG ATIS”

The receiving module responds by replying with ACK (0x06) or NAK (0x15).

2.4 Set New Standby Frequency and Channel Name

This command directly inputs a new frequency and channel name into the standby field. Note that although the memory slot number is part of the message for display purposes, this parameter is not actually saved into non-volatile memory.

0x02	STX
0x52	class code “R” – input new standby frequency and name
<MHz>	desired MHz frequency (118~136)
<kHz>	desired kHz channel (0~198); see Section 2.13)

<n0> ... <n7>	desired channel name, 8 *alphanumeric* ASCII characters
<checksum>	checksum = <MHz> xor <kHz> (bitwise)

Sample message:

0x02	STX
0x52	command: input new standby frequency and name
0x7B	0d123 = 123MHz
0x00	0d000 = channel 0 = 000kHz
0x4E	“N”
0x35	“5”
0x32	“2”
0x20	[space]
0x43	“C”
0x54	“T”
0x41	“A”
0x46	“F”
0x7B	checksum ... 0x7B xor 0x00

Meaning:

Input new standby frequency/name ... 123.000MHz “N52 CTAF”

The receiving module responds by replying with ACK (0x06) or NAK (0x15).

2.5 Commit a User-Defined Frequency and Channel Name to Memory

This command stores a frequency and channel name combination to the non-volatile memory of the module. This information is stored until deleted or recalled at a later time.

0x02	STX
0x5A	class code “Z” – commit new frequency and channel to memory
<MHz>	desired MHz frequency (118~136)
<kHz>	desired kHz channel (0~198); see Section 2.13)
<n0> ... <n7>	desired channel name, 8 *alphanumeric* ASCII characters
<mNr>	memory slot number (0~99)
<checksum>	checksum = <MHz> xor <kHz> (bitwise)

Sample message:

0x02	STX
0x5A	command: commit new frequency and channel to memory
0x76	0d118 = 118MHz
0xB4	0d180 = channel 180 = 900kHz
0x4F	“O”
0x52	“R”
0x46	“F”
0x20	[space]
0x41	“A”
0x50	“P”
0x50	“P”
0x20	[space]

0x22	0d34 = memory slot #34
0xC2	checksum ... 0x76 xor 0xB4

Meaning:

Store new user-defined channel – 118.900MHz “ORF APP ”, memory slot 34

The receiving module responds by replying with ACK (0x06) or NAK (0x15).

2.6 Set Receiver Volume, Receiver Squelch, and VOX squelch

This command modifies the receiver volume (on-screen: “VOL”), receiver squelch (“SQ”), and intercom squelch (“VOX”). Since this command controls all three variables, a change in only one or two of these variables requires the remaining variables to be re-commanded to their respective current values.

0x02	STX
0x41	class code “A” – enter new VOL, SQ, and VOX
<vol>	receiver volume, 1~20
<squelch>	receiver squelch, 1~10
<VOX_>	intercom squelch, 1~10
<checksum>	checksum = <squelch> + <VOX_>

Sample message:

0x02	STX
0x41	command: enter new VOL, SQ, and VOX
0x0A	0d10 = receiver volume 10
0x03	0d03 = receiver squelch 3
0x02	0d02 = intercom squelch 2
0x05	checksum ... 0x03 + 0x02

Meaning:

Receiver volume = 10, receiver squelch = 3, intercom squelch = 2

The receiving module responds by replying with ACK (0x06) or NAK (0x15).

2.7 Configure PTT Buttons

This command modifies the PTT switch selection. If the command is sent to the radio module, the radio module’s behavior will change, whereas if the command is sent to the remote module, the remote module will simply report the setting change as such.

0x02	STX
0x32	class code “2” – configure PTT buttons
<TXm>	PTT selection (0 = pilot only, 1 = copilot only, 2 = both)

Sample message:

0x02	STX
0x32	command: configure PTT buttons
0x02	0d02 = use both (pilot and copilot) PTT

Meaning:

Use both (pilot and copilot) PTT buttons

The receiving module responds by replying with ACK (0x06) or NAK (0x15).

2.8 Set Intercom Volume

This command modifies the intercom volume (on-screen: “INT”). If the command is sent to the radio module, the radio module’s behavior will change, whereas if the command is sent to the remote module, the remote module will simply report the setting change as such.

0x02	STX
0x33	class code “3” – enter new INT
<InterCm>	intercom volume, 1~9

Sample message:

0x02	STX
0x33	command: enter new INT
0x05	0d05 = intercom volume 5

Meaning:

Intercom volume = 5

The receiving module responds by replying with ACK (0x06) or NAK (0x15).

2.9 Set External Audio Input Volume

This command modifies the external audio input volume (on-screen: “EXT”).

0x02	STX
0x34	class code “4” – enter new EXT
<ExtAud>	external audio input volume, 0~9

Sample message:

0x02	STX
0x34	command: enter new EXT
0x09	0d09 = external audio input volume 9

Meaning:

External audio input volume = 9

The receiving module responds by replying with ACK (0x06) or NAK (0x15).

2.10 Set Sidetone Level

This command modifies the sidetone level (on-screen: “SIT”). If the command is sent to the radio module, the radio module’s behavior will change, whereas if the command is sent to the remote module, the remote module will simply report the setting change as such.

0x02	STX
0x31	class code “1” – enter new SIT
<SideT>	sidetone level, 1~9

Sample message:

0x02	STX
0x31	command: enter new SIT
0x06	0d06 = sidetone level 6

Meaning:

Sidetone level = 6

The receiving module responds by replying with ACK (0x06) or NAK (0x15).

2.11 Set Channel Spacing to 8.33kHz

This command changes the module's channel spacing to 8.33kHz increments. If the command is sent to the radio module, the radio module's behavior will change. If the command is sent to the remote module, the remote module's user interface behavior will change to follow 8.33kHz tuning.

0x02	STX
0x38	class code "8" – set channel spacing to 8.33kHz

There is no acknowledgement from the receiving module.

2.12 Set Channel Spacing to 25kHz

This command changes the module's channel spacing to 25kHz increments. If the command is sent to the radio module, the radio module's behavior will change. If the command is sent to the remote module, the remote module's user interface behavior will change to follow 25kHz tuning.

0x02	STX
0x36	class code "6" – set channel spacing to 25kHz

There is no acknowledgement from the receiving module.

2.13 Channel Designation for kHz Portion of a Frequency Value

Due to the fact that each byte may only contain 8 bits, representing the kHz portion of a frequency in raw numerical form (e.g. 665kHz) is not possible. In order to overcome this limitation, each increment of the 8.33 / 25kHz channel space is assigned to a channel number ranging from 000 to 199, and this channel number is used instead.

The channel number for a particular kHz value is equal to that kHz value divided by 5. However, due to the way the 8.33kHz pseudo-frequency schedule is constructed, note that those channel numbers that correspond to a *displayed* (pseudo) kHz frequency that is 5kHz below every 25kHz increment is invalid (e.g. channel 4, 9, 14, 19, and so forth).

$$n_{chnl} = \frac{f_{kHz}}{5} \begin{cases} 5 \mid f_{kHz} \\ 0 \leq f_{kHz} \leq 995 \\ f_{kHz} \neq 25x - 5, \text{where } x \in \mathbb{Z}^{\geq} \end{cases}$$

Channel	<kHz> Field	Displayed Frequency	Actual Frequency	Channel Space
0	0x00	xxx.000	xxx.0000	25kHz
1	0x01	xxx.005	xxx.0000	8.33kHz
2	0x02	xxx.010	xxx.0083	8.33kHz
3	0x03	xxx.015	xxx.0167	8.33kHz
4		xxx.020	(not used)	
5	0x05	xxx.025	xxx.0250	25kHz
6	0x06	xxx.030	xxx.0250	8.33kHz
7	0x07	xxx.035	xxx.0333	8.33kHz
8	0x08	xxx.040	xxx.0417	8.33kHz
9		xxx.045	(not used)	
		~ ~ ~		
20	0x14	xxx.100	xxx.1000	25kHz
21	0x15	xxx.105	xxx.1000	8.33kHz
22	0x16	xxx.110	xxx.1083	8.33kHz
23	0x17	xxx.115	xxx.1167	8.33kHz
24		xxx.120	(not used)	
		~ ~ ~		
195	0xC3	xxx.975	xxx.9750	25kHz
196	0xC4	xxx.980	xxx.9750	8.33kHz
197	0xC5	xxx.985	xxx.9833	8.33kHz
198	0xC6	xxx.990	xxx.9917	8.33kHz
199		xxx.995	(not used)	

Table 1: kHz channel number designation

3. Remote Module Commands to Radio Module

The following command messages originate from the remote module and are sent to the radio module. These messages may be generated by the remote module, transmitted, and complied by the radio module only when the remote connection confirmation flag is active.

3.1 Set Pilot- and Copilot-Side Microphone Gain

This command sets the pilot-side and copilot-side microphone gain on the radio module. The input range is 1~11; the behavior of the radio module corresponds directly as described in the KRT2 Series Installation Manual, *Section 8.2.1 "Microphone Gain Setup"*.

Note that although a provision exists for this command (as evidenced by its documentation in this manual), the KRT2-D remote head does not incorporate the microphone gain setup menu. If for development purposes it is desired to modify only the pilot-side microphone gain, it is suggested remember the current copilot-side microphone gain, execute this command, then execute the "set copilot-side microphone gain" command (as described in Section 3.2) with the aforementioned copilot-side microphone gain as its argument.

0x02	STX
0x49	class code "I" – set pilot- and copilot-side microphone gain
<lev>	microphone gain, 1~11

Sample message:

0x02	STX
0x49	command: set pilot- and copilot-side microphone gain
0x0B	0d11 = microphone gain 11

Meaning:

Pilot-side and copilot-side microphone gain setting = 11

The radio module responds by replying with ACK (0x06) or NAK (0x15).

3.2 Set Copilot-Side Microphone Gain

This command sets the copilot-side microphone gain on the radio module. The input range is 1~11; the behavior of the radio module corresponds directly as described in the KRT2 Series Installation Manual, *Section 8.2.1 "Microphone Gain Setup"*.

Note that although a provision exists for this command (as evidenced by its documentation in this manual), the KRT2-D remote head does not incorporate the microphone gain setup menu.

0x02	STX
0x4A	class code "J" – set copilot-side microphone gain
<lev>	microphone gain, 1~11

Sample message:

0x02	STX
0x4A	command: set copilot-side microphone gain
0x08	0d11 = microphone gain 8

Meaning:

Copilot-side microphone gain setting = 8

The radio module responds by replying with ACK (0x06) or NAK (0x15).

3.3 Call Next User-Defined Memory Channel to Standby Field

This command is used to call the frequency and name data stored in the next slot of the radio module's non-volatile memory within the context of browsing through the radio module's selection of user-defined channels. In a non-remote setting, this task is normally accomplished by pressing the MEM button to begin browsing user-defined channels, then turning the knob right to increment the channel selection.

Note that if the standby field is not a user-defined channel at the time this command is generated, the radio module will begin indexing the user-defined memory from Slot 00.

0x02	STX
0x57	class code "W" – call next memory channel to standby

The radio module responds by replying with ACK (0x06) or NAK (0x15).

3.4 Call Previous User-Defined Memory Channel to Standby Field

This command is used to call the frequency and name data stored in the previous slot of the radio module's non-volatile memory within the context of browsing through the radio module's selection of user-defined channels.

Note that if the standby field is not a user-defined channel at the time this command is generated, the radio module will begin indexing the user-defined memory from Slot 00. In this scenario, if this command is sent twice in succession, the radio module will call up Slot 00 upon receiving the first command, then Slot 99 upon receiving the second.

0x02	STX
0x77	class code “w” – call previous memory channel to standby

The radio module responds by replying with ACK (0x06) or NAK (0x15).

3.5 Activate DUAL Mode

This command activates the DUAL mode functionality (monitor standby frequency) in the radio module.

Note that this exact message can also be generated by the radio module and transmitted to the remote module; however, in such contexts, the message serves as a status report and not a command (see Section 4 “Status Reports”).

0x02	STX
0x4F	class code “O” – activate DUAL mode

There is no acknowledgement from the receiving module.

3.6 Deactivate DUAL Mode

This command deactivates the DUAL mode functionality (monitor standby frequency) in the radio module.

Note that this exact message can also be generated by the radio module and transmitted to the remote module; however, in such contexts, the message serves as a status report and not a command (see Section 4 “Status Reports”).

0x02	STX
0x6F	class code “o” – deactivate DUAL mode

There is no acknowledgement from the receiving module.

4. Status Reports

Status reports indicate the operational status of certain functions of the radio module. Each status report that activates a flag in the modules causes that module to sustain that flag until it is supplemented by another status report that deactivates (cancels) said flag.

Each status report consists of an ASCII STX (0x02) followed by a message class code, also encoded in ASCII.

Status reports may be generated by the radio module, transmitted, and displayed by the remote module at any time regardless of the remote connection confirmation flag.

Note that the status reports “activate DUAL mode” and “deactivate DUAL mode” may also be generated by a remote module and transmitted to the radio module; in such contexts, the message serves as a command to the radio module to enable and disable DUAL mode functionality, respectively.

STX	Code	ASCII	Meaning	On-Screen Manifestation
0x02	0x42	B	Low battery	Red “BAT”
0x02	0x44	D	Cancel low battery	
0x02	0x4A	J	Transceiver RX	Green “RX”
0x02	0x56	V	Cancel receiver RX	
0x02	0x4B	K	Transceiver TX	Yellow “TX”
0x02	0x59	Y	Cancel transceiver RX, TX or DUAL-RX	
0x02	0x4C	L	Transmitter time-out (stuck mic)	Yellow “Te”
0x02	0x4F	O	DUAL mode on	Yellow “DUAL”
0x02	0x6F	o	DUAL mode off	
0x02	0x4D	M	DUAL-RX, active side	White “^” adjacent to yellow “DUAL”
0x02	0x6D	m	DUAL-RX, standby side	White “v” adjacent to yellow “DUAL”

Table 2: KRT2 status report messages

5. Radio Module Error Reports

Radio module error reports indicate a problem or an abnormal condition in the radio module.

STX	Code	ASCII	Error Meaning
0x02	0x61	a	ADC error
0x02	0x62	b	Antenna impedance mismatch – high VSWR
0x02	0x63	c	FPAA error, startup blocked
0x02	0x64	d	Frequency synthesizer error
0x02	0x65	e	PLL error
0x02	0x66	f	Key inputs blocked
0x02	0x67	g	I2C bus error
0x02	0x68	h	Antenna switch error or damaged D10 diode
0x02	0x46	F	Clear all errors

Table 3: KRT2 error report messages