Multifunctional Handheld Spectrometer
(Nuclear Radiation Analyzer) KC761x

Programming Manual

Applicable Software Version: V1.8

(Trial Version)

科新社

Summary

This manual introduces the communication functions and communication protocol of the KC761x Portable Nuclear Radiation Analyzer. It is primarily intended for engineering and technical personnel engaged in secondary development of the KC761x.

Development Team

Chief Engineer

Tao Le

Engineers

Li Yun Yuan Xinzhi Liu Hu

Consulting Experts

Shi Congwei Xu Nuo Yang Tianhao Ke Wei

KC761x Series Multifunctional Handheld Spectroscopy Analyzer Programming Manual

Author: Tao Le

(Instrumentation Research Institute, Kechuang Academy)

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1. Scope of Application

This manual applies to models KC761A, KC761B, KC761C, and KC761CN. Unless otherwise specified, it is applicable to both Bluetooth Low Energy (BLE) and Ethernet (LAN) connections. The instrument supports integration with Kechuang Cloud. All three communication methods can be used simultaneously, and the instrument will execute all received commands.

2. Interface Definitions

2.1 Ethernet Interface Description

That is, the RJ45 interface supports PoE power supply: IEEE 802.3af (PoE) and IEEE 802.3at (PoE+). Through this interface, a local area network (LAN) connection can be established, and the device can connect to the Kechuang Cloud. This interface uses the TCP/IP protocol.

When connected via LAN, the spectrometer acts as the server. When connected to the cloud, the spectrometer acts as the client.

2.2 Bluetooth Low Energy (BLE) Interface Description

BLE 5.0, GATT protocol. The KC761 functions as the server. Similar to the NUS (Nordic UART Service) protocol, it uses two GATT characteristics to emulate serial port receive and transmit functions.

RX Characteristic UUID: 6E400002-B5A3-F393-E0A9-E50E24DCCA9E

RX Characteristic Property: write (the host writes to the KC761; the write is acknowledged at the GATT protocol level)

TX Characteristic UUID: 6E400003-B5A3-F393-E0A9-E50E24DCCA9E

TX Characteristic Property: notify (the host subscribes to this characteristic; the KC761 sends notifications unidirectionally without requiring acknowledgment from the host)

The principle behind the Bluetooth protocol is to minimize the power consumption and communication latency of the radiometer, which requires the Bluetooth hardware of the radiometer to remain in sleep mode as much as possible and only wake up when sending data or maintaining the connection. In most scenarios, the radiometer pushes data to the host computer using the "notification" method. After sending, it immediately returns to sleep mode without waiting for a response from the host. This results in a relatively high packet loss rate, but its impact is negligible in the application scenarios of this radiometer, as subsequent non-lost transmissions can achieve data synchronization. All data is backed up in the radiometer and can be retrieved through repeated reads if necessary.

To enable fast data synchronization, once the host subscribes to the Bluetooth TX channel, the KC761 automatically starts Bluetooth data upload and pushes data in spectrum mode in the first frame by default.

2.3 Maximum Packet Length of the Protocol

The BLE MTU is negotiated between both communication parties and may vary depending on the host platform, which may result in multiple maximum packet lengths (KC761x maximum MTU = 517). The MTU includes the Bluetooth protocol header, so the actual usable maximum packet length = MTU - 3. If slightly larger data (such as multi-channel spectra or dose-time curves)

needs to be transmitted, the data must be split into multiple segments, causing frequent Bluetooth transmissions. To reduce Bluetooth power consumption and communication overhead, the following maximum packet lengths are defined:

1072B: used only for Ethernet protocol.

504B: used only for BLE, applicable to newer device versions where both sides have MTU ⩾ 507B.

182B: used only for BLE, applicable to older device versions or when new devices fail to request a large MTU, where MTU ⩾ 185.

Most data packets are smaller than the lowest tier (182B), so the maximum packet length makes no difference from the host’s perspective. During communication, the radiometer will autonomously select the currently available maximum packet length, and the host cannot interfere. The host must parse the flag code at the beginning of the packet to identify the packet type and correctly decode the packet based on the agreed structure.

For Bluetooth hosts, MTU ⩾ 507 should be requested whenever possible, so the radiometer will use longer packets, which helps reduce power consumption and communication delay. If MTU < 185 is used, the radiometer will not respond to commands, and the host should inform the user “Bluetooth version too low.” In common Bluetooth libraries, a smaller MTU may be used by default when establishing the connection, and it should be explicitly specified.

2.4 Cloud Connection Verification

To reduce development complexity and simplify the communication process, data is transmitted in plaintext. To prevent attackers from injecting false data into the Kechuang Cloud, a verification code is added to cloud connections, compared to Bluetooth/LAN.

1.After connecting to the cloud service, the radiometer sends an 8-byte data packet to the server at regular intervals until it receives any properly formatted command from the server.

2.When the cloud server sends commands to the radiometer, it appends a 32-byte verification code to the end of the original data packet. If the user builds a private cloud (currently unsupported), the 32-byte verification code can be all zeros.

3.When the radiometer sends data to the cloud server, it appends a 32-byte verification code to the end of the original data packet. If the user builds a private cloud (currently unsupported), this 32-byte verification code should be ignored.

3. Communication Protocol

3.1 Spectrum Data acquisition

3.1.1 Spectrum acquisition Command

This command is used to retrieve the complete multi-channel spectrum (also referred to as the spectrum, but excluding energy conversion data) from the KC761.

Host sends:

Data Name	Data Width (Bytes)	Data Type	Specified Value	Data Meaning

NULL	1	uint	0x00	Placeholder
CMD_GET_MC_DATA	1	uint	0x52	Command Code (Get Multi-channel Data)
SYNC	1	uint		Frame Synchronization Marker, see notes
MC_DATA_SOURCE	1	uint	[0x00-0x02]	Multi-channel Data Source Marker, see notes
NULL	1	uint	0x00	Placeholder
Packet Length	5			

Notes:

NULL — Used as a placeholder, has no actual meaning, must be filled with 0.

SYNC — Known as the "Frame Synchronization Marker", the host can decide to fill it with any value, and the data packet returned by the KC761 will repeat this value. It is mainly used to distinguish the correspondence between request and response data packets.

MC_DATA_SOURCE — Multi-channel Data Source Marker. The KC761 may have multiple multi-channel spectra, and this data is used to mark which spectrum it refers to. The definition is as follows:

MC_DATA_SOURCE Definition		
Device Model	Multi-channel Spectrum Names	MC_DATA_SOURCE value
KC761 Series	Gamma Sensor Multi-channel Spectrum	0x00
	Neutron Sensor Multi-channel Spectrum	0x01
	PIN Sensor Multi-channel Spectrum	0x02

3.1.2 KC761 Sends Spectrum

The KC761 response, multi-channel data packet (MC_DATA):

Data Name	Data Width (Bytes)	Data Type	Specified Value	Data Meaning
SYNC	1	uint		Frame Synchronization Marker
MC_DATA_FLAG	1	uint	0xA0	Multi-channel Data Flag
BAG_LEN	2	uint	9+2N	Packet Length of This Data
MC_DATA_SOURCE	1	uint		Multi-channel Data Source Marker
MC_OFFSET	2	uint		Channel Address Offset, see notes
MC_RATIO	2	uint		Multi-channel Scaling Factor, see notes
MC_DATA [0+ MC_OFFSET]	2	uint		Relative Count of Channel [0 + MC_OFFSET], see notes
MC_DATA [1+ MC_OFFSET]	2	uint		Relative Count of Channel [1 + MC_OFFSET]
…				
MC_DATA [N-1+ MC_OFFSET]	2	uint		Relative Count of Channel [N-1 + MC_OFFSET]
Packet Length	9+2N			

Notes:

SYNC — Same as the SYNC value sent by the host.

MC_DATA_FLAG — 0xA0: This packet is a response to the host's multi-channel data request;

0xA1: This packet is automatically uploaded by the KC761 (see Section "3.3.2 Auto Upload –

Spectrum Mode").

MC_OFFSET — Channel address offset, i.e., the channel number of the first data point in this packet. A full spectrum transmission consists of multiple packets. The host should use this value to assemble the spectrum data correctly. As BLE communication is prone to packet loss, the host should update partial data upon receiving any packet without waiting for all packets to arrive.

MC_RATIO — Multi-channel scaling factor for this packet. The 2-byte relative count per channel can express up to 65535 counts, which may be insufficient in some cases. This variable is used for scaling and must be >= 1. See next item for details.

MC_DATA[k] — Relative count of channel k. Actual count = relative count × MC_RATIO.

N — Number of channels contained in each packet. This depends on the maximum packet length.

The following table describes the relationship between the total number of channels, maximum packet length, N, and actual packet length in this instruction:

Total Channels	Max Packet Length (Bytes)	Total Packets	Channels per Packet (N)	Actual Packet Length (Bytes)
4096	1072	8	512	1033
4096	504	18	228	465
4096	182	48	86	181
2048	1072	4	512	1033
2048	504	9	228	465
2048	182	24	86	181
1024	1072	2	512	1033
1024	504	5	228	465
1024	182	12	86	181

The last data packet in this command may contain some channel data that exceeds the actual range of the spectrometer. The spectrometer will fill the excess part with 0xFFFF.

Example 1: For the KC761 series, with a total of 2048 channels and Bluetooth MTU = 510. After deducting the 3-byte Bluetooth protocol overhead, the actual usable packet length is 507 > 504, so the protocol uses the maximum packet length of 504. This results in 9 packets, each containing 228 channels data, for a total of 2052 channels. The last four channels in the final packet exceed the actual range and are filled with 0xFFFF.

Example 2: If Bluetooth MTU = 256, then 182 < 256 - 3 < 504, so the maximum packet length is 182. A total of 24 packets is needed to transmit 2048 channels.

Example 3: If Bluetooth MTU = 180, then 180 - 3 < 182, which does not meet the minimum packet length required by this protocol. The spectrometer will not respond.

3.2 Reading and Setting Real-Time Status

3.2.1 Reading Device Real-Time Status

Used to obtain the KC761's real-time statistical data and current status information.

Host sends:

Data Name	Data Width (Bytes)	Data Type	Specified Value	Data Meaning
NULL	1	uint	0x00	Placeholder
CMD_GET_STA	1	uint	0x53	Command Code (Get Device Real-Time

				Status)
SYNC	1	uint		Frame Synchronization Marker
NULL	1	uint	0x00	Placeholder
Packet Length	4			

KC761 Response, Device Real-Time Status Data Packet (STATUS_DATA):

Data Name	Data Width (Bytes)	Data Type	Data Meaning
SYNC	1	uint	Frame Synchronization Marker
STATUS_DATA_FLAG	1	uint	Status Data Flag 0xA2
BAG_LEN	2	uint	Packet Length
RAD_SENSOR_STATUS	1	uint	Radiation Sensor Status
VOLUME_STATUS	1	uint	Volume Status
LED_SCREEN_STATUS	1	uint	Light and Screen Status
AUTO_UPLOAD_STATUS	1	uint	Automatic Data Upload Status
BAT_PERCENT	1	uint	Battery Percentage (%)
AIR_PRESSURE3BA	2	uint	Pressure (hPa)
DEVICE_TEMP	2	int	Device Temperature (0.1° C)
DEVICE_TIME	4	time_t	Device Time, UNIX Timestamp
RESERVE	16	-	Reserve
RAD0_RAW_CPS	4	int32	Sensor Slot 0 Real-Time Count Rate (cps)
RAD0_RAW_DOSE_RATE	2	FP16	Sensor Slot 0 Real-Time Dose Rate (mGy/h)
RAD0_RAW_DOSE_EQ_RATE	2	FP16	Sensor Slot 0 Real-Time Dose Equivalent Rate (mSv/h)
RAD0_AVG_CPS	4	float	Sensor Slot 0 Smoothed Count Rate (cps)
RAD0_AVG_DOSE_RATE	2	FP16	Sensor Slot 0 Smoothed Dose Rate (mGy/h)
RAD0_AVG_DOSE_EQ_RATE	2	FP16	Sensor Slot 0 Smoothed Dose Equivalent Rate (mSv/h)
RAD1_RAW_CPS	4	int32	Sensor Slot 1 Real-Time Count Rate (cps)
RAD1_RAW_DOSE_RATE	2	FP16	Sensor Slot 1 Real-Time Dose Rate (mGy/h)
RAD1_RAW_DOSE_EQ_RATE	2	FP16	Sensor Slot 1 Real-Time Dose Equivalent Rate (mSv/h)
RAD1_AVG_CPS	4	float	Sensor Slot 1 Smoothed Count Rate (cps)
RAD1_AVG_DOSE_RATE	2	FP16	Sensor Slot 1 Smoothed Dose Rate (mGy/h)
RAD1_AVG_DOSE_EQ_RATE	2	FP16	Sensor Slot 1 Smoothed Dose Equivalent Rate (mSv/h)
RAD2_RAW_CPS	4	int32	Sensor Slot 2 Real-Time Count Rate (cps)
RAD2_RAW_DOSE_RATE	2	FP16	Sensor Slot 2 Real-Time Dose Rate (mGy/h)
RAD2_RAW_DOSE_EQ_RATE	2	FP16	Sensor Slot 2 Real-Time Dose Equivalent Rate (mSv/h)
RAD2_AVG_CPS	4	float	Sensor Slot 2 Smoothed Count Rate (cps)
RAD2_AVG_DOSE_RATE	2	FP16	Sensor Slot 2 Smoothed Dose Rate (mGy/h)
RAD2_AVG_DOSE_EQ_RATE	2	FP16	Sensor Slot 2 Smoothed Dose Equivalent Rate (mSv/h)
Packet Length	81		

Notes:

STATUS_DATA_FLAG — Status data flag. 0xA2 indicates that this packet is a response to an inquiry from the host machine for status data. 0xA3 indicates that this packet is an automatically uploaded status data from the KC761 (see "3.3 Automatic Data Upload").

RAD_SENSOR_STATUS — For the KC761x, defined as follows:

RAD_SENSOR_STATUS Definition							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
			Sensor2 Energy Spectrum Accumulation	Sensor1 Energy Spectrum Accumulation	Sensor0 Energy Spectrum Accumulation	Sensor Selection	

Energy Spectrum Accumulation — 0b = Do not accumulate energy spectrum; 1b = Accumulate energy spectrum.

Sensor Selection — 00b = Gamma sensor; 01b = Neutron sensor; 10b = PIN sensor. This option implies the operational status of the radiation sensor, with the following rules:

(1) The PIN sensor cannot operate simultaneously with other sensors. When the PIN sensor is enabled, the other sensors will be turned off, and the host will not be able to obtain related data.

(2) If the device has a neutron sensor, the gamma and neutron sensors will be enabled simultaneously.

VOLUME_STATUS — Volume status, defined as follows:

VOLUME_STATUS Definition:							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
			Dense Counting Tone Effect	Enable Key Press Sound	Enable Counting Sound	Global Volume	

Global Volume Definition

00b = Global Mute;

01b = Low Global Volume;

10b = High Global Volume.

It should be noted that the KC761's alarm sound will not be affected by this setting (it will not be muted or reduced in volume).

Dense Counting Effect:

1b = Enable dense counting effect.

This series of radiometers features high sensitivity, with typical background count rates exceeding 10 cps. To make the counting effect (particle sound, LED flash) resemble that of a traditional Geiger counter, a random sampling algorithm is used—only after every n counts will a sound and light signal be triggered. Enabling this option reduces the value of n, making the counting effects more frequent.

LED_SCREEN_STATUS — LED and Screen Status, defined as follows:

LED_SCREEN_STATUS Definition							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
					Backlight Brightness	Enable Backlight	Enable Counting LED Flash

Enable Backlight: Indicates whether the backlight is currently on.

Backlight Brightness: 0b = Dim, 1b = Brightest. The firmware of the KC761 may not support adjustable brightness.

AUTO_UPLOAD_STATUS — Automatic upload status. 0x00 = Automatic upload off, 0x01 = Enable automatic upload. To quickly synchronize data, when the host subscribes to the Bluetooth TX channel, the KC761 will automatically enable Bluetooth automatic upload and push data in spectrum mode in the first frame.

DEVICE_TIME — Local time of the KC761. It follows the UNIX timestamp format.

RAD_RAW_CPS — Count rate of the previous second, indicating how many radiation events the corresponding sensor detected. If the sensor is not enabled, it will return -1 (same for the following fields).
RAD_RAW_DOSE_RATE — Dose rate of the previous second, in mGy/h. If the sensor is not enabled, it will return -1.
RAD_RAW_DOSE_EQ_RATE — Dose equivalent rate of the previous second, in mSv/h. If the sensor is not enabled, it will return -1.
RAD_AVG_CPS — Smoothed count rate over a period of time, automatically calculated by the KC761 using built-in smoothing logic. The related smoothing logic works as follows: the higher the count rate, the shorter the smoothing window, the better the data real-time performance. When the count rate is very high, the smoothing window may be 1, which is equivalent to the real-time count rate. The lower the count rate, the longer the smoothing window, and the worse the data real-time performance. If the sensor is not enabled, it will return -1.
RAD_AVG_DOSE_RATE — Smoothed dose rate over a period of time, in mGy/h. If the sensor is not enabled, it will return -1.
RAD_AVG_DOSE_EQ_RATE — Smoothed dose equivalent rate over a period of time, in mSv/h. If the sensor is not enabled, it will return -1.
RAD0-2: In the KC761 series, RAD0 = Gamma sensor slot; RAD1 = Neutron sensor slot; RAD2 = PIN sensor.

3.2.2 Set Operating Status

Host sends:

Data Name	Data Width (Bytes)	Data Type	Specified Value	Data Meaning
NULL	1	uint	0x00	Placeholder
CMD_SET_STA	1	uint	0x62	Command Code (Set Device Real-time Status)
SYNC	1	uint		Frame Synchronization Mark
RAD_SENSOR_STATUS	1	uint		Set Radiation Sensor Status
VOLUME_STATUS	1	uint		Volume Status
LED_SCREEN_STATUS	1	uint		Lighting and Screen Status
AUTO_UPLOAD_STATUS	1	uint	0x00/0x01	Automatic Data Upload Status
NULL	1	uint	0x00	Placeholder
Packet Length	8			

Notes:
The data definitions are essentially the same as those in "3.2.1 Read Device Real-Time Status," with the following differences:
For parameters that should not be overwritten, the corresponding byte can be written as 0xFF, and the KC761 will skip the related setting.
RAD_SENSOR_STATUS – If a non-existent sensor (e.g., neutron sensor) is selected, the setting will not take effect.
LED_SCREEN_STATUS – If the host writes 1b to the "Enable Backlight" bit, the KC761 will keep the backlight on; conversely, writing 0b will turn off the backlight.
AUTO_UPLOAD_STATUS – 0x00 = Disable automatic upload, 0x01 = Enable automatic upload. For Bluetooth upper computers, automatic upload should be used as much as possible to reduce the need for active instruction transmission. This helps reduce the KC761's power consumption.

KC761 Response:

Data Name	Data Width (Bytes)	Data Type	Specified Value	Data Meaning
SYNC	1	uint		Frame Synchronization Mark
CMD_ACK	1	uint	0xAA	Response Data Flag 0xAA
BAG_LEN	2	uint	6	Packet Length
STATUS	1	uint	0x00/0x01	0x00 = Setting Successful, 0x01 = Setting Failed
CMD_SET_STA	1	uint	0x62	Repeat the Corresponding Host Command Code
Packet Length	6			

3.3 Automatic Data Upload

3.3.1 Automatic Upload - Stream Mode

After setting the AUTO_UPLOAD_STATUS to 0x01, the KC761 will automatically upload data every 1 second. When the count rate is low, the KC761 will upload only one stream mode data packet. As the count rate increases, the KC761 may upload 2-3 stream mode data packets. Once the count rate exceeds a certain threshold, the KC761 will switch to spectrum mode for data upload. The host computer cannot interfere with the format of the automatically uploaded data packets.
The first packet of each upload cycle is as follows:

Data Name	Data Width (Bytes)	Data Type	Specified Value	Data Meaning
STATUS_DATA	81			Reference "3.2.1 Read Device Real-Time Status"”
SYNC	1	uint		Frame Sync Marker
STREAM_DATA_FLAG	1	uint	0xA4	Stream Data Flag
BAG_LEN	2	uint	4+2N	Packet Length
PULSE[0]	2	uint		Pulse Data[0], see notes
PULSE[1]	2	uint		Pulse Data[1]
…				
PULSE[N-1]	2	uint		Pulse Data[N]
Packet Length	81+4+2N			

Notes:
STATUS_DATA – This is mostly the same as the section "3.2.1 Read Device Real-Time Status" with the following differences:
(1) STATUS_DATA_FLAG = 0xA3, indicating that this is the status data uploaded automatically by the KC761.
(2) SYNC is decided by the KC761. After each round of automatic upload, SYNC will automatically increment by 1, with a range of 0x00 – 0xFF.
PULSE – Raw multi-channel data of nuclear pulses, with each pulse described by 2 bytes. The upper 2 bits represent the data source, defined the same as in "MC_DATA_SOURCE," and the lower 14 bits represent the pulse channel address. The upper computer should accumulate each

pulse into the corresponding channel address. If the upper computer has previously received the KC761's multi-channel chart, and every subsequent stream data packet can be delivered, the multi-channel chart on both the upper computer and the KC761 should be synchronized.

N: Indicates how many pulses this data packet carries. Due to the actual pulse count and the maximum packet length limit, N may vary and N <= 473. When using spectrum mode for data upload, N = 0.

If the data packet above cannot accommodate all the pulses from each upload cycle, the remaining pulses will be placed into a stream data packet with the following structure:

Data Name	Data Width (Bytes)	Data Type	Specified Value	Data Meaning
SYNC	1	uint		Frame Sync Mark
STREAM_DATA_FLAG	1	uint	0xA4	Stream Data Flag
BAG_LEN	2	uint	4+2N	Packet Length
PULSE[0]	2	uint		Pulse Data[0] (see notes)
PULSE[1]	2	uint		Pulse Data[1]
…				
PULSE[N-1]	2	uint		Pulse Data[N]
Packet Length	4+2N			

Notes:
SYNC - Frame synchronization mark, determined by the KC761. After each round of automatic upload, SYNC will automatically increment by 1, ranging from 0x00 to 0xFF, and will reset to 0 when overflow occurs.
The value of N is variable, with N <= 512.
In stream mode, there may be multiple such stream data packets. These packets will not exist when using spectrum mode for uploading.

3.3.2 Auto Upload - Spectrum Mode

When the count rate exceeds a certain threshold, the KC761 will switch to spectrum mode for data upload.
In spectrum mode, the KC761 will upload a real-time status data packet (STATUS_DATA) followed by a set of multi-channel data packets (MC_DATA). The structure of these packets is the same as the previously defined instructions, except for the following:
In STATUS_DATA, STATUS_DATA_FLAG = 0xA3, indicating that this packet is automatically uploaded by the KC761.
In MC_DATA, MC_DATA_FLAG = 0xA1, indicating that this packet is automatically uploaded by the KC761.
Due to transmission capacity limitations, this round of upload will only include one multi-channel data, as determined by MC_DATA_SOURCE. The KC761 will upload the currently selected multi-channel chart. "Selected" can refer to either the setting made by the host in RAD_SENSOR_SET or the operation made by the KC761 itself, with the last operation taking priority.
SYNC - Same as in the previous section, determined by the KC761 and automatically incremented.

3.4 Read Device Information

3.4.1 Get Device Information

Description: This instruction is used to retrieve the device's model information and less commonly used statistical data. It is recommended that this command be accessed at longer intervals (e.g., once every 1 minute).

Host sends:

Data Name	Data Width (Bytes)	Data Type	Specified Value	Data Meaning
NULL	1	uint	0x00	Placeholder
CMD_GET_DEVICE_INFO	1	uint	0x54	Command Code (Get Device Information)
SYNC	1	uint		Frame Synchronization Mark
NULL	1	uint	0x00	Placeholder
Packet Length	4			

KC761 Response, Device Information Data Packet (DEVICE_INFO):

Data Name	Data Width (Bytes)	Data Type	Data Meaning
SYNC	1	uint	Frame Sync Marker
DEVICE_INFO_FLAG	1	uint	Device Information Data Flag 0xA5
BAG_LEN	2	uint	Packet Length
DEVICE_MODEL	1	uint	Device Model
HW_VER	1	uint	Hardware Version
FW_VER	1	uint	Main Processor Firmware Version
CO_FW_VER	1	uint	Co-Processor Firmware Version
RAD0_SENSOR_TYPE	1	uint	Sensor slot 0 Sensor Model
RAD1_SENSOR_TYPE	1	uint	Sensor slot 1 Sensor Model
RAD2_SENSOR_TYPE	1	uint	Sensor slot 2 Sensor Model
RESERVE	25	-	Reserve
DEVICE_ID	16	str*16	Device Unique ID
RAD0_MC_RUNTIME	4	uint	Sensor slot 0 Multichannel Accumulation Time (s)
RAD0_SUM_DOSE_TIME	4	uint	Sensor slot 0 Dose Accumulation Time (s)
RAD0_SUM_DOSE	4	float	Sensor slot 0 Accumulated Dose (μGy)
RAD0_SUM_DOSE_EQ	4	float	Sensor slot 0 Accumulated Dose Equivalent (μSv)
RAD1_MC_RUNTIME	4	uint	Sensor slot 1 Multichannel Accumulation Time (s)
RAD1_SUM_DOSE_TIME	4	uint	Sensor slot 1 Dose Accumulation Time (s)
RAD1_SUM_DOSE	4	float	Sensor slot 1 Accumulated Dose (μGy)
RAD1_SUM_DOSE_EQ	4	float	Sensor slot 1 Accumulated Dose Equivalent

			(μSv)
RAD2_MC_RUNTIME	4	uint	Sensor slot 2 Multichannel Accumulation Time (s)
RAD2_SUM_DOSE_TIME	4	uint	Sensor slot 2 Dose Accumulation Time (s)
RAD2_SUM_DOSE	4	float	Sensor slot 2 Accumulated Dose (μGy)
RAD2_SUM_DOSE_EQ	4	float	Sensor slot 2 Accumulated Dose Equivalent (μSv)
Packet Length	100		

Notes:

The definition of DEVICE_MODEL is as follows:

Definition of DEVICE_MODEL		
Series	Model	Value (Decimal)
KC761x	KC761 (Beta version)	10
	KC761 (Official Version)	11
	KC761A/B	12
	KC761C	13
	KC761CN	14

HW_VER — Hardware version number, displayed by dividing the decimal value by 10. For example: value = 12 (decimal), version number displays as V1.2.

FW_VER/CO_FW_VER — Software version number, displayed by dividing the decimal value by 100. For example: value = 180, version number displays as V1.80.

RAD_SENSOR_TYPE — Sensor model, defined as follows:

Sensor Model Definition			
Model Name String	Model Index	Measured Radiation Type	Compatible Device Models
NULL	0x00	No Sensor	No Sensor
KC7601.21 CsI	0x01	γ、β	KC761 (Beta Version)、KC761
KC7601.24 CsI	0x02	γ、β	KC761A/B
KC7601.25 CsI	0x03	γ、β	KC761A/B
KC7601.26 CsI	0x04	γ、β	KC761C/CN
PIN	0x05-0x07	α, β, γ (Low Sensitivity)	KC761 Full Series
KC7601.31 6Li	0x08	n, γ (Low Sensitivity)	KC761A/B/C/CN

DEVICE_ID — Unique device ID. Format: "7601-0000-000001", note the two hyphens in between.

RAD_MC_RUNTIME — MCA accumulation time. While the MCA is in accumulation state, this value increases by 1 every second. When MCA data is cleared, this value resets to zero. Each Sensor slot accumulates MCA data independently.

RAD_SUM_DOSE_TIME — Dose accumulation time. After a Sensor slot is enabled (regardless of whether MCA is accumulating), this value increases by 1 every second. When the accumulated dose is cleared, this value resets to zero. Each Sensor slot accumulates dose data independently.

RAD_SUM_DOSE / RAD_SUM_DOSE_EQ — Accumulated dose / dose equivalent, in units of mSv/mGy. After a Sensor slot is enabled (regardless of whether MCA is accumulating), this value automatically increments with each detected nuclear pulse. When MCA data is cleared, this value

resets to zero. Each Sensor slot accumulates dose data independently. The dose definition for each Sensor slot may vary depending on the sensor's measurement type. For example, in the KC761 series, RAD0 is a γ sensor built with a CsI(Tl) scintillator, and the dose is calculated based on γ radiation. However, the scintillator is also sensitive to β radiation and may detect some cosmic rays, so the readings from RAD0 are not solely due to γ radiation.

3.5 Set Device Time

3.5.1 Set Device Time

Host sends

Data Name	Data Width (Bytes)	Data Type	Specified Value	Data Meaning
NULL	1	uint	0x00	Placeholder
CMD_SET_DEVICE_TIME	1	uint	0x63	Command Code: Set Device Time
SYNC	1	uint		Frame Sync Flag
DEVICE_TIME	4	time_t		UNIX Timestamp
NULL	1	uint	0x00	Placeholder
Packet Length	8			

Notes:

DEVICE_TIME — UNIX timestamp, representing the number of seconds since January 1, 1970.

Example: 2025-01-01 08:00:00 corresponds to UNIX time 1735689600 seconds, HEX = 0x67748580.

Due to endianness conversion, the byte order must be reversed before writing.

The full data packet (in HEX) is: 00 63 XX 80 85 74 67 00, where XX represents SYNC, any hexadecimal value.

KC761 Response:

Data Name	Bit Width (Bytes)	Data Type	Specified Value	Data Meaning
SYNC	1	uint		Frame Sync Flag
CMD_ACK	1	uint	0xAA	Response Data Flag 0xAA
BAG_LEN	2	uint	6	Packet Length
STATUS	1	uint	0x00/0x01	0x00 = Success, 0x01 = Failure
CMD_SET_STA	1	uint	0x63	Repeat Corresponding Host Command Code
Packet Length	6			

3.6 Read and Write Calibration Data

3.6.1 Read Calibration Data

Host sends:

Data Name	Data Width (Bytes)	Data Type	Specified Value	Data Meaning
NULL	1	uint	0x00	Placeholder

CMD_GET_CAL_DATA	1	uint	0x55	Command Code: Get User Calibration Data
SYNC	1	uint		Frame Sync Flag
NULL	1	uint	0x00	Placeholder
Packet Length	4			

KC761 Response, Calibration Data Packet (CAL_DATA):

Data Name	Bit Width (Bytes)	Data Type	Data Meaning
SYNC	1	uint	Frame Sync Flag
CAL_DATA_FLAG	1	uint	Calibration Data Flag 0xA6
BAG_LEN	2	uint	Packet Length
FAC_CAL_VER	1	uint	Factory Calibration Version
RAD0_ENERGY_CAL_SELECT	1	uint	Sensor slot 0 Energy Scale Selection
RAD0_ENERGY_ZOOM	4	float	Sensor slot 0 Energy Scaling
RAD0_ENERGY_OFFSET	4	float	Sensor slot 0 Energy Offset (keV)
RAD1_ENERGY_ZOOM	4	float	Sensor slot 1 Energy Scaling
RAD1_ENERGY_OFFSET	4	float	Sensor slot 1 Energy Offset (keV)
RAD2_ENERGY_ZOOM	4	float	Sensor slot 2 Energy Scaling
RAD2_ENERGY_OFFSET	4	float	Sensor slot 2 Energy Offset (keV)
RAD0_TRIGGER_OFFSET	2	uint	Sensor slot 0 Trigger Threshold Offset
RAD2_TRIGGER_OFFSET	2	uint	Sensor slot 2 Trigger Threshold Offset
RAD0_DOSE_ZOOM	4	float	Sensor slot 0 Dose Scaling
RAD1_DOSE_ZOOM	4	float	Sensor slot 0 Dose Scaling
RAD2_DOSE_ZOOM	4	float	Sensor slot 2 Dose Scaling
NEU_WINDOW_CENTER	2	uint	Neutron Discrimination Window Center (CH)
ALTITUDE_M_OFFSET	2	int16	Altitude Offset (m)
RAD0_CUSTOM_ENERGY_CAL	16	float*4	Sensor slot 0 Custom Energy Scale
RAD1_FAC_ENERGY_CAL	16	float*4	Sensor slot 1 Energy Scale
RAD2_FAC_ENERGY_CAL	16	float*4	Sensor slot 2 Energy Scale
RAD0_FAC_ENERGY_CAL_L	16	float*4	Sensor slot 0 Factory Energy Scale (Low Range)
RAD0_FAC_ENERGY_CAL_M	16	float*4	Sensor slot 0 Factory Energy Scale (Medium Range)
RAD0_FAC_ENERGY_CAL_H	16	float*4	Sensor slot 0 Factory Energy Scale (High Range)
RAD0_FAC_ENERGY_CAL_NODE1	2	uint	Channel 0 Factory Energy Scale Boundary Point 1 (CH)
RAD0_FAC_ENERGY_CAL_NODE2	2	uint	Channel 0 Factory Energy Scale Boundary Point 2 (CH)
Packet Length	150		

Notes:

CAL_DATA_FLAG — Indicates that this data packet is calibration data, with an expected value of 0xA6.

FAC_CAL_VER — Factory calibration version, used to indicate which version of the factory program generated the calibration parameters. For the KC761x, it is defined as follows:

0x00 = Single segment fitting, using a single polynomial to fit the entire energy range.

0x02 = Three-segment fitting, using three intersecting polynomials, each covering a low, medium, and high energy range. For KC761x produced after Q1 2025, three-segment fitting is typically used, offering better precision in the low-energy range, but the method for using the energy scale is more complex.

RAD0_ENERGY_CAL_SELECT — Sensor slot 0 energy scale parameter selection, default is 0x00.

0x00 = Use factory energy scale,

0x01 = Use user-defined energy scale.

RAD_ENERGY_ZOOM — Energy scaling for a given Sensor slot, default is 1.0. The corrected energy is calculated as:

Corrected Energy = RAD_ENERGY_ZOOM * Original Energy + RAD_ENERGY_OFFSET.

This parameter is effective regardless of whether the factory or user energy scale is used. It impacts the energy-related calculations of the KC761 and indirectly affects dose/dose equivalent readings.

RAD_ENERGY_OFFSET — Energy offset for a given Sensor slot, default is 0, in units of keV. The description is the same as above.

RAD_TRIGGER_OFFSET — Sensor slot comparator trigger threshold offset, default is 0. If the device has counting errors in the low-energy range (where noise is mistakenly sampled as nuclear signals), this value can be slightly increased, at the cost of a slight increase in the lower energy range. For the KC761C/CN, the adjustment step is finer, and it is recommended to increase by 20 each time; for other KC761x models, increase by 5 each time. RAD1 is typically the neutron sensor, with a large signal amplitude, and the corresponding comparator threshold is fixed by the program, so no user adjustment is needed.

NEU_WINDOW_LOW/HIGH — Neutron sensor discrimination window, default is the factory-calibrated value, in channel addresses. The user can modify this value. To restore factory calibration, reset to default. To calibrate on your own, accumulate a spectrum with the neutron sensor where the neutron peak is visible, and set the window at the left and right edges of the peak. This series of KC761s uses 6Li glass as the neutron-sensitive element, which also has low sensitivity to gamma rays. Therefore, the neutron discrimination algorithm works as follows:

First, neutron pulses fall within the discrimination window on the MCA;

Then, based on the gamma sensor's statistical information at the corresponding energy, the neutron pulse count is adjusted.

In the KC761 series, the discrimination window helper line can be seen on the neutron spectrum page.

RAD_DOSE_ZOOM — Dose/dose equivalent scaling for each Sensor slot, default is 1.0. This parameter is used to control the scaling of dose/dose equivalent and related statistical parameters for each Sensor slot.

For example, changing from 1.0 to 0.5 will reduce the dose rate, dose equivalent rate, and accumulated dose increments (the previously accumulated values remain unchanged) for the channel by half.

ALTITUDE_M_OFFSET — Altitude measurement offset for the KC761, in units of meters, default is 0.

RAD0_CUSTOM_ENERGY_CAL — User-defined energy scale for Sensor slot 0, default is 0,0,1,0, and it only affects the KC761's internal energy calculations. A cubic polynomial is used for fitting,

with four FP32 floating-point numbers, defined as:

$$E(x) = ax^3 + bx^2 + cx + d$$

Where x is the channel address, and a, b, c, d are the four floating-point coefficients. To apply this parameter in the KC761x, the user must also select the user-defined energy scale in RAD0_ENERGY_CAL_SELECT. Sensor slot 0 is the only channel where users can write energy scales, typically the gamma sensor.

RAD1_FAC_ENERGY_CAL / RAD2_FAC_ENERGY_CAL — Factory energy scale for Sensor slots 1 or 2, using a cubic polynomial fitting, defined as above. These two channels do not support user-defined energy scales, and users can only scale or offset the factory energy scale.

RAD0_FAC_ENERGY_CAL_L/M/H — Factory energy scale for Sensor slot 0, with low, medium, and high segments. Each segment uses a cubic polynomial fitting, defined as above. For the KC761 series, when the factory calibration (FAC_CAL_VER) uses single-segment fitting, only the middle segment, RAD0_FAC_ENERGY_CAL_M, is meaningful and should be applied to the entire energy range. When the factory calibration uses three-segment fitting, the rules are as follows:

For channel addresses lower than RAD0_FAC_ENERGY_CAL_NODE1, use the low segment (RAD0_FAC_ENERGY_CAL_L);

For channel addresses between RAD0_FAC_ENERGY_CAL_NODE1 and RAD0_FAC_ENERGY_CAL_NODE2, use the medium segment;

For channel addresses greater than RAD0_FAC_ENERGY_CAL_NODE2, use the high segment.

RAD0_FAC_ENERGY_CAL_NODE — Factory energy scale channel address boundary points for Sensor slot 0, in units of channel addresses. This is only meaningful when using multi-segment fitting, as explained above.

3.6.2 Write Calibration Data

The host computer sends:

Data Name	Width	Data Type	Specified Value	Data Meaning
NULL	1	uint	0x00	Placeholder
CMD_SET_REVISED_DATA	1	uint	0x64	Command Code (Write User Calibration Data)
SYNC	1	uint	[0x00, 0xFF]	Frame Sync Flag
RAD0_ENERGY_CAL_SELECT	1	uint	0x00/0x01	Sensor slot 0 Energy Scale Selection
RAD0_ENERGY_ZOOM	4	float	[0.5, 1.5]	Sensor slot 0 Energy Scaling
RAD0_ENERGY_OFFSET	4	float	(-1000,1000)	Sensor slot 0 Energy Offset (keV)
RAD1_ENERGY_ZOOM	4	float	[0.5, 1.5]	Sensor slot 1 Energy Scaling
RAD1_ENERGY_OFFSET	4	float	(-1000,1000)	Sensor slot 1 Energy Offset (keV)
RAD2_ENERGY_ZOOM	4	float	[0.5, 1.5]	Sensor slot 2 Energy Scaling
RAD2_ENERGY_OFFSET	4	float	(-1000,1000)	Sensor slot 2 Energy Offset (keV)
RAD0_TRIGGER_OFFSET	2	uint	[0, 1000]	Sensor slot 0 Trigger Threshold Offset
RAD2_TRIGGER_OFFSET	2	uint	[0, 1000]	Sensor slot 2 Trigger Threshold Offset
RAD0_DOSE_ZOOM	4	float	[0.2, 5.0]	Sensor slot 0 Dose Scaling
RAD1_DOSE_ZOOM	4	float	[0.2, 5.0]	Sensor slot 1 Dose Scaling

RAD2_DOSE_ZOOM	4	float	[0.2, 5.0]	Sensor slot 2 Dose Scaling
NEU_WINDOW_CENTER	2	uint	0,[500,2047]	Neutron Discrimination Window Center (CH)
ALTITUDE_M_OFFSET	2	int16	(-1000,1000)	Altitude Offset (m)
RAD0_CUSTOM_ENERGY_CAL	16	float*4	(-1000,1000)	Sensor slot 0 Custom Energy Scale
NULL	1	uint	0x00	Placeholder
Packet Length	65			

Comment: (Essentially the same as the previous section)

For parameters that you do not wish to overwrite, you can write 0xFF to the corresponding bytes, and the KC761 will skip the related settings. For example, if a float variable occupies four bytes, you need to write 0xFF to all of them; if Sensor slot 0 custom energy scale occupies 16 bytes, you need to write 0xFF to all of them.

RAD0_ENERGY_CAL_SELECT — Energy scale selection parameter for Sensor slot 0, default value is 0x00. 0x00 = Use factory energy scale, 0x01 = Use user-defined energy scale. To maintain the original setting of the KC761, write 0xFF.

RAD_ENERGY_ZOOM — Energy scaling for the Sensor slot. Default value is 1.0, with a permissible range of 0.5 to 1.5.

RAD_ENERGY_OFFSET — Energy offset for the Sensor slot. Default value is 0, with a permissible range of ±1000 keV.

RAD_TRIGGER_OFFSET — Trigger threshold offset. Default value is 0, with a maximum value of 1000.

NEU_WINDOW_LOW/HIGH — Lower/Upper limits of the neutron sensor discrimination window, measured in channel addresses. Writing 0 for a parameter means using the factory default value. The valid range is 500 to 2048. If the user enters valid values, the value for the lower limit must be less than the upper limit.

RAD_DOSE_ZOOM — Dose scaling for the Sensor slot. Default value is 1.0, with a permissible range of 0.2 to 5.0.

RAD0_CUSTOM_ENERGY_CAL — User-defined energy scale for Sensor slot 0, consisting of four floating-point numbers. Default values are 0, 0, 1, 0. Polynomial fitting calculations are usually performed using software like InterSpec, and the results of the polynomials should be filled in sequentially. The permissible range for each floating-point number is ±1000.

KC761 Response:

Data Name	Width (Bytes)	Data Type	Specified Value	Data Meaning
SYNC	1	uint		Frame Sync Flag
CMD_ACK	1	uint	0xAA	Response Data Flag 0xAA
BAG_LEN	2	uint	6	Length of This Data Packet
STATUS	1	uint	0x00/0x01	0x00 = Setting Successful, 0x01 = Setting Failed
CMD_SET_STA	1	uint	0x64	Repeat the Corresponding Host Command Code
Packet Length	6			

3.7 Clear Radiation Statistics Data

3.7.1 Set Clear Radiation Statistics Data

The host computer sends:

Data Name	Data Width (Bytes)	Data Type	Specified Value	Data Meaning
NULL	1	uint	0x00	Placeholder
CMD_SET_CLEAR	1	uint	0x66	Command Code (Clear Statistics Data)
SYNC	1	uint		Frame Sync Flag
MC_DATA_CLEAR	1	uint		Multichannel Data Clear
DOSE_RATE_CURVE_CLEAR	1	uint		Dose-Time Curve Clear
SUM_DOSE_CLEAR	1	uint		Cumulative Dose Clear
NULL	1	uint		Placeholder
Packet Length	7			

Notes:

MC_DATA_CLEAR — Multichannel Data Clear. Set the corresponding bit to 1 to clear the data, and the accumulated time of the spectrum will also be reset. Defined as follows.

MC_DATA_CLEAR Definition			
Bit7:3	Bit2	Bit1	Bit0
RESERVE	RAD2 Spectrum Clear	RAD1 Spectrum Clear	RAD0 Spectrum Clear

DOSE_RATE_CURVE_CLEAR — Dose-Time Curve Clear. Set the corresponding bit to 1 to clear the data. Defined as above. In this series of KC761s, Sensor slot 0 has two curves: dose rate and dose equivalent rate, both of which will be cleared together.

SUM_DOSE_CLEAR — Cumulative Dose Clear. Set the corresponding bit to 1 to clear the data, and the dose accumulation time will also be reset to zero. Defined as above.

SUM_DOSE_CLEAR Definition			
Bit7:3	Bit2	Bit1	Bit0
RESERVE	RAD2 Dose Reset	RAD1 Dose Reset	RAD0 Dose Reset

KC761 Response:

Data Name	Width (Bytes)	Data Type	Specified Value	Data Meaning
SYNC	1	uint		Frame Sync Flag
CMD_ACK	1	uint	0xAA	Response Data Flag 0xAA
BAG_LEN	2	uint	6	Length of This Data Packet
STATUS	1	uint	0x00/0x01	0x00 = Setting Successful, 0x01 = Setting Failed
CMD_SET_STA	1	uint	0x66	Repeat the Corresponding Host Command Code
Packet Length	6			

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