ka9q-radio command/status protocol element types - Phil Karn, KA9Q - Jan 2026

Type	num	Settable?	Encoding	Units	Global	Valid range/values
EOL	0					
COMMAND_TAG	1	Y	uint		Y	
CMD_CNT	2		uint	commands	Y	
GPS_TIME	3		uint	nanosec	Y	
DESCRIPTION	4		string		Y	free-form UTF-8
STATUS_DEST_SOCKET	5		socket		y	
SETOPTS	6	Y	uint			32 bits
CLEAROPTS	7	Y	uint			32 bits
RTP_TIMESNAP	8		uint			32 bits
BIN_BYTE_DATA	9		bytes			Limited by IP packet size
INPUT_SAMPRATE	10		uint	Hz		
SPECTRUM_BASE	11	Y	float32	dB		
SPECTRUM_AVG	12	Y	uint	frames		>= 1
INPUT_SAMPLES	13		uint	count		
WINDOW_TYPE	14	Y	uint			0=Kaiser 1=Rectangular(none) 2=Blackman 3=Exact Blackman 4=Gaussian 5=Hann 6=Hamming 7=Blackman-Harris
NOISE_BW	15		float32	bins		>0
OUTPUT_DATA_SOURCE_SOCKET	16		socket		Y	
OUTPUT_DATA_DEST_SOCKET	17	Y	socket			
OUTPUT_SSRC	18		uint			32 bits; 0 and ffffffff reserved
OUTPUT_TTL	19		uint	hops	Y	0 <= ttl <= 255
OUTPUT_SAMPRATE	20	Y	uint	Hz		>0
OUTPUT_METADATA_PACKETS	21		uint	count	y	
OUTPUT_DATA_PACKETS	22		uint	count		
OUTPUT_ERRORS	23		uint	count		
CALIBRATE	24	Y	double64		Y	
LNA_GAIN	25	Y	uint	dB	Y	0-255
MIXER_GAIN	26	Y	uint	dB	Y	0-255
IF_GAIN	27	Y	uint	dB	Y	0-255
DC_I_OFFSET	28		float32		Y	
DC_Q_OFFSET	29		float32		Y	
IQ_IMBALANCE	30		float32		Y	
IQ_PHASE	31		float32	radians	Y	-pi/2 to +pi/2
DIRECT_CONVERSION	32		boolean		Y	
RADIO_FREQUENCY	33	Y	double64	Hz	Y	>0 for real inputs. 0 reserved to mean “idle channel”
FIRST_LO_FREQUENCY	34	Y	double64	Hz	y	
SECOND_LO_FREQUENCY	35		double64	Hz		

Type	num	Settable?	Encoding	Units	Global	Valid range/values
SHIFT_FREQUENCY	36	Y	double64	Hz		
DOPPLER_FREQUENCY	37	Y	double64	Hz		
DOPPLER_FREQUENCY_RATE	38	Y	double64	Hz/sec		
LOW_EDGE	39	Y	float32	Hz		less than HIGH_EDGE
HIGH_EDGE	40	Y	float32	Hz		greater than LOW_EDGE
KAISER_BETA	41	Y	float32			>= 0
FILTER_BLOCKSIZE	42		uint	samples	Y	
FILTER_FIR_LENGTH	43		uint	samples	Y	
FILTER2	44	Y	uint	frames		
IF_POWER	45		float32	dBFS	Y	
BASEBAND_POWER	46		float32	dB		
NOISE_DENSITY	47		float32	dBJ		
DEMOD_TYPE	48	Y	uint	enum		0 - 4
OUTPUT_CHANNELS	49	Y	uint			1 - 2
INDEPENDENT_SIDEBAND	50	Y	boolean			
PLL_ENABLE	51	Y	boolean			
PLL_LOCK	52		boolean			
PLL_SQUARE	53	Y	boolean			
PLL_PHASE	54		float32	radians?		0 - 2 pi
PLL_BW	55	Y	float32	Hz		>0
ENVELOPE	56	Y	boolean			
SNR_SQUELCH	57	Y	boolean			
PLL_SNR	58		float32	dB		
FREQ_OFFSET	59		float32	Hz		
PEAK_DEVIATION	60		float32	Hz		>= 0
PL_TONE	61		float32	Hz		>= 0
AGC_ENABLE	62	Y	boolean			
HEADROOM	63	Y	float32	dBFS		<= 0
AGC_HANGTIME	64	Y	float32	sec		>= 0
AGC_RECOVERY_RATE	65	Y	float32	dB/sec		>= 0
FM_SNR	66		float32	dB		
AGC_THRESHOLD	67	Y	float32	dBFS		<= 0
GAIN	68	Y	float32	dB		
OUTPUT_LEVEL	69		float32	dBFS		
OUTPUT_SAMPLES	70		uint	samples		
OPUS_BITRATE	71	Y	uint	bits/sec		
MINPACKET	72	Y	uint	frames		0-10
FILTER2_BLOCKSIZE	73		uint	samples		>0
FILTER2_FIR_LENGTH	74		uint	samples		>0
FILTER2_KAISER_BETA	75	Y	float32			>=0
SPECTRUM_FFT_N	76		uint	bins		> 0
FILTER_DROPS	77		uint	blocks		
LOCK	78		boolean			

Type	num	Settable?	Encoding	Units	Global	Valid range/values
TP1	79		float32			
TP2	80		float32			
GAINSTEP	81		uint		Y	
AD_BITS_PER_SAMPLE	82		uint	bits	Y	
SQUELCH_OPEN	83	Y	float32	dB		
SQUELCH_CLOSE	84	Y	float32	dB		
PRESET	85	Y	string			defined in presets.conf
DEEMPH_TC	86		float32	ns		non-negative
DEEMPH_GAIN	87		float32	dB		
CONVERTER_OFFSET	88		float32	Hz	Y	
PL_DEVIATION	89		float32	Hz		>= 0
THRESH_EXTEND	90	Y	boolean			
SPECTRUM_SHAPE	91	Y	float32			>= 0
COHERENT_BIN_SPACING	92		float32		y	
RESOLUTION_BW	93	Y	float32	Hz		positive
BIN_COUNT	94	Y	uint	bins		> 0
CROSSOVER	95	Y	float32			positive
BIN_DATA	96		float32 vector			
RF_ATTEN	97	Y	float32	dB	Y	<= 0
RF_GAIN	98	Y	float32	dB	Y	
RF_AGC	99	Y	boolean		Y	
FE_LOW_EDGE	100		float32	Hz	Y	<FE_HIGH_EDGE
FE_HIGH_EDGE	101		float32	Hz	Y	> FE_LOW_EDGE
FE_ISREAL	102		boolean		Y	
BLOCKS_SINCE_POLL	103		uint			
AD_OVER	104		uint		Y	
RTP_PT	105		uint			0-127
STATUS_INTERVAL	106	Y	uint	frames	y	
OUTPUT_ENCODING	107	Y	uint			1-7
SAMPLES_SINCE_OVER	108		uint		Y	
PLL_WRAPS	109		signed int	rotations		
RF_LEVEL_CAL	110		float32	dBm	Y	
OPUS_DTX	111	Y	boolean			
OPUS_APPLICATION	112	Y	uint			2048 (VOIP), 2049 (AUDIO), 2051 (Low Delay)
OPUS_BANDWIDTH	113	Y	uint	Hz		1101 (4 kHz), 1102 (6 kHz), 1103 (8 kHz), 1104 (12 kHz) 1105 (20 kH)
OPUS_FEC	114	Y	uint	percent		0-100
SPECTRUM_STEP	115	Y	float32	dB		non-negative

Encoding notes:

“uint” is a variable length unsigned integer sent in big-endian order (MSB first).

“boolean” is an integer with value 0 (false/off) or 1 (true/on).

“float32” is a 32-bit IEEE 754 floating point number sent as 4 bytes, sign byte

Packets are encoded
command (1), follow
is the numerical type
the length; values 0-
bytes. A length of ze
double, or boolean (1

"float32" is a 32-bit IEEE-754 floating point number set as 4 bytes, sign byte (MSB) first.

double64 is a 64-bit IEEE-754 floating point number sent as 8 bytes, sign byte (MSB) first.

“socket” is an IPv4 or IPv6 address in big-endian order followed by a 2-byte port number in big-endian order.

A uint, float32 or double64 with value 0 may be sent as a zero-length value field.

A string is a UTF-8 character string that may or may not be null terminated because the length is explicitly specified in the prefix.

A “settable” parameter is one that can be changed with this protocol sent as a command packet. Some other parameters may be set through the configuration file. The rest are output-only, eg., counters and calculated values.

double, or boolean (
bytes long; subtract
the actual length fiel
length bytes are inte

The BIN_DATA (96) c
floats is the length di

Items marked “Globa
to a channel.

Type	Meaning & Use
EOL	End of option list. No length or value field
COMMAND_TAG	generated by controller, echoed by server to confirm command
CMD_CNT	Server count of received commands
GPS_TIME	Nanoseconds since GPS epoch of 6 January 1980 00:00:00 UTC. Generated by front end, passed through ‘radio’
DESCRIPTION	description of front end (antenna, etc). Generated by front end, passed through ‘radio’. Need not be null terminated.
STATUS_DEST_SOCKET	Source IP address and port number for control and status
SETOPTS	1-bits turn on specified option (32 max)
CLEAROPTS	1-bits turn off specified option (32 max)
RTP_TIMESNAP	Snapshot of RTP 32-bit timestamp field
BIN_BYTE_DATA	Vector representing spectrum data, 1 bin/byte, unsigned, with meaning SPECTRUM_BASE + SPECTRUM_STEP * x dB
INPUT_SAMPRATE	Sample rate of RTP input data stream
SPECTRUM_BASE	Used to interpret BIN_BYTE_DATA
SPECTRUM_AVG	Number of consecutive periodograms (power spectra) to be averaged in each response.
INPUT_SAMPLES	Count of input data samples
WINDOW_TYPE	Window applied to FFT input data in spectrum analysis. Kaiser and Gaussian require SPECTRUM_SHAPE parameter, β and α respectively.
NOISE_BW	Relative noise bandwidth of each FFT bin in spectral display, depends on WINDOW_TYPE and SPECTRUM_SHAPE. 1 for rectangular
OUTPUT_DATA_SOURCE_SOCKET	Source IP and port of output RTP data stream
OUTPUT_DATA_DEST_SOCKET	Destination (multicast) IP address and port of output data stream
OUTPUT_SSRC	RTP stream ID of output stream
OUTPUT_TTL	IP Time-to_live (hop count limit) of output data stream (not metadata, which can be different)
OUTPUT_SAMPRATE	Sample rate of RTP output data stream
OUTPUT_METADATA_PACKETS	Count of metadata packets sent
OUTPUT_DATA_PACKETS	Count of RTP output data packets
OUTPUT_ERRORS	Count of send errors on channel output packet stream
CALIBRATE	Frequency calibration factor for tuner reference and A/D sample clock. Actual freq = nominal * (1 + CALIBRATE), ie, 0 means “on frequency”
LNA_GAIN	Relative gain of analog input to receiver. Hardware dependent, not used by all front ends
MIXER_GAIN	Relative gain of mixer in analog receiver/downconverter. Hardware dependent, not used by all front ends
IF_GAIN	Relative gain of baseband analog amplifier in tuner just ahead of A/D converter. Hardware dependent, not used by all front ends
DC_I_OFFSET	DC offset of I-channel A/D converter (only direct conversion front ends)
DC_Q_OFFSET	DC offset of Q-channel A/D converter (only direct conversion front ends)
IQ_IMBALANCE	Relative gain of I and Q channels (only direct conversion front ends). 1 = no error
IQ_PHASE	Relative phase error of I & Q channels. 0 = no error
DIRECT_CONVERSION	Front end uses direct conversion with DC spike and 1/f noise that should be avoided
RADIO_FREQUENCY	RF tuning frequency that comes out of the downconverter at 0 Hz. I.e, “carrier frequency”
FIRST_LO_FREQUENCY	Front end tuner frequency. N/A for direct sampling front ends
SECOND_LO_FREQUENCY	Digital down converter frequency = -(RADIO_FREQUENCY+DOPPLER_FREQUENCY-FIRST_LO_FREQUENCY). Negative of IF frequency. <0 for direct sampling front ends. May be >0 or <0 for direct conversion (I/Q) front ends. >0 for tuners with high-side injection, <0 for tuners with low-side injection.

Type	Meaning & Use
SHIFT_FREQUENCY	Post-downconversion shift frequency, used primarily for CW. With IF filter centered, <0 shifts the LSB up in output frequency, >0 shifts the USB up in output frequency
DOPPLER_FREQUENCY	Doppler tuning offset (untested)
DOPPLER_FREQUENCY_RATE	Rate of change of Doppler tuning effort (untested). Limited to 1 bin/frame time
LOW_EDGE	Lower edge of post-mixer filter
HIGH_EDGE	Upper edge of post-mixer filter
KAISER_BETA	Kaiser β factor for downconverter filter window design
FILTER_BLOCKSIZE	Input samples per downconverter FFT processing block (
FILTER_FIR_LENGTH	Overlap samples per downconverter FFT processing block. Sets maximum impulse duration of downconverter channel filter
FILTER2	Size of secondary filter input in units of downconverter frames (eg, 20 ms). 0=off
IF_POWER	A/D output level
BASEBAND_POWER	Signal power at channel downconverter filter output, relative to unity
NOISE_DENSITY	Estimated noise spectral power density, N0, in and near downconverter channel
DEMOD_TYPE	Demodulator type, enum: 0 = linear; 1 = FM/PM; 2 = Wideband FM with stereo demodulator; 3 = spectrum; 4 = spectrum v2
OUTPUT_CHANNELS	mono (=1) stereo (=2); for front ends, 1 channel = real, 2 channels = complex (IQ)
INDEPENDENT_SIDEBAND	LSB in left channel, USB in right channel - currently unimplemented
PLL_ENABLE	Enable 0 Hz carrier tracking & squelch (Linear mode); PLL demodulation (FM)
PLL_LOCK	Indicate whether PLL is in lock (controlled by squelch threshold settings)
PLL_SQUARE	Square feedback to PLL; use for DSB AM and BPSK. Implies PLL_ENABLE
PLL_PHASE	Relative phase of PLL numerically controlled oscillator
PLL_BW	Noise bandwidth of PLL loop filter
ENVELOPE	Use envelope detector in linear demodulator
SNR_SQUELCH	Y=enable SNR squelch in all modes. N=enable moments squelch (in FM mode only)
PLL_SNR	Phase lock loop signal-to-noise ratio; = 10log10(I^2/Q^2 - 1), in-phase to quadrature power ratio
FREQ_OFFSET	Estimated signal frequency error. Only when PLL is enabled in linear modes
PEAK_DEVIATION	Peak deviation (FM demodulators only)
PL_TONE	PL tone squelch frequency (FM demodulator only); 0 = no tone
AGC_ENABLE	Automatic gain control (Linear demod only)
HEADROOM	Target channel output audio level, block average
AGC_HANGTIME	Time delay before automatic gain increase on lowered signal (linear demod only)
AGC_RECOVERY_RATE	Gain increase rate on lowered signal (linear demod only)
FM_SNR	Estimated SNR in FM; equal to channel SNR when moments squelch is disabled
AGC_THRESHOLD	Target demodulator output level on noise only
GAIN	Demodulator gain (constant for FM, variable for linear)
OUTPUT_LEVEL	Output level, frame average
OUTPUT_SAMPLES	Output sample count
OPUS_BITRATE	Target bitrate of Opus-compressed audio. 0 = auto
MINPACKET	Minimum number of receiver frames in an output IP packet, unless packet is already at MTU
FILTER2_BLOCKSIZE	Input samples per Filter2 block
FILTER2_FIR_LENGTH	Impulse response length in secondary filter (filter2)
FILTER2_KAISER_BETA	Kaiser β factor for secondary filter (filter2) window design
SPECTRUM_FFT_N	Number of bins in analysis FFTs. Calculated from BIN_COUNT and RESOLUTION_BW
FILTER_DROPS	Number of frame drops by digital downconverter
LOCK	Will ignore frequency tuning commands. Not yet implemented

Type	Meaning & Use
TP1	General purpose test point #1
TP2	General purpose test point #2
GAINSTEP	Front end analog gain, arbitrary units, hardware specific
AD_BITS_PER_SAMPLE	Width of A/D input word
SQUELCH_OPEN	Squelch opening threshold (FM, synchronous AM)
SQUELCH_CLOSE	Squelch closing threshold (FM, synchronous AM) - must be less than or equal than SQUELCH_OPEN
PRESET	Set demodulator mode - configured by modes.conf on 'radio'
DEEMPH_TC	Deemphasis time constant (0 = off), FM only
DEEMPH_GAIN	Static gain correction when de-emphasis used to maintain subjectively equal loudness
CONVERTER_OFFSET	Frequency offset of external frequency converter. Not yet implemented
PL_DEVIATION	Measured deviation of PL tone (FM demodulator only, tone squelch enabled)
THRESH_EXTEND	Enable/disable threshold extension (FM only)
SPECTRUM_SHAPE	Shape factor for spectrum analysis window (kaiser β, gaussian α)
COHERENT_BIN_SPACING	deprecated; can be calculated from INPUT_SAMPRATE, FILTER_BLOCKSIZE, FILTER_FIR_LENGTH
RESOLUTION_BW	Width of each bin in spectrum data
BIN_COUNT	Number of FFT bins wanted in spectrum data
CROSSOVER	Value of RESOLUTION_BW above which the wideband spectrum analyzer is used.
BIN_DATA	Vector of 4-byte float32s with linear spectrum data, spectrum mode only. Order: DC…max positive freq, max neg freq…-1
RF_ATTEN	Front end attenuation, hardware dependent (not present on all front ends). Setting turns off RF_AGC
RF_GAIN	Front end gain; hardware dependent. Setting turns off RF_AGC
RF_AGC	Enable front end RF automatic gain control
FE_LOW_EDGE	Low edge of A/D converter input frequency band (negative for tuners with high side injection)
FE_HIGH_EDGE	Upper edge of A/D converter input frequency band (negative for tuners with high side injection)
FE_ISREAL	Y: front end uses a single A/D converter; N: front end uses dual (I/Q) A/D converters
BLOCKS_SINCE_POLL	Count of status frames sent since last command received. Deprecated
AD_OVER	Count of A/D overrange events
RTP_PT	Real Time Protocol Payload Type for current output stream
STATUS_INTERVAL	Number of frames between periodic channel status beacons on output stream
OUTPUT_ENCODING	1=S16LE, 2=S16BE, 3=Opus, 4=F32BE, 5=AX25, 6=F16BE, 7=Opus with application=voip
SAMPLES_SINCE_OVER	Input A/D samples since last overrange event
PLL_WRAPS	Count of complete 360 degree (2 pi radian) rotations of PLL
RF_LEVEL_CAL	Input power that gives 0 dBFS from A/D converter with all RF gain and atten = 0
OPUS_DTX	enable discontinuous transmission by the Opus encoder
OPUS_APPLICATION	The application type parameter to the Opus encoder.
OPUS_BANDWIDTH	Input bandwidth to be considered important by Opus encoder
OPUS_FEC	Frame loss percentage the Opus encoder should use when in FEC mode
SPECTRUM_STEP	step size of 8-bit bins in v2 spectrum data

d as follows: 1 byte to indicate status(0) or
ed by a series of TLV-encoded items. The first byte
as shown in this table. The second byte encodes
127 indicate that the value that follows uses 0-127
ro encodes the value 0 as either an integer, float32,
false). A length of 128-256 indicate a value >127

alse). A length of 129-255 indicate a value > 127.
128 from this field to obtain the length in bytes of
d that will immediately follow. If > 1 byte long, the
rpreted in big endian order (MSB first).

ption contains a list of float32s. The number of
ivided by 4.

al" are common to all channels; the rest are unique

Type				
EOL				
COMMAND_TAG				
CMD_CNT				
GPS_TIME				
DESCRIPTION				
STATUS_DEST_SOCKET				
SETOPTS				
CLEAROPTS				
RTP_TIMESNAP				
BIN_BYTE_DATA				
INPUT_SAMPRATE				
SPECTRUM_BASE				
SPECTRUM_AVG				
INPUT_SAMPLES				
WINDOW_TYPE				
NOISE_BW				
OUTPUT_DATA_SOURCE_SOCKET				
OUTPUT_DATA_DEST_SOCKET				
OUTPUT_SSRC				
OUTPUT_TTL				
OUTPUT_SAMPRATE				
OUTPUT_METADATA_PACKETS				
OUTPUT_DATA_PACKETS				
OUTPUT_ERRORS				
CALIBRATE				
LNA_GAIN				
MIXER_GAIN				
IF_GAIN				
DC_I_OFFSET				
DC_Q_OFFSET				
IQ_IMBALANCE				
IQ_PHASE				
DIRECT_CONVERSION				
RADIO_FREQUENCY				
FIRST_LO_FREQUENCY				
SECOND_LO_FREQUENCY				

Type				
SHIFT_FREQUENCY				
DOPPLER_FREQUENCY				
DOPPLER_FREQUENCY_RATE				
LOW_EDGE				
HIGH_EDGE				
KAISER_BETA				
FILTER_BLOCKSIZE				
FILTER_FIR_LENGTH				
FILTER2				
IF_POWER				
BASEBAND_POWER				
NOISE_DENSITY				
DEMOD_TYPE				
OUTPUT_CHANNELS				
INDEPENDENT_SIDEBAND				
PLL_ENABLE				
PLL_LOCK				
PLL_SQUARE				
PLL_PHASE				
PLL_BW				
ENVELOPE				
SNR_SQUELCH				
PLL_SNR				
FREQ_OFFSET				
PEAK_DEVIATION				
PL_TONE				
AGC_ENABLE				
HEADROOM				
AGC_HANGTIME				
AGC_RECOVERY_RATE				
FM_SNR				
AGC_THRESHOLD				
GAIN				
OUTPUT_LEVEL				
OUTPUT_SAMPLES				
OPUS_BITRATE				
MINPACKET				
FILTER2_BLOCKSIZE				
FILTER2_FIR_LENGTH				
FILTER2_KAISER_BETA				
SPECTRUM_FFT_N				
FILTER_DROPS				
LOCK				

Type				
TP1				
TP2				
GAINSTEP				
AD_BITS_PER_SAMPLE				
SQUELCH_OPEN				
SQUELCH_CLOSE				
PRESET				
DEEMPH_TC				
DEEMPH_GAIN				
CONVERTER_OFFSET				
PL_DEVIATION				
THRESH_EXTEND				
SPECTRUM_SHAPE				
COHERENT_BIN_SPACING				
RESOLUTION_BW				
BIN_COUNT				
CROSSOVER				
BIN_DATA				
RF_ATTEN				
RF_GAIN				
RF_AGC				
FE_LOW_EDGE				
FE_HIGH_EDGE				
FE_ISREAL				
BLOCKS_SINCE_POLL				
AD_OVER				
RTP_PT				
STATUS_INTERVAL				
OUTPUT_ENCODING				
SAMPLES_SINCE_OVER				
PLL_WRAPS				
RF_LEVEL_CAL				
OPUS_DTX				
OPUS_APPLICATION				
OPUS_BANDWIDTH				
OPUS_FEC				
SPECTRUM_STEP				