KrakenSDR Datasheet (V1.0)

KrakenSDR is a five-channel software defined radio. Together with the Heimdall software, it can be used as a coherent software defined radio. A coherent software defined radio is capable of tasks like radio direction finding.

Tuner Chip	5x R820T2 / R860
ADC Chip	5x RTL2832U
ADC Bit Depth	8-bits (7-bits ENOB)
Tunable Frequency Range	24 MHz to 1.766 GHz
Maximum Bandwidth	**Standalone Mode:** 2.56 MHz stable (up to 3.2 MHz with drops). **Coherent Mode:** 2.4 MHz
Typical Input Impedance	50 Ohms
Input Voltage	5V
Maximum Current Draw (5 CH Active)	2.2A
Input Connector	5x SMA
USB Data Connector	USB-C Female
Power Connector	USB-C Female
Local Oscillator Stability	1PPM TCXO
Bias Tee	5x 4.5V, 100mA (software switchable)
Enclosure	Aluminum
Heat Dissipation	Thermal pad to aluminum enclosure, external fan, cooling fins
Transmit Capability	None
Coherence Implementation	Noise source + single clock source

Absolute Maximum Ratings

Input Voltage	5.5V
RF Input Power	+10 dBm
Ambient Temperature	-20°C to 50°C

ESD Warning

For protection, the KrakenSDR implements an ESD diode, gas discharge tube, and diode power clipper. However, it will not withstand direct or induced electrical surges from nearby lightning events, or large electrostatic discharge (ESD) events that are possible from events like snow and dust storms.

Therefore, we suggest that any outdoor connected antenna MUST have externally provided lightning and ESD protection measures in place.

KrakenSDR Hardware

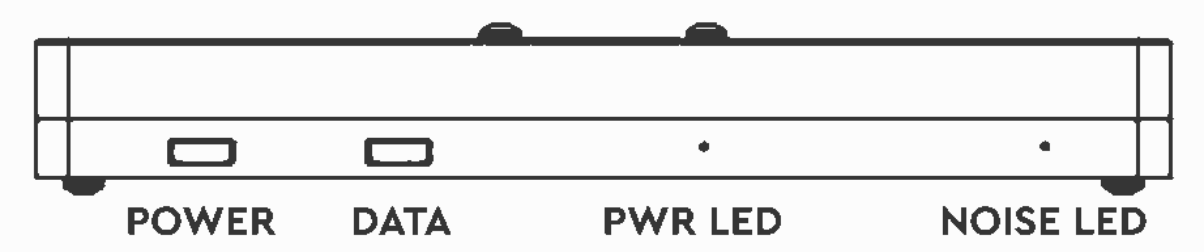

Figure 1. KrakenSDR Front

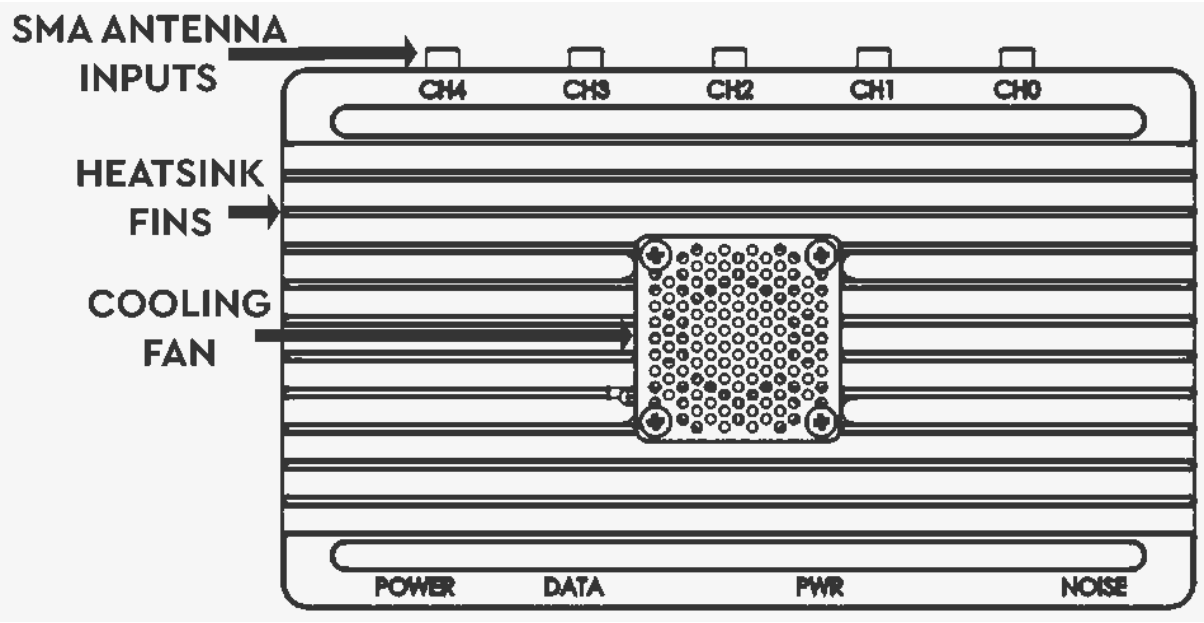

Figure 2. KrakenSDR Top

KrakenSDR utilizes USB-C ports for Power and Data.

The KrakenSDR provides peep holes for several status LED indicators.

PWR LED: The white PWR LED to the right of the two USB-C ports indicates that the KrakenSDR is receiving DC power from the POWER USB-C port.

NOISE LED: When illuminated the white NOISE LED to the right of the PWR LED indicates that the noise source on the KrakenSDR is active. This LED may flash briefly every few minutes when running the software when calibration monitoring/auto recalibration is turned on.

CHANNEL LEDS: There are five blue CHANNEL LEDS next to each of the SMA ports. When illuminated, these LEDs indicate that this channels tuner has been enumerated by the computing device. Please note that these LEDs do not provide status regarding the channel connection to the DSP software.

KrakenSDR Additional Hardware Requirements

KrakenSDR requires additional hardware listed below:

- Raspberry Pi 4/5, or similarly specified Linux single board computer, or a Linux PC
- A 5V 2.4A+ capable USB-C power supply
- A USB-A to USB-C USB data cable
- Five phase/length matched antennas and cables.

KrakenRF sells the KrakenTenna set, which is a set of five length matched antennas and cables. If you are using your own antennas, you must ensure that the antenna coax cables are at least all exactly the same length, to at least within 0.5cm.

Key Use Cases

KrakenSDR's main use case is for Radio Direction Finding (RDF). With RDF, a device like the KrakenSDR is used to determine a bearing towards a transmitter. These bearings can be plotted on a map, and the location of the transmitter can be triangulated by taking multiple readings at different locations.

KrakenSDR can also be used a receive only software defined radio with five independent channels.

Typical Direction Finding Use Case Block Diagram

In a typical use case scenario for direction finding, you will have the antenna array mounted on the roof of a vehicle, with the KrakenSDR connected to a computing device like a Raspberry Pi 4 or 5. The Raspberry 4/5 will communicate with the KrakenSDR mobile app via a mobile WiFi hotspot.

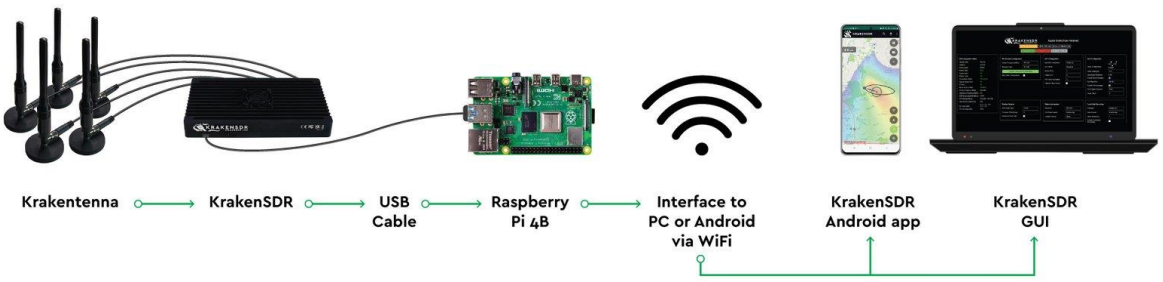

Figure 3. Direction Finding Use Case

KrakenSDR Hardware Block Diagram

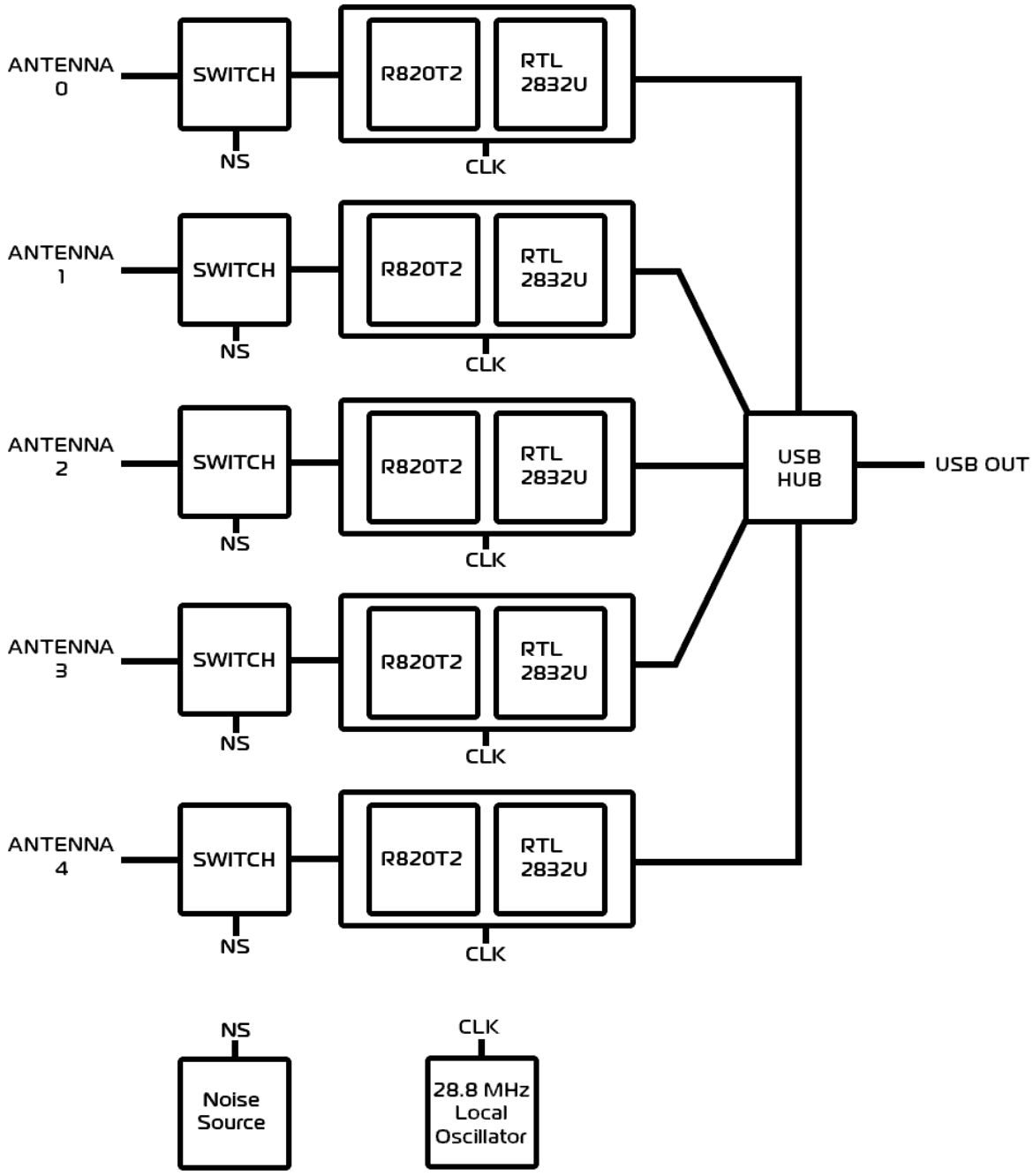

Figure 4. KrakenSDR Hardware Block Diagram

Coherence Principle of Operation

The KrakenSDR is not naturally coherent, but it achieves coherence via a combination of hardware tricks and software correlation techniques.

Hardware

The KrakenSDR hardware contains five RTL-SDR circuits which consist of a R820T2 and RTL2832U chip. Firstly, to achieve coherence, each RTL-SDR circuit is driven from the same clock with PCB clock distribution lines of identical length.

Secondly, there is an on-board switchable noise source that evenly distributes noise via a switch to each RTL-SDR. This noise can be used for correlation in the software.

Thirdly, there are several other tricks involved, such as heat balancing for each RTL-SDR, and ensuring that each RTL-SDR has PCB RF lines that are of identical lengths.

Software

Upon startup of the KrakenSDR, the IQ USB samples are not aligned in hardware, and the phase between channels is not coherent. It is up to the Heimdall software github.com/krakenrf/heimdall_daq_fw running on the host device to align the samples and phase in software.

The Heimdall software does this by first activating the noise source, so that each channel can be correlated against the reference channel (channel 0). Using the hardware rational resampler on the RTL2832U, the samples are aligned by slightly adjust the sample rates on each channel to 'slide' them in place to match with the reference channel. The phases of each channel are then measured, and a compensation value is determined for each channel, so that the phases with the noise source on match the phase of the reference channel.

After alignment and determination of the phase compensation value is completed, the noise source is turned off, and coherent samples are available from Heimdall via a socket connection, or via shared memory.

All phase coherence operations are handled automatically by the Heimdall software, so the KrakenSDR + Heimdall can be treated as a black box with coherent samples coming out.

Direction Finding DSP Software

KrakenRF has made available krakensdr_doa github.com/krakenrf/krakensdr_doa, which is an implementation of Direction of Arrival (DoA) algorithms for the KrakenSDR. This DSP software makes use of the coherent samples coming from Heimdall and applies direction finding algorithms such as MUSIC to the coherent data.

The algorithms produce a bearing, which points towards the signal source.

Mobile Mapping App + Web Based Mapping App

KrakenRF has also made available a mobile app for iOS and Android (search 'KrakenSDR RDF' on the Apple Store and Google Play Store), and a web-based mapping app at map.krakenrf.com. The app receives bearing data from the KrakenSDR direction finding DSP software and automatically logs and plots the bearings on a map. Over time, as the KrakenSDR is driven around, the location of the

transmitter will be revealed where the bearings intersect. Alternatively, with the web based mapping app, more than one KrakenSDR at fixed sites can be networked and bearings combined.

Enclosure Drawing

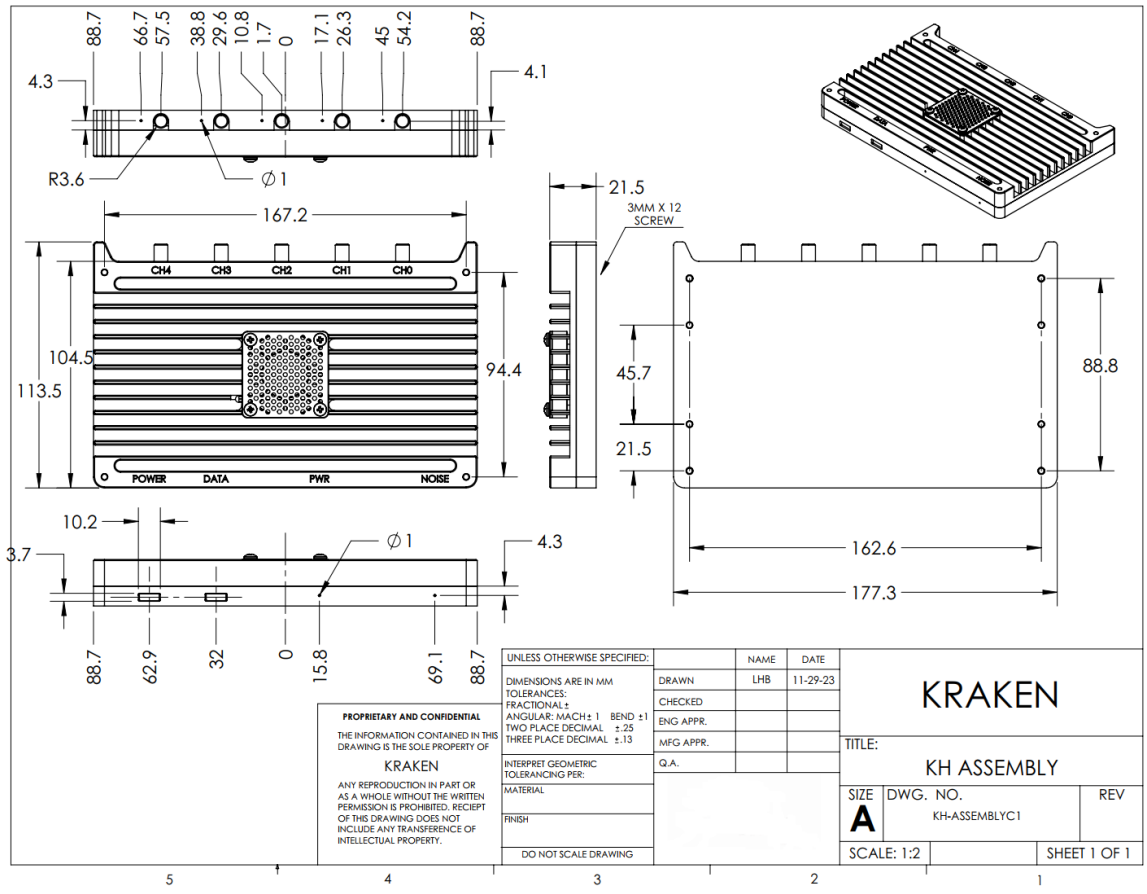

Figure 5. Enclosure Drawing

Support

Support is available on our community forums at forum.krakenrf.com

Additional Documentation

More in depth documentation is available on the KrakenSDR Wiki at github.com/krakenrf/krakensdr_docs/wiki

Glossary

RTL-SDR – A common low-cost software defined radio, originating from USB DVB-T tuner sticks.

SDR – Software defined radio

Coherent SDR – A multi-channel SDR where the output samples aligned with each channel, and the phases within the samples are also aligned.

MUSIC Algorithm – A direction finding algorithm used with the KrakenSDR