kuroBox Datasheet

Flexible, high-datarate metadata recorder for the film industry

Features

- Flexible on-set metadata recorder
- LTC input - all standard frame rates
- Inertial Measurement Unit - Yaw/Pitch/Roll
- GPS - World Position & UTC
- Flexible input/output data options, 2 serial ports (RS232)
- Writes to a standard SD Card (Class 10)
- Easy import into Maya
- All code is Open Source - both on-board and for post-production
- Wide input voltage (7-32V)
- Low current draw (~250mA)
- CNC machined aluminium enclosure

Applications

- Autonomous metadata logging of on-set data:
- Tilt / Roll / Pan of camera
- World position of camera to geo-tag footage

Overview

KuroBox is a data recorder specifically designed for the film industry. It has a dedicated Linear TimeCode (LTC) input capable of understanding all standard frame rates. Internally it has a high-performance, temperature calibrated, Inertial Measurement Unit (IMU) capable of outputting Yaw/Pitch/Roll along with raw measurement values at up to 200Hz. It also has a GPS module and altimeter to get world-position of the recorder, along with accurate UTC.

Fig 1: kuroBox

It has 2x RS232 serial ports, each capable of speeds up to 921600 baud for logging external data or for outputting real-time data to an external device or display. These ports can supply power to external devices.

An on-board display plus buttons allows the user to quickly and easily see the current status of all parameters, and to make on-set configuration changes. Status LED's allow very quick assessment of kuroBox's status.

The included mounting brackets are 1/4" UNC spaced at 3x5", but also has 6 mounting holes on the bottom for further options.

The SD card slot is recessed to prevent accidental removal.

All code is Open Source Software (OSS) to allow the user to configure and extend kuroBox to a particular need.

A series of python library are provided to interface the data to any particular need, including Maya.

Importance of Metadata

Collection of on-set metadata is of vital importance to any production and even more importance the longer and more intense the show gets.

Knowing where a camera is relative to other cameras on set can help untangle the confusion experienced in post-production, when all the deliveries are made in a single bundle, sometimes without any more information than who the camera operator was.

Metadata can describe the movements of the camera, what the tilt angles or roll were on a *per-frame* basis.

For quick camera movements, it can assist in camera tracking when it's not clear in the frame what the movement was.

Since all metadata is timecoded to the same source the frames, an approximate track can be obtained automatically - allowing for quick on-set decisions regarding camera angles, movements, lens choices, actor placement, etc. The chance of reshoots or pickups can be minimised.

Metadata without alignment to a specific frame can cause its own problems, since sorting through all the frames to find the corresponding metadata is a nightmare in itself. Therefore each data packet that kuroBox writes has the current timecode attached - the same timecode used by cameras and all other equipment on set.

System Operation

The operation of kuroBox is as simple as inserting an SD Card, attaching power and a timecode source. From then on, kuroBox will automatically record all data at its disposal - no intervention is needed. Even after an external power loss, recording will automatically resume.

KuroBox should be hard-mounted level to the camera. The supplied brackets have holes on a 5x3" grid - these brackets can be replaced with more suitable dimensions for specific needs. For consistent results, kuroBox should be mounted the same orientation at all times.

The timecode source should be the same as used on the rest of the on-set equipment. If at any time the timecode source is disconnected, kuroBox will be able keep accurate time as long as power is maintained. A TCXO (Temperature Compensated Crystal Oscillator) will keep the internal clock accurate to within 1/4 frame over a 12 hour period.

The two RS232 serial ports can be independently configured up to 961200 baud. Power can also be turned on or off to these ports, up to 150mA each. This can be used to power small displays or a small wireless module. Overcurrent and short-circuit protection is present on each port.

The data is created on the SD Card in 1GB chunks (~3hrs of continuous recording), seamlessly continuing onto the next chunk.

The data can be copied using any standard card reader and checked using the supplied Python scripts or loaded into Maya quickly.

Synchronising metadata to plates is done by aligning the displayed timecode from the kuroBox data to the timecode displayed on the plates.

The Python scripts are all Open Source Software (OSS), so modifications and extensions are encouraged and may be needed for custom needs. Also, the code running on kuroBox is also OSS, giving further value to it, since you are not locked-in to the supplied firmware.

System Architecture

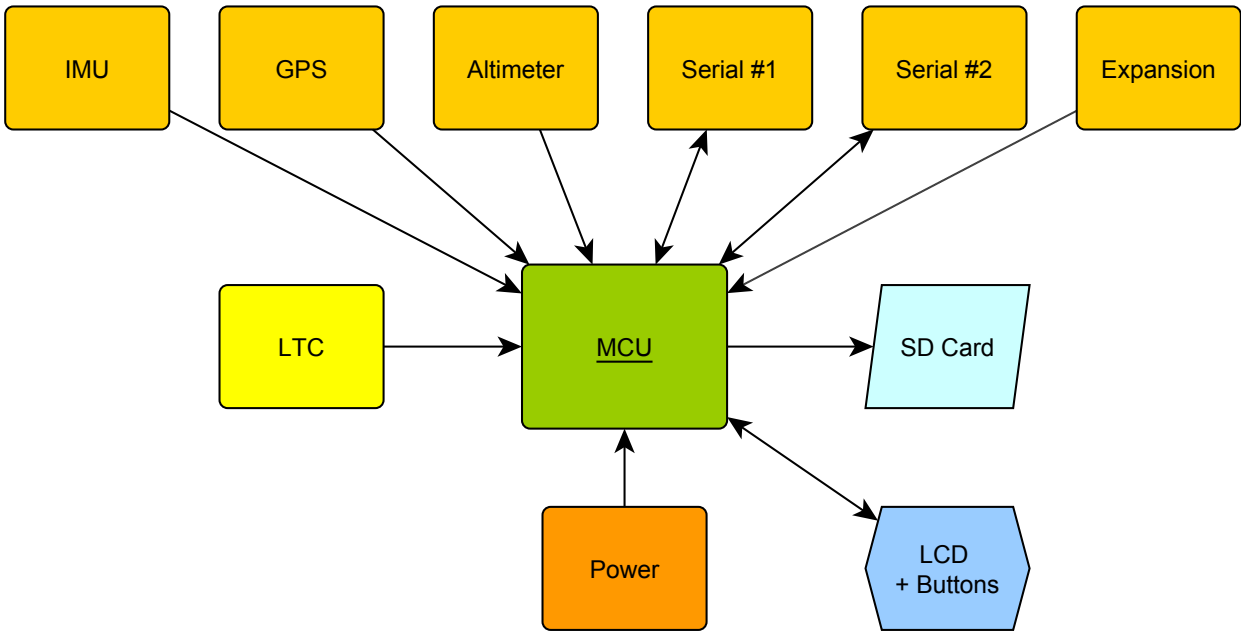


Fig 2: System Architecture

The kuroBox is comprised of 5 systems: Input/Output (IO), SD Card, Power, LCD & Buttons and the Microcontroller (MCU) - the brain.

The MCU is a powerful 32bit STM32F4 with an ARM Cortex-M4 DSP core running at 168MHz. With the current firmware and all features running, only 3% of the MCU's capacity is used, allowing plenty of power for future development and custom algorithms.

The Power system is capable of handling practically any DC power source available on set, from 32V right down to 7V. Overcurrent and reverse polarity circuitry protects it and surrounding equipment.

KuroBox accepts FAT32 formatted SD Card (Class 10), of any size, and it generates approximately 380MB/hr.

The LCD presents in detail the status of kuroBox: the current file, space left on the SD Card, current Yaw/Pitch/Roll, LTC, current longitude and latitude, input voltage, etc.

The LED's show power, error condition, and configurable statuses.

Industry standard LTC is read and interpreted so it can be displayed, but it is written out as it comes in, with all User Bits intact so they can become metadata.

The IMU generates a Yaw/Pitch/Roll solution at 200Hz, which is over 8 individual sub-frame values per frame at 24fps. Raw sensor data can also be written out so as to further refine data with post-processing.

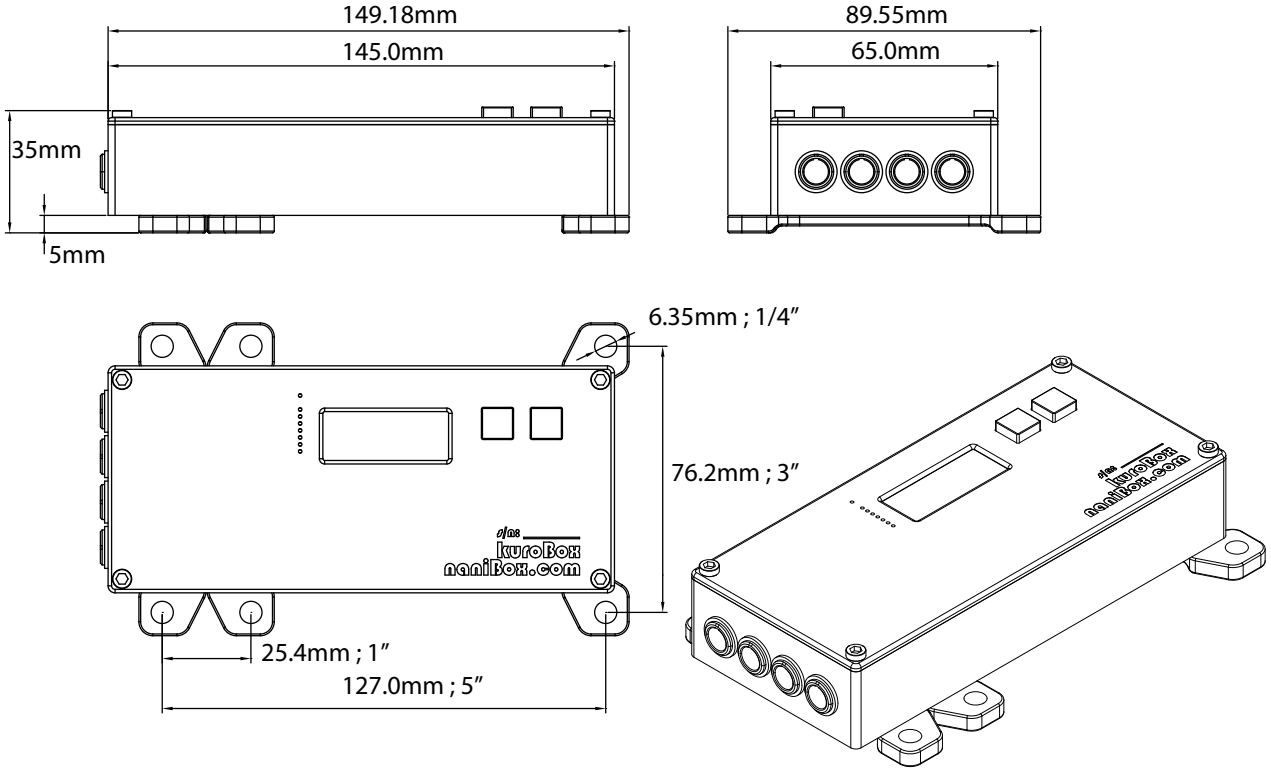
The GPS generates world coordinates and accurate UTC at 5Hz, this can then be used to synchronise to other equipment.

The serial ports can be used to display data over a serial link or can be used as inputs to be written out, the options are very flexible.

An internal expansion bus allows for custom inputs not handled by current hardware - in fact, the IMU/GPS combo is implemented on this bus.

Mechanical Specifications

- Weight (excluding mounts): 280gr
- Mount weight (including 1/4" UNC screws): 20gr (each)
- Machined from aircraft-grade alluminium alloy
- Hard annodised black
- CAD model available on request



Electrical Specifications

- Input voltage: 7-32V
- Current draw: 250mA in full logging mode
- Serial port: standard RS232, 8bit, no parity, 1bit stop, no hardware flow control
- Serial port baud rates: 9200, 19200, 38400, 57600, 115200, 230400, 460800, 961200 + custom rates possible
- Serial port supply: regulated 3.3v, max 150mA each
- Simplified schematic available on request

Connectors

- Power: LEMO EGG.0B.302
  - Pin 1: GND
  - Pin 2: 7-32V
- LTC: LEMO EGG.0B.305
  - Pin 1: GND
  - Pin 2: LTC IN
  - Pins 3,4,5: Not connected
- Serial: LEMO EGG.0B.305
  - Pin 1: GND
  - Pin 2: Not connected
  - Pin 3: RS232 RX
  - Pin 4: RS232 TX
  - Pin 5: 3.3V out (150mA MAX)
- GPS: Standard SMA-F