Reverse Engineering the Inkbird

What are we Reverse Engineering?

Inkbird ITH-20R provides direct and accurate display of humidity and temperature.You can choose Fahrenheit or Celsius according to your personal preference.

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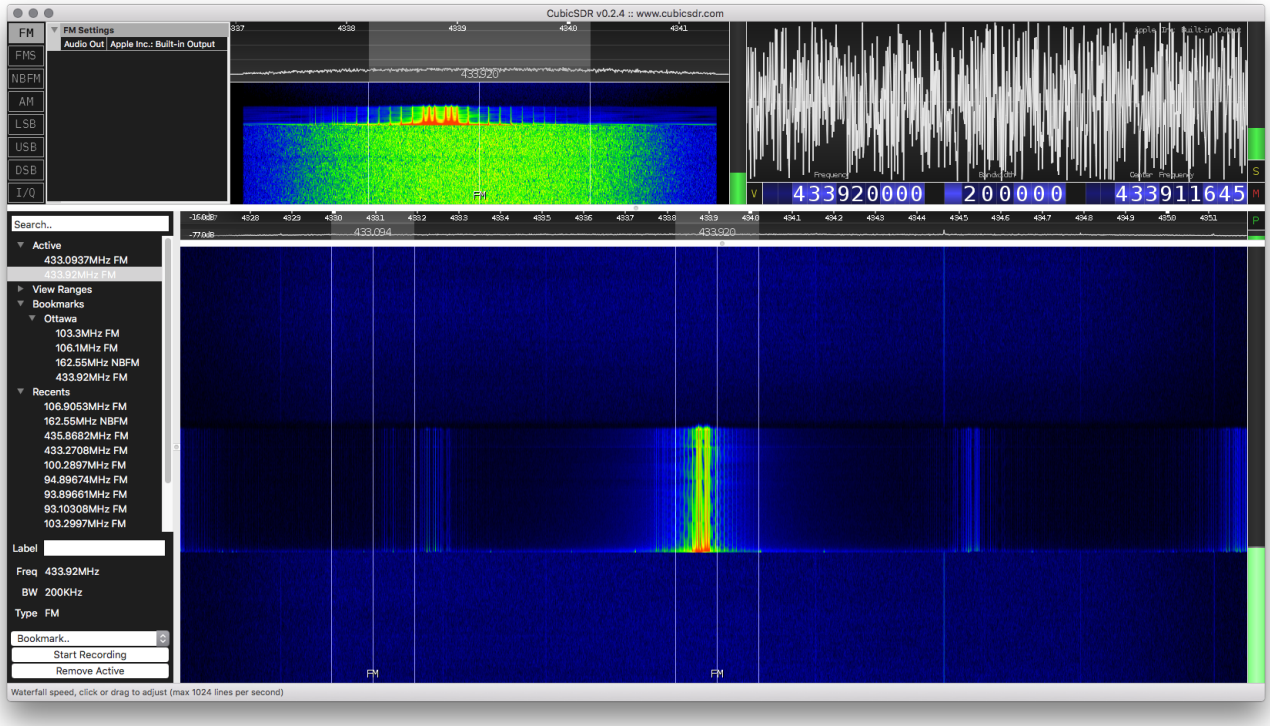
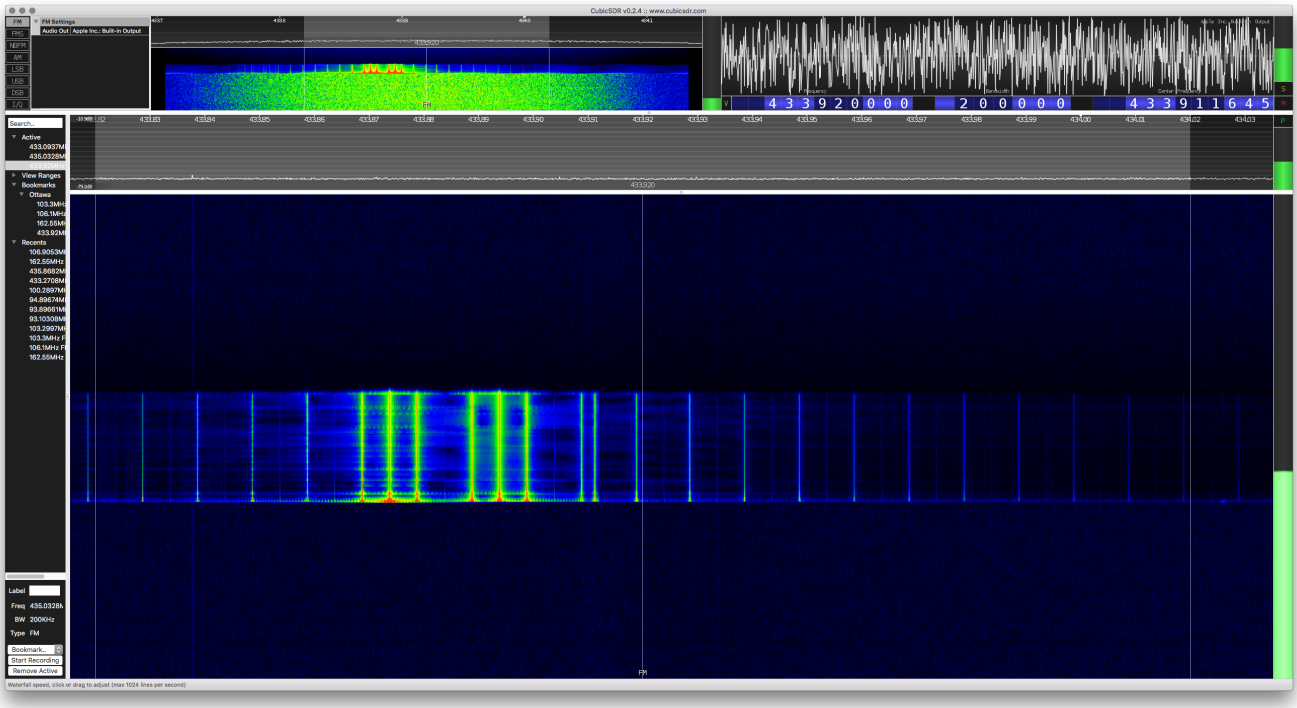
Specs

Spec	Value
Make	Inkbird
Model	ITH-20R
User Manual	Inkbird ITH-20R.pdf
Sampling Period	10s
Transmission Frequency	433MHz
Transmission Distance	300 Feet

Our Signal

Using CubicSDR we can see our signal which happens every 80 seconds or so.





Building RTL-433 on Mac

Clone repository

> git clone https://github.com/merbanan/rtl_433.git

Install rtl-sdr and cmake using brew

> brew install rtl-sdr cmake

Build

```
    cd rtl_433/
mkdir build
cd build
cmake ..
make
make install
```

For more details see: https://github.com/merbanan/rtl_433/blob/master/docs/BUILDING.md

Running RTL_433

> rtl_433

```
    $ rtl_433
rtl_433 version 19.08-18-g8eecdbb branch master at 201909241811 inputs file rtl_tcp RTL-SDR
Use -h for usage help and see https://triq.org/ for documentation.
Trying conf file at "rtl_433.conf"...
Trying conf file at "/Users/john.mehan/.config/rtl_433/rtl_433.conf"...
Trying conf file at "/usr/local/etc/rtl_433/rtl_433.conf"...
Trying conf file at "/etc/rtl_433/rtl_433.conf"...

        Consider using "-M newmodel" to transition to new model keys. This will become the default someday.
        A table of changes and discussion is at https://github.com/merbanan/rtl_433/pull/986.

Registered 108 out of 138 device decoding protocols [ 1-4 8 11-12 15-17 19-21 23 25-26 29-36 38-60 63 67-71 73-
100 102-103 108-116 119 121 124-128 131-138 ]
Found Rafael Micro R820T tuner
Exact sample rate is: 250000.000414 Hz
[R82XX] PLL not locked!
Sample rate set to 250000 S/s.
Tuner gain set to Auto.
Tuned to 433.920MHz.
pulse_FSK_detect(): Maximum number of pulses reached!
pulse_FSK_detect(): Maximum number of pulses reached!
pulse_FSK_detect(): Maximum number of pulses reached!
pulse_FSK_detect(): Maximum number of pulses reached!
```

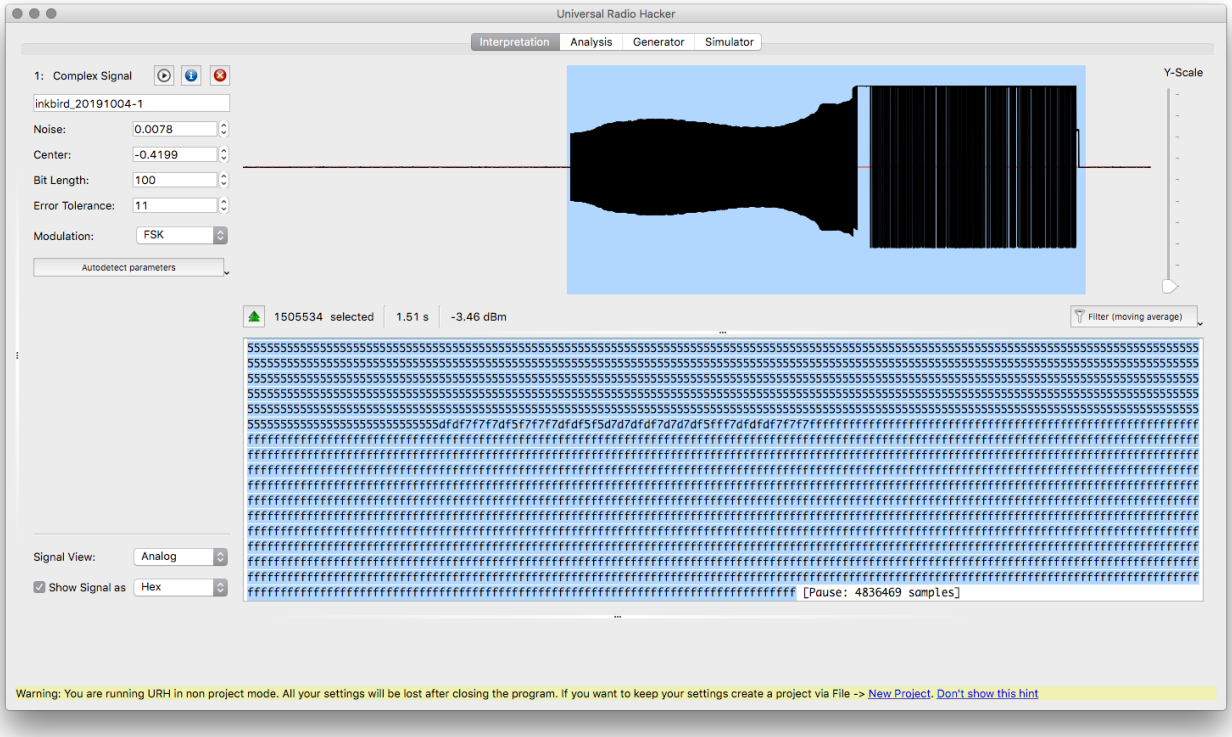
Googling Error

The error means the program is apparently receiving a very long FSK encoded signal with more bits/pulses than any currently known devices. However the Ambient sensors are nor FSK encoded, but OOK encoded instead. A likely cause is that your sensors are now sending their signal at the same time, disturbing the transmission of each other. As the sensors send at slightly different frequencies it is received as something that might look like a FSK encoded signal. It will happen as the periodic transmission from the sensors drift slightly and becomes overlapping, and it will disappear again as the timing drift further.

Using Pulse Analyser with all protocols disabled:

```
    rtl_433 -A -R 0
rtl_433 version 19.08-18-g8eecdbb branch master at 201909241811 inputs file rtl_tcp RTL-SDR
Use -h for usage help and see https://triq.org/ for documentation.
Trying conf file at "rtl_433.conf"...
Trying conf file at "/Users/john.mehan/.config/rtl_433/rtl_433.conf"...
Trying conf file at "/usr/local/etc/rtl_433/rtl_433.conf"...
Trying conf file at "/etc/rtl_433/rtl_433.conf"...
Disabling all device decoders.

        Consider using "-M newmodel" to transition to new model keys. This will become the default someday.
        A table of changes and discussion is at https://github.com/merbanan/rtl_433/pull/986.

Registered 0 out of 138 device decoding protocols [ ]
Found Rafael Micro R820T tuner
Exact sample rate is: 250000.000414 Hz
[R82XX] PLL not locked!
Sample rate set to 250000 S/s.
Tuner gain set to Auto.
Tuned to 433.920MHz.

Detected OOK package        2019-10-02 12:21:20
Analyzing pulses...
Total count:    1,  width: 1465.40 ms                (366351 S)
Pulse width distribution:
 [ 0] count:    1,  width: 1465404 us [1465404;1465404]        (366351 S)
Gap width distribution:
Pulse period distribution:
Level estimates [high, low]:  15892,      6
RSSI: -0.1 dB SNR: 33.6 dB Noise: -33.7 dB
Frequency offsets [F1, F2]:   19756,      0        (+75.4 kHz, +0.0 kHz)
Guessing modulation: Single pulse detected. Probably Frequency Shift Keying or just noise...

Detected OOK package        2019-10-02 12:22:41
Analyzing pulses...
Total count:    1,  width: 1465.44 ms                (366359 S)
Pulse width distribution:
 [ 0] count:    1,  width: 1465436 us [1465436;1465436]        (366359 S)
Gap width distribution:
Pulse period distribution:
Level estimates [high, low]:  15921,      5
RSSI: -0.1 dB SNR: 34.2 dB Noise: -34.4 dB
Frequency offsets [F1, F2]:   20432,      0        (+77.9 kHz, +0.0 kHz)
Guessing modulation: Single pulse detected. Probably Frequency Shift Keying or just noise...
```

Recording Signal using URH


Universal Radio Hacker
Interpretation
Analysis
Generator
Simulator
1: Complex Signal
inkbird_20191004-1
Noise: 0.0078
Center: -0.4199
Bit Length: 100
Error Tolerance: 11
Modulation: FSK
Autodetect parameters
Y-Scale
1505534 selected
1.51 s
-3.46 dBm
Filter (moving average)
Signal View: Analog
Show Signal as Hex
[Pause: 4836469 samples]
Warning: You are running URH in non project mode. All your settings will be lost after closing the program. If you want to keep your settings create a project via File -> New Project. Don't show this hint

Data:

```
000000000000000000000555555555555555555555555555555555555555555555555555555555555555555555555555555555555555555555555555555555
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aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa2dd4d3910f0001000160bf37bc00b7005402885
10 [Pause: 3987304 samples]
```

Notes:

PreAmble

0's followed by 5's

dfdf7f7f7df5f7f7f7dfdf5f5d7d7dfdf7d7d7df5fff7dfdfdf7f7f7

followed by f's

PAUSE

0's followed by a's

2dd4d3910f0001000160bf37bc00b700540288510

PAUSE

Data:

Iteration	After 5's	After a's	IN Temp	IN Humidity	OUT Temp	OUT Humidity	EXT Temp
1			66.7	47	67.1	56	65.6

Another Recording

Other Tests of RTL_433

RadioHead ASK code on ESP8266 Board (Lolin/Wemos mini)

Code

```
    // ask_transmitter.pde
#include <RH_ASK.h>
#ifdef RH_HAVE_HARDWARE_SPI
#include <SPI.h> // Not actually used but needed to compile
#endif
RH_ASK driver(2000, D4, D2, D1); // (bps, RX, TX, PTT)

void setup()
{
    Serial.begin(115200);          // Debugging only
    Serial.println("\n\nask_transmitter");
}
void loop()
{
    const char *msg = "hello";
    driver.send((uint8_t *)msg, strlen(msg));
    driver.waitPacketSent();
    delay(200);
}
```

Results:

```
    $ rtl_433
rtl_433 version 19.08-18-g8eecdbb branch master at 201909241811 inputs file rtl_tcp RTL-SDR
Use -h for usage help and see https://triq.org/ for documentation.
Trying conf file at "rtl_433.conf"...
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Trying conf file at "/usr/local/etc/rtl_433/rtl_433.conf"...
Trying conf file at "/etc/rtl_433/rtl_433.conf"...

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100 102-103 108-116 119 121 124-128 131-138 ]
Found Rafael Micro R820T tuner
Exact sample rate is: 250000.000414 Hz
[R82XX] PLL not locked!
Sample rate set to 250000 S/s.
Tuner gain set to Auto.
Tuned to 433.920MHz.
_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
time      : 2019-10-02 08:36:26
model     : RadioHead ASK Data len  : 5            To        : 255           From      : 255
Id        : 0
Flags     : 0            Payload   : 104, 101, 108, 108, 111                         Integrity : CRC
_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
```

RCSwitch code on ESP8266 Board (Lolin/Wemos mini)

Code:

```
    #include <RCSwitch.h>

RCSwitch mySwitch = RCSwitch();

void setup() {
  Serial.begin(115200);

  // Transmitter is connected to Arduino Pin #10
  mySwitch.enableTransmit(D2);
  Serial.println("\n\nSender Started");
  // Optional set protocol (default is 1, will work for most outlets)
  // mySwitch.setProtocol(2);

  // Optional set pulse length.
  // mySwitch.setPulseLength(320);

  // Optional set number of transmission repetitions.
  // mySwitch.setRepeatTransmit(15);

}

void loop() {
  Serial.print(".");
  mySwitch.switchOn("11111", "00010");
  delay(10000);
}
```

Results:

```
    Tuned to 433.920MHz.
_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
time      : 2019-10-02 09:13:58
model     : Waveman Switch Transmitter             id        : A
channel   : 4            button    : 3             state     : off
_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
time      : 2019-10-02 09:13:58
model     : Akhan 100F14 remote keyless entry      ID (20bit): 0x151
Data (4bit): 0x1 (Lock)
_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
time      : 2019-10-02 09:13:58
model     : Waveman Switch Transmitter             id        : A
channel   : 4            button    : 3             state     : off
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model     : Waveman Switch Transmitter             id        : A
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time      : 2019-10-02 09:13:58
model     : Waveman Switch Transmitter             id        : A
channel   : 4            button    : 3             state     : off
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time      : 2019-10-02 09:13:58
model     : Akhan 100F14 remote keyless entry      ID (20bit): 0x151
Data (4bit): 0x1 (Lock)
_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
time      : 2019-10-02 09:13:59
model     : Waveman Switch Transmitter             id        : A
channel   : 4            button    : 3             state     : off
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time      : 2019-10-02 09:13:59
model     : Waveman Switch Transmitter             id        : A
channel   : 4            button    : 3             state     : off
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time      : 2019-10-02 09:13:59
model     : Akhan 100F14 remote keyless entry      ID (20bit): 0x151
Data (4bit): 0x1 (Lock)
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time      : 2019-10-02 09:13:59
model     : Waveman Switch Transmitter             id        : A
channel   : 4            button    : 3             state     : off
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time      : 2019-10-02 09:13:59
```

```
model     : Akhan 100F14 remote keyless entry      ID (20bit): 0x151
Data (4bit): 0x1 (Lock)
_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
time      : 2019-10-02 09:13:59
model     : Waveman Switch Transmitter             id        : A
channel   : 4            button    : 3             state     : off
_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
time      : 2019-10-02 09:13:59
model     : Akhan 100F14 remote keyless entry      ID (20bit): 0x151
Data (4bit): 0x1 (Lock)
```

References

Reference	URL
User Manual	Inkbird ITH-20R.pdf
Inkbird ITH-20R	https://www.ink-bird.com/products-data-logger-ith20.html
RTL-SDR: 433.92Mhz ASK/OOK Decoding of Various Devices with rtl_433	https://goughlui.com/2013/12/20/rtl-sdr-433-92mhz-askook-decoding-of-various-devices-with-rtl_433/
RTL_433	https://github.com/merbanan/rtl_433
Building RTL_433	https://github.com/merbanan/rtl_433/blob/master/docs/BUILDING.md
Frequency Shift Keying	https://en.wikipedia.org/wiki/Frequency-shift_keying