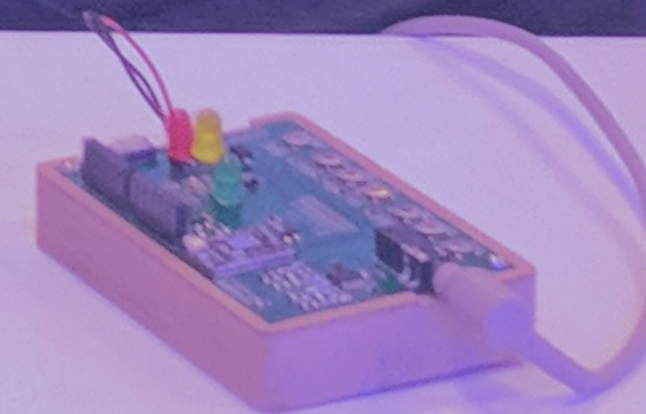


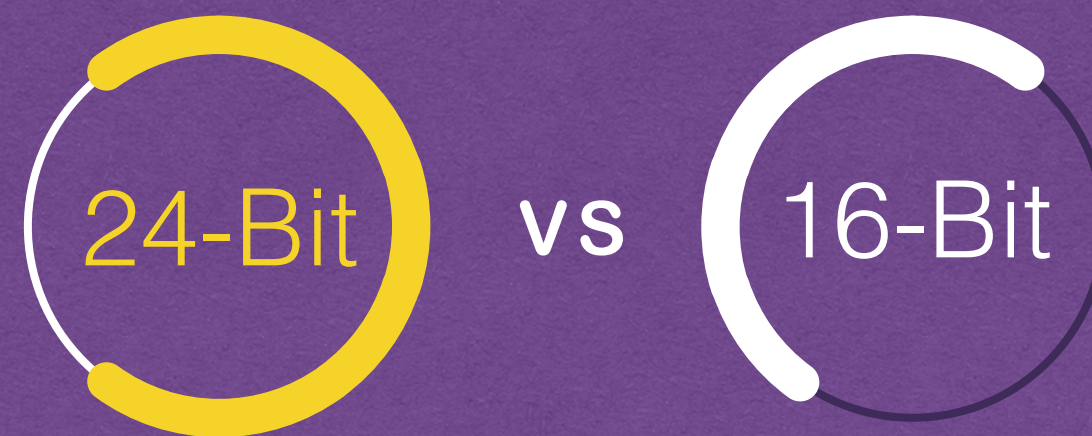
BLUETOOTH 24-BIT HEADPHONE ADAPTER



Introduction

- Portable Bluetooth Adapter for Wireless 24-Bit Audio Streaming

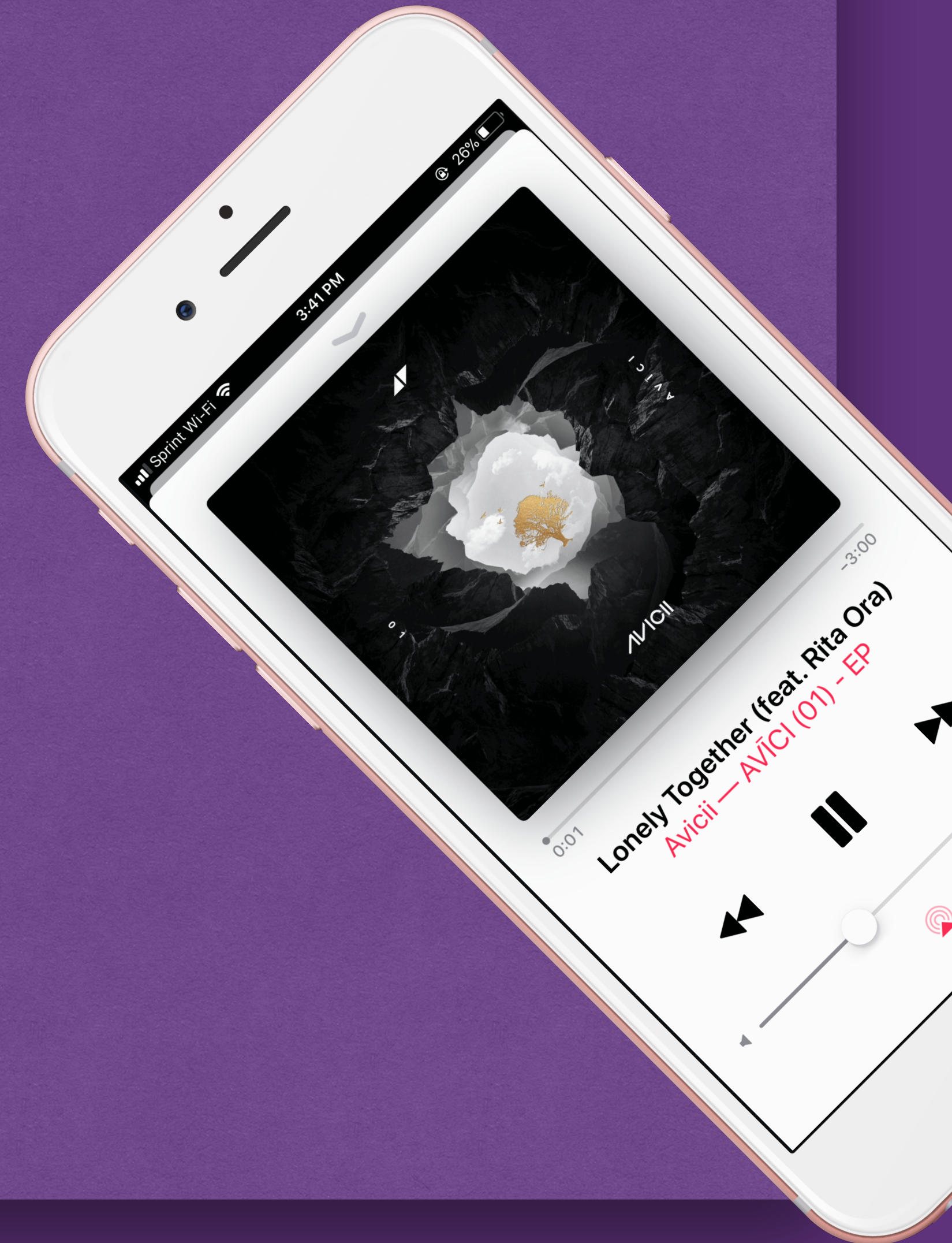
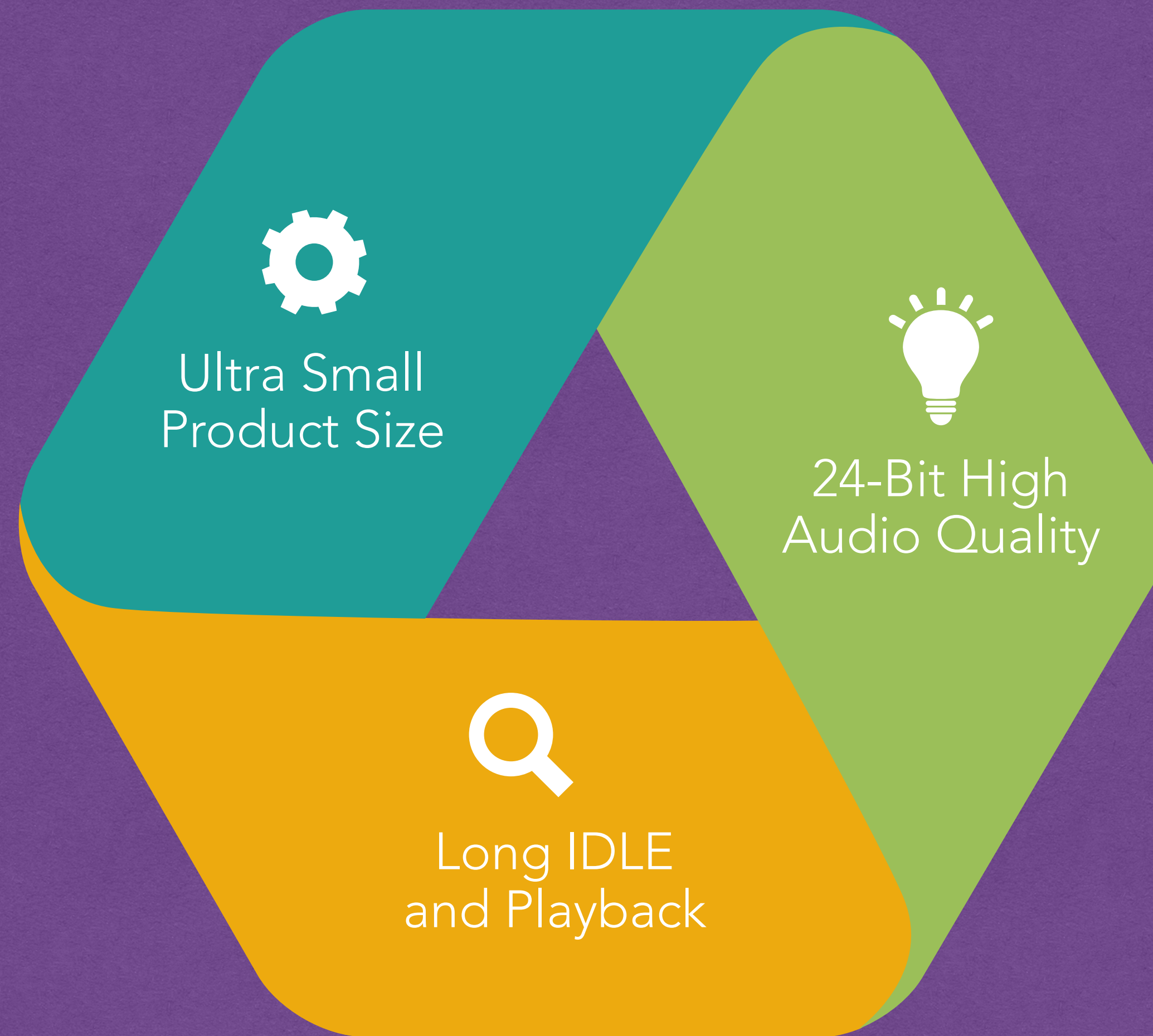
Bit Depth

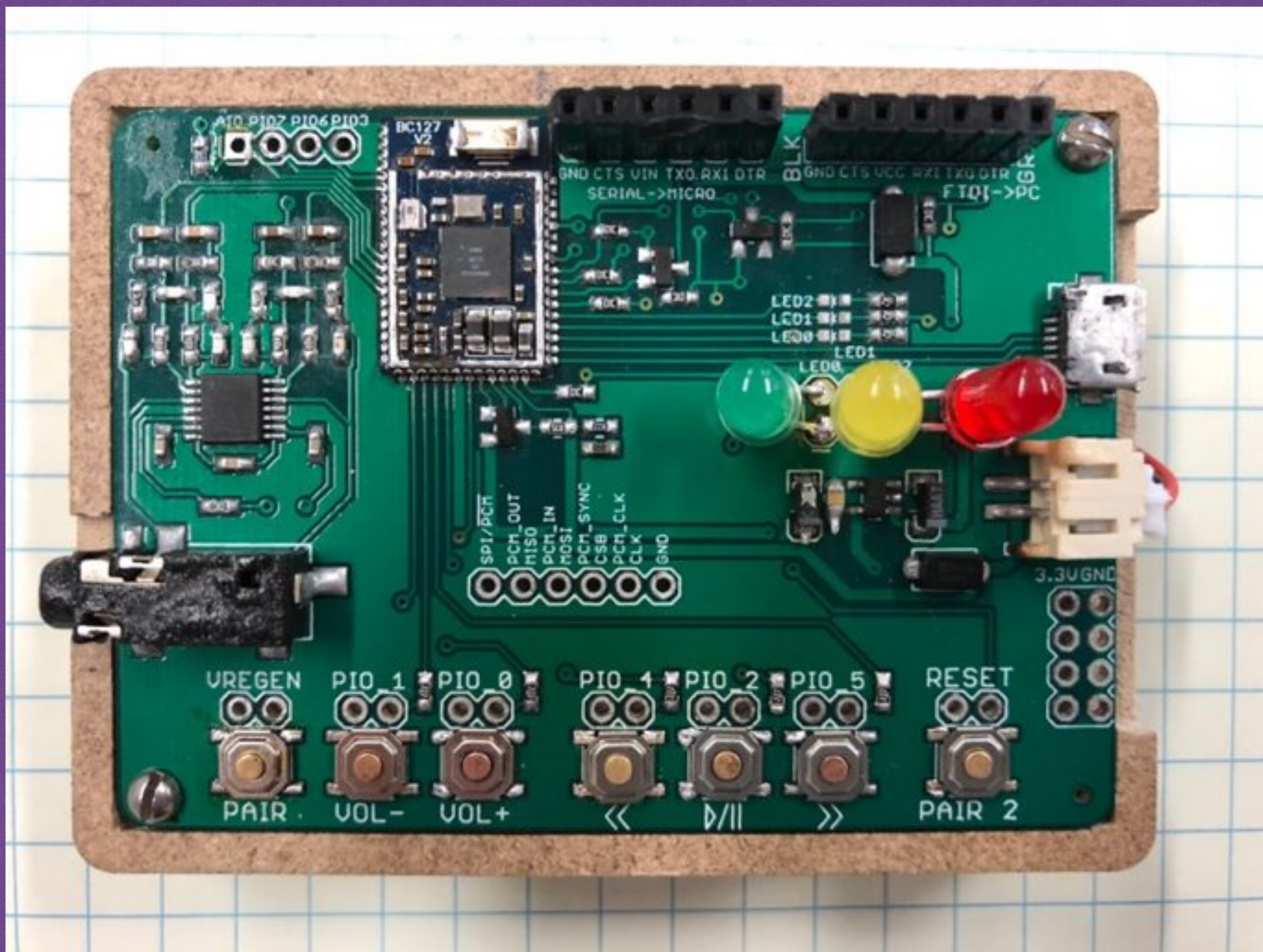


Playback Time

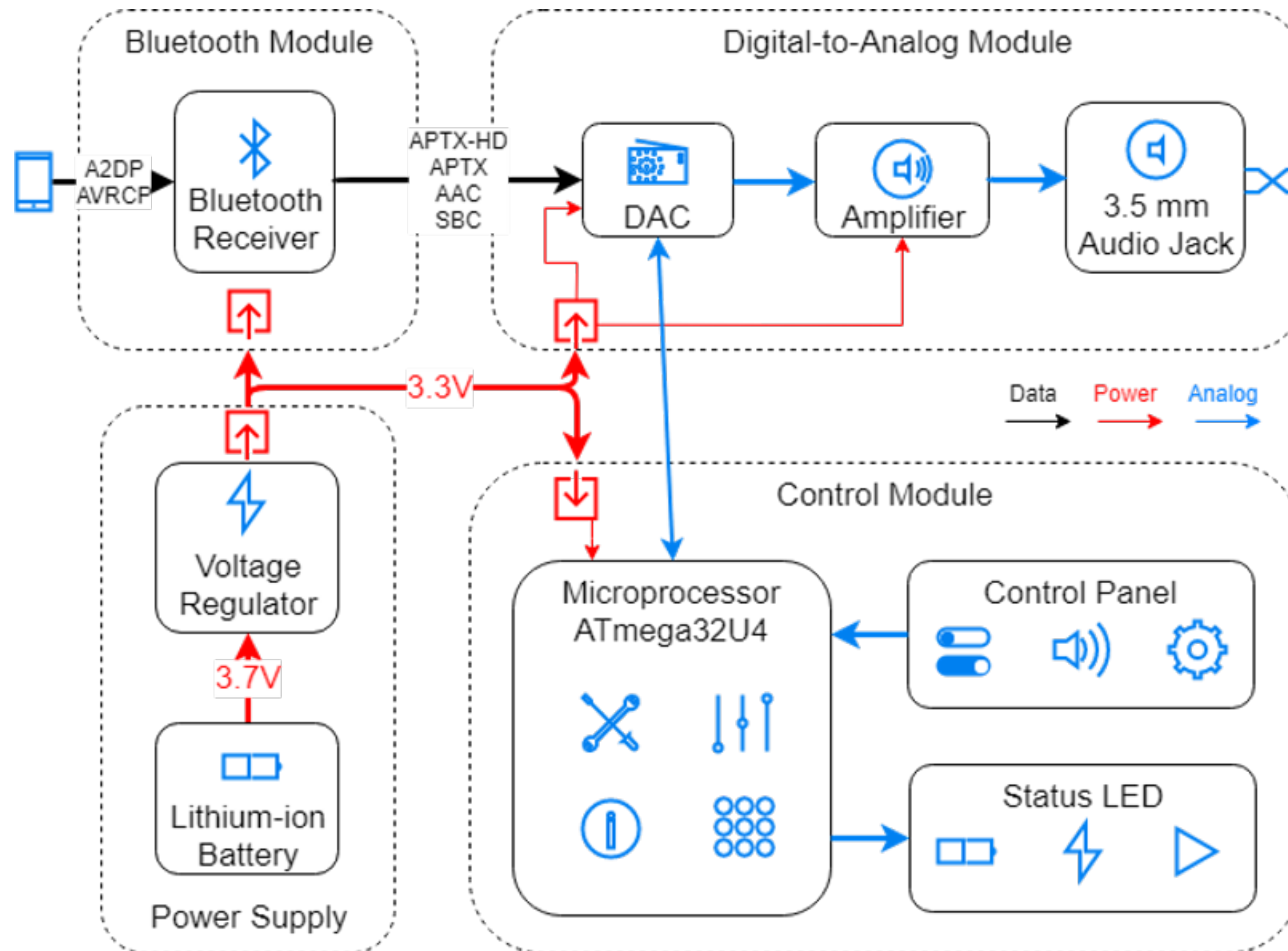


Design Goal





BLOCK DIAGRAM



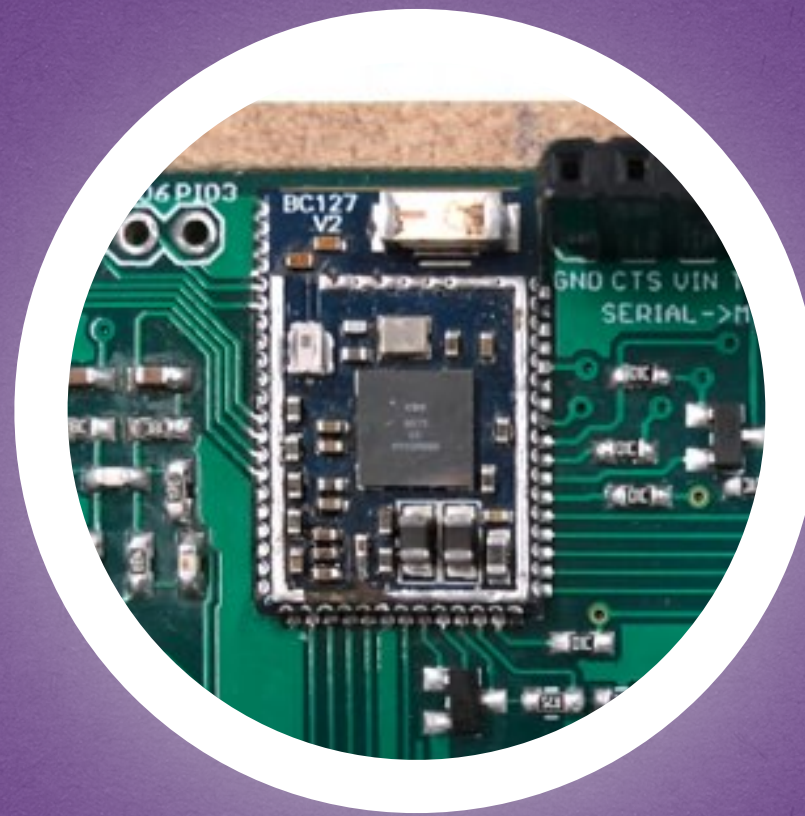


1. DATA TRANSMISSION

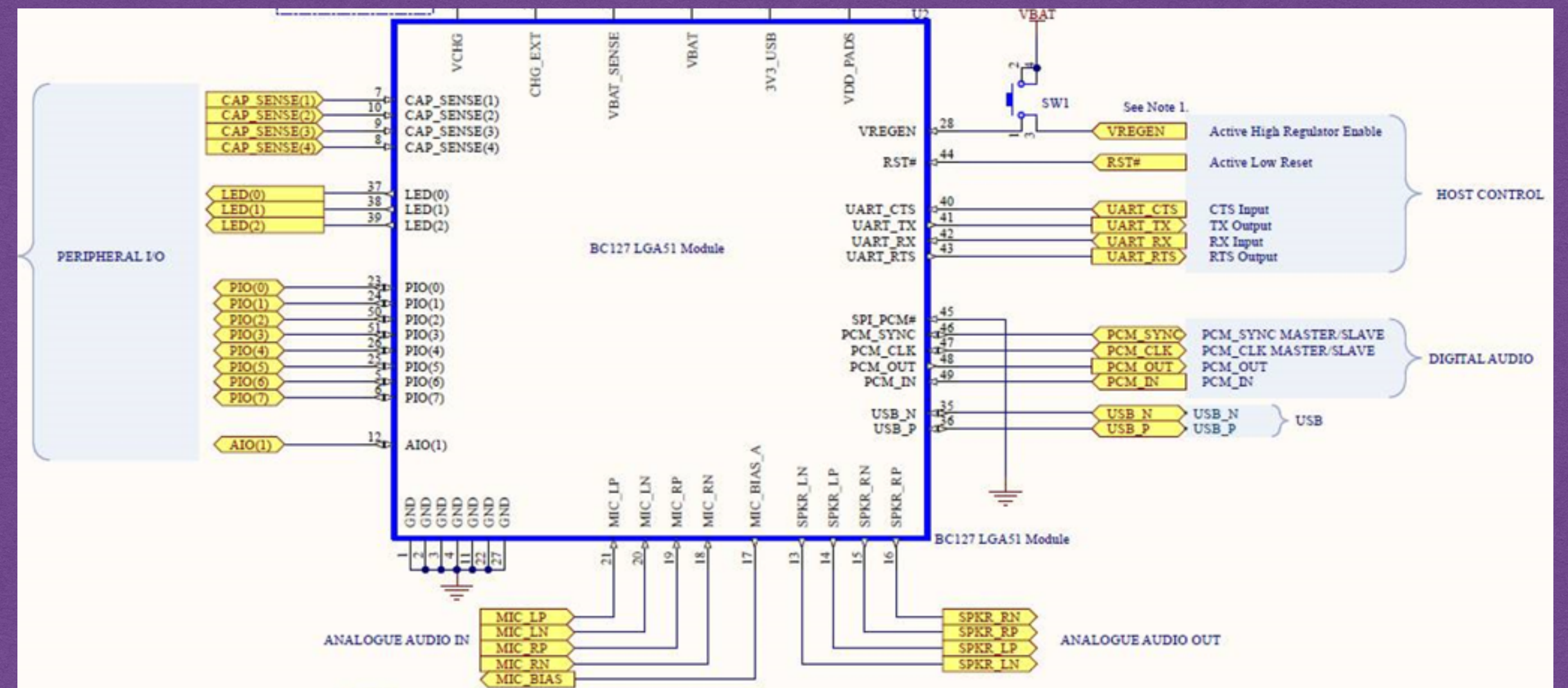
BLUETOOTH

WIRELESS

THE NAVIGATOR



QUALCOMM
CSR8875



Hi-Res Entertainment

- 24-Bit Depth For Higher Clarity
- Higher Sampling Rate For Higher Resolution
- Over 144dB Theoretical Dynamic Range
- Ultra Low Noise Floor Voltage





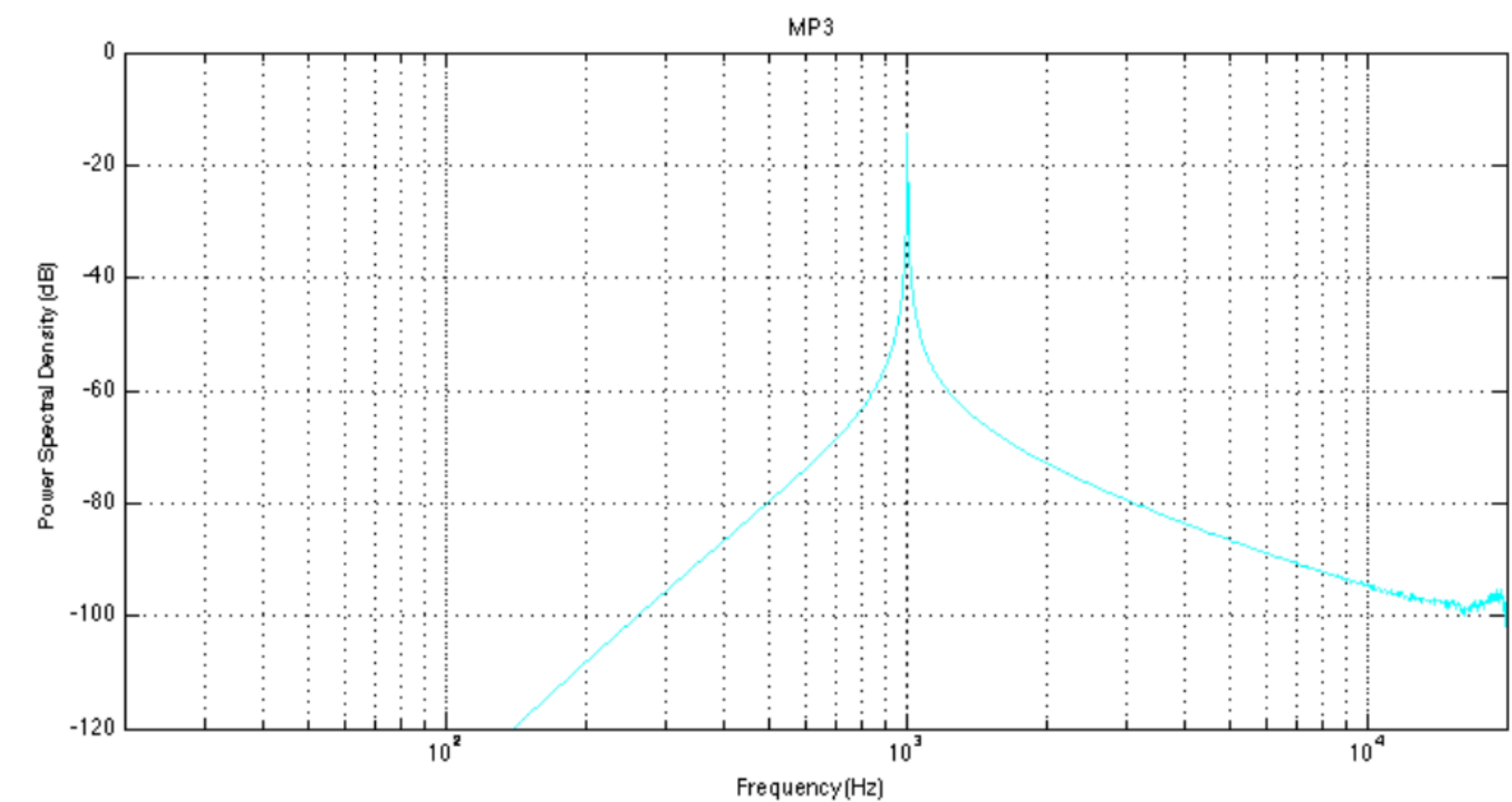
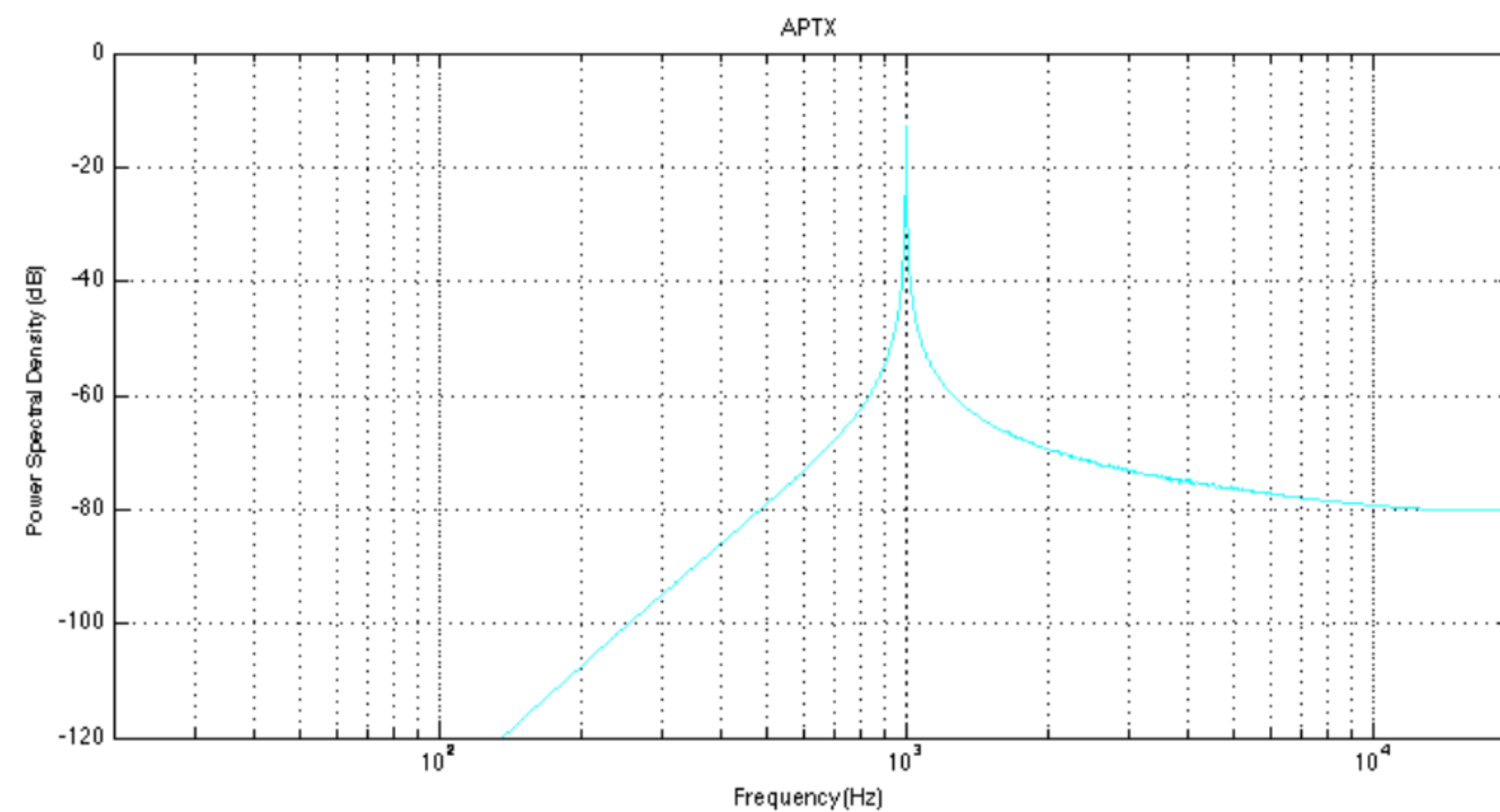
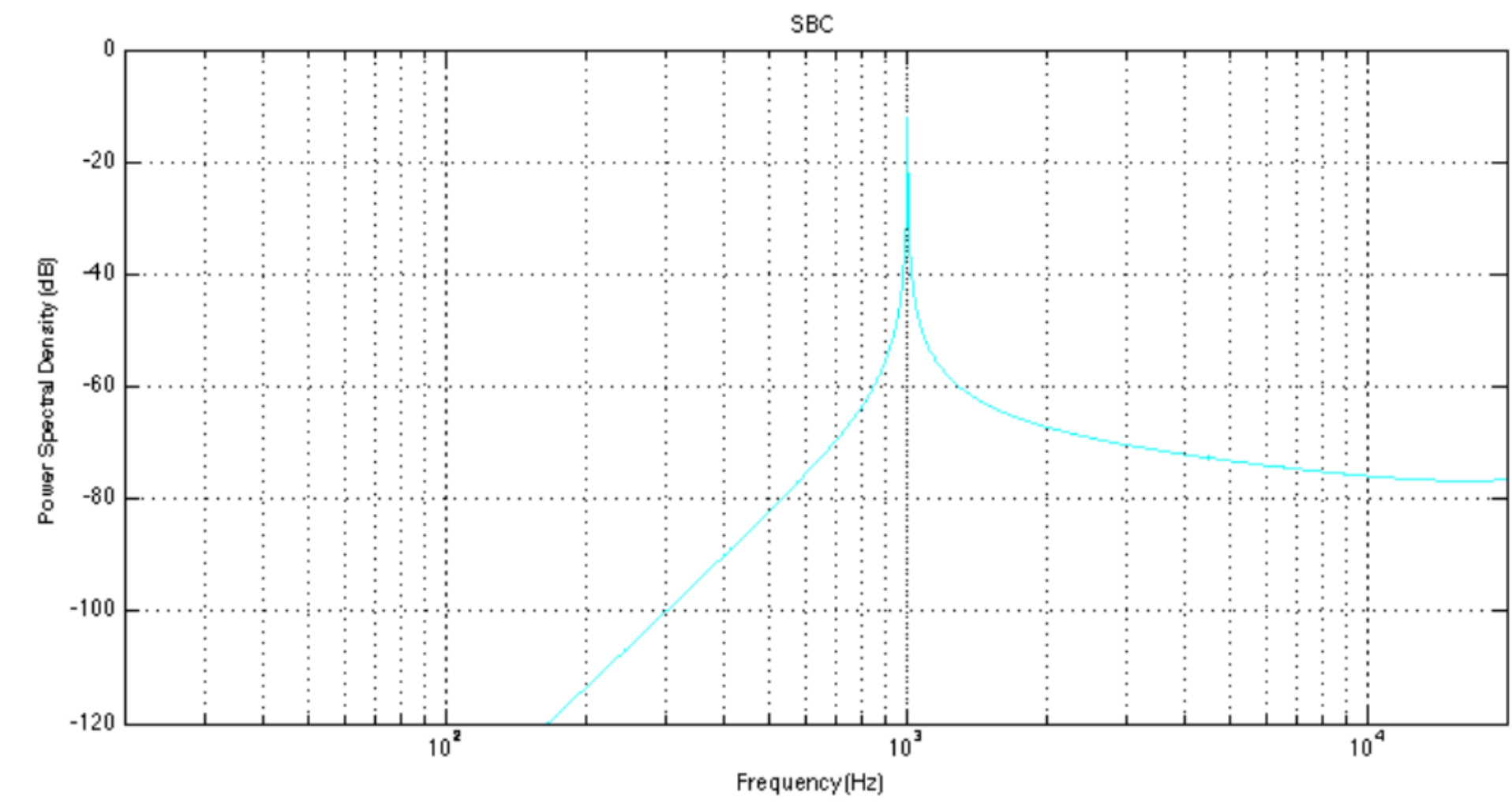
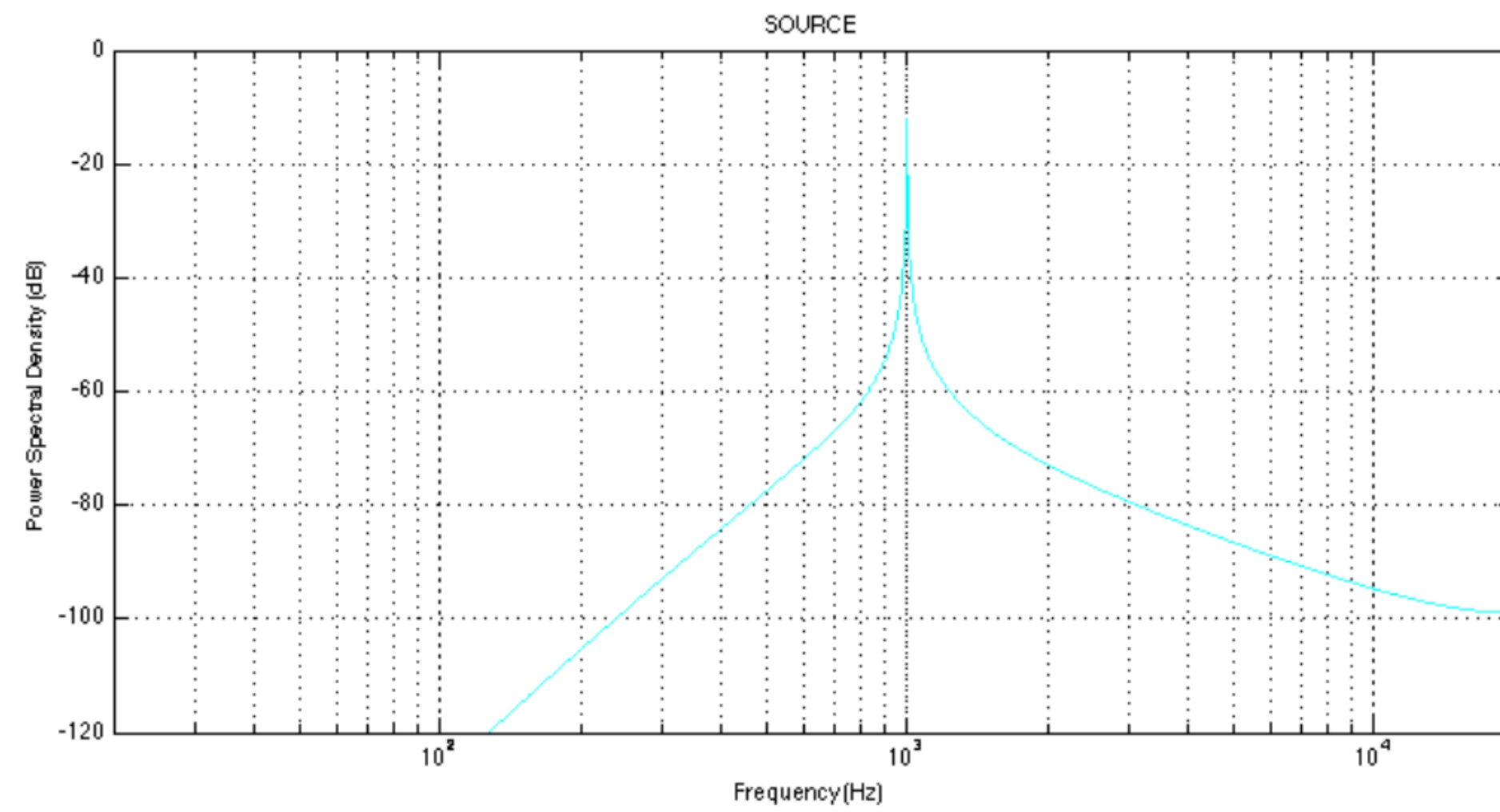
Codec Revolution

Qualcomm® aptX™ HD

- High Data Packet Compression
- Better Packet Transmission Algorithm
- Better Noise Handling
- Bluetooth 4.x Support

1000 HZ HARMONIC DISTORTION TEST

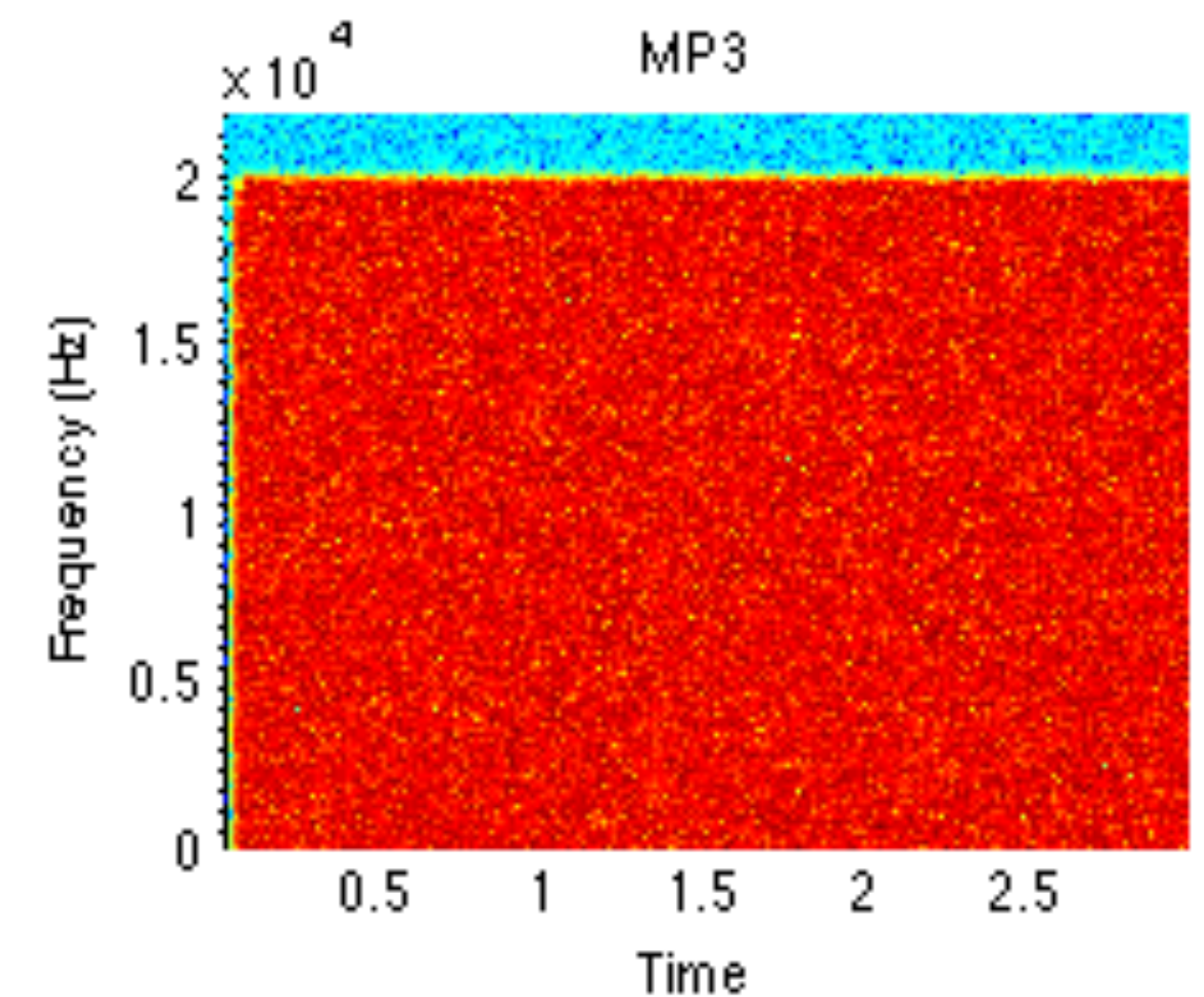
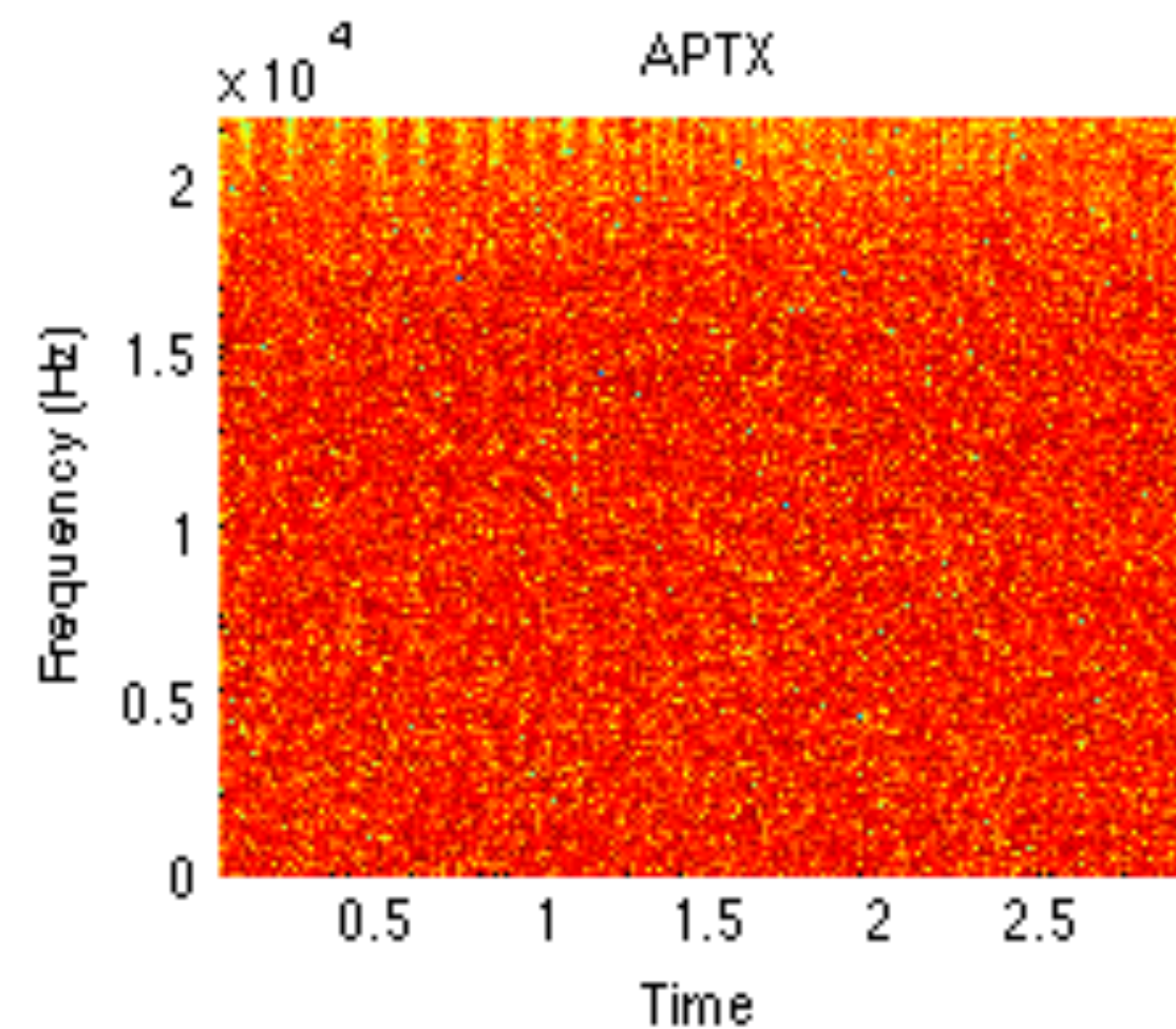
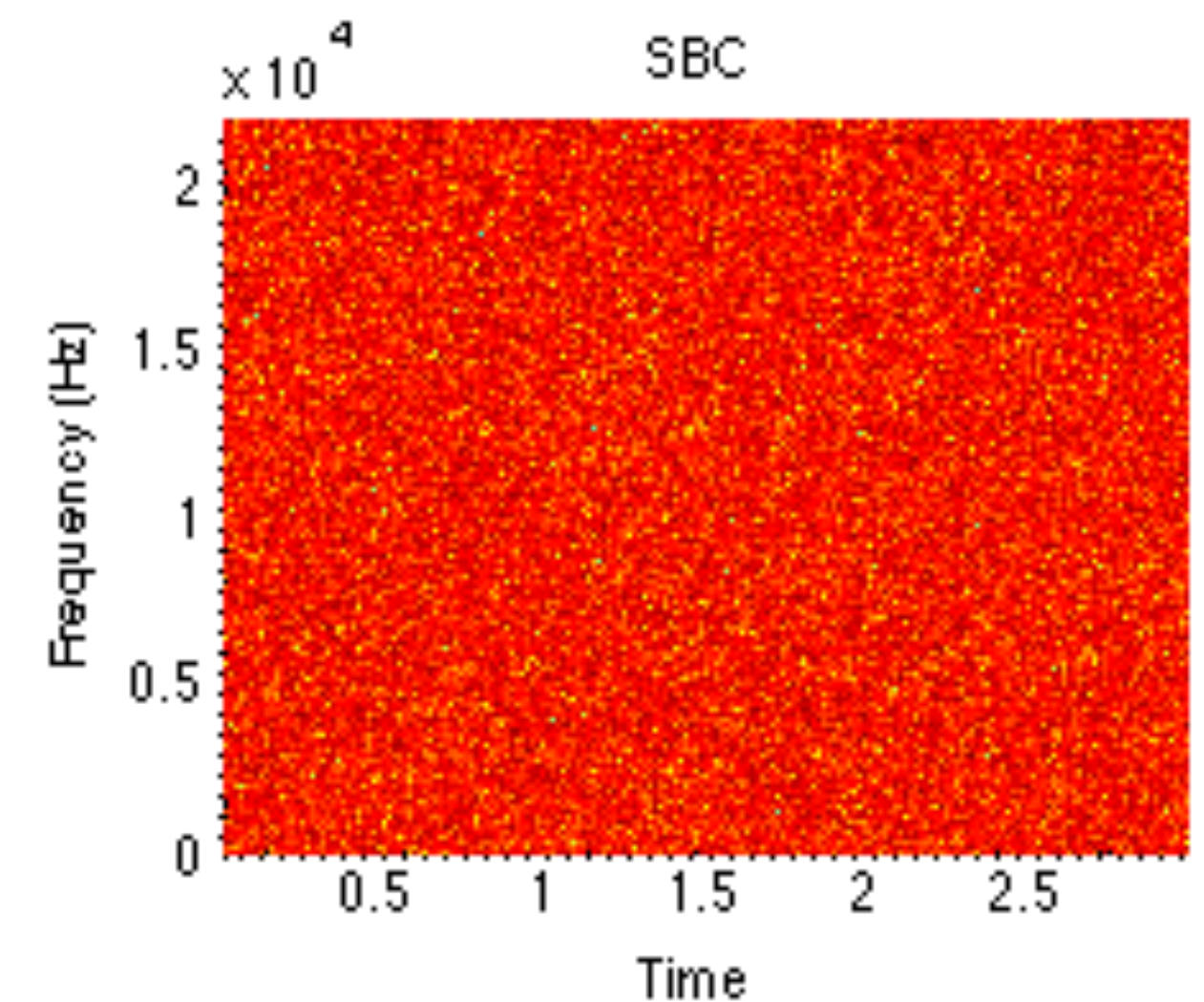
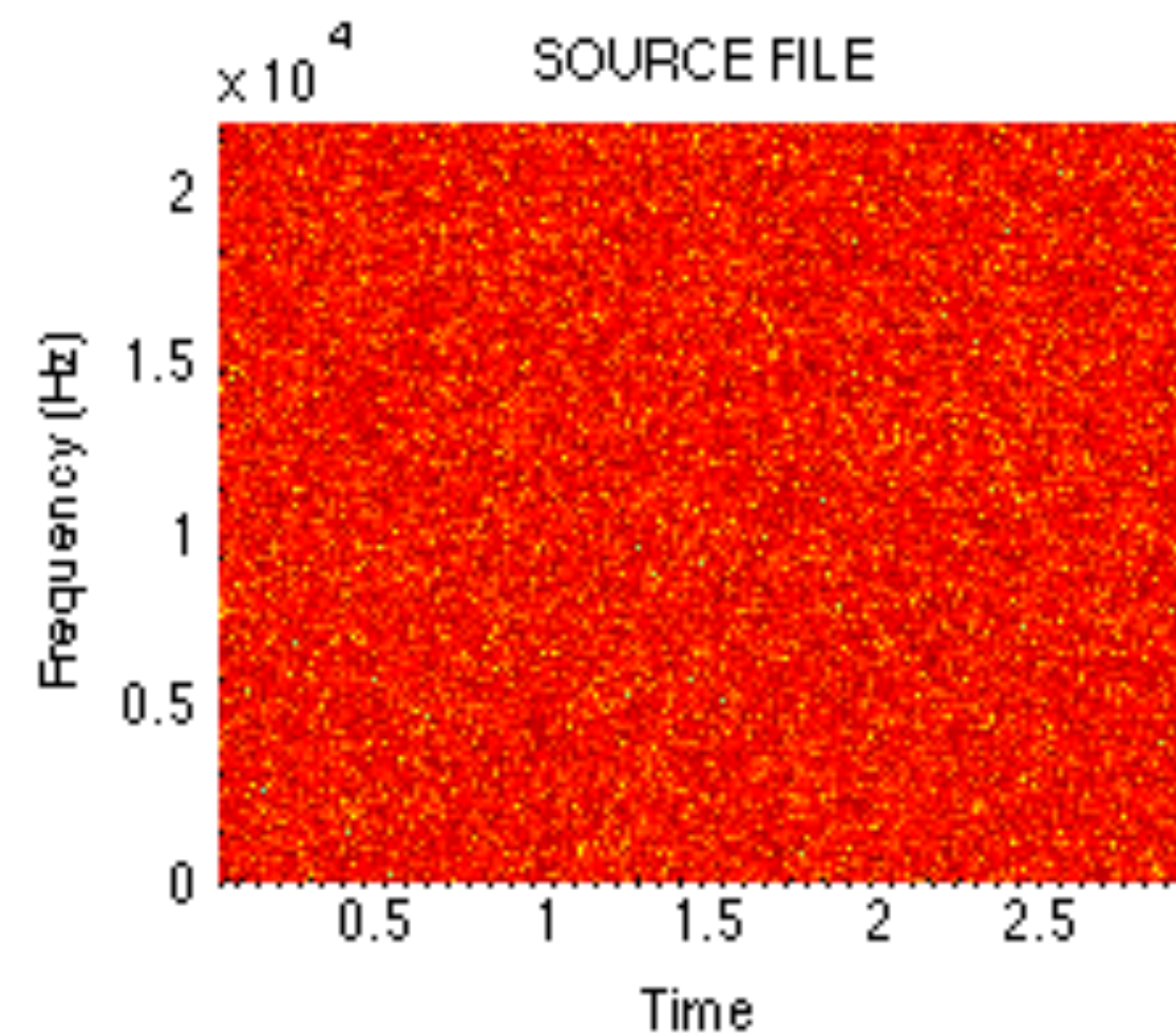
10



BROADBAND WHITE NOISE TEST

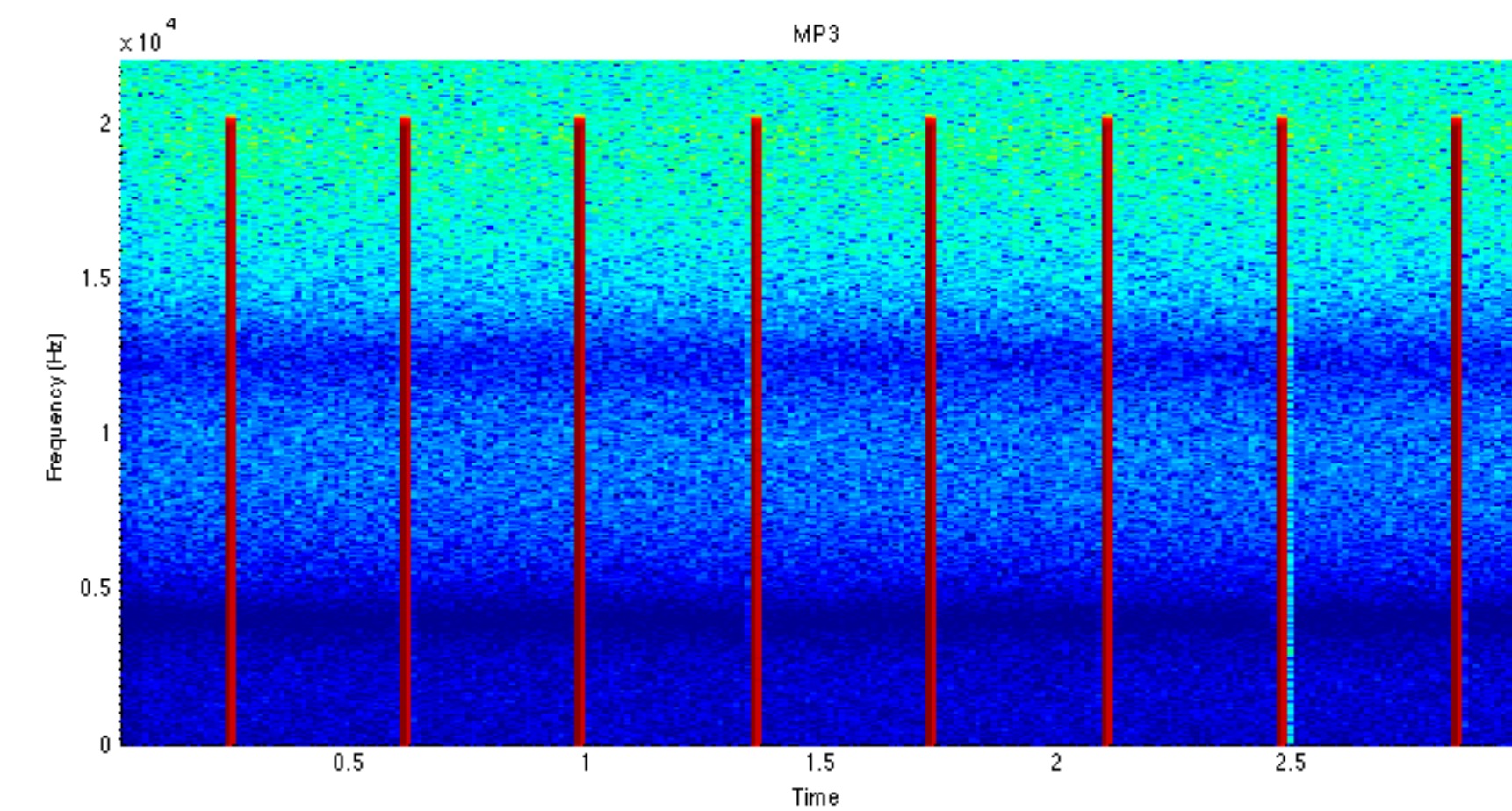
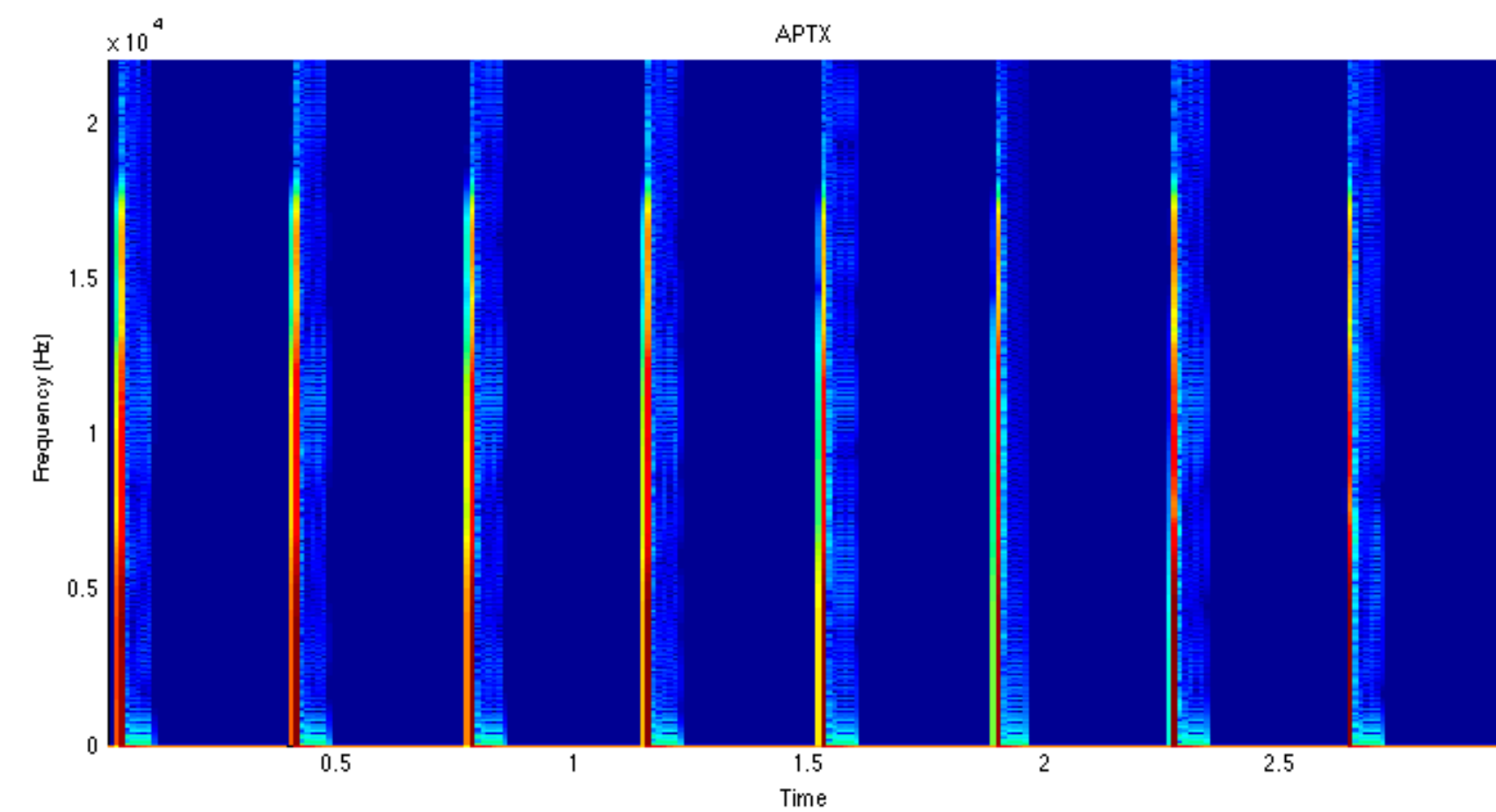
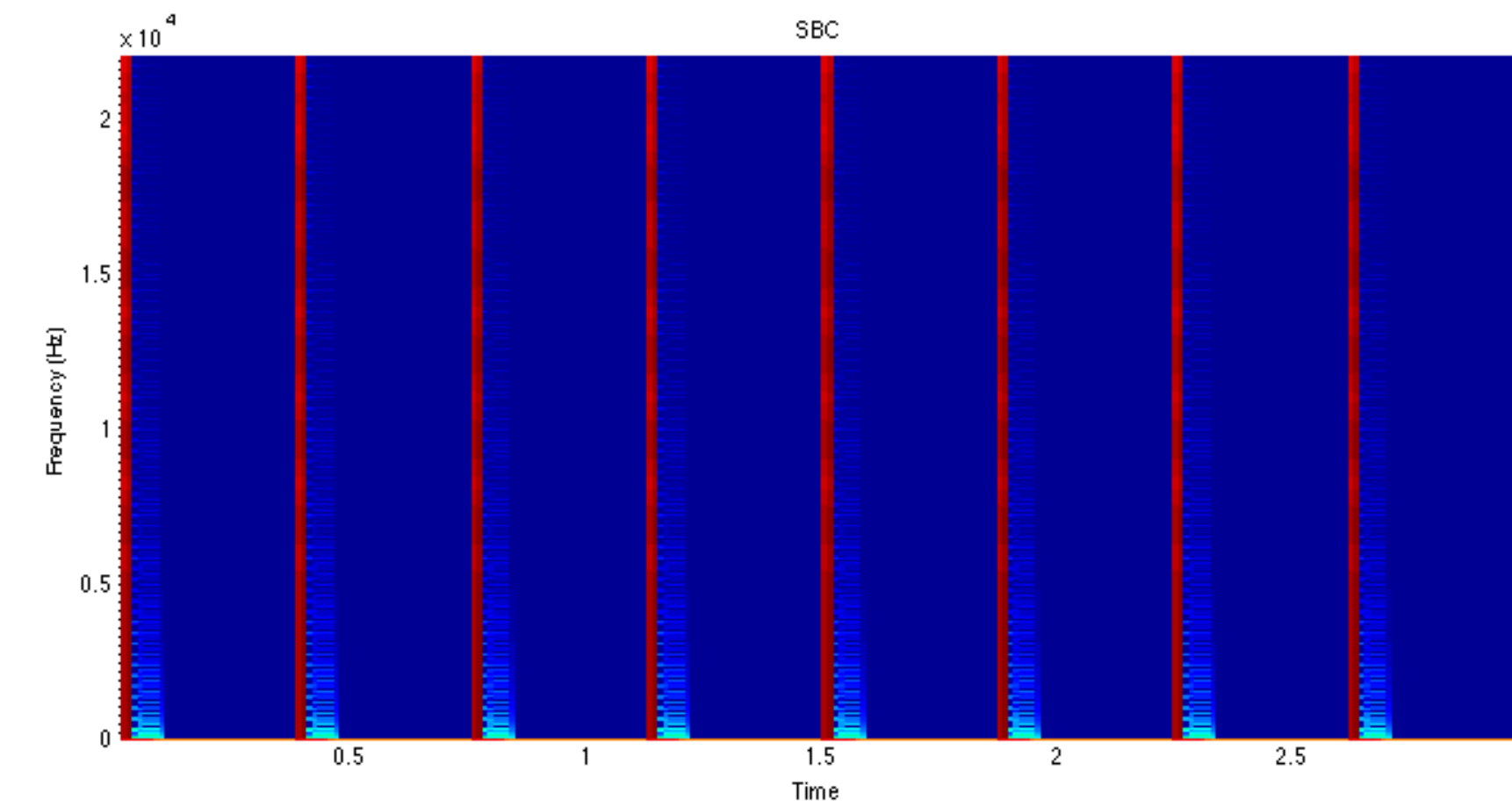
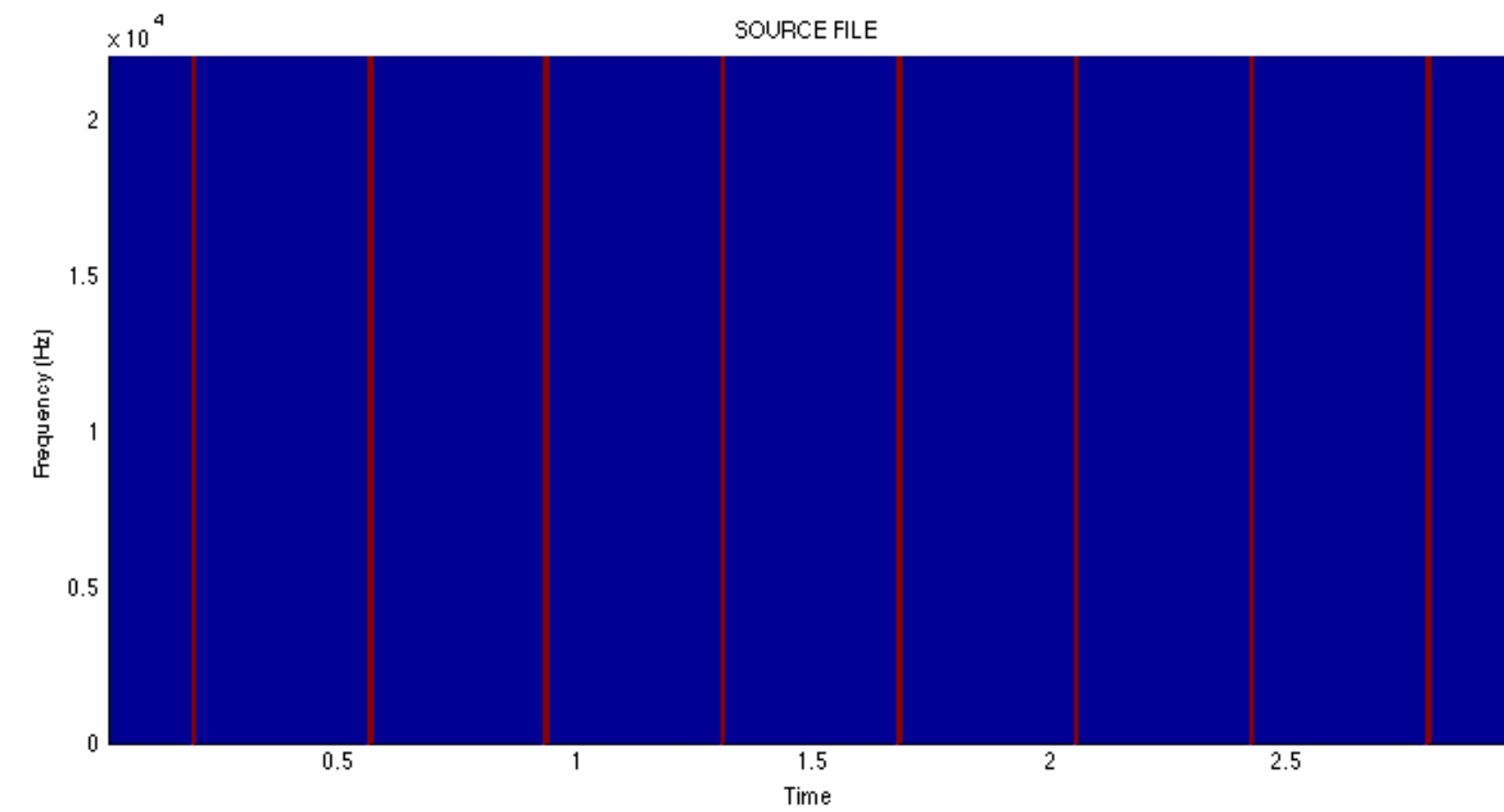
11

White noise helps us understand the behavior of a codec when it is excited at all frequencies and does not change in time.



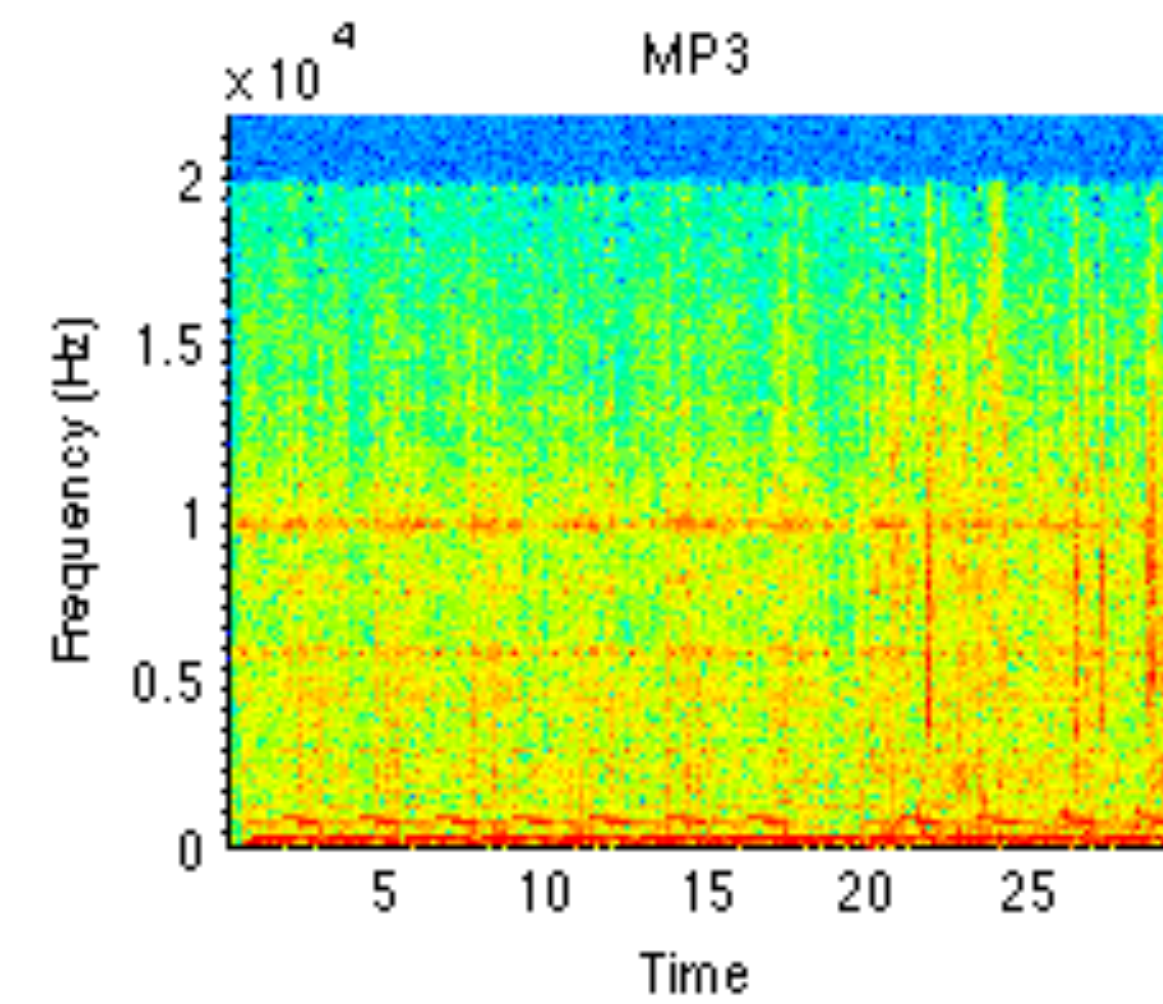
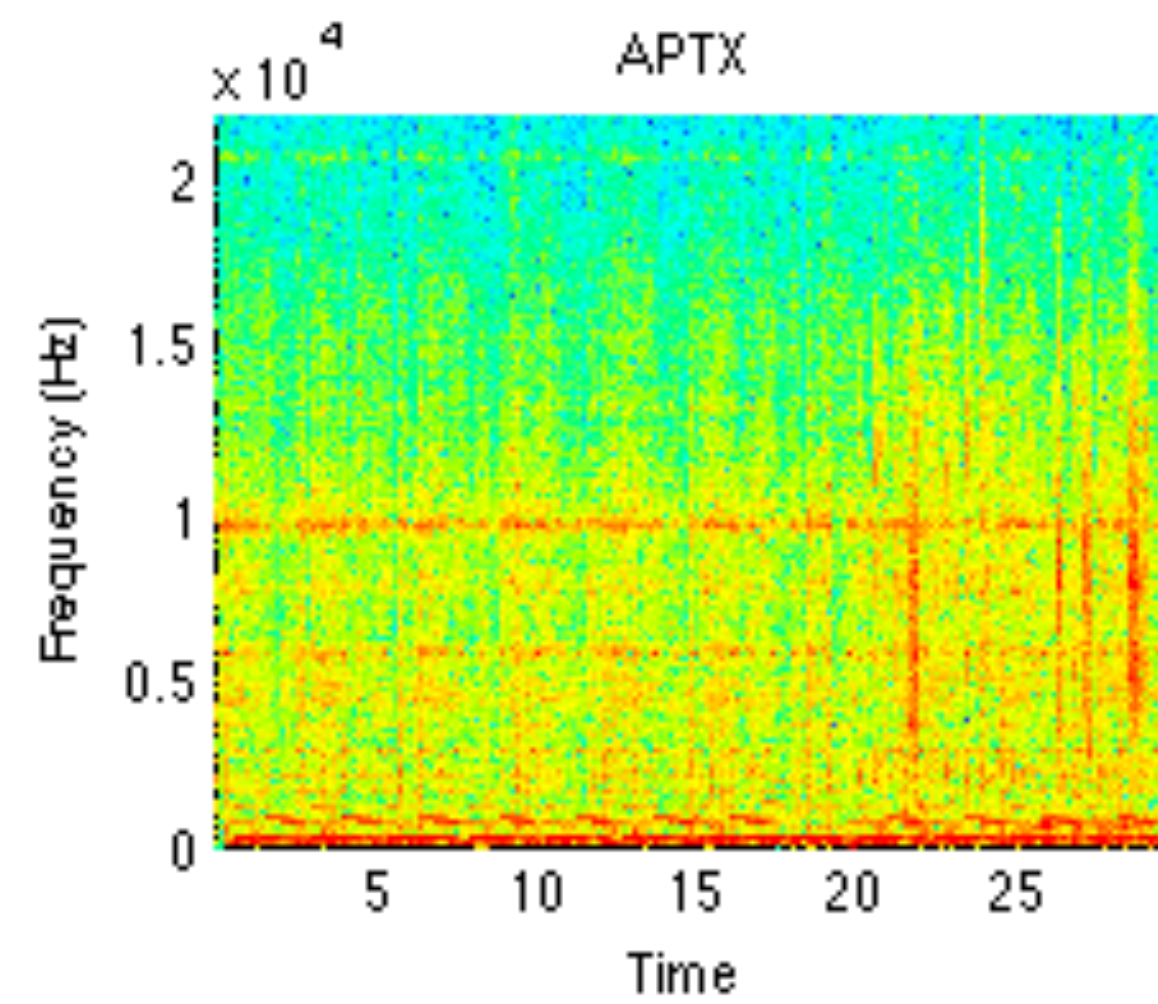
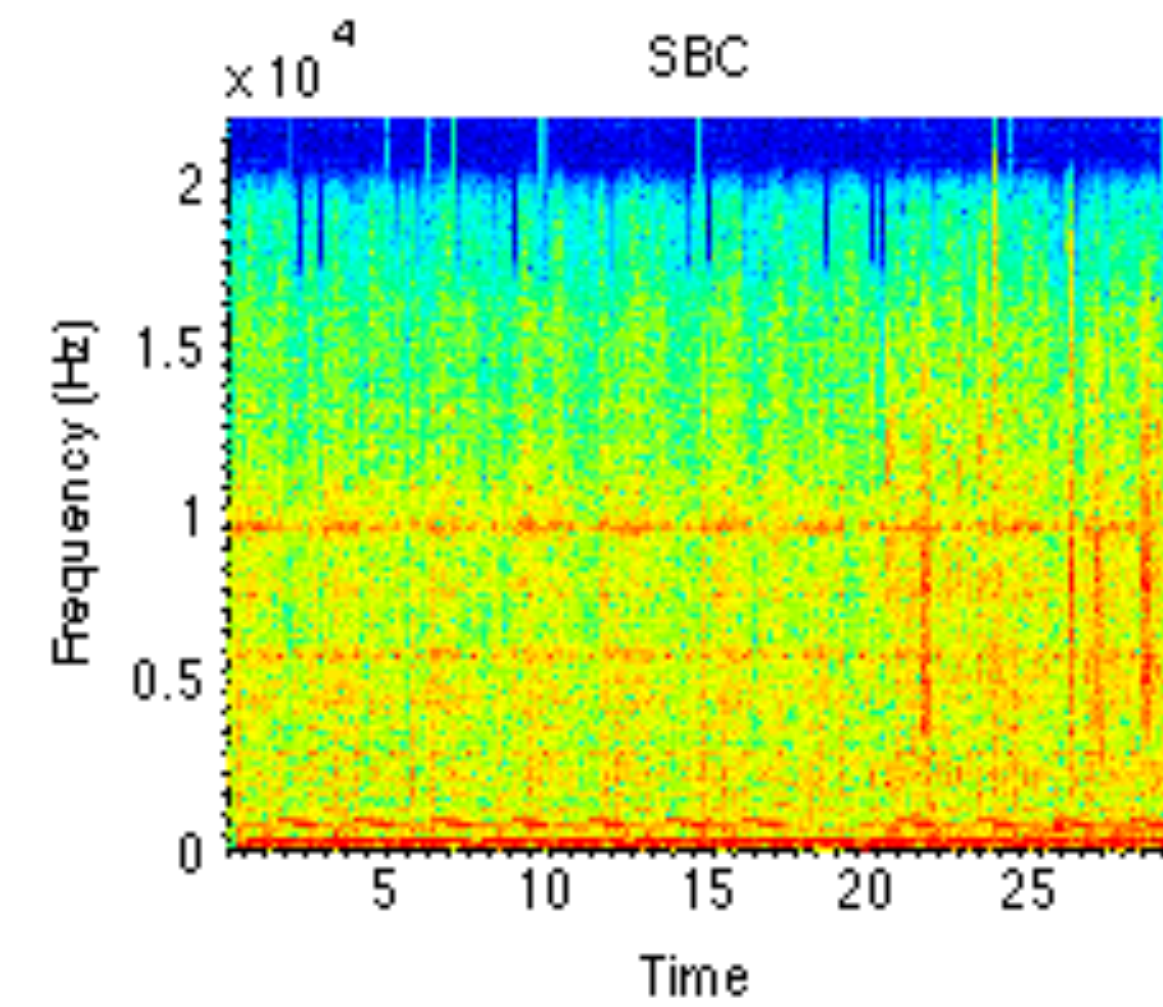
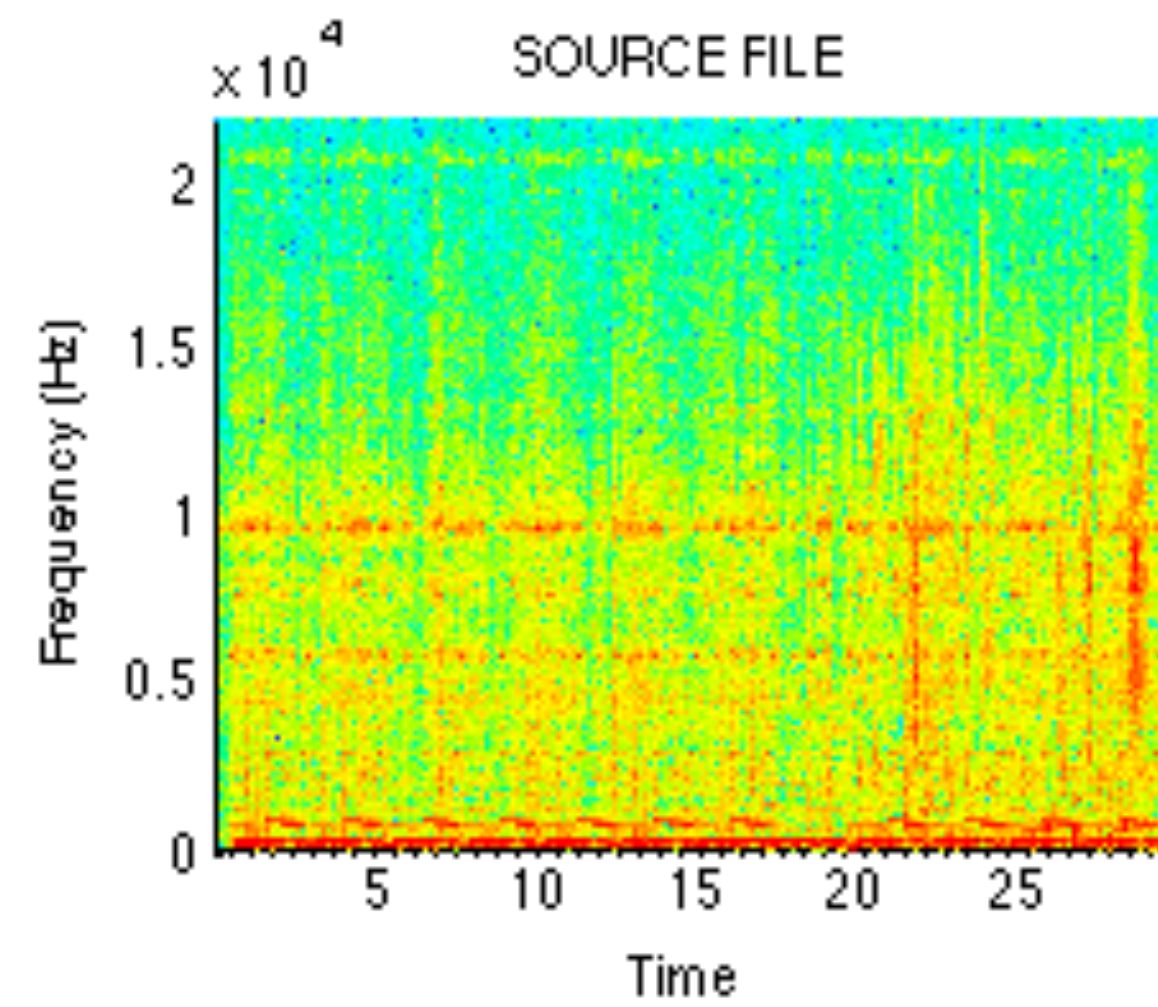
IMPULSE SIGNAL TEST

12



REAL MUSIC TEST

13



Play Nice With All Devices



MOBILE-READY STRATEGY

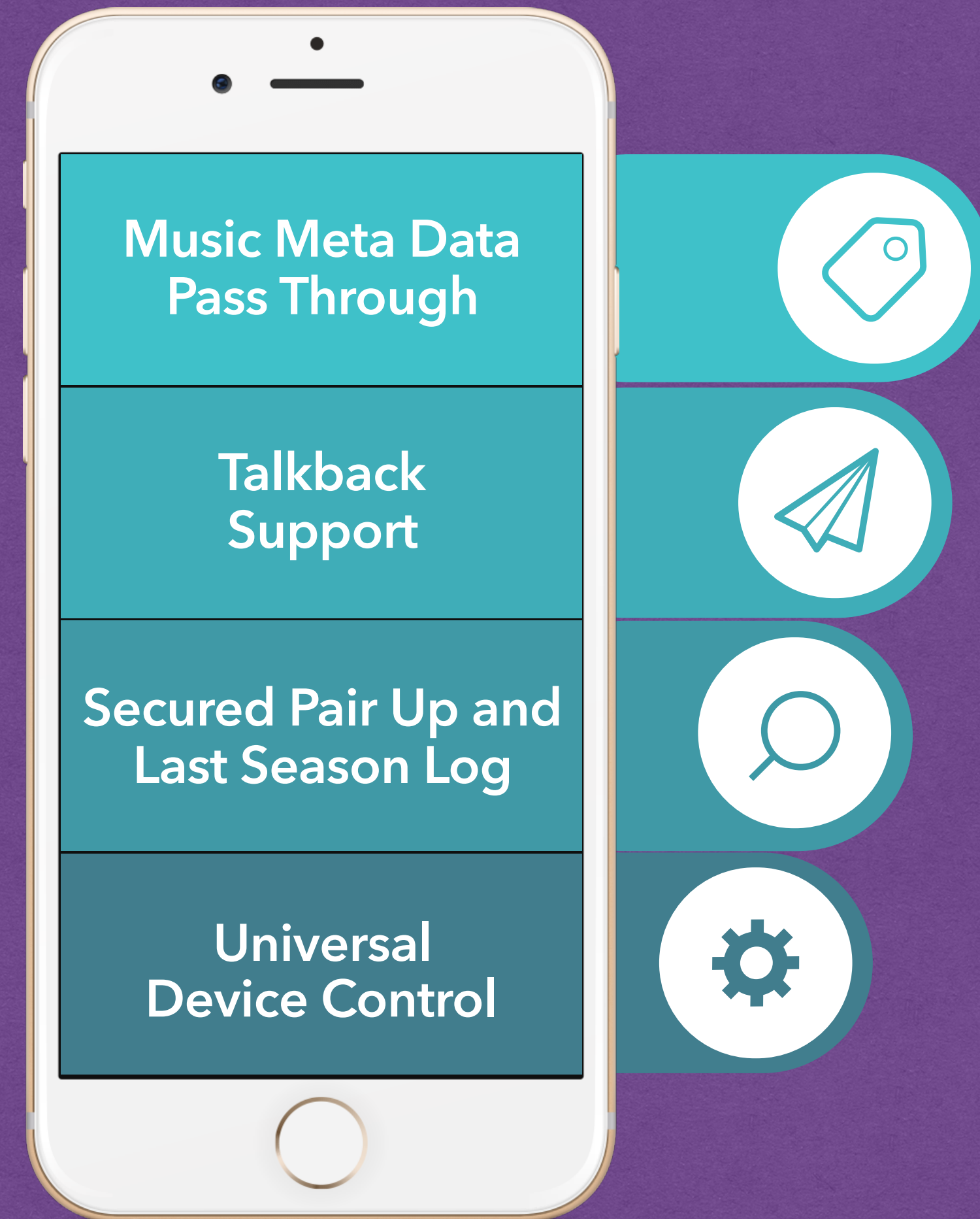
15

A2DP(Advanced Audio Distribution Profile):

- Widely Supported
- High Transmission Bandwidth
- Multi-Channel Support

AVRCP(Audio/Video Remote Control Profile):

- Multi-System Support
- System-Wise Audio Playback Control





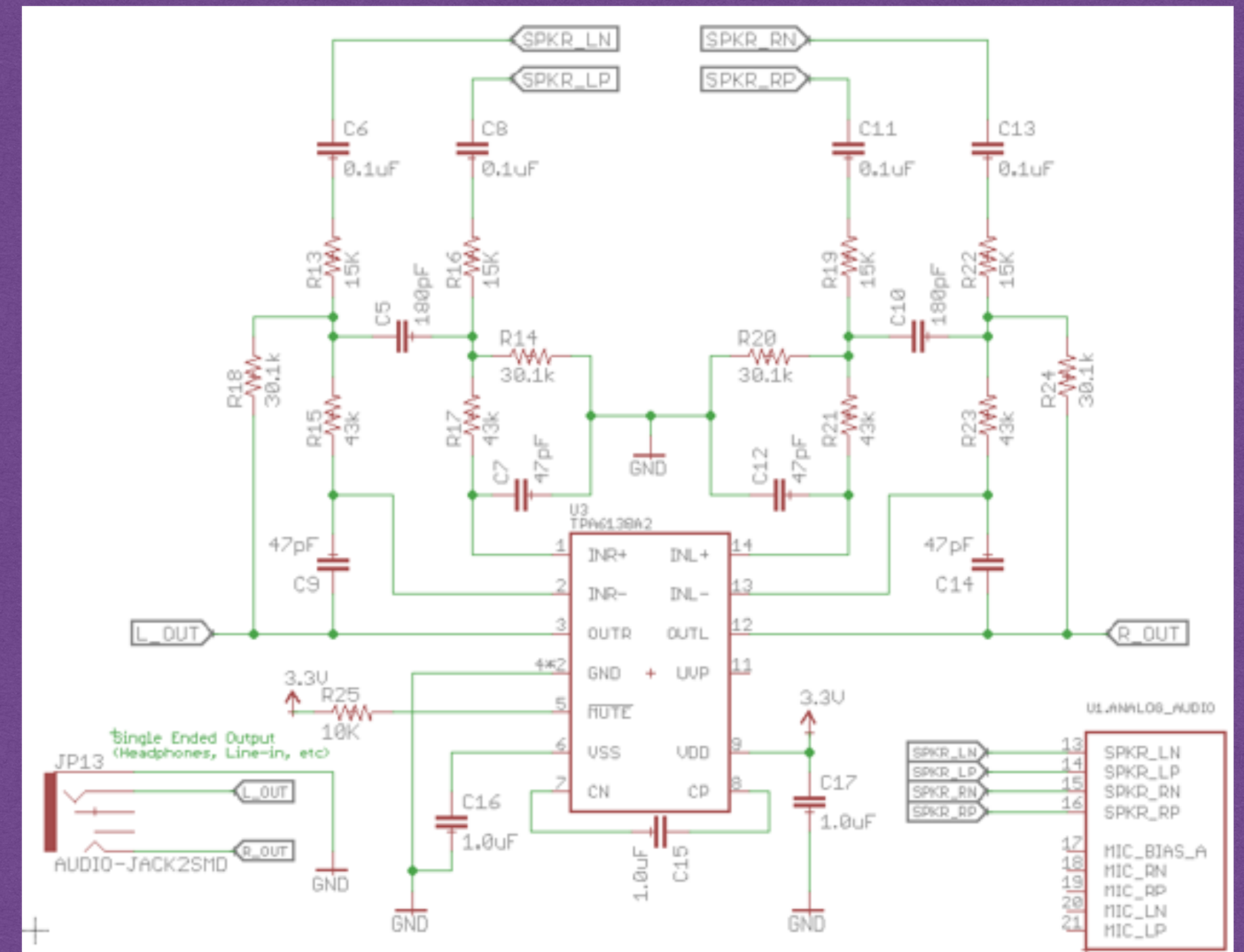
2.

AMPLIFIER UNIT

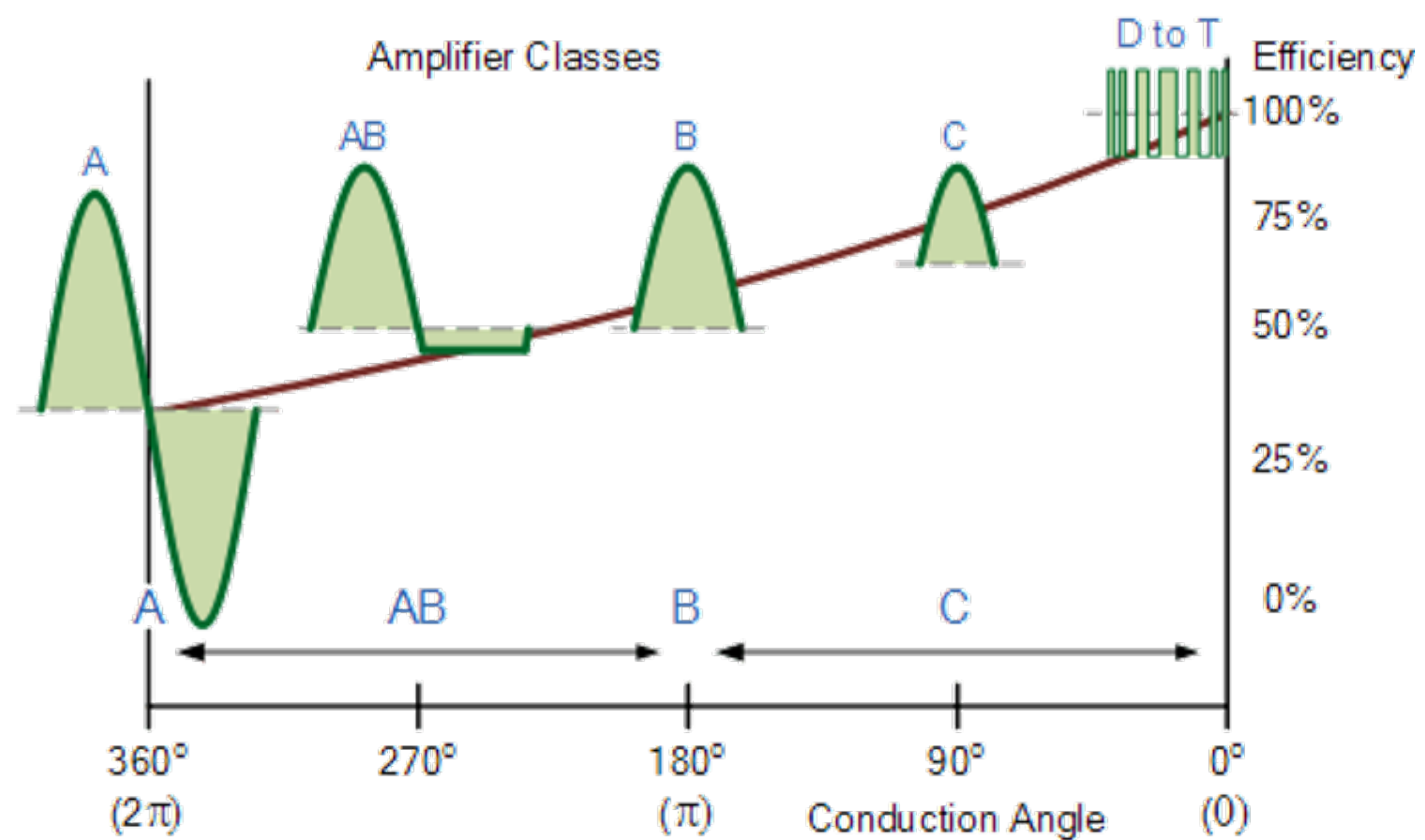
[MORE DETAILS](#)



1



AMPLIFIER COMPARISON

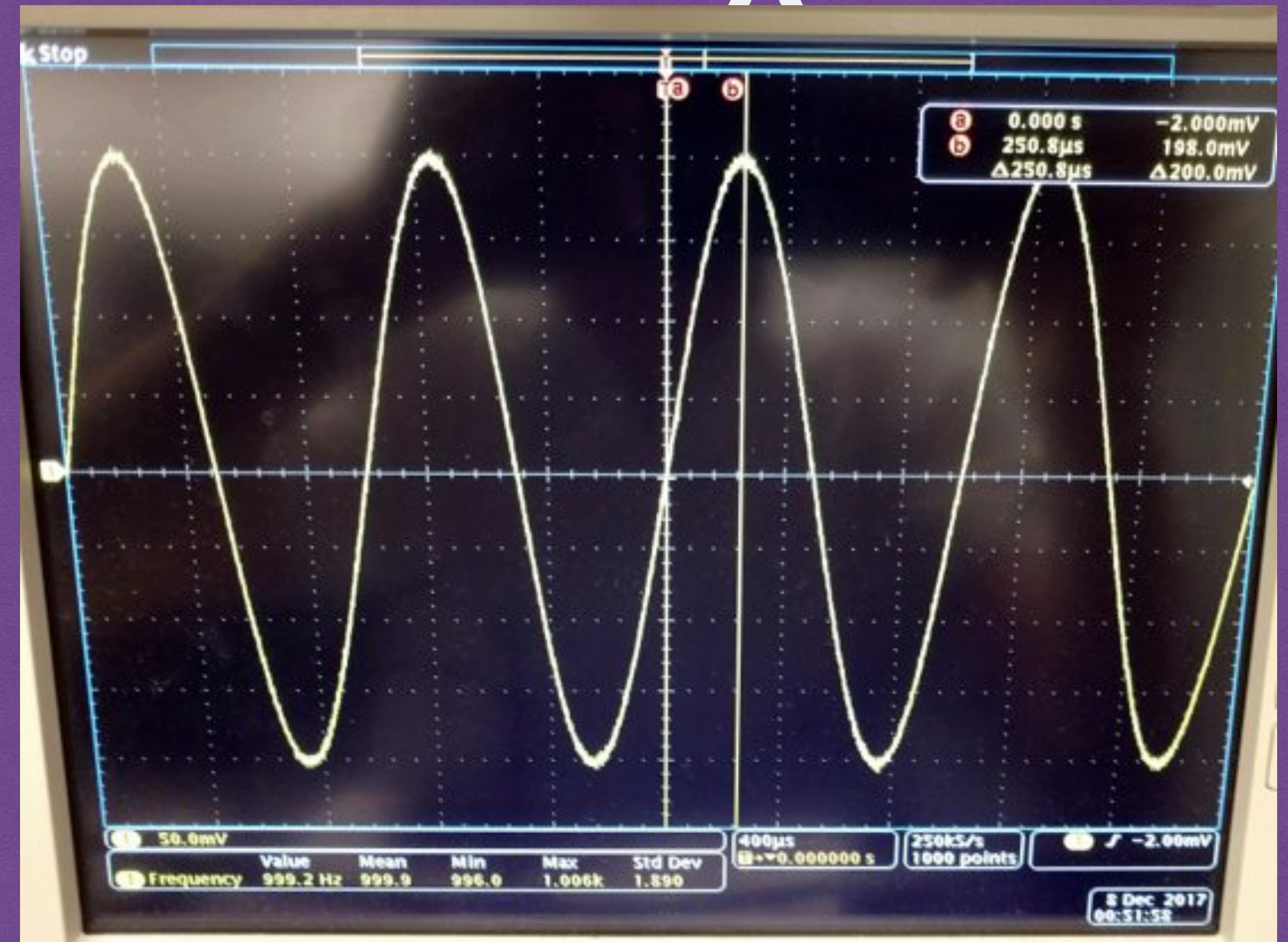


0



Before Amplifier

X



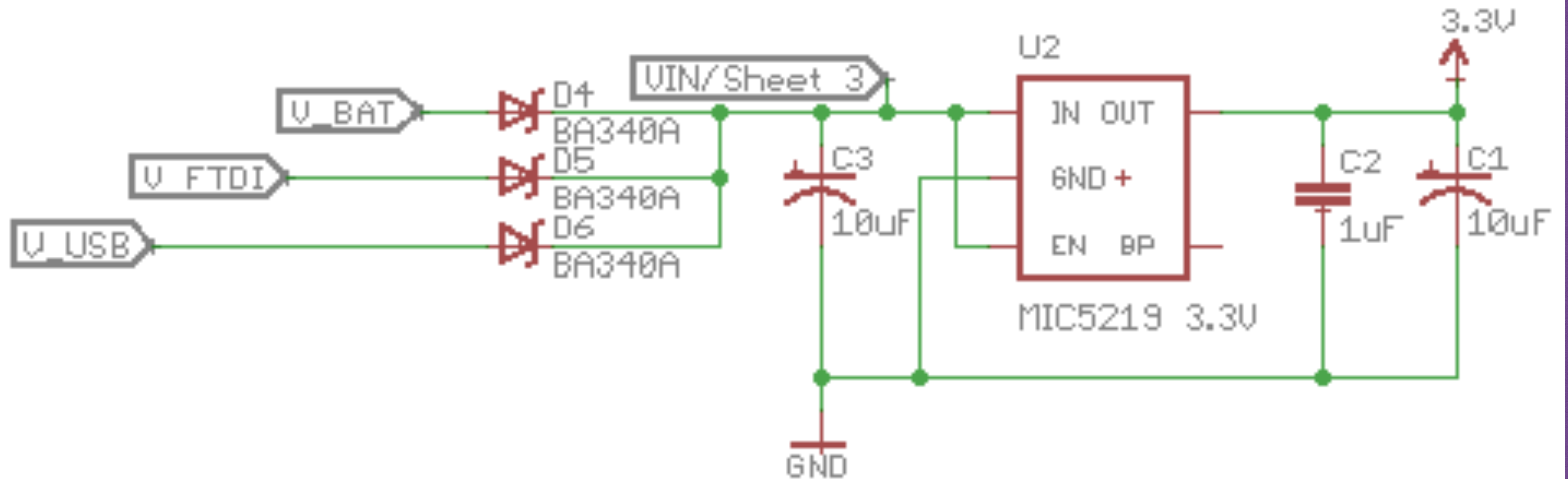
After Amplifier

Power Module

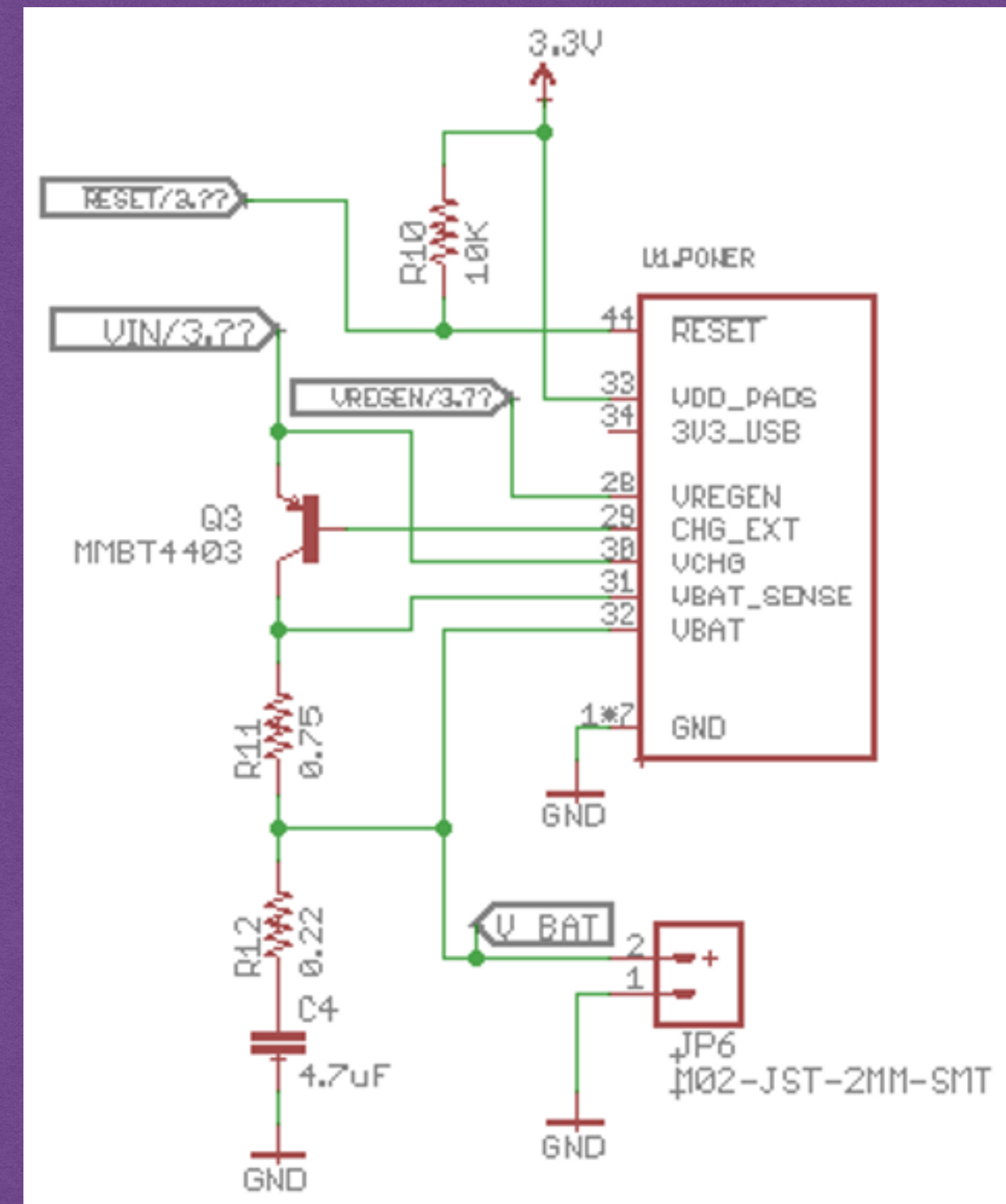
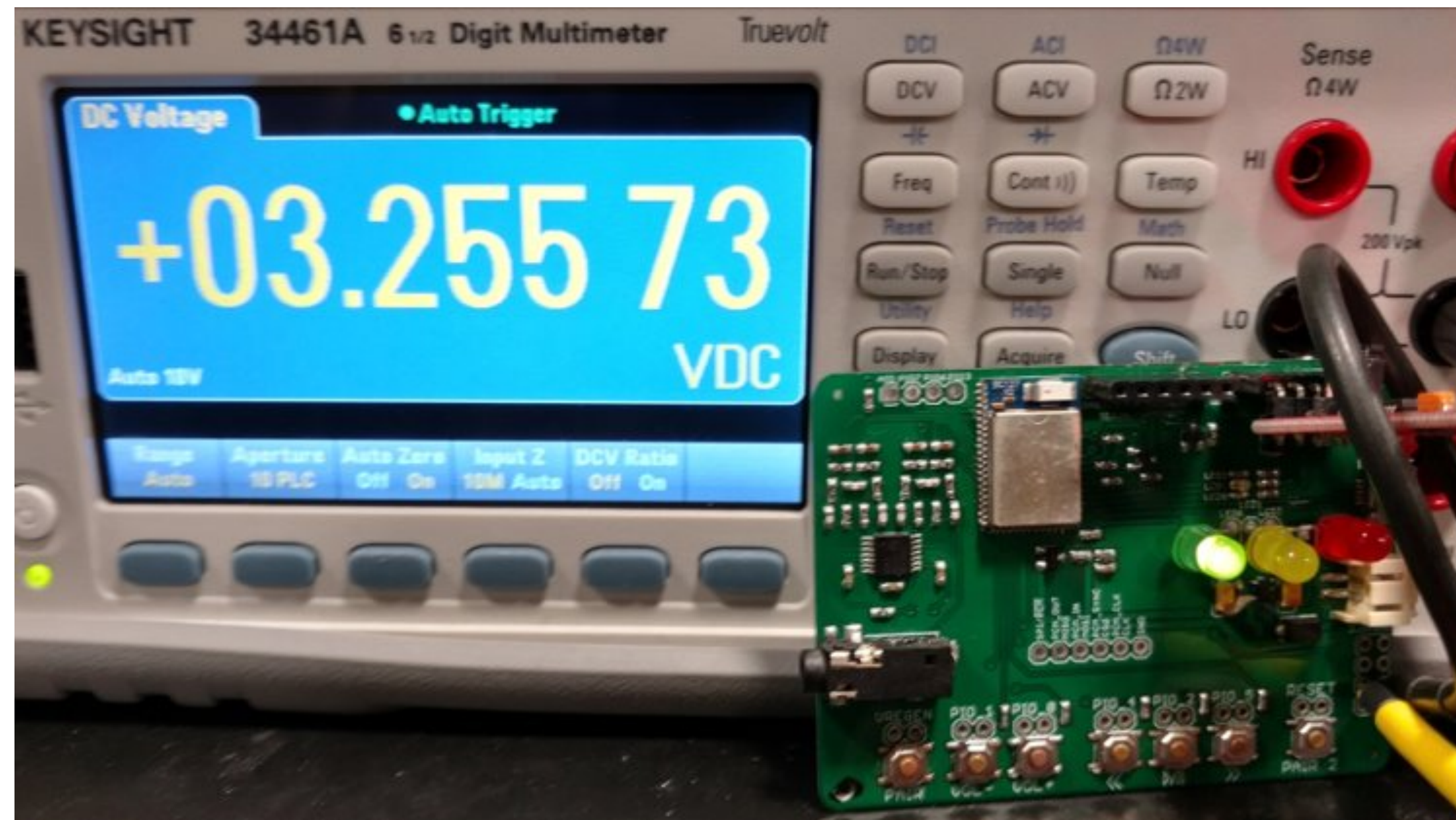
- Voltage Regulator 3.3V
- 3Ways power



Voltage Regulator Schematics



VOLTAGE REGULATOR



LITHIUM BATTERY

Voltage



Discharge time



//

Intelligent Low-Power System Master Controller

//

3. Micro-Control-Unit

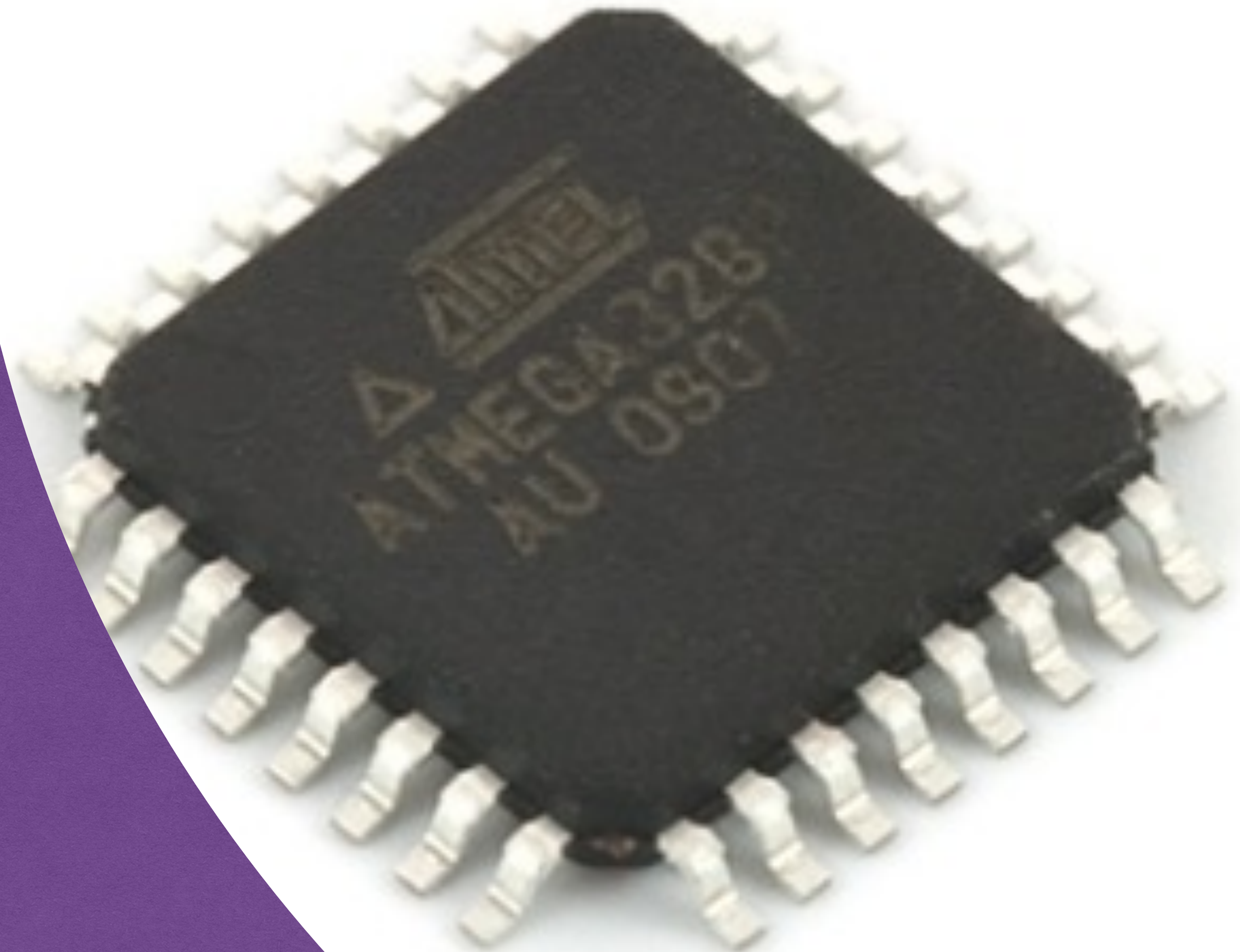
Control Module



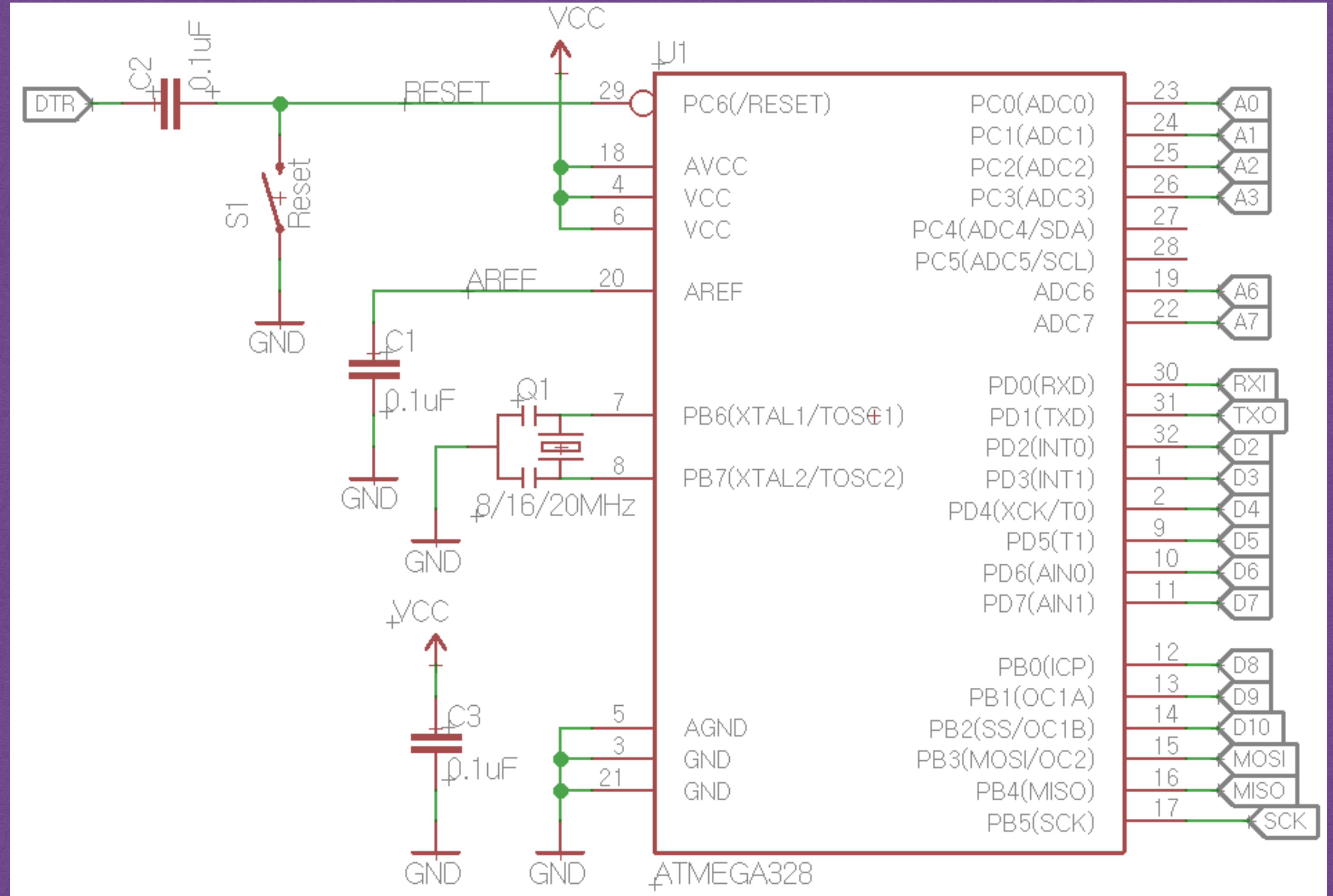
- ATmega328 MCU activates Bluetooth connection through AVRCP and A2DP
- MCU manages power to charge Li-on Battery
- MCU feeds proper GPIO connection for buttons
- Buttons communicate through AVRCP
- Status LEDs indicates power-on, pair

Microprocessor Module

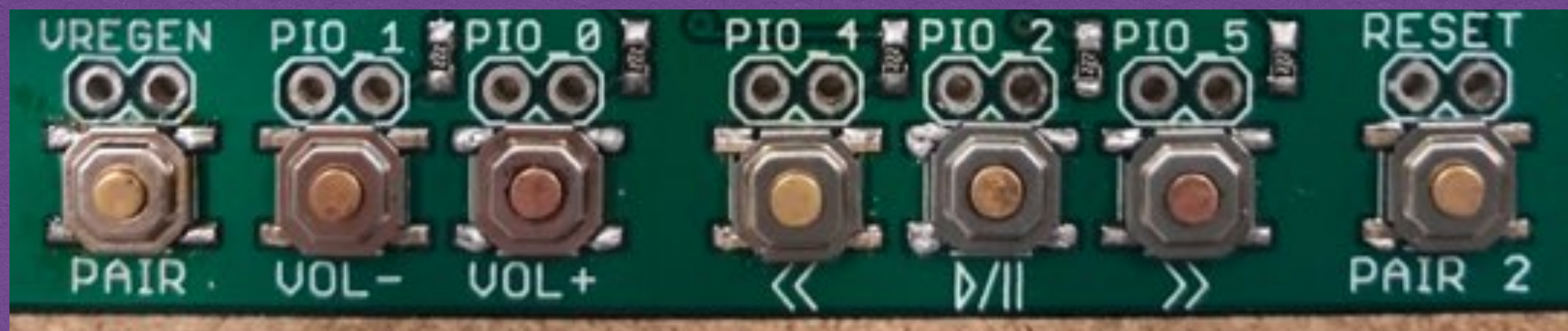
- UART Serial Communication with Bluetooth Chip
- A2DP and AVRCP Bluetooth protocol transmission control
- Power Management and Charging Battery



Microprocessor Schematics

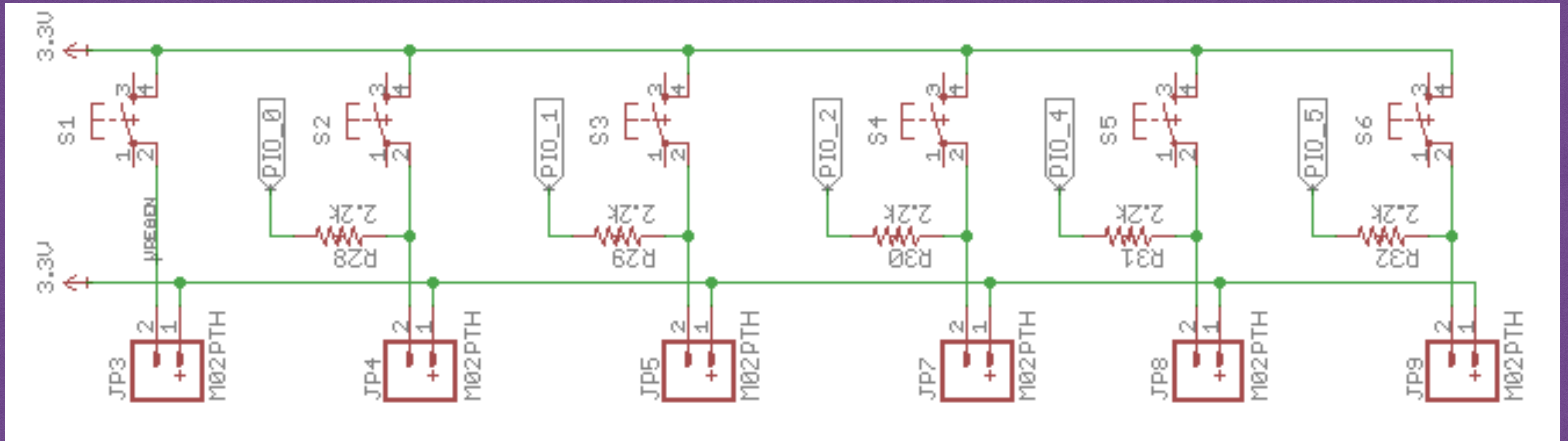


Buttons GPIO Configuration



- GPIO configuration connected with buttons
- VREGEN: Pair on SHORT press (Bluetooth)
Power ON/OFF on LONG press (Power)
- VOL-: Decrease volume (AVRCP)
- VOL+: Increase volume (AVRCP)
- << : Previous song (AVRCP)
- Pause/Play (AVRCP)
- >>: Next song (AVRCP)
- RESET: Reset device (active-low)

Buttons Schematics

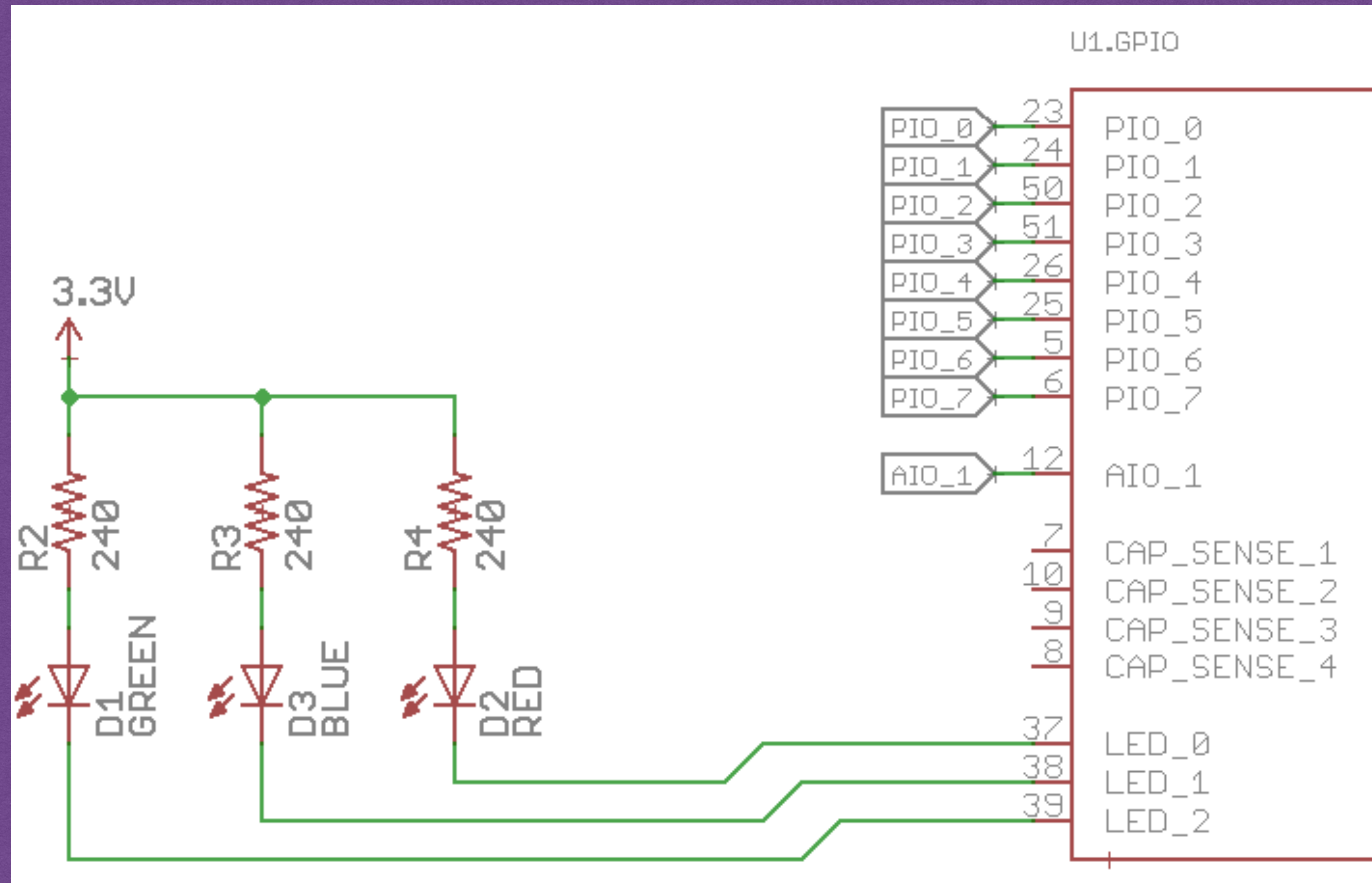


Status LEDs Module



- Unconnected: Flicks between LED0 and LED1
- Connected: LED1 flicks every 1s
- Power OFF: All LEDs goes off
- Power ON: All LEDs lights up
- Discoverable Mode: LED0 flicks every 1s

Status LEDs Schematics



Software

```
void setup() {
  // set up the LCD's number of columns and rows:
  lcd.begin(16, 2);
  // initialize the serial communications:
  Serial.begin(9600);
  Serial.print("RESTORE\r"); // Res
  // Enable the charging functionality.
  Serial.print("SET BATT_CONFIG=ON 145 4250 1500 200\r"); // Set
  // Set Codec Mode: APTX-HD > AAC > SBC. 11 for HD, 7 for non-HD
  Serial.print("SET CODEC=11 OFF\r"); // Off
  Serial.print("SET BT_VOL_CONFIG=9 9 9 1\r"); // Low
  Serial.print("SET MUSIC_META_DATA=ON\r"); // Ret
  Serial.print("SET ENABLE_BATT_IND=OFF\r"); // Turn
  Serial.print("SET AUDIO_ANALOG=15 15 0 OFF\r"); // To
  Serial.print("WRITE\r"); // SAV
  Serial.print("RESET\r");
}
```

```
void loop() {
  // when characters arrive over the serial port...
  if (Serial.find("AVRCP_MEDIA TITLE: ")) {
    // wait a bit for the entire message to arrive
    delay(20);
    // clear the screen
    lcd.clear();
    numberOfCharacter = 0;
    while (Serial.available() > 0) {
```

```
unsigned long testLines(uint16_t color) {
  unsigned long start, t;
  int          x1, y1, x2, y2,
              w = tft.width(),
              h = tft.height();

  tft.fillScreen(ILI9340_BLACK);

  x1 = y1 = 0;
  y2 = h - 1;
  start = micros();
  for(x2=0; x2<w; x2+=6) tft.drawLine(x1, y1, x2, y2, color);
  x2 = w - 1;
  for(y2=0; y2<h; y2+=6) tft.drawLine(x1, y1, x2, y2, color);
  t = micros() - start; // fillScreen doesn't count against

  tft.fillScreen(ILI9340_BLACK);

  x1 = w - 1;
  y1 = 0;
  y2 = h - 1;
  start = micros();
  for(x2=0; x2<w; x2+=6) tft.drawLine(x1, y1, x2, y2, color);
  x2 = 0;
  for(y2=0; y2<h; y2+=6) tft.drawLine(x1, y1, x2, y2, color);
  t += micros() - start;

  tft.fillScreen(ILI9340_BLACK);
```

```
  TIMSK1 |= (1 << OCIE1A);
  sei(); // enable interrupts
}
void loop()
{
  // catch all UART traffic when no hardware interrupts are iss
  if (swPort.available() > 0)
  {
    char temp = "";
    44
    while (swPort.available() > 0)
    {
      temp = swPort.read();
      buffer.concat(temp);
      delay(1);
    }
  }
  // print buffer if not empty
  if (buffer != "")
  {
    Serial.print("buffer:");
    Serial.println(buffer);
    //Serial.println(buffer.length());
  }
  // if UART message is ABS_VOL 11 0, switch mode to sink
  if (buffer == "ABS_VOL 11 0\r")
  {
    Serial.println("Command from other BC127 to switch to si
```


Button and Status LEDs

```
// input setup
pinMode(BTN_VREGEN, INPUT);
attachInterrupt(INT_VREGEN, ISR_VREGEN, RISING);
pinMode(BTN_VUP, INPUT);
attachInterrupt(INT_VUP, ISR_VUP, RISING);
pinMode(BTN_VDN, INPUT);
attachInterrupt(INT_VDN, ISR_VDN, RISING);
pinMode(BTN_BACK, INPUT);
attachInterrupt(INT_BACK, ISR_BACK, RISING);
pinMode(BTN_PAUSE, INPUT);
attachInterrupt(INT_PAUSE, ISR_PAUSE, RISING);
pinMode(BTN_FORWARD, INPUT);
attachInterrupt(INT_FORWARD, ISR_FORWARD, RISING);
pinMode(BTN_RESET, INPUT);
attachInterrupt(INT_RESET, ISR_FORWARD, FALLING);
// output setup
pinMode(LED_SINK, OUTPUT);
pinMode(LED_SOURCE, OUTPUT);
```

```
Serial.println(BTModu.battConfig());
Serial.println(BTModu.autoConnect());
Serial.println(BTModu.battStatus());
// determine module mode and set corresponding LEDs
determined_mode = BTModu.determineMode();
if (determined_mode == SINK)
{
    Serial.println("Determined mode: sink");
    ROLE = SINK;
    digitalWrite(LED_SOURCE, 0);
    digitalWrite(LED_SINK, 1);
}
else if (determined_mode == SOURCE)
{
    Serial.println("Determined mode: source");
    ROLE = SOURCE;
    digitalWrite(LED_SOURCE, 1);
    digitalWrite(LED_SINK, 0);
}
else
{
    sinkSetup();
}
```


ACHIEVEMENT

CONCLUSION

THE TICK

R&V TABLE

Module Name	High Level Requirement
Bluetooth Module	- This module should successfully pair up via Bluetooth 4.1+ protocol. - This module should successfully transmit audio signal under AAC/Aptx-HD codec. - Both codec should be send at 24-bits signal with a sampling rate higher than 44.1kHz.
DAC Module	- DAC should receive 24-bits audio data and output in both left and right channel. - Amplifier should successfully amplify audio signal with a gain setting of 2V/V (6dB) for each channel. - 3.5mm audio jack should successfully output the amplified audio signal to both right and left channel of the headphone/speaker.
Power Module	- Li-on battery should successfully provide 3.7V supply to the voltage regulator. The capacity should be 1000mAh or more. - Voltage regulator should successfully convert 3.7V from Li-on battery and output 3.3V to other chips. Voltage should be within 5% of 3.3V
Control Module	- MCU should successfully activate Bluetooth connection between the device and Bluetooth module. Also, should successfully feed proper GPIO connection for buttons. - Buttons should successfully function when pressed. The functions of buttons should be: volume down/up, previous song, pause/play, and next song. - Status LEDs should be visible from at least 3m away with a drive current of 10mA.

Bluetooth Noise Analysis



Noise can be neglected!

$$\Delta v = L \frac{\Delta i}{\Delta t} = 20 \text{ nH} \times \frac{10 \text{ mA}}{\text{ns}} = 200 \text{ mV}$$

207.1
mV

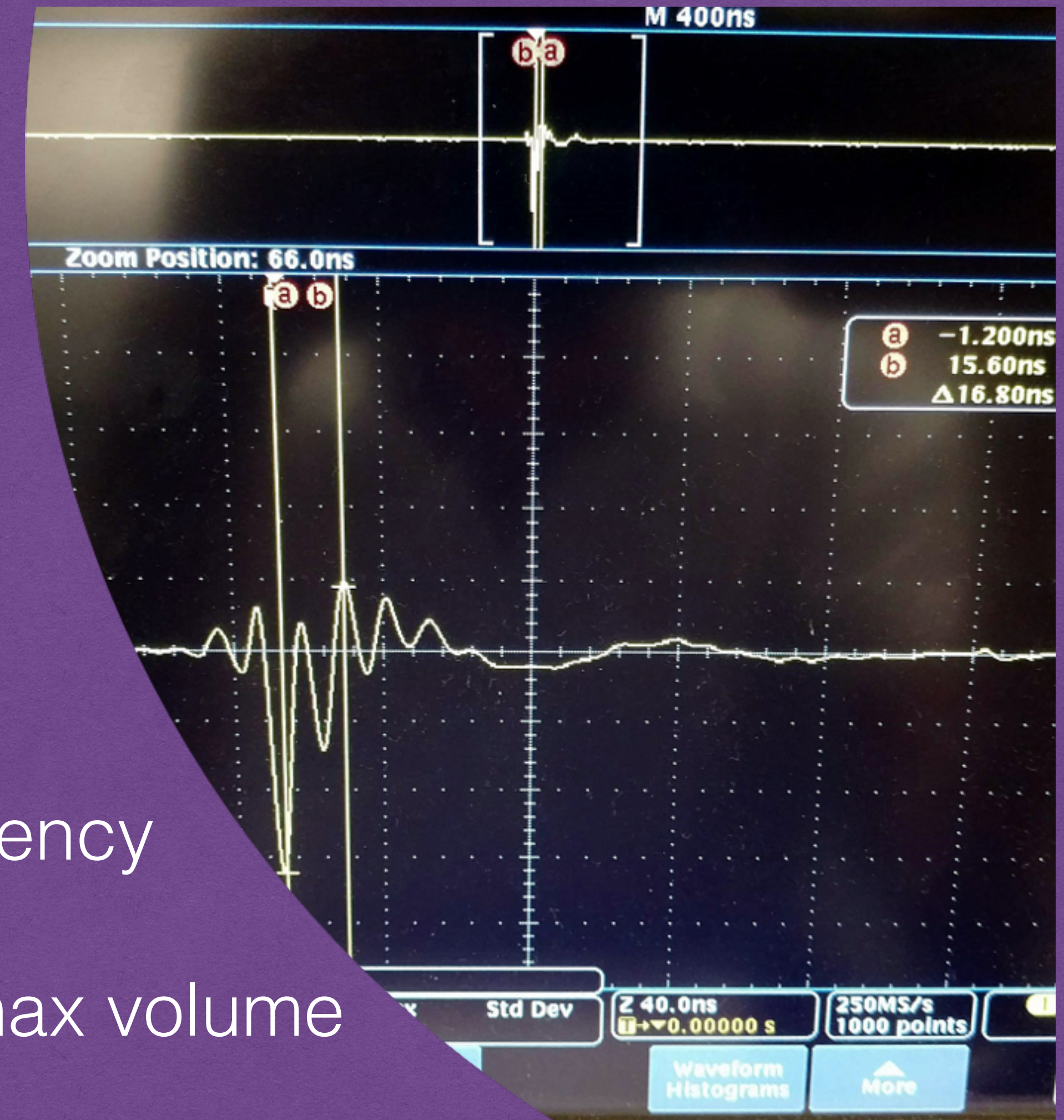
Low noise level

1.596
μs

Low noise frequency

1.15
V

Output 53.5% max volume



WHAT'S AWAITING

FUTURE WORK

THE TOCK

THE 'TOCK' CYCLE

-  Secured data transmission
-  Proper EMI prevention
-  Graphical User Interface
-  User self-serviceable
-  Analog/digital ground separation
-  Further footprint reduction
-  On-board media storage
-  Bluetooth 5.0 & NFC pairing





BEFORE WE SIP THE COFFEE

Q & A

THANK YOU