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MSGEQ7-Based DIY Audio Spectrum Analyzer: Construction

Max's Cool Beans

7/8/2014 07:30 PM EDT

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Here's a step-by-step guide to constructing a simple 14-band (2 x 7) audio spectrum analyzer using two MSGEQ7s and a chipKIT or Arduino microcontroller development platform.

Creating the first-pass software

Before we add the LEDs to the breadboard, this is a good point to pause and make sure that everything is working as planned. The software for the spectrum analyzer is identical for the chipKIT MAX32 and the Arduino Mega.

Let's start with a simple program that reads the values coming out of the spectrum analyzer and displays them on a serial I/O window on your host computer. You can access the full source code (including copious comments) by [clicking here](#).

We declare our RESET and STROBE signals (I called these "ctrlReset" and "ctrlStrobe") and assign them to digital pins 23 and 22 on the microcontroller, respectively. Also, we declare our left and right channel data pins and assign them to analog pins 0 and 1, respectively.

```
int ctrlReset    = 23;
int ctrlStrobe   = 22;
int channelLeft  = 0;
int channelRight = 1;
```

```
int spectrumLeft[7];
int spectrumRight[7];
```

As part of this, we declare two integer arrays, "spectrumLeft[]" and "spectrumRight[]," each of which contains seven elements. This is where we will store the spectrum values from the MSGEQ7s.

In the setup() function, we initialize the serial communications and select a data rate of 9,600 baud using the Serial.begin() function. Next, we define our "ctrlReset" and "ctrlStrobe" signals as digital outputs. Finally, we set the "ctrlReset" and "ctrlStrobe" signals to their inactive values of LOW and HIGH, respectively.

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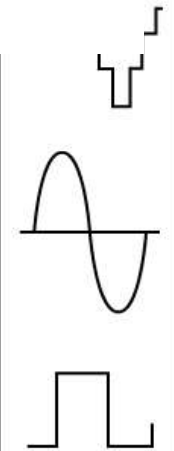
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```

void setup()
{
  Serial.begin(9600);
  pinMode(ctrlReset,OUTPUT);
  pinMode(ctrlStrobe,OUTPUT);
  digitalWrite(ctrlReset,LOW);
  digitalWrite(ctrlStrobe,HIGH);
}

```

Next, we have the main loop() function as shown below. We call a readMSGEQ7() function, which actually reads the spectrum data values out of the MSGEQ7 chips and stores these values in our "spectrumLeft[]" and "spectrumRight[]" arrays.

```

void loop()
{
  readMSGEQ7();

  // Display values from left channel on monitor
  for (int i = 0; i < 7; i++)
  {
    if (spectrumLeft[i] < 100) Serial.print(" ");
    if (spectrumLeft[i] < 10) Serial.print(" ");
    Serial.print(spectrumLeft[i]);
    Serial.print(" ");
  }
  Serial.print(" ");

  // Display values from right channel on monitor
  for (int i = 0; i < 7; i++)
  {
    if (spectrumRight[i] < 100) Serial.print(" ");
    if (spectrumRight[i] < 10) Serial.print(" ");
    Serial.print(spectrumRight[i]);
    Serial.print(" ");
  }
  Serial.println();
}

```

As soon as we return from the readMSGEQ7() function, we display the values we've read out of the MSGEQ7s on to our host computer's screen. As you can see, most of the above code is used for formatting to make sure everything lines up nicely.

The readMSGEQ7() function is shown below. We start by generating a positive pulse on the "ctrlReset" signal. This causes the MSGEQ7s to latch (store) their current spectrum data values, and it also resets the multiplexers in the MSGEQ7s. We follow this pulse with a delay of 75 μ s in order to meet (actually, slightly exceed) the minimum reset-to-strobe time of 72 μ s. If the truth be told, a lot of example code I've seen omits this delay, and my own system works without it, but I'd "rather be safe than sorry," as they say, so I'm keeping this delay in my code.

```

void readMSGEQ7()
// Read seven spectrum bands from MSGEQ7 chips
{
  digitalWrite(ctrlReset, HIGH);
  digitalWrite(ctrlReset, LOW);
  delayMicroseconds(75);

  for(int i=0; i <7; i++)
  {
    digitalWrite(ctrlStrobe,LOW);
    delayMicroseconds(40);

    spectrumLeft[i] = analogRead(channelLeft) / 4;
    spectrumRight[i] = analogRead(channelRight) / 4;

    digitalWrite(ctrlStrobe,HIGH);
    delayMicroseconds(40);
  }
}

```

Now we enter a loop, which we execute seven times. The first iteration will return the 63Hz data values, the second iteration will return the 160Hz values, and so on. We start each cycle by pulling the "ctrlStrobe" signal LOW. Then we wait for 40 μ s to allow the outputs to settle. Next, we read the spectrum values out of the

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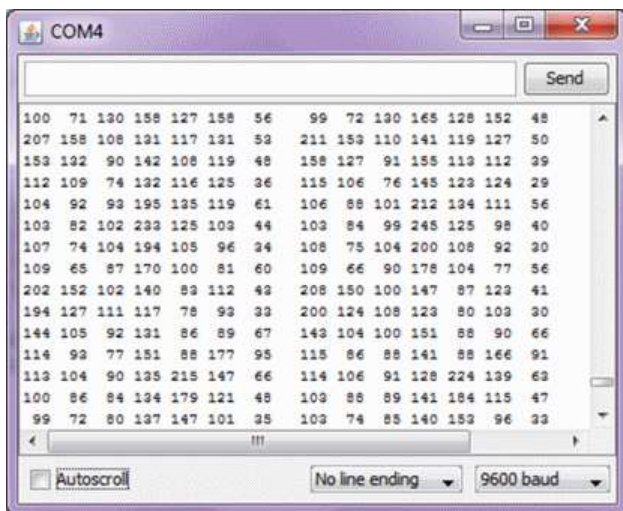
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MSGEQ7s and store them in the appropriate elements of our "spectrumLeft[]" and "spectrumRight[]" arrays.

Why do we divide these values by 4 before storing them? The analog-to-digital converters (ADCs) on the microcontroller's analog pins return values from 0 to 1,023 (these correspond to 0V to 3.3V on the chipKIT MAX32 and 0V to 5V on the Arduino Mega). In the fullness of time, when we come to drive our LEDs, we will require only values in the range of 0 to 255, and the easiest way to convert a value of 0 to 1,023 into a value of 0 to 255 is to divide it by 4.

The last thing we do in our loop is to drive the "ctrlStrobe" signal HIGH and wait for 40µs. A lot of example code I've seen omits this 40µs delay, which -- when added to the earlier 40µs delay -- is used to meet (actually, slightly exceed) the minimum strobe-to-strobe time of 72µs. My own system does work without this delay, but I think you're on shaky ground if you do decide to leave it out. I'll talk about this more in my next column, which will describe the test procedures I used and the interesting things I discovered along the way.

For the moment, just feast your orbs on the following screenshot, which shows the data from the MSGEQ7s being streamed to the serial I/O window on my notepad PC.



In case you were wondering, the tune being played is one of the tracks from *Babel* by Mumford & Sons. You can see all this in action on [this video](#) on YouTube.

MSGEQ7-based Audio Spectrum Analyzer Test 1



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.@Mobileye may currently hold a large lead in #ADAS processor market, but they're not the only game in town.
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11 Apr

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@MikeDemler thanks, Mike. The story is corrected!

09 Apr

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@MikeDemler Mentor's new platform could do away with each sensor module whose MCU is designed to do pre-processing to some degree.

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USER RANK
AUTHOR**Re: lacking vocals?**Clive "Max" Maxfield 9/9/2015
11:41:59 AMNO RATINGS
1 saves
[LOGIN TO RATE](#)*@antedeluvian: ROTFL- autocomplete, typo, modegreen or Freudian slip?*

My bad LOL

Even worse, when I first saw the Deja Vu album cover when I was a lad -- with all the arty-farty calligraphy, I read it as "Crosby Stills Nash & Donny" (instead of "Crosby Stills Nash & Young") ... so that's how I always think of them LOL

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AUTHOR**Re: lacking vocals?**

antedeluvian 9/9/2015 11:28:03 AM

NO RATINGS
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Max

I've played "out house" by Crosby Stills & Nash

ROTFL- autocomplete, typo, modegreen or Freudian slip?

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ROOKIE**Re: lacking vocals?**

sunneh 9/9/2015 10:00:25 AM

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Thanks for the quick response!

I havent scoped it yet, have bought a cheap version it should be on its way now.

do you think the timing could be the problem? i got everything set on 1000us (i figured hey it works) haha!!!

im using avr... so i think coding is a little different. my email is shangss@gmail.com thank you in advance :D

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AUTHOR**Re: lacking vocals?**Max The Magnificent 9/9/2015
9:43:33 AMNO RATINGS
[LOGIN TO RATE](#)*@sunneh: I was wondering if you know of any problems with the msgeq7.*

Hi there -- I haven't had any problems with my MSGEQ7s -- check out this blog (with embedded video) showing my BADASS Display <http://ubm.io/1FxDPPE2>.

I'm puzzled by your vocals problem -- I've played "out house" by Crosby Stills & Nash -- which is lagely vocals -- and it works great -- have you put a 'scope' on the input signal to see what's going in?

If you email me at max@clivemaxfield.com -- I'll send you the Arduino code I'm using to drive my BADASS display -- this includes the part that reads the data from the MSGEQ7s with the correct delays in it).

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ROOKIE**lacking vocals?**

sunneh 9/9/2015 7:52:23 AM

NO RATINGS
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Hi there, saw your post, great vu meter :D

i was wondering if you know of any problems with the msgeq7.

So far mine is working great, but the led display does not move when there are vocals.

it only goes up and down when there is instrumentals. maybe

it filtered out a frequency range? i am using lm386 to amplify the signal, otherwise the voltage would be too small

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Re: Input level for the MSGEQ7

Clive "Max" Maxfield 6/11/2015
1:31:29 PM

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AUTHOR

@jreza: *I just watched your BADASS display and I have to say it discouraged me from building my own analyzer*

It was that bad?

LOL

In the Coding Competition blog there's a link to the code I'm using for the BADASS Display. You could certainly create a much smaller version of the physical beast.

I agree that I feel really lucky being able to get components so easily.

I would love to see photos and video of your creation(s) -- maybe we could create a column around them...

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Re: Input level for the MSGEQ7

jreza 6/11/2015 1:18:52 PM

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USER RANK
ROOKIE

Max

Thanks for your quick response and all the info.

I just watched your BADASS display and I have to say it discouraged me from building my own analyzer :(, I know I'll never get close to that (just kidding! Baby steps). About the function generator and the shield, I live in Mexico, so it's kind of hard for me to try to get any of those (I barely got the MSGEQ7, I envy you and the way you get everything practically from around the corner : ()

I'll take a deeper look at the posts when I get home.

When it is done I'll share some photos or video on what you've helped to build :)

Thanks a lot.

jreza

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Re: Input level for the MSGEQ7

Clive "Max" Maxfield 6/11/2015
11:38:21 AM

5 RATINGS
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AUTHOR

@Jezra: *...I have a question though...*

You might also be interested in these related columns (I've included the link to this one because they form a set)

[Building a Low-Cost Frequency/Function Generator](#)

[Determining the Signal Characteristics of the iPad/iPod/iPhone Headphone Output](#)

[MSGEQ7-Based DIY Audio Spectrum Analyzer for BADASS Display](#)

[MSGEQ7-Based DIY Audio Spectrum Analyzer: Construction](#)

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[BADASS Display Coding Competition](#)

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Re: Input level for the MSGEQ7

Clive "Max" Maxfield 6/11/2015
11:33:24 AM

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AUTHOR

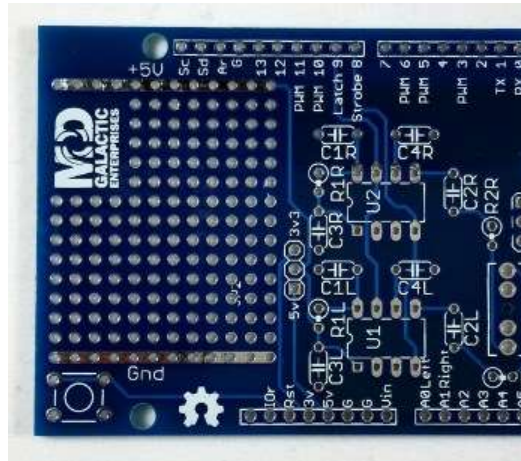
@Jreza: *What is the input level required by the MSGEQ7? Is it enough with just the output signal from a regular portable player? (from your tutorial it seems it does). Is it enough with the output level of a regular mic?*

Hi there -- I think you're going to really enjoy playing with this

chip. Take a look at [This YouTube Video](#) showing two of these chips driving my BADASS Display.

I'm using the output from the headphone jack from my iPod (sometimes my iPad) with no problems at all -- typically I set the iPad to about 3/4 full volume to drive this chip -- then I control the actual sound volume using the amplifier driving the speakers.

I started off by creating a prototype using a breadboard (see [This YouTube Video](#)), but later my chum Duane Benson took my circuit and generated a special printed circuit board (PCB) for an Arduino Shield (this uses two MSGEQ7 chips -- one for each channel).



You can buy one of these boards from Duane from his [SteelPuppet.com](#) website if you wish.

Are you using an Arduino? If so, one of the things I do when I've just built a new sound analyzer card (I've now constructed three using Duane's shield for different projects) is to use the Serial I/O to display the numerical values on the screen so I can see what's happening -- you could use this technique to see how your microphone was working.

If you want to see some example Arduino code for this, email me at max@clivemaxfield.com and I'll send it to you.

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ROOKIE

Input level for the MSGEQ7

jreza 6/11/2015 10:14:43 AM

NO RATINGS
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Hi there.

I'm getting all the components to start this project. Thanks for the tutorial.

I have a question though, What is the input level required by the MSGEQ7? Is it enough with just the output signal from a regular portable player? (from your tutorial it seems it does). Is it enough with the output level of a regular mic?

Thanks

jreza

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