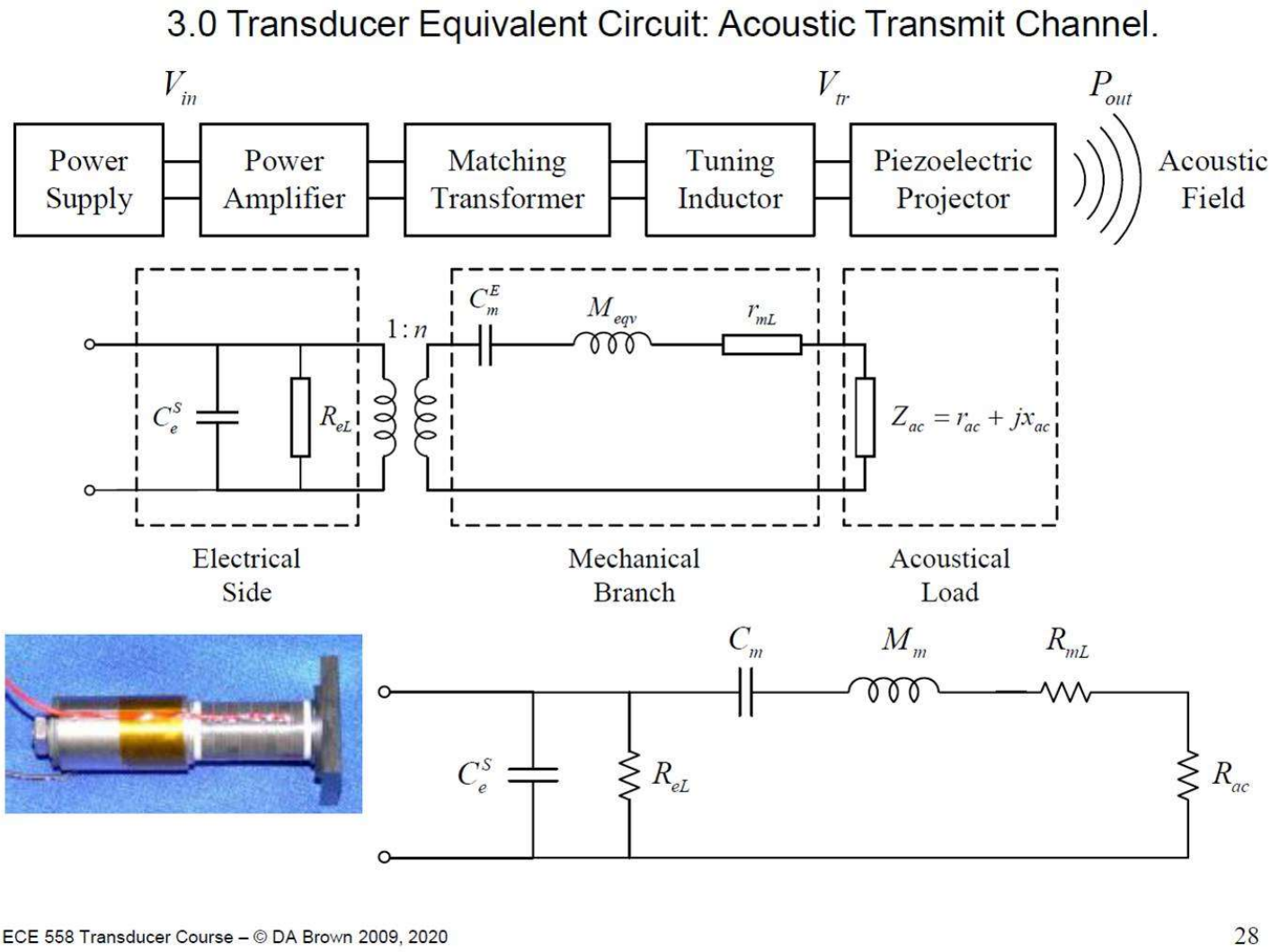
RE: Request for clarification on BT-2RCL specifications

dbrown@btechacoustics.com <dbrown@btechacoustics.com>
Wed 4/1/2020 6:17 AM

To: Kaufman, Isaac D <ikaufman@gatech.edu>

Yes it does…bring power factor to unity…but modeling the load as just a capacitor is not adequate except at low frequencies (but it is not used as a projector at low frequencies).
It's an electro-mechanical-acoustical circuit.
Probably for an undergrad project you can consider it at resonance…where the mass reactance cancels the stiffness reactance.



From: Kaufman, Isaac D <ikaufman@gatech.edu>
Sent: Tuesday, March 31, 2020 8:50 PM
To: dbrown@btechacoustics.com
Subject: Re: Request for clarification on BT-2RCL specifications

Dr. Brown,

I realize my mistake now, I was modelling the transducer as a resistive load, rather than a capacitive one. The recommended series inductance brings the power factor closer to unity.

Isaac

From: dbrown@btechacoustics.com <dbrown@btechacoustics.com>
Sent: Tuesday, March 31, 2020 7:38 PM

To: Kaufman, Isaac D <ikaufman@gatech.edu>; Savang, Thanath M <tsavang3@gatech.edu>
Subject: RE: Request for clarification on BT-2RCL specifications

Generally you don't need a filter on the drive side. You get to control the signal!

Dr. Brown

From: Kaufman, Isaac D <ikaufman@gatech.edu>
Sent: Tuesday, March 31, 2020 4:53 PM
To: Savang, Thanath M <tsavang3@gatech.edu>; dbrown@btechacoustics.com
Subject: Re: Request for clarification on BT-2RCL specifications

Hi Mr. Brown,

I'm having trouble interpreting the series and parallel tuning requirements outlined in the BT-2RCL datasheet. For the best performance, it calls for parallel or series impedances ranging from 1.9mH-2.2mH, however when inserting the inductance in this way, it affects the frequency response of the output in such a way that I cannot make a lowpass filter with a high enough cutoff frequency. My real question is: What should the output filter of my amplifier look like to correctly drive this transducer with the recommended series or parallel capacitance?

Thanks,

Isaac

From: Savang, Thanath M <tsavang3@gatech.edu>
Sent: Wednesday, March 25, 2020 1:30 PM
To: dbrown@btechacoustics.com <dbrown@btechacoustics.com>; Kaufman, Isaac D <ikaufman@gatech.edu>
Subject: Re: Request for clarification on BT-2RCL specifications

Ah, that has nothing to do with the actual specs we need from the transducer. For our project we're using it as part of a modem so we need to design a circuit to step up the received voltage to the 3.3 V logic level to use with our microcontroller. Like Isaac said, you've already been tremendously helpful and we don't want to take up too much of your time.

From: dbrown@btechacoustics.com <dbrown@btechacoustics.com>
Sent: Tuesday, March 24, 2020 8:09 PM
To: Kaufman, Isaac D <ikaufman@gatech.edu>; Savang, Thanath M <tsavang3@gatech.edu>
Subject: RE: Request for clarification on BT-2RCL specifications

Why do you need such a large voltage

From: Kaufman, Isaac D <ikaufman@gatech.edu>
Sent: Tuesday, March 24, 2020 7:44 PM
To: dbrown@btechacoustics.com; Savang, Thanath M <tsavang3@gatech.edu>
Subject: Re: Request for clarification on BT-2RCL specifications

I meant 3.3 Vpeak by the end of our receive chain. So we would need about 19000x linear gain to step up from 126 uV RMS. I don't have much experience with this type of circuit design, so I planned to have only one LNA in the receive chain, but the op amp I've chosen only has a 1.3 MHz gain-bandwidth product, so it looks like I'll need to add another cascaded gain stage into the chain. In any event, the calculations make more sense to me and I can see a path forward in terms of design now, so thank you for that.

Isaac

From: dbrown@btechacoustics.com <dbrown@btechacoustics.com>
Sent: Tuesday, March 24, 2020 7:32 PM
To: Kaufman, Isaac D <ikaufman@gatech.edu>; Savang, Thanath M <tsavang3@gatech.edu>
Subject: RE: Request for clarification on BT-2RCL specifications

The attenuation loss could be greater in a channel with significant refraction. Bellhop is widely used tool.
I don't think you need 3.3V …that seems ridiculously high.
A rule of thumb is that decent preamplifiers and op amps have a noise floor about 5 to nV/root Hz.
So 126 uV RMS is very high signal to noise.
No worries.

From: Kaufman, Isaac D <ikaufman@gatech.edu>
Sent: Tuesday, March 24, 2020 1:37 PM

To: dbrown@btechacoustics.com; Savang, Thanath M <tsavang3@gatech.edu>
Subject: Re: Request for clarification on BT-2RCL specifications

Thanks for the comments, the 20log correction finds us 15 or so dB, and the transmission loss estimation accounts for the rest of the difference between our calculations. This is what one of our group members produced with the WHOI acoustic toolbox:

So the worst case transmission loss was 80 dB instead of the 90 dB that I said, but that is still ~15 dB higher than the figure you gave. If the data you used is standard for estimating transmission loss, I'm willing to believe it, but we're all new to underwater acoustics so we may have done something unorthodox unintentionally. That being said, with your calculations, we're still receiving at a very low voltage, is there a rule of thumb for what voltage we should receive at to be able to amplify it reliably? Our end goal is to amplify it up to 3.3 Vpeak for compatibility with our microcontrollers ADC.

Thanks again for the help, and feel free to send any resources we could read, I don't want to take up too much of your time with our questions.

Isaac

From: dbrown@btechacoustics.com <dbrown@btechacoustics.com>
Sent: Monday, March 23, 2020 6:03 PM
To: Kaufman, Isaac D <ikaufman@gatech.edu>; Savang, Thanath M <tsavang3@gatech.edu>
Subject: RE: Request for clarification on BT-2RCL specifications

SEE CORRECTIONS AND COMMENTS BELOW>>>

From: Kaufman, Isaac D <ikaufman@gatech.edu>
Sent: Monday, March 23, 2020 5:04 PM
To: Savang, Thanath M <tsavang3@gatech.edu>; David Brown <dbrown@btechacoustics.com>
Subject: Re: Request for clarification on BT-2RCL specifications

Hi Mr. Brown,

Here is what we have for calculations using the MIT paper that was linked earlier in the email chain. We're trying to determine at what voltage level we'll receive a transmission from 1km away, so we can choose what voltage to transmit at.

From BT-2RCL datasheet:

OCVS = -190 db re 1V/uPa
TVR = 150 db (tuned)

Transmitting at 30 Vrms
150+10*log(30) = 164.75 db re 1uPa
ERROR should be 20 Log ( )
RESPONSE
SPL at 1m = 150+20*log(30) = 150 + 20 +9.5 dB re 1uPa at 1m = 180dB rounded

According to our simulations, worst case loss transmitting 1km = 90 dB.
REPLY: Why don't you supply those calculations.
If I assume spherical spreading and losses at 30kHz 20 log r +ar = 60 + 8 dB

Vreceive = 164.75 - 90 - 190 = -115 dBV
REPLY: I get
180 dB -68 dB = 112 dB re 1 uPa
That will produce a voltage of
OCVS = -190 db re 1V/uPa +112 dB re 1 uPa = -78 dB re 1 V rms. That is -18 dB re 1 mV rms or 126micro-V RMS

David Brown

The calculations show that we would be receiving at -115 dBV, far too low for our purposes. Even transmitting at maximum pressure according to the datasheet, we'd still be receiving at -85 dBV. I am unsure if we are performing these calculations correctly, could you shed some light on what the correct procedure for estimating the receiving voltage level?

Thanks for the help,

Isaac

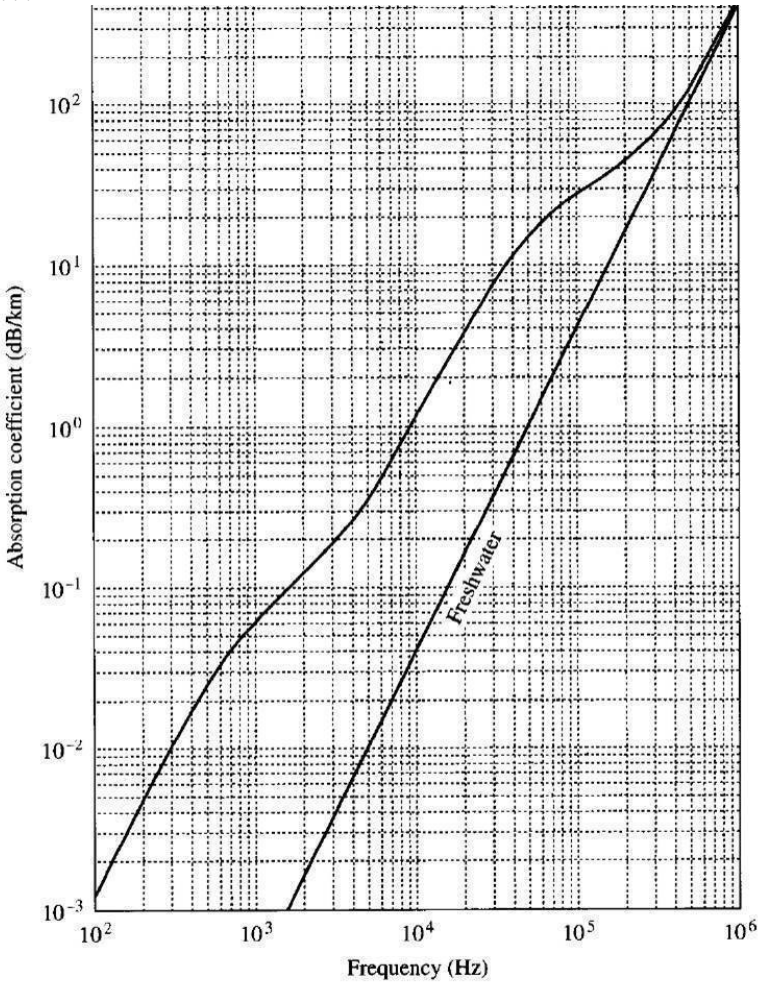


Figure 8.7.1 Sound absorption at $T = 5°C$ and $Z = 0$ km in freshwater and seawater (pH = 8, $S = 35$ ppt).

From: Savang, Thanath M <tsavang3@gatech.edu>
Sent: Monday, March 23, 2020 3:38 PM
To: David Brown <dbrown@btechacoustics.com>; Kaufman, Isaac D <ikaufman@gatech.edu>
Subject: Re: Request for clarification on BT-2RCL specifications

Hello again,

Sorry it's been so long since my last response. I've added one of my partners into the email chain, he has some calculations he would like to ask you to review.

Thank you.

From: David Brown <dbrown@btechacoustics.com>
Sent: Monday, March 9, 2020 10:37 PM
To: Savang, Thanath M <tsavang3@gatech.edu>
Subject: Re: Request for clarification on BT-2RCL specifications

It will take a couple days as I'm on excursion in Panama.
But I'll try now. TVR is high so calculate split from your drive voltage. How many pascal do you get? Then assume spherical spreading 20 log r. Then you get pressure at receiver. Convert that to voltage. What do you get? Send me those calcs.

On Mar 9, 2020, 4:21 PM, at 4:21 PM, "Savang, Thanath M" <tsavang3@gatech.edu> wrote:
>Yes, the setup is using one of your BT-2RCL transducers on the transmit
>end and another on the receive end.
>
>We already have your data sheets from the website. Our issue is with
>using the TVR, SPL, and OCVS specifications to calculate required gain
>to reach some usable voltage level for DSP.

>
>We're wondering if you have a different set of equations from those in
>the MIT lecture notes we're referring to, or if our mistake is in
>equating OCVS and OCRR and SPL with SIL.
>
>I'm sorry to bother you during a busy time. If you want to respond at a
>later date I completely understand.
>_____
>From: David Brown <dbrown@btechacoustics.com>
>Sent: Monday, March 9, 2020 4:26 PM
>To: Savang, Thanath M <tsavang3@gatech.edu>
>Subject: Re: Request for clarification on BT-2RCL specifications
>
>Hello, our data sheets are on website. I'm on travel this week with
>limited access.
>What is your setup? Transmitting on one and receiving on the other?
>
>
>On Mar 9, 2020, 1:45 PM, at 1:45 PM, "Savang, Thanath M"
><tsavang3@gatech.edu> wrote:
>>Hello Mr. Brown,
>>
>>I'd like to preemptively state that I'm a student working on a
>capstone
>>design project.
>>
>>The team I am is working with is currently in possession of a few of
>>your BT-2RCL transducers to be used on modems for underwater
>>communication. However, when we're making theoretical calculations for
>>voltage gain on the receiving end we'r ending up with an extremely low
>>number (on the order of microvolts for the maximum input voltage).
>>
>>We're working on an assumption that the maximum transmission loss that
>>we have to deal with for our design specifications is 90 dB and our
>>reference for the equations used is the following lecture note set
>from
>>MIT:
>>
>>https://dspace.mit.edu/bitstream/handle/1721.1/74140/2-017j-spring-2006/contents/lecture-notes/05_3uap_notes.pdf
>>Underwater Acoustics - DSpace@MIT:
>>Home<https://dspace.mit.edu/bitstream/handle/1721.1/74140/2-017j-spring-2006/contents/lecture-notes/05_3uap_notes.pdf>
>>VdB = 10 log10(V/1). Then the output voltage in Volts is V =
>10(VdB/10)
>>= 1 V. Figure 1 OCRR for ITC1001 spherical transducer. Transmitting
>>Voltage Response (TVR) is defined as the output sound intensity level
>>(SIL) generated at 1m range by the transducer per 1 V of input Voltage
>>as a function of
>>dspace.mit.edu
>>I noticed that some of the terms differ between that set of notes and
>>your BT-2RCL datasheet. Is there anything that you can point out to
>>make this make sense to us (for example is it wrong to assume OCCR and
>>OCVS are reffering to the same thing)?
>>
>>Thank you,
>>
>>
>>Thanath M. Savang
>>Senior Year Electrical Engineering Major
>>Georgia Institute of Technology
>>tsavang3@gatech.edu<mailto:tsavang3@gatech.edu>