How to determine pulse width, duty cycle and off-time with input pulse power (peak power)

This document is exclusively for BII transducers and related BII products.

SL: Source Level, in dB μPa*m; T: Temperature of the loading medium such as sea water, in °C, [°C × 9/5] + 32 = °F; TVR: Transmitting Voltage Response, in dB μPa*m/V; Gp: Conductance of the Transducer, in Siemens. RTL: normalized Load Resistance of the transducer such as a 50Ω transducer which, generally, has a built-in impedance matching network. MIPP: Maximum Input Pulse Power, in RMS Watt; MCIP: Maximum Continuous Input Power, in RMS Watt; IPP: input pulse power (peak power), in RMS Watt; MPW: Maximum Pulse Width at MIPP, in Second; PW: Pulse Width, in Second; D: Duty Cycle.

1. Determine SL or RMS drive voltage required by the application and get the temperature T of the loading medium in field.
2. Calculate IPP:

\[
10 \times \log IPP = SL + 10 \times \log Gp - TVR, \quad IPP = V_{rms}^2 \cdot Gp, \quad \text{or} \quad IPP = \frac{V_{rms}^2}{RTL}
\]

If the Gp and TVR are not published online, please contact BII for the Gp and TVR of the specific transducers.

If impedance of the transducer ((Z, θ), or (R, X)) are published, Gp can be deduced from impedance.

\[
Gp = \frac{\cos \theta}{Z} = \frac{R}{R^2 + X^2}
\]

3. Choose suitable transducers with IPP and MIPP.

The transducers with MIPP greater than IPP are suitable for the application. Warning: IPP MUST be less than MIPP. If IPP > MIPP, the transducer would be damaged beyond repair.

For example, IPP = 500 W, and it is chosen that a BII transducer with MIPP of 1000 Watt, MPW of 1 Second and MCIP of 10 Watt. Loading medium is sea water at 17°C.

4. \(PW \leq \frac{MIPP - MPW \cdot (\frac{103° C - T}{103° C})}{IPP}\)

PW ≤ 1000*1*1/500 = 2 (Seconds). That is, pulse width of 500W driving signal at 17°C sea water must be less than 2 seconds.

5. \(D \leq \frac{MCIP \cdot (\frac{103° C - T}{103° C})}{IPP}\)

D ≤ 10*1/500 = 2%. That is, duty cycle of 500W driving signal at 17°C sea water must be less than 2%.

6. Off-time ≥ Pulse Width*(1-D)/D.

Off-time ≥ 98 (Seconds) at PW=2 seconds;
Off-time ≥ 49 (Seconds) at PW=1 second;
Off-time ≥ 49 (Seconds) at PW=100 ms;
Off-time ≥ 490 (ms) at PW=10 ms;
Off-time ≥ 490 (ms) at PW=1 ms;

etc ...

After driving transducer for 2s with 500W, the transducer MUST be off and allow it to cool down in the 17°C water for 98 seconds at least before driving it again.

... After driving transducer for 1ms with 500W, the transducer Must be off and allow it to cool down in the 17°C water for 49 milliseconds at least before driving it again

7. If calculated PW and D do not meet the requirements of the application, please choose another transducer and re-evaluate it by repeating step 2 to step 6 listed above; or, consider using an array. For a planar array of N element parallel-mounted transducers, the sound level of the array will increase by 20*log N and the narrower beam width will be achieved by comparing the sound level and beam width of the single element.

8. After a suitable transducer is chosen, and IPP, PW and D are checked out completely, it is time to choose power amplifier and impedance matching network.

a. Choose the power amplifier which can be used with the IPP, PW and D;

Note: power amplifiers with maximum power rating less than transducers’ MIPP are recommended to use. This can reduce the possibility of damaging transducers with over-power (or over-voltage) by accident.

b. Find out the load requirements from the specification of the power amplifier.

Most RF power amplifiers drive 50Ω load, and most Audio power amplifiers drive 2 Ω to 32Ω.

BII power amplifiers drive 2 Ω to 32Ω from 20Hz to 2MHz, and BII’s bespoke power amplifier drive 50Ω from 20Hz to 2MHz.

c. BII’s BII-6000 series provide impedance matching between transducers and power amplifiers at specified operating frequency. There are two packages available: an impedance matching unit is built inside transducer housing or is manufactured inside a separate housing as a standalone unit.

9. Email BII about your request on transducers and impedance matching units.

BII wishes all the best to your project!