PRECISION ACOUSTICS

Maximum drive levels for Precision Acoustics transducers

Precision Acoustics transducers will produce an acoustic response to any applied voltage. There is no minimum drive level, only an upper.

There is no simple answer to the question of "What is the maximum safe drivel level for my transducer"? The answer depends on many factors, the most common of which are explained in this document along with descriptions of the physical reasons for failure when a transducer is over-driven.

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REASONS FOR FAILURE

1) Excessive internal heating.
    a) No transducer is 100% efficient. Inefficiencies in the conversion of input electrical energy to acoustic energy will result in heat being generated in the transducer. If this heat cannot be dissipated then components within a transducer may suffer mechanical failure as a result of melting or burning.
2) Mechanical fracture of the piezo element.
    a) High amplitude vibrations across the thickness of a piezo element give rise to large tensional stresses on the outer surface and can lead to a ceramic being ripped apart.
3) Failure of internal electrical components.
    a) Electrical components will often fail if subjected to operating conditions outside their manufactured rating. High currents (for inductors) and high voltages (for capacitors) will cause these components to breakdown.

FACTORS AFFECTING MAXIMUM DRIVE LEVEL

DRIVE REGIME

The choice of drive regime is an important factor to consider when determining the maximum safe drive level of a transducer. Transducers respond well to voltage impulses or Sinusoidal inputs.

PULSED DRIVE REGIMES

For pulsed applications (ie; low cycle count sinusoidal drives or voltage impulses) the time-averaged power entering the transducer is likely to be very low. If the power entering the transducer is low then it is unlikely that significant amounts of heat will be generated. For this reason, the most likely failure mechanism for a pulse driven transducer is mechanical fracture or component breakdown.

CONTINUOUS WAVE (CW) DRIVE REGIMES

Transducers which are driven CW are liable to generate significant amounts of internal heat. For example, a transducer with an electrical-mechanical conversion efficiency of 90% efficiency will generate 10W of heat if driven with 100W input electrical power. Often this heating is localised to the internal circuitry of a transducer and can quickly lead to transducer failure. Additionally, CW regimes can also lead to the same failure mechanisms as pulsed drive regimes.

TONEBURST DRIVE REGIMES

Causes of failure for a transducer driven with a toneburst will vary with the length of the toneburst and the PRF (pulse repetition frequency) on a sliding scale from those of the pulsed regime to those of the CW regime.

ENVIRONMENTAL FACTORS

A transducer's surrounding environment can impact its maximum safe drive level. There are two main implications of a transducer's environment;

1) How does the environment affect the transducer's ability to dissipate heat?
    a. Immersion setups are generally very good at dissipating internally generated heat from a transducer. At the opposite end of the scale, a contact setup, with the main body of the transducer open to the air is less efficient at dissipating heat.
    b. The ambient temperature of the environment will impact the operating temperature of the transducer. Precision Acoustics transducers are not recommended for use above 50 °C.
2) How does the transducer's environment affect the transducer's ability to radiate ultrasound?
    a. Unless otherwise stated, Precision Acoustics transducers are intended for immersion use. Media with a different acoustic impedance to water will result in a different amount of acoustic energy being radiated from the transducer and will result in different amounts of internal heating.

PIEZOCERAMIC TRANSDUCERS

As a general guide, the following are typical of the maximum drive amplitude for a ceramic transducer. Note; actual values may be higher or lower depending on the transducer design and operating conditions.

	Max drive voltage (Vpp)
Pulse	500
Low duty cycle toneburst	200
CW	100

PIEZOPOLYMER (PVDF) TRANSDUCERS

As a general guide, the following are typical of the maximum drive amplitude for a piezopolymer transducer. Note; actual values may be higher or lower depending on the transducer design and operating conditions.

	Max drive voltage (Vpp)
Pulse	900
Low duty cycle toneburst	200
CW	50

SUMMARY

Questions to ask yourself when considering if a drive amplitude is safe;

- What type of transducer am I using?
- What is the duty cycle?
- What power am I applying?
- What is the transducer's surrounding environment?