RESONANCE ACTUATION · FREQUENCY TRACKING

# PHILL™

PHILL™ is a resonance actuation and tracking device, specifically designed for resonant sensors. It features a self-sustaining oscillator (SSO) and a frequency counter-based architecture. The enhanced wide-band-pass and digital low-pass filtering conditions the signal, converting sinusoidal input into precise rectangular waveforms and driving the resonator with accurate frequency data and stable operation, free of intermodulation noise.


| FREQUENCY RANGE | FREQ. FLUCTUATION | SAMPLING RATE | WEIGHT |
|---|---|---|---|
| 1 kHz–1 MHz | $10^{-9}$ fractional | 20 MSa/s | 1.1 kg |

## FEATURES

- Resonance mode selection
- Frequency data acquisition
- Positive feedback oscillation driving and measurement in one system
- Stable oscillation frequency tracking and driving
- Integrated pre-amplifier
- OEM software
- Robust and easy to use

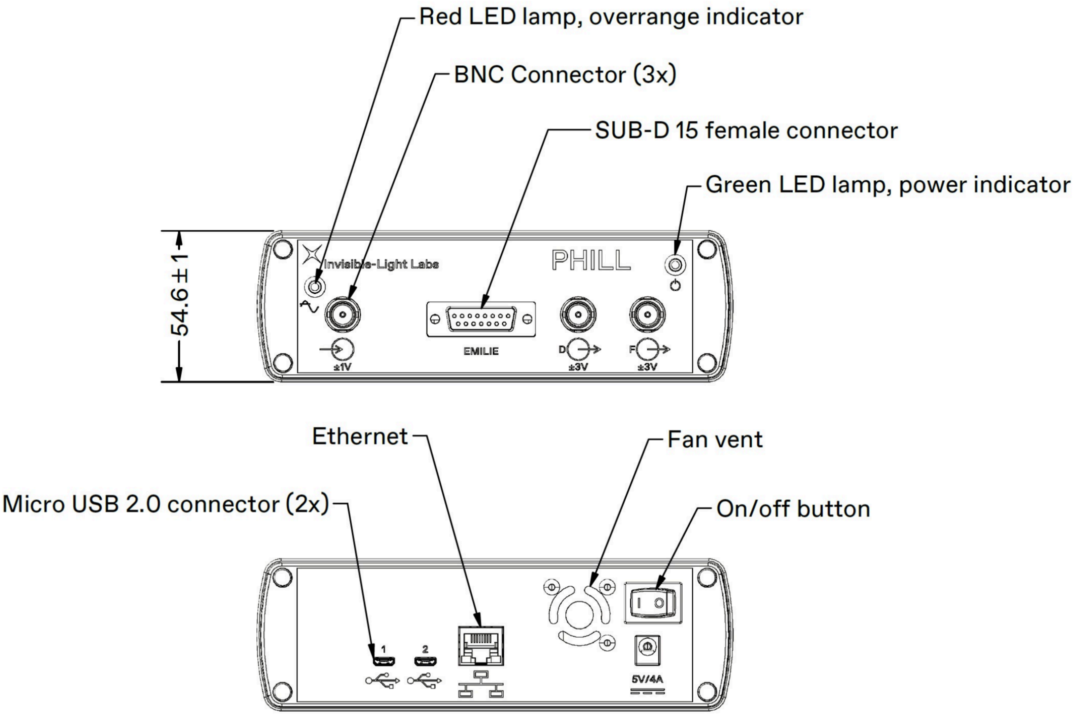
## APPLICATIONS

- NEMS and MEMS chip sensor measurements
- Quartz crystal balance measurements
- Temperature control of resonators
- Calibration of the oscillation frequency of resonators

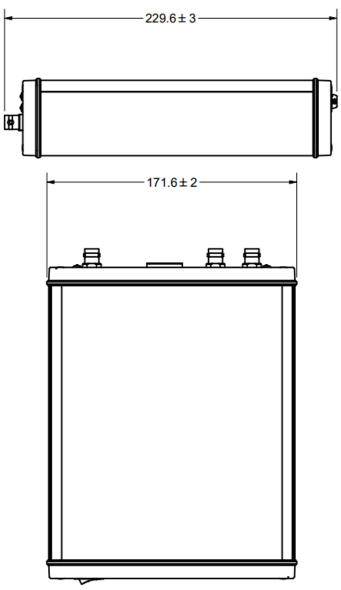
## TABLE 1 GENERAL SPECIFICATIONS

| | |
|---|---|
| Dimensions (L×W×H) | 23×17×6 cm |
| Weight | 1.1 kg |
| Enclosure material | 3.3206, AlMgSi0.5 powder-coated; seals TPE |
| Supply voltage | 5 V DC (SELV) |
| Power rating | 6.25 W, max. 20 W |
| I/O | Sensor In (BNC), Drive (BNC), Frequency Out (BNC), EMILIE connector (Sub-D) |
| Host connection | Micro-USB 2.0, 480 Mbit/s; Ethernet 10/100/1000 Mbit/s |
| Operating environment | IEC 61010, indoor, installation category II, pollution degree 2 |
| Storage temperature | 5 °C to 35 °C |
| Operating temperature | 5 °C to 35 °C |

## FRONT & REAR PANEL




## DIMENSIONS




All dimensions in mm.

## KEY CHARACTERISTICS

- Plug-and-play Micro-USB connection to PC
- Communicates between EMILIE™ and your spectrometer software
- Data visualization and processing for stand-alone systems

### STABILITY WITHOUT LOCK LOSS

PHILL™ matches the frequency stability of Phase-Locked Loop systems, but never loses 'lock'. The oscillator bandwidth is freely selectable in the frequency counter, independent of circuit constraints. No PID parameters adjustment needed to track the resonator phase.

## TABLE 2 ANALOG INPUT

| | |
|---|---|
| Input frequency range | 1 kHz to 1 MHz |
| Input impedance | 10 kΩ |
| Input voltage | ±1 V DC |
| A/D conversion | 12 bit, 80 MSa/s |

## TABLE 4 PREAMPLIFICATION

| | |
|---|---|
| Amplification stages | 1, 3, 10 and 30 |
| Bandwidth | 1 MHz |
| Slew rate | 30 V/μs |

## TABLE 6 FREQUENCY COUNTER

| | |
|---|---|
| Resolution at 100 Hz with no averaging | 1 Hz |

## TABLE 7 FREQUENCY OUTPUT FILTER

| | |
|---|---|
| Cut-off | 1 Hz to 10 kHz |

## TABLE 3 ANALOG OUTPUT

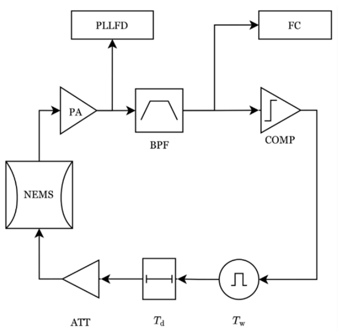
| | |
|---|---|
| Frequency counter output frequency | 3 kHz to 1 MHz |
| Resonator drive output frequency | 1 kHz to 1 MHz |
| Frequency counter output voltage | ±3 V DC |
| Resonator drive output voltage | ±3 V DC |
| D/A conversion | 14 bit, 200 MSa/s |

## TABLE 5 BAND-PASS FILTER

| | |
|---|---|
| Center frequency range | 1 kHz to 1 MHz |
| Maximum Q-factor | 1000 |
| Gain | 1 |
| Fractional frequency fluctuation | $10^{-9}$ @ 100 kHz input signal, 1 s averaging |

## TABLE 8 SCOPE

| | |
|---|---|
| Input channels | Signal input, band-pass out, drive |
| Trigger channels | Signal input, band-pass out |
| Trigger modes | Edge |
| Sampling rates | 100 kSa/s to 20 MSa/s |
| Vertical resolution | 14 bit |
| Bandwidth limit mode, vertical resolution increase | Sample decimation, averaging |




## SSO TRACKING SCHEME

Block representation of the self-sustaining oscillator loop: the NEMS resonator signal is pre-amplified (PA), band-pass filtered (BPF) and squared by a comparator (COMP) to feed the frequency counter (FC), then returned to the resonator through pulse shaping ($T_w$), delay ($T_d$) and attenuation (ATT).



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