

# Reliable White Goods

## High Throughput Production Testing of Electric Motors for Household Appliances

Arçelik is a Turkish company which manufactures household equipment and entertainment electronics and sells them in more than 100 countries. To support this worldwide business, Arçelik has an impressive research and development department. During production of electric motors for these products, acoustic tests and vibration measurements are made for quality control purposes to ensure that given tolerances are met. Using laser vibrometers, these measurement tasks can be done at a high production rate by exploiting the non-contact properties of the measurement technology.



### Maintenance-free Sensor System

The Polytec IVS Industrial Vibrometer is particularly suitable for making measurements in production plants. This vibrometer uses a laser beam (Fig. 1) as a measurement probe and has no external control elements; it is configured via the internal serial interface so that it is not possible to accidentally change the settings during service and maintenance work.

Other advantages of this optical measurement technology include:

- Simplified installation eliminates mechanical fixturing and direct contact with the object being tested.
- Measurements in difficult to access regions are allowed by the small probe size.
- The vibration characteristics of the test specimen are not affected by a probe mass, for example the mass of an accelerometer.
- The technology can be quickly adapted to various types and versions of test specimen and to the test environment.

### Customized Test Procedures

Two methods are predominantly used to test the motors: making measurements while the motor is warming up and/or making measurements at a constant RPM

(Fig. 2). This means that a test bench must be designed to have flexible control of the motor speed, including acquisition and monitoring of the actual RPM on the motor to be tested. During the measurement, the structure-borne sound vibrations at the individual measurement points are recorded and then evaluated using software.

Depending on the test stand, the RPM is specified by setting a control voltage, for example by using a function generator without feedback, or by setting the motor speed directly and actively regulating it. In the first case, the actual motor speed must be measured using an encoder or an analog voltage which is proportional to the motor speed.



Fig. 1: Example of a measurement using a laser vibrometer to characterize an electric motor.

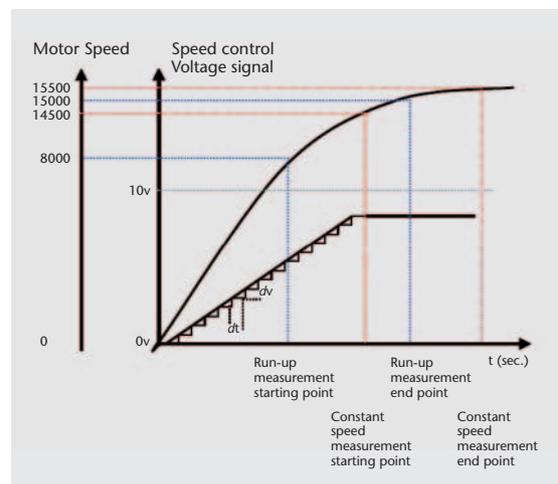


Fig. 2: Time-speed diagram for the two different measurement procedures.

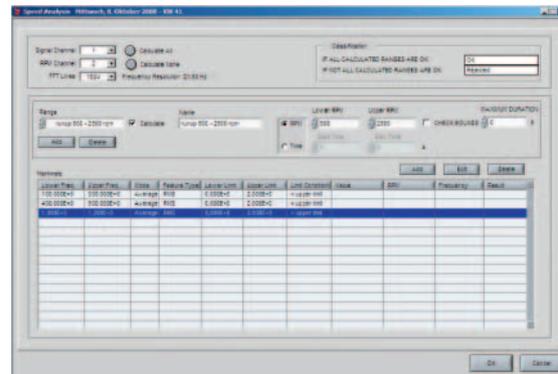


Fig. 3: Screen shot of the evaluation module in the QuickCheck test software.



The test procedure is controlled and evaluated using the Polytec QuickCheck test software. The function generator integrated into QuickCheck allows the setting of a trapeze shaped speed profile with an adjustable increase, an adjustable maximum voltage and a variable duration of the constant voltage. The measurement time is adjusted to correspond to the total duration of the measurement cycle. Alternatively, the measurement time is specified according to the production cycle and the motor speed profile is adjusted accordingly.

Simultaneous with the setting of the motor speed, the vibration signals are measured. The measurement data can be divided into sections on the basis of the motor speed specifications or the actual measured speed. A section can incorporate traversing the RPM range from 500 to 2,500 RPM or, as shown in Figure 2, from 8,000 to 15,000 RPM. On the basis of the velocity signal, the software searches the relevant time domain and analyzes the vibration signals acquired in this range. This time signature can be different for every motor and arises out of its dynamic behavior.

#### Efficient Evaluation

With QuickCheck, there is an evaluation model available for the test bench which makes such tests very easy and user-friendly (Fig. 3).

For this analysis, an RPM range is given initially. The QuickCheck software only analyzes the corresponding measurement data from the individual measurement channels in the relevant time section and then calculates the spectrogram for this data using an adjustable block size. Various characteristics are calculated from this data and can be compared to specified limits (for example, the band energy or the peak value in the frequency range from 100 to 300 Hz). The software allows any number of characteristics to be calculated in an RPM range and any number of RPM ranges can be defined. These ranges can even overlap each other.

When measuring at a constant speed, a specified time domain can be selected for the analysis. Setting and calculating characteristics can be done with the options described above. For off-line analyses, the measured time signals can be saved for subsequent order analysis.

All characteristics calculated in this way are shown in a table in the QuickCheck test software. For the tested motor to pass the test and move on to the next manufacturing step, all characteristics must be within their specified limits. The measurement values can easily be saved in a database with the time stamp of the measurement. QuickCheck also allows the serial number of every motor to be read by bar code or data-matrix code and the value

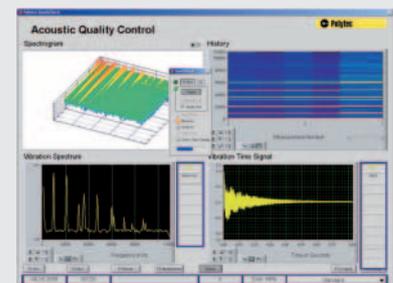
can be saved with the corresponding measurement values. This is an extremely useful feature since it is possible to trace the individual production and testing results for each product at any given time.

[www.industrial-test.net](http://www.industrial-test.net)

#### QuickCheck Software

QuickCheck is a multichannel, PC-based software for semi or fully automatic process monitoring and quality control based on the vibration behavior of the products. QuickCheck acquires and evaluates the measurement signals, makes the pass/fail decision, controls the test routine and communicates with the customer's process control system.

[www.polytec.com/software](http://www.polytec.com/software)



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