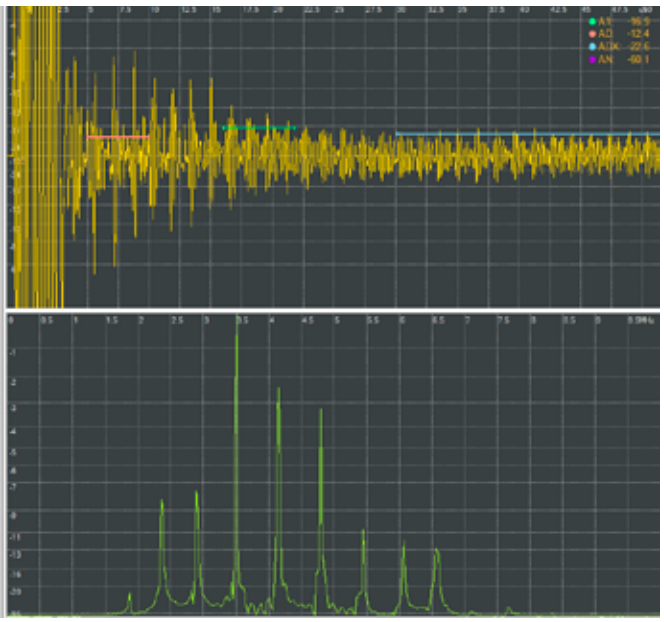
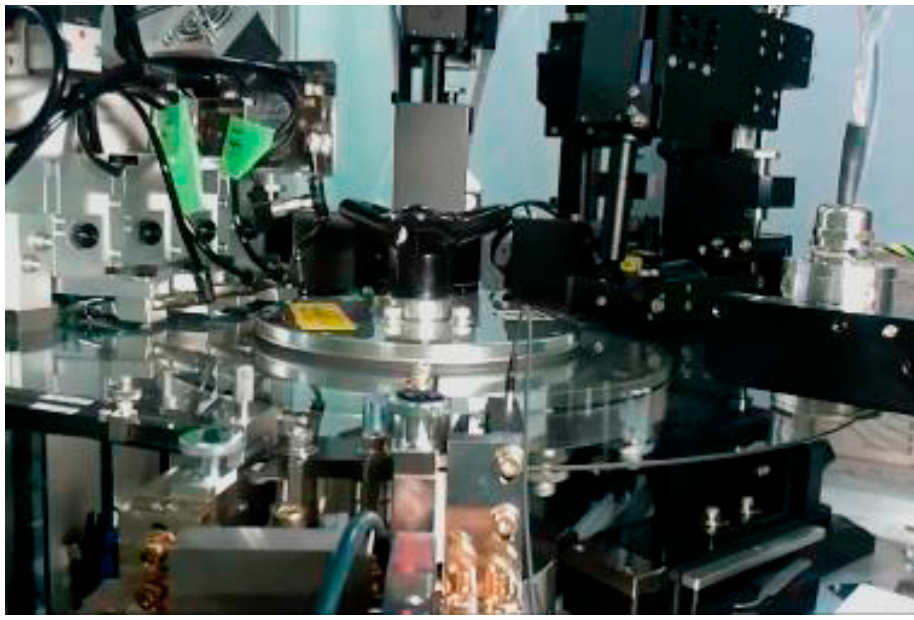
EMATEST-EC

Set of Equipment for Automated Non-Contact In-line Examination of Electronic Components





Introduction of EMATEST-EC

EMATEST-EC system is intended for automated ultrasonic non-contact testing of the Electronic Components like multilayer ceramic capacitors, ferrite components and similar elements (further on “Components”) with high mechanical quality factor (Q-Factor) and reacting properly on the EMAT-influence.

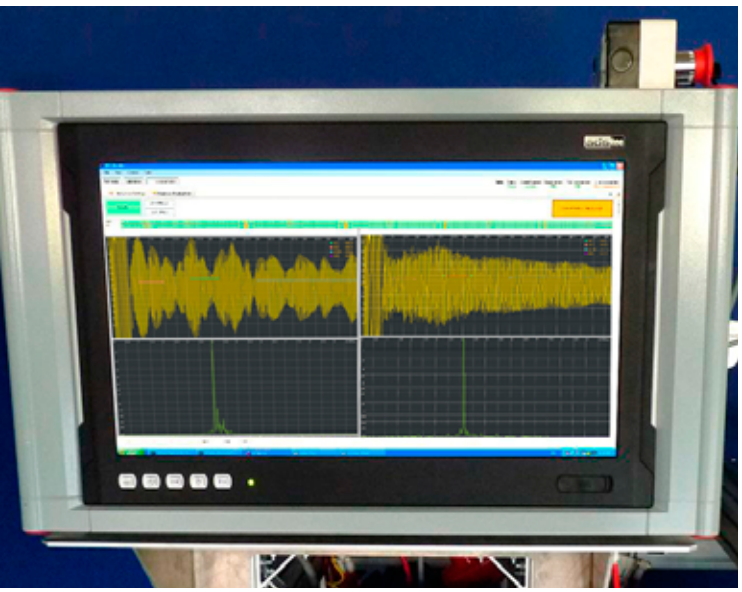
An ultrasonic non-contact method of detecting of detrimental imperfections in Components comprising the following sequence:

- Bringing a Component to be tested into the active area of the EMAT-probe generating electromagnetic pulses;
- Transforming some part of energy of these pulses into energy of free mechanical vibrations of the Component;
- Receiving electromagnetic response caused by the mechanical vibrations above by means of the same EMAT;
- Analyzing the above response by means of comparing its parameters with the respective parameters of the reference (healthy) Component and making corresponding conclusion on the quality of the Component to be tested;
- Removing the Component from the active area and sorting it according to the test results.

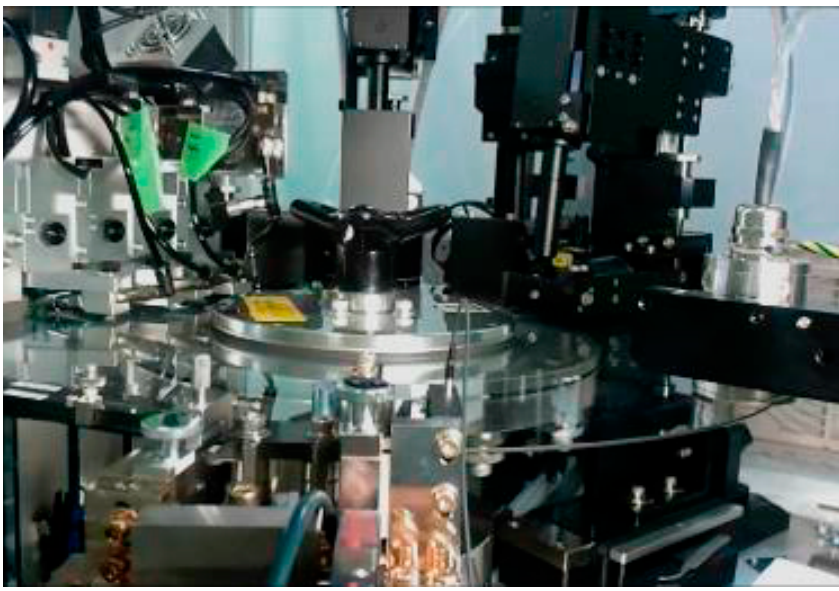
Electromagnetic pulses generated by the EMAT have spectrum which is much broader than the expected spectrum of free mechanical vibrations of the Component so that the expected mechanical vibrations spectrum is to be within the range of effective frequencies of the spectrum of electromagnetic pulses generated by the EMAT.

At least one of the following parameters of the response is to be compared with the respective parameters of the reference Component:

- Q-factor or effective duration of the response;
- Amplitude of the response measured immediately or with a certain delay after generating electromagnetic pulse by the EMAT.



Test Electronics / Control Computing Unit



Feeding Table with the EMAT-probe

Main Advantages of EMATEST-EC

- Test process is fast: result can be received practically immediately after brining the Component into the test area. Theoretically, one initial pulse generated by EMAT is enough to get the response and determine status of the Component. In this case Components may move or fly along the test unit in non-stop mode;
- Test process is simple and intelligent. No couplant is needed. Test result is not critical to the position of the Component at the test area;
- Test process is very reliable as even the small defect is able to completely destroy resonant vibration of the Component;
- Test process can be fully automatic. Advantages 1 and 2 facilitate automatization enabling test process of very high capacity: for example, 20 Components per second can be easily tested;
- Because of the advantages above – no human factor influence is provided.

Main Technical Parameters of EMATEST-EC

Parameter	Value
Mode of Operation	Automatic or manual
Inspection Capacity (components per second)	Up to 20
Probe Frequency, MHz	0.5 – 6.0
Sorting signal delay, not more, s	0.7

Scope of Supply

	Equipment Description	Q-ty
1	Test Electronics / Control Computing Unit, including	1
	Test Electronics	1 set
	Power Supply Electronics	1 set
	Industrial PC with installed WINDOWS 7 software	1
	Industrial Touch Screen Monitor	1
	Exchange Port Device	1
2	One-Channel EMAT probe	1
3	UTE Software (generally, the standard software is suitable for the task)	1
4	Connection Cables	1 set
5	Documentation in English	1 set

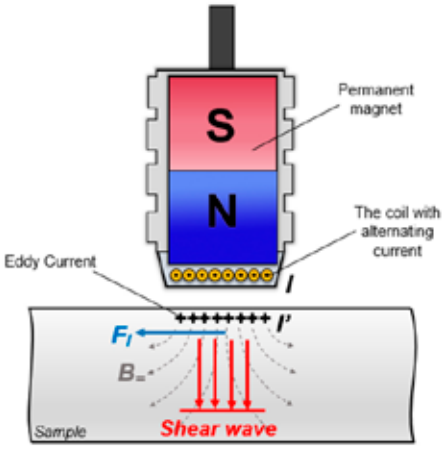
Introduction of EMAT technology

Ultrasonics is the leading, most versatile method in non-destructive testing. Nordinkraft has had great success with non-contact testing using electromagnetic acoustic transformation to generate and receive ultrasonic signals.

An EMAT transducer consists of a case with a socket, an induction coil, a protective cover, a magnetic flux concentrator and a permanent magnet.

Alternate current feeds the induction coil, causing electromagnetic oscillations which, in turn, induce eddy currents on the surface of the test object. Eddy current interferes with the permanent magnetic field, creating ultrasonic waves directly on the surface of the test object.These waves propagate in the test object, reflecting and deflecting from the walls back to the EMAT coil. Measuring the reception of these waves allows thickness to be gauged.

The use of electromagnetism as a testing technique allows testing to be done without direct contact between the probe and test surface. As EMAT non-destructive testing does not even require the use of a couplant, this technique has extensive advantages over testing with classic thickness gauges.



Principle of generating/receiving of shears waves with EMAT. Waves are generated exactly normal to the surface.

Physical Principle of Electronic Components Testing by Means of EMAT

Normally, EMAT makes no influence on dielectrics like plastic, glass, neutral ceramic, and may not be influenced by them.
However, some neutral dielectric Electronic Components have metallic electrodes inside. Therefore, they (the electrodes) can be influenced mechanically by EMAT as well as the EMAT can be influenced electromagnetically by the vibrating electrodes. As the electrodes in a healthy Component are integrated into the ceramic block and bound to the ceramics, it can be also influenced by the EMAT and the EMAT can be indirectly influenced by vibrating block of ceramic. In case of poor cohesion between electrodes and ceramics EMAT is not able to affect body of the Component or be affected by it. This is the physical background of the effective application of the EMAT for ultrasonic examination of multilayer Electronic Components.
Every ceramic Component with high level of cohesion between electrodes and ceramics can be considered as a high Q-factor vibratory system. Every vibratory system has its own set of resonance frequencies of mechanical vibrations. The first resonance frequency F_1 of the Component with full rate of cohesion between metal electrodes and ceramic basis can be estimated as:

(1)
$$F_1 = \frac{C}{2H},$$

where:
H – is the Component's dimension in direction relevant to its vibration,
C – effective velocity of ultrasonic waves of the respective type in the composed material of the Component. This velocity depends on physical (mechanical) properties of the materials to be applied (as ceramics prevails in the composition, it makes the biggest contribution in the effective velocity of ultrasonic waves).

Resonance can appear in all cases when:

(2)
$$H = N \cdot \frac{\lambda}{2},$$

where:
N = 1, 2, 3…n,
λ - effective wavelength of the respective ultrasonic wave in the composed material; $\lambda = C/F_N$, where F_N is the resonance frequency of number N.

So, a set of resonance frequencies can be determined as:

(3) $$F_N = \frac{NC}{2H},$$

As an example, we can estimate first resonance frequency of the Component. According to formula (1), at the consumption that the velocity of the longitudinal wave C_L may have a magnitude of about:
C_L = 5 000 m/s, H=2 mm,

$$F_1(L) = \frac{5000}{2 \cdot 2 \cdot 10^{-3}} = 1.25 \text{ MHz}$$

Symbol “L” shows that frequency was estimated in supposition that the longitudinal resonance is applied.

Generating of shear waves is also possible with EMAT. As the velocity of shear waves for most of materials is almost two times less than one of longitudinal waves, the resonance frequency in this case can be estimated as

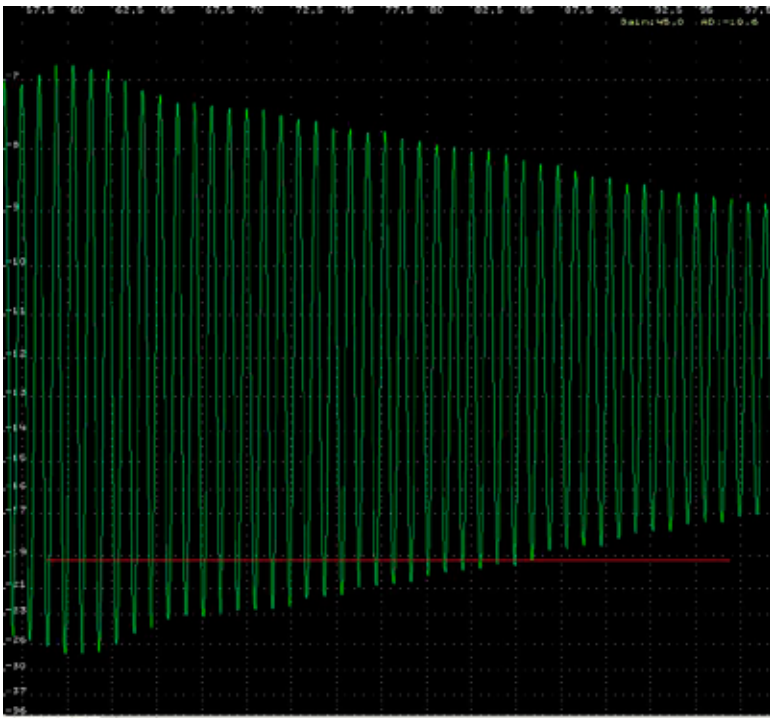
$F_1(S) \approx 0, 7$ MHz

When three following conditions as:

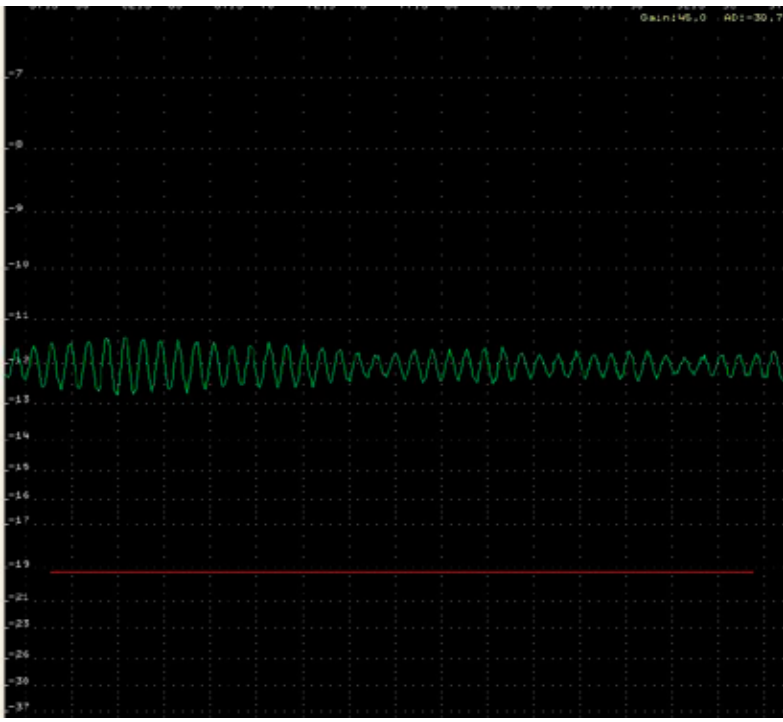
- The Component is “healthy”;
- It is located properly at the EMAT-area;
- Spectrum of frequencies of electromagnetic pulse generated by the EMAT includes at least one of the resonance frequencies.

Take place at the same time, the Component will respond with long-lasting free vibrations.

In case of lack of integrity the response of the tested Component will be not so clear and distinct as in case of the reference one, and/or the frequency of its free vibrations will be different.



Typical response from a “Healthy” Component



Typical response from a Component with imperfection

Amplitude of the response for a “bad” Component will be much lower than one received from the healthy Component.
Lack of cohesion between metal electrodes and basic material plays a role of structural defect (crack) inside of the vibratory system decreasing substantially its Q-factor, damping and scattering mechanical vibrations, destroying its spectrum.
So, determining status of the response may be carried out by monitoring of amplitudes and attenuation of the response.
The very similar idea is widely used to test dishware for cracks. If a tall wineglass is healthy, its response on mechanical click will be long and monochromatic. Even a little invisible crack may dramatically change the response: it will be short and muffled.
The method of Components integrity testing is based on a very similar principle. By means of an EMAT we influence basic material or metal electrodes of the Component to be tested by electromagnetic pulses. Because of well known effects of Lorentz and/or magnetostrictive interaction, every pulse induces mechanical forces applied to the electrodes or basic material.
As the electrodes are bound to the surrounding block of ceramics, and spectrum of the electromagnetic pulse comprises at least one of the resonance frequencies of the block, the process above initiates resonant vibrating of the Component as the whole.

The response caused by mechanical free vibrations of the Component is to be put into analysis. This analysis assumes comparing characteristics of the response of the Component to be tested with the respective features of the reference Component response. “Healthy” Components response should be similar to one of the reference Component.

For more information please contact us or send us the description of your technical requirements, in order to define relevant parameters.
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Plate testing equipment EMATEST-PL / EMASCAN-PL

Pipe testing equipment EMATEST-PI

Bar & billet testing equipment EMATEST-BB

EMATEST – BB Wire

Tube testing equipment EMATEST-TU

Portable EMAT thickness gauge NKD-019E Ultrasonic

We are sure, we'll find the best way for quality improvement of your engines!

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