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# COMPUTERIZED PORTABLE EDDY-CURRENT FLAW DETECTORS

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**Abstract**

We describe a new eddy-current flaw detector that operates with a pocket PC (PPC), the flaw detector meeting all present-day requirements set for means of NDT, particularly documentation of inspection results.
The VD-12NFP eddy-current flaw detector is intended to reveal defects with the depth from 0.5 mm on complex geometry surfaces and high roughness surfaces, up to Rz 320. Such surfaces are met with disks of railway wheels, coupler carriers, solebars, bolsters, labyrinth rings, sheaves, etc. The distinguishing feature of the device is the elimination of lift-off interference, up to 3 mm.
The device is certified and widely used at locomotive facilities and carriage repair workshops of Ministry of Railways and other industries as well. Small dimensions, low weight and battery power supply allow the use of it in field conditions.
The employment of a PPC broadens the application of the device, viz an operator gets the widest possibilities to store the results, their processing and information representation, including setting of the inspection parameters on the PPC display, marks on the signal graph and direct printing of reports from PPC. The use of a radio channel to transfer data lets us get rid of cables, provide high mobility of the complex and easily integrate the device into an automated inspection workbench.
We have managed to substitutes the PPC display for the device display that also extends the possibilities of inspection and makes it easier for operators. When fastened to a wrist, the PPC does not restrict movements and allows inspection in hard-to-reach places due to its low weight and ergonomic casing.

**keywords:** eddy-current method, comuterized systems, flaw detectors

## 1. VD-90NP eddy current flaw detector

The latest development in eddy current defectoscopy is the VD-90NP eddy current flaw detector (Figure 1). It features the highest sensitivity and is capable of detecting defects of 0.1 mm and less depth in ferromagnetic and non-magnetic materials. The distinguishing feature of the device is the operating frequency range 10Hz-2MHz that allows everyone to solve almost all tasks of eddy current defectoscopy. Moreover, the device can be powered by both a battery and mains and it can have a boost battery to prolong the time of free running.

**Figure 1. VD-90NP eddy current flaw detector. General view.**

The device design employs the PLED high contrast display with the wide viewing angle that features high information display speed at subzero temperatures.

The device design allows the operator to hold the device on his wrist or on his waist belt (figure 2). Taking into account the low weight of the device, it significantly makes the operation simpler.

**Figure 2. Use example of the VD-90NP**

The weight and dimensions of the VD-90NP has no analogs among ones with close characteristics. The wide temperature operation range lets us use it in field conditions even during winter period. Moreover, high robustness against dust and moisture provides safety in severe operational conditions.

To connect to a peripheral unit, the VD-90NP is provided with a wireless communication unit via Bluetooth 2.0 that allows data transfer and device control at the distance up to 20 m. The device can be provided with a pocket PC with specialized software.

**Basic specifications**

| | |
|---|---|
| Scanning speed | - 0,02...0,1 m/s |
| Frequency range | - 10Hz — 2MHz |
| Rotation | - 0-359° |
| Rotation step | - 0.1° |
| Operating temperature | -30°C…+40°C |
| Level sealing protection | - IP54 |
| Distance of radio transfer | - 20 m |
| Power supply – 4 x 2.7AHr NiMh AA batteries; | |
| Consumption current, max | |
| • passive radio channel | - 0.7 W |
| • active radio channel | - 0.9 W |
| Set time for operation mode, max | - 1 min |
| Running time, not less | |
| • passive radio channel | - 20 hours |
| • active radio channel | - 15 hours |
| Electronic unit weight (with batteries), max | - 0,38 kg |
| Dimensions, mm: | |
| • Electronic unit (LxWxD) | 140x72x40 |
| Complete mean lifetime, years, min | – 10 |
| Set lifetime, years, min | - 2 |

Tables 1 and 2 show sensitivity threshold and maximum allowed insulant thickness for the VD-90NP flaw detector.

Table 1

| Material | Sensitivity threshold, mm | | |
|---|---|---|---|
| ferromagnetic | Surface roughness, max | $R_a$ 1,25 | $R_z$ 320 |
| | Depth | 0,1 | 1.0 |
| | Width | 0,05 | 0,1 |
| nonmagnetic | Surface roughness, max | $R_a$ 1,25 | $R_z$ 160 |
| | Depth | 0,1 | 0,5 |
| | Width | 0,05 | 0,1 |

Table 2

| Maximum thickness of insulant, mm | |
|---|---|
| Specimen material | |
| ferromagnetic | nonmagnetic |

| | |
|---|---|
| 10 | 3 |

Differential eddy current probes (see figure 3) are used to transduce nonelectric parameters (local discontinuities) into electrical signal by exciting eddy current in a tested object. Then signal enhancement follows where the amplitude and phase are determined by the acting induced field. To link the units we use a common cable with enhanced noise immunity. Due to that, the device turns out to be compact and has low weight. The probes are wear-proof, the contact point being protected by strong corundum cap.

The flaw detector's generator ranges widely the excitation current frequency from 10Hz up to 2MHz, the excitation circuit current ranging 5-200 mA, that allows the use of the full range of both pencil and hole probes. The flaw detector automatically defines the probe type and sets the necessary excitation current and frequency that significantly simplifies the compensation.

**Figure 3. VD-90NP probes package**

## 2. Use of pocket PC

The use of a pocket PC considerably increase the device functionality, an operator has the widest possibilities to store, process and represent the data including setting of test parameters on the pocket PC display, setting of marks on a signal graph, direct printing of reports by Bluetooth. The use of radio channel for data transfer allows us not to use tie cables providing high mobility and easy integration into automated test workbenches.

The software helps to use the pocket PC display instead of the device display that also broadens test possibilities.

Modern requirements set for NDT means demand binding test reporting. However, the use of a personal computer and a printer is quite problematic in field and workshop conditions. An optimal way out is the employment of a pocket PC that uses a wireless radio channel for device-to-printer data transfer. Having low weight and small dimensions, the pocket PC provides an operator with the widest possibilities to store, process and represent the data. The bright and highly contrast graphical display with the resolution 640x480 pixels deserves special attention.

The use of a built-in GPS navigator affixes a defectogram to a test site that is important when a long oil-and-gas pipeline is tested.

Figure 4 shows the pocket PC display in test parameter set (a) and defect detection (b) modes.

**Figure 4 a) Test parameters set mode b) Defect location mode**

## 3. Digital filtration methods to enhance resolution ratio

At present, the wide use of microprocessor means of data receipt, its process and transfer enables the employment of digital filtration methods [1, 4]. The relevant ones are folding method and digital filtration by a window function. The results received by the use of these methods make us conclude about considerable enhancement of signal-to-noise ratio as well as results reliability.

To eliminate random noise from a received signal, the VD-90NP uses methods of digital filtration that provides high accuracy and noise immunity for the equipment. When using digital filtration it is important to correctly choose a window function [2, 3] that is widely used for spectrographic analysis of signals. The processing by windows is used to control the effects

caused by side lobes in a signal spectrum. The wisest way is to make up an optimal window function to solve a specified task rather than to choose from the list of acquainted ones. Figure 5 shows the use results of a window function.

**Figure 5. Signal digitally filtered by a window function.**

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**Figure 1. VD-90NP eddy current flaw detector. General view.**


**Figure 2. Use example of the VD-90NP**

**Figure 3. VD-90NP probes package**

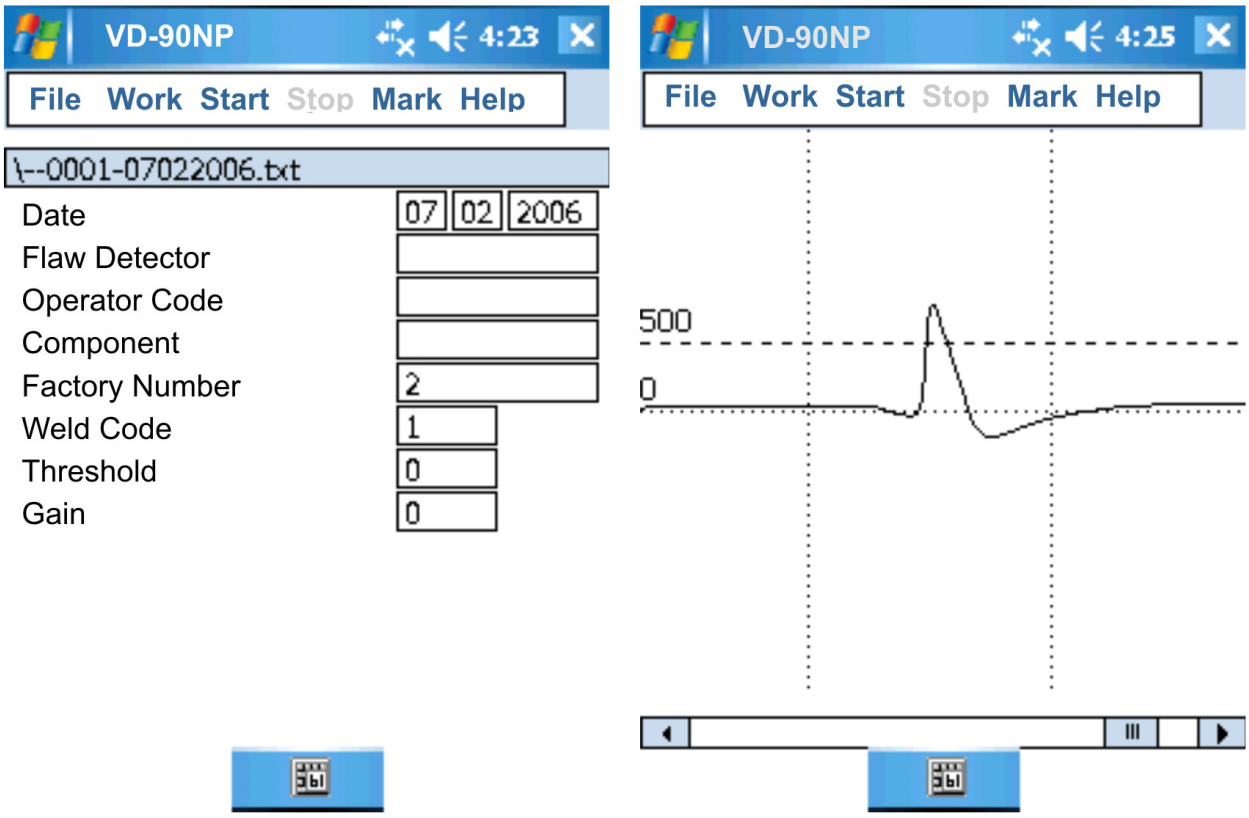


**Figure 4** **a) Test parameters set mode** **b) Defect location mode**

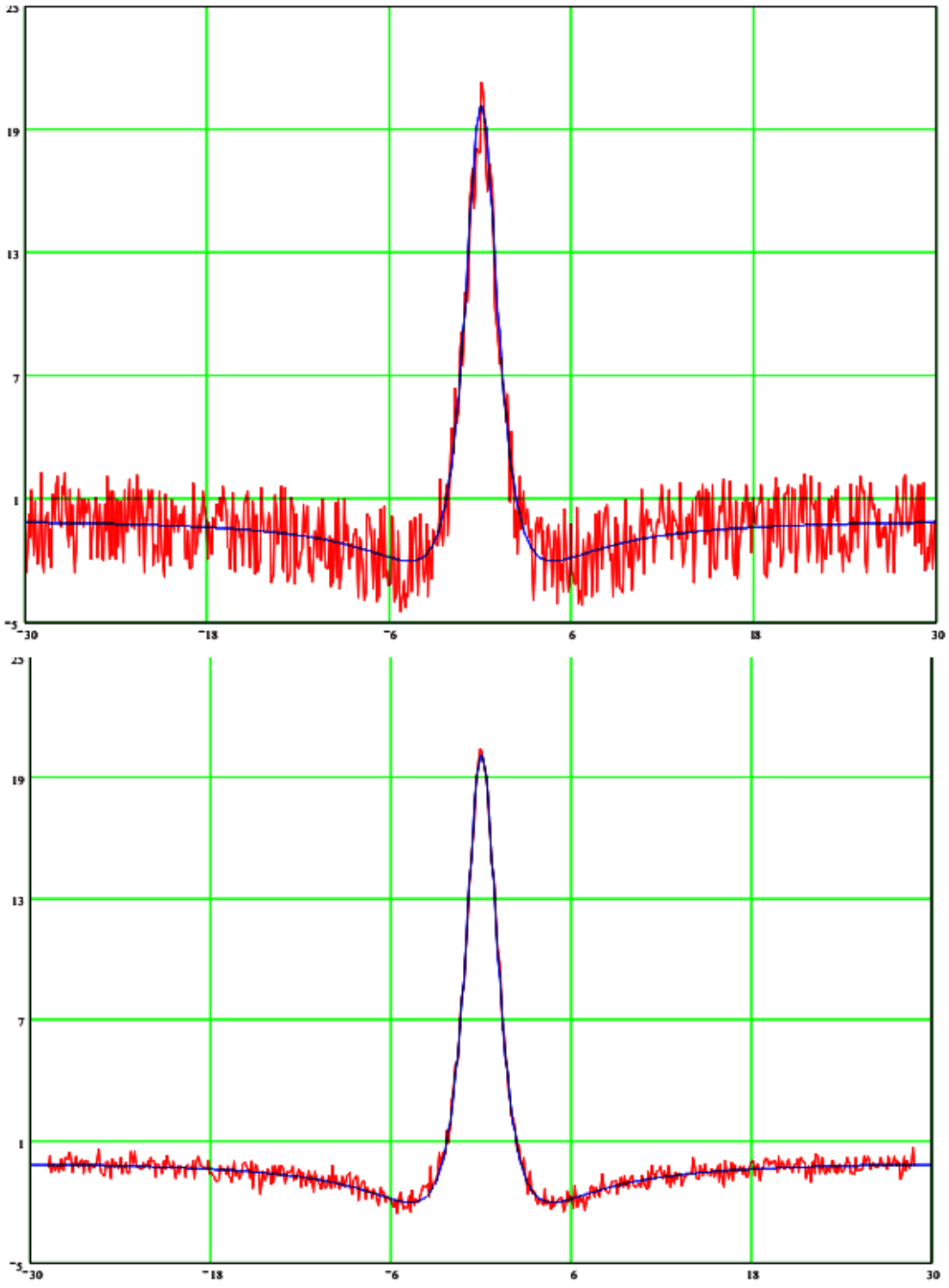


**Figure 5. Signal digitally filtered by a window function.**