Evaluation of the Russian 'Eagle' Non-linear Junction Detector

Background

1. From April to July of 2007 DSTO hired, for the purpose of evaluation, a Russian 'Eagle' Non-Linear Junction Detector (NLJD).

2. The NLJD consists of a main electronic unit, an antenna module, and a power supply. In its normal operating mode the transceiver and power supply units are placed in pockets of the operator's vest. The antenna module is comprised of transmitting and receiving antennas covered in a plastic case, a control panel, and a handle. On the control panel there are five buttons each with a LED indictor to confirm certain operation modes and two LED-bar graph indicators for monitoring the returning 2nd and 3rd harmonic signal levels. A headphone is provided to monitor an audible output signal.

3. When the transmitter emits radio-frequency (RF) signals, conducting objects illuminated with the RF signals will have induced electrical currents. Non-linear characteristics of metallic and semi-conductor junctions in the object will then reradiate RF signals at higher harmonics. Semi-conducting components generate return signals dominant in the 2nd harmonic, while corroded metals and metal-to-metal contacts generate return signals dominant in the 3rd harmonic. Therefore, by analyzing the two harmonic return signals and their ratio, operators can determine the nature of the suspected items. By further adjusting the transmitting signal output and receiver's sensitivity, together with the directional antenna parameters, the suspected items can be pinpointed accurately.

Test Scenarios

4. Tests with the 'Eagle' NLJD device in a hand held operational mode were conducted in an open outdoor area within DSTO's High Power Microwave (HPM) Facility.

5. For a diode at the centre of half-wavelength dipole, the following three placements of the target were tested:

a. 1.5m above ground on wooden pedestal;

b. surface laid

c. burial 150mm below ground.

6. For electronic circuits typically found in IED initiators, tests were conducted in the following more realistic scenarios:

a. inside briefcase which was either held in hand or rested on ground

b. inside a metal rubbish bin with lid both on and off

c. inside culvert about 250mm under road

d. 0.6m behind 280mm red brick wall

e. Inside a concrete block

7. Based on the 'Eagle' hand-held unit, DSTO also designed and built an adjustable mounting structure to produce an experimental vehicle-based detection system. The capability was then assessed in a trial conducted in Woomera over the period from 23 to 27 July 2007.

Summary of Results

8. For the diode terminating a λ/2-dipole, the effective detection ranges are tabulated in the following table

Location	**Detection Range (m)**
1.5m above ground	45 (max.)
On ground	6 - 8
Buried 150mm below ground	~ 2

Results with the diode at the centre of half-wavelength dipole

9. For the selected electronic circuits and an anti-tank landmine, the test results are tabulated below:

Objects	**Location**	**Detection Range (m)**
Electronic circuits	Inside briefcase resting on ground	4 - 8
Electronic circuits	Inside briefcase carried in hand	7 - 13
Electronic circuits	Inside a metal rubbish bin with lid off	4 - 11
Electronic circuits	Inside a metal rubbish bin with lid on	4 - 7
Electronic circuits	Inside culvert ~250mm under road	1 - 2
Electronic circuits	0.6m behind 280mm red brick wall	1 – 3
Sensor circuits	Inside a concrete block	6 - 11
Anti-tank mine	Buried 150mm below ground	2 - 4

Results with the electronic and sensor circuits and landmine

10. The results from the experimental vehicle mounted non-linear junction detection system are classified information and therefore not suitable for public release.

Conclusions

11. The Russian ‘Eagle’ Non Linear Junction Detector was evaluated by Weapons Systems Division of DSTO. The results suggest that the system generally delivers its claims against detection of typical electronic circuits used in IED initiators. It is believed that the detector could be very useful in many route clearance and explosive ordnance disposal scenarios.

Dr Kevin Hong
HPM Program Manager
Weapons System Division
DSTO