Journal of Conventional Weapons Destruction

Volume 12
Issue 1 *The Journal of Mine Action*

Article 44

July 2008

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A forerunner in the field of metal detection, Vallon GmbH has recently developed the VMXC1, an unexploded-ordnance detector specifically designed to determine the presence of submunitions. The detector's innovative metal-discrimination option allows for fewer false alarms during UXO clearance. Field results of the new detector are discussed below.

by Jürgen Braunstein, Armin Merz, Markus Sautter and Gerhard Vallon [Vallon GmbH]

In many regions the dominant problem with explosive remnants of war is submunitions or bomblets. They can be detected easily by conventional metal detectors, but only with a high false-alarm rate due to metallic clutter. Consequently, clearance work is tedious, frustrating and time-consuming. To facilitate the work in affected areas, Vallon developed a new UXO detector, the VMXC1, especially for the efficient detection of submunitions (e.g., BLUs). The VMXC1 has a built-in programmable metal-discrimination option, which can be adapted to the local threat scenario.

Introduction

Vallon, based in Eningen, Germany, has been working in the field of metal detection since 1965, originally manufacturing metal detectors using the continuous wave principle, and then metal detectors using the electromagnetic inference principle with advanced pulse technology. In 2003, Vallon introduced the very successful VMH3 and VMH3CS with digital magnetic-pulse induction technology, which is the basis for the new unexploded-ordnance detector, the VMXC1.

The use of cluster munitions created the problem of detecting submunitions efficiently in countries such as Cambodia, the Lao People's Democratic Republic and Lebanon. Standard metal detectors or magnetometers are typically used to search for bomblets. Both classical detection systems respond to all objects of their search category (i.e., the metal detector gives an alarm for all metal objects, and the magnetometer gives an alarm for all ferrous objects). These behaviors lead to a tremendous number of alarms, especially in urban areas, as a lot of metallic clutter is present. These false alarms are not only annoying but also absorb much of the operator's time; hence, clearance progress is slow. To enhance the speed of clearance, Vallon developed the VMXC1, a metal detector with a metal-discrimination option.

Figure 1 shows the block diagram of the electronics included in the VMXC1. The man-machine interface is placed in the handlebar of the detector and can be operated easily with the thumb during normal operation. The VMXC1 is built symmetrically, allowing for operation by left-handed or right-handed users.

The search head of the VMXC1 sends out a bipolar pulse train, which influences eddy currents in metal objects in the vicinity. The return signal from these metal objects is picked up by the search head of the VMXC1. Subsequent digital signal processing allows for the detailed analysis of the signals. As a result, when metal is present, alarms are given as an audible signal, on an LED bar graph or by vibration in the handlebar.

The core of the detector is the digital signal-processing unit that takes care of all processes running while the detector is in use. The major focus for it is to control the analog preprocessing, evaluate the preprocessed information from the search head and control the alarm generation. The operator can influence this processing by using the MMI and the mode selector switch, which selects the working principle of the detector or the access to the setup level.

The high flexibility of the system is achieved by storing parameters determining the behavior of the detector into the built-in flash memory. Different metal targets in different soils have specific signal patterns, which can be used for the metal discrimination. With this feature, user-defined setups are possible. For example, a BLU-26[1] is recognized as a target and this response can be stored and automatically recalled after power-on.

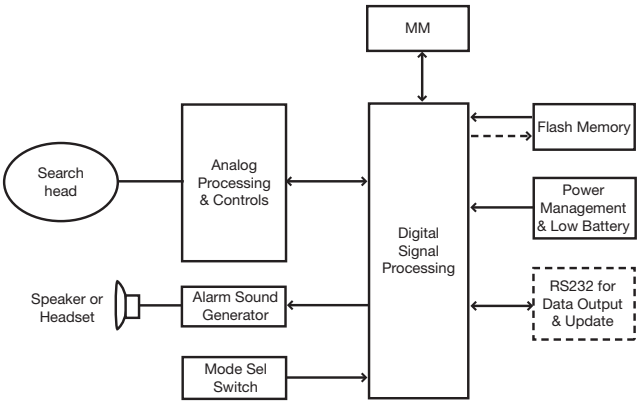

Figure 1: Block diagram of the VMXC1.
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The analog processing is responsible for the electromagnetic pulse generation. It also controls the reception of the returned target signals and preprocesses them in a way that background noise is minimized and the signal-to-noise ratio of the target responses can be optimized. A large signal-to-noise ratio is crucial to achieve great detection depths in normal and in mineralized soils.

The VMXC1 has a built-in data-output feature, which can be used for data recording and documentation of the searched areas that were found to be free of submunitions and mines. Also, the VMXC1 has a built-in connector for firmware uploads. The firmware is the operating system of the detector and can be adapted to the type of ammunition searched in the particular surrounding. The firmware can be uploaded to the detector from a laptop without special training for the operator.

Adapting the VMXC1 to particular submunitions is done by analyzing the returned signals from test objects in a calibration lane with

Left to right: VMXC1-1, VMXC1-3 and VMCX1-6.

the particular soils and objects. As a result of the analysis, the individual parameter sets are derived and integrated into the firmware for the particular task. Generating the individual firmware is typically done at the manufacturer's site, whereas the upload of the code to the detector can be done easily in the field.

The operator can select between two different operation modes, one for the detection of larger metal objects and one that includes additional metal discrimination.

Detection of large metal objects. Like a conventional metal detector, the VMXC1 can be set to trigger alarms when metal is close to the search head. The VMXC1 is designed to neglect alarms from smaller objects because the desired alarms are only reacting to larger metal objects, namely UXO and especially cluster munitions or submunitions. As smaller metal objects (e.g., nails, screws, pieces of wire) mostly do not trigger an alarm in this operation mode, the working efficiency is already increased in comparison to Vallon's standard mine detector with high sensitivity for all kinds of objects of any dimensions.

Detection of large metal objects and metal discrimination. The VMXC1 has a second mode with additional metal discrimination. The digital signal processing

Visual alarm indication on the right side of the bar graph of a ferrous object, a BLU-26.

Visual alarm indication on the left side of the bar graph of an aluminum object, 16mm in diameter and 50 mm long.

allows the detector to analyze the received signals and to identify the metallic nature of the object from which the signal was picked up. In this mode, the VMXC1 distinguishes between the alarms from ferrous objects and nonferrous objects (pictured above). Without an object, no acoustic alarm is given and the LED is in the neutral position in the middle of the LED bar graph. Depending on the object, the detector gives different visual and acoustic alarms. For ferrous objects, a continuous alarm tone is audible and the activated LED is right of center. A pulsed tone (a series of beeps) is audible for nonferrous objects and the activated LED is left of center. The deviation from the center is an indication of the type and shape of the metal target. The customized firmware can be optimized also for ammunition with different kind of metals like the BLU-63; hence, the operator has the option to neglect alarms from, for example, aluminum cans and bottle caps, and concentrate on the alarms from ferrous objects and selected submunitions. As a result of using this mode of operation, the search speed for the submunitions is substantially increased in comparison to working with a standard metal mine detector.

Three versions of the VMXC1 are offered:

1. VMXC1-1 with slim, 31 x 17 cm search head
2. VMXC1-3 with 30cm round search head
3. VMXC1-6 with 60cm round search head

Field Results

The VMXC1 was first trialed successfully in Lao PDR and Lebanon, and it was used later in the field because of its efficient UXO detection ability. In Lao PDR, in the region of Pakse, the VMXC1-3 found BLU-26 munitions reliably and efficiently. In southern Lebanon, the VMXC1-1 searched for the BLU-63. It found the munitions efficiently, neglecting the alarms from metallic clutter.

Summary

The Vallon VMXC1 is based on the well-known metal-mine detectors VMH3 and VMH3CS. Different search heads for the VMXC1 offer a reliable and efficient detection of ordnance, submunitions and metal-cased mines with fewer false alarms from other metallic waste because small objects are neglected. In the metal-discrimination mode, the detector differentiates between ferrous and nonferrous metals; therefore, the operator can focus on the type of alarm that the locally buried ERW will give and consequently, clearance work in areas with metal contamination can be performed with a significantly increased efficiency. With the highly effective automatic ground compensation, the VMXC1 is also recommended if the use of magnetometers is limited by ferrous soils.

See Endnotes, page 114

Jürgen Braunstein has served as Authorized Signatory and Sales Director of Vallon GmbH since 2005. Braunstein is also Deputy Sales Director for Force Ware GmbH, a subsidiary company of Vallon GmbH that offers body protection and tools for explosive-ordnance disposal and demining.

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Gerhard Vallon obtained his Bachelor of Science (*Diplom*) in electrical engineering from FH Esslingen, Germany. Together with his father he founded the Vallon company in 1965, aiming for the development and production of high-performance detectors for mines and UXO. He is currently Owner and President of the company.

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News Brief

U.S. Congress Extends Ban on Transfer of Anti-Personnel Landmines

As part of the Consolidated Appropriations Act of 2008, the United States Congress voted to extend a moratorium on the transfer or exportation of anti-personnel landmines to other countries until 2014. Legal prohibitions on the transfer of landmines date to October 1992, when they were formalized in the Landmine Export Moratorium that was amended in 2001. The moratorium does not apply to the employment of AP mines by U.S. forces.