CHAPTER 1 Introduction

White's *V3i* represents the latest technology in metal detecting. The heart of *V3i* is a high-performance ARM-9 RISC microprocessor which simultaneously analyzes signals from 3 transmitted frequencies. Those frequencies — 2.5kHz, 7.5kHz, and 22.5kHz — were chosen for their diverse responses to a variety of metal targets, resulting in a superior system of target analysis and identification.

The face of *V3i* is a stunning 320x240 color display with an easy-to-use menu-driven interface. Along with three frequencies, there are three search modes and five analysis screens which provide more detailed target information than has ever been available before. With a level of simplicity for the novice user, and a depth of configurability that will satisfy even the most advanced user, *V3i* is a metal detector for everyone.

This manual is organized to provide progressive information, a format that attempts to minimize information overload. If you are a new detectorist, the *Quick Start* chapter will allow you to get a quick jump on using *V3i*. Then, as you run across new features and want to find out more, continue reading the manual to get progressively detailed information.

If you are already familiar with high-end detectors (especially those with a menu interface), you might want to read over the *Quick Start* chapter to get a feel for *V3i*'s features. *V3i*'s graphical interface makes the rest easy.

While *V3i* is easy to use, it does have more features than any other detector before it, and can appear overwhelming. Don't be intimidated! Start with the preset programs and go at your own pace. There is no need to master all the features to get excellent performance.

Finally, if you need help, White's Electronics is a phone call or mouse click away. Your dealer is an excellent resource, and the White's web site has a *V3i* help forum for questions & answers, tips, and sharing programs. Go to www.whiteselectronics.com and click on the Forum link.

Conventions

In discussing the features of *V3i*, we will use **Arial-Bold-Caps** to distinguish keypad buttons and menu selections. For example, "press **ENTER**" means to press the "Enter" key on the keypad, and "select **Enable**" might mean to select the "Enable" menu option, probably by using the arrow keys to highlight it and then pressing **ENTER**. *V3i* keys and menus work just like a modern computer graphical interface, so things are fairly intuitive.

In some cases, you need to use multiple key combinations, or combinations with the trigger switch. "Press **MENU, ENTER**" means to press and release the **MENU** button, then press and release the **ENTER** button. But "press **MENU+ENTER**" means to press and hold the **MENU** button, and while holding it down press the **ENTER** button. Order often matters, so **MENU+ENTER** is not the same as **ENTER+MENU.** If you find that you have accidentally pressed the wrong key or key combo, pulling the trigger switch will usually back you out.

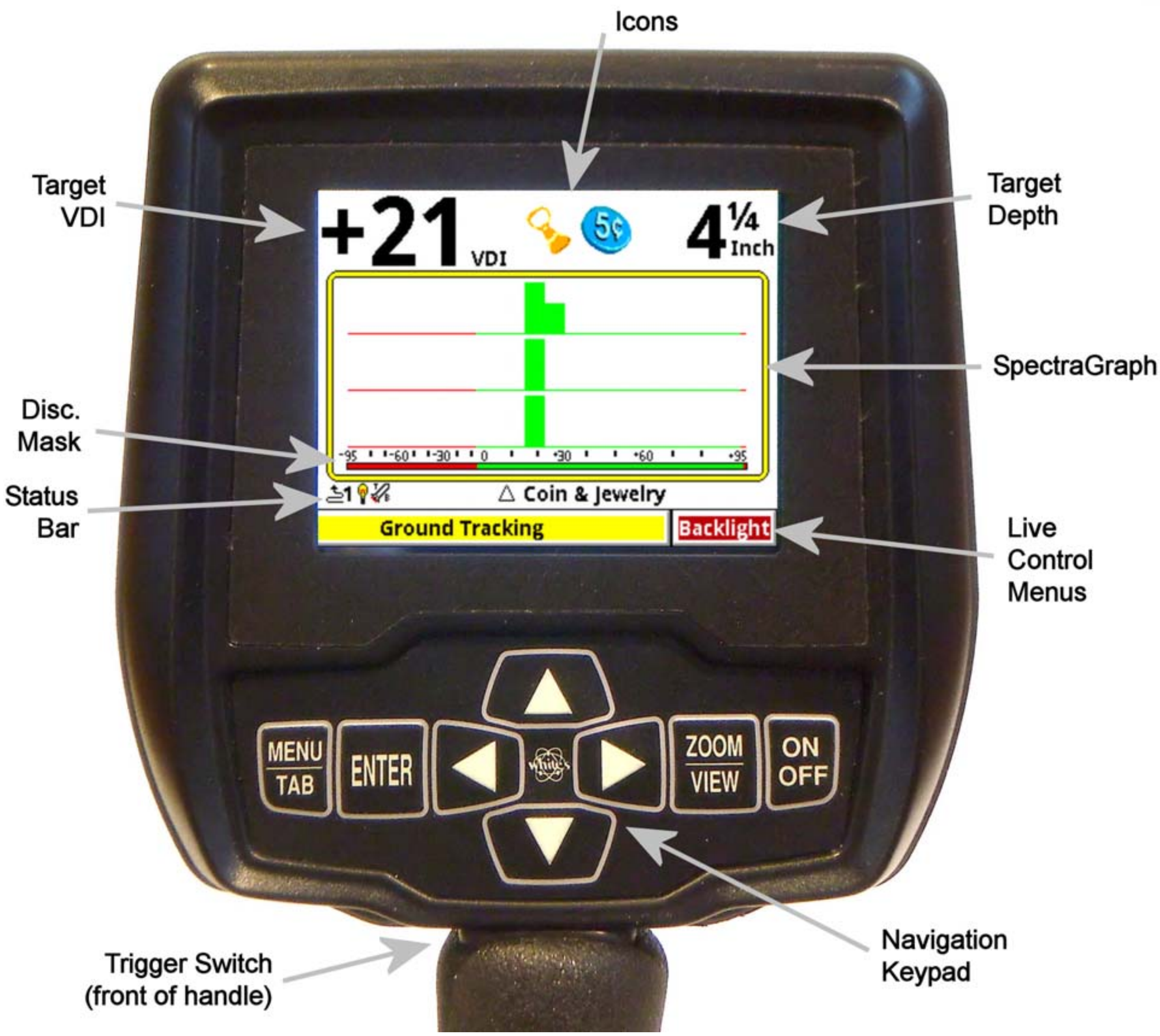
Two of the *V3i* keypad buttons have dual names. **MENU/TAB** is used both as an entry button into the menu system, and to "tab" from one screen area to the next. This tab method is identical to how a PC interface uses it. So in some cases we will tell you to press **MENU**, in other cases press **TAB**. It's the same button. **ZOOM/VIEW** works the same way. *V3i* also has four arrow keys, and these may be either called **UP DOWN LEFT RIGHT** (or **UP DN LT RT**) or represented with the symbols ▲▼◀ ▶. We are free to randomly choose any of these representations.

Most menus are nested, so instead of telling you to select the **Expert Menu**, then select the **Configure** menu, then select **Live Search Screen**, then select **Analysis**, then select **Sizing**, then select **Screen Top**, we may instead say, select **Expert Menu→Configure→Live Search Screen→Analysis→Sizing→Screen Top**. This means to drill down through the stated menu path.

Finally, there is a trigger switch under the pod. It has a normal (center) position, a forward position, and a momentary pulled position. When we say "pull the trigger," we mean to pull it to the momentary position and release it. If we say "Pull/hold the trigger," then pull it back and hold it there. This might be in conjunction with a key press, such as, "Pull/hold the trigger and press **ENTER**," which is the same as "Trigger+**ENTER**."

Layout

The *V3i* interface consists of a keypad and a color screen. Below is a picture of the pod face with the default layout for the search screen.



The search screen has four major regions:

1. Target information
2. SpectraGraph
3. Status Bar
4. Live Control Bar

The target information includes the VDI number, the depth, and icons representing the likely target. SpectraGraph displays signal strength versus VDI and gives a detailed look at the VDI response. The status bar shows a few operational pieces of information, and the Live Control Bar provides quick on-the-fly access to operating modes and adjustment parameters. All of these will be covered in detail in subsequent chapters.

The Basics of VLF Operation

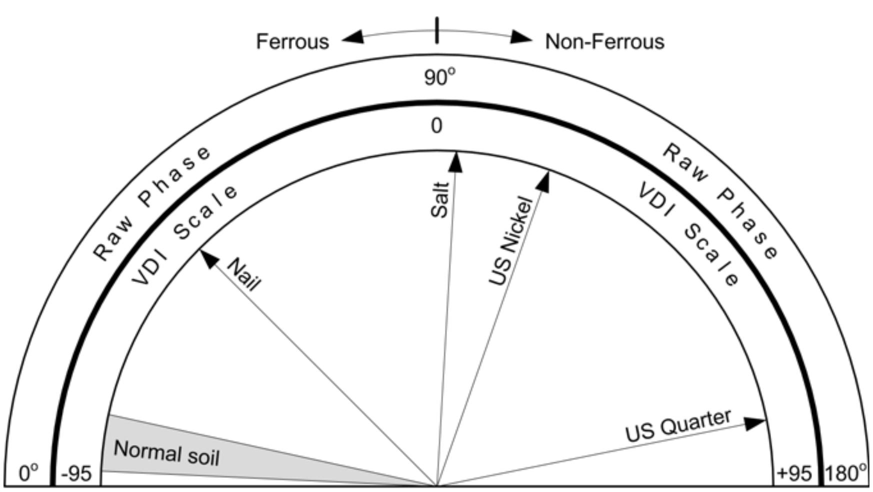
V3i is a multi-frequency (MF) induction-balance (IB) very low frequency (VLF) transmit-receive (TR) metal detector. It has more user-adjustability than any other detector in the world, and in order to understand what all these adjustments do, it is important to have at least a rudimentary understanding of how a modern metal detector works.

Metal detectors work on the principle of induction, discovered by Michael Faraday in 1831. The typical induction-balance metal detector[1] uses a transmit coil to produce a magnetic field, and this magnetic field in turn produces a small reaction in nearby metal targets. A receive coil is used to detect this small reaction. A so-called "induction-balanced" coil arrangement prevents the receive coil from being overwhelmed by the transmit signal, allowing it to see very small target signals.

Phase & VDI

Practically all VLF-IB detectors operate as phase discriminators. The received signal is converted to phase, and the phase is a strong indication of what the target might be. The particular phase of a target can vary with the frequency of the transmitted signal, so different detectors designed to use different frequencies can report completely different phase results. To keep users from having to learn all these different phase response scales, White's has chosen to normalize them all to a standard VDI scale. Therefore, a US nickel detected with a 6kHz detector will have the same VDI as with a 15kHz detector. For historical reasons, the standard VDI scale is based on a 6.592kHz detector. The standard VDI scale is shown below.

1. The first practical metal detector was an induction-balance design, built by Alexander Graham Bell in an effort to locate an assassin's bullet lodged in US President James Garfield. He failed — not enough sensitivity. Ever since then, "more sensitivity" has been the goal of every detector.

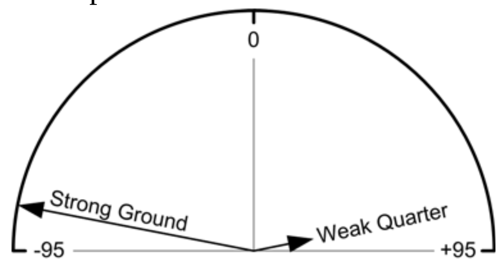


The ability to separate targets by VDI is what allows a detector to discriminate. Targets with a negative VDI are usually ferrous, and targets with a positive VDI are usually non-ferrous. Small gold tends to have low VDI's while thick silver coins have high VDI's. Other targets like cupro-nickel coins, brass and bronze relics, and aluminum trash can have wildly varying VDI's depending on their alloy, size, and thickness. This means you need to apply your own discriminator — your brain — in deciding what the VDI responses are telling you. We'll take a closer look at VDI responses, but first let's look at...

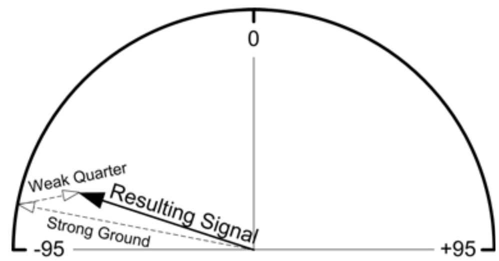
Ground Response

Unfortunately, buried metal is not the only thing the detector sees. Most soil contains ferric oxide minerals, and this mineralization looks like a target[1]. In terms of VDI, practically all ground mineralization falls in the extreme negative range of the scale, even beyond most iron targets. But it can vary somewhat as shown by the gray range in the diagram. At most locations the variation is small, so you can ground balance at a particular spot and be very close for the entire area. Some locations have significant variations and you should occasionally re-ground balance as you hunt, or use automatic ground tracking.

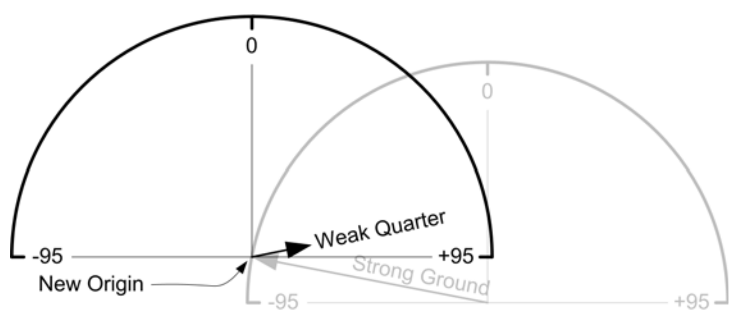
Many locations have enough mineralization to create quite a strong ground signal, often much stronger than that of a moderately deep target. The VDI diagram on the preceding page uses vectors to represent specific target responses, with the angle of the vector representing the VDI value. We can also use the length of the vector to represent the strength of the target response, so that a strong ground and weak quarter response would look like:



The detector will see both signals at the same time, and the combination of the two can be represented with a third vector as follows:



The resulting signal appears to be a fairly strong ferrous target instead of a quarter. This is the downfall of the old TR-discriminator designs. Fortunately, since the VDI response for ground is usually far away from the response of desirable targets, there are ways to deal with it. In a modern VLF motion discriminator, the receiver determines what part of the signal is the ground response and, using special filter techniques, normalizes the whole VDI scale to the current ground signal, resulting in the ground signal being ignored. Graphically, this looks like:



Any error in the ground balance point will result in an error in the target VDI response so it's important to maintain a decent ground balance point.

1. In this manual, we'll refer to the signal resulting from ground mineralization (including salts) as the "ground signal" or the "ground response."

Ground Tracking

In order to better handle variations in ground mineralization, many detectors now incorporate automatic ground tracking (White's uses the trademarked term *AutoTrac*). The detector attempts to determine what part of the signal is due to ground and continuously track the phase and strength of that signal, and eliminate it. One trick is to limit the range of VDI's for normal ground (the grayed area in the VDI scale) and consider anything else a target. This works for most soils, with two caveats.

Besides "normal" ground mineralization, some areas contain rocks or small pockets consisting of material with slightly different mineralization than the surrounding ground. The difference in VDI between these anomalies and the surrounding ground isn't enough to consider them a true target, but they are small enough to act like a target to the detector's ground filters. These so-called "hot rocks" can create annoying responses in many detectors.

Another situation concerns soils with significantly conductive salts. A pure salt response lies all the way in the non-ferrous region of the VDI scale, roughly in the midst of foil. Some salt-water beaches are close to having a pure salt VDI, while other beaches include black sand mineralization that creates a composite VDI that can land anywhere between pure ferrite (VDI=-95) and pure salt. Other areas, like fertilized fields with residual salt ions, can also have a composite ground response. Many deserts have a layer of surface salts that have been leached from the soil; this is generally not a problem as long as it is dry.

Frequency

Metal detectors are produced using a wide range of transmitted frequencies, from 1kHz up to around 100kHz, though the vast majority fall in the VLF range of 3kHz - 30kHz. Low frequencies usually favor thicker targets and metals of higher conductivity, while high frequencies favor thin and low-conductive targets.

Interesting Experiment: Thickness matters because of a phenomenon known as *skin effect*. To demonstrate this, cut several identical flat squares (say, 1"x1") of aluminum foil. Test the VDI response of a single square, and see how the VDI varies as you stack more squares (tightly) together.

Low frequencies also do a better job penetrating ground mineralization, including salt. High frequencies tend to generate stronger ground and salt signals which can limit the ability to distinguish weak targets. Obviously, when trying to detect thin low-conductive targets (like nuggets and jewelry) in harsh ground (like wet salt sand or black sand) there are competing frequency requirements, so a compromise is necessary. With the ability to run 3 simultaneous frequencies or any one of them individually, *V3i* has the ability to deal with a wide variety of conditions.