

4 Operating Modes

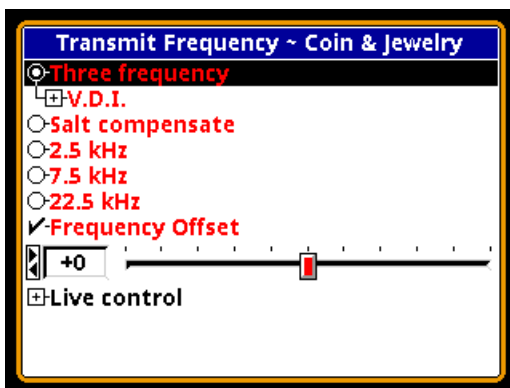
Chapter 3 covered some of the basic settings of *V3i*, such as sensitivity or audio volume. These are adjustment controls which are used to alter the performance or user preferences. There are other settings which fundamentally alter the operation of *V3i*. We will refer to these as *mode* settings. Different mode settings might affect completely different aspects of the detector — such as frequency, tracking, and tone ID — so taken together they offer a tremendous amount of flexibility to the user.

Frequency

The most fundamental of all modes is that of frequency. *V3i* is a 3-frequency metal detector, but it has the ability to run in other optimized frequency modes. The available modes are:

- 3-frequency normal
- 3-frequency salt compensate
- Single frequency 2.5kHz
- Single frequency 7.5kHz
- Single frequency 22.5kHz

The frequency selection screen in *V3i* looks like this:

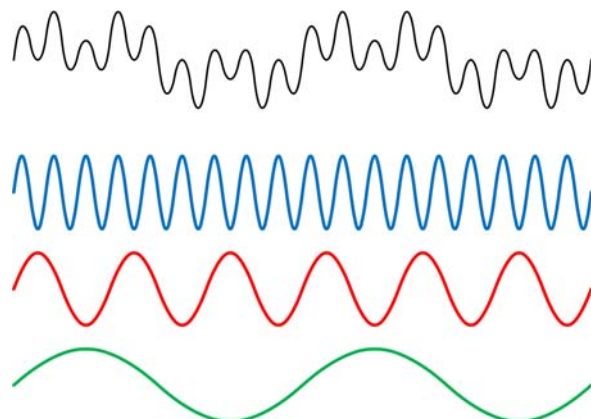


One reason for using multiple frequencies is that some targets respond better to certain frequencies than others. Targets that are thin and made of low-conductive metal — typical of most jewelry — respond better to higher frequencies, which is why many gold nugget detectors are designed to run at much higher frequencies than most other detectors. High conductive targets, especially those that are thick, respond better at lower frequencies. Also, ground mineralization has a weaker response at lower frequencies, resulting in better ground penetration in highly mineralized areas.

The three frequencies — 2.5kHz, 7.5kHz, and 22.5kHz — were chosen because they offer excellent target coverage. Note also that they are harmonically related, by factors of three. This makes waveform processing much easier. Though not particularly important to the discussion, here is what the transmit waveform looks like:



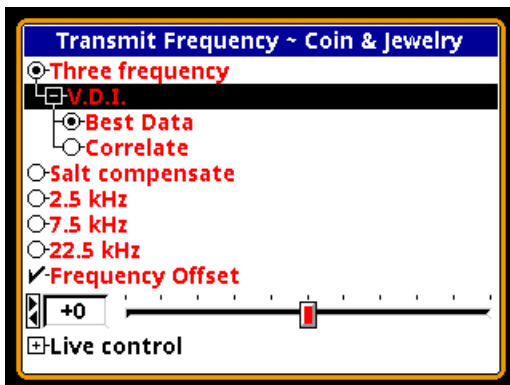
The received composite waveform and its three frequency components look like this:



Three Frequency

The default frequency mode for V3i is standard **Three Frequency**. In this mode, V3i simultaneously transmits 2.5kHz, 7.5kHz, and 22.5kHz. 3-frequency mode gives the best overall response to the broadest range of target conductivities.

In any frequency mode V3i will plot the VDI responses in the SpectraGraph screen and also calculate an overall VDI number for the target. Under the **Three Frequency** selection you will see an additional selection for the VDI calculation method:



Best Data means that the VDI is taken from the strongest responding frequency. **Correlate** means that the results from at least two responding frequencies must agree in order to display the VDI number. Factory programs default to Best Data as this typically offers good VDI accuracy.

Salt Compensate

Salt Compensate mode is the same as **Three Frequency** mode, except that salt responses are subtracted out. This eliminates salt signals while still allowing V3i to track ferrous mineralization. This technique is only possible in multi-frequency detectors, which is a second reason to use multiple frequencies.

Trivia: White's DFX is always in salt compensate mode.

The VDI for salt is around +4 to +5 which is normally the area for bits of foil. However, very small gold nuggets and some jewelry can also fall in this range, which is why V3i has the added option to run a normal 3-frequency with salt subtraction disabled. Some users have reported situations where the salt-compensate mode helps reduce EMI noise.

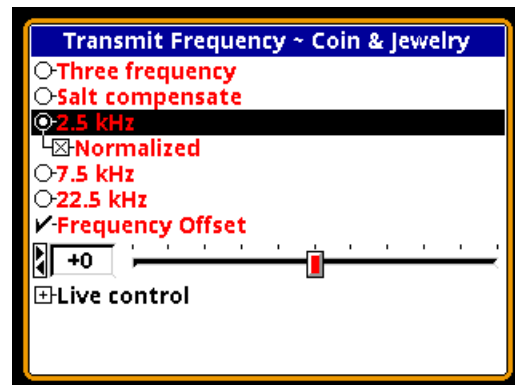
Like normal 3-frequency, salt-compensate includes the option of calculating target VDI from either best data or correlate.

Single Frequency

With any multiple frequency detector, the total transmit power must be divided among the active frequencies. V3i offers the ability to transmit only one of its three frequencies. In single frequency mode, the transmit waveform is optimized to focus power to the selected frequency, resulting in slightly better depth but for a more narrow range of targets.

Trivia: The single frequency modes in White's DFX do not use optimized transmit waveforms.

When a single frequency mode is selected you will also see an option called **Normalized**:



The VDI responses for targets vary with frequency, which means that a particular target will have completely different VDI numbers at each of the three frequencies. For example, a US silver quarter has the following raw VDI responses:

Frequency	VDI
2.5kHz	70
7.5kHz	85
22.5kHz	91

By checking **Normalized**, all VDI's will be normalized (shifted) to a common frequency. That common frequency is, for historical reasons, 6.592kHz, meaning the US silver quarter will have a normalized VDI response of 83.

With **Normalized** unchecked, *V3i* will report the raw VDI numbers for the frequency mode selected. There is at least one situation where this is an advantage. At 22.5kHz the lower part of the non-ferrous VDI range is expanded, resulting in more numerical separation of low-conductive targets. This can help in separating nickels and jewelry from pull tabs. Here is a table showing the difference in normalized versus un-normalized VDI's for a number of targets:

Target	Normalized VDI	Un-normalized VDI
Ladies ring	2	9
Foil 1	4	14
1 gm nugget	6	17
Foil 2	6	23
Nickel	19	57
Square tab 1	21	59
Pull tab 1	22	60
Pull tab 2	25	63
\$2.50 gold	30	66
Pull tab 3	33	68
Men's band	35	69
Square tab 2	42	73
Minie	47	76
Screw cap	65	83

This shows there is a significant expansion of the VDI range up to nickels, while the upper

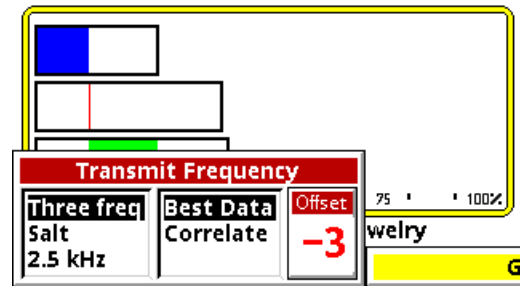
VDI is actually compressed. The opposite occurs at 2.5kHz: the upper VDI range is expanded at the expense of the lower.

Frequency Offset

This is not a mode, but rather an adjustment control. It was discussed in Chapter 3: *The **Frequency Offset** control provides slight offsets (± 5 steps) to the selected frequency(ies) and is useful to minimize EMI, especially when hunting near other detectorists. In general, adjust the offset up or down to find the quietest setting. One source of EMI that is difficult to deal with are electric fences, including invisible dog fences. It is best to try to have them switched off when hunting.*

The frequency offset applies to all active frequencies. If you have a single frequency mode selected, then the offset shifts that frequency. If you are in a 3-frequency mode, the offset proportionally shifts all the frequencies.

When making offset adjustments, put *V3i* in pinpoint mode (by pulling the trigger) and watch the pinpoint bars, like this:



Along with the audio, the pinpoint bars will help you find the quietest offset. In some situations, you may not be able to find a quiet offset for all three frequencies at the same time. Pay attention to the pinpoint bars and see if one of the frequencies tends to run quieter than the others. If so, run in single frequency mode with the proper offset. A stable single frequency mode is usually better than an unstable 3-frequency mode.

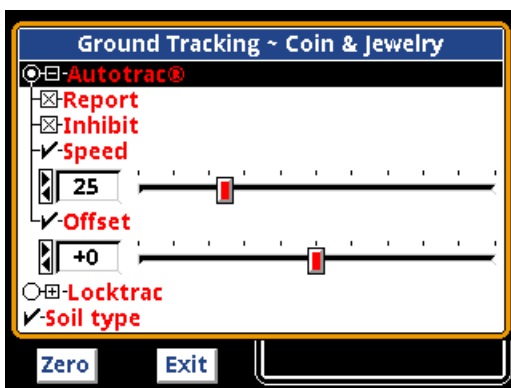
Ground Balance

In Chapter 1 we briefly covered how ground balance works, and how automatic tracking can compensate for varying ground conditions. *V3i* offers both automatic tracking (AutoTrac™) mode and the ability to lock the ground balance when needed (LockTrac).

Whether you are using AutoTrac or LockTrac, it's important to know how to check if *V3i* is properly ground balanced. As you are hunting, test the ground balance occasionally using these steps: lift the loop a foot off the ground, pull the trigger to put *V3i* in pinpoint mode, then lower the loop to the ground, making sure you are not over a target. In most ground, the pinpoint threshold level should remain constant (unless you have implemented a track offset) as the loop is lowered to the ground. In severe mineralization, a lift-off effect can cause an abrupt threshold change in the last inch or so, and this is difficult to balance out.

AutoTrac™

AutoTrac mode automatically tracks the phase of the ground signal. This is the default ground balance mode for most programs and is the recommended mode except in certain conditions. There are several parameters which control automatic tracking:



The **Report** selection determines whether the tracking status is displayed to the screen.

When enabled, you will see

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<<< Tracking <<<
>>> Tracking >>>
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occasionally pop up on the status bar whenever *V3i* is changing its ground balance point. At start-up, it may say **Fast Track** instead. If you don't care to see this information, simply uncheck the option.

Ground tracking is adjusted whenever *V3i* sees a change in the overall RX signal phase. Targets can cause a phase change as well, but far more radically. The **Inhibit** option tells *V3i* to inhibit tracking when it goes over a fast ground anomaly.

The tracking **Speed** selection adjusts the rate at which ground tracking is allowed to change. A faster speed (higher number) is useful for ground that varies a lot over short distances, but can also be more subject to errors, especially in high-trash areas. Generally, use the lowest setting your ground allows.

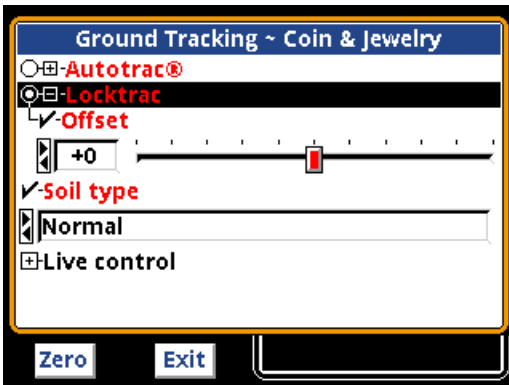
How do you determine a proper track speed? Occasionally check the ground balance using the test several paragraphs back. If you find that the balance is often off, then increase the track speed. However, if *V3i* seems to be noisy as the loop is swept over the ground and you're sure it's not due to targets, then the track speed may be too high.

Some users prefer to use a slight amount of offset in their ground balance. If the **Offset** control is set to the positive side, then a properly ground-balanced detector will still give a positive response to mineralization. If the **Offset** control is set to the negative side, then a properly ground-balanced detector will have a "null" audio response to mineralization. The latter is usually undesirable because it can mask faint target responses. Conversely, giving the ground balance a little bit of positive offset can prevent masking. The default setting is 0.

LockTrac

There are some uncommon situations where AutoTrac does not work well. In extreme ground that has a lot of variability, or when a lot of trash targets are present, automatic tracking may result in excessive noise and tracking errors. High levels of electromagnetic interference can also cause problems with automatic tracking. In these situations locking the ground balance at one value may provide better performance. Keep in mind that when tracking is locked, V3i will only be properly ground balanced for one type of ground. As the ground varies, there will be errors in the balance point, so there may be some compromise in depth. But LockTrac may allow hunting an area where AutoTrac does not.

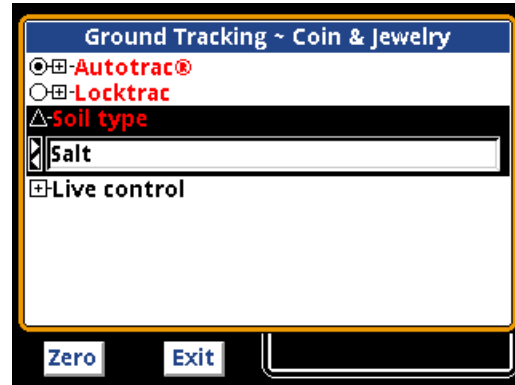
The selection screen looks like this:



The only parametric setting is for **Offset**, which is identical to the **Offset** control in AutoTrac. In LockTrac, using a slightly positive offset can help compensate for variations in mineralizations and keep the balance point from going negative.

Soil Type

V3i includes a 3-frequency mode called **Salt Compensate**, which literally subtracts the signal response from salt. This technique won't work in single frequency mode, so a different method is included to allow the use of single frequencies in wet salt sand. V3i includes a **Soil Type** selection for choosing a **Normal** or **Salt** tracking range:



As explained in Chapter 1, ground tracking is normally restricted to a region of VDI's where mineralization is found. However, we can open up this range to include salt, so that V3i will ground balance in any combination of salt and mineralization. This technique does not work as well as true salt subtraction, but does allow the practical use of single frequencies in salt environments.

In some areas such as mineralized beaches, there can be extreme variations in the composite ground VDI in very short distance, such as swinging over black sand streaks, or across the transition to wet salt sand. It may be necessary to increase the tracking speed to deal with this.

One of the advantages of using the salt soil setting is in extremely noisy environments. There are cases where, in 3-frequency mode, a quiet frequency offset cannot be found, but a quiet single frequency setting can be found¹. Another case is when using a single frequency mode in highly alkaline soil such as fields that have been fertilized for years, or some prospecting areas. In general, if you are having problems with either EMI or ground noise, try using the **Salt** setting, possibly with a single frequency mode.

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1. There have been a few reports from users that simply switching to 'salt soil' in 3-frequency improved noise rejection. This is likely due to the fact that salt mode notches out a small portion of VDI responses.

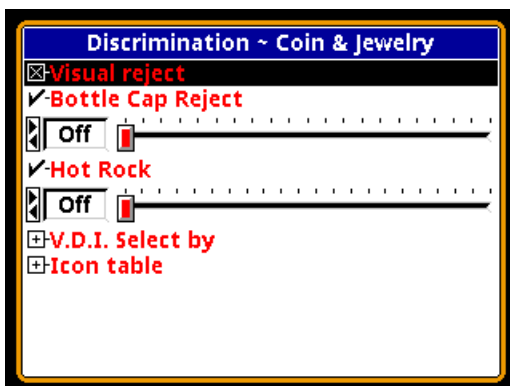
Audio

V3i has the most extensive audio system ever offered in a detector, including four audio modes and complete user-customization. Because of the extent of the audio system and the number of options, it will be presented in its own chapter.

Discrimination

A primary mode of practically all detectors since the 1970's has been discrimination. V3i is no different. Discrimination, of course, allows us to accept or ignore certain targets based on their phase (or VDI) response. In analog detectors, this is accomplished with a knob that sets the threshold point of discrimination; everything below the threshold is rejected, and everything above is accepted.

Modern digital detectors take discrimination to a higher level, allowing the user to accept and reject narrow VDI regions. While V3i has a discrimination resolution down to the single VDI number, there are several ways to set up the discrimination. The basic Discrimination menu is:



Visual Reject

Visual Reject is a preference setting for displaying rejected VDI numbers. If it is unchecked, then the VDI numbers for targets which are discriminated out will still be dis-

played. If you don't want to see the VDI numbers of rejected targets, then check this option. This option does not alter the audio response or the SpectraGraph response for rejected targets; they are controlled separately.

Bottle Cap Reject

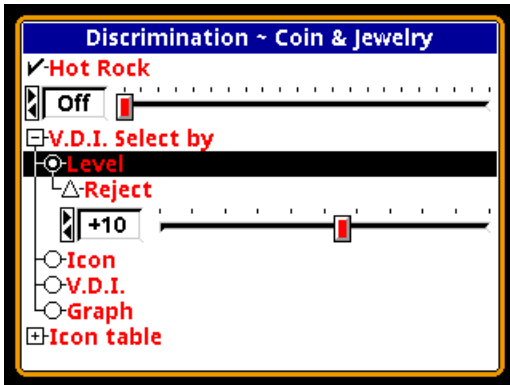
The next control is **Bottle Cap Reject** (BCR). Bottle caps are difficult targets because, as the search coil is swept over them, they look both ferrous and non-ferrous. This can fool the discriminator into deciding on non-ferrous and reporting a good target, and can be further exacerbated by DD coils. BCR controls how aggressively V3i attempts to break up the audio on bottle caps, making them produce a distinct "chatter." A higher BCR setting breaks up the audio more. BCR can be fooled by an iron target buried adjacent to a good target, and a higher setting can also make faint targets falter as well. Set this as low as you can stand.

Hot Rock Reject

Hot rocks are mineralized rocks that usually fall in the normal mineralization tracking range, but being rocks they have a very quick rise-and-fall signal response. Technically, hot rocks have a VDI higher than the current ground balance point, while rocks with a lower VDI are often called "cold rocks." We won't bother to distinguish. With **Hot Rock Reject** (HRR) turned on, when V3i identifies a target as a hot rock it automatically assigns it a VDI of +95. With HRR turned **Off** no VDI reassignment is done.

Normally, +95 is rejected so that a hot rock has no audio response. However, if +95 is accepted then the HRR number controls how the audio is altered. More positive numbers increase the audio response, negative numbers decrease it. Setting HRR=0 means the audio is not altered.

VDI Select By



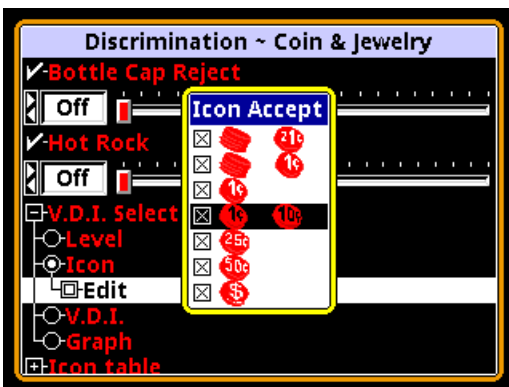
The next item in the menu, **VDI Select By**, is where the discrimination is set. There are four ways to set up the discrimination:

Level

This control works just like the traditional discrimination knob on an analog detector. Everything below (and including) the setting is rejected, everything above the selection is accepted.

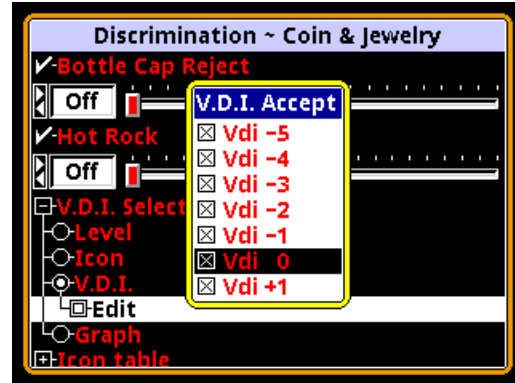
Icon

Discrimination can also be set to accept or reject predefined icon ranges. Icons can be user-defined to certain VDI ranges, such as a US nickel to +18 to +23 (see Chapter XX). Then, using **VDI Selected By Icon**, that icon range can be wholly accepted or rejected. When this method is selected, an **Edit** box becomes available, and each icon range is listed with a check box. A checked range is accepted, an un-checked range is rejected. The **Edit** box looks like this:



VDI

The most detailed method of setting the discrimination mask is by individual VDI numbers. When this option is selected, the following Edit box is available:

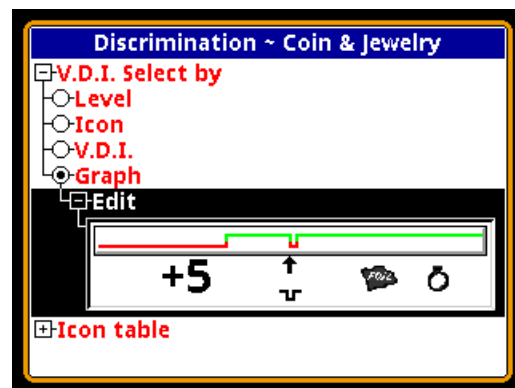


Each VDI number is listed with a check box; a checked VDI is accepted, an un-checked VDI is rejected.

Tip: There are 191 VDI numbers, and setting each one individually can take a long time. There is a short-cut: when you press the **ENTER** button to check or un-check a VDI, continue holding down the **ENTER** button, then press the **▲** or **▼** button to rapidly set a range of VDI's to the same setting.

Graph

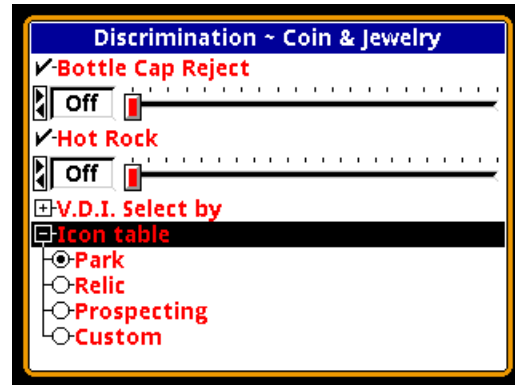
The final method of setting up a discrimination mask is by using the **Graph**. When selected, the following Edit box becomes available:



The displayed number shows the VDI number you are editing. Also shown are the icons that are set for that VDI. Use the ◀ and ▶ buttons to move left and right through the VDI range, and the ▲ and ▼ buttons to accept and reject (respectively) the selected VDI.

Tip: As with the prior VDI edit method, there is a short-cut: when you press the ▲ or ▼ button to check or un-check a VDI, continue holding the button, then press the ◀ or ▶ button to rapidly set a range of VDI's to the same setting.

The final entry in the **Discrimination** menu is the **Icon table**. It is as follows:



There are three pre-defined icon tables for **Park**, **Relic**, and **Prospecting**. These are shown in tables below. There is also a **Custom** selection for setting up your own icons. This is covered in detail in Chapter XX.

Preset Icon Tables

Park		Relic		Prospecting	
-97 to -57		-97 to -57		-97 to -57	
-56 to -27		-56 to -27		-56 to -27	
-26 to -1		-26 to -1		-26 to -21	
+0 to +12		0 to +17		-20 to -1	
+13 to +16		+18 to +23		0 to +16	
+17 to +24		+24 to +37		+17 to +24	
+25 to +50		+38 to +40		+25 to +50	
+51 to +54		+41 to +44		+51 to +57	
+55 to +57		+45 to +55		+58 to +75	
+58 to +68		+56 to +60		+76 to +80	
+69 to +75		+61 to +70		+81 to +86	
+76 to +80		+71 to +75		+87 to +90	
+81 to +86		+76 to +78		+91 to +94	
+87 to +90		+79 to +82		+95	NONE
+91 to +94		+83 to +86			
+95	NONE	+87 to +90			
		+91 to +93			