B

Analog Signal Input

B.1 Analog Connections

Refer to the diagram (page B-10) showing the VAN analog boards for connection of analog inputs. Be sure you follow the indicated positive and negative polarity indications, except in the case of TS705 temperature sensor inputs, for which positive and negative polarity does not matter. Two signal wires are required for each input. The terminal blocks can be unplugged for convenience. Because of the space constraints, it is best to use small gauge wire like telephone wire. If bulkier wire is needed outside the dialer, it is best to install a terminal strip outside the dialer to make the transition from the bulkier wire to the more compact wiring going into the analog input connection points.

Note:
Take care to route the incoming signal wires to one side of the enclosure or the other so that they do not interfere with the front panel circuit board when the unit’s door is closed. Also, try to route the analog signal wires away from power wiring to minimize noise pickup.

B.1.1 Programming for Analog Channels

Each analog input will need to be programmed to specify:

1. The analog Input Signal Type (if other than standard 4-20 ma input).
2. The numerical value to be spoken at a corresponding minimum signal level.
3. The numerical value to be spoken at a corresponding maximum signal level. Items 2 and 3 amount to programming the translating scaling factors for each analog input.
4. In many cases you will also want to program high and low setpoint limits for each analog input.
5. You may also elect to replace the generic default voice message with your own recorded messages for any analog channel, as described in section 4.
B.1.2 **Assignment of Input Channel Numbers**

The unit automatically assigns the lowest channel numbers to whatever number of contact input channels exist on the unit (whether or not you are using them) and the analog channels are assigned channel numbers beginning with the next available number.

For example, the first analog input on a unit with 24 contact inputs and 16 analog inputs would be “channel 25” and the last analog input would be “channel 40”. Note that since the unit’s maximum LED display capacity is a total of 32 channels, on such a unit the final 8 analog channels would not have corresponding LED status indicators on the front panel. Further, note that on units with remote channels, the LED display may group inputs into a single indicator.

It is important that you have correctly determined the channel number assigned for each analog input channel before performing the following programming steps.

B.1.3 **Programming the Input Signal Type**

(You may skip this step if you are using 4-20 ma inputs).

The analog inputs are very flexible and can accommodate a variety of Input Signal Types, but the unit needs to know which type each input is being used for a given analog input. Note that in addition to programming the Input Signal Type, the physical component configurations on the VAN plug-in circuit card must match the Signal Type used. Normally this will have been handled in the process of ordering the unit and will not require additional user attention. If there is any doubt about this, refer to the markings on the rear of the VAN circuit board. If there is still any question, refer to the markings you find and also your unit’s serial number, when contacting the factory.

- To program the Input Signal Type for input channel ZZ:
  
  5 ZZ 7 N ENTER

  where ZZ is the two-digit channel number, and N is a single digit as follows:

  0  for a 4-to-20 milliamp current loop input. This is the default setting, so if your inputs are 4-20 milliamp current loops, you may skip this step.

  1  for 0 to 1 volt DC signal input. In the case of larger signal levels, such as 0 to 10 volts DC, the hardware input circuitry on the VAN card will have been factory configured to pre-scale the signal to a range within 0 to 1 volt DC, and corresponding special scaling information will be provided to fit the particular application.
2 for a Raco Temperature Sensor input (sensor model TS705A),
used to measure temperatures from -20 to +120 degrees F.
3 for additional types of special custom-specified signals.

## Summary of Codes for Input Signal Type

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>4-20 ma current loop</td>
</tr>
<tr>
<td>1</td>
<td>0-1 volt DC</td>
</tr>
<tr>
<td>2</td>
<td>Raco temperature sensor</td>
</tr>
<tr>
<td>3</td>
<td>Other special inputs</td>
</tr>
</tbody>
</table>

### B.1.4 Programming the Scaling and Offset Factors

This set of steps is not necessary for inputs using a Raco Temperature Sensor,
since these values will be automatically inserted if the parameter 2 is selected in
the above step.

In the above step, accepting the default parameter of 0 for 4-20 milliamp inputs
automatically provides for a spoken reading of 0.0 percent for the minimum (4
ma) signal input value, and 100.0 percent for the maximum (20 ma) signal, until
you enter different factors.

In most cases, you will want to program the unit to give spoken reports in terms
of the actual physical variables being monitored, such as water level in feet, etc.
In general, you will need to determine the desired spoken numerical values
corresponding to two widely separated (low end and high end) signal input
values. Often this will be available from the overall system specifications. In
other cases, this will be determined (or revised) based on actual on-the-spot
observations. The Verbatim Autodialer offers the unique option of entering this
scaling information based either on your particular system specifications (the
System Specification method) or else on your real world observations (the Real
World Method). Also, scaling information which you may have originally
entered based on your system specifications may later be easily “fine tuned”
based on real world observation.

In addition, you may wish to record your own identifying message to replace
the default message, as described in the message recording section of the
manual.
### Additional Perspective on Scaling Factors

#### Analog Math

It may be useful, in comprehending the process of establishing the scaling factors, to visualize a graph which relates the water level in a tank to the input from a 4-20 ma transducer. To establish the relationship on such a graph, it is necessary to define two separate points, or coordinate pairs ideally at two widely separated points on the graph. For such a linear relationship any point on the “reading” (Y) may be calculated from the formula:

\[ y = mx + b \]

where m is the gain and b is the zero crossing point or Input (ma -> offset. The gain may be calculated from: \( m = (y_2 - y_1) / (x_2 - x_1) \)

where \( x_1, y_1 \) is one coordinate pair on the graph and \( x_2, y_2 \) is the other. Therefore, when you have chosen to enter non-default coordinates you are in fact setting the gain factor. This gain factor is taken along with the input signal type you have chosen which will define both the gain and offset.

Notice that each of the two points requires two separate coordinate pieces of information to define: the signal level and the corresponding water level. With two such points defined, an entire line or linear equation is defined, so that given any new signal level, we could use the graph to “look up” the corresponding water level. In operation, the Verbatim autodialer measures the signal level presented to it, and then calculates the corresponding physical value, all based on the line or linear equation defined by your entry of the high end and low end scaling information whether done by the System Specification Method or the Real World Method.
Be sure that the correct Input Signal Type setting is entered as described above, because changing the Signal Type setting will overwrite the programming described next.

**System Specification Method of Programming Scaling Factors**

*The following four codes must be entered to invoke scaling:*

- For the low-end portion of the data for channel ZZ, enter the following pair of codes:
  
  ```
  5 ZZ 1 X.XXXX ENTER
  ```

  where X.XXXX is the low input signal value chosen, within the bounds of input signal type.

- Then to complete the scaling factors for this channel, enter the following pair of codes for the high-end portion of the data:
  
  ```
  5 ZZ 3 X.XXXX ENTER
  ```

  or

  ```
  5 ZZ 3 POINT ENTER
  ```

  for the high-end signal value

  ```
  5 ZZ 4 YYYY.YYYY
  ```

  for the high-end corresponding spoken value

**Note:**

For all analog value entries you may enter up to four digits before an optional decimal point, and up to four digits after, but simple entries (such as -20, 3.45, 500, 4, etc.) work as well.

**Alternative Real World Method of Programming Scaling Factors**

If the system specifications for the scaling factors are not known, or if you wish to adjust a previous entry to reflect real-world as opposed to system specification conditions, wait until the input signal or the physical variable happens to be near the low end of the scale. Enter the following pair of codes:

```  
5 ZZ 1 POINT ENTER
```
which will automatically accept the present moment signal value as the low input signal value, rather than having to enter the value shown as X.XXXX above. Then, enter:

```
5 ZZ 2 YYYY.YYYY ENTER
```

where YYYY.YYYY is the corresponding low-end physical value which you observe in real-world terms.

At another time, when the signal or physical variable is toward the high end of the scale, enter the following pair of codes:

```
5 ZZ 3 POINT ENTER
```

which accepts the present signal level as corresponding to the high-end physical value which you enter as:

```
5 ZZ 4 YYYY.YYYY ENTER
```

**Example:**

It may already be known from your system’s specification that for channel 6, a low-end signal of 4 milliamps corresponds to a desired spoken value of 34.5 feet of tank water level. In such a case, you would use the System Specifications Method to enter:

- for 4 milliamps
  ```
  5 06 1 4 ENTER
  ```
- for a spoken reading of 20.5
  ```
  5 06 2 20.5 ENTER
  ```
- for 20 milliamps
  ```
  5 06 3 20 ENTER
  ```
- for a spoken reading of 34.6
  ```
  5 06 4 34.6 ENTER
  ```

Then, suppose with the system in operation, you observe that the tank level is 31.7 feet, but the Verbatim reports a value of 31.45 feet. The discrepancy will most likely be due to a discrepancy of the sensor’s actual output versus the theoretical system specification. Regardless, to correct for it, keeping in mind that the signal is presently near the high end of the scale, you would use the Real-World Method, entering:

- To reference the present signal level
  ```
  5 06 3 POINT ENTER
  ```
- To recalibrate 31.7 as the corresponding spoken value
  ```
  5 06 4 31.7 ENTER
  ```
Continue the example, there might also be a discrepancy toward the low end of the scale. Suppose on another day you observe a tank level of 22.5 feet but the Verbatim report 2293 feet. Since this signal is at the low end of the range, you would enter:

\[
5 \ 06 \ 1 \ \text{POINT} \ \text{ENTER}
\]

and

\[
5 \ 06 \ 2 \ 22.5 \ \text{ENTER}
\]

**Note:**

These Real-World Method adjustments did not require you to measure any actual signal levels!

From that time on, assuming that the sensor maintains its calibration and has a linear output, the spoken value should track the actual value very closely. The Verbatim itself is much more accurate and consistent than almost any sensor available to connect to it. Note that the signal does not need to be exactly at the end of its range (e.g. 4 ma or 20 ma) for these programming steps. However, in general the wider the spread between the signal levels used, the better informed the Verbatim will be to reflect the actual relationship between the sensor’s output and the real value being measured.

**Note:**

While the unit reports with very high accuracy and resolution, you do not need to enter your programming value to the same high degree of accuracy unless you choose to.

**For TS705 Temperature Sensor Inputs**

Selecting signal type “2” (TS705 sensor) will automatically load scaling factors as describe earlier. However, these automatically loaded scaling factors are not adjustable. If you want to be able to do Real World calibration adjustments for temperature sensor inputs, then instead of selecting sensor type “2”, select sensor type “1” (0-1 VDC input) and enter scaling factors as follows:

\[
5 \ ZZ \ 7 \ 1 \ \text{ENTER} \quad \text{(Selects signal type 1)}
\]

\[
5 \ ZZ \ 1 \ .843 \ \text{ENTER}
\]

\[
5 \ ZZ \ 2 \ -19.8 \ \text{ENTER}
\]

\[
5 \ ZZ \ 3 \ .316 \ \text{ENTER}
\]

\[
5 \ ZZ \ 4 \ 120.1 \ \text{ENTER}
\]
This gives the same scaling factors as would otherwise automatically result from selecting signal type 2, but it allows for subsequent adjustments using the Real-World adjustment method.

**B.1.6 Programming High and Low Analog Setpoints**

You should first enter the gain, offset and scaling factor programming described above before entering setpoints. Later, if you adjust the factors as described above, you may also need to adjust the setpoints correspondingly. Changing setpoint values after scaling is set could cause changes in the scaling values.

- To program a low limit setpoint for channel ZZ, use code:
  5 ZZ 5 X.XX ENTER

*Note:*  
X.XX is the desired setpoint in terms of spoken units, rather than in terms of the signal value. You do not need to enter all four possible leading and trailing digits. Simple entries like 7 and 3.68 work as well.

- To program a high limit setpoint for channel ZZ, use code:
  5 ZZ 6 X.XX ENTER

Thereafter, whenever the measured value exceeds the setpoint for a continuous period exceeding the alarm trip delay, the unit will go into unacknowledged alarm and begin dialing to report the specific violation, also reporting the current measured value. As with contact inputs, if the input is no longer in violation at the moment of the report, the phrase “Now Normal” will be appended to that channel's report.

- To check an existing setpoint value, use the above codes but omit the value (X.XX).
- To turn off (completely disable) an unused analog channel so that it will not be included in status report, enter code:
  5 ZZ 0 ENTER
  where ZZ is the 2-digit channel number.
- To turn the channel on again, you must enter some high or low setpoint value for that channel.
- To turn off (disable) a high or low analog setpoint, while still leaving the channel able to report readings, enter a setpoint value of -0 for that particular setpoint. If you try to enter a setpoint value outside a wide signal range, the Verbatim will say “Error in number.”
**Note**

The scanning time required by the unit to check all analog readings against established setpoints increases with the number analog channels. With 16 channels, the time can total on the order of one second, and this imposes a limit on how fast the unit can detect analog setpoint violations. Normally, this will not be noticed unless you set Alarm Trip Delays of less than two seconds, and there is no effect on the trip delay for contact channels in any case.

Refer to the following section for recording the corresponding voice messages other than the spoken numerical values.

### B.1.7 Summary of Analog Programming Codes

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Signal Type:</strong></td>
<td></td>
</tr>
<tr>
<td>5 ZZ 7 N</td>
<td>Select input signal type. 0 is default for 4-20 ma</td>
</tr>
<tr>
<td><strong>Scaling:</strong></td>
<td></td>
</tr>
<tr>
<td>5 ZZ 1 X.XX or POINT</td>
<td>Low end signal value</td>
</tr>
<tr>
<td>5 ZZ 2 YYYYY.YYYY</td>
<td>Corresponding low end spoken value</td>
</tr>
<tr>
<td>5 ZZ 3 X.XX or POINT</td>
<td>High end signal value</td>
</tr>
<tr>
<td>5 ZZ 4 YYYYY.YYYY</td>
<td>Corresponding high end spoken value</td>
</tr>
<tr>
<td><strong>Setpoints:</strong></td>
<td></td>
</tr>
<tr>
<td>5 ZZ 5 X.XX</td>
<td>Low alarm limit setpoint</td>
</tr>
<tr>
<td>5 ZZ 6 X.XX</td>
<td>High alarm limit setpoint</td>
</tr>
<tr>
<td>5 ZZ 5(6) -0</td>
<td>Disable low (high) setpoint</td>
</tr>
<tr>
<td><strong>Disable Channel:</strong></td>
<td></td>
</tr>
<tr>
<td>5 ZZ 0</td>
<td>Turn off (disable) channel ZZ</td>
</tr>
</tbody>
</table>

### B.1.8 Recording Speech Messages for Analog Channels

This information supplements the basic information in the manual on recording speech messages. Refer to that information before attempting to record any speech messages.

**For analog input channels**, the default message is “The present channel N reading is ...”

**For any analog inputs**, in place of the default messages you may plan to record a preamble message of the general form “The total water flow in gallons is” or “the main tank water level in feet is.”

Use program code 1 ZZ to record the analog preamble message.
Analog Signal Input

*Units equipped for 16 analog channels will require 2 Van Cards. The second (upper) card will be for the higher numbered analog channels. The second Van Card if any will have its JB50 jumper strap in the upper position.

Outlet of Van or VCP Cards

Left Card Guide with Bottom Notch

Orientation of Standoff Fastener

Connector J1

Main Circuit Board
B.1.9 **If Analog Inputs Do Not Work Correctly**

Recheck programming settings, especially the Input Signal Type setting. Verify that the polarity of your input connections is correct.

In the case of 4-20 ma input, does the spoken value always reflect a 0 ma signal level? If so, the problem is presumably with the connection or the signal source. Use a DC meter to verify that both sides of the offending input are within 10 VDC of ground. A 4-20 ma current loop input should give a meter reading of about .07 volt per milliamp of current as measured across the two signal input terminals.

Are other instruments included in the same current loop? If they read correctly, temporarily disconnect the input to the Verbatim Autodialer. This should throw the readings of the instruments off scale. If there is no such effect, your wiring is not including the Verbatim autodialer in the loop. Verify that the type of signal source agrees with the physical configuration on the VAN card according to the marking on the back of the card.

B.1.10 **Troubleshooting Analog Grounding Problems for Verbatim Analog**

The most common analog signal type in use in the Verbatim marketplace is current loops, wherein the signal is a controlled DC current ranging from 4 to 20 milliamperes.

The loop consists of a current transmitter (consisting of a transducer and a supporting power supply which may or may not be packaged into one unit), and one or more receiving devices which measure and respond to the current signal they detect on the loop. The power supply voltage is typically 24 volts DC.

The terms "transducer" and "transmitter" are used interchangeably. The transmitter's job is to ensure that the current level accurately reflects the physical parameter which the transducer is measuring (typically a pressure or liquid level), regardless of what impedance it sees in the loop.

In order to do this, it presents whatever voltage across its terminals is needed to achieve the correct current flow. This voltage must be great enough to accommodate the total resistance in the loop. The typical resistance contribution presented by each receiving device is 250 ohms. However, the DC resistance presented by the Verbatim analog inputs is around 70 ohms (49.9 ohm precision resistor plus two 10 ohm surge standoff resistors).

In theory, all elements in the loop are isolated from any connection to electrical ground. This is intended to eliminate concerns about errors in the signal caused by conflicting ground or other conflicting connections.
In practice it is not unusual to have some element of the loop in fact tied to ground or to some other voltage source away from ground -- or if not directly tied, at least limited in its ability to depart from the ground or other voltage. As long as only one element in the loop is so committed, there is no problem since the other elements can freely accommodate as needed.

The Verbatim has its own limitations in this respect. It can only accommodate a departure from ground voltage potential, of 8 volts nominal, before its protective tranzorbs begin to conduct and clamp the signal. Such clamping when in direct conflict with some other voltage commitment in the loop, will not only cause incorrect readings by the Verbatim, but also cause the other elements in the loop to read and respond incorrectly.

This ability to accommodate departures of both sides (positive and negative) or the analog signal input, is called the common mode input voltage range. A truly isolated input would have as much common mode input voltage range as the voltage limitation of the isolation, typically over 1,000 volts.

The reason we do not provide isolated inputs is because it is bulky, and expensive to achieve accurate translation across the isolation barrier. Also, these days there has been a large shift to transformer and capacitive coupling schemes to achieve DC isolation, but these provide almost zero protection against the fast rise time transients induced by lightning. So, we need to be able to troubleshoot when a customer places one of our analog inputs into a current loop where there is another conflicting voltage commitment.

When this problem occurs, the customer will typically report that his loop works but is thrown off when our analog input is placed in the loop. Sometimes the disturbance takes the form of not just altering the DC current but causing parasitic oscillations in the loop. It may not be easily discernible whether the disturbance is or is not taking the form of a parasitic oscillation. Regardless, temporarily ungrounding the dialer or unplugging the analog card, will usually eliminate the disturbance.

The procedure for troubleshooting and correction of this problem is generally as follows: First we need to find out as much as we can about any preexisting, conflicting voltage commitments. To do this, have the customer unplug the card or unground the dialer so that the loop is not disturbed, and then use a voltmeter to check both the AC and the DC voltage readings at each node around the loop, with respect to electrical ground.

We hope there is not much AC signal present. If there is a strong enough AC component on top of the DC voltages, there will be disturbance to the extent that the peak level in the AC waveform exceeds the common mode input limitation of our analog input. In such a case the cause of the AC component of the signal needs to be found and eliminated, if the following procedure does not lead to a good result.
However, it is possible and even likely, that an observed AC signal is merely a "softly" induced hum that holds no sway when it meets any clamping introduced by our analog input. With this in mind, it may be best to defer even taking AC reading until after the DC oriented methods have proven unsuccessful.

With the main focus being the DC voltage readings, we are looking at some point on the loop that is much less than eight volts DC away from ground, and that is where the Verbatim input should be relocated in the loop. Chances are good that the Verbatim had previously been placed at a point on the loop well away from ground potential and that the relocation will end the problem.

An added step that may be useful in addition to the two sets of voltage readings (AC and DC), especially if the voltage readings seem to be erratic, is to have the customer use a jumper wire to temporarily connect some candidate point in the loop to electrical ground, and observe whether the loop is disturbed by this temporary grounding. If it is not, that is a good place to locate our input in the loop. In fact, this approach can be used without taking voltage readings at all. But if it does not work, then we do want the voltage readings in order to best understand what is going on.

Occasionally, something in the loop will cause there to be no available point in the loop that is close to ground potential. In such cases, if this cannot be changed, then the customer will need to install an optical isolator between the loop and our inputs. The customer may be referred to: Action Instruments, San Diego, CA, (619) 279-5726. Isolators cost $300 per loop.