VTL User Guide – Technical Reference

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1. OVERVIEW

1.1. Scope

The purpose of this document is to provide technical information for the VTL Product. Adherence to the processes specified in this document, in addition to other Reign Monitoring Solutions (REIGN) supporting documentation is intended to provide detailed information as to the operation of the VTL Product.

This is a living document and may change from time to time. Please refer to the Document Revision Log below for the latest information regarding the VTL product.

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1.2. Revision Control & History

Rev	Who	Date	Description of Change
1.0	Delynn Montrose	October 28, 2024	Initial Release

1.3. Definitions

VTL	Visual Tank Level
LED	Light Emitting Diode

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2. VTL Device Overview

1.1. The Visual Tank Level (referred to simply as VTL) is a device used to represent the level or other vital conditions inside a tank or the associated equipment. It consists of:
1.2. Controller board. This accepts sensor signals and converts them into data to drive an addressable LED.
1.3. It is powered from 12 to 24V (matching the LED supply power).
1.4. It can accept two 0 to 5-volt or 4-20mA signals or a Modbus data connection.
1.5. It contains a processor board with integrated 2.4 GHz Wi-Fi and Bluetooth radio.
1.6. Addressable LED segments. Each segment is 5 ft tall. The LEDs are encapsulated in a special polymer compound that is UV resistant and designed not to yellow with exposure to the elements.
1.7. There are two styles of segments
1.8. Base segment. This segment starts 18 inches from the bottom.
1.9. This ensures the segment can rest on the ground, and the LED segments will be above any possible contamination in the confinement area or rising water.
1.10. Each base segment consists of 14 pixels, and each pixel contains 7 LEDs.
1.11. Expansion segments.

The Reign RMC LLC VTL is protected by Patent USD1000987S1 and others pending patents.

Caution: DO NOT remove the tape covering on the power supply, possible shock point.

Note: Please follow all site safety guidelines before installing the equipment at your location.

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3. Technical Specifications

1.12. LED Display
- 1.12.1. 60” x 2.5” x 1.32” industrial black anodized, IP67 corrosion-free segments
- 1.12.2. 147 high-power LEDs/21 pixels per segment (98/14 in base segment)
- 1.12.3. UV-resistant extreme temperature polymer coating
- 1.12.4. Resolution 2.86” per pixel
- 1.12.5. Operating temperature -40°C to 75°C -40°F to 165°F
- 1.12.6. Over 80,000 hours of operating life

1.13. Sensor Connections
- 1.13.1. Two 4-20mA, 0.5-3V, 0-3V or 0-5V analog sensors
- 1.13.2. Modbus RTU. Can be configured as Modbus Master for Slave nodes or passive “listen-in”to capture existing SCADA sensor readings

1.14. Maximum Tank Height
- 1.14.1. 50 ft with standard VTL segments
- 1.14.2. Can be expanded to any height using a power injection

1.15. Wireless Connectivity
- 1.15.1. 2.4 GHz Wi-Fi 4 and Bluetooth 5(LE) support
- 1.15.2. 802.11b (1 MBps) 20 dBm, 802.11n (72.2 Mbps) 18 dBm transmit power, -100 dBm receiver sensitivity

1.16. Power
- 1.16.1. 24 Volts DC
- 1.16.2. A continuous level display uses 0.5 Amps per VTL section. Recommend 2.5 amps capacity power supply
- 1.16.3. Dynamic level bar display requires 0.6 Amps total. Recommend 1 Amp supply

1.17. Configuration
- 1.17.1. Analog sensor input types and voltages set using DIP switch S1
- 1.17.2. Choose between two preset configurations using DIP switch S2-1
- 1.17.3. Set number of VTL tank segments or custom length using DIP switch S2-2,3,4
- 1.17.4. Configuration library provides management of preset configurations
- 1.17.5. Connection using 2.4 GHz Wi-Fi
- 1.17.6. USB C connector

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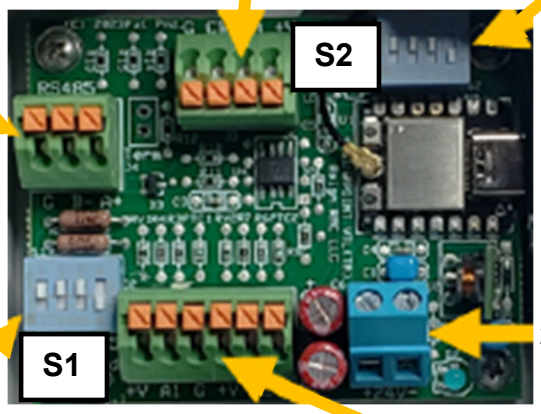
4. VTL Hardware Connections

Modbus RTU Connection
G B- A+

Connection for VTL LED and External Output
G n/a Data +24V



24V DC @ 2.5Amps
+24V 0V

Switch S2 Configuration & Light Stick Settings

1	Light Sticks Settings	2	3	4
ON:Config1	Base Only 5 ft	OFF	OFF	OFF
OFF:Config0	Base+1 Seg 10 ft	OFF	OFF	ON
	Base+2 Seg 10 ft	OFF	ON	OFF
	Base+3 Seg 10 ft	OFF	ON	ON
	Base+4 Seg 10 ft	ON	OFF	OFF
	Base+5 Seg 10 ft	ON	OFF	ON
	Custom # Pixels	ON	ON	OFF
	Test Mode	ON	ON	ON

Switch S1 Sensor Type Settings

Input 1 Pin 1	Input 2 Pin 2	V+ 24V Out Pin 3	V+ 5V Out Pin 4
ON 4-20mA	ON 4-20mA	ON 4-20mA	ON 0-5V
OFF 0-5V	OFF 0-5V	OFF No V+	OFF No V+

Connections for 2 Analog Sensors And Supply Voltage (+24V or +5V)
+V A1 G +V A2 G

4-20mA VTL Factory Settings

SHOWN FOR 4-20Ma SENSORS NON-MONITORED

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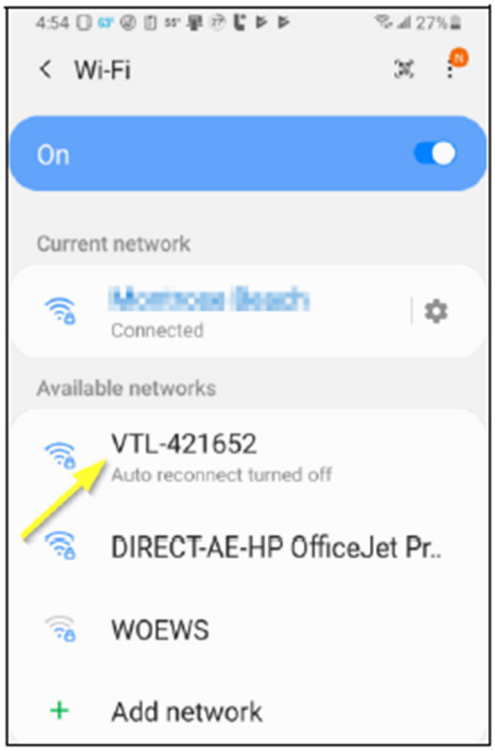
5. Connecting to the VTL using Wi-Fi (Version 1.4 or later)

The VTL includes a 2.4 GHz Wi-Fi radio that allows you to connect to the device and enter commands to manage the device settings. It broadcasts its' Access Point (AP) SSID as "VTL-nnnnnn" which corresponds to the VTL name on the side of the Control box. The default password is "VTL12345". The user can change both the SSID and Password. You can connect wirelessly to the VTL using either a **Telnet** program or using your device's **browser**. The browser connection is currently used to monitor a real-time display of the device, but configuration capabilities will be added, while the Telnet connection allow full control over the VTL.

1. Open your wireless settings and look for the access point name corresponding to your VTL. e.g. VTL-12345



2. Click or tap on the VTL's Wi-Fi SSID name to connect to the VTL's Wi-Fi connection. The default password is VTL12345. This will not have an Internet connection, so if your device connection manager warns you about not having an Internet connection, instruct it to connect anyway.

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6. Connecting to the VTL using Telnet

To connect to the VTL, you need a Telnet program. Telnet is a very common line-oriented computer interface program, and there are many free or low-cost Telnet programs available for all computer and mobile devices. Some programs we have tested are:

- All Platforms
  - Putty is the most common Telnet program available. To is freely available for Windows, Linux, MacOS and has been ported to many other systems. The main repository is at https://www.chiark.greenend.org.uk/~sgtatham/putty/latest.html
  - Mocha Telnet. This is a paid program ($6 to $30) and is available for many platforms. https://mochasoft.dk/buy.htm
  - Terminus. https://termius.com/ is a multi-platform solution, but subscriptions start at $10/user/month
- Windows
  - Built into Windows. Window versions include a free Telnet client. To enable it:
    - Open the Control Panel.
    - Go to “Programs” and select “Turn Windows features on or off.”
    - Check the box next to “Telnet Client” and click “OK.”
    - Open Windows command windows (Windows Key+R, cmd.exe) and then enter **telnet 192.168.4.1 23**
  - SmarTTY https://sysprogs.com/SmarTTY/
  - TeraTerm https://hp.vector.co.jp/authors/VA002416/teraterm.html
- MacOS
  - ZOC Terminal. This requires a license after 30 days. https://www.emtec.com/download.html
  - Telnet Lite. The free version limits you to 5 minutes for a connection, but that’s often enough to configure the VTL https://apps.apple.com/us/app/telnet-lite/id998101119?mt=12
- Android
  - Mocha Telnet Lite is free on Android. https://play.google.com/store/apps/details?id=dk.mochasoft.telnetlite&hl=en_US&gl=US
  - Terminus https://play.google.com/store/apps/details?id=com.partumsoftware.terminus&hl=en_US&gl=US
  - Juice SSH https://play.google.com/store/apps/details?id=com.sonelli.juicessh&hl=en_US&gl=US
- iOS
  - Termius https://apps.apple.com/us/app/termius-terminal-ssh-client/id549039908
  - Telnet Lite https://apps.apple.com/us/app/telnet-lite/id286893976
  - iTerminal https://apps.apple.com/us/app/iterminal-ssh-telnet-client/id581455211

To connect to the VTL:

- Start your connection using your Telnet application. The VTL’s IP address is **192.168.4.1**. Enter that IP address for the host or connection name.
- Select **Telnet** as the type of connection. If you see a place to enter a port number, enter **23**. Telnet connections are normally done over port **23**.

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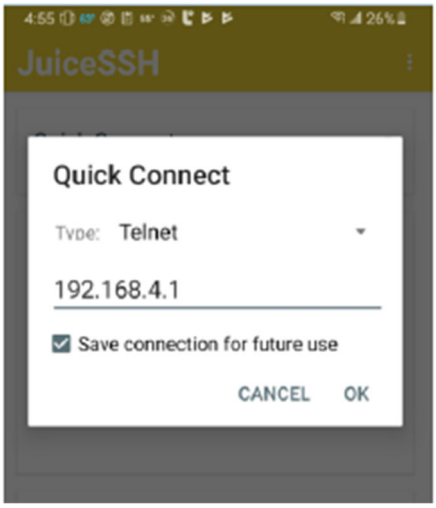

- Enable “echo input” so you see what you are typing. Or set the **Option** for echo input.
- You should see confirmation of a successful connection. The display may look like the ones below. If you do not see anything, press the Enter key, and you should see a **VTL >** prompt. Enter **s** followed by the Enter key to see the VTL’s status

```
--- Miniterm on COM3  9600,8,N,1 ---
--- Quit: Ctrl+] | Menu: Ctrl+T | Help: Ctrl+T followed by Ctrl+H ---
ViewPointVTL™ ©2023 Reign RMC LLC©. Patent Pending. All Rights Reserved
VTL-421652 terminal started

Enter HELP or ? for a list of commands
VTL >
s

VTL-421652 Ver 1.407 Built:Dec 20 2023 17:11:43 settings:
Using config#0 H1 35ft tank, 15 psi 4-20ma, Cyan, Low 6%, High 92%, Flashing 3 & 97% DB:VTL
Tank level reads -2In (-99.8In -23.8%) Level is -103.8In TankSensorOffset=4.0In
        Tank Height 35Ft 0In (420In) SG=1.00 Sensor 103.4kPa/15.0PSI Max height 34Ft 7In (415In)
        Sensor reads 0.00mA (Input level 0mV Calc Factor=25.949584 Offset=-103.798334)
Top level band at 92% 18.7mA Pixel 39 and Bottom level band at 6% 5.0mA Pixel 3, Increment is 2.38%/Pixel
Top flashing level band at 97% 19.5mA Pixel 41 Bottom flashing level band at 3% 4.5mA Pixel 2
Options Set: 1.Display the Scale markers 2.VTL Display ON 4.Flash Top 97.0% 5.Flash Bottom 3.0% 6.DIP sets Tank Height
        7.Flash All LEDS at Top 97.0% 8.Flash All LEDS at Bottom 3.0%
LED Colors are set to GRB with 42 Pixels in a strip starting at 0 with Non-standard segments 42 Pixels total (Base=14 Segments=21 Pixels)
LED Level color is Cyan
Analog UserDef sensor, levels 0%=4.00mA 100%=20.00mA SensorOffset=0.000mA
Analog calibration correction Factor=1.013171 Offset=-7.092199
Analog readings averaged over 16 readings with filtering set to 0.3. Update Rate: 1000ms
DIP Switch S2 set to 0x6. User-defined LED, 42 pixels from 0. S2-1 Set to 0
VTL >
```

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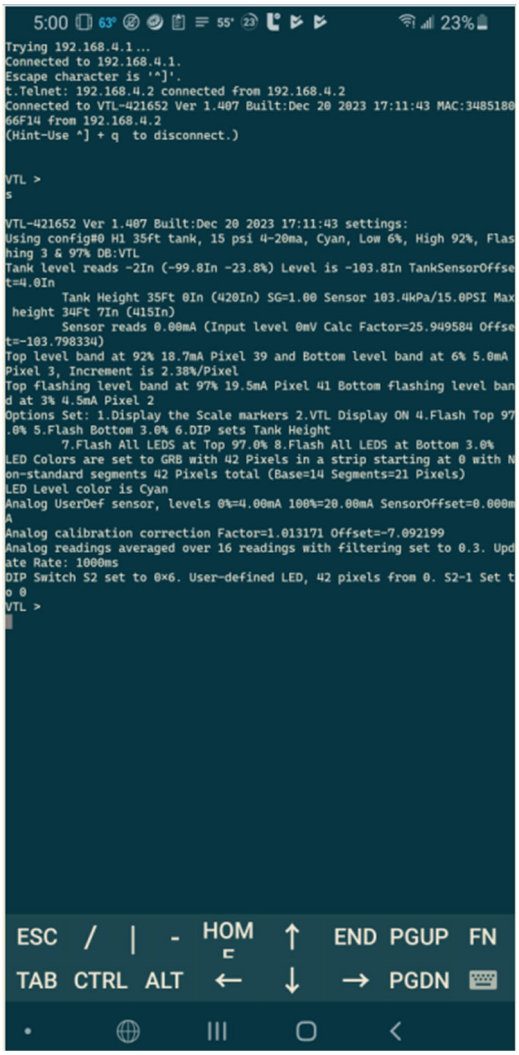

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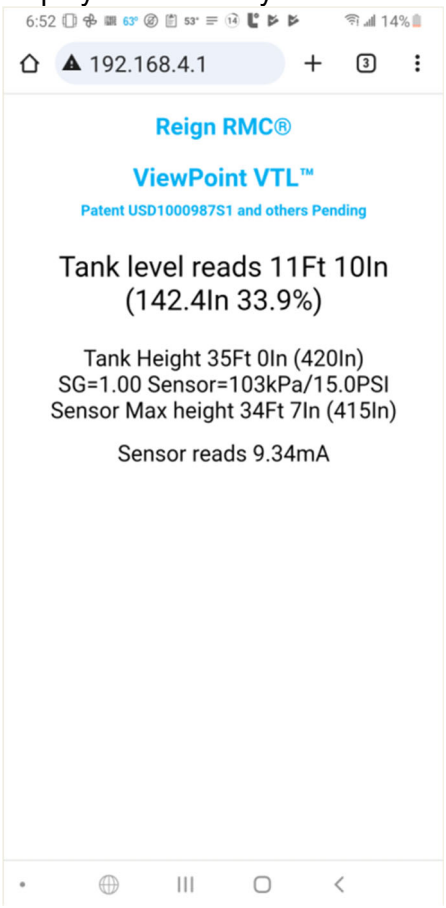
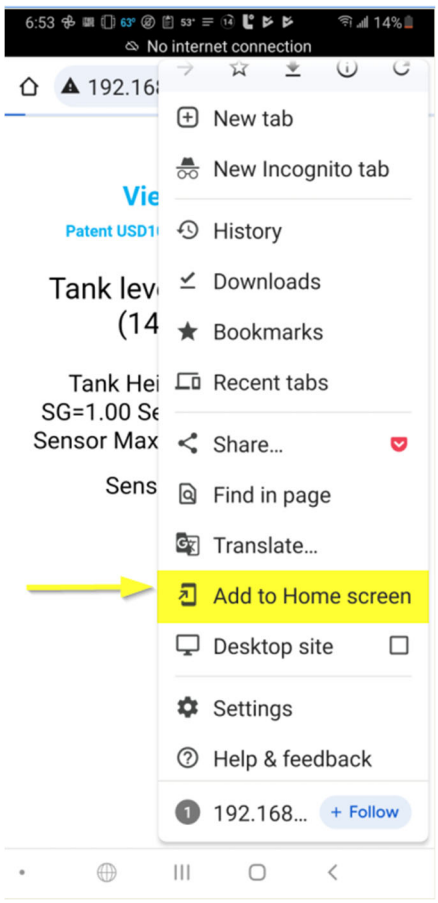
7. Connecting to the VTL from a web Browser

Once you are connected to the VTL over a Wi-Fi connection, you can open your device's browser to **192.168.4.1**, and it will display the current reading and status from the VTL. This display automatically refreshes every 5 seconds with the latest reading.





It is recommended to store a shortcut on your desktop or home screen to allow quick bringing up the VTL. Most browsers have a Tools or Sharing command to save the shortcut.

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8. Connecting to the VTL using USB-C

You can plug a USB-C cable into the side processor of the VTL to connect using a serial terminal emulator. Many of the Telnet programs listed earlier also support a serial terminal connection and can be used, along with other programs like MiniTerm (which requires Python to be installed), HyperTerm, YAT, RealTerm, and others. This may require removing the VTL board from the enclosure to gain access to the side of the USB-C connection.

Once the VTL's USB-C cable has been connected between the VTL and your computer, your computer's operating system should automatically assign a communications port (e.g. **COM4**, **/dev/tty.usbserual-A6004byf**, **/dev/cu.SLAB_USBtoUART**). Use your serial terminal program to connect to the serial port and you can then enter commands. You can connect using any baud rate.

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9. Basic VTL Setup and Configuration

This section covers the basic VTL commands most used.

VTL Configuration Commands

Below is a list of the VTL configuration commands also available when the **?** or **h** is entered at the VTL prompt. The following commands assumes you enter the letter plus any options followed by the enter key. The commands are case sensitive.

- a - analog input levels for 0%,100% V or mA. You can enter 4-20mA or 0-5V.
  Example: a 4,20 mA
- A - Enter calibration values for Analog input.
  Example: A mv1,300 mv2,1000
- B Set the number of LED pixels in a Base and other segments. bb,ss where bb=base pixels and ss=segment pixels.
  Example: B 14,21
- c Set a configuration to use 0 to 9 available. Default is 0.
  Example: c 2
- C Brings up the Configuration management menu. When in the configuration menu system, the prompt changes from **VTL >** to **Config(#0) >**. The (#0) refers to the current configuration database 0 to 9 you are actively editing. This can be changed using the **a**ctive configuration command.
- ***Example C***

```
VTL >
C
Please select Configuration Management option to perform:
a Set Active configuration number use (0 to 9) for Editing. Does n
ot Load the configuration
c List the current configuration information
l List the available Configurations in the library
L Load a library configuration into the editing configuration
n Set Configuration's name
S Save the current settings into the editing configuration file
R Make the Editing configuration active and Reset the VTL
O Set S2-1 ON Configuration
F Set S2-1 OFF Configuration
Q Exit back to VTL Main
? Display Configuration Management menu
Config(#0) >
```

- d Toggles debug On and Off. Adding a second character toggles the various debugs statements. v debugs VTL, m debugs Modbus and w debugs Wi-Fi.
  Example: dv would begin listing the VTL debug statements
- D Toggle Debug On and Off and saves the setting. V debugs VTL, M debugs Modbus, W debugs Wi-Fi.
  Example: DW would begin listing the WiFi debug statements and saves settings.

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- f Set the top and bottom flashing critical levels for the display (normally 99 and 1%). Enter f by itself and it will display the current settings.
  Example: f 90,10
- F Set the Analog Filter value for smoothing the readings (0.1 to 1.0)
  Example: F 0.2
- J Select the LED color system or display mode. Enter J to get the current setting.
  - Available Display Modes are:
    - 1 RGB color order
    - 2 RBG color order
    - 3 GRB color order
    - 4 GBR color order
    - 5 BRG color order
    - 6 BGR color order

  Example: J 3
- l Set the top high and bottom low levels for color display (default is 90 and 10%). Enter the top and bottom levels as L 85, 15 or L 0.85 0.15
  Example: l 80, 20
- L Set the LED Level color or display the current setting. Enter L Color to set.
  - Valid Colors:
    - Amber
    - Black
    - Blue
    - Cyan
    - Gray
    - Green
    - Dark Green
    - Orange
    - Purple
    - Red
    - White
  - Values to set include:
    - 1 Sensor 1 Level
    - 2 Sensor 2 Level
    - 3 Scale Marker
    - 4 Error Color

  Example: L 1 Orange
- m modbus configuration and test program
  Example: m
- M Modbus terminal Testing program mode talking to the RS485 port. Enter data to send and receive from RS485 port. Enter ~ to end.
  Example: M
- N Set the Number of samples in an Analog reading (defaults to 16)
  Example: N 18

o Set option flags. Display the options and you select which ones to enable or disable.
Example: o T ON ← would set Timed VTL display to ON

- When you enter o it displays what the current option is set to.
  - Enter the Option Number followed by ON or 1 to turn On, or OFF or 0 to turn OFF:
    - 1 Display the Scale markers. Set to ON

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- The scale markers are the white LED pixels that are displayed at the 0%, 25%, 50%, 75%, and 100% levels. If the top of the reading is on the scale pixel, the pixel turns the normal display color (e.g. cyan) and not white, until the reading isn't on the exact pixel. This turns the scale markers off.

- 2 Enable Sensor Input 2. Set to OFF
- 3 Only to display the level mark, not the continuous level. Set to OFF
  - The VTL normally displays a continuous level indicator to show the level inside the tank. Turning this option on will replace the level with only 3 pixels being displayed for the level, and the level is the center pixel. For large VTL displays, enabling level mark display can dramatically reduce the amount of power used and allow the VTL to be powered from solar or other limited power sources.
- 4 Flash at the Top 95.0%. Set to ON
  - When the tank level reaches the high-level point (set using the **f** command), the LEDs will start flashing RED. If it's set off, the LEDs turn RED.
- 5 Flash at the Bottom 5.0%. Set to ON
  - When the tank level reaches the low-level point (set using the **f** command), the LEDs will start flashing AMBER. If it's set off, then the LEDs just turn AMBER.
- 6 Use DIP switch segments set Tank Height. Set to ON
  - When this is set ON, DIP switch S1 sets the number of pixels in the LED according to the number of segments attached to the VTL base (see Number of Pixels in LEDs). If this is turned OFF, then you must use the P command to set the number of LED Pixels attached to the VTL. This could be turned off if switch S1 is used for another purpose.
- 7 Flash All the LEDs at the Top 95.0%. Set to OFF
  - When the tank level reaches the high-level point (set using the **f** command), ALL the LEDs in the bottom ¾ will start flashing RED, and the LEDs at the top ¼ will be on solid RED. If it's set off, the LEDs at or above the high-level will flash.
- 8 Flash All the LEDs at the Bottom 5.0%. Set to OFF
  - When the tank level reaches the low-level point (set using the **f** command), ALL the LEDs in the top ¾ will start flashing AMBER, and the LEDs at the bottom ¼ will be on solid AMBER. If it's set off, the LEDs at or below the low-level will flash.
- 9 Flash the Bottom LEDs to Red instead of Amber. Set to OFF
  - This modified the low-level settings so the LEDs flash RED instead of AMBER. If Option 7 and 8 are ON, you know it's a low-level event because the lower ¼ LEDs will be on solid RED and the ones above it flashes. If it's a high-level event, the top ¼ LEDs are on solid and the bottom ¾ LEDs will be flashing.
- E Echo input characters. Set to OFF
  - This is used to echo the input characters typed to the output. This is useful if your Telnet or serial terminal program does not provide character echo.
- H Display the level on the HMI. Set to OFF

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    - T Enabled Timed VTL display ON/OFF. Set to OFF
    - V Turn the VTL display ON or OFF. Set to ON
        - This allows turning off the VTL display. You need to enable it using this command.
    - W Turn the VTL display ON while connected to WiFi Access Point. Set to OFF
- O Set reading Offset in either Volts or mA. Corrects for the Actual value read from the sensor
  Example: O 0.3000
- P Set the number of Pixels in the LED lights, (Base=14 Segments=21 Pixels) and starting Pixel=0 or enter the number of standard Segments above the Base (10 or less).
  Example: P 14 ← Pixels to 14 just a Base segment(Base=14 Segments=21 Pixels), starting Pixels is 0
  Example: P 4 ← Setting number of Pixels to 98 using 4 Segments(Base=14 Segments=21 Pixels), starting Pixels is 0
- Q Color test mode. Enter Q R G B value like Q 200 192 34 to set every other LED to this. Q by itself to end. Optionally Q R G B Brightness Flashing
  Example: Q 200 192 34 ← Displaying color Red=200 Green=192 Blue=34 Level=255 Flash=0 (n=3)
  Example: Q 200 192 35 255 30 ← Displaying color Red=200 Green=192 Blue=35 Level=255 Flash=30 (n=5)
- r reset all settings to default. Prompts to if you are sure you want to do this. No take backs!
  Example: r
- R Reboot the VTL
  Example: R

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- s Display current settings and values
  Example: s

```
VTL-408384 Ver 1.501 Built:Aug 21 2024 09:57:08 settings:
Using config#0 VTL Default Configuration DB:VTL
Display level -24.7% Input is 0.1mA (13mV)
Top level band at 90% 18.4mA Pixel 89 and Bottom level band at 10% 5.6mA Pixe
l 10, Increment is 1.02%/Pixel
Top flashing level band at 95% 19.2mA Pixel 94 Bottom flashing level band at
5% 4.8mA Pixel 5
Options Set: 1.Display the Scale markers 4.Flash Top 95.0% 5.Flash Bottom 5.0
% 6.DIP sets Tank Height V.VTL Display ON
LED Colors are set to GRB with 98 Pixels in a strip starting at 0 with 98 Pix
els in 4 segments (Base=14 Segments=21 Pixels)
LED Level1 color is Green, Scale Marker is White, LevelMarkerWidth is 1, Erro
r Color is White
Analog UserDef sensor, levels 0%=4.00mA 100%=20.00mA SensorOffset=0.000mA
Analog calibration correction Factor=1.006036 Offset=13.078471
Analog readings averaged over 16 readings with filtering set to 0.3. Update R
ate: 1000ms
DIP Switch S2 set to 0x6. User-defined LED, 98 pixels from 0. S2-1 Set to 0
Access Point is Enabled, SSID is VTL-408384 password is VTL12345 #Connections
=0
HotSpot connection is Disabled
DNS name is vtl.local Unique mDNS is Disabled
```

- S Display current Status of the Processor and memory
  Example: S

```
VTL-408384 Ver 1.501 Built:Aug 21 2024 09:57:08 status:
Processor ESP32-C3 Rev:4 MAC=348518063B40
Flash size=4194304 Program size=1313216 max=1966080 used=66.8%
Heap size=296804(0,0) used=119984 40.4% free=176820(-92864,0) maxFreeBlock=11
4676(-16384) frag=35% minFreeBlock=174456
```

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- t tank setup mode. Walks you through entering data for the Tank we are monitoring. Enter q to quit anytime.

    - Tank Height. Enter the number of feet, or as ft ‘ in “, or F ft I in. For example, an 18 ft, 6-inch tank can be entered as 18.5, 18 ft 6 in, or 18’ 6”. If you just hit enter, it keeps the current value.
    - Sensor Offset: If the sensor is above the bottom of the tank, enter the height in inches. This allows the display to show the correct level when the liquid is at the sensor. Note that levels below the sensor will not be displayed since the sensor does not have an input.
    - Specific Gravity: The specific gravity of the liquid is entered. This is a very important parameter since it directly affects the accuracy of the reading.
    - Pressure Sensor: Enter the sensor’s full-scale pressure reading. This can be entered as NN kPa, NN PSI, or NN bar. If no unit is entered, it defaults to kPa for the number.
    - Sensor Electrical: Enter the sensor’s electrical connection as either 0-5Volt, 0-5-3.0Volt, 4-20mA.
    - Review: It will then review the settings, and you need to enter Y for Yes to use the settings. Anything else will discard any changes you have entered.
    - At any point, you can enter **q** to quit entering data.

Example: t

```
Starting to setup Tank parameters. Just press Enter to keep the current value. Press Q to quit without sa
ving.
If there is not a Tank, enter 0 for the Height and Tank calculations will be disabled.
What is the Tank Height? Current Tank Height is n/a ( 0 inches)
Enter the height followed by Ft or In, or ' for feet and " for inches.
Set Tank >
15
Setting Tank Height=15Ft 0In (180.00in)
Enter the capacity of the Tank. Enter this as the full capacity, optionally the empty capacity, and the u
nits (BBL, m3, GAL or L).
Current settings: Tank Capacity Full=0.0 Units=Gal
Just press Enter if you don't know or need the Tank capacity
Set Tank >
30
Settings Tank Capacity Full=30.0 BBL
Enter how far the Tank Sensor is above the bottom of the tank, in Inches. If the sensor is above the bott
om of the tank,
the VTL's 0% point is the sensor and 100% is the height of the sensor, less the sensor offset from the bo
ttom.
Current Tank Sensor offset value is 0.00 Inches
Set Tank >
.03
Setting Tank Sensor Offset to 0.03 Inches
Enter the Tank's liquid Specific Gravity. Current value is 1.00
Set Tank >

Keeping Tank specific gravity of 1.00
Enter the sensor pressure rating, then PSI, kPa or Bar after the value. Current value is 103.4 kPa / 15.0
 PSI
Set Tank >

Keeping existing Pressure sensor of 103.4 kPa / 15.0 PSI
What type of sensor is this? 0-5V, 0.5-3.0V, 4-20mA, or other range? Currently set to UserDef 4.00-20.00m
A
Set Tank >
4-20ma
Setting Pressure sensor to 4-20mA
Reviewing Tank Configuration:
Tank Height = 15Ft 0In (180in) Sensor offset from Tank bottom is 0.03in. SG = 1.00
Tank sensor is a 103.4kPA / 15.0PSI measured over 4-20mA
Tank Capacity Full=30.0 BBL
Enter Y)es to use these settings and save or anyting else to ignore.
Set Tank >
Y
Saving settings...Tank settings saved
```

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- T Toggles testing the LEDs by displaying Red, Green, Amber, Cyan, Purple, Blue and White bottom to top for a specific time period.
  Example: T 1,2 ← Would set On time for 00:01:00 and Off time for 00:02:00
- U Set VTL Update rate in milliseconds. Enter U for the current rate.
  Example: U 1500
- W Wi-Fi Configuration Setup menu
- h ? (h)elp of available commands

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10. Status Display Explained

The status command (lowercase s) will summarize the VTL's settings and current readings.

```
VTL-421652 Ver 1.406 Built:Dec 12 2023 19:24:41 settings:
Using config#0 H1 35ft tank, 15 psi 4-20ma, Cyan, Low 6%, High 92%, Flashing 3 & 97% DB:
Tank level reads 32Ft 8In (392.3In 93.4%) Level is 388.3In TankSensorOffset=4.0In
    Tank Height 35Ft 0In (420In) SG=1.00 Sensor 103.4kPa/15.0PSI Max height 34Ft 7In (415In)
    Sensor reads 18.96mA (Input level 4741mV Calc Factor=25.949584 Offset=-103.798334)
Top level band at 92% 18.72mA Pixel 129 and Bottom level band at 6% 4.96mA Pixel 9, Increment is 0.71%/Pixel
Top flashing level band at 97% 19.52mA Pixel 136 Bottom flashing level band at 3% 4.48mA Pixel 5
Options Set: 1.Display the Scale markers 2.VTL Display ON 4.Flash Top 97.0% 5.Flash Bottom 3.0% 6.DIP sets Tank Height
    7.Flash All LEDS at Top 97.0% 8.Flash All LEDS at Bottom 3.0%
LED Colors are set to GRB with 140 Pixels in a strip starting at 0 with 140 Pixels in 6 segments (Base=14 Segments=21 Pixels)
LED Level color is Cyan
Analog 4-20mA sensor, levels 0%=4.00mA 100%=20.00mA SensorOffset=0.000mA
Analog calibration correction Factor=1.013171 Offset=-7.092199
Analog readings averaged over 16 readings with filtering set to 0.3. Update Rate: 1000ms
DIP Switch S2 set to 0x6. User defined LED, 140 pixels from 0. S2-1 Set to 0
```

This shows:

- The VTL serial number, firmware version, and date the software was built.

VTL-421652 Ver 1.405 Built:Dec 8 2023 19:08:57 settings:

- If the VTL is configured for tank levels, this displays the tank's height, current level reading in feet and inches, total inches, and percent. Next, it displays the Tank sensor offset, which is the number of inches the sensor is above the bottom of the tank. The specific gravity of the liquid, the type of sensor, and the maximum height detectable for the sensor in the given specific gravity. Lastly, it displays the current sensor reading in milliamps and the conversion values.

Tank level reads 32Ft 8In (392.4In 93.4%) Level is 388.4In TankSensorOffset=4.0In
Tank Height 35Ft 0In (420In) SG=1.00 Sensor 103.4kPa/15.0PSI Max height 34Ft 7In (415In)
Sensor reads 18.97mA (Input level 4742mV Calc Factor=25.949584 Offset=-103.798334)

- The percentage values, pixels and sensor milliamps/volts for the **Critical Low, Low, High** and **Critical High** levels. These are set using the **l**evel and **f**lash setting commands.

Top level band at 92% 18.72mA Pixel 129 and Bottom level band at 6% 4.96mA Pixel 9, Increment is 0.71%/Pixel
Top flashing level band at 97% 19.52mA Pixel 136 Bottom flashing level band at 3% 4.48mA Pixel 5

- The various **Options** set. The available options are:
  - Display the Scale markers. Defaults to ON
  - Set ON to display only the level mark, not the continuous level. Defaults to OFF
  - Set ON to flash at the Top 95.0%. Defaults to ON
  - Set ON to flash at the Bottom 5.0%. Defaults to ON
  - Set ON to have DIP switch segments set Tank Height. Defaults to ON
  - Set ON to flash All the LEDs at the Top 95.0%. Defaults to OFF
  - Set ON to flash All the LEDs at the Bottom 5.0%. Defaults to OFF
  - Set ON to flash the Bottom LEDs Red instead of Amber. Defaults to OFF
  - Set ON to Echo input characters. Defaults to OFF
  - Turn the VTL display ON or OFF. Defaults to ON
- LED configuration, number of pixels. Standard VTL configurations have a base unit with 14 pixels, with 7 LEDs per pixel, and one or more 1.5M/5 ft segments with 21 pixels per segment. The number of segments can be specified using the S2 DIP switch or using the **P**ixel command, where the number of segments up to 10 can be specified.

LED Colors are set to GRB with 140 Pixels in a strip starting at 0 with 140 Pixels in 6 segments (Base=14 Segments=21 Pixels)

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- The normal LED fill color is displayed. This is set using the **L**)evel command. Valid colors are Amber, Black, Blue, Cyan, Gray, Green, DarkGreen, Orange, Purple, Red or White.

LED Level color is Cyan

- It next displays the analog sensor type (standard sensors are 0-5V, 0.5-3V or 4-20mA), the voltage/milliamps for 0% and 100% scale, and the Sensor Offset. The Sensor Offset is set using the **O**ffset command and the offset voltage or milliamp value is applied to the sensor reading. Note this is an offset in the sensor's reading units, while the Tank offset is in inches.

Analog 4-20mA sensor, levels 0%=4.00mA 100%=20.00mA SensorOffset=0.000mA

- The analog calibration values are displayed. These values are set at the factory and normally do not need to be adjusted. If the calibration values are outside the expected values, a warning message will be displayed. This is set using the **A**)nalog input calibration command.

Analog calibration correction Factor=1.013171 Offset=-7.092199

- Sensor readings are filtered to eliminate jitter and provide a smooth display as the level changes. This is set using the **F**ilter command. The VTL reads from the sensor about once a second. This is configured using the **U**pdate command.

Analog readings averaged over 16 readings with filtering set to 0.3. Update Rate: 1000ms

- The S2 DIP switch is used to set the number of segments, or user-defined segments, or place the VTL LEDs into Test mode, where each pixel is a different color. This is set by switches 2, 3 and 4, as described earlier. Switch 1 is used to select the configurations (see Configuration section). This reports if the S2-1 switch is read as a 1 or 0

DIP Switch S2 set to 0x6. User-defined LED, 140 pixels from 0. S2-1 Set to 0

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11. Configuration Menu Explained

The purpose of configurations is to maintain settings in a VTL, so if a VTL is moved between different tanks, the tank's configuration can be quickly selected instead of re-entering the tank's settings. This also allows for library preset settings that can be quickly pulled up. Lastly, DIP switch S2-1 can be set to select between two configurations, allowing easy configuration settings in the field without connecting to the VTL.
Configuration settings include

- The name of the configuration.
- Tank configuration settings (Tank height, sensor max value, sensor type, sensor offset above the bottom of the tank, specific gravity.
- Option flag settings.
- LED configuration, including the first LED, number of LED pixels, and LED color.
- Critical Low, Low, Low Warning, High Waring, High, and Critical High-level settings.
- Number of analog readings, the update rate, and sensor offset.

The items not specified in a configuration are unique to the individual VTL hardware configuration and include

- Analog calibration values
- Type of LED string

The VTL can store up to 10 configurations, numbered 0 to 9. Configuration 0 is the default configuration.

From the configuration menu the ***l*** command the **l**ist command displays preset configurations. There can be any number of configurations (more than 10) to choose from:

```
Library configurations available:
1. VTL Default Configuration
2. VTL Test44 Configuration
3. H1 35ft tank, 15 psi 4-20ma, Cyan, Low 6%, High 92%, Flashing 3 & 97%
4. N1 25ft tank, 15 psi 4-20ma, Green, Low 15%, High 85%, Flashing 10 & 90%
```

To load a library into the currently active configuration, use the **L**oad library command.
Example: L 3 ←loads the #3 library configuration.

Using library #3 H1 35ft tank, 15 psi 4-20ma, Cyan, Low 6%, High 92%, Flashing 3 & 97%
This loads the configuration into running memory but doesn't save the values. If VTL power is removed and then reconnected, the VTL will return to the last saved configuration. To save the configuration, use the **S**ave command. Entering **S** will display "wrote configuration#0 to PrefDb 'VTL.'"

To start using the new configuration, you need to enter the **R**eset command to reboot the VTL using the new configuration. This will reboot the VTL with the new configuration settings. The **s**tatus display will display the current configuration in the second line.
Using config#0 H1 35ft tank, 15 psi 4-20ma, Cyan, Low 6%, High 92%, Flashing 3 & 97% DB:

The **n**ame command allows setting the name of the configuration. This is the name displayed on the 2nd line of the status display. Configurations can be named for specific tank configurations or setups.

The **O** and **F** commands allow setting the configurations selected when DIP switch S2 switch 1 is set ON and OFF. The VTL defaults to selecting configuration 0 for both.

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The **Q**uit command returns to the main VTL menu.

Entering **?** will display the Configuration menu.

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12. Advanced VTL Setup Commands

The rest of the document covers specialized commands that many users will not need to use. It is primarily given as a reference guide and to help users handle special setup requirements.

2.3 LED Setup Commands

The high-intensity LEDs used in the Reign VTL have 14 pixels per meter and 7 LEDs per meter.
Reign sells the VTL segments as a Base segment and then 0 to 6 Display segments. Each segment is 5 ft long (1.5 meter). Base segments contain 14 pixels (98 LEDs), starting a half meter (18 inches) above the bottom. This allows water or other materials to swirl around the unit's base and not touch the LEDs. The Display segments have 21 pixels (147 LEDs) and run the entire segment length. The VTL control box's female connector supplies power and data to the male connector on the bottom of the Base segment. Each Base and Display Segment has a female connector on the top, which can be connected to the male connector on the bottom of the next section. Segments can be disassembled and reconnected in the field.

Each pixel can be set to a unique color, following Red, Green, and Blue additive color mixing. Note that since the LEDs are producing light, the colors generated are often "whiter" than colors in a color chart.

2.4 L- LED Level Color

L Set the (L)ED Level color or display the current setting. Enter L Color to set
Sets the color the LED fills the display. This is set to Cyan by default but can be changed to Amber, Black, Blue, Cyan, Gray, Green, DarkGreen, Orange, Purple, Red or White. Enter L followed by the color
VTL >
L purple
New LED Level color is Purple

2.5 l - High and Low-Level Display

l Set the top high and bottom low levels for color display (normally 90 and 10%)
When the level drops below the Low setpoint, the LED color changes to either Amber or Red, depending on the setting in **Option 9** (OFF=Amber, ON=Red). When the level rises above the High setpoint, the LED color changes to Red. ***9*** Set ON to flash the Bottom LEDs to Red instead of Amber. Set to OFF

Entering lowercase **l** by itself will display the command format and the current values.
Enter the top and bottom levels as L 85, 15 or L 0.85 0.15. Current settings are 92.0%, 6.0%

If we want the low setpoint to be 15% and the high setpoint to be 85%, we would enter
VTL >
l 85,15
Setting top level band to 85.0% and bottom level band to 15.0%

2.6 f Critical High and Critical Low Flashing Display

f Set the top and bottom (f)lashing levels for the display (usually 99 and 1%)

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When the level is below the critical low level, the display can be programmed to flash, either just the LEDs displaying the level, or the entire VTL display. Likewise, when the level is above the critical high level, the LEDs will either start flashing or the entire VTL will start flashing.

The levels are set with the **f**lashing command. Entering the lowercase f by itself will display the current values:
Enter the top and bottom flashing levels as f 90, 10 or f 0.90 0.10. Current settings are 97.0%, 3.0%

To set the Critical High level to 92% and the Critical Low level to 8%, we would enter:
VTL >
f 92, 8
Setting top flashing level band to 92.0% and bottom level band to 8.0%

The Critical High and Low functions can be set using the **o**ption command, specifically:
VTL >
o
Enter the Option Number followed by ON or 1 to turn On, or OFF or 0 to turn OFF:
1. Display the Scale markers. Set to ON
2. Turn the VTL display ON or OFF. Set to ON
3. Set ON only to display the level mark, not the continuous level. Set to OFF
4. Set ON to flash at the Top 97.0%. Set to ON
5. Set ON to flash at the Bottom 3.0%. Set to ON
6. Set ON to have DIP switch segments set Tank Height. Set to ON
7. Set ON to flash All the LEDs at the Top 97.0%. Set to OFF
8. Set ON to flash All the LEDs at the Bottom 3.0%. Set to OFF
9. Set ON to flash the Bottom LEDs to Red instead of Amber. Set to OFF
Set Option >

For example, to set the VTL so the entire VTL flashes at the Critical levels, enter:
VTL >
o 7 on
Enable Flash All LEDs at Top set to ON
VTL >
o 8 on
Enable Flash All LEDs at Bottom set to ON
VTL >
o ?
Enter the Option Number followed by ON or 1 to turn On, or OFF or 0 to turn OFF:
1. Display the Scale markers. Set to ON
2. Turn the VTL display ON or OFF. Set to ON
3. Set ON only to display the level mark, not the continuous level. Set to OFF
4. Set ON to flash at the Top 92.0%. Set to ON
5. Set ON to flash at the Bottom 8.0%. Set to ON
6. Set ON to have DIP switch segments set Tank Height. Set to ON
7. Set ON to flash All the LEDs at the Top 92.0%. Set to ON
8. Set ON to flash All the LEDs at the Bottom 8.0%. Set to ON
9. Set ON to flash the Bottom LEDs to Red instead of Amber. Set to OFF
VTL >

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2.7 B - Pixels in Segments

The **Base** command allows setting the number of pixels in the Base and Display segments. It is entered as:

Example: B 14,21

The default is 14 pixels in the Base and 21 in the Display segments, allowing you to override these default values. **A user should normally never need to use this command with standard Reign VTL segments**

2.8 P - Number of Pixels in LEDs

Set the number of Pixels in the LED lights [, first LED (starting with 0)], or enter the number of standard Segments above the Base (10 or less)

The number of pixels in a VTL is normally set using the S2 DIP switch as shown below.

Light Sticks Settings	Pixels	2	3	4
Base only 5 ft	14	OFF	OFF	OFF
Base+1 seg 10 ft	35	OFF	OFF	ON
Base+2 seg 15 ft	56	OFF	ON	OFF
Base+3 seg 20 ft	77	OFF	ON	ON
Base+4 seg 25 ft	98	ON	OFF	OFF
Base+5 seg 30 ft	119	ON	OFF	ON
Custom # Pixels	User	ON	ON	OFF
Test Mode	All	ON	ON	ON

Entering **P** by itself will display the current configuration

Number of Pixels=119 in 5 segments (Base=14 Segments=21 Pixels) and starting Pixel=0

Custom LED configurations can be specified using the **P**)ixel command, which specifies the total number of LED pixels. For example, a 35 ft VTL with one base (14 pixels) and six segments (6 * 21 pixels) has a total LED pixel count of 140 pixels. Since the number of segments exceeds 5, it must be set using the **P**)ixel command and the S2 DIP switch needs to be set to **ON ON OFF.**

VTL > P 140

Setting number of Pixels to 140 using 6 Segments(Base=14 Segments=21 Pixels), starting Pixels is 0

VTL > P

Number of Pixels=140 in 6 segments (Base=14 Segments=21 Pixels) and starting Pixel=0

Entering a number less than 10 for the **P**)ixel command is taken as the number of segments

VTL > P 10

Setting number of Pixels to 224 using 10 Segments(Base=14 Segments=21 Pixels), starting Pixels is 0

VTL > P 0

Setting number of Pixels to 14 just a Base segment(Base=14 Segments=21 Pixels), starting Pixels is 0

2.9 Q - Color Test

Used to set every other pixel to the color specified to see how the color looks. The color is specified as a number from 0 to 255 for Red, Green, and Yellow.

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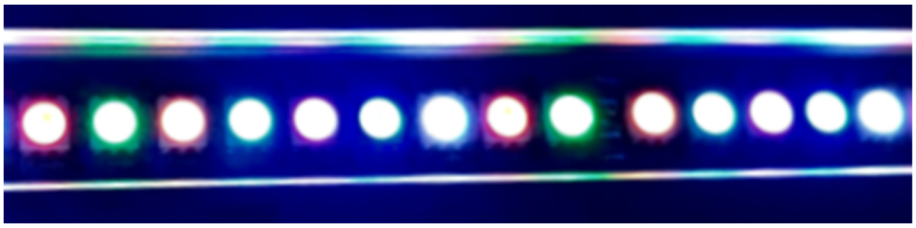
Example: Q 200 192 34
Displaying color Red=200 Green=192 Blue=34 Level=255 Flash=0 (n=3)
LED Color Test > Q
Stopping LED Color Test mode

2.10 T - LED Test Mode

T Toggles testing the LEDs by displaying Red, Green, Amber, Cyan, Purple, Blue and White bottom to top



Example: T
LED Test mode set to ON
VTL > T
LED Test mode set to OFF

2.11 J - Set LED Color System

J Select the LED color system or display the current setting
Addressable LEDs have multiple ways to address the LEDs. The Reign VTL LEDs use GRB addressing. This allows changing for a custom LED system. Users normally do not need to use this function.
VTL > J
Please select the LED display mode from:
1. RGB color order
2. RBG color order
3. GRB color order
4. GBR color order
5. BRG color order
6. BGR color order

VTL > J 3
Sets the color Display Mode to GRB

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13. Analog Input Settings

1. a - Analog Input Ranging

Example: a

Shows analog input levels for 0%,100% V or mA. You can enter 4-20mA or 0-5V. Example 4,20 mA or 0.25 4.5 V

This command allows setting the levels in which the 0% reading and 100% readings on the VTL correspond to analog inputs from the sensor. This is necessary if you did not set up the sensor using the Set Tank Parameters, or if you are using a new type of sensor. Remember to set the **S1** DIP switch #1 **ON** for a 4-20mA sensor and **OFF** for voltage inputs. Similarly, **S2** for Analog Input 2.

Examples of analog setting commands:

a 0.5-3V

This defines we use an analog sensor producing between 0.5V at 0 pressure and 3.0V at maximum pressure. If a Tank Configuration is set, it updates the tank level.
Setting 0.5-3.0V analog input levels 0%=0.5, 100%=3.0 Volts and updated Tank Values

a 20-4ma

This specifies a sensor operating backward from the normal, where for this sensor, the 0 or empty level is 20mA and the full or maximum level is at 4mA. An ultrasonic sensor could produce these values if it has the minimum output value when the tank is full.
Setting 0.5-3.0V analog input levels 0%=0.5, 100%=3.0 Volts and updated Tank Values

a 0.7-2.5v

Specifies we use a sensor where the 0 point produces 0.7 volts and the maximum point produces 2.5 volts.
Setting User Sensor analog input levels 0%=0.700, 100%=2.500 Volts and updated Tank Values

2. A - Analog Calibration

A sets the calibration values for Analog input. Enter mv1,expected1 mv2,expected2
The VTL is calibrated at the factory and should not require recalibration. Calibration is used to correct for:

- Inherit offsets and errors in analog readings by the processors.
- 4-20mA current signal is converted to a voltage using sensor resistors, with an error
- Input is reduced to ½ the maximum input value of 5 volts to protect the processor, and this input divider introduces some errors.

To calibrate a VTL, you need an accurate voltage or current generator to mimic the signal from the sensor.

The steps are:

1. Connect the signal generator to the Analog A1 input and ground (or supply for current generators).
2. Set the generator to the 0% level. Usually, it is 0 volts, 0.5 volts, or 4 mA
3. Enable reading debug by entering
   Example: d r
   This will begin displaying lines like this:

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r.In=999mv InCalr=1004 Ain=4.02mA Lvl=4.4In 1.1% LEDIdx=0 (F=0 C=140 N=140 I=0.714 L%=8 H%=128

- The In= value is the raw millivolts the sensor sees at the 0% input. Record this value at *mv1*. The expected value (ev1) should correspond to:
  - 000mv for a 0-5 volt input
  - 500mv for a 0.5 to 3 volt input
  - 1000mv for a 4-20 mA input.

4. Set the signal generator to the 100% level. This could be 5 volts, 3 volts or 20 mA. Record the In= value seen on the debug readings display. These numbers fluctuate so try to determine an average value. This is the mv2 value. The expected value (ev2) should correspond to:
   - 5000mv for a 0-5 volt input
   - 3000mv for a 0.5 to 3 volt input
   - 5000mv for a 4-20mA input
5. Enter d r to toggle the debug readings off. It will stop the continuous output lines.
6. Enter the calibration as mv1,ev1 mv2,ev2
   For example, if you have a 4-20mA sensor and the 4mA reading was about 995 and the 20mA IN= value was 4967, you would enter:
   A 995,1000 4967,5000
   Entered mv1=995.00 ev1=1000.00 mv2=4967.00 ev2=5000.00) Setting Analog calibration Factor=1.007049 Offset=-2.014099

   If the numbers entered would result in a calibration being outside expected values (Factors need to be between 0.90 and 1.10, and Offset from -50 to +50), the calibration is rejected.
   You would see a message like:
   Entered mv1=600.00 ev1=1000.00 mv2=4000.00 ev2=5000.00) WARNING-INVALID CALIBRATION VALUES. Factor=1.176471 is above 1.10 Offset=294.117647 is above 50.00 NOT SAVED!!! Something isn't right.

   The analog calibration values are stored in a special memory location, so they are not changed or corrupted when the VTL software is updated.

3. N - Number of Readings

N - Number of samples in an Analog reading (usually 16)
The analog reading software reads multiple readings. It uses an average number of readings as the reading value. This also helps eliminate noise and jitter in the sensor readings. The VTL normally reads 16 times per reading, but this value can be increased or decreased using this command.

4. O - Sensor Offset

O Set reading Offset in either Volts or mA. Corrects for the Actual value read from the sensor
This allows correction for a built-in bias or error in the sensor. Enter a number in volts or milliamps, which is added to the base sensor reading before being converted to a VTL height.
This differs from the Tank Sensor Offset, set in the Setting Tank Parameters. That offset is the number of inches the sensor is above the bottom of the tank and is used

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to accurately reflect the actual level height in a tank when the sensor is above the bottom of the tank.

5. U - Analog Update Rate

U Set VTL Update rate in milliseconds
Sets how often the VTL reads from the sensors, with the default being 1000ms (1 second). Enter the number of milliseconds between update. You don't want the VTL reading too often otherwise you can see jittering in the readings. The VTL software will only allow a minimum update rate of 100ms,
Example: U 1500 ← Sets update rate to 1500 ms

6. F - Analog Filtering

F Sets the Analog Filter value for smoothing the readings (0.1 to 1.0)
The VTL dampens or smooths the actual readings to prevent jitter or readings cycling in and out of an error condition. Filter values must be between 0.1 to 1.0 and the smaller the number, the greater the filtering. VTLs default to 0.3 for the filtering.
Example: F 0.5 ← Sets Analog filter value to 0.50

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14. Wi-Fi Configuration

The 2.4 GHz Wi-Fi radio can be customized using its own configuration menu. Enter an upper-case W to enter the Wi-Fi configuration menu.

Example: W

Please select the Wi-Fi Management option to perform:
1 Set our AccessPoint Name (override default)
2 Set our AccessPoint Password
3 Set SSID of remote Hotspot to connect
4 Set Password of remote Hotspot to connect
a/A Enabled Access Point for a user to connect. a shows setting, A toggles setting
h/H Enabled HotSpot access for us to connect. h shows setting, H toggles setting
t/T Enable Telnet server. t shows setting, T toggles setting
w/W Enable Web server for remote connections. w shows setting, W toggles setting
Q Exit back to VTL Main
? Display Wi-Fi Management status
Wi-Fi >

- ***Example: ?*** ← Displays the current Wi-Fi status
  Wi-Fi > ?
  Access Point is Enabled Our AccessPoint name is VTL-421652 and our password is VTL12345
  HotSpot connection is Disabled The HotSpot SSID connection is Test using Password Test321$
  Web Server set to Enabled
  Telnet Server set to Enabled
- ***Example: 1*** ← Set the AccessPoint Name (overrides the default)
  The default Access Point name broadcast (the SSID) is in the form similar to **VTL-421652**. This command allows setting it to any other String. It's recommended you mark the VTL with the name of the VTLSSID, and unless you can ensure no two VTLs will be powered on simultaneously in the same 100-foot area, they all have unique names.
- ***Example: 2*** ← Set the AccessPoint Password
  The default Access Point password is set to **VTL12345**. It can be changed to any string up to 32 characters long.
- ***Example: 3*** ← Set the SSID of the remote Hotspot to connect
  The VTL can connect to a 2.4 GHz Wi-Fi Hotspot to report its data to the Reign Cloud gateway and server. This allows reporting data in remote areas using a cellular, wired, or satellite connection. This sets the SSID we will use to connect.
- ***Example: 4 ← Set the Password of the remote Hotspot to connect***
  Set the password used to connect to the 2.4 GHz Wi-Fi Hotspot.

Note:

For the next four commands, the lower-case letter displays the current setting, and entering the upper-case letter will toggle the command setting. For example:
Wi-Fi > w
Web Server set to Enabled
Wi-Fi > W
Web Server set to Disabled
Wi-Fi > W
Web Server set to Enabled

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- ***Example a ← Enabled***
  Example A ← Disable Access Point for a user to connect
  Shows or toggles the 2.4 GHz Wi-Fi Access point on and off. When the Wi-Fi Access Point is disabled, remote users cannot connect for Web or Telnet connections,
- ***Example h ← Enabled***
  ***Example H ← Disable* Hot Spot access for us to connect**
  Shows or toggles the 2.4 GHz Wi-Fi remote Hotspot connection on and off. When the Wi-Fi Hotspot connection is disabled, the unit cannot send readings to the remote ReignCloud server.
- ***Example t ← Enabled***
  ***Example T ← Disable* Telnet server**
  Shows or toggles the Telnet server to allow remote connections. This needs to be enabled for a user to remotely connect and configure the VTL.
- ***Example w ← Enabled***
  ***Example W ← Disable* Wi-Fi server for remote connections**
  Shows or toggle the Web server to allow remote browser connections. This must be enabled for users to connect using their laptop, tablet or mobile web browser..

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15. Modbus Operation

Note: Modbus support is still being implemented, and this section is mainly for testing purposes.

- ***Example m*** ← Modbus configuration and test program
  The Modbus configuration program will be entered by this command. This is currently not implemented.
- ***Example M*** ← Modbus terminal mode talking to the RS485 port
  This allows sending and receiving data over the RS485 port to talk directly to RS485 devices. This is mainly for development and testing purposes.

1. **System Commands**
   - **Debug**
     d Toggle debug On and Off. d v debugs VTL. d m debugs Modbus. d w debugs Wi-Fi.
     D Toggle Debug On and Off and save the setting. D V debugs VTL. D M debugs Modbus. D W debugs Wi-Fi.
     Debug commands allow the displaying of additional information during the operation of the VTL. There are multiple debug sections that can be individually turned on and off. Entering **d ?** will display the current debug settings.
     Example d ? ←
     Debug set to d.Main=OFF v.VTL=OFF r.Readings=OFF m.Modbus=OFF w.Wi-Fi=OFF

     The debug levels are:
     - ***Example d*** ← Main. Provides overall information about the VTL. Debug lines start with **d**.
     - ***Example d v*** ← VTL Provides additional information primarily about the VTL LED display. Debug lines start with **v.**
     - ***Example d r*** ←Readings Displays a line for each sensor reading. Debug lines start with **r.** The display line looks like:
       r.In=3238mv InCalr=3210 Ain=12.84mA Lvl=233.4In 55.6% LEDIdx=77 (F=0 C=140 N=140 I=0.714 L%=8 H%=128)
       The values displayed in each line are::
       - In=3238mv The raw input level to the VTL processor. 3238 millivolts read
       - InCalr=3210 The adjusted input reading with the calibration and sensor offset applied
       - Ain=12.84mA Input level in mA or Volts
       - Lvl=233.4In 55.6% The VTL level the input calculates to, in inches (for tanks) and % of the overall VTL LED display
       - LEDIdx=77 The top LED pixel displayed, starting at pixel 0.
       - (F=0 C=140 N=140 I=0.714 10=8 90=128) Additional information used in calculating the results:
         - F=0 First LED for 0%
         - C=140 Top pixel LED for 100%
         - N=140 Total number of pixels in the VTL LED segments
         - I=0.714 The input increment per LED pixel
         - L%=8 H%=128 The LED pixels for Low percent and High percent levels
     - ***Example d m*** ← Modbus. Displays messages to and from the Modbus device. Debug lines start with **m.**

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- ***Example d w*** ←Wi-Fi. Displays additional information about the Wi-Fi, Telnet, and Web server operations. Debug lines start with **w.**

Debug levels are toggled on and off by entering the **d** or **D** and then the debug flag (**d, v, r, m, w**). Lowercase **d** will turn the debug on and off for the current session, but it is not permanent. Uppercase **D** will store the debug settings in the VTL's configuration, so it will always have that level of debug information between power on.

- **Reboot the VTL**
  Example: R ← Reboot the VTL
  This allows you to reboot the VTL using the saved parameters and settings. Note if you are connected using Telnet, you will need to reconnect, including reconnecting to the VTL's Wi-Fi Access Point connection..
  VTL > R
  Rebooting...
- **Reset all Settings to Default**
  Example: r ← Reset all settings to default. Prompts to if you are sure you want to do this. No take backs!
  This allows resetting the VTL to factory configurations. All settings, except for Analog calibration, are set to default values.
  VTL > r
  Are you 100% sure you want to RESET all the settings (except calibration) to the default values?? (Y/N)
  Reset? y
  All settings are reset (except calibration) to default and saved to configuration.
  VTL >
  DIP switch S2 set to 0x6
  DIP switch S2 set to User-defined LED, 44 pixels from 0
  S2-1 OFF using Configuration 0 (No change)

2. **Default Settings for the VTL**
   Example: s
   VTL-421652 Ver 1.408 Built:Dec 28 2023 18:37:10 settings:
   Using config#0 Base Config0 DB:VTL
   Display level -25.0% Input is 0.0mA (2mV)
   Top level band at 90% 18.4mA Pixel 40 and Bottom level band at 10% 5.6mA Pixel 5, Increment is 2.27%/Pixel
   Top flashing level band at 95% 19.2mA Pixel 42 Bottom flashing level band at 5% 4.8mA Pixel 3
   Options Set: 1.Display the Scale markers 4.Flash Top 95.0% 5.Flash Bottom 5.0% 6.DIP sets Tank Height V.VTL Display ON
   LED Colors are set to GRB with 44 Pixels in a strip starting at 0 with Non-standard segments 44 Pixels total (Base=14 Segments=21 Pixels)
   LED Level color is Cyan
   Analog 4-20mA sensor, levels 0%=4.00mA 100%=20.00mA SensorOffset=0.000mA
   Analog calibration correction Factor=1.007049 Offset=-2.014099
   Analog readings averaged over 16 readings with filtering set to 0.3. Update Rate: 1000ms
   DIP Switch S2 set to 0x6. User-defined LED, 44 pixels from 0. S2-1 Set to 0

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3. **Default System Processor Settings**
   Example: S ← Display current Status of the Processor and memory internal nerdy values some people find interesting.

   VTL-421652 Ver 1.408 Built:Dec 28 2023 18:37:10 status:
   Processor ESP32-C3 Rev:4 MAC=348518066F14
   Flash size=4194304 Program size=982592 max=1966080 50.0%
   Heap size=305284(0,0) used=81820 26.8% free=223464(-55068,0) minFree=220900 maxAlloc=114676

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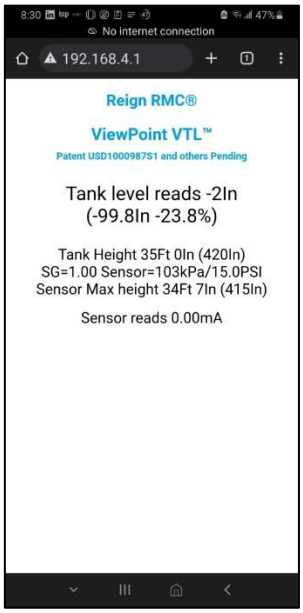
16. Release Notes

- **Firmware Version 1.4xx**
  VTL firmware 1.400 adds the following functions:
- **Configuration management**.
  - Users can store up to 9 configuration settings. These are stored in files VTL-1 to VTL-9.
  - The initial default configuration 0 is stored in a file ' VTL'.
  - Preset configurations can be loaded and stored to either the default configuration 0 file 'VTL' or one of the user configuration files.
  - Configurations can be selected using DIP switch S1, switch 1. This defaults to the default configuration 0 ('VTL') for both settings, but this can be assigned to any of the other configurations 1 to 9.
- **Wi-Fi wireless connectivity support**
  - The VTL's internal 2.4 GHz Wi-Fi access point (AP) can be enabled. This allows remote access by connecting to the VTL's AP. The AP's SSID defaults to 'VTL-NNNNN', which is the VTL serial number. The password defaults to "VTL12345". Both of these can be changed, and the AP can be disabled. The AP's default IP address is 192.168.4.1 (this is common for all VTLs).
  - The VTL can also connect to a remote Hotspot for connectivity. The hotspot's SSID and password can be set, and the VTL will connect to the hotspot using a DHCP IP address. In a future version, this will be used to send data to the ReignCloud.
  - Users can connect to the VTL using Telnet to the AP IP 192.168.4.1 on port 23. This provides the same functionality as the local terminal connection using the USB C cable. Users can also connect to the device when connected to a Hotspot if they know the VTL's IP address.
  - Users can connect to the VTL using a browser (either desktop or mobile), and they get a display showing the current tank level readings. Future versions will be enhanced to allow configuration changes using the browser.



- **Support for Actual level display**. The VTL typically provides a Virtual Level display, where the level inside the tank is displayed as a percentage of the overall display, and the reference markers are at 0, 25%, 50%, 75%, and 100% of the LED display. This allows

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any size VTL LED bar to display the level inside any tank. In Actual mode, the level matches the physical level inside the tank, providing the LEDs are sized to match the physical tank. Each LED pixel represents 2.86 inches of overall length, and the base display of 14 pixels is about 20 inches above the ground (7 pixels). An actual display can be entered by entering the total number of pixels in the tank height minus the offset for non-displayed pixels.

- For example, a 25 ft tank is displayed using four 5 ft segments (21 pixels per segment) and one base (14 pixels). This is 4 * 21 + 14 = 98 pixels. The base has 7 pixels in the 20 inches above the bottom of the tank. The user can enter a custom length using the **P**ixel command as

Example: P 98,-7

This will make the VTL think it has 105 pixels total, or 300 inches, 25 feet.

- The bottom 0% reference marker will not be seen since it's not on a visible LED. The 50% marker will be at the tank's half height, and the 100% marker should be at the top of the tank.
- If the total VTL segments do not match the actual tank height, the total number of pixels needed to display, less 7, is entered for the P command. The display will match the actual level, even if the LEDs are over the end of the physical VTL LED display. For example, you have an 18 ft tank using 15 feet of VTL lights (Base and two display segments, with 2 * 21 + 14 or 56 pixels). 18 feet would require 76 pixels (18 ft is 216 inches, 216 / 2.86 is 76 pixels). 76 – 7 = 69 pixels above the seven non-displayed ones on the base. You would enter

Example: P 69,-7

You would see the 25%, 50%, and 75% reference markers since the 0% and 100% reference markers are on non-displayed LEDs.

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