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Sutron Satlink 3 ISCO sampler control application using a Python script

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This document describes a Sutron Satlink 3 setup and Python script. The goal is to provide our USGS customer with an automated way of triggering an ISCO sampler.

At the current installation site, there is a Sutron Satlink 3 measuring turbidity, temperature, and SC on site, as well as a programmable ISCO sampler (not connected to Satlink). Currently, customer has to manually setup for rain events by going to site prior to an event and programming the ISCO sampler to collect data on a schedule. Customer desires that Satlink automatically trigger the sampler based on turbidity conditions.

The goal is twofold:

- Decrease the number of visits to the site
- Improve the collection of the water samples

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Sampling criteria

There are multiple criteria that may result in the triggering of the sampler.

References to GP are to the General Purpose variables in setup – see [the next section](#).

Baseline

The system will trigger the sampler based on a user entered interval expressed in hours, default 99.

Initial operation - trigger after the initial interval expires, 99 hours after bootup by default

There are no additional qualifiers for this sampler trigger except for exceeding bottle capacity.

This setting is GP1, BaselineHours

Change Since Last Trigger

Compare current turbidity reading with the last reading that triggered the sampler. If the absolute difference exceeds user set threshold (default 250), trigger the sampler.

This setting is GP2, ChangeSinceTrigger

Minimum time between sampler triggers

This value may be used to restrict how often the sampler may be triggered.

By default, this is set to zero hours, meaning sampler may be triggered as frequently as possible.

This setting is GP3, TriggerDeadtimeHrs and is expressed in hours

High Threshold

If turbidity is higher than a user set level (default 2000), the system will sample periodically at a user set interval (default 1 hour).

High Threshold will combine with Change Since Last Trigger, allowing for even faster triggering if the turbidity change is high enough.

The threshold is GP4 HighThreshold

The interval is GP5 HighIntervalHrs

Bottle count

Sampler holds a limited number of bottles, dictating how many times it may be triggered.

The default value is 24.

This setting is GP6, BottleCapacity

- The system will track bottles used, and not attempt to trigger sampler once all bottles are used up.
- The number of bottles used is setup as a measurement, so the value can be transmitted over GOES and setup for alarms.



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- Bottle count may be reset via [script task S1](#).
- Bottle count will be reset to 0 on power up. If it is important for this value to persist across reboots, it may be placed into a GP.

SMS

The system will send SMS when most of the bottles are used up (default is 22).

- A telemetry setup will be used to setup the SMS phone numbers and the frequency of the alarm.
- A measurement will be setup to track bottles used. An alarm will be setup on this measurement. The alarm will trigger the SMS.

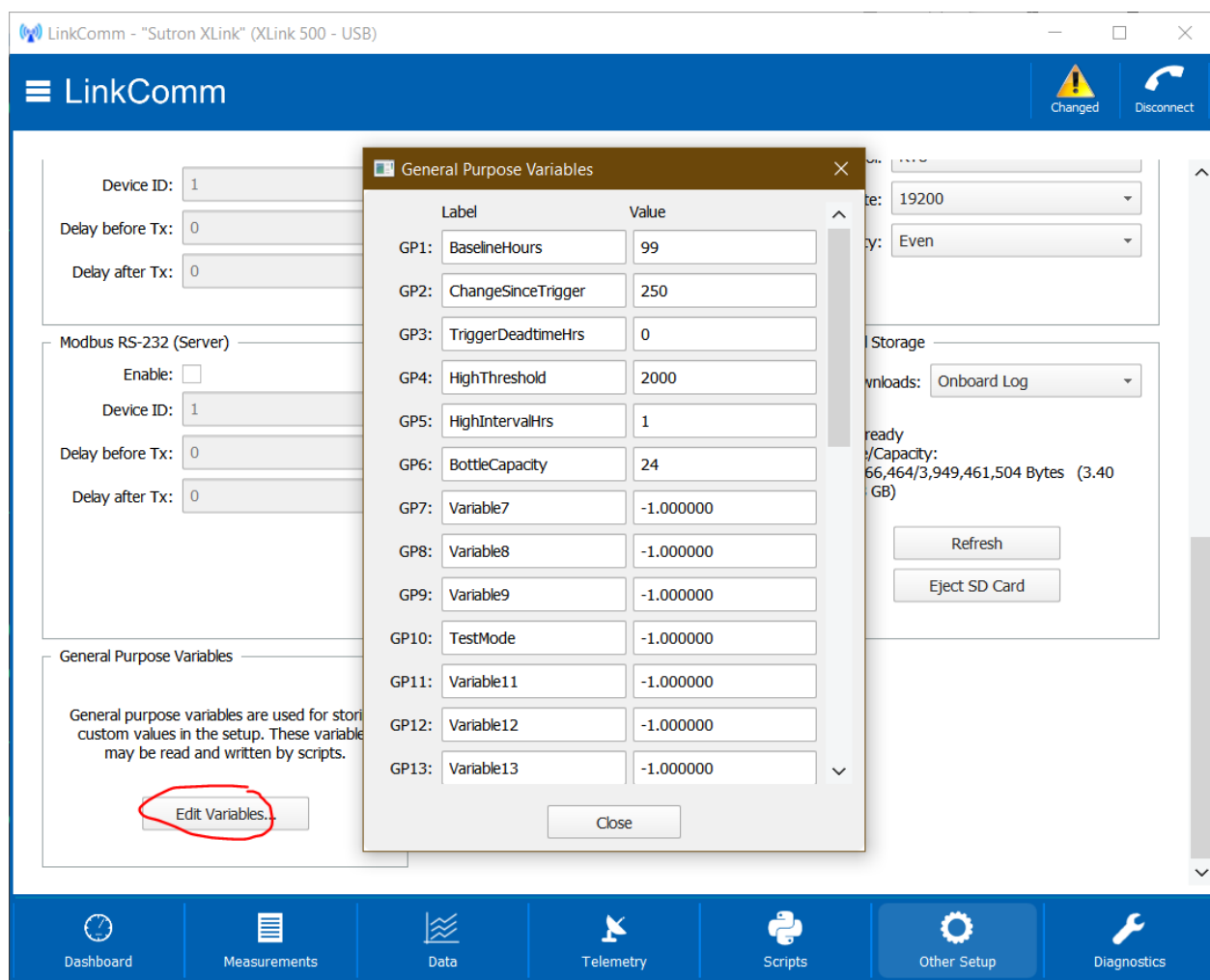
Physical interface

Satlink's digital output 1 will be used to trigger the ISCO sampler.

Setup

General Purpose Variables (GP)

These are general purpose setup fields, accessible via LinkComm->Other tab->General Purpose Variables->Edit Variables.

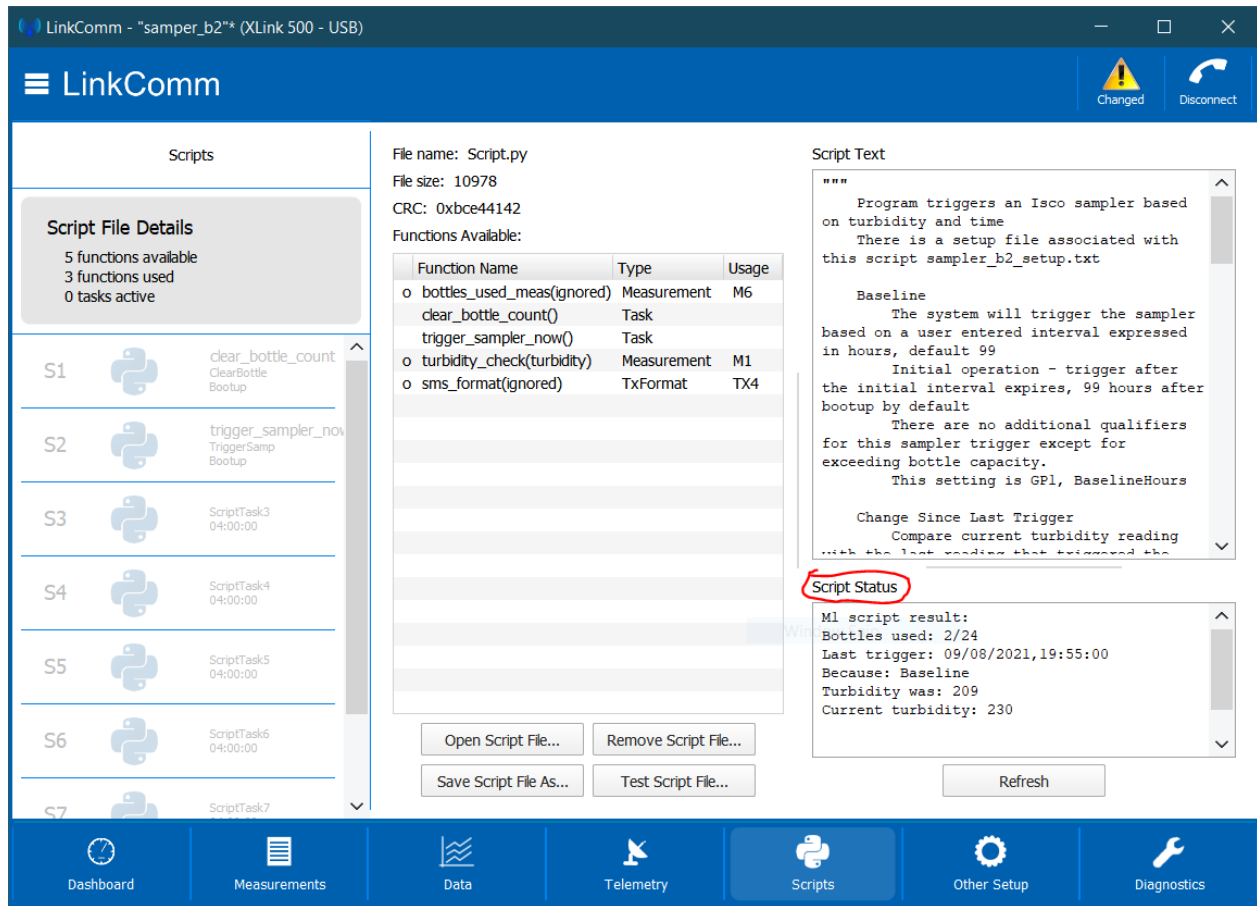


Script Status

The script status provides information on the sampler status:

- The number of bottles used
- The time the sampler was last triggered
- The reason for the trigger
- Turbidity at the time of the trigger
- Current turbidity

See the screenshot below for where to find the Script Status in LinkComm.



The screenshot shows the LinkComm software interface for a device named "sampler_b2" (XLink 500 - USB). The interface is divided into several sections:

- Scripts:** A list of scripts on the left, including S1 (clear_bottle_count), S2 (trigger_sampler_now), S3 (ScriptTask3), S4 (ScriptTask4), S5 (ScriptTask5), S6 (ScriptTask6), and S7 (ScriptTask7).
- Script File Details:** A section showing details for the selected script (Script.py):
 - File name: Script.py
 - File size: 10978
 - CRC: 0xbce44142
 - Functions Available:
- Function Name, Type, Usage Table:**

Function Name	Type	Usage
o bottles_used_meas(ignore)	Measurement	M6
clear_bottle_count()	Task	
trigger_sampler_now()	Task	
o turbidity_check(turbidity)	Measurement	M1
o sms_format(ignore)	TxFormat	TX4
- Script Text:** A text area showing the script's content, including comments about the program's purpose and baseline settings.
- Script Status:** A section showing the results of the script execution:
 - M1 script result:
 - Bottles used: 2/24
 - Last trigger: 09/08/2021,19:55:00
 - Because: Baseline
 - Turbidity was: 209
 - Current turbidity: 230

The interface also includes a bottom navigation bar with icons for Dashboard, Measurements, Data, Telemetry, Scripts, Other Setup, and Diagnostics.

Status via SMS

Note that the Script Status is identical to the SMS sent as the system goes into alarm.

To get the status via SMS at any time, send an SMS to the station with this exact command:
!STATUS SCRIPT

Please note that Satlink will turn off the cell modem to conserve power. Check Other Setup->Cell to control how often messages are checked (Msg interval) or make the modem stay on all the time (enable Listening)

Script Tasks

Two script tasks have been setup to allow manual control:

- S1 ClearBottle
- S2 TriggerSamp

Both of these tasks are intentionally not active. They are not meant to run automatically, but to be invoked by the user by pressing the Run Script Now button in LinkComm
(LinkComm->Script Tab->S1 (or S2)->Run Script Now

The S1 ClearBottle script will clear the number of bottles and reset other trackers.
The S2 TriggerSamp will trigger the sampler immediately.

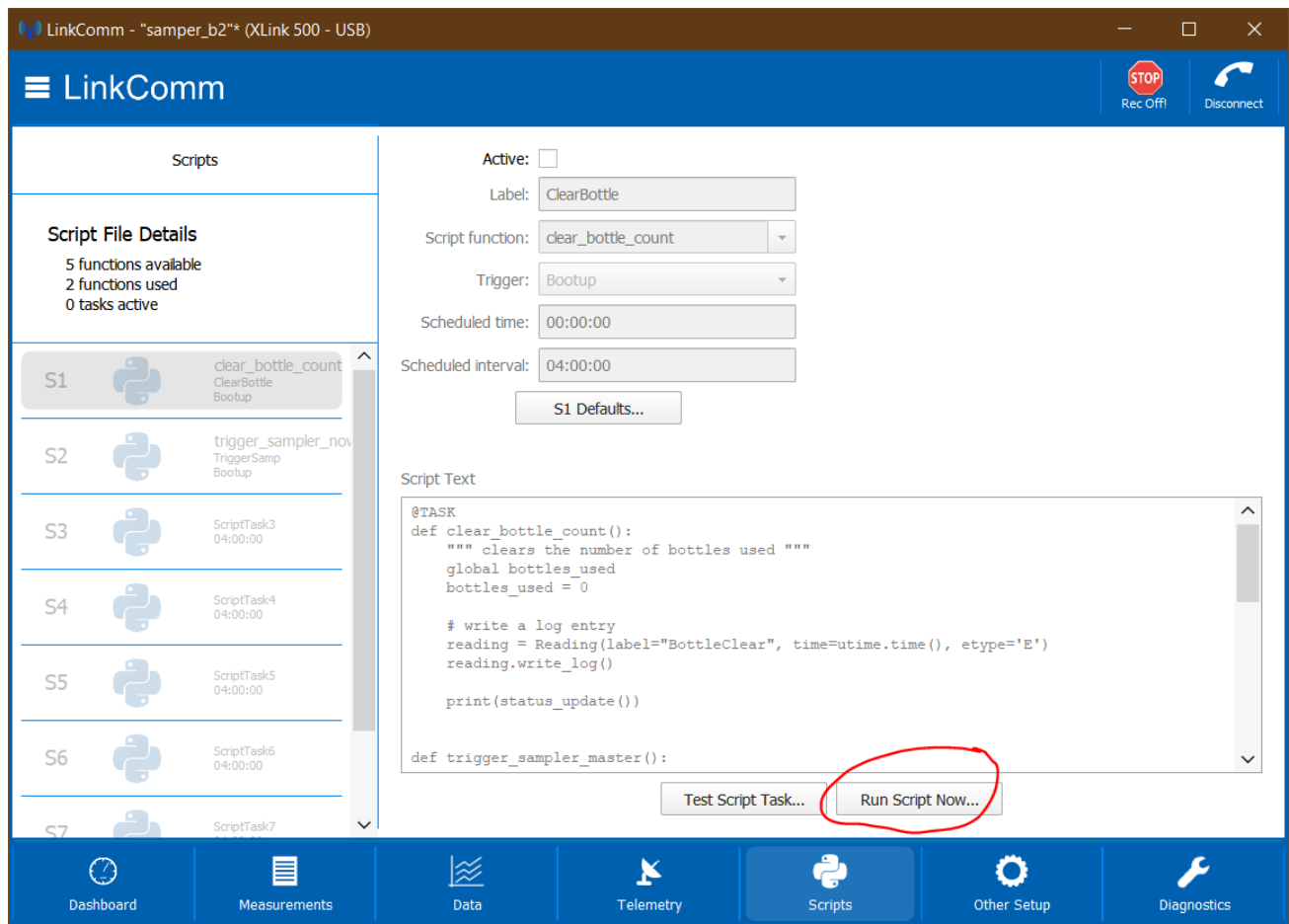
These scripts may be invoked by sending an SMS with the following content:

IS1 SCRIPTRUN

or

IS2 SCRIPTRUN

Note script task is not active, but may be run anyway via LinkComm's Run Script Now button.
Script Task S2 may be likewise run in order to trigger the sampler.



The screenshot shows the LinkComm software interface. The title bar indicates the connection to "samper_b2" (XLink 500 - USB). The interface has a blue header with the LinkComm logo and status indicators (STOP Rec Off!, Disconnect). The main area is divided into a left sidebar and a right panel. The sidebar lists scripts S1 through S7. S1 is "clear_bottle_count" (ClearBottle, Bootup), S2 is "trigger_sampler_now" (TriggerSamp, Bootup), and S3 through S7 are "ScriptTask3" through "ScriptTask7" with a scheduled time of 04:00:00. The right panel shows the configuration for S1, including fields for Label, Script function, Trigger, Scheduled time, and Scheduled interval. Below these fields is a "Script Text" area containing Python code for the script. At the bottom of the right panel, there are two buttons: "Test Script Task..." and "Run Script Now...". The "Run Script Now..." button is circled in red. The bottom navigation bar includes icons for Dashboard, Measurements, Data, Telemetry, Scripts, Other Setup, and Diagnostics.

LinkComm - "samper_b2" (XLink 500 - USB)

LinkComm

Scripts

Script File Details

5 functions available
2 functions used
0 tasks active

S1 clear_bottle_count
ClearBottle
Bootup

S2 trigger_sampler_now
TriggerSamp
Bootup

S3 ScriptTask3
04:00:00

S4 ScriptTask4
04:00:00

S5 ScriptTask5
04:00:00

S6 ScriptTask6
04:00:00

S7 ScriptTask7
04:00:00

Active: ☐

Label: ClearBottle

Script function: clear_bottle_count

Trigger: Bootup

Scheduled time: 00:00:00

Scheduled interval: 04:00:00

S1 Defaults...

Script Text

```
@TASK
def clear_bottle_count():
    """ clears the number of bottles used """
    global bottles_used
    bottles_used = 0

    # write a log entry
    reading = Reading(label="BottleClear", time=utime.time(), etype='E')
    reading.write_log()

    print(status_update())

def trigger_sampler_master():
```

Test Script Task... Run Script Now...

Dashboard Measurements Data Telemetry Scripts Other Setup Diagnostics

Measurement setup

Turbidity

M1 is turbidity. It is linked to the script and is the primary cause for triggering the sampler.

Bottles Used








M6 is bottles used. The value is generated by the script and represents the number of USED bottles so far.

- It resets to zero every bootup.
- It may be manually reset to zero via S1 Script Task.
- **Calibrating this value via the measurement tab will not work.**

M6 is also used to trigger SMS when the bottle count reaches the limit. Setup the Alarm 1 Threshold to the desired number of bottles used. Once the system reaches this number, it will send SMS to the phone numbers setup via Telemetry (see below).

M6 is required to send SMS. If logging this value is not desired, change the Logging setting to Do Not Log.

Measurements (2/32)

M1		Turbidity 00:05:00
M2		Sense2 00:15:00
M3		Sense3 00:15:00
M4		Sense4 00:15:00
M5		Sense5 00:15:00
M6		BottlesUsed 00:05:00
M7		Sense7 00:15:00

☐ Use equation

Last reading: 1.00 G

Time of last: 2021/09/08 19:45:00

Time of next: 2021/09/08 19:50:00

Alarms

Type	threshold	Alarm tx mode:	Tx In Only
Alarm 1:	High 22.000000	Deadband:	0.000000
Alarm 2:	Off 1.000000	Alarm logging:	Every Reading
Alarm 3:	Off 1.000000	ROC interval:	Since Last Meas

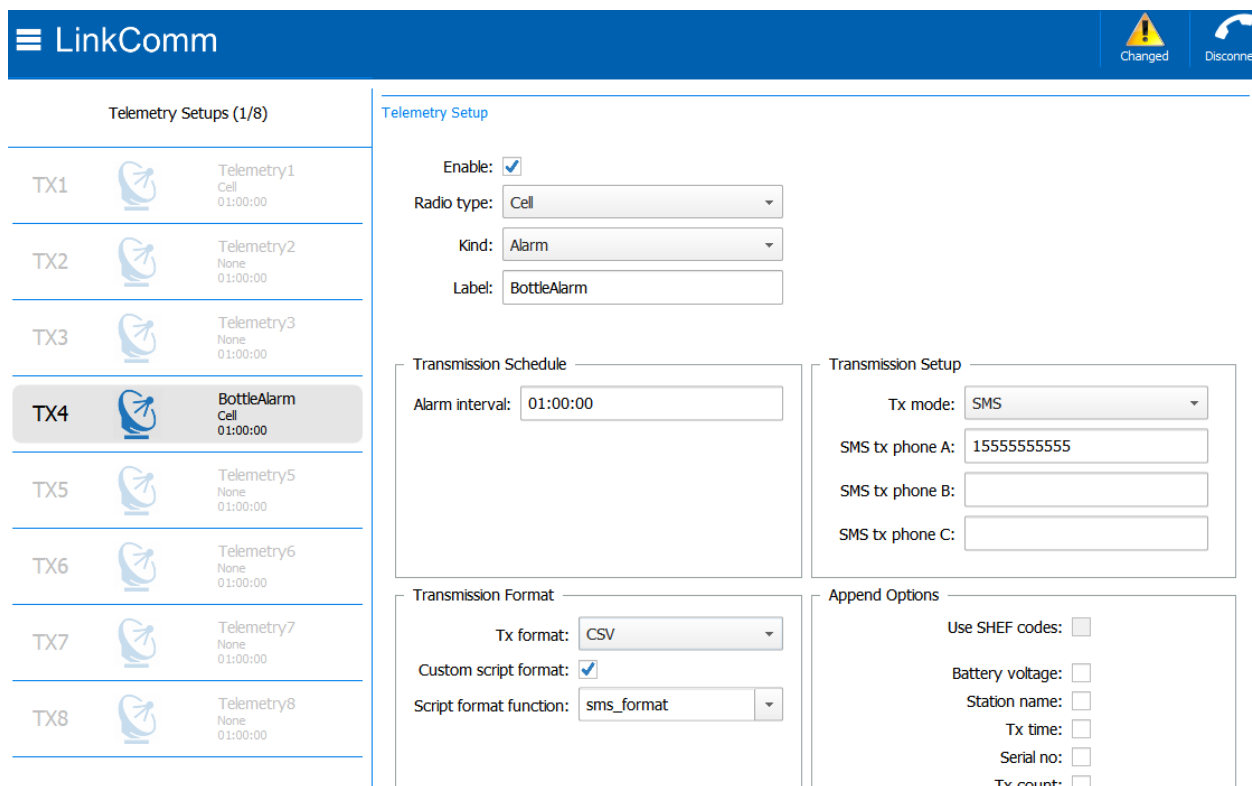
Telemetry setup

TX4 is setup as an alarm tx. It sends SMS when the bottle count reaches threshold.

The content of the text message is the same as shown for [Script Status](#).

Modify TX4 and add the correct SMS phone numbers for up to three recipients. If you require more, setup TX5 to look exactly like TX4, but to have the rest of the phone numbers.

As long as the bottle count exceeds the threshold, the system will keep sending alarms! Alarm interval controls how often this happens. Set alarm interval to zero to have only one set of SMS sent.



The screenshot shows the LinkComm web interface for Telemetry Setup. On the left is a list of Telemetry Setups (1/8) with TX1 through TX8. TX4 is selected and highlighted. The main panel shows the configuration for TX4, which is labeled 'BottleAlarm' and has a 'Cell' radio type. The 'Enable' checkbox is checked. The 'Kind' is set to 'Alarm'. The 'Label' is 'BottleAlarm'. The 'Transmission Schedule' section shows an 'Alarm interval' of '01:00:00'. The 'Transmission Setup' section shows 'Tx mode' set to 'SMS', 'SMS tx phone A' as '1555555555', and empty fields for 'SMS tx phone B' and 'SMS tx phone C'. The 'Transmission Format' section shows 'Tx format' set to 'CSV', 'Custom script format' checked, and 'Script format function' set to 'sms_format'. The 'Append Options' section has several unchecked checkboxes: 'Use SHEF codes', 'Battery voltage', 'Station name', 'Tx time', 'Serial no', and 'Tx count'.

Test Mode

To test how the script behaves without a sampler or a turbidity sensor, do the following:

- To rig the turbidity values, modify python script file
 - Search for test_turbidity
 - Modify the list of values to have the turbidity readings that you would like to test
 - The system will sequentially read the list, and use the values as if they were produced by the turbidity sensor
- Set GP10, TestMode to +1.0
 - To disable test mode, set GP10 to -1

- Increase the measurement interval
 - Otherwise you will be waiting a long time to test the script!
- Baseline interval
 - This value defaults to 99 hours. If you want to test the baseline, change it to a small number (0.5 is half an hour, 0.1 is 6 minutes).

Logged Data

In addition to logging measurements, Satlink will log data as it controls the sampler. To view this data, you will need to select the Include Events option in LinkComm. Also check the download Options for downloading one log file (with both meas and events) or two log files (one for meas, one for events).

These are the events logged:

- Triggered
 - Indicates that the sampler was triggered
 - Includes the bottle count
- The cause of the trigger will be one of the following:
 - User
 - Baseline
 - ChangeSince (change since last trigger)
 - Threshold