

Application Note 11 - Totalization

Using the TrendView Recorders for Totalization

The totalization function is normally associated with flow monitoring applications, where the input to the recorder would be a measure of a flow rate (e.g. in liters per second) and the amount that has flowed over a certain time period (i.e. cubic meters) would be the total of interest. The TrendView recorders make it easy to view and totalize these flows on the recorder.

Recorder Requirements for Totalization

Setting up the recorder to do totalizations requires Credits to enable the Totalizer function. The Credit system in the TrendView recorders provides a flexible method to enable functions for better viewing, logging and control of the totalizations in the recorder.

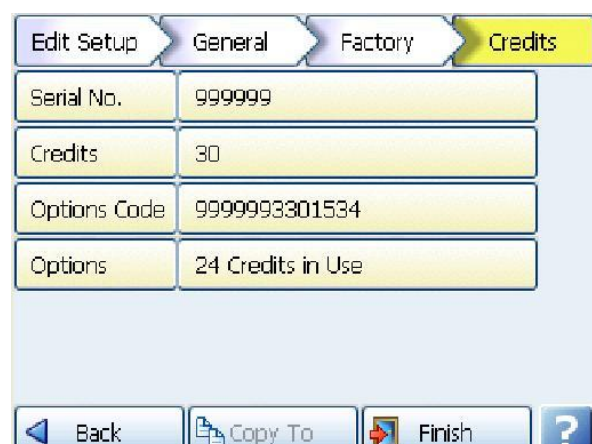
The minimum recorder requirement for doing a totalization, besides having an analog input for the flow signal, is that you need four credits to enable the totalization function; you do not need Math to actually do a totalization. Enabling the total function in the Credits set up screen, allows you to set up as many totalizers as available analog inputs. If you want to display the totalizer value as a trace, log the totalizer, use it in a Math expression or alarm off of the total you will need the Extra Pens to do this. For a **eZtrend** recorder this could be up to 12 Analog inputs + 12 Extra Pens, for **DR Graphic** and **Minitrend** recorders this could be up to 16 Analog inputs + 16 Extra Pens, and for a **Multitrend** recorder this could be up to 48 Analog inputs + 48 Extra Pens. Totalizers can be viewed, started, stopped and reset at the recorder by using the Process Screen or by setting up scheduled control actions using the Events. If you plan to do scheduled or remote control actions, such as starting, stopping and resetting a totalizer, you will also need six credits for the Events.

Setting up Totalizers at the recorder

Totalizers, once the function has been enabled in the Credits function of the recorder, are set up as part of the Pen set up. To enable the credits for totalizers, you would first go to the Main Menu button to enter the configuration mode of the recorder. To get to the Credits set up, just follow the path MENU>CONFIGURE>SETUP>EDIT>GENERAL>FACTORY>CREDITS; select the Options button to open the screen to enable Totals. To use the Rollover feature in the Totalizer and count the number of times the totalizer rolls over you will also need to enable and use Counters and Events. These also require credits and should be enabled at the same time.



Recorder Factory Setup Screen



Recorder Credits Setup Screen

Pen Set up for Totalization

The totalizer is set up under the Pens configuration in the recorder and will totalize the signal that has been tied to that particular pen in the “Edit Maths” Pen selection. The input is set up based on the parameters of the actual flow signal coming into the recorder, while the totalizer is set up for the conditions of the totalized value. This allows you to set up the flow signal to be measured in one set of engineering units while calculating the totalized value in a completely different set of units. To set up a totalizer, click on the “Totalizer” selection under the Pen Setup screen. The “breadcrumbs” at the top of the recorder setup screen shows the path that was taken to get this particular screen.

| Edit Setup | Pens | Pen 8 |
|-------------|--|-------|
| Enabled | <input checked="" type="checkbox"/> | |
| Tag | Pen 8 | |
| Description | Inlet #1 | |
| Maths Type | Basic Maths | |
| Edit Maths | A8 | |
| Scale | 0.0 to 1000.0 Gals/Hr | |
| Logging | <input checked="" type="checkbox"/> 1 Min Cont | |
| Alarms | None | |
| Totaliser | <input checked="" type="checkbox"/> Normal | |

Back Copy To Finish ?

Pen Setup Screen

| Edit Setup | Pens | Pen 8 | Totaliser |
|----------------|-------------------------------------|-------|-----------|
| Enabled | <input checked="" type="checkbox"/> | | |
| Type | Normal | | |
| Tag | Total 8 | | |
| Add to Msgs | <input checked="" type="checkbox"/> | | |
| Units | None | | |
| Time Factor | 1.0 | | |
| Unit Factor | 1.0 | | |
| No Backflow | <input checked="" type="checkbox"/> | | |
| Backflow Level | 0.0 | | |

Back Copy To Finish ?

Totalizer Setup Screen

When you get to the Totalizer screen, “Enabling” the totalizer allows you to configure the totalizer parameters. Under the “Type”, you will see two different types of totalizers – Normal and Sterilization. The Normal totalizer function is typically used for flow monitoring applications while the Sterilization type is for applications involving sterilization or pasteurization processes where you need to monitor lethality rates for the product being sterilized.

The totalizer can be identified with a customizable “Tag” name that can be up to 17 characters in length, making it easy to identify each totalization or sterilization. The “Add to Msgs” configuration item allows you to decide if messages associated with starting, stopping or resetting the totalizers will be added to the message and trend screens. The “Units” allow you to enter a label for the units of the totalizer; the units label can be up to 12 characters in length and this can be different then the actual flow signal being totalized.

The Time Factor and Unit Factor are key setup parameters for getting the totalization correct. The recorder’s totalizer adds the flow input value every second, so depending on the actual flow rate, you need to divide by the Time Factor to insure that the flow being added is based on a flow rate per second. For example, if your flow meter is measuring a flow in gallons per minute, you will need to divide by a time factor of 60, so for every 1 second, a 60th of the flow signal is added to the totalization. (i.e. 1 minute = 60 seconds). For an hourly flow rate, the Time Factor used would be 3600 (1 hour = 60 seconds X 60 minutes = 3600).

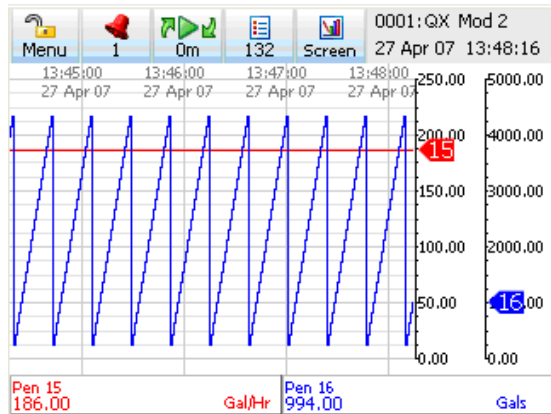
The Unit Factor works in a similar manner but it used to adjust the engineering units of the flow instrument to match the units being totalized. So in the case of the Unit Factor, if the flow rate is being measured in liters per second and you are totalizing in liters, the Unit Factor would be 1, so for every 1 second 1 liter is added to the total. If you want to totalize in cubic meters, you would need to divide by 1000 (1 cubic meter = 1000 liters) to have the totalized value represent cubic meters.

When actually totalizing any value the totalizer is set to totalize up to a maximum value of 16777215 and roll over to zero when this value has been reached. The reason for this is to prevent errors from entering the calculation. Above this number the math precision used in the recorder would begin to affect the totalizer accuracy.

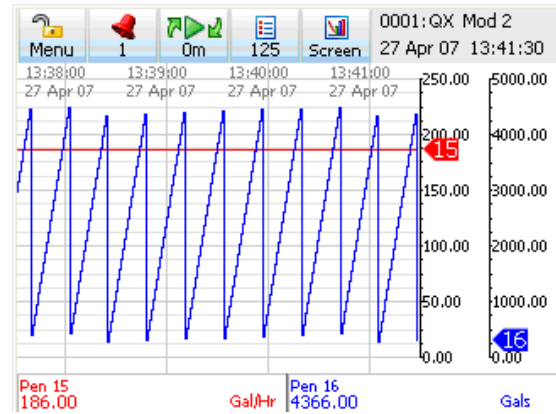
If you need to totalizer values greater than 16777215, this can be done by setting up a counter to count the number of times the totalizer rolls over and to use a Math Expression to calculate the overall total. This is discussed later in this application note.

The totalizer set up also allows the user to set whether the recorder's totalizer is to ignore backflow along with a level setting at which the backflow is to be ignored, if it is used. Backflow is a condition where the flow reading from the flow meter indicates a negative flow or essentially flow going in the opposite direction. If "No Backflow" is made inactive in the recorder set up and the flow reverses, the recorder's totalizers would begin to subtract from the present total in the recorder. If "No Backflow" is active, the recorder will just stop totalizing until the flow level signal exceeds the Backflow level set in the recorder.

You can set up a restricted range for the totalizer so it restarts at the minimum range value once it reaches the maximum range value that was set in the recorder and starts totalizing again. When you use a restricted range you can also set it up to use the remainder if the total exceeds the maximum range set. If Use Remainder is set, the recorder will carry any excess remainder over, adding it to the next totalization cycle. The below recorder screens show a totalization set up with a restricted range with no remainder being used and with Use Remainder being set to enable. In the Use Remainder, you can see that the trace of the totalizer is not uniform between the restricted ranges because of the remainder that is added to the next totalization cycle.



Restricted Range 250 to 4500 No Remainder

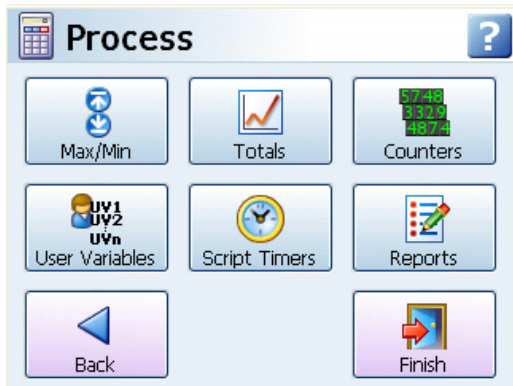


Restricted Range 250 to 4500 Use Remainder

One final setting for the totalizer is the number format, which can be set for scientific notation or normal engineering format. The totalization values can be 10 digits plus the exponent.

Viewing Totalizers

There are a number of ways to view the totalizers at the recorder. The easiest way is to use the Process screen of the recorder. This is accessed by going to the Main Menu and selecting Process.

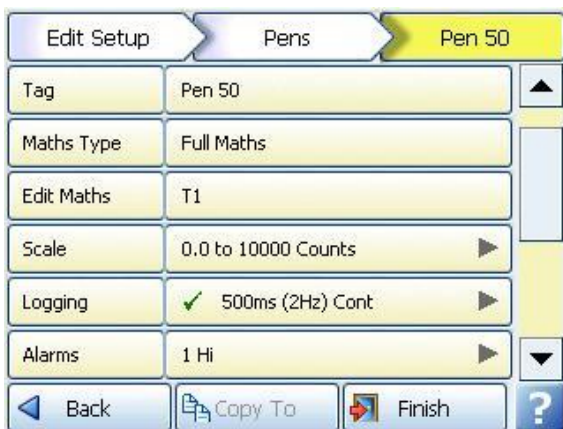


Process Recorder Screen

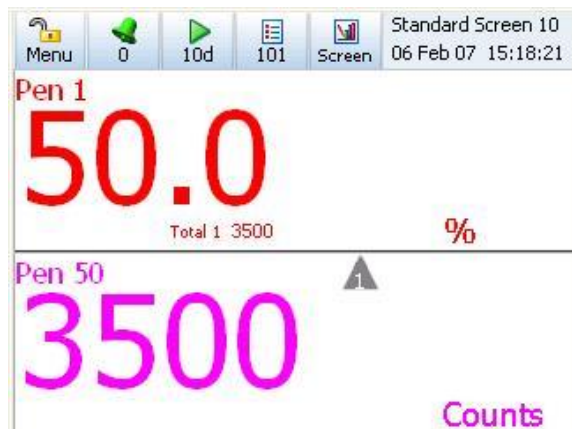
| | | | |
|--|--|--|--|
| Total 1 Running 6.1e+10 Liters | Total 2 Running 3700.0 None | Total 3 Running 2883.2 None | Total 4 Running 2923.5 None |
| Total 5 Running 2917.0 None | Total 6 Running 3022.4 None | Total 7 Running 1849.9 None | Total 8 Running 1846.9 None |
| Total 9 Running 5827814 None | Total 11 Running 1670.0 None | Total 13 Running 2036.7 None | Total 14 Running 2570.8 None |
| Total 15 Running 808.0 Gallons | Total 49 Running 3053.0 None | Total 50 Running 5541.1 None | Total 51 Running 2312.5 None |
| ◀ Back | | Prev | Next |

Process View - Totalizers

Viewing Totals with the Process screen allows you to see all the enabled totalizers in a panel meter type display; if more totalizers are enabled then what fits on a single screen a “Next” page can be accessed to view these additional totalizers. Another method of viewing totalizers is to set the Totalizer up using another Pen; this Pen can be associated with an analog input or an extra pen. Assigning a totalizer to a Pen allows you to log the “Total” to memory, display it as a trace, set up an alarm based on the totalized pen value and to use it in a Math expression. Totals can also be included in a message using the Embedded Variables feature of the Event system. The embedded totalizer variable would include the current value of the totalizer as part of the message that is logged in the message screen. Assigning a Totalizer to a Pen is as simple as setting the Pen’s “Edit Maths” expression to be a total, so for example, if the pen was to display the value of Total 1, the Edit Maths expression for an extra pen would be T1. In the example shown below, Total 1 is set up on Pen 1, which would represent the flow signal and Pen 50 has been set up to show the value of Totalizer 1, which allows you to set up an alarm for the totalized value and to log Total 1 to memory.



Extra Pen 50 used to display Total 1



Recorder Display showing Both Pens

Controlling Totalizers

There are a number of methods that can be used to control Totalizers in the recorder; some require the use of the Event function to do this. The Event system provides a highly flexible way to control when totals can be started, stopped and reset. Events can also be used to improve on the documentation of the logged totalizer results. Of course, all totalizers can be controlled using the Process screen of the recorder, allowing the user to locally Start, Stop and Reset the totalizers. These actions can be done individually by Pen, by Group or All at once.

Using Events to Control Totalizers

Events make it easy to control Starting, Stopping and Resetting events based on a remote action, an alarm or setting up a schedule such as getting a daily, weekly or monthly total. Using the Event function does require the use of six credits to enable Events. One of the most useful Event functions used with Totalizers is the "Schedule" Cause Event; this event allows you to schedule an action based on a time schedule. You can set it up as a single one time action or to occur on a regular periodic basis, making it useful to use for doing hourly, daily, weekly or monthly totals. To set up a Scheduled totalization, you would configure a Cause Event to be a Schedule, under Schedule you would decide if it is to occur once at a select time, periodically based on a Time Interval, based on a Specific Day or days of the week or to occur at Month's end. If setting this for an Interval, you can set it to align to the minute, hour or day so the totalization will begin once the recorder's clock aligns with the desired setting. This way, if you want a totalization to begin on the hour rather than at a random time you would use the align function and the totalization will start at the beginning of the next hour rather than as soon as you exit the configuration mode. The recorder configuration screen below shows using the Schedule Event to align the totalization to a minute and using an embedded variable to print the totalized value as a message before resetting it; it is set up to occur every two minutes. This could easily be changed to do it hourly, daily, or weekly.

| | | | | |
|-------------|-------------------------------------|---------|--------|---------|
| Events/C... | Events | Event 1 | Causes | Cause 1 |
| Enabled | <input checked="" type="checkbox"/> | | | |
| Type | Scheduled | | | |
| Sub Type | Interval | | | |
| Period | 2m:00s | | | |
| Alignment | Minute | | | |
| Count | 0 (Repeat) | | | |
| Back | Copy To | Finish | ? | |

Cause Event Set up as a Schedule

| | | | | |
|-----------------|-------------------------------------|---------|---------|----------|
| Events/C... | Events | Event 1 | Effects | Effect 1 |
| Enabled | <input checked="" type="checkbox"/> | | | |
| Type | Mark Chart | | | |
| Marker Type | User Defined | | | |
| Mark Chart Text | Totalizer 15 [[P16.V]] [[P16.U]] | | | |
| Back | Copy To | Finish | ? | |

Event Effect Set up as Embedded Message



Recorder Trend, Total Printed & Reset every 2 Minutes, aligned to the minute

| Users Messages | | | |
|----------------|----------|------------|--------------------------|
| Type | Time | Date | Message |
| ▲ | 09:51:01 | 30/04/2007 | Total 15: Total 15 Reset |
| ▲ | 09:51:00 | 30/04/2007 | Totalizer 15 2380.0 Gals |
| ▲ | 09:49:01 | 30/04/2007 | Total 15: Total 15 Reset |
| ▲ | 09:49:00 | 30/04/2007 | Totalizer 15 2380.0 Gals |
| ▲ | 09:47:01 | 30/04/2007 | Total 15: Total 15 Reset |
| ▲ | 09:47:00 | 30/04/2007 | Totalizer 15 2380.0 Gals |
| ▲ | 09:45:01 | 30/04/2007 | Total 15: Total 15 Reset |
| ▲ | 09:45:00 | 30/04/2007 | Totalizer 15 2380.0 Gals |
| ▲ | 09:43:01 | 30/04/2007 | Total 15: Total 15 Reset |
| ▲ | 09:43:00 | 30/04/2007 | Totalizer 15 2380.0 Gals |
| ▲ | 09:41:01 | 30/04/2007 | Total 15: Total 15 Reset |
| ▲ | 09:41:00 | 30/04/2007 | Totalizer 15 2380.0 Gals |

Message Screen showing Totals

Using Events and Counters to Totalize Values Above 16777215

Totals in the recorder now roll over once they reach a value of 16777215, but it is possible to totalize and display totalizer values above this value by using Events, Counters and Math to calculate these values. To set this up, once you have set up the Totalizer the next step would be to enable and set up a Counter in the Event/Counter configuration section of the recorder. This would now allow you to set up the Events required to detect the Totalizer Rollover condition and have this cause the counter to increment by 1. A second Event is used to handle resetting the totalizer and making sure the individual totalizer result and the accumulated totalizer value say in sync if the totalizer is reset. To calculate the accumulate totalizer result, a Math expression can be set up on a Pen to count the number of times the totalizer rolls over and use this to calculate the Totalizer Result. The Math expression to use would be $P2 = (UC1 * 16777215) + T1$; this takes the current counter value which is how many times the totalizer has rolled over, multiplied by the 16777215 count and then adds the current value of the active totalizer to give the accumulated result for the totalizer.

The set up of the Events to handle this would be as follows (the set up screens are shown below).

Event 1 – Cause 1 Type Totalizer, Sub-Type Rollover; Effect 1 Type Counters, Event Action Increment, Set to Increment by 1

Event 2 - Cause 1 Type Totalizer, Sub-Type Reset; Effect 1 Type Counters, Event Action Reset, Sub-Type – User, Reset to 0

Totalizers - Logging and Reports

Totals, unless they are actually set up as a Math Expression in a Pen (i.e. Pen X = T1), are only displayed as part of the Digital Panel Meter or the Process display. They can be included in the Messages as part of the totalizer setup or with Events, but in order to actually log what is happening with the totalizer over time; the totalizer needs to be assigned to a Pen. Once it has been assigned to a pen, you can use it in other Math expressions, tie an alarm to the totalizer value, log the total, and get the value in real time over the network. Logging the total, using an extra pen provides the most flexibility for managing the data and doing analysis afterwards.

Another method to document totals is to use the Reports function of the recorder. The Reports function provides a preformatted summary report that can be saved to the removable media of the recorder (Compact Flash or USB memory key), e-mailed or printed. The Report function allows the user to set up parameters such as Current Pen Values, Max/Min Values, Averages, Totals, Messages, Counter information, Digital Input and Digital Output information that are inserted into a document that uses a Rich Text Format and can be opened as a Word document. With the Totals, the user can decide if they want Hourly, Daily, Weekly, Monthly or the Current value of the selected Totals included in the report when it is generated.

The report is set up under the Reports icon of the recorder and is triggered using the Event system or manually as part of the Process Screen. For example, if you want an hourly report, you would set up a schedule event to trigger the report on an hourly basis at the pre-determined time. In the Reports section, you would select Hourly Totals; it would provide, in the report, the totals for the hour prior to the scheduled event. So in the example below, the schedule was triggered at 2:00 and the report provided the totals at the end of the previous hour as shown below; (this was extracted from the Totals section of the recorder generated Report). Note that if the totalizers are reset during the specified time period, the report only provides the total at the end of the hour.

Hourly Totals between 1h:00m:00s and 1h:59m:59s 01/05/2007

| Pen | Totals |
|--------|---------------|
| Pen 4 | 284124.66 ° F |
| Pen 5 | 280744.41 ° F |
| Pen 6 | 286749.59 ° F |
| Pen 15 | 1180.00 Gals |

Understanding Totalizers - a real world example

This example should help you better understand how totalizers work and how they should be set up in the recorder to provide the results you desire. This example uses a flow meter that outputs an instantaneous flow value of water being pumped to a reservoir and from that flow value we derive a cumulative flow number. This flow value is usually based on hours, days, weeks, etc.

The most important items to remember when setting up totalizers in the recorders is the Time and Unit factors; the Time Factor will determine to which time base you are totalizing and the Unit Factor lets you convert to other engineering flow units. If a flow meter had an output ranged to 500 gallons per minute, by tweaking the Unit factor we could totalize in liters, barrels, buckets or any other unit.

- The Analog input represents a certain unit set in time eg. gal/min, liters/ sec, barrels/hour or tons/day
- The total engineering units represents unit of Volume, Mass or Length and will not be related to time.

For our flow application, we have a flow meter that has a calibrated output of 0 to 500 Gallons per hour (GPH), where 0 GPH = 4mA and 500 GPH = 20mA output. The transmitter is connected to Analog 1 (A1) of the recorder. The Field I/O, Analog Input (A1) is setup with an input zero of 4mA and span of 20mA. Proceeding to the PEN 1 (P1) setup, set the Edits Math to equal the analog input from the flow meter, this would be A1, set the scale to match the range set in the flow meter "Span" as 500 and "Zero" as 0. At this point, you now have Pen 1 (P1) and Analog Input (A1) setup to measure and display the instantaneous flow value from the transmitter.

The "Totalizer" can now be set up for this pen; this assumes that the Credits for the Totalizer option have been enabled. Under the Pen setup, click on the Totalizer, select "Normal" for the Type, since we are doing a flow totalization; the next key item is to determine the "Time Factor" which is your time reference. The Totalizer, embedded in the recorder, adds or updates itself every 1 second; so for our example, we need to set the time factor to match the "H" (hours) of GPH of our application.

The "H" stands for hour, we know the recorder's totalizer adds every 1 sec, there are 60 seconds in a minute and 60 minutes in an hour, so our Time Factor in this application would be 60 sec x 60 min. = 3600. So any time you are totalizing in hours the Time Factor would be 3600. If you were going to totalize in gallons per day, then your Time Factor would be 60 sec. x 60 min. x 24 hours = 86400.

The other factor that needs to be considered is the Unit Factor; the Unit Factor works in a similar manner as the Time Factor but it used to adjust the engineering units of the flow instrument to match the units being totalized. So in the case of the Unit Factor, if the flow rate is being measured in GPH and you are totalizing in Million Gallons, the Unit Factor would be 1,000,000 so for every 1 second, 1 millionth of a gallon is added to the total. So for this example, you need to divide by 1,000,000 to have the totalized value represent million gallons.

Displaying and Recording the Totalizer Value

Once the Totalizer is setup, the totalizer value can be displayed as part of the Digital Panel Meter display of the recorder or by viewing the Process screen and viewing the active totalizers. To log the totalizer value, you will need another Pen to display and log the totals, which requires the use of Extra Pens. Extra pens do not have real hard wired analog inputs associated with them, but can be used to enhance the display and logging capabilities of the recorder; they are the ones labeled P49 and higher. We can use any other pen to do a totalization but those below Pen 49 (P49) would consume an actual analog input. To assign a totalization to another pen, in the Edit Maths Expression for the extra Pen, you would enter "T1" (assuming that T1 is the totalizer that is being utilized). So in this case, if we use Extra Pen 50 for setting up the trending of the Totalizer of Input 1 that is tied to Pen 1, the Edit Maths Expression for Pen 50 is T1; this will now display the totalization of Pen 1 on this Pen. If you looked at the Panel Meter display with Pen 1 and Pen 50 side by side the Total on Pen 1 should agree within one scan cycle with the Pen value on Pen 50 (this was shown above). Since Pen 50 is independent of Pen 1 you can set the pen scale for what is needed to properly display the totalized value along with a completely different logging rate, if desired. Keep in mind that the totalization is being done on Pen 1, not the Extra Pen 50, so you should not enable the totalizer on Pen 50, otherwise you will see a totalization of the totalization.

Starting/Stopping/Resetting Totals

There are two key ways to start, stop or reset the totalizer; the easiest method is to do this using the recorder's Process screen. This allows you to start, stop or reset totalizers individually by Pen, as a Group or to do all of them at once. The other way to start, stop or reset totals is through the recorder's Event system. You can create events to reset any or all of the totalizers based on any of the Event Causes such as a Digital input or a Schedule Event that allows you to set a Time and Day of the week for the Event action or by repetition such as every 24 hours. You can also setup the event so you can reset using the Remote Viewing and Control function of the recorder.

Summary

The TrendView recorders make it easy to set up, display, record and control totalizers. The totalizers are tied to a pen, allowing you to easily alarm on the Totals value, you can get a standard Trend line for Totals, you can use the totals value in a math equation and you have the flexibility of any other pen when it comes to logging and doing real-time data collection of the total. Using the Event system allows you to control the starting, stopping and resetting totals automatically based on various Event Causes.