Schedules

General operation of the *DT80* data loggers centres on scheduling.
Schedules determine when various processes are to occur, and can be triggered by the real time clock, by digital or counter events, by alarm states, and by the host computer.

The *DT80* range supports 14 different types of schedules.
1.   11 general purpose schedules, A-K, which can be triggered by a variety of different events
2.   1 polled schedule, X, which is normally triggered by a poll command from the host computer (although most of the other triggers can also be applied to it, making it effectively a 12th general purpose schedule)
3.   1 immediate schedule, which executes once immediately after being entered
4.   1 statistical schedule, which collects and accumulates data to be returned as statistical summaries by the other schedules.

The Schedules manage schedule lists, which contain the various actions that are to be performed when the Schedule is triggered or runs.
These actions include
1.   Reading input
2.   Internal channels
3.   Setting output channels
4.   Evaluating expressions
5.   Testing alarms
6.   Returning data
7.   Logging data, etc.

Many *dataTaker* commands relate to the Schedules and their schedule lists.
Therefore it is important to understand this core concept of Schedules and scheduling.

Schedule types

There are three basic types of Schedules;
1.   On logger activation (AKA immediate schedule)
2.   Triggered schedules
3.   Statistical Sub Schedule

On logger activation

Also known as the Immediate Schedule, the schedule list is processed or scanned once immediately upon being entered, and any data produced is returned to the host computer. Data from the Immediate Schedule cannot be logged or displayed. This schedule is primarily used to configure digital i/o, initialize channel variables with calibration factors to be used latter in the configuration
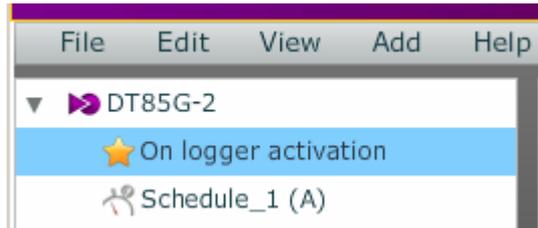

Figure 1 On logger activation schedule

Triggered Schedules

The schedule list is processed or scanned at regular time intervals or on a specified event. Any data that is produced can be returned to the host and logged to the memory.

The 11 different triggered schedules can each have their own triggering conditions independent of who the other schedules are configured.
A common application is that of a weather station where it is common to report the 5 minute values, 1 hour values and 1 day values. In this case 3 schedules would be set up to take measurements with each schedule set to trigger at each of the different time intervals.
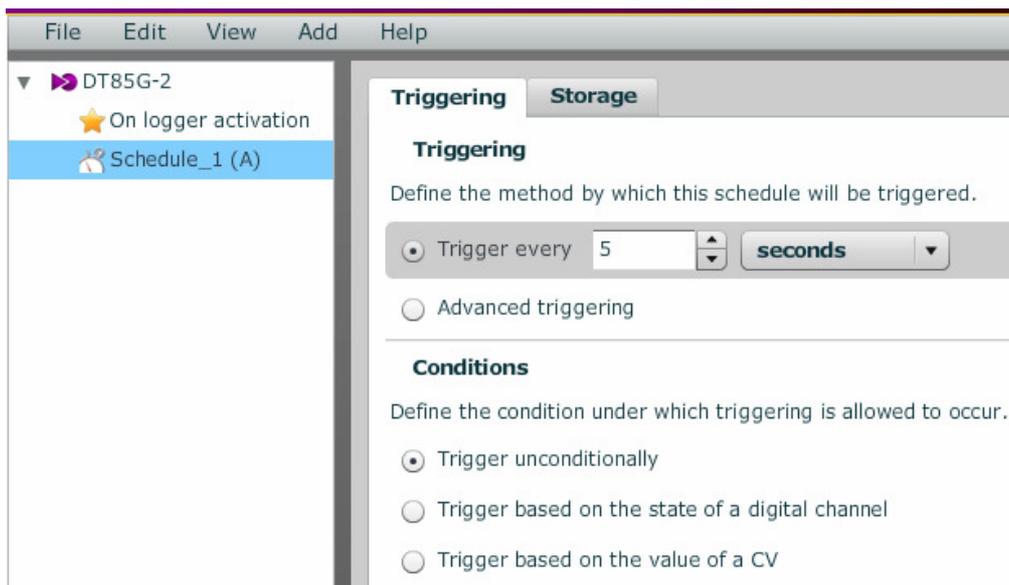

Figure 2 Repeating schedule selection and definition dialog

Statistical Sub Schedule

The schedule list is processed or scanned repeatedly and the data is used to calculate a periodic average, standard deviation, minimum and/or maximum or integral data for the input channels. This Sub Schedule is used in conjunction with the Triggered Schedules, which determine the interval at which the statistical data is calculated and returned to the host, logged into the data memory and displayed.
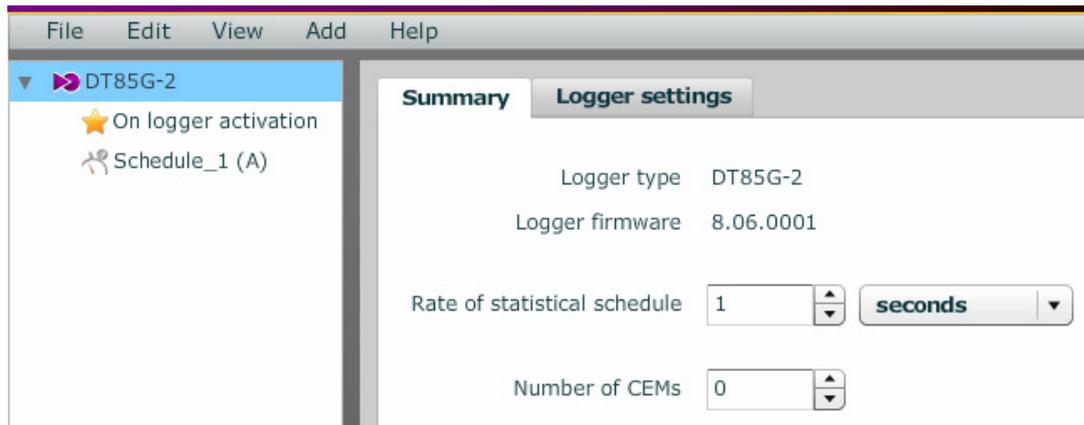

Figure 3 Statistical schedule definition dialog

Notes:
The statistical sample rate must be set faster than the reporting schedule.

Schedule triggers

The Triggered Schedules and the Statistical Sub Schedule can be triggered by;

Time

Using the *dataTaker* real time clock as time base.
Time intervals available are;
1.   milliseconds
2.   seconds
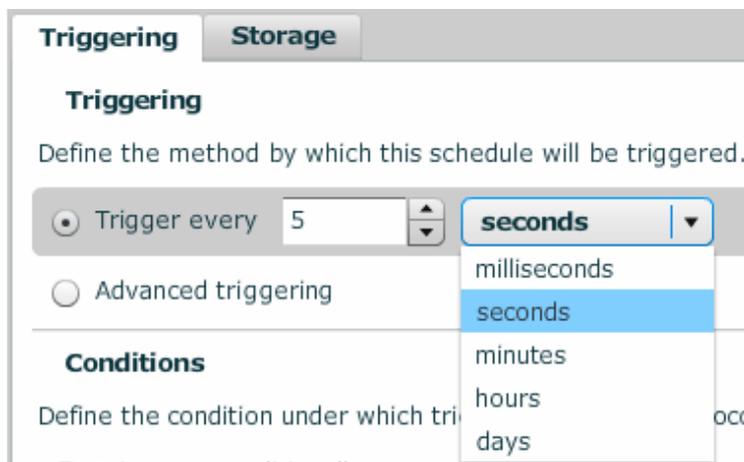3.   minutes
4.   hours
5.   days

Figure 4 Time based schedule trigger dialog

Notes:
1.   *Value entered in "Trigger every" is an integer in the range of 1 to 65535 except for the millisecond time interval where the minimum value is 5 milliseconds*
2.   *The schedule first runs on the next multiple of the interval since last midnight and subsequently runs every multiple of the interval thereafter. If the interval is not an even multiple of 24 hours, the DT80 inserts a short interval between the last run of the schedule prior to midnight, and the run of the schedule beginning at midnight.*

Continuous

If continuous is selected the *DT80* will sample this schedule as fast as possible. The actual sample speed will be determined by the number of channels being sampled, the channel type and other processes running during the sampling.

To select continuous sampling under the trigger tab check "Advanced triggering" and select "continuous" from the trigger selector.
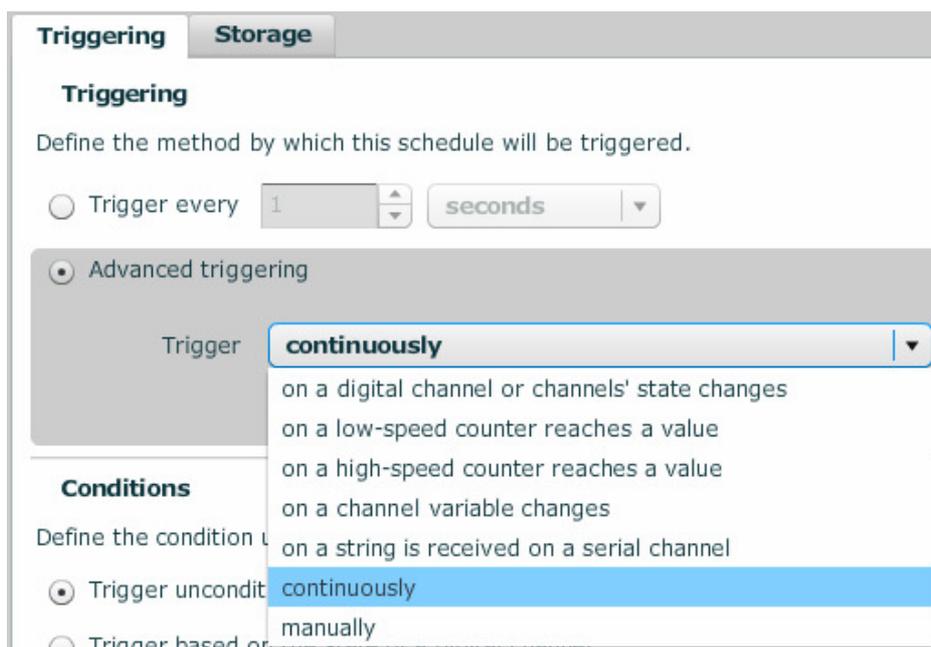

Figure 5 Selecting continuous triggering for a schedule

Note:
1. *Care should be taken when using continuous sampling as it can interrupt the operation of other schedules. It is preferable to use continuous mode if no other schedule is defined. Please refer to section Schedule considerations for further details.*

Digital events
A change of state of one or more digital input channels

1.   Rising or falling edge of a digital input
2.   Rising edge of a digital input
3.   Falling edge of digital input
4.   Rising or falling edge of a range of digital inputs
5.   Rising edge of a range of digital inputs
6.   Falling edge of range of digital inputs

To select on digital event sampling, under the trigger tab check "Advanced triggering" and select "on a digital channel or channel's state change" from the trigger selector
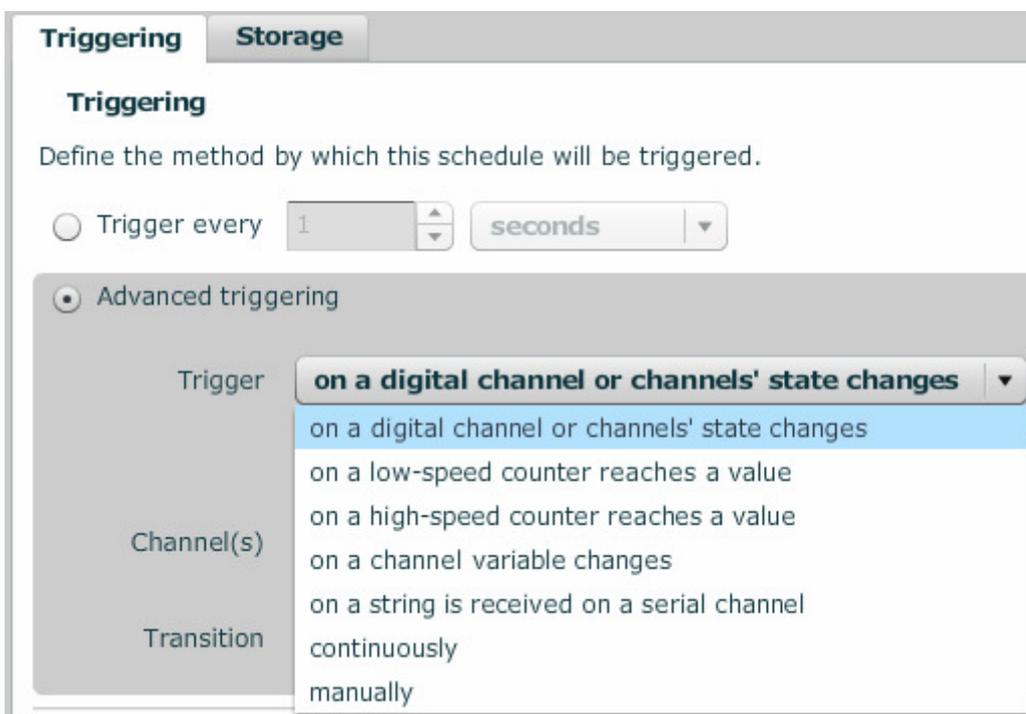

Figure 6 Selecting digital triggering for a schedule

Use the sliding selector to choose the range of digital inputs to be monitored for changing state. If only on digital is being used place the two selector arrows over the number of the desired digital input.

Figure 7 Selecting digital trigger channel or channel's for a schedule

Note:
1.   The selected digital channel numbers will appear in brackets just to the right hand side of the selector.

From the "Transition" selector list choose the edge trigger condition.
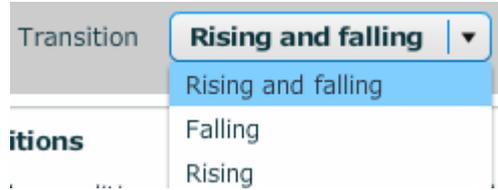

Figure 8 Selecting trigger edge condition

Counter events
When a counter incrementing to a preset value
1.   Low speed (Software) counter reaches a value
2.   High speed (Hardware) counter reaches a value.

To select counter event sampling, under the trigger tab check "Advanced triggering"
and select either "on a low-speed counter reaches a value" or
"on a high-speed counter reaches a value" from the trigger selector
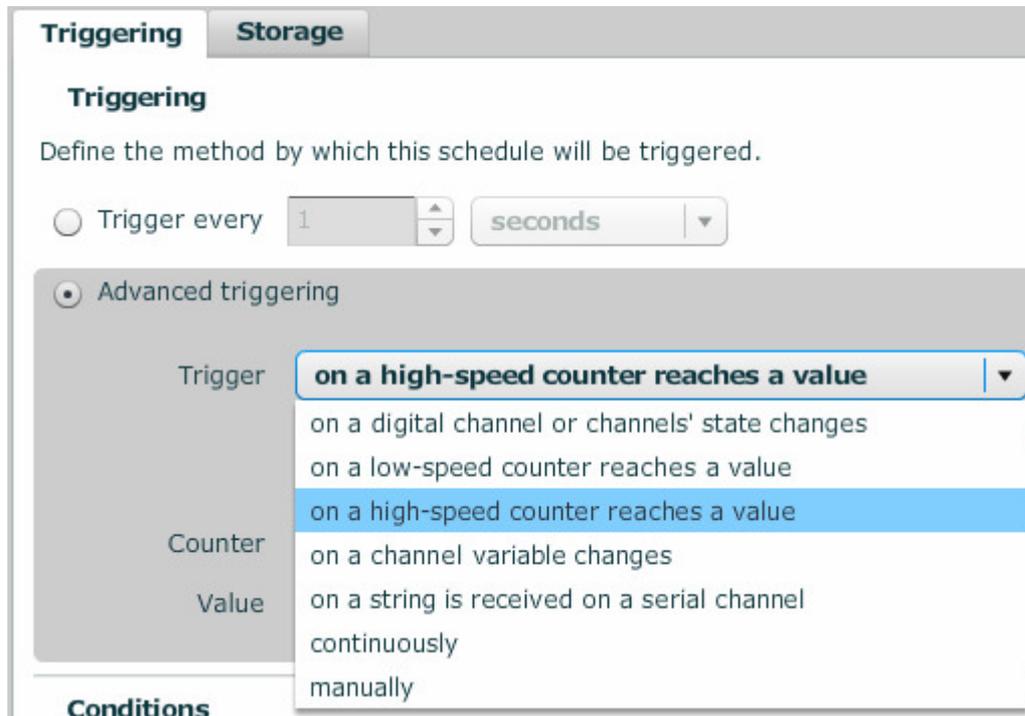

Figure 9 Selecting high or low speed trigger condition

Use the counter dialog to select the counter number to be used as the schedule trigger. (High speed counter selector shown in figure 10)
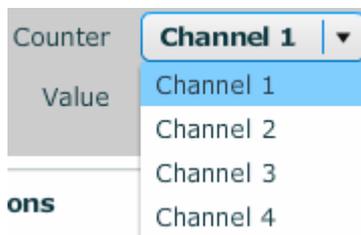

Figure 10 Selecting counter number to trigger schedule

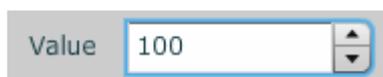Enter the trigger count set point in the "Value" dialog.

Figure 11 Entering counter threshold value

Notes:
1. *Low speed counters are digital inputs 1 to 8 and are labelled 1D to 8D in the DT80 digital section.*
2. *Low speed counters will only count when the DT80 is awake. They will not count when the logger is in sleep mode.*
3. *High speed counters are inputs 1C to 4C in the DT80 digital section.*
4. *High speed counters are implemented in hardware and will count when the DT80 is in sleep mode. For this reason they are commonly used for tipping bucket rain gauge inputs.*
5. *Trigger value will be set to zero once the schedule has triggered.*
6. *Counters used to trigger a schedule can not be used else where in the configuration.*

Serial events
On serial activity on one of the serial ports
Trigger when text or specified text arrives on a nominated serial port.
The serial sensor capabilities are extensive and extremely powerful. Please refer to separate serial sensor port documentation and the *DT80* range user manual for further details on using the *DT80* range serial sensor capabilities.

To select on serial event sampling, under the trigger tab check "Advanced triggering" and select "on a string is received on a serial channel" from the trigger selector
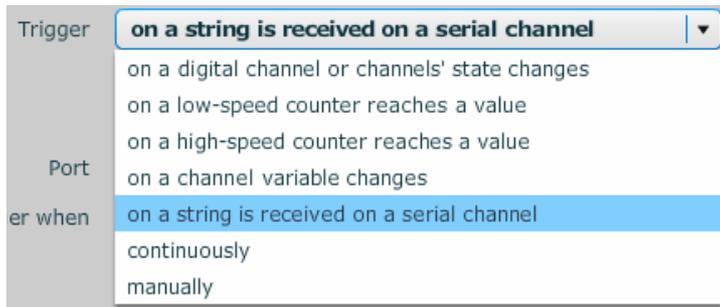

Figure 12 Selecting serial schedule trigger

The schedule can be triggered by data arriving on either the Host serial port which is the RS232 port on the communications an power end of the logger or from the serial sensor port located in the digital section of the *DT80* range.
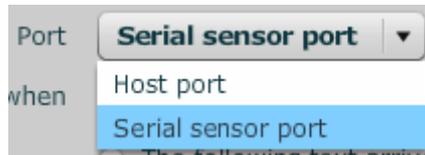

Figure 13 Selecting serial input channel

The schedule can be triggered on any incoming serial data or a specified text string.
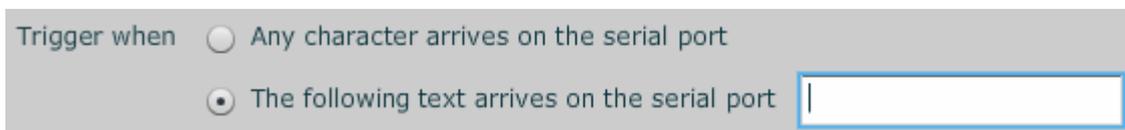

Figure 14 Selecting trigger text

Calculations
On the result of a calculation changing to or from zero
1. When a specified channel variable changes to or from zero
2. When a specified channel variable changes to zero
3. When a specified channel variable changes from zero

To select on channel variable based sampling, under the trigger tab check "Advanced triggering" and select "on a channel variable changes" from the trigger selector.
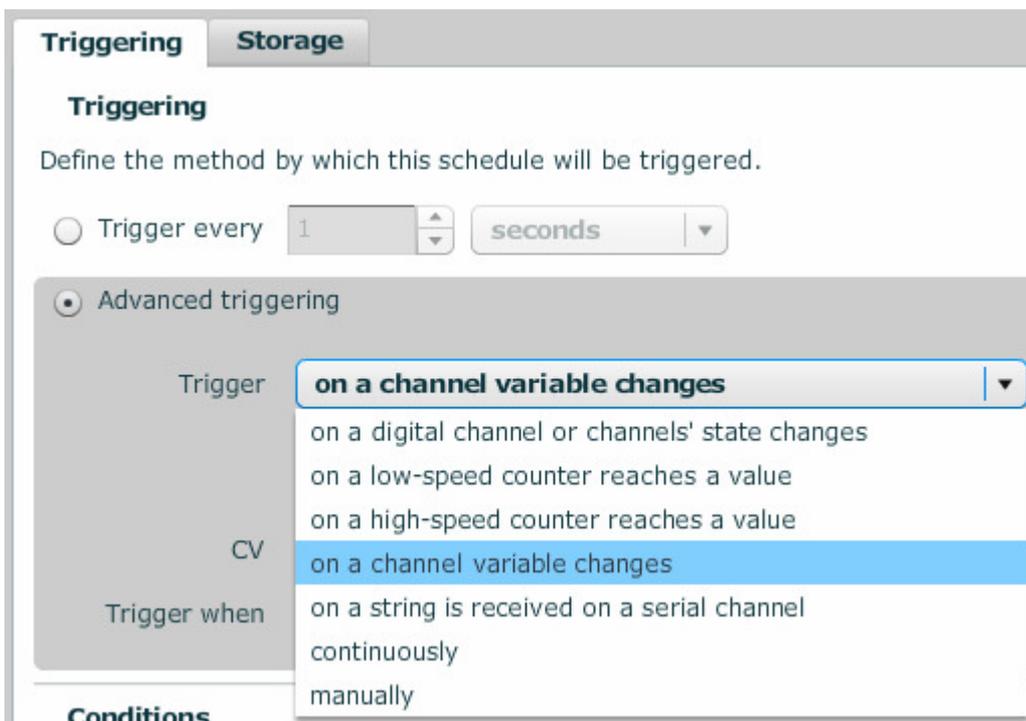

Figure 15 Selecting channel variable changes trigger

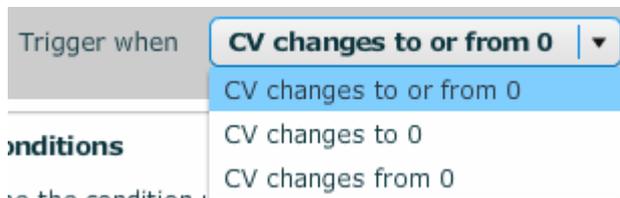Use the trigger dialog to select change state to use as the trigger event

Figure 16 Channel variable state change selection dialog

Enter the channel variable number to be used as the schedule trigger. (Range 1 to 1000)
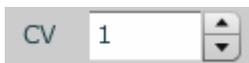

Figure 17 Entering channel variable to use a trigger

Polled
When called from another process or user request.

To select on manual (Polled) sampling, under the trigger tab check "Advanced triggering" and select "manually" from the trigger selector.

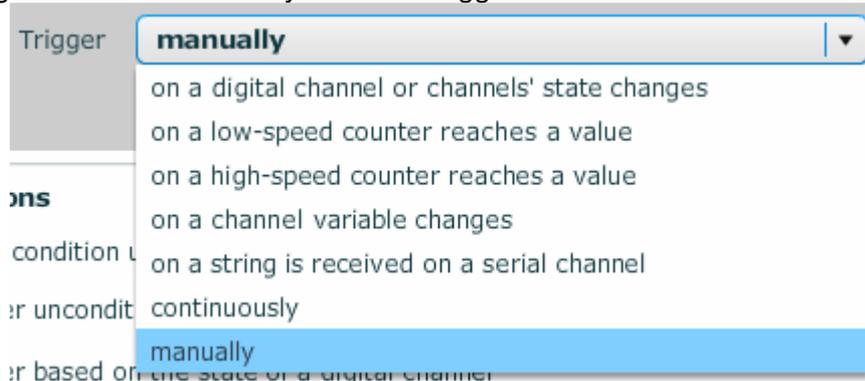

Figure 18 Selecting Manual (polled trigger)

Note:
1.   *There are no options for a schedule that is manually called.*
2.   *To call a manual schedule the DT80 series command Xt where t is the schedule text identifier must be sent to the DT80 command processor. e.g XA to poll schedule A in an alarm command statement*

Trigger while schedule conditions

Further to the above triggering conditions schedules can be made to run while a specific condition exists and stop running if the condition is not present.

These while conditions are;
1.   Unconditional

Digital input based
1.   While a digital input is high
2.   While a digital input is low
3.   While a range of digital inputs are high
4.   While a range of digital inputs are low

Channel variable based
1.   While a channel variable is zero
2.   While a channel variable is not zero

Unconditional

This is the default configuration. When a new configuration the *DT80* will run the configuration until the global Halt command (H) is received or the individual schedule is halted (e.g. HA)

To select on Unconditional sampling, under the trigger tab in the Conditions section check the "Trigger unconditionally" control.

Figure 19 Unconditional while schedule control

Digital while condition

A schedule can be configured to run when a single digital or any one of a range of digital inputs transition to either high or low condition.

To select on Unconditional sampling, under the trigger tab in the Conditions section check the "Trigger based on the state of a digital channel" control.

Conditions

Define the condition under which triggering is allowed to occur.

○ Trigger unconditionally

◉ Trigger based on the state of a digital channel

Permit triggering when one or more of the selected digital channel(s) match the specified state.

Channel(s)   1D   2D   3D   4D   5D   6D   7D   8D   (1..2D)

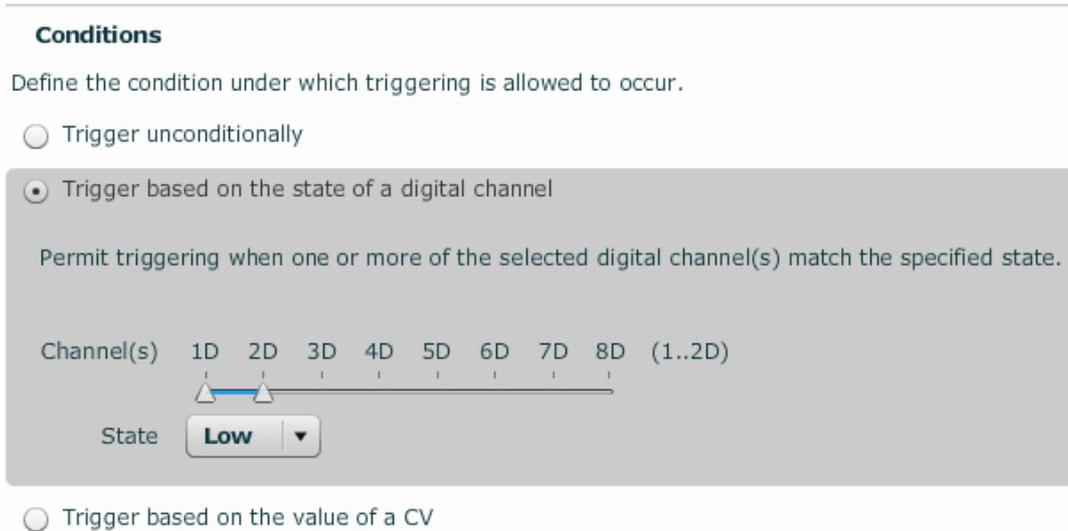State Low ▼

○ Trigger based on the value of a CV

Figure 20 Run schedule while digital control

Use the sliding selector to choose the range of digital inputs to be monitored for changing state. If only on digital is being used place the two selector arrows over the number of the desired digital input.

Channel(s)   1D   2D   3D   4D   5D   6D   7D   8D   (1..2D)

Figure 21 Selecting digital trigger channel or channel's for a schedule

Note:
1.   *The selected digital channel numbers will appear in brackets just to the right hand side of the selector.*

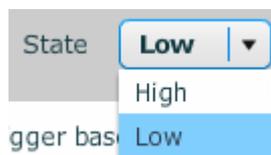Use the state dialog to select if the schedule is to run when a digital input is high or low

State Low ▼
       High
gger bas Low

Figure 22 Digital state selector

Channel variable while condition

A schedule can be configured to run when a single channel variable is either zero or non zero. Channel variables hold the results of a calculation or can be mapped directly to a MODBus slave register hence allowing a SCADA system to control the data logging process.

To select on Unconditional sampling, under the trigger tab in the Conditions section check the "Trigger based on the value of a CV" control.

Figure 23 CV state while selector dialog

Enter the channel variable (CV) used to control the schedule

Figure 24 CV number selector

Use the state dialog to select if the schedule is to run when a channel variable is zero or non zero

Figure 25 CV state selector

Data and alarm message storage

Each schedule has a pre-allocated data binary file associated with it.
This file contain contains two parts
1.   Logged data
2.   Logged alarm messages

A file for each defined schedule is created when the configuration is sent to the *DT80*.
If there is not enough room to create a data file in the *DT80's* disc structure then an error message will be returned.

The data files can be sized to suit the need of the application.

Figure 26 Storage control dialog pane

General area

The general area allows the data for this schedule to be logged (Enable logging checked) or not (Enable logging unchecked) and allows the storage media to be selected.

Figure 27 General dialog area

WARNING:
USB memory devices are not recommended as the primary storage media.
The primary reasons being;
1. **They are not as reliable as the internal memory**
2. **They are easily removed causing logging errors and corruption of data files if not closed correctly before removing.**
3. **They have a slower access speed than the internal memory.**
4. **The large memory devices available will greatly slow down the operation of the logger due to the large file allocation tables.**

A better solution is to increase the internal memory inside the *DT80*. Please refer to the *DT80* user manual for further details.

Data area

The data area allows the size of the selected schedule data files to be configured

Figure 28 Data dialog area

The size of the store file can be set by;
Bytes, Kilobytes, Megabytes, Records, Seconds, Minutes, Hours or Days.

Note:
1. *Record files of a number Seconds, Minutes, Hours or Days can only be applied to time based schedule triggers.*
2. *For file sizes based on number of records, Seconds, Minutes, Hours or Days the DT80 calculates the size of the files required based on the entries in the channel list.*

To select on required file size, under the storage tab, in the Data section check the Enter the record size as an integer required and select the file size modifier of the selection list.

Figure 29 Setting the file size dialog

The files can be set to either stop logging when the when the data file is full or to over write the oldest data in the file. Check the required selector dialog

Figure 30 Data over write dialog

Event area

As with the data file the size of the alarm log can also be configured to suit the requirements of the application.

Figure 31 Event dialog area

Due to the events not being time based the size of the files are limited to records, bytes, kilobyte or megabytes in size.

Enter the required file size as an integer and select the size modifier from the dialog list.

Figure 32 Setting alarm record file size

The files can be set to either stop logging when the when the data file is full or to over write the oldest data in the file. Check the required selector dialog

Figure 33 Event data over write dialog

The size of the messages can be set by entering the size in the "Event text width" dialog
If the event message exceeds the set size the message will be truncated and saved in the file

Figure 34 Event message size

Schedule considerations

Schedule priorities

Schedules will always run in alphabetical order with schedule A having the highest priority and so will always run first and the K schedule running the last.

Once a schedule has been started it can not be exited until every channel and alarm listed in the schedule has been completed. As each channel takes time to process for (example a single analog sample takes about 30 milliseconds) there is a finite amount of time required to process the channel list for the schedule.

If a schedule channel list scan time takes longer than the time interval selected then it the next schedules scan will be missed as it will be past the due time and the scan will occur in the next scheduled time slot.

This can have some unexpected consequences for other schedules with a lower priority setting as they to might be dropped because there due time has been exceeded having been delayed by the processing of schedules with a high priority. Particular care needs to be taken when using delays or channels like SDI-12 that can have very long processing times.

For example if schedule A is sampling some analog channels every once every 5 seconds and schedule B is sampling an SDI-12 device that takes 8 seconds to respond then the following sequence will occur.
1.	Schedule A will sample the analog channels at the 5 second mark
2.	Schedule B will take a sample of the SDI-12 channel which takes 8 seconds.
3.	As schedule B was running when the time for schedule A became true and schedule A can not run due to schedule B still processing the channel requirements then schedule A will not run at this time.
4.	In the next 5 second time comes due schedule A will run.

The result is that schedule A can only run every 10 seconds due to being delayed by schedule B. The solution in the case is to request the SDI-12 device to use continuous mode if it is supported.

Another example is if Schedule A has been set to continuous mode and schedule B is set to run at a set time interval. The reporting of schedule B may become intermittent due to the high priority of schedule A interrupting the scheduling of schedule B. It this case it is advantageous to move the continuous schedule to a lower letter thus reducing the priority.
This will guarantee the slower schedules will run when requested.

Order of sampling channels

The channels, calculations and alarms will be sampled in the order the are listed in the schedule.

When the data is unloaded the data will also appear in the order the data is listed in the schedule.

Channel table

Whenever a configuration containing schedules with lists of channels are entered into the *DT80*, the channels, internal or external, that are to be scanned and any associated calculations that are to be performed are all entered into an internal channel table.

The channel table contains all of the details of the individual channels to be scanned, including the type of input signal, the scan interval, how resultant data is to be processed, where resultant data is to be sent, etc. The channel table also contains form of each mathematical expression.

The Data Schedules and the Alarm Schedule all share the internal channel table. A maximum of 100 channels, calculations and alarms can be entered into the channel table.

While 1000 entries in the channel table is generally more than enough for most applications there will be occasions where either the application or poor programming practices can lead to the channel table capacity being exceeded.
If the channel table limit is exceeded the *DT80* will return the error message

```
E25 – Channel table full
```

As the channel table size can not be increased the only option is to simplify the configuration or reduce the size of the project.