ACS380 Continuous Cycle Programmable ON-OFF Run Timer with Manual Mode Override

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Application Overview: Mixer

- In the ACS380 drive we have timer 1 (Let’s call it “Run Timer”)
  - This countdown timer is limited to the range of 0-60 seconds.
  - If the time is set to “0” (for manual mode) there is no timed function and the ACS380 will run the motor continuously when the hardwired Run input is closed.
- Also in the ACS380 drive we have timer 2 (Let’s call it “Stop Timer”)
  - This countdown timer is limited to the range of 0-1440 minutes.
  - If you set the time to zero, no stop occurs after the Run Timer has expired, and the ACS380 will run the motor continuously until the hardwired Run input is open (Stop command received).
- The Run/Stop input is a maintained ON/OFF contact wired to Digital Input 1.
- An external Bluetooth control panel (ACS-AP-W) will be used for entry of Run time, Stop time and Speed.
- The speed command will be set by the arrow keys on the external control panel.

Basic operation of VFD and timer function:

- **Manual mode example:**
  If zero is set in timers 1 or 2, the ACS380 will run the motor continuously when the hardwired Run input is closed. The ACS380 will only stop when the Run input is open (Stop command received).

- **Auto mode example:**
  The Run Timer is set to 15 seconds and the Stop Timer is set to 20 minutes.
  When hardwired Run input is closed, the ACS380 will run for 15 seconds. Then the ACS380 will stop the motor and wait for 20 minutes. After the Stop Time has expired, this cycle will repeat until the hardwired Run input is open (Stop command received).

Solution:

The standard Adaptive Program and Sequence programming features of the ACS380 can be used to perform this application, without the use of a PLC.

The free version of Drive Composer software (Drive Composer Entry) can be used to program the ACS380 VFD.

Drive Composer Entry can be downloaded at: [https://new.abb.com/drives/software-tools/drive-composer](https://new.abb.com/drives/software-tools/drive-composer)
Base Program

The Adaptive Program is divided into two sections, the Base Program and the Sequence Program. The Base Program runs continuously and, in this example, is used to limit the entered data to be within the application constraints of 0 to 60 seconds for Run Time and 0-86400 minutes (24 hours) for Stop Time.

- The ACS380 timers are limited to 2097152 seconds (which is 34952.53 minutes or 582.54 hours), so there are a wide range of possibilities for different application timing requirements.

The Base Program for this application looks like this:

From left to right, the blocks are labelled 1, 2, 3 and 4 in the upper right corner to indicate order of execution. The order of execution is incremented as blocks are added to the program.

For block #1, Limit, the entered data labelled User Run Time (coming from parameter “47.01 Data storage 1 real32”) is shown as DS1 at the block input, In). The Limit block constrains the entered value connected to the In input between the Max (60) and Min (0) values which are set as constants for this example. The block output on the right side of the block #1 stores the limited value into another parameter, labelled Limited Run Time (coming from parameter “47.21 Data Storage 1 int16”). The Limit block uses Float type inputs and also outputs a value of type Float.

However when connecting the block output to a parameter of type Integer, a Float to Integer conversion is automatically performed.
Because the Stop Time needs to be entered as minutes instead of seconds, a multiply block (block #2) is used to convert minutes into seconds. The value of seconds from the Multiply block output is fed into the In input of the second Limit block (block #3). Label **User Stop Time** (coming from parameter “47.02 (Data storage 2 real32”) shown as DS2 at the Multiply block In input, In) is Limited between the values connected to the Min and Max of the second Limit block inputs. The Max (86400) and Min (0) values are set as constants for this example. The output of the second Limit block is stored as label **Limited Stop Time**, which is set as parameter “47.22 (Data storage 2 int16)”.

To display the limited value in minutes on the Control Panel, the Limited Stop Time in seconds needs to be converted into minutes and saved into another parameter. To accomplish this, the output of the second Limit (block #3) is connected to a Divide (block #4). The output of the Divide (block #4) writes the value of **Limited Stop Time** (in seconds) divided by 60 into DS3. DS3 is parameter “47.03 Data storage 3 real32”.
Sequence Program Summary
The rest of the application is accomplished by utilizing the Sequence Programming feature of the ACS380. The Sequence Program is a state machine where only 1 state can be active at any time.

This example uses a sequence program that consists of four states of operation:

State 1: Wait for Run input command – Default State when hardwire Run input is open
State 2: Run received
State 3: Run Timer
State 4: Stop Timer

The Drive Composer software graphically shows how what the state diagram connections are. For this example, the state diagram is:

NOTE: The speed reference for this example is set by the arrow keys on the external control panel. The speed reference can also be set from: integrated control panel, external potentiometer or 0-10 VDC, internal constant speed or fieldbus value.
Sequence Program - State 1: Wait for Run

State 1 is accomplished with a single block (Connect). The Connect block input (In) is activated by the hardwired **RUN Input** (DI1 which is connected from +24V to Digital Input 1). When the Connect block input becomes active, the Connect block output becomes active. When the block output is active, the **RUN Forward** signal is issued by the program and simultaneously the sequence program moves into **State 2**.

The **RUN Forward** is accomplished by an active Connect block output connected to the arrow labelled E1In1 (which represents External 1 control source, Input 1 start source).

The State is changed by an active Connect (block #1) output with the arrow labelled S2.
The drive is already running when State 2 becomes active.

Block #1 (NOT) is used to reset the program back to State 1 when the hardwired RUN Input at DI1 is open. This will stop the drive.

Block #2 (Greater than) checks for the Limited RUN Time being greater than 0. If the Limited RUN Time is 0, the program remains in State 2 and runs continuously until the RUN Input at DI1 is deactivated. If the Limited RUN Time is greater than 0, the program moves into State 3. The Hyst (Hysteresis) input is not used and is left unconnected for this example.
The drive is already running when State 3 becomes active.

Block #1 (NOT) is used to reset the program back to State 1 when the hardwired RUN Input at DI1 is open. This will override the timer and stop the drive.

Block #2, block #3 and block #4 work together as the Run Timer. When block #3 (T_on) has counted down from the value of Limited RUN Time, the block output activates which simultaneously stops the drive and moves the program into State 4.

The Stop Running is accomplished by a deactivated NOT (block #4) output connected to the arrow labelled E1In1.

The State is changed by an active T_on (block #3) output with the arrow labelled S4.
Sequence Program - State 4: Stop Timer

The drive is already stopped when state 4 becomes active.

Block 1 (NOT) is used to reset the program back to state 1 when the RUN Input at DI1 is open. This will override the timer.

Block 2 and block 3 work together as the Stop Timer. When block 3 ($T_{on}$) has counted down from the value of **Limited RUN Time**, the block output activates which simultaneously starts the drive and moves the program into state 2.
Default Wiring for ACS380 drives without Fieldbus module installed

NOTE: a jumper wire from DGND to DCOM must be installed

For this example, an external maintained switch must be connected from +24V to DI1.

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Parameter settings for this application

**NOTE:** By default, Adaptive Programming and Sequence Programming is disabled. To enable the Adaptive/Sequence programming feature of the drive a parameter must be changed. For this example, the first parameter to change is in Group 96 (System), parameter 96.70 (Disable adaptive program); change this parameter from Yes to No.

**Additional parameters to set are:**

**Group 99 (Motor data)**
- 99.03 (Motor type):
  - Asynchronous motor – when using an induction motor
  - Permanent magnet motor
  - SynRM – when using a Synchronous Reluctance motor

- 99.04 (Motor control mode):
  - Vector (open loop (sensorless) or closed loop) – use for better performance
  - Scalar (AKA Volts/Hertz) – factory default; use for lower performance applications

- 99.06 (Motor nominal current) – set to the motor nameplate Full Load Amps (FLA)
- 99.07 (Motor nominal voltage) – set to the motor nameplate voltage
- 99.08 (Motor nominal frequency) – set to the motor nameplate Hertz
- 99.09 (Motor nominal speed) – Set to the motor nameplate RPM
- 99.10 (Motor nominal power) – Set to the motor nameplate Horsepower
- 99.11 (Motor nominal cos φ) – Set to the motor nameplate Power Factor, if shown

**Group 7 (System info)**
- 7.35 (Drive configuration) – set to BMIO-01 for this example

**Group 20 (Start/stop/direction)**
- 20.01 (Ext1 commands) – set to In1 Start
- 20.03 (Ext1 in1 source) – after the Adaptive Program is downloaded to the ACS380 and is run, this parameter will be set to **Adaptive program** and cannot be changed.
- 20.04 (Ext1 in2 source) – set to Not selected

**Group 22 (Speed reference selection)**
- 22.11 (Ext1 speed ref1) – set to Control panel (ref saved)

**Group 23 (Speed reference ramp)**
- 23.12 (Acceleration time 1) – default is 3 seconds, set to whatever the application requires
- 23.13 (Deceleration time 1) – default is 3 seconds, set to whatever the application requires

**Group 47 (Data storage)**
- 47.01 (Data storage 1 real32) – set to Run Time in seconds
- 47.02 (Data storage 2 real32) – set to Stop Time in minutes
First Start ID Run

The first time after the motor data has been entered (with 99.04 set to Vector), the ACS380 will set parameter 99.13 (ID run requested) to Standstill, and will wait for a start command while in Local mode.

The ID Run is used to calculate a motor model to provide better performance. The default Standstill ID Run will not spin the motor. For even better performance, set parameter 99.13 to Normal. However, note that the motor must be uncoupled from any load and it will spin during the Normal ID Run. With the motor connected, put the ACS380 into Local mode and hit start on the control panel to perform the ID Run routine.

**NOTE:** After the ACS380 has been programmed and when parameter 96.06 (Parameter restore) is set to Reset motor data, the motor data will default to the factory values. When new motor data is entered (with 99.04 set to Vector), a Standstill ID Run will be required again.
Different levels of interface available on units without fieldbus module

Integrated control panel:
The base VFD includes an integrated control panel for programming and local operation. For the lowest cost option, the integrated panel can be used to set the Run Time and Stop Time parameters.

External control panel / keypad:
The ACS380, ACS480, ACS580 and ACS880 all share the same programming software (Drive Composer), parameter sets and control panel. In the case of the ACS380, this plain text menu structure interface is optional and needs to be remotely mounted. The external Advanced control panel utilizes a menu structure with plain text language for ease of use.

The above screenshots show use of the menu structure to go through the parameter groups to get to Group 47 and then to get to parameters 47.01 (Run Time) and 47.02 (Stop Time).
Setting frequently used parameters as Favorites:

A quicker method to access the Run Time and Stop Time parameters is to set those two parameters as Favorites.
Changing the data shown on the control panel Home Screen

When using the external control panel, displaying relevant data is easy to do.

The default Home screen shows:

<table>
<thead>
<tr>
<th>Remote</th>
<th>ACS380</th>
<th>0.0 rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output frequency</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Motor current</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Motor torque</td>
<td>0.0</td>
<td></td>
</tr>
</tbody>
</table>

However, this can be changed to display more relevant data for this application.

For example, for this application it may be desirable to have the current Run Time, Stop Time and Program state displayed:

<table>
<thead>
<tr>
<th>Remote</th>
<th>ACS380</th>
<th>611.0 rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUN Time (Sec)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>STOP Time (Min)</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Program state</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Options 21:48 Menu
The steps to change the default Home Screen are:

From the Home screen press the **Options** button. Arrow down to “Edit Home view” and press the **Select** button.

The top item will begin flashing. The Down Arrow and Up Arrow buttons can be used to select any of the three display items.

With the top item highlighted, press the **Edit** button.

Arrow Up or Arrow Down until “Other” is highlighted. Press the **Select** button.
Arrow Up or Down to “47 Data Storage”.
Press the Select button.

Arrow Down to “47.21 Data storage 1 int16”.
Press the Select button.

The top Home Screen item is now set to the value stored in parameter 47.21, which is where the Limited Run Time is stored by the Adaptive Program.

Next, Arrow Down until the Display name line is highlighted.
Press the Edit button.

Press Left Arrow until the existing display name is erased.
Press the Up Arrow once to highlight the double arrows ().

The Right Arrow and Left Arrow button can now be used to change to: lower case, upper case, numbers, or symbols.

Arrow Right once to highlight “ABC” to use upper case letters.

Press Up Arrow or Down Arrow to select the desired letter.

Press the Right Arrow once when the letter is correct.

For this example, set the Display name for the top item to:

“RUN Time (Sec)”

Set the middle item to parameter “47.03 Data storage 3 real32” and the Display name to: “STOP Time (Min)”. Also Change Display decimals from 3 to 1, so that it will show as 1.5 Minutes instead of 1.500 Minutes.

Set the bottom item to parameter “7.31 AP sequence state” and the Display name to: “Program State”.

**NOTE**: There are other settings for minimum and maximum value as well as a label for units that will be displayed below the Display name (instead of adding the unit of measure to the Display name).
Bluetooth Wireless VFD programming:
The external control panel (ACS-AP-W) also includes Bluetooth communication. The free ABB Drivetune app (for iPhone and Android) provides full control panel programming and operation capabilities for wireless programming of Run Time and Stop Time for this example.

The custom Home Screen on the external Control Panel shows up as the Drivetune dashboard. However the actual parameter names are shown instead of the custom labels.
Setting the run speed from the external Advanced Control Panel

The external control panel is available with and without Bluetooth communication. When Bluetooth is included, the word Bluetooth will be printed on the top front of the control panel. Other than Bluetooth, the control panels operate identically.

Use the Up Arrow and Down Arrow keys to set the run speed:
- When parameter “99.04 Motor control mode” is set to Vector, parameter “22.11 Ext1 speed ref1” must be set to “Control panel (ref saved)”
- When parameter “99.04 Motor control mode” is set to Scalar, parameter “28.11 Ext1 frequency ref1” must be set to “Control panel (ref saved)”

The speed reference will be displayed in the upper right corner of the control panel display.

NOTE: When parameter “99.04 Motor control mode” is set to Vector, the speed will be shown in RPM.
NOTE: When parameter “99.04 Motor control mode” is set to Scalar, the speed will be shown in Hertz
Set the run speed by direct entry of the speed value:

From the Home Screen, press the **Options** button.

With Reference highlighted, press the **Select** button.

The run speed can be directly entered.

The Right Arrow and Left Arrow buttons can be used to select a specific digit.

The Up Arrow and Down Arrow buttons can be used to set the digit value.

The allowed speed values are determined by the values set in Group 30, Limits.

When parameter “99.04 Motor control mode” is set to Vector, parameters “30.11 Minimum speed” and “30.12 Maximum speed” are used.

When parameter “99.04 Motor control mode” is set to Scalar, parameters “30.13 Minimum frequency” and “30.14 Maximum frequency” are used.