Applications & Tools

SINAMICS G120
MICROMASTER 4

Wobble generator for standard drive inverters
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Aim of the application

This application description is intended for all users that wish to implement a "wobble function" using a standard drive inverter. It is assumed that the drive inverter has been commissioned and that the user has basic knowledge about these subjects.

Scope

The wobble generator function has not been implemented in standard drive inverters. However, there are various ways of generating a "wobble generator".

Reference to the Automation and Drives Service & Support

This article is from the Internet Application Portal of the Automation and Drives Service & Support. You can go directly to the download page of this document using this link.

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</table>
Application description

Content

For drives with periodic traversing motion, for technological reasons, the drive inverter frequency should periodically change around the selected frequency setpoint. To implement this, a periodically changing supplementary setpoint (the wobble signal) is superimposed on the frequency setpoint.

The following example is described using the free blocks of a MICROMASTER 440, alternatively a SINAMICS G120 with PM240 and CU240 ,,,also can be taken.

The following will be described in the example:

- Emulation of the wobble function using the free blocks – index term OSCILLATOR.
- Emulating the wobble function using the PID controller
- Emulating the wobble function using the S7 control
1 Emulating the wobble function using an oscillator

An oscillator is the simplest way to emulate a wobble generator. This oscillator can be implemented using the free blocks.

It is parameterized using the Starter commissioning tool.

The simplest oscillator comprises an AND logic element and a timer element (refer to Figure 1-1). Using this oscillator, the wobble frequency setpoint can be changed in the form of a triangular signal (e.g. 10 disturbances per second).

This configuration can be used in many other similar applications; for example, to change the direction, switch between different fixed frequencies etc.

![Figure 1-1 Basic oscillator](image)

The base frequency (operating frequency), depending on which source suits the particular application or is necessary – can be generated using any source as main setpoint for the drive inverter. In this example, a potentiometer at analog input 1 was used.

A fixed frequency must be parameterized as supplementary setpoint for the wobble amplitude. Using the oscillator, this supplementary setpoint is switched-in and switched-out - whereby the timer defines the wobble frequency.

The oscillator generates the signal as a logical signal with a square waveform (refer to Figure 1-2: Generating the wobble signal). To do this, the output of timer r2852 is connected to parameter P1020 (fixed frequency).

The main and supplementary setpoints are added in front of the ramp-function generator (RFG) and after the RFG are transferred as total setpoint (triangular signal).

In order to obtain the required wobble characteristic the parameters for the ramp times (P1120, P1121) must be appropriately parameterized.

The wobble generator is enabled using digital input 6.

Please refer to the parameter list (Table 1-1) for the parameter settings.

The wobble frequency (setpoint after the RFG, r1170) is shown in Figure 1-3.
Application description

Emulating the wobble function using an oscillator

Wobble generator for standard drive inverters Beitrags-ID: 23684572

Figure 1-2 Generating the wobble signal
Emulating the wobble function using an oscillator

Figure 1-3 Wobble frequency using an oscillator
Application description

Emulating the wobble function using an oscillator

Wobble generator for standard drive inverters

Parameter list, oscillator

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Description</th>
<th>Value</th>
<th>Comment, significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>P0700</td>
<td>Selects the command source</td>
<td>0..6</td>
<td>As required</td>
</tr>
<tr>
<td>P0706</td>
<td>Function, digital input 6</td>
<td>99</td>
<td>Allows BICO connection from digital input 6</td>
</tr>
<tr>
<td>P1000</td>
<td>Selects the frequency setpoint source</td>
<td>3x</td>
<td>Main setpoint: 0..7 - as required Supplementary setpoint: 3 - fixed frequency</td>
</tr>
<tr>
<td>P1001</td>
<td>Fixed frequency 1</td>
<td>650.00..650.00</td>
<td>Select as required</td>
</tr>
<tr>
<td>P1020</td>
<td>Fixed frequency selection, bit 0</td>
<td>r2852</td>
<td>Selects fixed frequency 1</td>
</tr>
<tr>
<td>P2800</td>
<td>Activates free blocks</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>P2801[0]</td>
<td>Activates AND1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>P2810[0]</td>
<td>Input 1 from AND1</td>
<td>r0722.5</td>
<td>Digital input 6 starts the function</td>
</tr>
<tr>
<td>P2810[1]</td>
<td>Input 2 from AND1</td>
<td>r2853</td>
<td></td>
</tr>
<tr>
<td>P2820[0]</td>
<td>Activates timer 1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>P2850</td>
<td>Delay of timer 1</td>
<td>0.0-6000.0 s</td>
<td>Delay as required</td>
</tr>
<tr>
<td>P2851</td>
<td>Mode of timer 1</td>
<td>2</td>
<td>Switch-in/switch-out delay</td>
</tr>
<tr>
<td>P2849</td>
<td>Input of timer 1</td>
<td>r2811</td>
<td>Connects output from the AND logic element to the input from timer 1</td>
</tr>
<tr>
<td>P1120 / P1121</td>
<td>Ramp-up and ramp-down time</td>
<td>0.00..650.00 s</td>
<td>Select as required</td>
</tr>
</tbody>
</table>

Table 1-1 parameterizing the simplest oscillator
2 Wobble function using PID control

For some applications the triangular waveform of the wobble signal is not sufficient. The reason for this is that these applications require a P-jump at the reversal point of the wobble frequency (refer to Figure 2-1). This P step is required e.g. to correctly construct the coil (at right angles) when winding thread.

![Figure 2-1 Wobble signal](image)

The following example is described just as the previous example using the free blocks of a MICROMASTER 440. For this application, in addition to the free blocks, the PID controller, provided in the drive inverter and "speed feedback" are required.
2.1 Structure of the PID controller

The principle of how the signal is generated

… is the same in this application as the one described in the previous chapter.

The wobble frequency is defined by the time of the timer element.

The wobble amplitude is defined by the fixed PID frequency that was selected.

The oscillator described in the previous chapter is also used here to select the PID fixed frequency (refer to Fig. 1-1).

The PID fixed frequency is entered into parameter P2201.

In order to select this fixed frequency, output of timer r2852 should be connected to parameter P2220. Parameter P2220 is used to select the PID fixed frequency.

The PID frequency is selected as PID supplementary setpoint, P2254 = r2224.

Base frequency (operating frequency)

The base frequency (operating frequency) - depending on which source fits or is necessary for the application – can be generated with any source as PID main setpoint for the drive inverter. A potentiometer was used in the example, P2253 = r0755.0.

Three PID controller parameters are responsible in defining the wobble waveform; these parameters define the waveform as described in the following.
1. The gradient of the curve is set using the integration time (TI) of the PID controller in P2285;
2. The P step is set using the proportional gain (TP) P2280 of the PID controller;
3. Parameter P2293 sets the maximum ramp-up and ramp-down time of the PID controller output.

Other additional parameter assignments:

The ramp times of the PID controller should be set to "0" (off): P2257=0, P2258=0.

A signal for the feedback of the PID controller still has to be selected.

In this example, the signal from an actual value encoder (speed encoder; P2264 = r0061) was selected.

Please refer to the parameter list (Table 2-1) for the parameterization of the wobble function.

The wobble frequency using the PID control (r2294) is shown in Figure 2-3.
## Wobble function using PID control

### Parameter list, PID controller

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
<th>Comment, significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Parameterizing the wobble amplitude</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P2201</td>
<td>PID fixed frequency 1</td>
<td>-200.00..200.00</td>
<td>Select as required</td>
</tr>
<tr>
<td>P2220</td>
<td>Selects fixed frequency, bit 0</td>
<td>r2852</td>
<td>Selects the PID fixed frequency 1</td>
</tr>
<tr>
<td>P2800</td>
<td>Activates free blocks</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>P2801[0]</td>
<td>Activates AND1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>P2810[0]</td>
<td>Input 1 from AND1</td>
<td>r0722.5</td>
<td>Digital input 6 starts the function</td>
</tr>
<tr>
<td>P2810[1]</td>
<td>Input 2 from AND1</td>
<td>r2853</td>
<td></td>
</tr>
<tr>
<td>P2820[0]</td>
<td>Activates timer 1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>P2850</td>
<td>Delays timer 1</td>
<td>0.0..6000.0 s</td>
<td>Delay as required</td>
</tr>
<tr>
<td>P2851</td>
<td>Mode of timer 1</td>
<td>2</td>
<td>Switch-in/switch-out delay</td>
</tr>
<tr>
<td>P2849</td>
<td>Input of timer 1</td>
<td>r2811</td>
<td>Connects the output from AND element to the input of timer 1</td>
</tr>
<tr>
<td>P2200</td>
<td>Enables the PID controller</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>P2251</td>
<td>PID mode</td>
<td>0</td>
<td>PID as main setpoint</td>
</tr>
<tr>
<td>P2253</td>
<td>PID setpoint</td>
<td>2224: PID-FF</td>
<td>Setpoint input, select as required</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2250: PID-MOP</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>755.0: ADC 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.1: USS at BOP</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2019.1: USS at COM</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2050.1: CB at COM</td>
<td></td>
</tr>
<tr>
<td>P2254</td>
<td>Supplementary PID setpoint</td>
<td>r2224</td>
<td>Supplementary setpoint input via PID-FF</td>
</tr>
<tr>
<td>P2264</td>
<td>PID actual value</td>
<td>r0061</td>
<td>Actual value entered via the actual value transducer (can also be entered via analog input 1 / 2, r0755.0 / r0755.1)</td>
</tr>
<tr>
<td>P2257</td>
<td>Ramp-up time for PID setpoint</td>
<td>0</td>
<td>Ramp times should be switched-out</td>
</tr>
<tr>
<td>P2257</td>
<td>Ramp-down time for PID setpoint</td>
<td>0</td>
<td>Ramp times should be switched-out</td>
</tr>
<tr>
<td>P2280</td>
<td>PID proportional gain</td>
<td>0.000..65.00</td>
<td>Must be adapted</td>
</tr>
<tr>
<td>P2285</td>
<td>PID integral time</td>
<td>0.000..60.000 s</td>
<td>Must be adapted</td>
</tr>
<tr>
<td>P2283</td>
<td>Ramp-up/ramp-down time of the PID limit value</td>
<td>0.00..100.00 s</td>
<td>Must be adapted</td>
</tr>
</tbody>
</table>

Table 2-1 Parameterizing the wobble function using PID control
3 Wobble function using an S7 control

Description

The S7 project "wobble function" is described as part of this function in which the function with the same name is implemented. The function outputs the triangular waveform signal with a P step at the reversal point. Aligning the function parameters and more specifically the three main parameters: the amplitude, the frequency and that of the P step can be very easily implemented.

Two potentiometers are required to change the amplitude and the frequency (analog inputs 1 and 2).

The limit values for the potentiometers (maximum amplitude [Hz] and maximum frequency [Hz], refer to Figure 3-11) are specified in the variable table.

The P step is entered into the variable table of the S7 project as a % of the maximum amplitude.

The wobble function is enabled using digital input 6.

When generating the wobble signal, the interdependency between the setpoint and time must be taken into account. This function is implemented in the program example.

The CPU continuously communicates with the MICROMASTER and reads-out the three parameters:

4. r0754.0: Analog input 1 (ADC1 value after scaling, [%]),
   r0754.1: Analog input 2 (ADC2 value after scaling, [%]);
5. r0722: Status, digital inputs;
6. P2000: Reference frequency, [Hz].

These values are used for further calculation in the program.

The setpoint amplitude is then calculated as follows:

\[ A = \frac{(r0754.0 \times MD42 \times 4000h)}{P2000.1} \]

Two timers are used to form the time channel; they are cyclically started one after the other (refer to Figure 3-1).

The actual times of T1 and T2 are used as time functions (the time runs from the maximum value towards 0).
The maximum values of times of T1 and T2 are used as ramp-up and ramp-down time of the wobble curve. The times for both timers have been assumed to be the same in this example (T1max = T2max) and are set by the user using potentiometer 2. The frequency is actually set using potentiometer 2 and the conversion is then made in the program:

\[ T1_{\text{max}} = T2_{\text{max}} = \frac{1}{(r0754.1 \times MD46)} \]

The P step is calculated using the following formula:

\[ P = \frac{(MD104 \times MD42 \times 4000h)}{P2000.1} \]

The setpoint is sent to the drive during time T1; it can be calculated using the following formula:

\[ Y1 = (A - P) \times (T1_{\text{max}} - T1) / T1_{\text{max}} + P \]

The setpoint is sent to the drive during time T2 and is calculated using the following formula:

\[ Y2 = A \times T2 / T2_{\text{max}} (1 - P) \]

The setpoint that is generated is sent as supplementary setpoint to the drive via PROFIBUS. Any other source can be used as main setpoint (basic frequency). The supplementary setpoint is added to the main setpoint.

It is only permissible to activate the wobble function after the motor has ramped-up to the operating frequency. The normal ramp times (P1120 and P1121) should be used to accelerate to the operating frequency and to
brake to zero (or drive off). It is not permissible that they are at zero during this time. However, if the wobble function is active they must be switched-out.

As already described, the wobble function is activated using digital input 6 = r0722.5. Bit 722.5 can also be used to toggle between different drive data sets. In drive data set 2 DDS2 should be used to set the ramp times to zero.

**Parameterizing the MICROMASTER drive**

MICROMASTER should be parameterized before the S7 project can be used. Please refer to the parameter list for the complete parameterization (Table 3).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
<th>Comment/significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>P0700</td>
<td>Selects the command source</td>
<td>2</td>
<td>Selects the terminal strip as command source</td>
</tr>
<tr>
<td>P0706</td>
<td>Function, digital input 6</td>
<td>99</td>
<td>Allows BICO connection of digital input 6</td>
</tr>
<tr>
<td>P1000</td>
<td>Selects the frequency setpoint source</td>
<td>6x</td>
<td>Main setpoint: 0..7 - as required; Supplementary setpoint: 6 via Profinet</td>
</tr>
<tr>
<td>P0820</td>
<td>Drive data set (DDS) bit 0</td>
<td>r0722.5</td>
<td>Digital input 6 as the command source to select the 2nd drive data set DDS2 (wobble function active)</td>
</tr>
<tr>
<td>P1120[0]</td>
<td>Ramp-up time DDS1</td>
<td>0.00..650.00 s</td>
<td>Select as required</td>
</tr>
<tr>
<td>P1120[1]</td>
<td>Ramp-up time DDS2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>P1121[0]</td>
<td>Ramp-down time DDS1</td>
<td>0.00..650.00 s</td>
<td>Select as required</td>
</tr>
<tr>
<td>P1121[1]</td>
<td>Ramp-down time DDS2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>P2000</td>
<td>Reference frequency</td>
<td>1.00..650.00 Hz</td>
<td>Select as required; set P2000.0 = P2000.1</td>
</tr>
</tbody>
</table>

Table 3-1 Parameterizing MICROMASTER
3.1 **Prerequisites**

In this example it has been assumed that the required hardware components have been correctly connected-up as shown in Figure 3-2 and the required software has been installed.
Wobble generator for standard drive inverters

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Hardware:
- PG/PC to control
- Profibus / MPI interface
- SIMATIC S7 – 3xx/4xx station

Software:
- STEP 7 from V5.1 SP3

Drive:
- MICROMASTER 440

3.2 Adapting the project

The following steps must be carried-out in order to be able to use the S7 project:
1. Download and unzip the "wobble function" project;
2. Start the SIMATIC Manager and open the "wobble function" project;
3. Open HW Config (refer to Figure 3-3):
   - (1) Select your SIMATIC station. The 'Hardware' symbol is shown in the righthand partial window.
   - (2) Open the window for the hardware configuration (HW Config) by double clicking on this symbol.

Figure 3-3 Opening HW Config
4. Replace the power supply modules, if required (refer to Figure 3-4):
   - (1) Select the power supply module.
   - (2) In the menu 'Insert' of HW Config, select the sub-item 'Replace object…'.

5. In the window that then appears select the power supply module (PS) (Figure 3-5).

6. If required, replace the CPU module (refer to Figure 3-6):
   - (1) Select the CPU module and then in the menu 'Insert' of HW Config select the sub-item 'Replace object…'.
   - (2) A new window appears in which the CPU should be selected.
   - (3) Select the Order No. of the CPU (MLFB).
Wobble generator for standard drive inverters

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- (4) Select the firmware version of the CPU.

![Figure 3-6 Replacing the CPU](image)

7. Setting the DP address on MICROMASTER.
Select the correct bus address for your project (in the example, address 3 was selected). Proceed as follows (refer to Figure 3-7):
- (1) In HW Config, click twice on the 'MICROMASTER' symbol.

![Figure 3-7 Changing the DP address](image)

8. The 'Properties – DP slave' window is displayed, here: (Figure 3-8)
- (1) Press the button 'PROFIBUS…'. A new window is displayed 'Properties – PROFIBUS interface MICROMASTER 4'.
- (2) Select the bus address. It should be noted that addresses 1, 2 and 4 are assigned in the project.
- (3) Exit the window with 'OK'.
- (4) Close the window 'Properties – DP slave'.
9. Save and compile your project as follows: (Figure 3-9),
   - (1) Press the button 'Save and compile'.

10. Downloading the project into the CPU: (Figure 3-10)
   - (1) Select your S7 station in SIMATIC Manager.
11. Setting the main parameters of the wobble function: (Figure 3-11)

(1) Enter the maximum wobble amplitude in [Hz].
(2) Enter the maximum wobble frequency in [Hz].
(3) Enter the P step as a [%] (0..1).
(4) Press the button to go online.
(5) Press 'Monitor variables' to monitor the current values.
(6) Send the control values to the CPU using 'Control variables'.

Figure 3-10 Downloading the project

Figure 3-11 Setting the wobble parameters
12. The result of the wobble function (setpoint after RFG, r1170) is shown in Figure 3-12.
4 Historie

Tabelle 4-1 Historie

<table>
<thead>
<tr>
<th>Version</th>
<th>Datum</th>
<th>Änderung</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1.0</td>
<td>20.07.2006</td>
<td>First edition</td>
</tr>
</tbody>
</table>

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