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SINAMICS

SINAMICS V20 multi-pump control

Operating Manual

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Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

> **⚠ DANGER**
>
> indicates that death or severe personal injury **will** result if proper precautions are not taken.

> **⚠ WARNING**
>
> indicates that death or severe personal injury **may** result if proper precautions are not taken.

> **⚠ CAUTION**
>
> indicates that minor personal injury can result if proper precautions are not taken.

> **NOTICE**
>
> indicates that property damage can result if proper precautions are not taken.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

> **⚠ WARNING**
>
> Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

Trademarks

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Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

Table of contents

Overview

<div style="text-align: right; font-size: 3em;">1</div>

Multi-pump control is suitable for applications that require simultaneous operation of up to four pumps, for example, equalizing significantly fluctuating water pressures or flow rates. After the multi-pump control is enabled, you can configure the following four sub-functions based on your particular requirements: switching-in/out, stop mode, pump switchover, and service mode.

Note

To control more than two pumps simultaneously, you must connect an optional I/O Extension Module to expand the number of V20 I/O terminals. For more information about this option module, see Section "I/O Extension Module" in "SINAMICS V20 Converter Operating Instructions".

Enabling the function

To enable this function, you must first make sure that the firmware version of the V20 converter is 3.94 or later. Then, use the optional Parameter Loader and an SD card to download the multi-pump control script files into the converter. For more information about the Parameter Loader and the SD card, see Section "Parameter Loader" in "SINAMICS V20 Converter Operating Instructions".

Proceed through the following steps to download the script files into the converter:

1. Download the script files "autorun.lua" and "utils.lua" via the Internet address (https://support.industry.siemens.com/cs/us/en/ps/13208).

2. Place "SSTAGE.bin" in the root directory of the SD card.

   ### Note

   You can obtain the "SSTAGE.bin" file from the corresponding firmware updating package. Make sure that the version of the firmware updating package to be downloaded and the version of your V20 firmware are the same.

3. Create a folder named "romfs" under the root directory of the SD card and place "autorun.lua" and "utils.lua" in the folder.

4. Fit the Parameter Loader to the converter, and then insert the SD card into the Parameter Loader.

5. Power on the converter, and data transfer starts automatically. The converter displays "Updating" during the transfer.

6. After a successful transfer, the converter displays "Update complete". If any fault or alarm occurs during the transfer, see Section "Faults and alarms (Page 21)" or Section "Faults and alarms" in "SINAMICS V20 Converter Operating Instructions" for possible reasons and remedies.

7. Remove the Parameter Loader and re-power on the converter. Then you can enable the multi-pump control function by setting P4002 = 1.

Note

- Make sure that the function-specific script files you use is downloaded from the previous Internet address. Otherwise, alarm A650 may appear reminding you that this script is not an officially released script. Also, you can download the "SINAMICS V20 Converter Operating Instructions" from the link.
- After you successfully download the script files into the converter, all parameters used for this function are automatically set to their default settings. Note that the default settings of parameters P0731, P0732, P0733, P0734, P0840, P0845, P1200, and P2200, which are different from their factory defaults, are changed to adapt to the function. To make sure that the multi-pump control function runs properly, do not manually set the values of P0840 and P0845 after the function is enabled.
- Multi-pump control uses PID controller-specific parameters. For more information about how to configure those parameters, see Section "Setting the PID controller" in "SINAMICS V20 Converter Operating Instructions".
- If you use the motor staging function on the converter, this function is automatically disabled after the multi-pump control function is enabled.

Setting parameters

Parameter	Function	Setting
P4002	Control of script inter-preter	This parameter controls the execution of the script. 0: Stop script 1: Start script
r4003	Status of script inter-preter	Displays the status of the script interpreter. 0: Interpreter ready 1: Script loading 2: Script loading failed 3: Script executing 4: Script execution error 5: Script execution complete Range: 0 to 5 (default setting: 0)
P4004	Script start control	Controls when the script is executed. 0: The script will be executed only when the value of P4002 is changed from 0 to 1. 1: The script will be executed automatically after power-on if P4002 = 1. Range: 0 to 1 (default setting: 1)
P4030	Multi-pump control script parameter default	Controls the reset operation of the script parameters. The value change to this parameter takes effect after the next time the script is started. 0: Set values of all script parameters to default settings after the script is started. 1: Do not reset. Range: 0 to 1 (default setting: 1)

Note

You can only use digital input 1 as the ON/OFF control source, related to r4000.0.

Note

To enable the multi-pump control function automatically after each converter power-on, make sure that both P4002 and P4004 are set to "1".

Pump switch-in/switch-out

<div style="text-align: right">2</div>

The converter uses four relays (KP1 to KP4), which are connected to digital outputs DO1 to DO4, to switch pumps in and out according to the PID error (r2273). In addition, two groups of contactors, KDs and KMs, are used to switch the pumps between converter operation and line system operation. Soft pump switching can be realized as all motors start/stop with ramp speeds, so as to minimize the shock to the pipes.
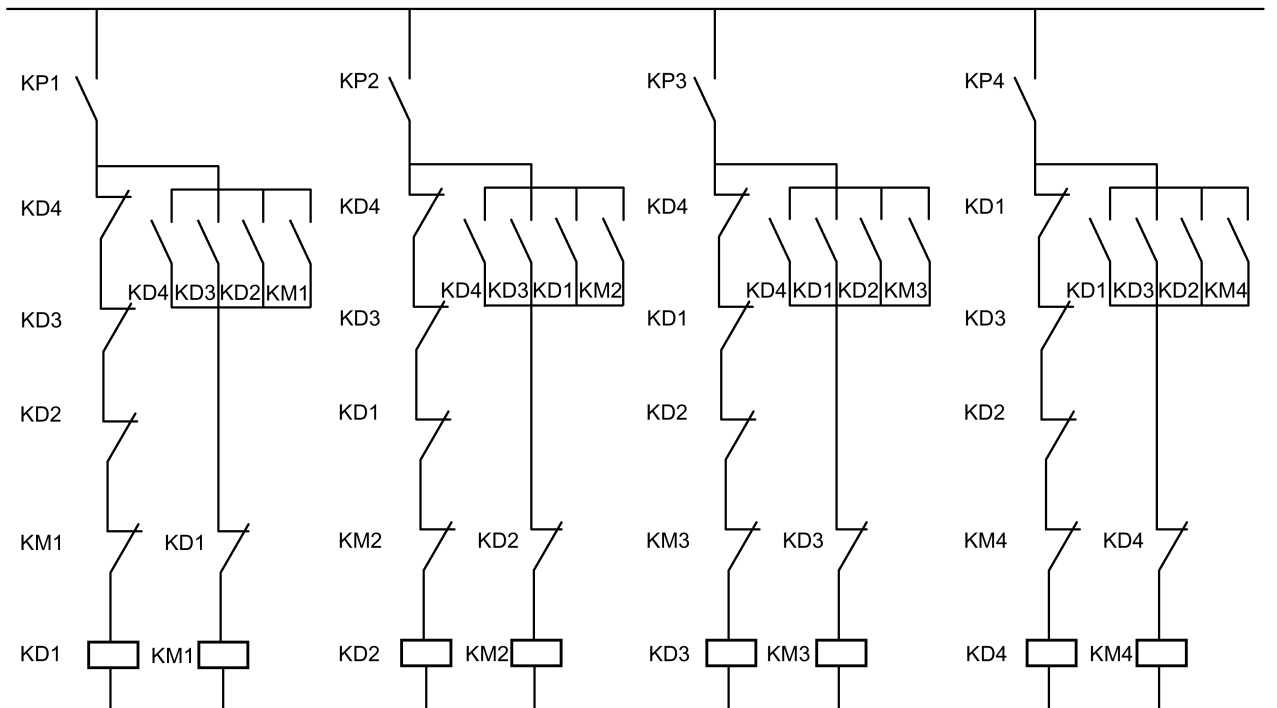
Main circuit
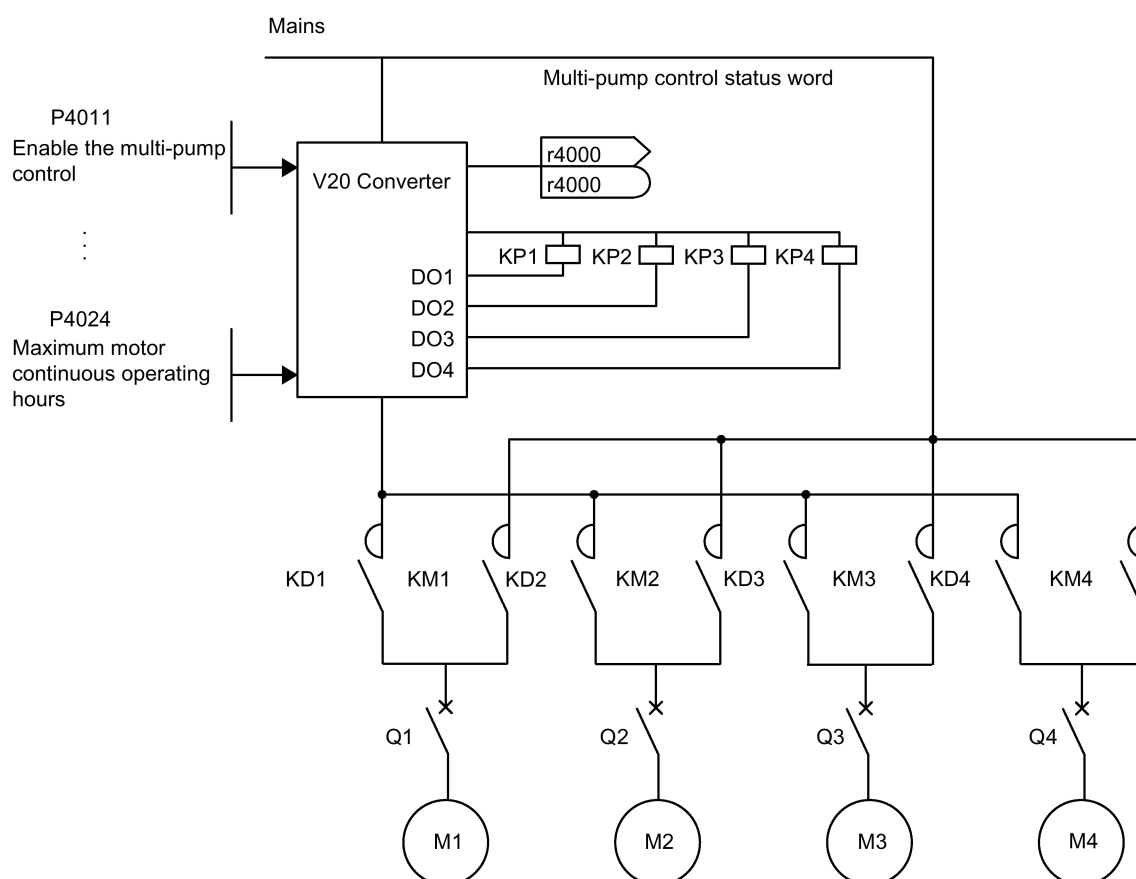
Note

The maximum voltage on DO1 is ± 35 V DC. The maximum load current on DO1 is 100 mA.

External control circuit
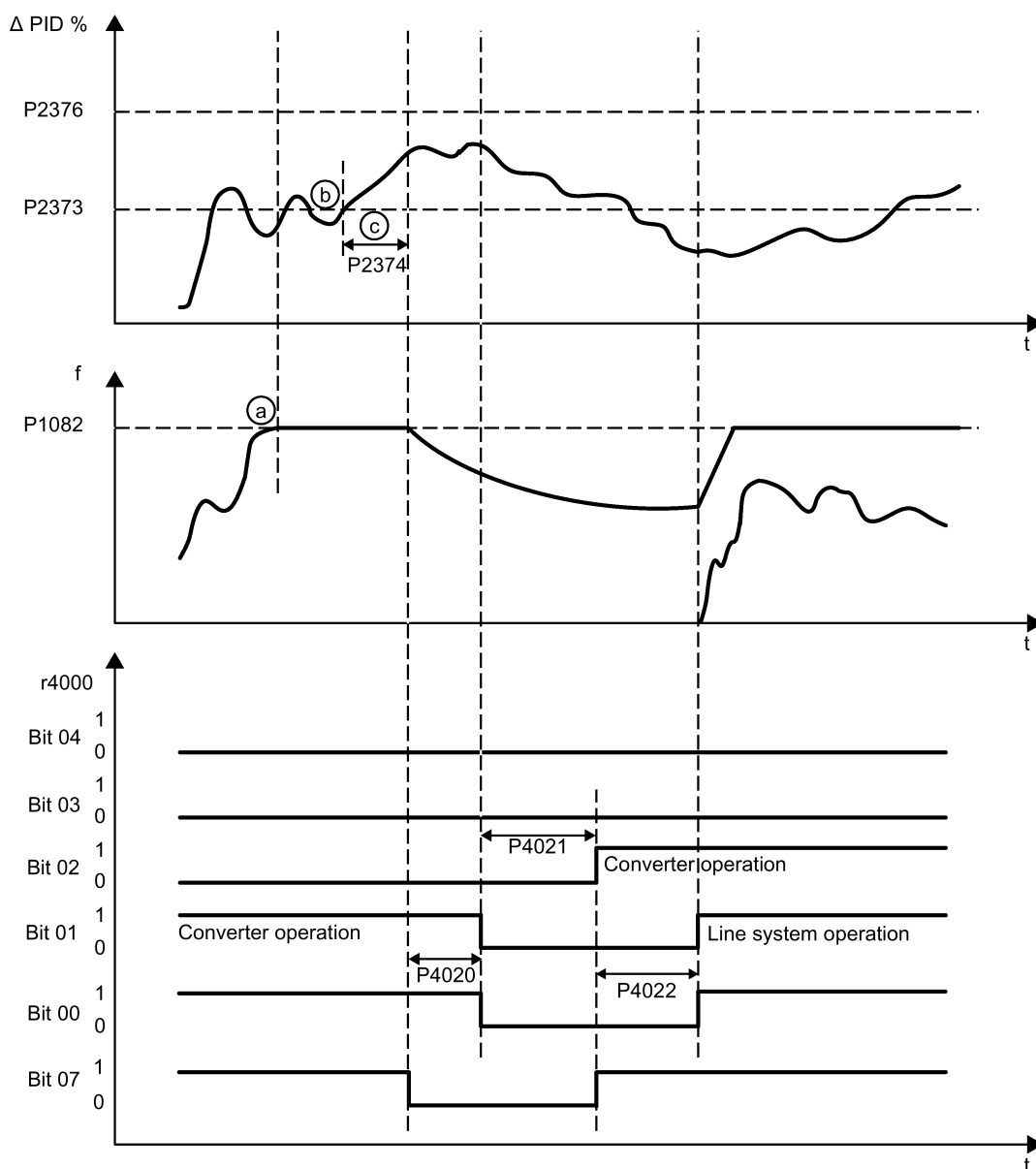

Pump switch-in

If the pump controlled by the converter runs at the maximum speed (P1082) and the PID error is higher than the switch-in threshold (P2373) and lower than the delay override threshold (P2376) for a specified time (P2374), the converter first switches the pump from converter operation to line system operation, and then switches on an idle pump which is softly started with a ramp-up speed and runs in converter operation.

Note

If the PID error rises above the switch-in delay override threshold (P2376), the converter skips the switch-in delay (P2374) and performs the switch-in operation immediately.

Parameter P4012 is used to control the selection mode of the next pump that is softly started by the converter. Bits 01 to 04 of r4000 control the pump which is selected to run depending on P4012.

- P4012 = 0: Selecting the next pump according to the fixed sequence. The converter switches in the pump by following the sequence M1, M2, M3, to M4.

- P4012 = 1: Selecting the next pump according to the operating hours. The converter switches in the pump with the least absolute operating hours (r4026 to r4029).

Conditions for pump switch-in:

(a) f_act = P1082

(b) P2376 > Δ PID ≥ P2373

(c) t > P2374

Pump switch-out

If the pump controlled by the converter runs at a speed lower than the frequency switch-out threshold (P4014 + P1080) and the PID error is lower than the PID error switch-out threshold (-P2373) for specified time (P2375), the converter first switches off the pump (OFF2) which runs in converter operation, and then captures a running pump and switches it from line system operation to converter operation. Parameter P4012 is used to control the selection mode for switching in/out motors.

- P4012 = 0: Selecting the next pump according to the fixed sequence. The converter switches out the pump by following the sequence M4, M3, M2, to M1.

- P4012 = 1: Selecting the next pump according to the operating hours. The converter first switches out the pump with the most absolute operating hours (r4026 to r4029).

Note

If the PID error drops below the switch-out delay override (-P2376), the converter skips the switch-out delay (P2375) and performs the switch-out operation immediately.
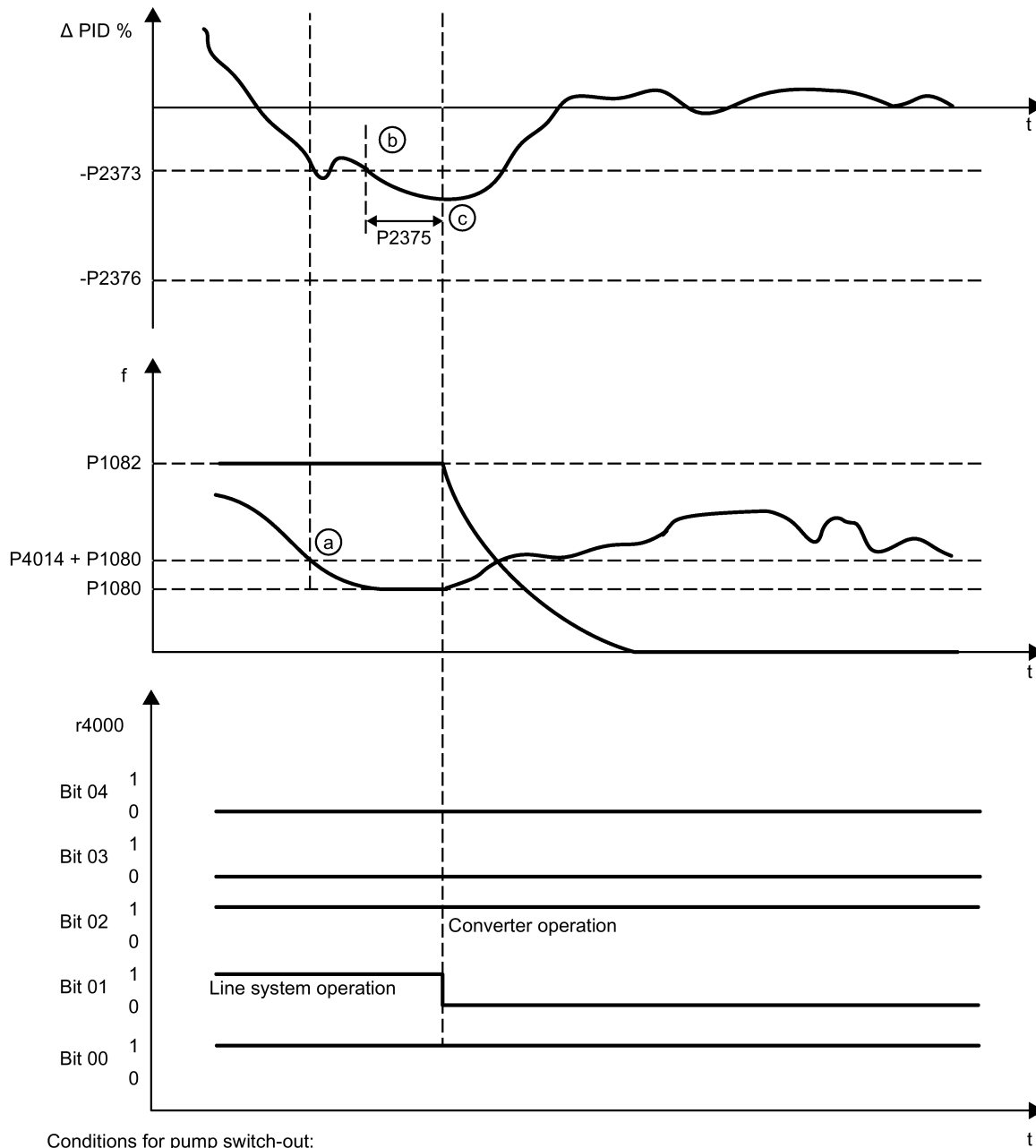
Pump switch-out based on the fixed sequence (P4012 = 0)
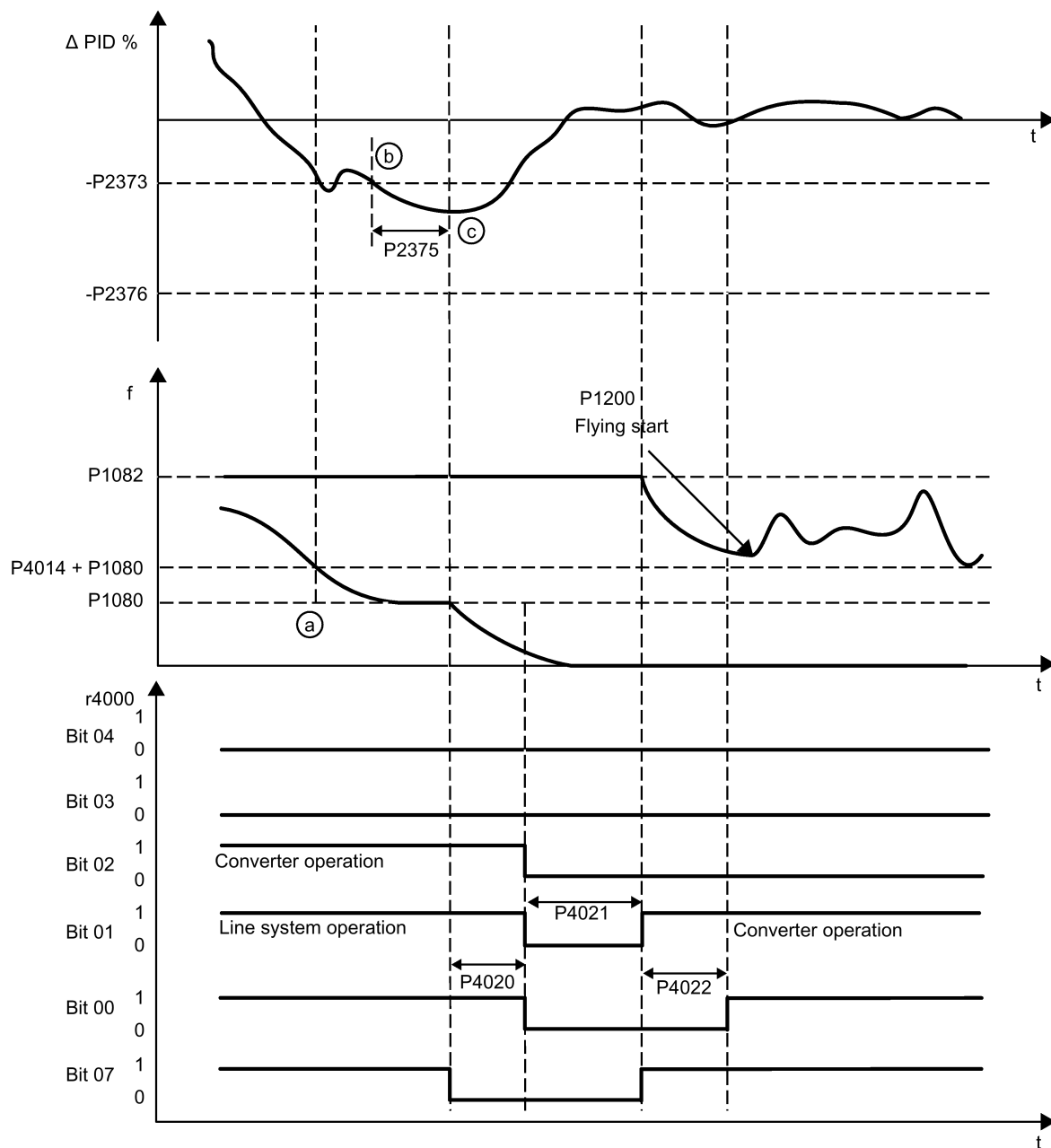
Conditions for pump switch-out:

(a) f_act < P4014 + P1080

(b) -P2376 < Δ PID ≤ -P2373

(c) t > P2375

Pump switch-out based on the absolute operating hours (P4012 = 1)

Conditions for pump switch-out:

(a) f_act < P4014 + P1080

(b) -P2376 < Δ PID ≤ -P2373

(c) t > P2375

Setting parameters

Parameter	Function	Setting
P1080[0...2]	Minimum frequency [Hz]	This parameter sets minimum motor frequency at which motor will run irrespective of frequency setpoint. The value set here is valid both for clockwise and for counterclockwise rotation. Range: 0.00 to 550.00 (default setting: 0.00)
P1082[0...2]	Maximum frequency [Hz]	This parameter sets maximum motor frequency at which motor will run irrespective of the frequency setpoint. The value set here is valid for both clockwise and counterclockwise rotation. Range: 0.00 to 550.00 (default setting: 50.00)
P1200	Flying start	Starts converter onto a spinning motor by rapidly changing the output frequency of the converter until the actual motor speed has been found. Then, the motor runs up to setpoint using the normal ramp time. Settings 1 to 3 search in both directions: = 0: Flying start disabled = 1: Flying start always active = 2: Flying start active after power on, fault, OFF2 = 3: Flying start active after fault, OFF2 Settings 4 to 6 search only in the direction of the setpoint: = 4: Flying start always active = 5: Flying start active after power on, fault, OFF2 = 6: Flying start active after fault, OFF2 Range: 0 to 6 (default setting: 1)
P2373[0...2]	Motor staging hysteresis [%]	P2373 is a percentage of PID setpoint that PID error r2273 must be exceeded before staging delay starts. Range: 0.0 to 200.0 (default setting: 20.0)
P2374[0...2]	Motor staging delay [s]	This parameter defines the time that PID error r2273 must exceed motor staging hysteresis P2373 before staging occurs. Range: 0 to 650 (default setting: 30)
P2375[0...2]	Motor destaging delay [s]	This parameter defines the time that PID error r2273 must exceed motor staging hysteresis P2373 before destaging occurs. Range: 0 to 650 (default setting: 30)
P2376[0...2]	Motor staging delay override [%]	P2376 as a percentage of PID setpoint. When the PID error r2273 exceeds this value, a motor is staged / destaged irrespective of the delay timers. Range: 0.0 to 200.0 (default setting: 25.0) **Note**: The value of this parameter must always be larger than staging hysteresis P2373.
P2377[0...2]	Motor staging lockout timer [s]	This parameter defines the time for which delay override is prevented after a motor has been staged or destaged. Range: 0 to 650 (default setting: 30)
r4000	Multi-pump control status word	This parameter defines the bitwise status word for the multi-pump control function. Bit 00: ON/OFF1 (output to P0840) Bit 01: Motor 1 switching on (output to P0731) Bit 02: Motor 2 switching on (output to P0732) Bit 03: Motor 3 switching on (output to P0733) Bit 04: Motor 4 switching on (output to P0734) Bit 05: Switching-in/-out operation in progress Bit 06: No idle motor is running Bit 07: OFF2 (output to P0845)

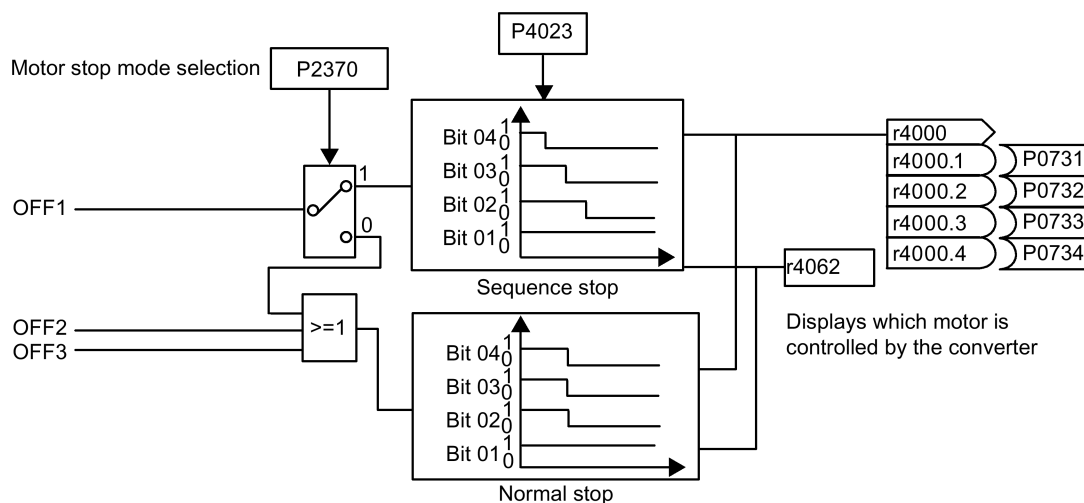| Parameter	Function	Setting
P4011	Multi-pump control enable	This parameter controls the execution of the multi-pump function.
		0: Disable the multi-pump control function
		1: Enable the multi-pump control function
		Range: 0 to 1 (default setting: 1)
P4012	Multi-pump control motor selection mode	This parameter controls the selection mode for switching in/out motors
		0: Fixed sequence (switching-in: M1, M2, M3, M4; switching-out: M4, M3, M2, M1)
		1: Absolute operating hours
		Range: 0 to 1 (default setting: 0)
P4013	Multi-pump control motor number configuration	This parameter configures the total number of existing motors. The value change to this parameter takes effect after the next time the script is started.
		Range: 1 to 4 (default setting: 4)
		Note: Before changing the value of P4013, change the value of P4002 to 0 first. After the value of P4013 is changed, re-power on the converter.
P4014	Multi-pump control switch-out offset [Hz]	The offset value is the threshold for switching out a motor. When actual frequency r0021 < P1080 + P4014, the converter will start to check whether the switching out operation is necessary according to PID error r2273.
		Default setting: 0
P4020	Multi-pump control switching delay time [ms]	After the multi-pump function is enabled, when switching in/out motors, the converter first switches off the directly controlled motor by OFF2, and then switches off the corresponding relay. This parameter is used to configure the delay time between the two operations.
		Default setting: 800
P4021	Multi-pump control switch-out time [ms]	After the relay of the directly controlled motor is switched off, the converter switches on the relay of the motor to be controlled. This parameter is used to configure the delay time between the two operations.
		Default setting: 1500
P4022	Multi-pump control switch-in time [ms]	After the relay of the motor to be controlled is switched on, the converter switches on the motor to be controlled by ON/OFF1. This parameter is used to configure the delay time between the two operations.
		Default setting: 1500
P4024	Multi-pump control max time for continuous operation [h]	The motor cycling function will be triggered if the continuous operating hours of a motor exceed the threshold. This parameter is used to configure the threshold value.
		Default setting: 24 (minimum value: 0.1)
r4026	Multi-pump control absolute operating hours: motor 1 [h]	Absolute operating hours timer for motor 1. It will be cleared after re-power on.
r4027	Multi-pump control absolute operating hours: motor 2 [h]	Absolute operating hours timer for motor 2. It will be cleared after re-power on.
r4028	Multi-pump control absolute operating hours: motor 3 [h]	Absolute operating hours timer for motor 3. It will be cleared after re-power on.
r4029	Multi-pump control absolute operating hours: motor 4 [h]	Absolute operating hours timer for motor 4. It will be cleared after re-power on.
r4062	Converter-controlled motor number	This parameter displays which motor is controlled by the converter.

Stop mode

<div style="text-align: right">3</div>

Two stop modes are available as follows:

- Normal stop: All pumps running in line system operation are switched off at the same time as soon as the stop command is received. The pump in converter operation stops under the control of the converter.

- Sequence stop: The pumps running in line system operation stop one by one in the reverse sequence in which they are switched on. There is a delay time between every pump stop. The pump in converter operation stops under the control of the converter after the other pumps are switched off.

After the OFF command is received, the pumps are switched off in either of the two stop modes:

- With OFF1 command received, the pump stop mode is selected in P2370 as follows:
  - P2370 = 0: normal stop
  - P2370 = 1: sequence stop
- With OFF2/OFF3 command received, the pumps are switched off with normal stop.

Setting parameters

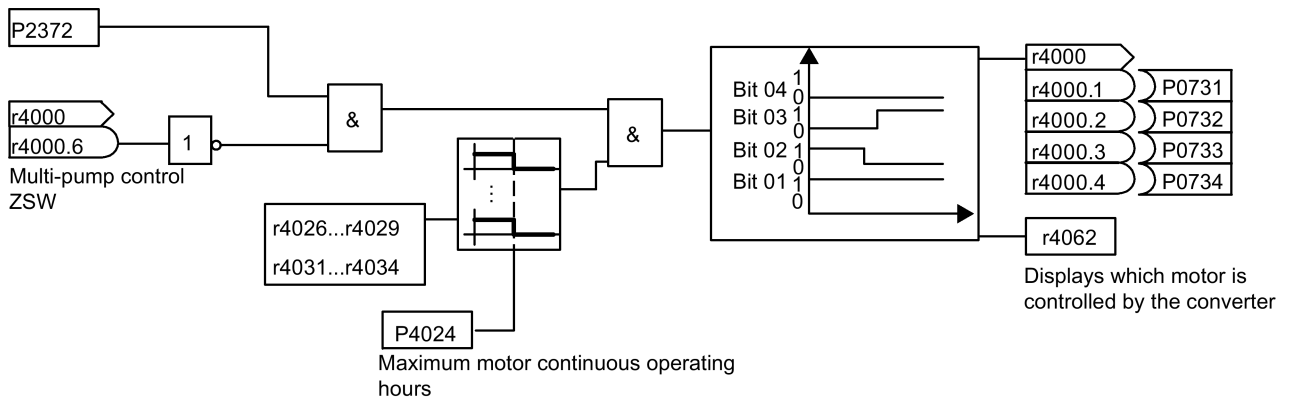| Parameter	Function	Setting
P0731[0...2]	BI: Function of digital output 1	Defines source of digital output 1.
		Range: 0 to 4294967295 (default setting: 4000.1)
P0732[0...2]	BI: Function of digital output 2	Defines source of digital output 2.
		Range: 0 to 4294967295 (default setting: 4000.2)
P0733[0...2]	BI: Function of digital output 3	Defines source of digital output 3.
		Range: 0 to 4294967295 (default setting: 4000.3)
P0734[0...2]	BI: Function of digital output 4	Defines source of digital output 4.
		Range: 0 to 4294967295 (default setting: 4000.4)
P2370[0...2]	Motor staging stop mode	This parameter selects stop mode for external motors when motor staging is in use.
		= 0: Normal stop
		= 1: Sequence stop
		Range: 0 to 1 (default setting: 0)
r4000	Multi-pump control status word	This parameter defines the bitwise status word for the multi-pump control function.
		Bit 00: ON/OFF1 (output to P0840)
		Bit 01: Motor 1 switching on (output to P0731)
		Bit 02: Motor 2 switching on (output to P0732)
		Bit 03: Motor 3 switching on (output to P0733)
		Bit 04: Motor 4 switching on (output to P0734)
		Bit 05: Switching-in/-out operation in progress
		Bit 06: No idle motor is running
		Bit 07: OFF2 (output to P0845)
P4023	Multi-pump control disconnection lockout time [h]	After a switching operation is finished, the operation will be locked out for a certain time. This parameter is used to configure the lockout time.
		Default setting: 0
r4062	Converter-controlled motor number	This parameter displays which motor is controlled by the converter.

Pump switchover

4

With pump switchover enabled, the converter monitors the operation status of all running pumps.

- If the continuous operating hours of the pump in converter operation exceed the threshold (P4024), the converter switches off the pump and then switches in an idle pump to keep constant output power.

- If the continuous operating hours of a pump in line system operation exceed the threshold (P4024), the converter first switches off the pump, switches out the directly controlled pump from converter operation to line system operation, and switches in an idle pump to keep constant output power.

You can use parameter P4012 to define the selection mode for the next pump. The internal counters (r4026 to r4029 and r4031 to r4034) are used to calculate the operating hours of the pumps.

- P4012 = 0: Selecting the next pump according to the fixed sequence. The converter first switches out the pump with most continuous operating hours (r4031 to r4034) and then switches in the pump following the sequence M1, M2, M3, to M4.

- P4012 = 1: Selecting the next pump according to the operating hours. The converter first switches out the pump with the most continuous operating hours (r4031 to r4034) and then switches in the pump with the least absolute operating hours (r4026 to r4029).

Setting parameters

Parameter	Function	Setting
P0731[0...2]	BI: Function of digital output 1	Defines source of digital output 1.
		Range: 0 to 4294967295 (default setting: 4000.1)
P0732[0...2]	BI: Function of digital output 2	Defines source of digital output 2.
		Range: 0 to 4294967295 (default setting: 4000.2)

Parameter	Function	Setting
P0733[0...2]	BI: Function of digital output 3	Defines source of digital output 3. Range: 0 to 4294967295 (default setting: 4000.3)
P0734[0...2]	BI: Function of digital output 4	Defines source of digital output 4. Range: 0 to 4294967295 (default setting: 4000.4)
P2372[0...2]	Motor staging cycling	This parameter enables motor cycling for the motor staging feature. = 0: Disabled = 1: Enabled Range: 0 to 1 (default setting: 0)
r4000	Multi-pump control status word	This parameter defines the bitwise status word for the multi-pump control function. Bit 00: ON/OFF1 (output to P0840) Bit 01: Motor 1 switching on (output to P0731) Bit 02: Motor 2 switching on (output to P0732) Bit 03: Motor 3 switching on (output to P0733) Bit 04: Motor 4 switching on (output to P0734) Bit 05: Switching-in/-out operation in progress Bit 06: No idle motor is running Bit 07: OFF2 (output to P0845)
P4012	Multi-pump control motor selection mode	This parameter controls the selection mode for switching in/out motors. 0: Fixed sequence (switching-in: M1, M2, M3, M4; switching-out: M4, M3, M2, M1) 1: Absolute operating hours Range: 0 to 1 (default setting: 0)
P4013	Multi-pump control motor number configuration	This parameter configures the total number of existing motors. The value change to this parameter takes effect after the next time the script is started. Range: 1 to 4 (default setting: 4) Note: Before changing the value of P4013, change the value of P4002 to 0 first. After the value of P4013 is changed, re-power on the converter.
P4024	Multi-pump control max time for continuous operation [h]	The motor switchover will be triggered if the continuous operating hours of a motor exceed the threshold. This parameter is used to configure the threshold value. Default setting: 24 (minimum value: 0.1)
r4026	Multi-pump control absolute operating hours: motor 1 [h]	Absolute operating hours timer for motor 1. It will be cleared after re-power on.
r4027	Multi-pump control absolute operating hours: motor 2 [h]	Absolute operating hours timer for motor 2. It will be cleared after re-power on.
r4028	Multi-pump control absolute operating hours: motor 3 [h]	Absolute operating hours timer for motor 3. It will be cleared after re-power on.
r4029	Multi-pump control absolute operating hours: motor 4 [h]	Absolute operating hours timer for motor 4. It will be cleared after re-power on.
r4031	Multi-pump control continuous operating hours: motor 1 [h]	Continuous operating hours timer for motor 1. It will be cleared when the motor is switched out.
r4032	Multi-pump control continuous operating hours: motor 2 [h]	Continuous operating hours timer for motor 2. It will be cleared when the motor is switched out.
r4033	Multi-pump control continuous operating hours: motor 3 [h]	Continuous operating hours timer for motor 3. It will be cleared when the motor is switched out.
r4034	Multi-pump control continuous operating hours: motor 4 [h]	Continuous operating hours timer for motor 4. It will be cleared when the motor is switched out.
r4062	Converter-controlled motor number	This parameter displays which motor is controlled by the converter.

Service mode 5

You can use parameters P4016 to P4019 to set the pumps in service mode respectively. When a pump is in service mode, the converter locks the corresponding relay, which allows you to perform troubleshooting of this pump without interrupting the operation of other pumps.

> ⚠️ **WARNING**
>
> **Danger to life due to unconnected low-voltage circuit breakers**
>
> If a pump is not connected to the mains and converter through a low-voltage circuit breaker, troubleshooting the pump in service mode can result in electric shock and unexpected movement of the pump, causing serious personal injury or death.
>
> - Make sure that all pumps are connected to the mains and converter through low-voltage circuit breakers. After a pump is set in service mode, cut off its low-voltage circuit breaker before performing any troubleshooting operation.
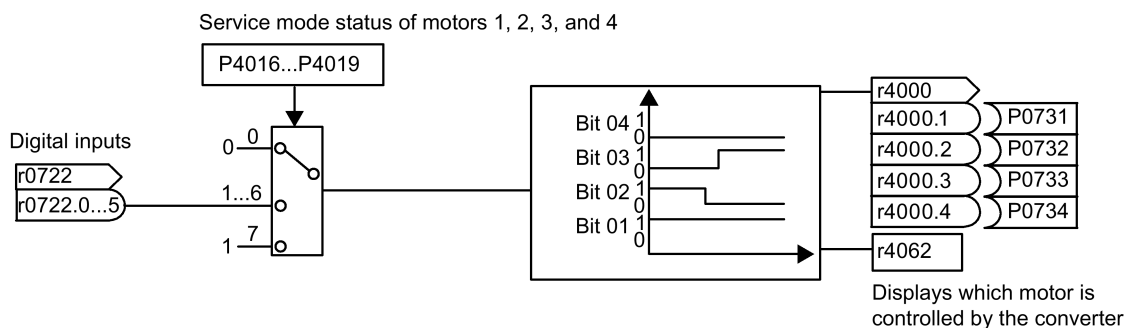
Setting parameters

Parameter	Function	Setting
r0722.0...12	Digital input values	Displays status of digital inputs. Bit 00: Digital input 1 Bit 01: Digital input 2 Bit 02: Digital input 3 Bit 03: Digital input 4 Bit 04: Digital input 5 Bit 05: Digital input 6 Bit 11: Analog input 1 Bit 12: Analog input 2
P0731[0...2]	BI: Function of digital output 1	Defines source of digital output 1. Range: 0 to 4294967295 (default setting: 4000.1)

Parameter	Function	Setting
P0732[0...2]	BI: Function of digital output 2	Defines source of digital output 2.
		Range: 0 to 4294967295 (default setting: 4000.2)
P0733[0...2]	BI: Function of digital output 3	Defines source of digital output 3.
		Range: 0 to 4294967295 (default setting: 4000.3)
P0734[0...2]	BI: Function of digital output 4	Defines source of digital output 4.
		Range: 0 to 4294967295 (default setting: 4000.4)
r4000	Multi-pump control status word	This parameter defines the bitwise status word for the multi-pump control function.
		Bit 00: ON/OFF1 (output to P0840)
		Bit 01: Motor 1 switching on (output to P0731)
		Bit 02: Motor 2 switching on (output to P0732)
		Bit 03: Motor 3 switching on (output to P0733)
		Bit 04: Motor 4 switching on (output to P0734)
		Bit 05: Switching-in/-out operation in progress
		Bit 06: No idle motor is running
		Bit 07: OFF2 (output to P0845)
P4016	Multi-pump control service mode: motor 1	This parameter controls the service mode of motor 1.
		= 0: Motor 1 service mode is disabled
		= 1: Motor 1 service mode is enabled by DI1 high level
		= 2: Motor 1 service mode is enabled by DI2 high level
		= 3: Motor 1 service mode is enabled by DI3 high level
		= 4: Motor 1 service mode is enabled by DI4 high level
		= 5: Motor 1 service mode is enabled by DI5 high level
		= 6: Motor 1 service mode is enabled by DI6 high level
		= 7: Motor 1 service mode is enabled
		Range: 0 to 7 (default setting: 0)
P4017	Multi-pump control service mode: motor 2	This parameter controls the service mode of motor 2. Refer to P4016.
P4018	Multi-pump control service mode: motor 3	This parameter controls the service mode of motor 3. Refer to P4016.
P4019	Multi-pump control service mode: motor 4	This parameter controls the service mode of motor 4. Refer to P4016.
r4062	Converter-controlled motor number	This parameter displays which motor is controlled by the converter.

Faults and alarms

<div style="text-align: right; font-size: xx-large;">6</div>

Alarm

A650		
Unofficial script running	The script running is not approved and should not be used.	Use an officially released script.