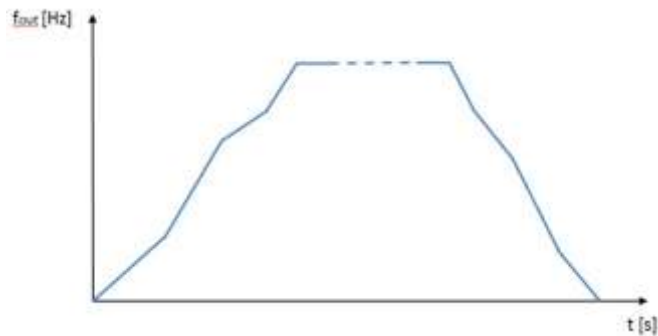


PowerXL™

DA1 Variable Frequency Drives Use of multiple ramps



| | |
|---------|--|
| Level 3 | <ul style="list-style-type: none">1 – Fundamental – No previous experience necessary2 – Basic – Basic knowledge recommended3 – Advanced – Reasonable knowledge required4 – Expert – Good experience recommended |
|---------|--|

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Danger! - Dangerous electrical voltage!

- Disconnect the power supply of the device.
- Ensure that devices cannot be accidentally restarted.
- Verify isolation from the supply.
- Cover or enclose any adjacent live components.
- Follow the engineering instructions (AWA/IL) for the device concerned.
- Only suitably qualified personnel in accordance with EN 50110-1/-2 (VDE 0105 Part 100) may work on this device/system.
- Before installation and before touching the device ensure that you are free of electrostatic charge.
- The functional earth (FE, PES) must be connected to the protective earth (PE) or the potential equalization. The system installer is responsible for implementing this connection.
- Connecting cables and signal lines should be installed so that inductive or capacitive interference does not impair the automatic control functions.
- Suitable safety hardware and software measures should be implemented for the I/O interface so that an open circuit on the signal side does not result in undefined states.
- Deviations of the mains voltage from the rated value must not exceed the tolerance limits given in the specification, otherwise this may cause malfunction and/or dangerous operation.
- Emergency stop devices complying with IEC/EN 60204-1 must be effective in all operating modes. Unlatching of the emergency-stop devices must not cause a restart.
- Devices that are designed for mounting in housings or control cabinets must only be operated and controlled after they have been properly installed and with the housing closed.
- Wherever faults may cause injury or material damage, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (e.g. by means of separate limit switches, mechanical interlocks etc.).
- Frequency inverters may have hot surfaces during and immediately after operation.
- Removal of the required covers, improper installation or incorrect operation of motor or frequency inverter may destroy the device and may lead to serious injury or damage.
- The applicable national safety regulations and accident prevention recommendations must be applied to all work carried on live frequency inverters.
- The electrical installation must be carried out in accordance with the relevant electrical regulations (e. g. with regard to cable cross sections, fuses, PE).
- Transport, installation, commissioning and maintenance work must be carried out only by qualified personnel (IEC 60364, HD 384 and national occupational safety regulations).
- Installations containing frequency inverters must be provided with additional monitoring and protective devices in accordance with the applicable safety regulations. Modifications to the frequency inverters using the operating software are permitted.
- All covers and doors must be kept closed during operation.

To reduce the hazards for people or equipment, the user must include in the machine design measures that restrict the consequences of a malfunction or failure of the frequency inverter (increased motor speed or sudden standstill of motor). These measures include: – Other independent devices for monitoring safety related variables (speed, travel, end positions etc.).

– Electrical or non-electrical system-wide measures (electrical or mechanical interlocks).

– Never touch live parts or cable connections of the frequency inverter after it has been disconnected from the power supply. Due to the charge in the capacitors, these parts may still be alive after disconnection. Consider appropriate warning signs.

Disclaimer

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1 General

Variable frequency drives of the series **PowerXL™ DA1** have the possibility to use up to four acceleration ramps and four deceleration ramps. They are selected either with a digital control command or depending on the motor speed.

This Application Note describes

- the general functionality
- the configuration of the device depending on the required number of ramps and the ramp mode

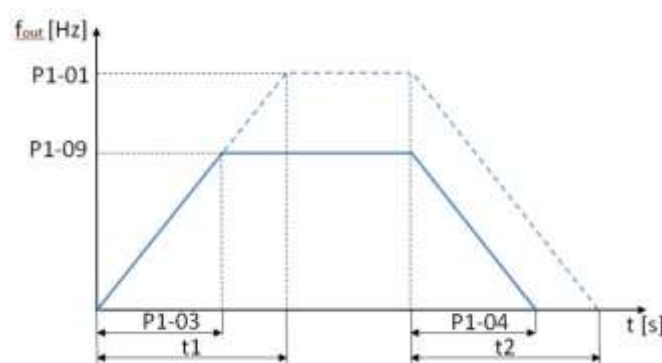
The required parameters are inside Level 3 of the menu. This level has to be activated by prompting the “Password Level3” (P6-30) into P1-14 (Password). Password Level3 is “201” by default.

2 Setting the ramp times

The variable frequency drives of the series **PowerXL™ DA1** have multiple ramps, which can be set independently:

- Acceleration ramp „t-acc“ (P1-03)
- Deceleration ramp „t-dec“ (P1-04)
- Quick stop ramp „t-QuickDec“ (P2-25)
- Acceleration ramp 2 „t-acc2“ (P8-01)
- Acceleration ramp 3 „t-acc3“ (P8-03)
- Acceleration ramp 4 „t-acc4“ (P8-05)
- Deceleration ramp „t-dec2“ (P8-11)
- Deceleration ramp „t-dec3“ (P8-09)
- Deceleration ramp „t-dec4“ (P8-07)

The set times refer to the time between standstill and the rated frequency of the motor (P1-09 „Motor Nom Frequency“) or vice versa.



In most cases the rated frequency of the motor (P1-09) is equal to the max frequency (P1-01). In case a motor is operated above its rated speed, this has to be taken into account when setting the ramp times.

Calculation of the parameter values, using the example of P1-03 and P1-04:

$$P1-03 = t1 \cdot \frac{P1-09}{P1-01} \qquad P1-04 = t2 \cdot \frac{P1-09}{P1-01}$$

The setting of the acceleration and deceleration ramp times in menu 8 „ramps“ is done accordingly.

When the deceleration time is set too short, this leads to an energy feedback from the machine into the d.c. link and a trip of the variable frequency drive because of overvoltage. In this case, the value of the deceleration ramp must be increased or a brake resistor has to be used.

2.1 t-acc (P1-03), t-acc2 (P8-01), t-acc3 (P8-03), t-acc4 (P8-05), t-dec (P1-04), t-dec2 (P8-11), t-dec3 (P8-09), t-dec4 (P8-11)

| PNU | Parameter | Name | Range | Default |
|-------|-----------|--------|------------------|---------|
| 111.0 | P1-03 | t-acc | 0.00 s ... 600 s | 5.0 s |
| 130.1 | P8-01 | t-acc2 | 0.00 s ... 600 s | 5.0 s |
| 130.2 | P8-03 | t-acc3 | 0.00 s ... 600 s | 5.0 s |
| 130.3 | P8-05 | t-acc4 | 0.00 s ... 600 s | 5.0 s |
| 114.0 | P1-04 | t-dec | 0.00 s ... 600 s | 5.0 s |
| 134.1 | P8-11 | t-dec2 | 0.00 s ... 600 s | 5.0 s |
| 134.2 | P8-09 | t-dec3 | 0.00 s ... 600 s | 5.0 s |
| 134.3 | P8-07 | t-dec4 | 0.00 s ... 600 s | 5.0 s |

3 Selection of the ramp mode

Parameter P8-13 „Ramp Mode“ determines, if the ramps are selected by control commands (see 4.) or if the active ramp depends on the speed of the motor (see 5.).

3.1 Ramp Mode (P8-13)

P8-13 = 0

The ramp is selected by a control command. The terminals have to be configured respectively with P9-24 ... P9-27. In case P9-24 ... P9-27 = 0, the multi ramp function is deactivated and only the ramps “t-acc” (P1-03) and “t-dec” (P1-04) are effective.

P8-31 = 1

The ramps “t-acc“ ... „t-acc4“ and „t-dec“ ... „t-dec4“ are activated speed dependent.

| PNU | Parameter | Name | Range | Default |
|-------|-----------|-----------|---|---------|
| 630.1 | P8-13 | Ramp Mode | 0: Ramp according selection 1: Ramp depending on speed | 0 |

4 Selection of the ramps with control commands

Up to four acceleration and deceleration ramps can be selected by using digital control commands at the terminals. It has to be noted, that this is not possible with the preconfigured terminal combinations (P1-13 = 1...21), but it has to be configured manually. For doing this, P1-13 has to be set to "0". The assignment of commands to terminals is done inside menu 9. The parameters in the table below are important for the ramp selection. In addition other terminals have to be configured, e.g. the ones for the enable signal and the speed reference.

4.1 Terminal configuration, t-acc Select B0 (P9-24), t-acc Select B1 (P9-25), t-dec Select Bit0 (P9-26), t-dec Select Bit1 (P9-27)

| PNU | Parameter | Name | Range | Default |
|-------|-----------|-----------------|--|---------|
| 433.0 | P9-24 | t-acc Select B0 | 0: OFF / Function not activated 1: Digital Input 1 (DI1 = Terminal 2) 2: Digital Input 2 (DI2 = Terminal 3) 3: Digital Input 3 (DI3 = Terminal 4) 4: Digital Input 4 (DI4 = Terminal 6) 5: Digital Input 5 (DI5 = Terminal 10) 6: Digital Input 6 (DI6 = Terminal 1 on DXA-EXT-3DI1RO) 7: Digital Input 7 (DI7 = Terminal 2 on DXA-EXT-3DI1RO) 8: Digital Input 8 (DI8 = Terminal 3 on DXA-EXT-3DI1RO) 9: Analog Output 1 (AO1 = Terminal 8) 10: Analog Output 2 (AO2 = Terminal 11) 11: Digital Output 1 (RO1 = Terminal 14 / 15 / 16) 12: Digital Output 2 (RO2 = Terminal 17 / 18) 13: Digital Output 3 (DO3 = Terminal 5 / 6 on DXA-EXT-3DI1RO resp. Terminal 1 / 2 on DXA-EXT-3RO) 14: Digital Output 4 (DO4 = Terminal 3 / 4 on DXA-EXT-3RO) 15: Digital Output 5 (DO5 = Terminal 5 / 6 on DXA-EXT-3RO) 16: ON / Function activated 17: User register 1 18: User register 2 19: User register 3 20: User register 4 21: User register 5 22 = User register 6 23 = User register 7 24 = User register 8 25 = User register 9 | 0 |
| 433.1 | P9-25 | t-acc Select B1 | see P9-24 | 0 |
| 434.0 | P9-26 | t-dec Select B0 | see P9-24 | 0 |
| 434.1 | P9-27 | t-dec Select B1 | see P9-24 | 0 |

4.2 Selection of the ramps

The combination of the control commands result in the following possibilities:

| | t-acc B0 | t-acc B1 |
|--------|----------|----------|
| t-acc | LOW | LOW |
| t-acc2 | HIGH | LOW |
| t-acc3 | LOW | HIGH |
| t-acc4 | HIGH | HIGH |

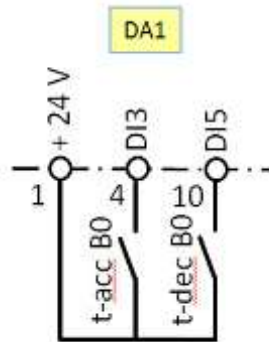
| | t-dec B0 | t-dec B1 |
|--------|----------|----------|
| t-dec | LOW | LOW |
| t-dec2 | HIGH | LOW |
| t-dec3 | LOW | HIGH |
| t-dec4 | HIGH | HIGH |

It is not mandatory to use all of the four ramps. See examples.

4.3 Examples

HINT: the terminal configurations inside the examples take only these assignments into account, which are necessary for the ramp selection.

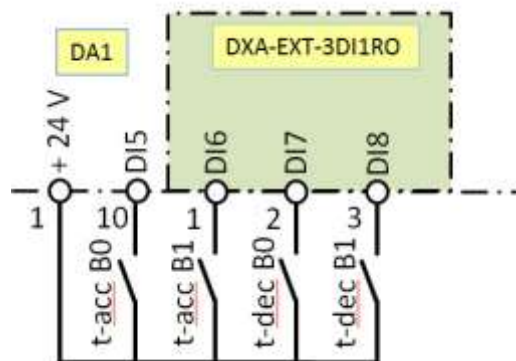
4.3.1 Example 1: Two ramps



In case only two ramps for acceleration and deceleration are used, the commands „t-acc B1“ and t-dec B1“ are not required.

- P9-24 = 3 Input for „t-acc B0“ is DI3 (terminal 4)
- P9-26 = 5 Input for „t-dec B0“ is DI5 (terminal 10)
- Acceleration
 - „t-acc B0“ = LOW → t-acc (P1-03)
 - „t-acc B0“ = HIGH → t-acc2 (P8-01)
- Deceleration
 - „t-dec B0“ = LOW → t-dec (P1-04)
 - „t-dec B0“ = HIGH → t-dec2 (P8-11)

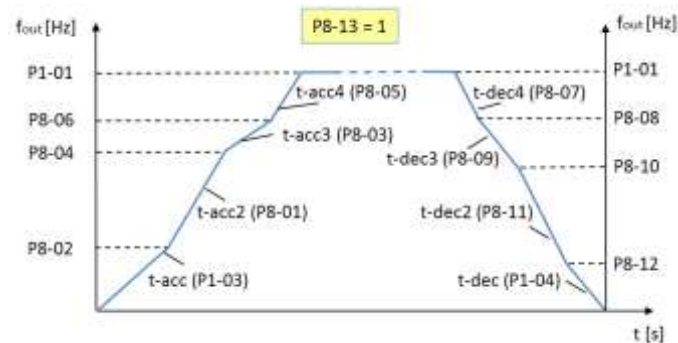
4.3.2 Example 2: Four ramps



Four terminals are required to select four acceleration and four deceleration ramps. In this example the optional I/O extension DXA-EXT-3DI1RO is used, which increases the number of digital I/Os by three: DI6 (terminal 1), DI7 (terminal 2) and DI8 (terminal 3).

- P9-24 = 5 Input for „t-acc B0“ is DI5 (terminal 10 on the device DA1)
- P9-25 = 6 Input for „t-acc B1“ is DI6 (terminal 1 on DXA-EXT-3DI1RO)
- P9-26 = 7 Input for „t-dec B0“ is DI7 (terminal 2 on DXA-EXT-3DI1RO)
- P9-27 = 8 Input for „t-dec B1“ is DI8 (terminal 3 on DXA-EXT-3DI1RO)
- Selection of the ramps see table in 4.2

5 Speed dependent ramps



With parameter „Ramp Mode“ (P8-13) = „1“ the ramps are selected depending on the speed. It is not mandatory to use all four ramps. It is also possible to have hybrid forms (e.g. two acceleration ramps and three deceleration ramps).

The threshold values for the acceleration are set with P8-02, P8-04 and P8-06, the ones for deceleration with P8-08, P8-10 and P8-12. With P1-10 „Motor Nom Speed“ = 0 the setting is done in Hz, with P1-10 > 0 in rpm.

„AND“ in the paragraphs below means, that all conditions have to be fulfilled at the same time.

Acceleration:

- t-acc → Frequency / speed < P8-02 AND < P8-04 AND < P8-06
- t-acc2 → Frequency / speed > P8-02 AND < P8-04 AND < P8-06
- t-acc3 → Frequency / speed > P8-02 AND > P8-04 AND < P8-06
- t-acc4 → Frequency / speed > P8-02 AND > P8-04 AND > P8-06

Deceleration:

- t-dec → Frequency / speed < P8-12 AND < P8-10 AND < P8-08
- t-dec2 → Frequency / speed > P8-12 AND < P8-10 AND < P8-08
- t-dec3 → Frequency / speed > P8-12 AND > P8-10 AND < P8-08
- t-dec4 → Frequency / speed > P8-12 AND > P8-10 AND > P8-08

5.1 Thresholds, n-accMulti1 (P8-02), n-accMulti2 (P8-04), n-accMulti3 (P8-06), n-decMulti1 (P8-12), n-decMulti2 (P8-10), n-decMulti3 (P8-08)

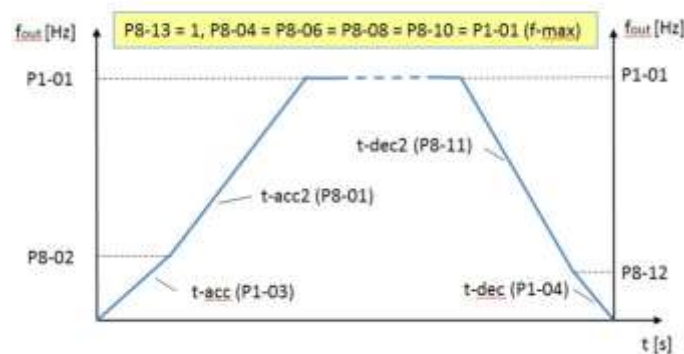
The thresholds determine the change from one ramp to the next one:

- n-accMulti1 between t-acc and t-acc2
- n-accMulti2 between t-acc2 and t-acc3
- n-accMulti3 between t-acc3 and t-acc4
- n-decMulti1 between t-dec2 and t-dec
- n-decMulti2 between t-dec3 and t-dec2
- n-decMulti3 between t-dec4 and t-dec3

| PNU | Parameter | Name | Range | Default |
|-------|-----------|-------------|------------------------|---------|
| 121.0 | P8-02 | n-accMulti1 | 0.0 Hz / rpm ... P1-01 | 0.0 Hz |
| 121.1 | P8-04 | n-accMulti2 | 0.0 Hz / rpm ... P1-01 | 0.0 Hz |
| 121.2 | P8-06 | n-accMulti3 | 0.0 Hz / rpm ... P1-01 | 0.0 Hz |
| 123.1 | P8-12 | n-decMulti1 | 0.0 Hz / rpm ... P1-01 | 0.0 Hz |
| 123.2 | P8-10 | n-decMulti2 | 0.0 Hz / rpm ... P1-01 | 0.0 Hz |
| 123.3 | P8-08 | n-decMulti3 | 0.0 Hz / rpm ... P1-01 | 0.0 Hz |

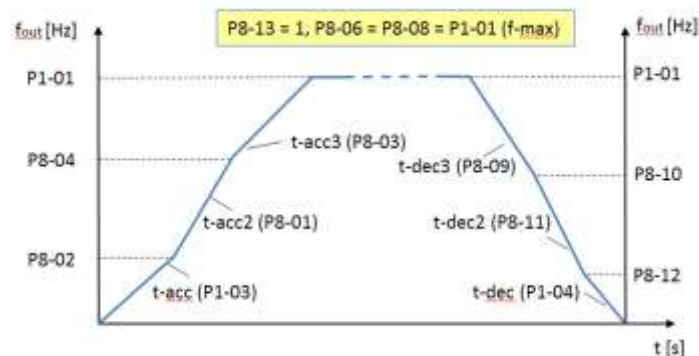
5.2 Examples

5.2.1 Example 1: Two ramps



- P8-13 = 1 (speed dependent ramp selection)
- The thresholds for the ramps, which are not used (t-acc3, t-acc4, t-dec3, t-dec4) must be set to the value of the maximum frequency (= P1-01 "f-max").
 - P8-04 = P8-06 = P8-08 = P8-10 → same value as P1-01 „f-max“

5.2.2 Example 2: Three ramps



- P8-13 = 1 (speed dependent ramp selection)
- The thresholds for the ramps, which are not used (t-acc4, t-dec4) must be set to the value of the maximum frequency (= P1-01 "f-max").
 - P8-06 = P8-08 → same value as P1-01 „f-max“