ENGINEERING
TOMORROW

Design Guide

APP pumps and iSave® overload protection

hpp.danfoss.com

Table of Contents

Table of Contents

1. Introduction

This document shows what to consider when programming a VFD that can protect the APP pump and the iSave against overloads. It also shows how to program the Danfoss VLT FC 202 and FC 302 in connection with the APP pump and iSave.
Similar functions need to be available on other VFD brands.

There are principal two choiches that can be made when selecting the torque limits for the pump and iSave.

1. Protecting the pump or iSave against maximum allowable load, means maximum torque at maximum pressure. This choice may not give the possibility to detect additional critical torque caused by wear of internal parts. See graph in example #1 in chapter 2.1.
2. Protecting the pump or iSave against significant change in actual load. This choice gives you the possibility to detect additional critical torque caused by wear of internal parts. This means the torque limit typical will b set lower than maximum Allowable Operating Torque. See graph in example #2 in chapter 2.1.
Danfoss strongly recommend to use the possibility to detect significant change in actual load.

2. APP pump and iSave overload protection

When protecting the pump and iSave against overload **both the maximum torque and maximum pressure must be taken into account.**

- Maximum allowable operation torque is the maximum torque the product can handle in normal operation.
- Maximum allowable operation torque is the maximum torque the product need in a specificl operation.

2.1 Maximum torque

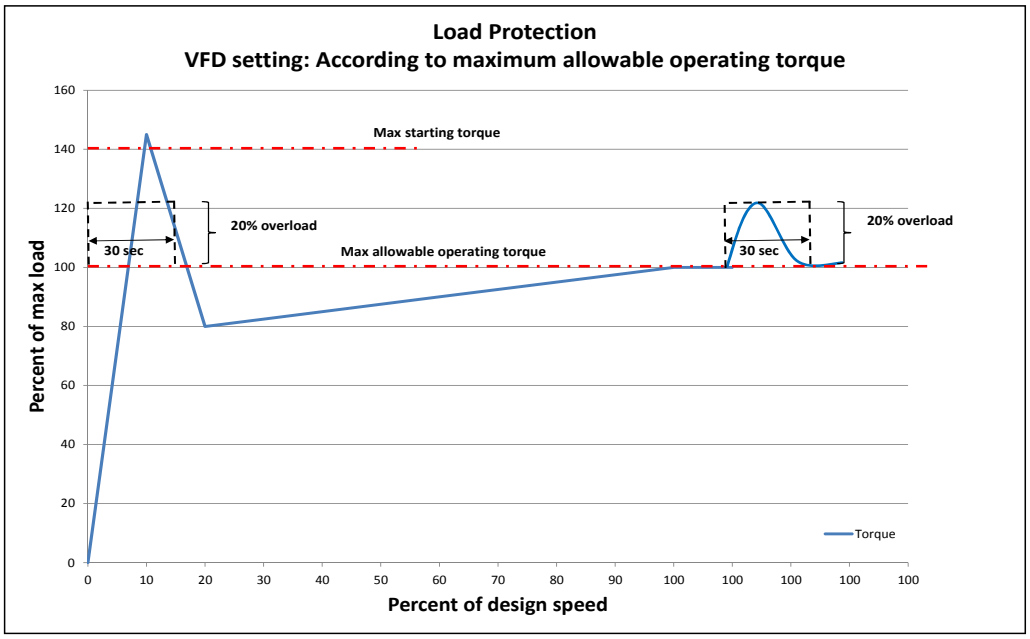
Start up:

- Ramp up speed from 0 to set-point
- The starting torque must not exceed maximum Starting Torque according to chapter 5.

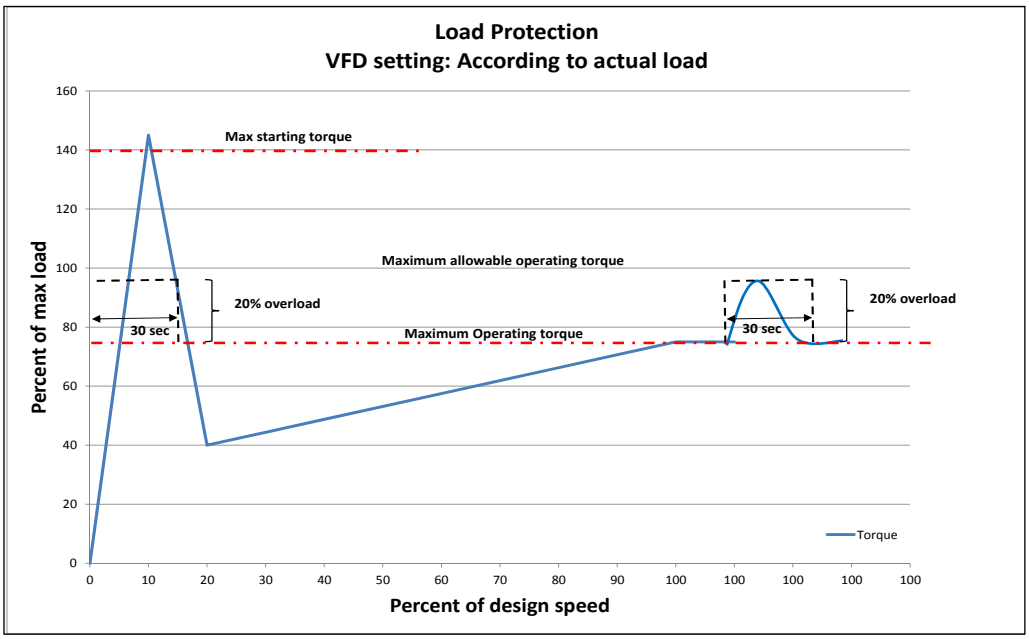
Ongoing operating:

- Continuouslythe torque must not exceed 120% of maximum Allowable Operating Torque for more than 30 sec.
- Periodically the torqu can for a very short time go up to maximum Starting torque.

Example #1



Example #2



3. Standard preferred settings

3.1 VLT FC 202 and VLT FC 302

For detailed information on how to program a VLT FC 202 or FC 302 we refer to the "Programming Guide VLT Aqua Drive FC 202 and FC 302". vlt-drives.danfoss.com

To calculate setting for parameter 4-16 and 4-18 please contact Danfoss.

Programming VLT:		
Parameter 0-01	"Language"	Set language
Parameter 0-02	"Motor speed unit"	Set to rpm
Parameter 0-20	"LCD Display"	Choose rom, Amp, kW, Hz, Torque
Parameter 1-03	"Torque characteristic"	Set to 0 (Constant torque)
Parameter 1-06	"Clockwise direction"	Set to inverse (Clockwise)
Parameter 1-20	"Motor power kW"	According to motor name plate
Parameter 1-22	"Motor voltage"	According to motor name plate
Parameter 1-23	"Motor frequency"	According to motor name plate
Parameter 1-24	"Motor current"	According to motor name plate
Parameter 1-25	"Motor nominel speed"	Rpm according to name plate
Parameter 1-29	"Automatic motor adaption AMA"	Run full AMA. (Remember to fuse terminals 12 and 27. Push hand on. Remove fuse after AMA)
Parameter 1-71	"Start delay"	Set in sec. (See chapter 5.3)
Parameter 1-72	"Start function"	Set to 0. (DC hold/delay/time)
Parameter 2-00	"DC hold current"	Set in % (please contact Danfoss or see chapter 5.2 for iSave)
Parameter 3-02	"Minimum reference"	Set to 0
Parameter 3-03	"Maximum reference"	Set needed rpm. For application
Parameter 3-41	"Ramp 1. Ramp up time"	Motor ramp up time. Pump: 10-60 sec. = 1 barg/sec. iSave: 10.15 sec.
Parameter 3-42	"Ramp 1. Ramp down time"	Motor ramp down time. Pump: 10-60 sec. = 1 barg/sec. iSave: 10-15 sec.
Parameter 4-11	"Motor speed low limit"	Set low limit [rpm] for product according to chapter 5
Parameter 4-13	"Motor speed high limit"	Set max. limit [rpm] for product according to chapter 5
Parameter 4-19	"Max. output frequency"	[Hz] Set max. output for product
Torque limit		
Parameter 4-16	"Torque limit motor mode"	Set in [%] (please contact Danfoss or see chapter 5.2 for iSave)
Parameter 14-25	"Trip delay at torque limit"	Set to 30 sec.
Current limit		
Parameter 4-18	"Current limit"	Set in [%] (Par. 4-18 must always be larger or equal to Par. 4-16), (please contact Danfoss or see chapter 5.2 for iSave)

4. Examples of VLT overload limit settings

Below is two examples of how to calculate the torque limit settings for an APP pump.
All calculations are made in the Danfoss HPP calculation tool (please contact Danfoss HPP for help).

Example 1:
Settings are made according to actual operating pressure (see graph #2 in chapeter 2.1).

- 77 m^3/h and 60 barg max. operating pressure
- **Design pressure 60 barg**

√ Calculated operating torque: 934 Nm at 1,490 rpm and 60 barg.

√ Selected motor:
- 160 kW, 4 pole
- Efficiency: 95.8%
- Power factor (cosφ): 0.87
- Power supply: 400 [V]
- Rated speed: 1,490 rpm
- Max. current: 275 [A]
- Max. operating torque: 1,026 Nm

√ Calculate torque at 20% higher than 934 Nm = > 1,121 Nm
Parameter 4-16 setting = 107%

√ Calculate starting torque at 40% higher than 934 Nm = > 1,308 Nm
Parameter 4-18 setting = 121%

√ Calculated DC-hold: Parameter 2-00 is 49%

√ Selected delay before start
Parameter 1-71 is 4
(see chapter 5.3)

√ Trip delay torque limit:
Parameter 14-25 is 30 sec.

√ Calculated starting current: 334 [A]

√ Calculated operating current at 60 barg: 257 [A]

Example 2:
Settings are made according to maximum allowable operating pressure (see graph #1 in chapter 2.1)

- 77 m^3/h and 60 barg max. operating pressure
- **Design pressure 80 barg**

√ Calculated maximum operating torque: 1,246 Nm at 1,490 rpm and 80 barg.

√ Calculated operatin torque: 934 Nm at 1,490 rpm and 60 barg.

√ Selected motor:
- 200 kW, 4 pole
- Efficiency: 96%
- Power factor (cosφ): 0.88
- Power supply: 400 [V]
- Rated speed: 1,490 rpm
- Max. current: 340 [A]
- Max. operating torque: 1,282 Nm

√ Calculate torque at 20% higher than 934 Nm = > 1,121 Nm
Parameter 4-16 setting = 90%

√ Calculate starting torque at 40% higher than 934 Nm = > 1,308 Nm
Parameter 4-18 setting = 102%

√ Calculated DC-hold:
Parameter 2-00 is 47%

√ Selected delay before start
Parameter 1-71 is 4.5

√ Trip delay torque limit:
Parameter 14-25 is 30 sec.

√ Calculated starting current: 345 [A]

√ Calculated operating current at 60 barg: 271 [A]

5. APP and iSave maximum load and speed limit

5.1 APP pumps

APP pump	Code number	Max. starting torque Use without VFD control	Max. starting torque Use in Parameter 4-18	Max. allowable operating torque Use in Parameter 4-16	Max. allowable operating pressure	Operational speed (min.) Parameter 4-11	Operational speed (max.) Parameter 4-13
APP 86/1700	180B7802	1700 [Nm]	1155 [Nm]	1111 [Nm]	70 barg	700 rpm	1700 rpm
APP 78/1500	180B7800	1700 [Nm	1700 [Nm]	1246 [Nm]	80 barg	700 rpm	1500 rpm
APP 65/1500	180B7803	1700 [Nm	1541 [Nm]	1101 [Nm]	80 barg	700 rpm	1500 rpm
APP 53/1500	180B7801	1700 [Nm	1205 [Nm]	861 [Nm]	80 barg	700 rpm	1500 rpm
APP 43/1700	180B3072	851 [Nm]	764 [Nm]	546 [Nm]	70 barg	700 rpm	1700 rpm
APP 38/1500	180B3071	851 [Nm]	851 [Nm]	608 [Nm]	80 barg	700 rpm	1500 rpm
APP 30/1200	180B3060	851 [Nm]	851 [Nm]	608 [Nm]	80 barg	700 rpm	1200 rpm
APP 30/1500	180B3062	851 [Nm]	699 [Nm]	499 [Nm]	80 barg	700 rpm	1500 rpm
APP 26/1200	180B3056	851 [Nm]	738 [Nm]	527 [Nm]	80 barg	700 rpm	1200 rpm
APP 26/1500	180B3057	851 [Nm]	596 [Nm]	426 [Nm]	80 barg	700 rpm	1500 rpm
APP 24/1200	180B3054	851 [Nm]	685 [Nm]	489 [Nm]	80 barg	700 rpm	1200 rpm
APP 24/1500	180B3055	851 [Nm]	543 [Nm]	388 [Nm]	80 barg	700 rpm	1500 rpm
APP 21/1200	180B3051	851 [Nm]	585 [Nm]	418 [Nm]	80 barg	700 rpm	1200 rpm
APP 21/1500	180B3052	851 [Nm]	497 [Nm]	355 [Nm]	80 barg	700 rpm	1500 rpm
APP 22/1200	180B3257	596 [Nm]	596 [Nm]	426 [Nm]	80 barg	700 rpm	1200 rpm
APP 22/1500	180B3253	596 [Nm]	427 [Nm]	305 [Nm]	70 barg	700 rpm	1500 rpm
APP 19/1200	180B3256	596 [Nm]	521 [Nm]	372 [Nm]	80 barg	700 rpm	1200 rpm
APP 19/1500	180B3252	596 [Nm]	368 [Nm]	263 [Nm]	70 barg	700 rpm	1500 rpm
APP 17/1200	180B3255	596 [Nm]	480 [Nm]	343 [Nm]	80 barg	700 rpm	1200 rpm
APP 17/1500	180B3251	596 [Nm]	328 [Nm]	234 [Nm]	70 barg	700 rpm	1500 rpm
APP 16/1200	180B3254	596 [Nm]	442 [Nm]	316 [Nm]	80 barg	700 rpm	1200 rpm
APP 16/1500	180B3250	596 [Nm]	312 [Nm]	223 [Nm]	70 barg	700 rpm	1500 rpm
APP 13/1200	180B3214	384 [Nm]	384 [Nm]	274 [Nm]	80 barg	700 rpm	1200 rpm
APP 13/1500	180B3213	384 [Nm]	286 [Nm]	204 [Nm]	70 barg	700 rpm	1500 rpm
APP 11/1200	180B3212	384 [Nm]	321 [Nm]	229 [Nm]	80 barg	700 rpm	1200 rpm
APP 11/1500	180B3211	384 [Nm]	232 [Nm]	166 [Nm]	70 barg	700 rpm	1500 rpm

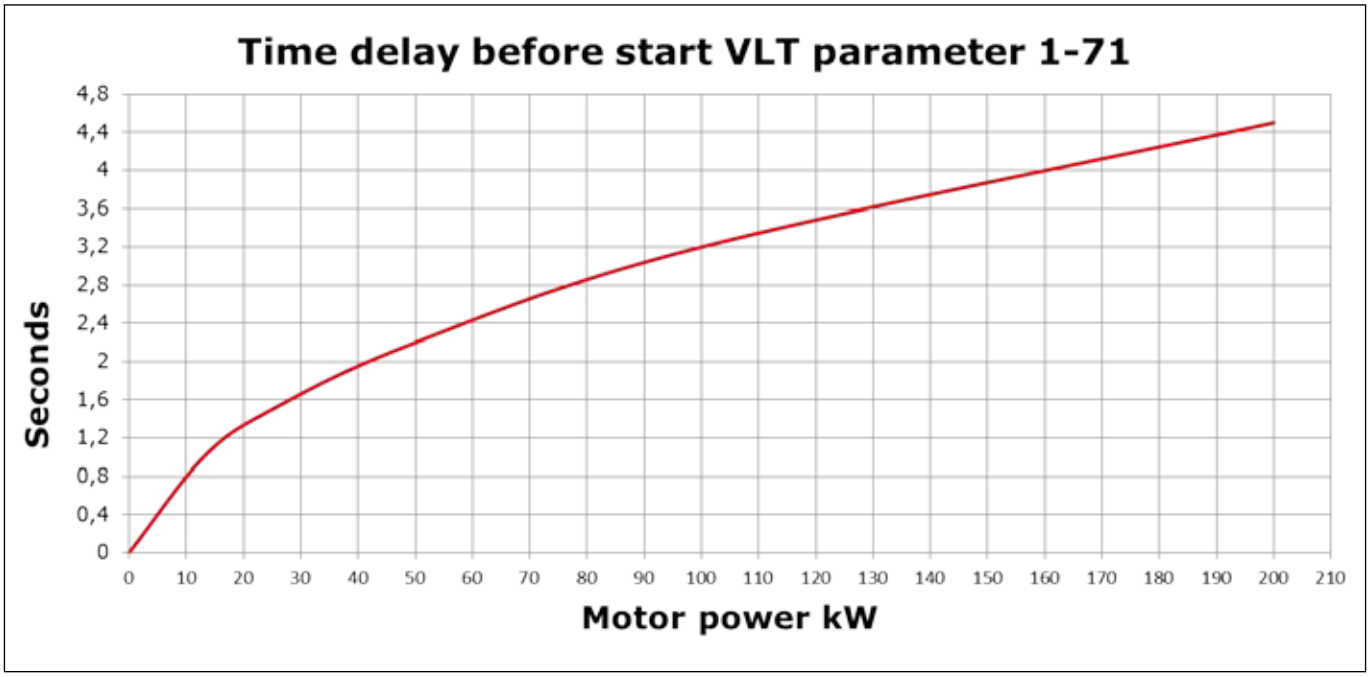
5.2 iSave energy recovery device

iSave	iSave 21	iSave 21	iSave 40	iSave 40	iSave 40
Code number	180F7000	180F7010N104H	180F7001 180F7003	180F7004 180F7005	180F011N206H 180F011N206V
Motor	5.5 kW IEC	10 HP NEMA	11 kW IEC	15 kW IEC	20 HP NEMA
Max. allowable operating differential pressure	3 barg	3 barg	5 barg	5 barg	5 barg
Max. allowable operating torque	34 Nm	34 Nm	102 Nm	102 Nm	102 Nm
Max. starting torque	50 Nm	50 Nm	150 Nm	150 Nm	150 Nm
Delay before start **Parameter 1-71**	0.4 sec.	0.7 sec.	0.8 sec.	1.1 sec.	1.1 sec.
DC hold **Parameter 2-00**	60%	56%	61%	59%	53%
Max. starting torque **Parameter 4-18**	126 %	116%	125%	89%	117%
Max. allowable operating torque **Parameter 4-16**	108%	100%	108%	101%	100%
Operational speed (Min.) **Parameter 4-11**	500	500	600	600	600
Operational speed (Max.) **Parameter 4-13**	1500	1500	1200	1200	1200
Delay torque limit **Parameter 14-25**	30 sec.	30 sec.	30 sec.	30 sec.	30 sec.

iSave	iSave 50	iSave 50	iSave 70	iSave 70
Code number	180F7022	NA	180F7024	NA
Motor	18.5 kW IEC	30 HP NEMA	18.5 kW IEC	30HP NEMA
Max. allowable operating differential pressure	5 barg	5 barg	5 barg	5 barg
Max. allowable operating torque	170 Nm	170 Nm	180 Nm[1)]	179 Nm[1)]
Max. starting torque	180 Nm	180 Nm	180 Nm	180 Nm
Delay before start **Parameter 1-71**	1.3 sec.	1.5 sec.	1.3 sec.	1.5 sec.
DC hold **Parameter 2-00**	59%	56%	59%	56%
Max. starting torque **Parameter 4-18**	109 %	110%	113%	114%
Max. allowable operating torque **Parameter 4-16**	109%	110%	113%	114%
Operational speed (Min.) **Parameter 4-11**	525	525	625	625
Operational speed (Max.) **Parameter 4-13**	650	650	875	875
Delay torque limit **Parameter 14-25**	30 sec.	30 sec.	30 sec.	30 sec.

[1)] Maximum torque the electric motor is able to operate with

5.3 Time delay before start



Danfoss A/S
High Pressure Pumps
DK-6430 Nordborg
Denmark