



AC DRIVES

AC15 AC20 Series

Application Note Basic tuning

08.03.2024



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Non-warranty clause

We checked the contents of this publication for compliance with the associated hardware and software. We can, however, not exclude discrepancies and do therefore not accept any liability for the exact compliance. The information in this publication is regularly checked, necessary corrections will be part of the subsequent publications.

English Master created.

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1 Introduction

1.1 About this document

1.1.1 Definitions

In this documentation the product Variable Frequency Drives AC15 /AC20 is referred to as A15 or AC20.

The AC20 general purpose drive provides advanced Ethernet connectivity and Safe Torque Off for open or closed loop AC induction and PM motor control in applications up to 250HP/180kW.

The AC15 compact drive provides Ethernet connectivity and Safe Torque Off in a low cost, compact drive for simple open loop AC induction and Permanent Magnet motor control in applications up to 40HP/30kW.

1.1.2 Terms and abbreviations

AC20	AC20 general purpose drive
AC15	AC15 compact drive
	–
Application	A customer specific use of Parker hardware and software
STO	Safe Torque Off

1.1.3 This revision

This revision replaces all previous revisions of this document. Parker has made every effort to ensure that this document is complete and accurate at the time of printing. In accordance with our policy of continuous product improvement, all data in this document is subject to change or correction without prior notice.

1.1.4 Scope

This document shows the general adjustments and 1st setup of an AC20 drive with an Induction motor and PMAC motor.

The prerequisite for this application is the correct dimensioning of the motor and controller and the complete wiring of the components.

The aim of this application note is to demonstrate the correct way, to get an optimal speed loop control of the system.

Before continuing with this application note, ensure the Start-up and Commissioning section from the hardware manual (see chapter 1.1.5) has been completed and is fully understood.

It is also helpful to have the DSElite software tool installed and the software manual has been readed with all information of all parameters the AC Drive has, when reading through this manual.

1.1.5 Related Documents

For more information about the AC drive, see the following related documents.

Reference number	Document	Description
1	DOC-0017-01_AC15_Quickstart_Frame1_EN DOC-0017-14_AC15_Quickstart_Frame2-5_EN DOC-0017-02_AC20_Quickstart_Frame2-5 DOC-0017-15_AC20_Quickstart_Frame6-10	AC15 / AC20 Quickstart manuals
2	DOC-0017-03-EN_AC15_Hardware_manual DOC-0017-04-EN_AC20_Hardware_manual	AC15 / AC20 Hardware manuals
3	DOC-0017-05-EN_AC15_Software_Reference DOC-0017-13-EN_AC20_Software_Reference	AC15 / AC20 Software manuals
4	DOC-0017-16-C_04-04-2023_AC15-AC20_Safety_Instructions	AC15-AC20 Safety Instructions

Table 1 References

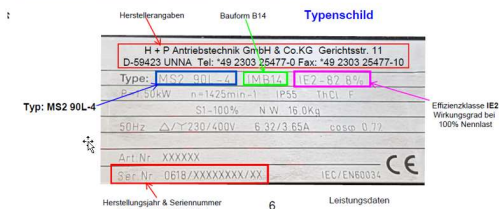
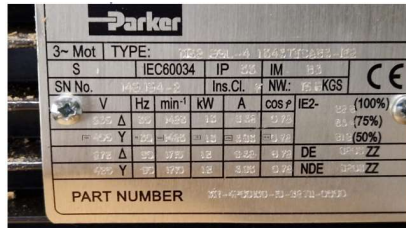
2 Test components

Induction Motor

PMAC Motor

AC20 Drive

2.1 Induction Motor Data

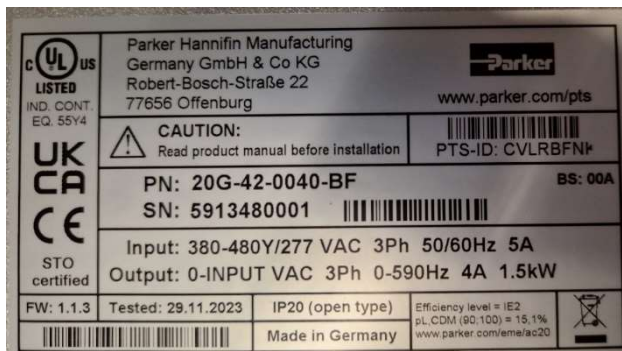


Y connection 50 Hz, 400V, 1.5kW, 1425 rpm, 3.65A, cosφ 0.72, 4 Pole

2.2 PMAC Motor Data

ACM 0045-4/0-6	
Rated current:	0.6 A
Maximum current:	2.4 A
Rated torque:	0.45 Nm
No. of pole pairs:	3
EMF:	45 V/1000 rpm
Inductance:	30 mH
Resistance:	32 Ohm
I ₂ monitoring:	2 sec
Inertia:	0.25 kgcm ²
Sensor offset:	0 °

2.3 AC20 Drive Data



Firmware version 1.1.3

3 Test procedure

The test is carried out with an AC20 Drive coming with the factory values.

To be sure to have the same situation with an unknown drive, setup it is possible to get the factory values with the device command **“Reset to Default”**.

See chapter 7.5. Resetting to Factory Defaults in the AC20 Series Software Reference Manual (DOC-0017-13-EN)

- The test is carried out in the control mode sensor less vector control.
- With this control mode the auto tuning run is mandatory for IMAC motors.
- The recording is done with the AC Scope Tool.

4 IMAC Motor Test procedure

4.1 IMAC Motor Commissioning

Usually, you'll find the necessary motor data on the nameplate of the motor.

4.1.1 DSElite Induction Motor Nameplate

Open DSElite Software Tool with Standard Macro for AC20 and select in the 2nd sheet the **Induction Motor Nameplate**. Double-Click on the function Block and edit the motor parameter.

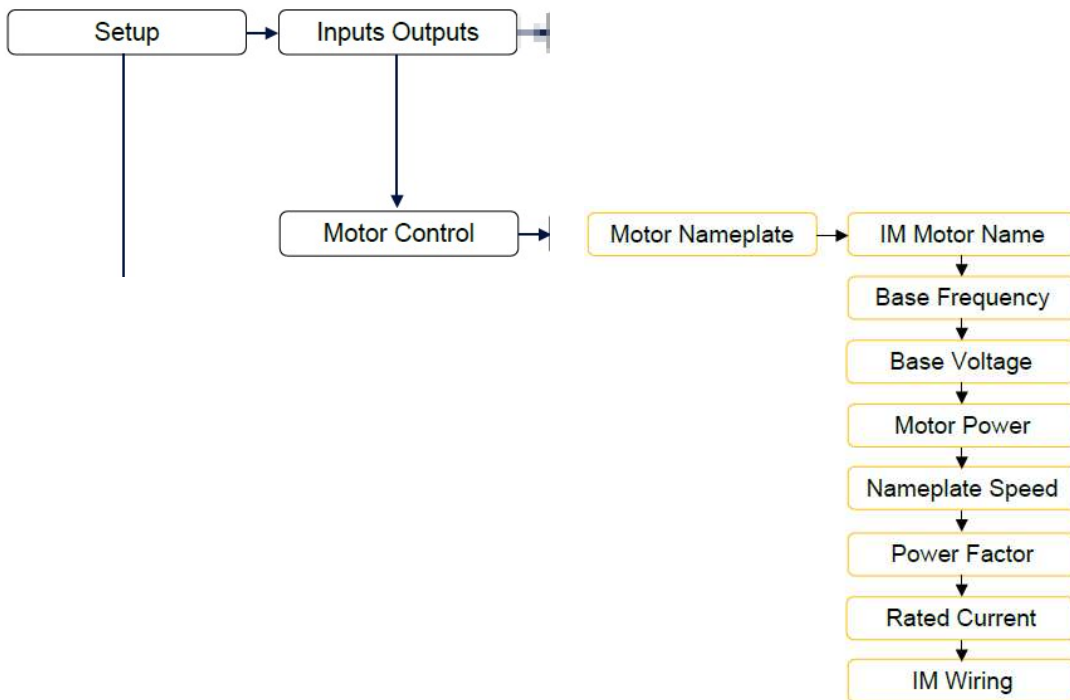
Another possibility is to navigate in the Parameters View list to the submenu Motor Nameplate and edit the parameters there.

The screenshot displays the DSE Lite software interface for configuring an Induction Motor. The main window shows a Motor Nameplate block with the following parameters:

- RATED CURRENT: 3.65 A
- BASE VOLTAGE: 400 V
- BASE FREQUENCY: 50 Hz
- MOTOR POLES: 4
- NAMEPLATE SPEED: 1425 rpm
- MOTOR POWER: 1.5 kW
- AUTO POLE PAIRS: TRUE
- IM MOTOR NAME: My IM name

The Motor Nameplate block is highlighted with a green box. The Motor Control block is also highlighted with a green box. The Parameters list on the left shows the Motor Nameplate parameters: RATED CURRENT (3.65 A), BASE VOLTAGE (400 V), BASE FREQUENCY (50 Hz), MOTOR POLES (4), NAMEPLATE SPEED (1425 rpm), MOTOR POWER (1.5 kW), POWER FACTOR (0.72), AUTO POLE PAIRS (TRUE), and IM MOTOR NAME (My IM name). The Motor Nameplate block shows parameters: RATED CURRENT (3.65 A), BASE VOLTAGE (400 V), BASE FREQUENCY (50 Hz), MOTOR POLES (4), NAMEPLATE SPEED (1425 rpm), MOTOR POWER (1.5 kW), AUTO POLE PAIRS (TRUE), and IM MOTOR NAME (My IM name). The Motor Control block shows parameters: INDUCTION MOTOR (VECTOR CONTROL), MOTOR TYPE (SENSORLESS), CONTROL STRATEGY (HEAVY DUTY), CONTROL TYPE (DUTY SELECTION), ATN ENABLE (FALSE), ATN MODE (ROTATING), ATN MAG I MOTOR (0.88 A), ATN TEST DISABLE (0.0000), ATN RAMP TIME (10 s), ATN PMAC DISABLE (0.0000), ATN PMAC LS FREQ (100 Hz), and ATN MAG I USER ENABLE (TRUE). The Parameters list on the left also shows the Motor Nameplate parameters: RATED CURRENT (3.65 A), BASE VOLTAGE (400 V), BASE FREQUENCY (50 Hz), MOTOR POLES (4), NAMEPLATE SPEED (1425 rpm), MOTOR POWER (1.5 kW), POWER FACTOR (0.72), AUTO POLE PAIRS (TRUE), and IM MOTOR NAME (My IM name). The Motor Nameplate block shows parameters: RATED CURRENT (3.65 A), BASE VOLTAGE (400 V), BASE FREQUENCY (50 Hz), MOTOR POLES (4), NAMEPLATE SPEED (1425 rpm), MOTOR POWER (1.5 kW), AUTO POLE PAIRS (TRUE), and IM MOTOR NAME (My IM name). The Motor Control block shows parameters: INDUCTION MOTOR (VECTOR CONTROL), MOTOR TYPE (SENSORLESS), CONTROL STRATEGY (HEAVY DUTY), CONTROL TYPE (DUTY SELECTION), ATN ENABLE (FALSE), ATN MODE (ROTATING), ATN MAG I MOTOR (0.88 A), ATN TEST DISABLE (0.0000), ATN RAMP TIME (10 s), ATN PMAC DISABLE (0.0000), ATN PMAC LS FREQ (100 Hz), and ATN MAG I USER ENABLE (TRUE).

4.1.2 AC20/ 6901 Display Induction Motor Nameplate



4.1.3 WEB Browser Induction Motor Nameplate

Parker Parameters AC20

Summary | **Parameters** | Passwords

ENGINEER ▾

Home ▶ **Setup ▶ Motor Control ▶ Motor Nameplate (IM)**

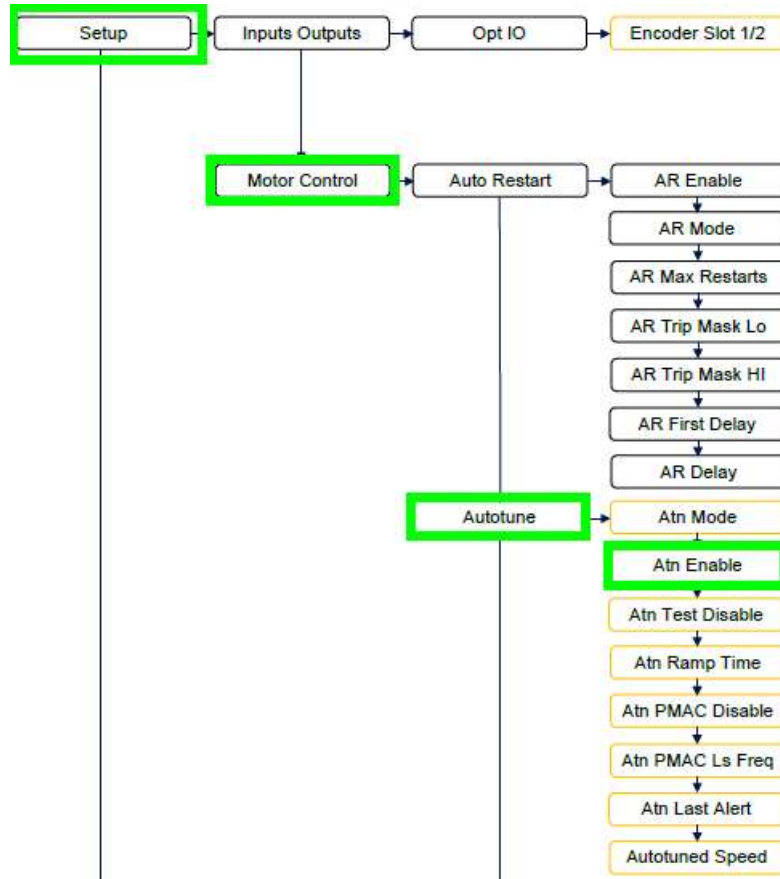
2552: IM Motor Name	My IM name
0224: Base Frequency	50.00 Hz
0223: Base Voltage	230.00 V
0227: Motor Power	1.50 kW
0226: Nameplate Speed	1425.00 rpm
0228: Power Factor	0.72
0222: Rated Current	3.65 A
0182: IM Wiring	<input type="checkbox"/>

State: **Operational**
Drive: **OK**

4.2 IMAC Motor Autotuning

4.2.1 IMAC Motor Autotuning setup

1st method: Enable Autotune via GPK

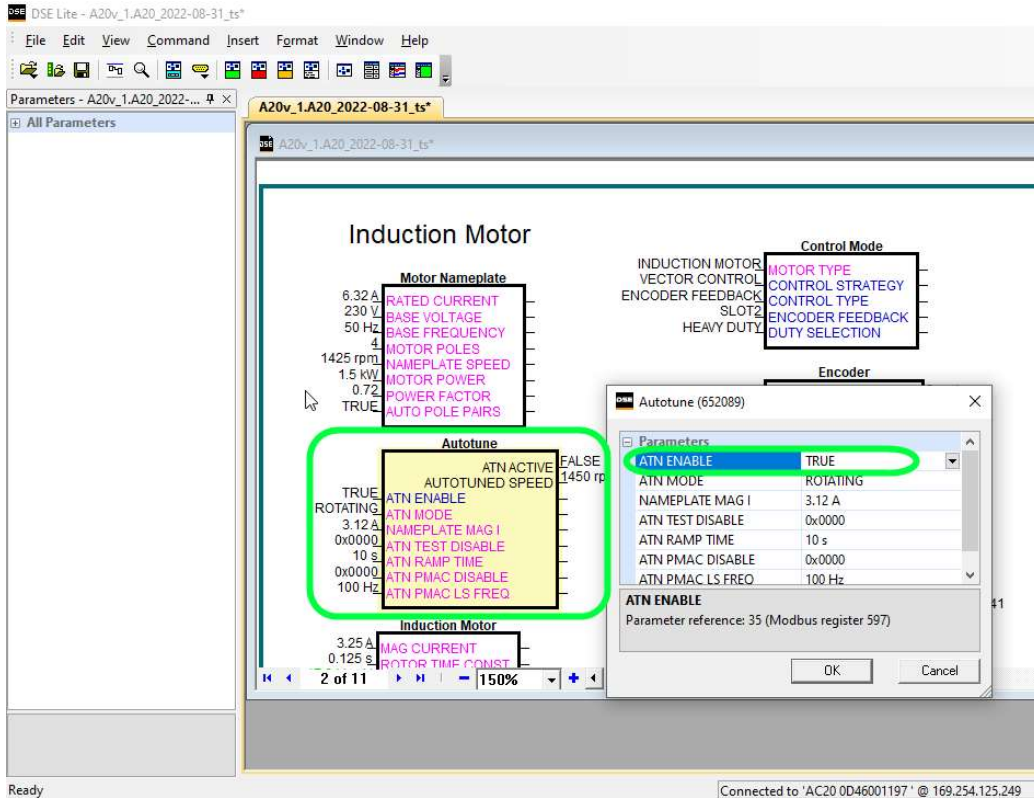


and start in Local mode the Autotune with the GPK Run Key



ATN ENABLE is set automatically to FALSE after the execution.

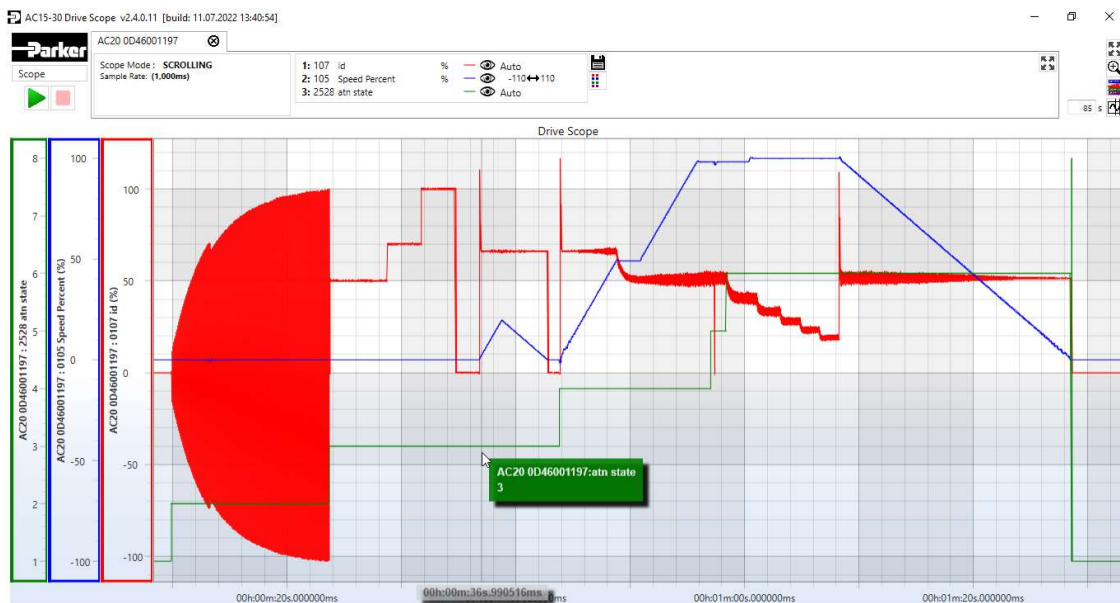
2nd method: Enable Autotune via DSELite function block



and start with a RUN Forward Signal the Autotune

ATN ENABLE is set automatically to FALSE after the execution.

4.2.2 IMAC Motor Autotuning Run



4.2.3 IMAC Motor Autotuning Verification

A20v_1-ONLINE*

Induction Motor

Motor Nameplate

3.65 A	RATED CURRENT
400 V	BASE VOLTAGE
50 Hz	BASE FREQUENCY
4	MOTOR POLES
1425 rpm	NAMEPLATE SPEED
1.5 kW	MOTOR POWER
0.72	POWER FACTOR
TRUE	AUTO POLE PAIRS
My IM name	IM MOTOR NAME

Autotune

	ATN ACTIVE	FALSE
	AUTOTUNED SPEED	1500 rpm
FALSE	ATN ENABLE	
ROTATING	ATN MODE	
2.5 A	ATN MAG I MOTOR	
0x0000	ATN TEST DISABLE	
10 s	ATN RAMP TIME	
0x0000	ATN PMAC DISABLE	
100 Hz	ATN PMAC LS FREQ	
TRUE	ATN MAG I USER ENABLE	

Induction Motor

2.04 A	MAG CURRENT
0.089 s	ROTOR TIME CONST
46.289 mH	LEAKAGE INDUCT
3.4638 Ohm	STATOR RES
0.0001 Ohm	ROTOR RES
314.32 mH	MUTUAL INDUCT
FALSE	IM WIRING

Check the parameters in the **Induction Motor** function block before and after the AUTOTUNE!

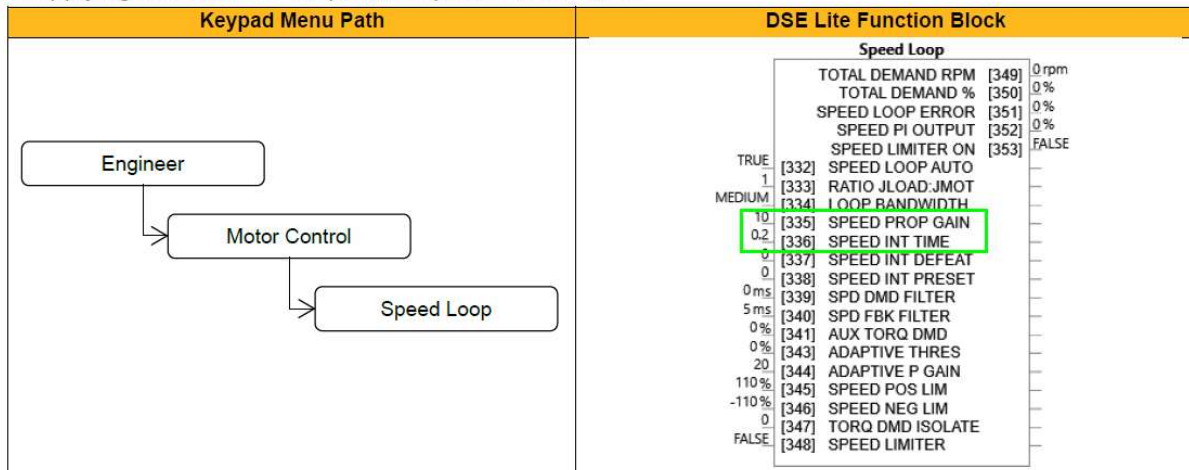
Note: the parameter **ROTER RES** is not calculated and not used in control functions!

4.3 IMAC Motor Speed Loop Tuning

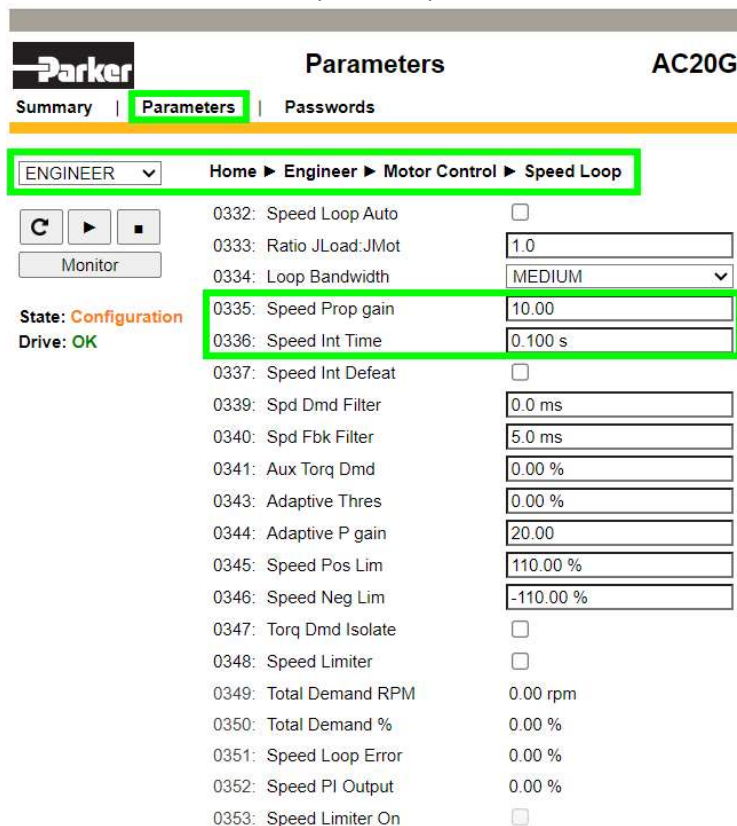
The parameters for the Speed Loop are possible to setup via the Keypad Engineer Menu or in the DSE Lite function block "Speed Loop".

The basic parameters to adjust the tuning are the speed proportional gain [335] **SPEED PROP GAIN** and the speed integration time [336] **SPEED INT TIME**.

This function block controls the speed of the motor by comparing the actual speed to the demanded speed and applying more or less torque in response to the error.

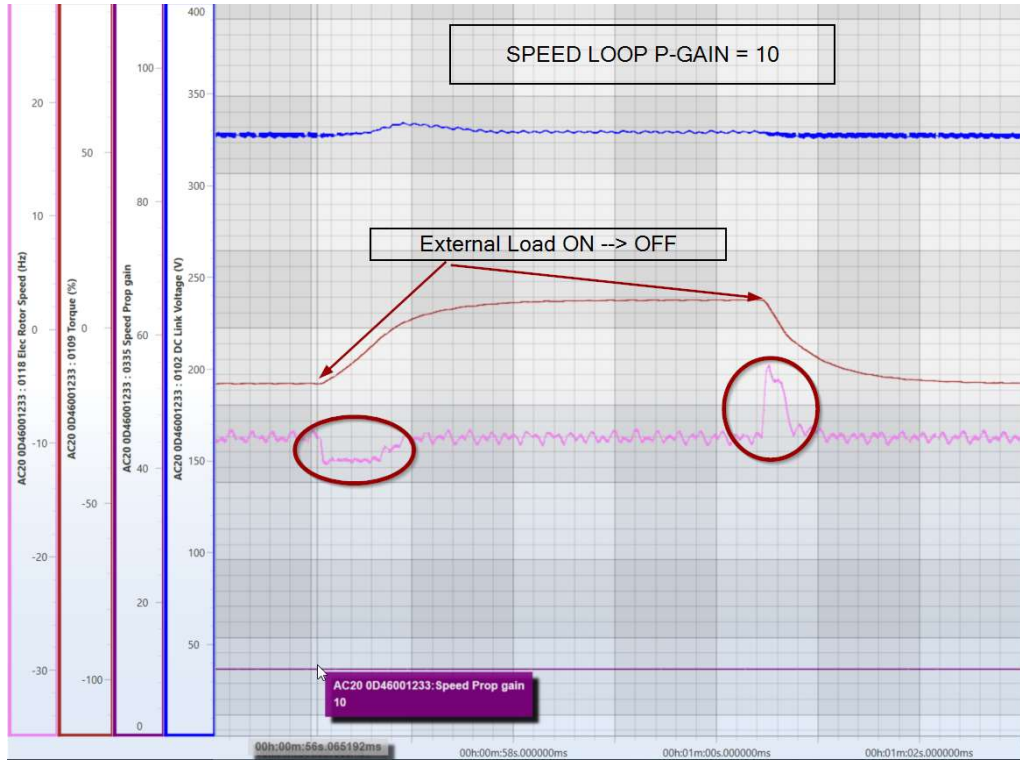


Another method to tune the Speed Loop is Via the AC20 Web Browser



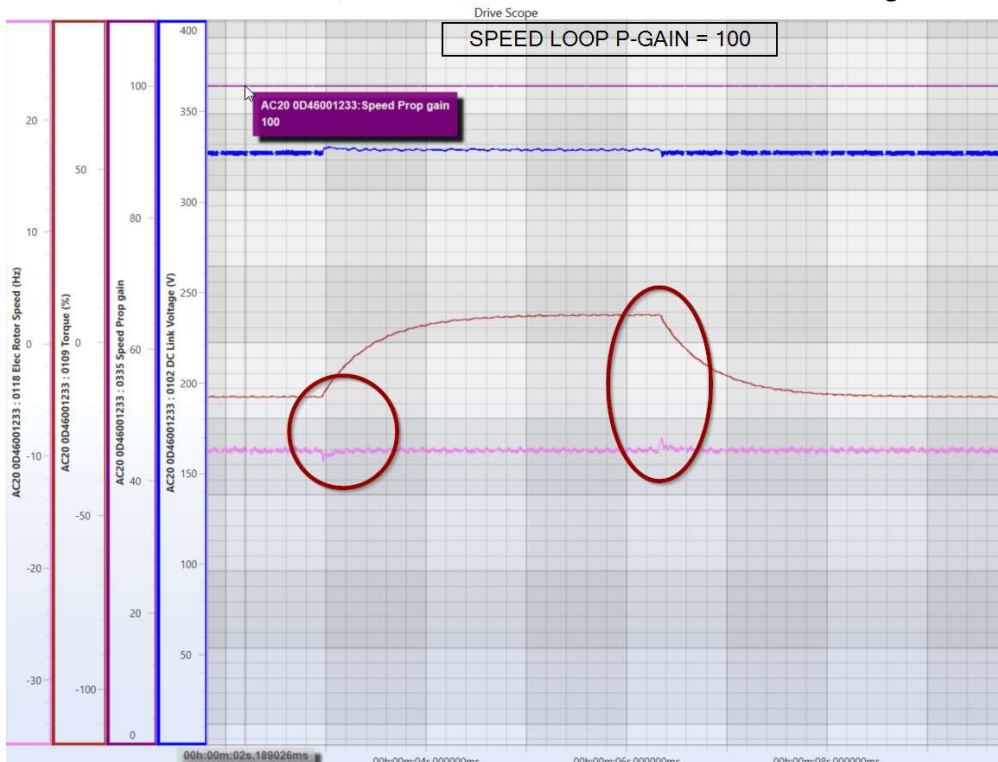
4.3.1 IMAC Default Parameter reaction during load change

SPEED PROP GAIN = 10; SPEED INT TIME = 0.2 s This are the default values from factory settings.



4.3.2 IMAC Optimized Parameter reaction during load change

SPEED PROG GAIN = 100; SPEED INT TIME = 0.1s No overshoot during load change!



5 IMAC Motor Test procedure

5.1 PMAC Motor Commissioning

5.1.1 DSELite PMAC Motor Nameplate

Open DSElite Software Tool with Standard Macro for AC20 and select in the 2nd sheet the **PMAC Motor Data**. Double-Click on the function Block and edit the motor parameter.

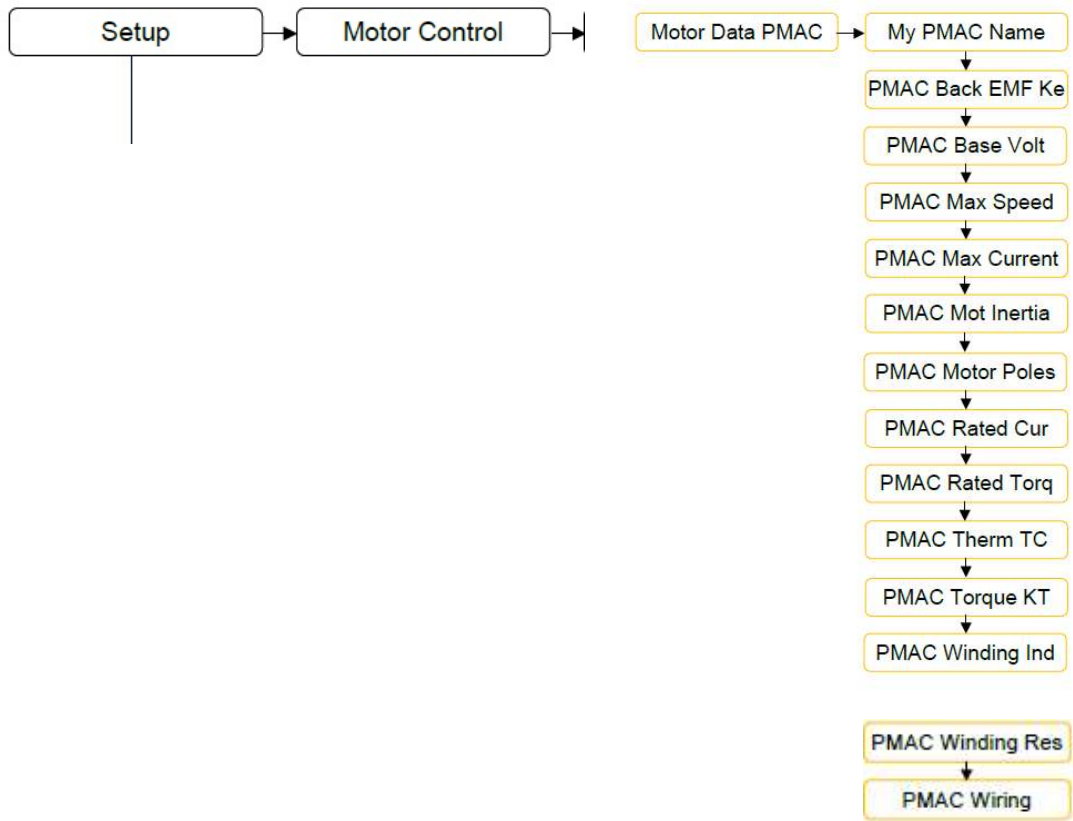
Another possibility is to navigate in the Parameters View list to the submenu **PMAC Motor Data** and edit the parameters there.

The screenshot shows the DSELite software interface with the following components:

- Parameters - A20_PMAC_ACM0045...** (Left sidebar): Lists various motor parameters, with **PMAC Motor Data** selected.
- Induction Motor** (Middle-left): Shows motor nameplate data (e.g., 6.32 A, 230 V, 50 Hz) and induction motor parameters (e.g., 2.93 A, 0.093 s).
- Motor Control** (Middle-right): Shows control mode parameters (e.g., MOTOR TYPE, CONTROL STRATEGY).
- PMAC Motor** (Right): Shows PMAC motor data parameters (e.g., 4000 rpm, 2.4 A, 0.6 A).
- PMAC Motor Data (652065)** (Pop-up window): A detailed view of PMAC parameters, including:
 - PMAC MAX SPEED: 4000 rpm
 - PMAC MAX CURRENT: 2.4 A
 - PMAC RATED CUR: 0.6 A
 - PMAC RATED TORQ: 0.45 Nm
 - PMAC MOTOR POLES: 6
 - BACK EMF KE: 45 V
 - PMAC WINDING RES: 32 Ohm
 - PMAC WINDING IND: 30 mH
 - PMAC TORQUE KT: 0.82 Nm/A
 - PMAC MOT INERTIA: 0.0007 kgm²
 - PMAC THERM TC: 62 s
 - PMAC BASE VOLT: 400 V
 - PMAC WIRING: STANDARD
 - PMAC MOTOR NAME: ACM 0045-4/0-6

A red arrow points from the **PMAC MAX SPEED** parameter in the pop-up window to the **PMAC Motor Data** window. The status bar at the bottom indicates a connection error: "Connection error! AC20 version 1.1 (connected to DSELite, drive NOT running) : AC20 0D46001233 (169.254.127.52)".

5.1.3. AC20/ 6901 Display PMAC Motor Nameplate



5.1.3 WEB Browser PMAC Motor Nameplate

Parameters
AC20

Summary
Parameters
Passwords

ENGINEER ▾

⏪
▶
⏩

Monitor

State: Operational
Drive: OK

Home ▶ **Setup ▶ Motor Control ▶ Motor Data PMAC**

2573: PMAC Motor Name	ACM 0045-4/0-6
0284: PMAC Back EMF Ke	100.0 V
0290: PMAC Base Volt	400.00 V
0279: PMAC Max Speed	4000 rpm
0280: PMAC Max Current	2.40 A
0288: PMAC Mot Inertia	0.0001 kgm ²
0283: PMAC Motor Poles	6
0281: PMAC Rated Cur	0.60 A
0282: PMAC Rated Torq	0.45 Nm
0289: PMAC Therm TC	62 s
0287: PMAC Torque KT	0.75 Nm/A
0286: PMAC Winding Ind	48.20 mH
0285: PMAC Winding Res	37.074 Ohm
0291: PMAC Wiring	STANDARD ▾

5.2 PMAC Motor Autotuning

If a permanent magnet motor is used and there is no datasheet available from your motor provider, you MUST perform an autotune before operating the inverter in the Vector control mode.

See chapter 4.2.1.....4.2.3 IMAC Autotuning.

5.3 PMAC Motor Speed Loop Tuning

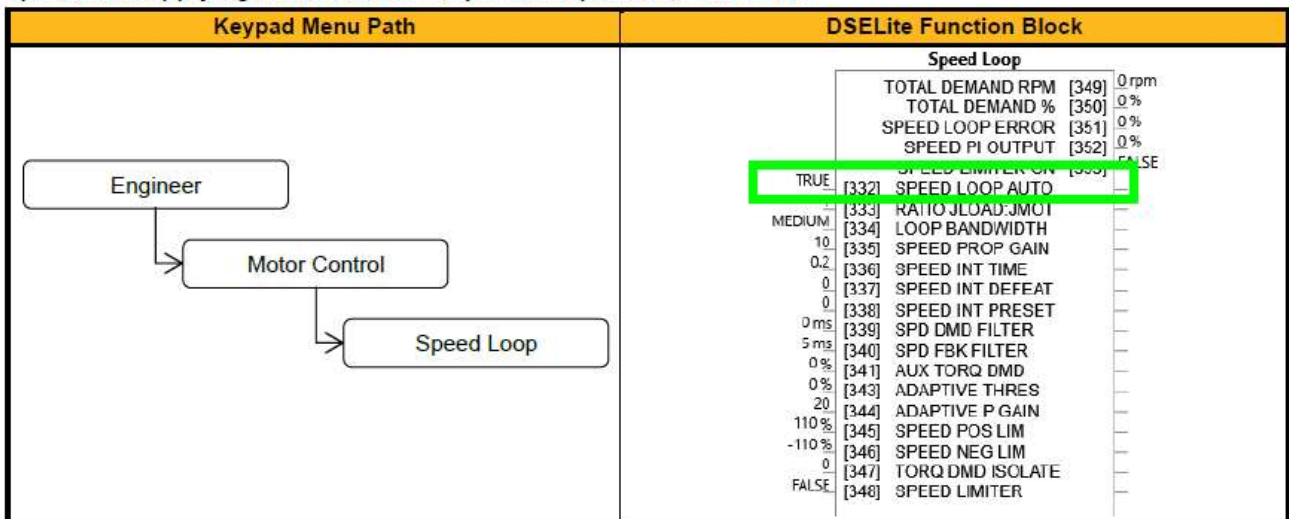
If a PMAC motor is used it is possible to set the speed loop parameter [332] SPEED LOOP AUTO to “TRUE”. This allows an automatic calculation of the speed loop control parameters.

Speed Loop

Overview

Only applies to **Vector Control Mode**, Induction Motor or PMAC.

This function block controls the speed of the motor by comparing the actual speed to the demanded speed and applying more or less torque in response to the error.



Function Block Inputs

Parameter Name	No.	Default Value	Range	Units	Type	Writable
SPEED LOOP AUTO	332	TRUE			BOOL	ALWAYS
Only for PMAC Motor. TRUE: Allows automatic calculation of speed loop control parameters Speed Prop gain (P0335) and Speed Int Time (P0336). For a correct estimation, the PMAC motor parameters PMAC Mot Inertia (P0288), PMAC Rated Torq (P0282) and speed loop parameter Ratio JLoad:JMot (P0333) need to be set correctly. FALSE: No automatic calculation.						

If you intend to adjust the speed loop parameters manually, please refer to the chapter 4.3 in this manual.

5.4 PMAC SVC Function Block

Where applications need to start the motor with a high inertia and/or friction load and the standard start is ineffective an optimization of the start procedure with PMAC in sensorless vector mode is necessary.

With the 3 parameters [307] PMAC START TIME, [308] PMAC START CUR and [309] PMAC START SPEED it is possible to optimize the start behavior.

With higher inertia you need more start current with a higher start speed.

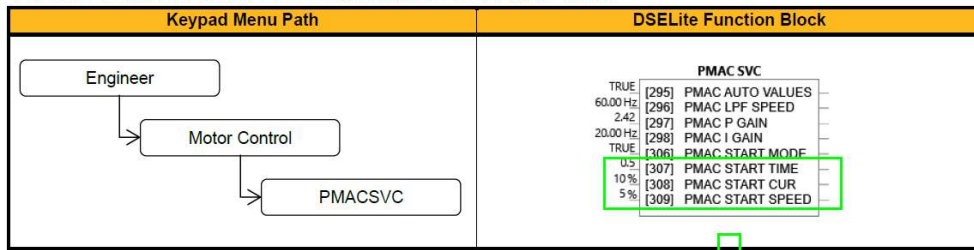
Please refer to the AC20 software manual DOC-0017-13-EN: AC20 Series - Software Reference Manual.

PMAC SVC

Overview

Only available if PMAC MOTOR selected in **Motor Type**.

Parameters related to the **SVC Control mode** of a PMAC Motor



Function Block Inputs

Parameter Name	No.	Default Value	Range	Units	Type	Writable
PMAC AUTO VALUES	295	TRUE			BOOL	ALWAYS
Selection of PI controller values for PMAC motors. TRUE: use pre-calculated values, FALSE: use user settings.						
PMAC LPF SPEED	296	60.00	0 to 10000	Hz	REAL	ALWAYS
Set the Low Pass Filter frequency of the estimated speed.						
PMAC P GAIN	297	2.42	0 to 10000		REAL	ALWAYS
Set the Proportional gain of the PI corrector used for extracting speed and position.						
PMAC I GAIN	298	20.00	0 to 10000	Hz	REAL	ALWAYS
Set the Integral frequency of the PI corrector used for extracting speed and position.						
PMAC START MODE	306	TRUE			BOOL	ALWAYS
This parameter is used to enable/disable a specific startup procedure when the motor/drive is switched ON (starting rotation). This is mainly used where applications need to start the motor with a high inertia and/or friction load and the standard start is ineffective.						
PMAC START TIME	307	0.5	0 to 1000		TIME	ALWAYS
This parameter is used in conjunction with PMAC Start Mode. It selects the duration of Step 1 in the startup procedure used for starting motors with a high inertia and/or friction load.						
PMAC START CUR	308	10	0 to 600	%	REAL	ALWAYS
This parameter is used in conjunction with PMAC Start Mode. It selects the current level during the startup procedure used for starting motors with a high inertia and/or friction load.						
PMAC START SPEED	309	5	0 to 200	%	REAL	ALWAYS
This parameter is used in conjunction with PMAC Start Mode. It selects the speed setpoint at which the speed control is switched from an open loop mode (V/Hz Control) to a closed loop mode (using speed observer for PMAC motors) during the startup procedure used for starting motors with a high inertia and/or friction load.						

Functional Description

Using **0306 Start Mode** (=TRUE), the following procedure is applied each time the motor is switched on and before closing the speed loop, based on the external speed setpoint.

The drive must be used in speed loop mode (**0347 Torq Dmd Isolate** = FALSE).

When the drive is switched ON, the system is placed in open loop control.

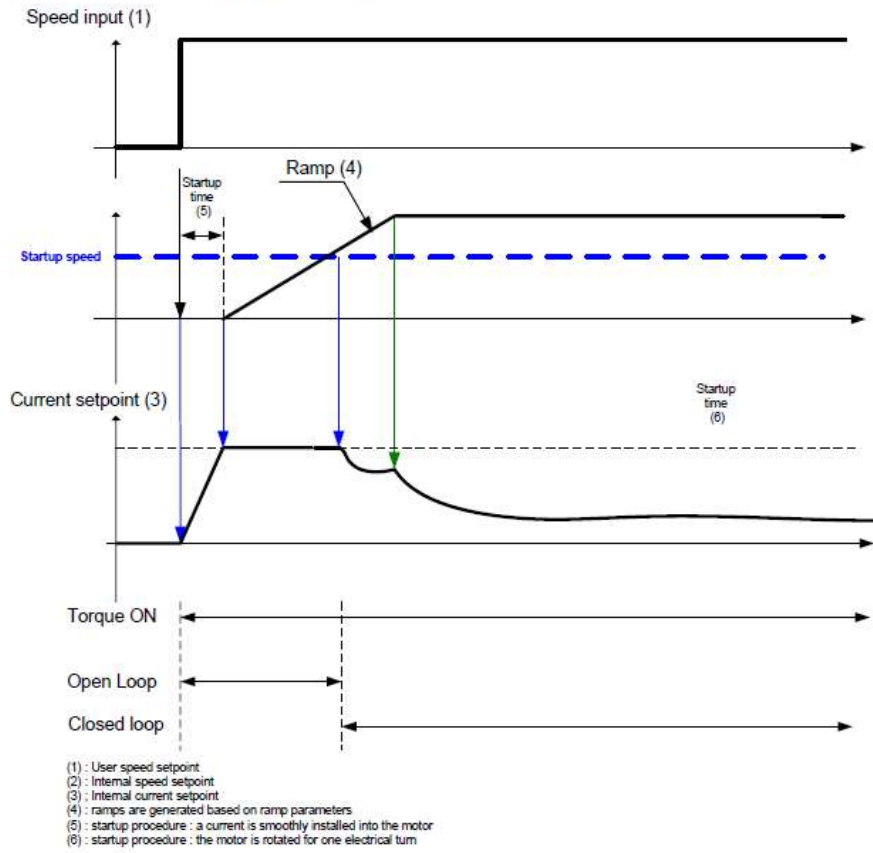
Step 1:

For a time equal to the **0307 PMAC Start Time** parameter, the current is ramped to the **0308 PMAC Start Cur** value. The sign is dependent upon the speed loop setpoint. A normal value is between 0.5 to 1s.

Step 2:

Once Step 1 is complete, the position is ramped in such a way as to follow the speed setpoint generated, based on the configuration (ramp, etc...), until the **0309 PMAC Start Speed** value is reached. The speed loop is then closed. The ramp value must be kept low to ensure the motor follows the speed setpoint.

For a positive speed setpoint when the drive is switched ON :



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