Frequency Inverter

CFW700

Programming and Troubleshooting Manual

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QUICK PARAMETER REFERENCE, FAULTS AND ALARMS

Param.	Description	Adjustable Range	Factory Setting	User Setting	Propr.	Grorps	Pag.
P0000	Access to Parameters	0 to 9999	0				5-2
P0001	Speed Reference	0 to 18000 rpm			ro	READ	16-1
P0002	Motor Speed	0 to 18000 rpm			ro	READ	16-1
P0003	Motor Current	0.0 to 4500.0 A			ro	READ	16-1
P0004	DC Link Voltage (Ud)	0 to 2000 V			ro	READ	16-2
P0005	Motor Frequency	0.0 to 1020.0 Hz			ro	READ	16-2
P0006	VFD Status	0 = Ready 1 = Run 2 = Undervoltage 3 = Fault 4 = Self-Tuning 5 = Configuration 6 = DC Braking 7 = STO			ro	READ	16-2
P0007	Motor Voltage	0 to 2000 V			ro	READ	16-3
P0009	Motor Torque	-1000.0 to 1000.0 %			ro	READ	16-3
P0010	Output Power	0.0 to 6553.5 kW			ro	READ	16-4
P0012	DI8 to DI1 Status	Bit 0 = DI1 Bit 1 = DI2 Bit 2 = DI3 Bit 3 = DI4 Bit 4 = DI5 Bit 5 = DI6 Bit 6 = DI7 Bit 7 = DI8			ro	I/O or READ	13-9 16-4
P0013	DO5 to DO1 Status	Bit 0 = DO1 Bit 1 = DO2 Bit 2 = DO3 Bit 3 = DO4 Bit 4 = DO5			ro	I/O or READ	13-14 16-4
P0014	AO1 Value	0.00 to 100.00 %			ro	I/O or READ	13-5 16-4
P0015	AO2 Value	0.00 to 100.00 %			ro	I/O or READ	13-5 16-4
P0018	AI1 Value	-100.00 to 100.00 %			ro	I/O or READ	13-1 16-4
P0019	AI2 Value	-100.00 to 100.00 %			ro	I/O or READ	13-1 16-4
P0023	Software Version	0.00 to 655.35			ro	READ	6-1 16-5
P0028	Accessories Configuration	0000h to FFFFh			ro	READ	6-2 16-5
P0029	Power Hardware Configuration	Bit 0 to 5 = Rated Current Bit 6 and 7 = Rated Voltage Bit 8 = EMC Filter Bit 9 = Safety Relay Bit 10 = (0)24 V/(1) DC Link Bit 11 = (0)RST/(1) DC Link Bit 12 = Dyn. Braking IGBT Bit 13 = Special Bit 14 and 15 = Reserved			ro	READ	6-2 16-5
P0030	IGBTs Temperature	-20.0 to 150.0 °C			ro	READ	15-3 16-5
P0034	Internal Air Temperature	-20.0 to 150.0 °C			ro	READ	15-3 16-5
P0036	Heatsink Fan Speed	0 to 15000 rpm			ro	READ	16-5
P0037	Motor Overload Status	0 to 100 %			ro	READ	16-5
P0038	Encoder Speed	0 to 65535 rpm			ro	READ	16-5
P0039	Encoder Pulse Counter	0 to 40000			ro	READ	16-6
P0042	Powered Time	0 to 65535 h			ro	READ	16-6
P0043	Enabled Time	0.0 to 6553.5 h			ro	READ	16-6

Param.	Description	Adjustable Range	Factory Setting	User Setting	Propr.	Grorps	Pag.
P0044	kWh Output Energy	0 to 65535 kWh			ro	READ	16-7
P0045	Enabled Fan Time	0 to 65535 h			ro	READ	16-7
P0048	Present Alarm	0 to 999			ro	READ	16-8
P0049	Present Fault	0 to 999			ro	READ	16-8
P0050	Last Fault	0 to 999			ro	READ	16-8
P0054	Second Fault	0 to 999			ro	READ	16-8
P0058	Third Fault	0 to 999			ro	READ	16-8
P0062	Fourth Fault	0 to 999			ro	READ	16-8
P0066	Fifth Fault	0 to 999			ro	READ	16-8
P0090	Last Fault Current	0.0 to 4500.0 A			ro	READ	16-9
P0091	Last Fault DC Link Voltage	0 to 2000 V			ro	READ	16-9
P0092	Last Fault Speed	0 to 18000 rpm			ro	READ	16-9
P0093	Last Fault Reference	0 to 18000 rpm			ro	READ	16-9
P0094	Last Fault Frequency	0.0 to 1020.0 Hz			ro	READ	16-10
P0095	Last Fault Motor Voltage	0 to 2000 V			ro	READ	16-10
P0096	Last Fault DIx Status	Bit 0 = DI1 Bit 1 = DI2 Bit 2 = DI3 Bit 3 = DI4 Bit 4 = DI5 Bit 5 = DI6 Bit 6 = DI7 Bit 7 = DI8			ro	READ	16-10
P0097	Last Fault DOx Status	Bit 0 = DO1 Bit 1 = DO2 Bit 2 = DO3 Bit 3 = DO4 Bit 4 = DO5			ro	READ	16-11
P0100	Acceleration Time	0.0 to 999.0 s	20.0 s			BASIC	12-1 19-9 19-18 19-21
P0101	Deceleration Time	0.0 to 999.0 s	20.0 s			BASIC	12-1 19-9 19-18 19-21
P0102	Acceleration Time 2	0.0 to 999.0 s	20.0 s				12-1 19-18 19-21
P0103	Deceleration Time 2	0.0 to 999.0 s	20.0 s				12-1 19-18 19-21
P0104	Ramp Type	0 = Linear 1 = S Curve	0 = Linear				12-2
P0105	1st/2nd Ramp Selection	0 = 1st Ramp 1 = 2nd Ramp 2 = DIx 3 = Serial 4 = CO/DN/DP 5 = SoftPLC	2 = DIx		cfg		12-3
P0120	Speed Reference Backup	0 = Inactive 1 = Active	1 = Active				12-3
P0121	Keypad Reference	0 to 18000 rpm	90 rpm				12-4
P0122	JOG/JOG+ Reference	0 to 18000 rpm	150 (125) rpm				12-4 12-5
P0123	JOG- Reference	0 to 18000 rpm	150 (125) rpm		Vector		12-5
P0132	Maximum Overspeed Level	0 to 100 %	10 %		cfg		12-5
P0133	Minimum Speed	0 to 18000 rpm	90 (75) rpm			BASIC	12-6 19-9 19-18 19-21
P0134	Maximum Speed	0 to 18000 rpm	1800 (1500) rpm			BASIC	12-6 19-9 19-18 19-21

Param.	Description	Adjustable Range	Factory Setting	User Setting	Propr.	Grorps	Pag.
P0135	Maximum Output Current	0.2 to 2 x I_{nom-HD}	1.5 x I_{nom-HD}		V/f and VVW	BASIC	9-7
P0136	Manual Torque Boost	0 to 9	1		V/f	BASIC	9-2
P0137	Automatic Torque Boost	0.00 to 1.00	0.00		V/f		9-2
P0138	Slip Compensation	-10.0 to 10.0 %	0.0 %		V/f		9-3
P0139	Output Current Filter	0.0 to 16.0 s	0.2 s		V/f and VVW		9-4
P0142	Maximum Output Voltage	0.0 to 100.0 %	100.0 %		cfg and Adj		9-5
P0143	Intermediate Output Voltage	0.0 to 100.0 %	50.0 %		cfg and Adj		9-5
P0144	3 Hz Output Voltage	0.0 to 100.0 %	8.0 %		cfg and Adj		9-5
P0145	Field Weakening Speed	0 to 18000 rpm	1800 rpm		cfg and Adj		9-6
P0146	Intermediate Speed	0 to 18000 rpm	900 rpm		cfg and Adj		9-6
P0150	V/f DC Regulation Type	0 = Ramp Hold 1 = Ramp Acceleration	0 = Ramp Hold		cfg, V/f and VVW		9-11
P0151	V/f DC Regulation Level	339 to 800 V	800 V		V/f and VVW		9-11
P0152	V/f DC Regulation P Gain	0.00 to 9.99	1.50		V/f and VVW		9-12
P0153	Dynamic Braking Level	339 to 800 V	748 V				14-1
P0156	100 % Speed Overload Current	0.1 to 1.5 x I_{nom-ND}	1.05 x I_{nom-ND}				15-4
P0157	50 % Speed Overload Current	0.1 to 1.5 x I_{nom-ND}	0.9 x I_{nom-ND}				15-4
P0158	5 % Speed Overload Current	0.1 to 1.5 x I_{nom-ND}	0.65 x I_{nom-ND}				15-4
P0159	Motor Tripping Class	0 = Class 5 1 = Class 10 2 = Class 15 3 = Class 20 4 = Class 25 5 = Class 30 6 = Class 35 7 = Class 40 8 = Class 45	1 = Class 10		cfg		15-5
P0160	Speed Regulation Optimization	0 = Normal 1 = Saturated	0 = Normal		cfg and Vector		11-14
P0161	Speed Proportional Gain	0.0 to 63.9	7.4		Vector		11-15
P0162	Speed Integral Gain	0.000 to 9.999	0.023		Vector		11-15
P0163	LOC Reference Offset	-999 to 999	0		Vector		11-16
P0164	REM Reference Offset	-999 to 999	0		Vector		11-16
P0165	Speed Filter	0.012 to 1.000 s	0.012 s		Vector		11-16
P0166	Speed Differential Gain	0.00 to 7.99	0.00		Vector		11-16
P0167	Current Proportional Gain	0.00 to 1.99	0.50		Vector		11-17
P0168	Current Integral Gain	0.000 to 1.999	0.010		Vector		11-17
P0169	Maximum + Torque Current	0.0 to 350.0 %	125.0 %		Vector		11-25
P0170	Maximum - Torque Current	0.0 to 350.0 %	125.0 %		Vector		11-25
P0175	Flux Proportional Gain	0.0 to 31.9	2.0		Vector		11-17
P0176	Flux Integral Gain	0.000 to 9.999	0.020		Vector		11-17
P0178	Rated Flux	0 to 120 %	100 %		Vector		11-18
P0179	Maximum Flux	0 to 120 %	120 %		Vector		11-18
P0182	Speed for I/f Activation	0 to 90 rpm	18 rpm		Sless		11-19
P0183	Current in I/f Mode	0 to 9	1		Sless		11-19
P0184	DC Link Regulation Mode	0 = With losses 1 = Without losses 2 = Enable/Disable DIx	1 = Without losses		cfg and Vector		11-26
P0185	DC Link Regulation Level	339 to 800 V	800 V		Vector		11-27
P0186	DC Link Proportional Gain	0.0 to 63.9	18.0		Vector		11-27
P0187	DC Link Integral Gain	0.000 to 9.999	0.002		Vector		11-27
P0190	Maximum Output Voltage	0 to 480 V	440 V		Vector		11-18
P0191	Encoder Zero Search	0 = Inactive 1 = Active	0 = Inactive				12-22
P0192	Encoder Zero Search Status	0 = Inactive 1 = Finished	0 = Inactive		ro	READ	12-22

Param.	Description	Adjustable Range	Factory Setting	User Setting	Propr.	Grorps	Pag.
P0200	Password	0 = Inactive 1 = Active 2 = Change Password	1 = Active			HMI	5-3
P0202	Control Type	0 = V/f 60 Hz 1 = V/f 50 Hz 2 = V/f Adjustable 3 = VVW 4 = Sensorless 5 = Encoder	0 = V/f 60 Hz		cfg		9-5
P0204	Load/Save Parameters	0 = Not Used 1 = Not Used 2 = Reset P0045 3 = Reset P0043 4 = Reset P0044 5 = Load 60 Hz 6 = Load 50 Hz 7 = Load User 1 8 = Load User 2 9 = Save User 1 10 = Save User 2	0 = Not Used		cfg		7-1
P0205	Main Display Parameter Selection	0 to 1199	2			HMI	5-3
P0206	Secondary Display Parameter Selection	0 to 1199	1			HMI	5-3
P0207	Bar Graph Parameter Selection	0 to 1199	3			HMI	5-3
P0208	Main Display Scale Factor	0.1 to 1000.0 %	100.0 %			HMI	5-4
P0209	Engineering Unit	0 = None 1 = V 2 = A 3 = rpm 4 = s 5 = ms 6 = N 7 = m 8 = Nm 9 = mA 10 = % 11 = °C 12 = CV 13 = Hz 14 = HP 15 = h 16 = W 17 = kW 18 = kWh 19 = H	3 = rpm			HMI	5-4
P0210	Decimal Point 1	0 = wxyz 1 = wxy.z 2 = wx.yz 3 = w.xyz	0 = wxyz			HMI	5-4
P0211	Secondary Display Scale Factor	0.1 to 1000.0 %	100.0 %			HMI	5-4
P0212	Decimal Point 2	0 = wxyz 1 = wxy.z 2 = wx.yz 3 = w.xyz	0 = wxyz			HMI	5-4
P0213	Bar Full Scale	1 to 65535	1			HMI	5-5
P0216	HMI Backlighting	0 to 15	15			HMI	5-5
P0217	Zero Speed Disable	0 = Inactive 1 = Active	0 = Inactive		cfg		12-7
P0218	Condition to Leave Zero Speed Disable	0 = Reference or Speed 1 = Reference	0 = Reference or Speed				12-7
P0219	Delay for Zero Speed Disable	0 to 999 s	0 s				12-8

Param.	Description	Adjustable Range	Factory Setting	User Setting	Propr.	Grorps	Pag.
P0220	LOC/REM Selection Source	0 = Always LOC 1 = Always REM 2 = LR Key LOC 3 = LR Key REM 4 = DIx 5 = Serial LOC 6 = Serial REM 7 = CO/DN/DP LOC 8 = CO/DN/DP REM 9 = SoftPLC LOC 10 = SoftPLC REM	2 = LR Key LOC		cfg	I/O	13-22
P0221	LOC Reference Selection	0 = HMI 1 = AI1 2 = AI2 3 = Sum AIs > 0 4 = Sum AIs 5 = Serial 6 = CO/DN/DP 7 = SoftPLC	0 = HMI		cfg	I/O	13-23 19-9 19-18 19-22
P0222	REM Reference Selection	Refer to the P0221 options	1 = AI1		cfg	I/O	13-23 19-9 19-18 19-22
P0223	LOC FWD/REV Selection	0 = Forward 1 = Reverse 2 = FR Key FWD 3 = FR Key REV 4 = DIx 5 = Serial FWD 6 = Serial REV 7 = CO/DN/DP (H) 8 = CO/DN/DP(AH) 9 = SoftPLC (H) 10 = SoftPLC (AH) 11 = AI2 Polarity	2 = FR Key FWD		cfg	I/O	13-23 19-29
P0224	LOC Run/Stop Selection	0 = I/O Keys 1 = DIx 2 = Serial 3 = CO/DN/DP 4 = SoftPLC	0 = I/O Keys		cfg	I/O	13-24 19-26 19-29
P0225	LOC JOG Selection	0 = Inactive 1 = JOG Key 2 = DIx 3 = Serial 4 = CO/DN/DP 5 = SoftPLC	1 = JOG Key		cfg	I/O	13-24
P0226	REM FWD/REV Selection	Refer to the P0223 options	4 = DIx		cfg	I/O	13-23 19-29
P0227	REM Run/Stop Selection	0 = I/O Keys 1 = DIx 2 = Serial 3 = CO/DN/DP 4 = SoftPLC	1 = DIx		cfg	I/O	13-24 19-26 19-29
P0228	REM JOG Selection	Refer to the P0225 options	2 = DIx		cfg	I/O	13-24
P0229	Stop Mode Selection	0 = Ramp to Stop 1 = Coast to Stop 2 = Fast Stop 3 = By Ramp with Iq = 0 4 = Fast Stop with Iq = 0	0 = Ramp to Stop		cfg		13-24
P0230	Analog Input Dead Zone	0 = Inactive 1 = Active	0 = Inactive			I/O	13-1

Param.	Description	Adjustable Range	Factory Setting	User Setting	Propr.	Grorps	Pag.
P0231	AI1 Signal Function	0 = Speed Reference 1 = N* without Ramp 2 = Maximum Torque Current 3 = SoftPLC 4 = PTC 5 = Application Function 1 6 = Application Function 2 7 = Application Function 3 8 = Application Function 4 9 = Application Function 5 10 = Application Function 6 11 = Application Function 7 12 = Application Function 8	0 = Speed Reference		cfg	I/O	13-2 19-9
P0232	AI1 Gain	0.000 to 9.999	1.000			I/O	13-3 19-9
P0233	AI1 Signal Type	0 = 0 to 10 V / 20 mA 1 = 4 to 20 mA 2 = 10 V / 20 mA to 0 3 = 20 to 4 mA 4 = -10 V to +10 V	0 = 0 to 10 V / 20 mA		cfg	I/O	13-5 19-9
P0234	AI1 Offset	-100.00 to 100.00 %	0.00 %			I/O	13-3 19-9
P0235	AI1 Filter	0.00 to 16.00 s	0.00 s			I/O	13-4 19-9
P0236	AI2 Signal Function	Refer to the P0231 options	0 = Speed Reference		cfg	I/O	13-2 19-9
P0237	AI2 Gain	0.000 to 9.999	1.000			I/O	13-3
P0238	AI2 Signal Type	0 = 0 to 10 V / 20 mA 1 = 4 to 20 mA 2 = 10 V / 20 mA to 0 3 = 20 to 4 mA 4 = -10 V to +10 V	0 = 0 to 10 V / 20 mA		cfg	I/O	13-5 19-9
P0239	AI2 Offset	-100.00 to 100.00 %	0.00 %			I/O	13-3 19-9
P0240	AI2 Filter	0.00 to 16.00 s	0.00 s			I/O	13-4 19-9
P0251	AO1 Function	0 = Speed Reference 1 = Total Reference 2 = Real Speed 3 = Torque Current Reference 4 = Torque Current 5 = Output Current 6 = Active Current 7 = Output Power 8 = Torque Current >0 9 = Motor Torque 10 = SoftPLC 11 = PTC 12 = Motor I x t 13 = Encoder Speed 14 = P0696 Value 15 = P0697 Value 16 = Id* Current 17 = Application Function 1 18 = Application Function 2 19 = Application Function 3 20 = Application Function 4 21 = Application Function 5 22 = Application Function 6 23 = Application Function 7 24 = Application Function 8	2 = Real Speed			I/O	13-6 19-9
P0252	AO1 Gain	0.000 to 9.999	1.000			I/O	13-6 19-9
P0253	AO1 Signal Type	0 = 0 to 10 V / 20 mA 1 = 4 to 20 mA 2 = 10 V / 20 mA to 0 3 = 20 to 4 mA	0 = 0 to 10 V / 20 mA		cfg	I/O	13-8 19-9
P0254	AO2 Function	Refer to the P0251 options	5 = Output current			I/O	13-6 19-9

Param.	Description	Adjustable Range	Factory Setting	User Setting	Propr.	Grorps	Pag.
P0255	AO2 Gain	0.000 to 9.999	1.000			I/O	13-6 19-9
P0256	AO2 Signal Type	0 = 0 to 10 V / 20 mA 1 = 4 to 20 mA 2 = 10 V / 20 mA to 0 3 = 20 to 4 mA	0 = 0 to 10 V / 20 mA		cfg	I/O	13-8 19-9
P0263	DI1 Function	0 = Not Used 1 = Run/Stop 2 = General Enable 3 = Fast Stop 4 = FWD/REV 5 = LOC/REM 6 = JOG 7 = SoftPLC 8 = Ramp 2 9 = Speed/Torque 10 = JOG+ 11 = JOG- 12 = No External Alarm 13 = No External Fault 14 = Reset 15 = Flying Start Disabling 16 = DC Link Regulator 17 = Program. Disabling 18 = Load User 1 19 = Load User 2 20 = Application Function 1 21 = Application Function 2 12 = Application Function 3 23 = Application Function 4 24 = Application Function 5 25 = Application Function 6 26 = Application Function 7 27 = Application Function 8	1 = Run/Stop		cfg	I/O	13-9 19-10 19-18 19-26 19-30
P0264	DI2 Function	Refer to the P0263 options	4 = FWD/REV		cfg	I/O	13-9 19-10 19-18 19-26 19-30
P0265	DI3 Function	Refer to the P0263 options	0 = Not Used		cfg	I/O	13-9 19-10 19-18 19-26 19-30
P0266	DI4 Function	Refer to the P0263 options	0 = Not Used		cfg	I/O	13-9 19-10 19-18 19-22 19-26 19-30
P0267	DI5 Function	Refer to the P0263 options	6 = JOG		cfg	I/O	13-9 19-10 19-18 19-22 19-26 19-30
P0268	DI6 Function	Refer to the P0263 options	8 = Ramp 2		cfg	I/O	13-9 19-10 19-18 19-22 19-26 19-30
P0269	DI7 Function	Refer to the P0263 options	0 = Not Used		cfg	I/O	13-9 19-10 19-18 19-26 19-30
P0270	DI8 Function	Refer to the P0263 options	0 = Not Used		cfg	I/O	13-10 19-10 19-18 19-30

Param.	Description	Adjustable Range	Factory Setting	User Setting	Propr.	Grorps	Pag.
P0275	DO1 Function (RL1)	0 = Not Used 1 = N* > Nx 2 = N > Nx 3 = N < Ny 4 = N = N* 5 = Zero Speed 6 = Is > Ix 7 = Is < Ix 8 = Torque > Tx 9 = Torque < Tx 10 = Remote 11 = Run 12 = Ready 13 = No Fault 14 = No F070 15 = No F071 16 = No F006/21/22 17 = No F051 18 = No F072 19 = 4-20 mA OK 20 = P0695 Value 21 = Forward 22 = Ride-Through 23 = Pre-Charge OK 24 = Fault 25 = Enabled Time > Hx 26 = SoftPLC 27 = N > Nx / Nt > Nx 28 = F > Fx (1) 29 = F > Fx (2) 30 = STO 31 = No F160 32 = No Alarm 33 = No Fault/Alarm 34 = Application Function 1 35 = Application Function 2 36 = Application Function 3 37 = Application Function 4 38 = Application Function 5 39 = Application Function 6 40 = Application Function 7 41 = Application Function 8	13 = No Fault		cfg	I/O	13-14 19-10
P0276	DO2 Function	Refer to the P0275 options	2 = N > Nx		cfg	I/O	13-14 19-10
P0277	DO3 Function	Refer to the P0275 options	1 = N* > Nx		cfg	I/O	13-14 19-10
P0278	DO4 Function	Refer to the P0275 options	0 = Not Used		cfg	I/O	13-14
P0279	DO5 Function	Refer to the P0275 options	0 = Not Used		cfg	I/O	13-15 19-10
P0281	Fx Frequency	0.0 to 300.0 Hz	4.0 Hz				13-20
P0282	Fx Hysteresis	0.0 to 15.0 Hz	2.0 Hz				13-20
P0287	Nx/Ny Hysteresis	0 to 900 rpm	18 (15) rpm				13-20
P0288	Nx Speed	0 to 18000 rpm	120 (100) rpm				13-21
P0289	Ny Speed	0 to 18000 rpm	1800 (1500) rpm				13-21
P0290	Ix Current	0 to 2 x I_{nom-ND}	1.0 x I_{nom-ND}				13-21
P0291	Zero Speed	0 to 18000 rpm	18 (15) rpm				12-8 13-21
P0292	N = N* Band	0 to 18000 rpm	18 (15) rpm				13-21
P0293	Tx Torque	0 to 200 %	100 %				13-22
P0294	Hx Time	0 to 6553 h	4320 h				13-22

Param.	Description	Adjustable Range	Factory Setting	User Setting	Propr.	Grorps	Pag.
P0295	ND/HD VFD Rated Current	0 = 2 A / 2 A 1 = 3.6 A / 3.6 A 2 = 5 A / 5 A 3 = 6 A / 5 A 4 = 7 A / 5.5 A 5 = 7 A / 7 A 6 = 10 A / 8 A 7 = 10 A / 10 A 8 = 13 A / 11 A 9 = 13.5 A / 11 A 10 = 16 A / 13 A 11 = 17 A / 13.5 A 12 = 24 A / 19 A 13 = 24 A / 20 A 14 = 28 A / 24 A 15 = 31 A / 25 A 16 = 33.5 A / 28 A 17 = 38 A / 33 A 18 = 45 A / 36 A 19 = 45 A / 38 A 20 = 54 A / 45 A 21 = 58.5 A / 47 A 22 = 70 A / 56 A 23 = 70.5 A / 61 A 24 = 86 A / 70 A 25 = 88 A / 73 A 26 = 105 A / 86 A 27 = 105 A / 88 A 28 = 142 A / 115 A 29 = 180 A / 142 A 30 = 211 A / 180 A			ro		6-4
P0296	Line Rated Voltage	0 = 200 - 240 V 1 = 380 V 2 = 400 - 415 V 3 = 440 - 460 V 4 = 480 V	According to the inverter model		cfg		6-5
P0297	Switching Frequency	0 = 1.25 kHz 1 = 2.5 kHz 2 = 5.0 kHz 3 = 10.0 kHz	2 = 5.0 kHz		cfg		6-5
P0298	Application	0 = Normal Duty (ND) 1 = Heavy Duty (HD)	0 = Normal Duty (ND)		cfg		6-6
P0299	Starting DC-Braking Time	0.0 to 15.0 s	0.0 s		V/f, VVW and Sless		12-17
P0300	Stopping DC-Braking Time	0.0 to 15.0 s	0.0 s		V/f, VVW and Sless		12-18
P0301	DC-Braking Speed	0 to 450 rpm	30 rpm		V/f, VVW and Sless		12-19
P0302	DC-Braking Voltage	0.0 to 10.0 %	2.0 %		V/f and VVW		12-20
P0303	Skip Speed 1	0 to 18000 rpm	600 rpm				12-21
P0304	Skip Speed 2	0 to 18000 rpm	900 rpm				12-21
P0305	Skip Speed 3	0 to 18000 rpm	1200 rpm				12-21
P0306	Skip Band	0 to 750 rpm	0 rpm				12-21
P0308	Serial Address	1 to 247	1			NET	17-1
P0310	Serial Baud Rate	0 = 9600 bits/s 1 = 19200 bits/s 2 = 38400 bits/s 3 = 57600 bits/s	1 = 19200 bits/s			NET	17-1
P0311	Serial Byte Configuration	0 = 8 bits, no, 1 1 = 8 bits, even, 1 2 = 8 bits, odd, 1 3 = 8 bits, no, 2 4 = 8 bits, even, 2 5 = 8 bits, odd, 2	1 = 8 bits, even, 1			NET	17-1

Param.	Description	Adjustable Range	Factory Setting	User Setting	Propr.	Grorps	Pag.
P0313	Communication Error Action	0 = Off 1 = Ramp Stop 2 = General Disable 3 = Goes to LOC 4 = LOC Keeping Enabled 5 = Causes Fault	0 = Off			NET	17-4
P0314	Serial Watchdog	0.0 to 999.0 s	0.0 s			NET	17-1
P0316	Serial Interface Status	0 = Off 1 = On 2 = Watchdog Error			ro	NET	17-1
P0317	Oriented Start-up	0 = No 1 = Yes	0 = No		cfg		10-6 11-29
P0318	Copy Function MMF	0 = Off 1 = VFD → MMF 2 = MMF → VFD 3 = VFD Synchronization → MMF 4 = MMF Format 5 = SoftPLC Program Copy	0 = Off		cfg		7-2
P0320	FlyStart/Ride-Through	0 = Off 1 = Flying Start 2 = FS / RT 3 = Ride-Through	0 = Off		cfg		12-8
P0321	DC Link Power Loss	178 to 616 V	505 V		Vector		12-15
P0322	DC Link Ride-Through	178 to 616 V	490 V		Vector		12-15
P0323	DC Link Power Back	178 to 616 V	535 V		Vector		12-15
P0325	Ride-Through P Gain	0.0 to 63.9	22.8		Vector		12-16
P0326	Ride-Through I Gain	0.000 to 9.999	0.128		Vector		12-16
P0327	FS I/f Current Ramp	0.000 to 1.000 s	0.070		Sless		12-10
P0328	Flying Start Filter	0.000 to 1.000 s	0.085		Sless		12-10
P0329	FS I/f Frequency Ramp	2.0 to 50.0	6.0		Sless		12-10
P0331	Voltage Ramp	0.2 to 60.0 s	2.0 s		V/f and VVW		12-12
P0332	Dead Time	0.1 to 10.0 s	1.0 s		V/f and VVW		12-13
P0340	Auto-Reset Time	0 to 255 s	0 s				15-7
P0343	Ground Fault Configuration	0 = Off 1 = On	1 = On		cfg		15-8
P0344	Current Limit Configuration	0 = Hold - FL ON 1 = Decel. - FL ON 2 = Hold - FL OFF 3 = Decel.- FL OFF	1 = Decel. - FL ON		cfg, V/f and VVW		9-7
P0348	Motor Overload Configuration	0 = Off 1 = Fault/Alarm 2 = Fault 3 = Alarm	1 = Fault/Alarm		cfg		15-8
P0349	I x t Alarm Level	70 to 100 %	85 %		cfg		15-9
P0350	IGBT Overload Configuration	0 = F, w/ SF rd. 1 = F/A, w/ SF rd. 2 = F, no SF rd. 3 = F/A, no SF rd.	1 = F/A, w/ SF rd.		cfg		15-9
P0351	Motor Overtemperature Config.	0 = Off 1 = Fault/Alarm 2 = Fault 3 = Alarm	1 = Fault/Alarm		cfg		15-10
P0352	Fan Control Configuration	0 = HS-OFF, Int-OFF 1 = HS-ON, Int-ON 2 = HS-CT, Int-CT 3 = HS-CT, Int-OFF 4 = HS-CT, Int-ON 5 = HS-ON, Int-OFF 6 = HS-ON, Int-CT 7 = HS-OFF, Int-ON 8 = HS-OFF, Int-CT	2 = HS-CT, Int-CT		cfg		15-10

Param.	Description	Adjustable Range	Factory Setting	User Setting	Propr.	Grorps	Pag.
P0353	IGBTs/Air Overtemp. Config.	0 = HS-F/A, Air-F/A 1 = HS-F/A, Air-F 2 = HS-F, Air-F/A 3 = HS-F, Air-F	0 = HS-F/A, Air-F/A		cfg		15-11
P0354	Fan Speed Configuration	0 = Inactive 1 = Fault	1 = Fault		cfg		15-12
P0356	Dead Time Compensation	0 = Off 1 = On	1 = On		cfg		15-12
P0357	Line Phase Loss Time	0 to 60 s	3 s				15-12
P0372	Sless DC Braking Current	0.0 to 90.0 %	40.0 %		Sless		12-20
P0397	Regen. Slip Compensation	0 = Off 1 = On	1 = On		cfg and VVW		10-3
P0398	Motor Service Factor	1.00 to 1.50	1.00		cfg	MOTOR	10-3 11-10
P0399	Motor Rated Efficiency	50.0 to 99.9 %	67.0 %		cfg and VVW	MOTOR	10-3 11-10
P0400	Motor Rated Voltage	0 to 480 V	440 V		cfg	MOTOR	10-4 11-10
P0401	Motor Rated Current	0 to 1.3 x I_{nom-ND}	1.0 x I_{nom-ND}		cfg	MOTOR	10-4 11-11
P0402	Motor Rated Speed	0 to 18000 rpm	1750 (1458) rpm		cfg	MOTOR	10-4 11-11
P0403	Motor Rated Frequency	0 to 300 Hz	60 (50) Hz		cfg	MOTOR	10-4 11-11
P0404	Motor Rated Power	0 = 0.33 HP 0.25 kW 1 = 0.5 HP 0.37 kW 2 = 0.75 HP 0.55 kW 3 = 1 HP 0.75 kW 4 = 1.5 HP 1.1 kW 5 = 2 HP 1.5 kW 6 = 3 HP 2.2 kW 7 = 4 HP 3 kW 8 = 5 HP 3.7 kW 9 = 5.5 HP 4 kW 10 = 6 HP 4.5 kW 11 = 7.5 HP 5.5 kW 12 = 10 HP 7.5 kW 13 = 12.5 HP 9 kW 14 = 15 HP 11 kW 15 = 20 HP 15 kW 16 = 25 HP 18.5 kW 17 = 30 HP 22 kW 18 = 40 HP 30 kW 19 = 50 HP 37 kW 20 = 60 HP 45 kW 21 = 75 HP 55 kW 22 = 100 HP 75 kW 23 = 125 HP 90 kW 24 = 150 HP 110 kW 25 = 175 HP 130 kW	Motor $_{max-ND}$		cfg	MOTOR	10-4 11-12
P0405	Encoder Pulse Number	100 to 9999 ppr	1024 ppr		cfg	MOTOR	11-12
P0406	Motor Ventilation	0 = Self-Ventilated 1 = Separated Ventilation 2 = Optimal Flux	0 = Self-Ventilated		cfg	MOTOR	10-4 11-13
P0407	Motor Rated Power Factor	0.50 to 0.99	0.68		cfg and VVW	MOTOR	10-4 11-13
P0408	Run Self-Tuning	0 = No 1 = No Rotation 2 = Run for I_m 3 = Run for T_m 4 = Estimate T_m	0 = No		cfg, VVW and Vector	MOTOR	10-4 11-13 11-20
P0409	Stator Resistance	0.000 to 9.999 ohm	0.000 ohm		cfg, VVW and Vector	MOTOR	10-4 11-13 11-21
P0410	Magnetization Current	0 to 1.25 x I_{nom-ND}	I_{nom-ND}			MOTOR	10-4 11-13 11-22

Param.	Description	Adjustable Range	Factory Setting	User Setting	Propr.	Grorps	Pag.
P0411	Leakage Inductance	0.00 to 99.99 mH	0.00 mH		cfg and Vector	MOTOR	11-13 11-22
P0412	T_r Time Constant	0.000 to 9.999 s	0.000 s		Vector	MOTOR	11-13 11-23
P0413	T_m Time Constant	0.00 to 99.99 s	0.00 s		Vector	MOTOR	11-13 11-24
P0680	Status Word	Bit 0 to 4 = Reserved Bit 5 = 2nd Ramp Bit 6 = Configuration Mode Bit 7 = Alarm Condition Bit 8 = Running Bit 9 = General Enabling Bit 10 = Forward Bit 11 = JOG Bit 12 = Remote Bit 13 = Undervoltage Bit 14 = Reserved Bit 15 = Fault Condition			ro	NET	17-4
P0681	Motor Speed in 13 Bits	-32768 to 32767			ro	NET	17-4
P0682	Serial Control Word	Bit 0 = Ramp Enable Bit 1 = General Enable Bit 2 = Run Forward Bit 3 = JOG Bit 4 = Remote Bit 5 = 2nd Ramp Bit 6 = Reserved Bit 7 = Fault Reset Bit 8 to 15 = Reserved			ro	NET	17-1
P0683	Serial Speed Reference	-32768 to 32767			ro	NET	17-1
P0684	CO/DN/DP Control Word	Refer to the P0682 options			ro	NET	17-1
P0685	CO/DN/DP Speed Reference	- 32768 to 32767			ro	NET	17-1
P0695	Settings for the Digital Outputs	Bit 0 = DO1 Bit 1 = DO2 Bit 2 = DO3 Bit 3 = DO4 Bit 4 = DO5	Bit 4 = DO5			NET	17-4
P0696	Value 1 for Analog Outputs	- 32768 to 32767	0			NET	17-4
P0697	Value 2 for Analog Outputs	- 32768 to 32767	0			NET	17-4
P0700	CAN Protocol	1 = CANopen 2 = DeviceNet	2 = DeviceNet			NET	17-1
P0701	CAN Address	0 to 127	63			NET	17-1
P0702	CAN Baud Rate	0 = 1 Mbps/Auto 1 = Reserved/Auto 2 = 500 Kbps 3 = 250 Kbps 4 = 125 Kbps 5 = 100 Kbps/Auto 6 = 50 Kbps/Auto 7 = 20 Kbps/Auto 8 = 10 Kbps/Auto	0 = 1 Mbps/Auto			NET	17-1
P0703	Bus Off Reset	0 = Manual 1 = Automatic	1 = Automatic			NET	17-1
P0705	CAN Controller Status	0 = Disabled 1 = Auto-baud 2 = CAN Enabled 3 = Warning 4 = Error Passive 5 = Bus Off 6 = No Bus Power			ro	NET	17-1
P0706	Received CAN Telegrams	0 to 65535			ro	NET	17-1
P0707	Transmitted CAN Telegrams	0 to 65535			ro	NET	17-1
P0708	Bus Off Counter	0 to 65535			ro	NET	17-1
P0709	Lost CAN Messages	0 to 65535			ro	NET	17-2

Param.	Description	Adjustable Range	Factory Setting	User Setting	Propr.	Grorps	Pag.
P0710	DeviceNet I/O Instances	0 = ODVA Basic 2W 1 = ODVA Extended 2W 2 = Manuf. Spec. 2W 3 = Manuf. Spec. 3W 4 = Manuf. Spec. 4W 5 = Manuf. Spec. 5W 6 = Manuf. Spec. 6W	0 = ODVA Basic 2W			NET	17-2
P0711	DeviceNet Reading Word # 3	0 to 1199	0			NET	17-2
P0712	DeviceNet Reading Word # 4	0 to 1199	0			NET	17-2
P0713	DeviceNet Reading Word # 5	0 to 1199	0			NET	17-2
P0714	DeviceNet Reading Word # 6	0 to 1199	0			NET	17-2
P0715	DeviceNet Writing Word # 3	0 to 1199	0			NET	17-2
P0716	DeviceNet Writing Word # 4	0 to 1199	0			NET	17-2
P0717	DeviceNet Writing Word # 5	0 to 1199	0			NET	17-2
P0718	DeviceNet Writing Word # 6	0 to 1199	0			NET	17-2
P0719	DeviceNet Network Status	0 = Offline 1 = Online, Not Connected 2 = Online, Connected 3 = Timed-out Connection 4 = Connection Failure 5 = Auto-Baud			ro	NET	17-2
P0720	DeviceNet Master Status	0 = Run 1 = Idle			ro	NET	17-2
P0721	CANopen Com. Status	0 = Disabled 1 = Reserved 2 = Com. Enabled 3 = Error Control Enabled 4 = Guarding Error 5 = Heartbeat Error			ro	NET	17-2
P0722	CANopen Node Status	0 = Disabled 1 = Initialization 2 = Stopped 3 = Operational 4 = Preoperational			ro	NET	17-2
P0740	Profibus Communication Status	0 = Inactive 1 = Access Error 2 = Offline 3 = Configuration Error 4 = Parameterization Error 5 = Clear Mode 6 = Online			ro	NET	17-2
P0741	Profibus Data Profile	0 = PROFIdrive 1 = Manufacturer	1 = Manufacturer			NET	17-2
P0742	Profibus Reading # 3	0 to 1199	0			NET	17-2
P0743	Profibus Reading # 4	0 to 1199	0			NET	17-2
P0744	Profibus Reading # 5	0 to 1199	0			NET	17-2
P0745	Profibus Reading # 6	0 to 1199	0			NET	17-2
P0746	Profibus Reading # 7	0 to 1199	0			NET	17-3
P0747	Profibus Reading # 8	0 to 1199	0			NET	17-3
P0748	Profibus Reading # 9	0 to 1199	0			NET	17-3
P0749	Profibus Reading # 10	0 to 1199	0			NET	17-3
P0750	Profibus Writing # 3	0 to 1199	0			NET	17-3
P0751	Profibus Writing # 4	0 to 1199	0			NET	17-3
P0752	Profibus Writing # 5	0 to 1199	0			NET	17-3
P0753	Profibus Writing # 6	0 to 1199	0			NET	17-3
P0754	Profibus Writing # 7	0 to 1199	0			NET	17-3
P0755	Profibus Writing # 8	0 to 1199	0			NET	17-3
P0756	Profibus Writing # 9	0 to 1199	0			NET	17-3
P0757	Profibus Writing # 10	0 to 1199	0			NET	17-3
P0918	Profibus Address	1 to 126	1			NET	17-3

Param.	Description	Adjustable Range	Factory Setting	User Setting	Propr.	Grorps	Pag.
P0922	Profibus Telegram Selection	1 = Standard Telegram 1 2 = Telegram 100 3 = Telegram 101 4 = Telegram 102 5 = Telegram 103 6 = Telegram 104 7 = Telegram 105 8 = Telegram 106 9 = Telegram 107	1 = Standard Tel. 1			NET	17-3
P0944	Fault Counter	0 to 65535			ro	NET	17-3
P0947	Fault Number	0 to 65535			ro	NET	17-3
P0963	Profibus Baud Rate	0 = 9.6 kbit/s 1 = 19.2 kbit/s 2 = 93.75kbit/s 3 = 187.5 kbit/s 4 = 500 kbit/s 5 = Not detected 6 = 1500 kbit/s 7 = 3000 kbit/s 8 = 6000 kbit/s 9 = 12000 kbit/s 10 = Reserved 11 = 45.45 kbit/s			ro	NET	17-3
P0964	Drive Identification	0 to 65535			ro	NET	17-3
P0965	Profile Identification	0 to 65535			ro	NET	17-3
P0967	Control Word 1	0000h to FFFFh	0000h		ro	NET	17-3
P0968	Status Word 1	0000h to FFFFh	0000h		ro	NET	17-3
P1000	SoftPLC Status	0 = No Applicative 1 = Installing App. 2 = Incompatible App. 3 = Stopped Applicative 4 = Applicative Running			ro	SPLC or READ	18-1 19-10 19-18 19-22 19-27 19-30
P1001	SoftPLC Command	0 = Stop Applicative 1 = Run Applicative 2 = Delete Applicative	0 = Stop Applicative			SPLC	18-1 19-10 19-19 19-22 19-27 19-30
P1002	Scan Cycle Time	0.0 to 999.9 ms			ro	SPLC or READ	18-1 19-10 19-19 19-22 19-27 19-30
P1003	Applicative Selection	0 = User 1 = PID 2 = EP 3 = Multispeed 4 = 3-Wire Start/Stop 5 = FWD Run/ REV Run	0 = User		cfg	SPLC	18-2 19-10 19-19 19-22 19-27 19-30
P1010	SoftPLC Parameter 1	-32768 to 32767	0		cfg	SPLC	18-2 19-10 19-19 19-22 19-27 19-30
P1011	SoftPLC Parameter 2	-32768 to 32767	0		cfg	SPLC	18-2 19-11 19-19 19-22
P1012	SoftPLC Parameter 3	-32768 to 32767	0		cfg	SPLC	18-2 19-11 19-19 19-23
P1013	SoftPLC Parameter 4	-32768 to 32767	0		cfg	SPLC	18-2 19-11 19-23

Param.	Description	Adjustable Range	Factory Setting	User Setting	Propr.	Grorps	Pag.
P1014	SoftPLC Parameter 5	-32768 to 32767	0		cfg	SPLC	18-2 19-23
P1015	SoftPLC Parameter 6	-32768 to 32767	0		cfg	SPLC	18-2 19-23
P1016	SoftPLC Parameter 7	-32768 to 32767	0		cfg	SPLC	18-2 19-11 19-24
P1017	SoftPLC Parameter 8	-32768 to 32767	0		cfg	SPLC	18-2 19-24
P1018	SoftPLC Parameter 9	-32768 to 32767	0		cfg	SPLC	18-2 19-12 19-24
P1019	SoftPLC Parameter 10	-32768 to 32767	0		cfg	SPLC	18-2
P1020	SoftPLC Parameter 11	-32768 to 32767	0		cfg	SPLC	18-2 19-12
P1021	SoftPLC Parameter 12	-32768 to 32767	0		cfg	SPLC	18-2 19-12
P1022	SoftPLC Parameter 13	-32768 to 32767	0		cfg	SPLC	18-2 19-12
P1023	SoftPLC Parameter 14	-32768 to 32767	0		cfg	SPLC	18-2 19-13
P1024	SoftPLC Parameter 15	-32768 to 32767	0		cfg	SPLC	18-2 19-13
P1025	SoftPLC Parameter 16	-32768 to 32767	0		cfg	SPLC	18-2 19-14
P1026	SoftPLC Parameter 17	-32768 to 32767	0		cfg	SPLC	18-2 19-14
P1027	SoftPLC Parameter 18	-32768 to 32767	0		cfg	SPLC	18-2 19-15
P1028	SoftPLC Parameter 19	-32768 to 32767	0		cfg	SPLC	18-2 19-15
P1029	SoftPLC Parameter 20	-32768 to 32767	0		cfg	SPLC	18-2
P1030	SoftPLC Parameter 21	-32768 to 32767	0		cfg	SPLC	18-2
P1031	SoftPLC Parameter 22	-32768 to 32767	0		cfg	SPLC	18-2 19-15
P1032	SoftPLC Parameter 23	-32768 to 32767	0		cfg	SPLC	18-2 19-15
P1033	SoftPLC Parameter 24	-32768 to 32767	0		cfg	SPLC	18-2
P1034	SoftPLC Parameter 25	-32768 to 32767	0		cfg	SPLC	18-2
P1035	SoftPLC Parameter 26	-32768 to 32767	0		cfg	SPLC	18-2
P1036	SoftPLC Parameter 27	-32768 to 32767	0		cfg	SPLC	18-2
P1037	SoftPLC Parameter 28	-32768 to 32767	0		cfg	SPLC	18-2
P1038	SoftPLC Parameter 29	-32768 to 32767	0		cfg	SPLC	18-2
P1039	SoftPLC Parameter 30	-32768 to 32767	0		cfg	SPLC	18-2
P1040	SoftPLC Parameter 31	-32768 to 32767	0		cfg	SPLC	18-2
P1041	SoftPLC Parameter 32	-32768 to 32767	0		cfg	SPLC	18-2
P1042	SoftPLC Parameter 33	-32768 to 32767	0		cfg	SPLC	18-2
P1043	SoftPLC Parameter 34	-32768 to 32767	0		cfg	SPLC	18-2
P1044	SoftPLC Parameter 35	-32768 to 32767	0		cfg	SPLC	18-2
P1045	SoftPLC Parameter 36	-32768 to 32767	0		cfg	SPLC	18-2
P1046	SoftPLC Parameter 37	-32768 to 32767	0		cfg	SPLC	18-2
P1047	SoftPLC Parameter 38	-32768 to 32767	0		cfg	SPLC	18-2
P1048	SoftPLC Parameter 39	-32768 to 32767	0		cfg	SPLC	18-2
P1049	SoftPLC Parameter 40	-32768 to 32767	0		cfg	SPLC	18-2
P1050	SoftPLC Parameter 41	-32768 to 32767	0		cfg	SPLC	18-2
P1051	SoftPLC Parameter 42	-32768 to 32767	0		cfg	SPLC	18-2
P1052	SoftPLC Parameter 43	-32768 to 32767	0		cfg	SPLC	18-2
P1053	SoftPLC Parameter 44	-32768 to 32767	0		cfg	SPLC	18-2
P1054	SoftPLC Parameter 45	-32768 to 32767	0		cfg	SPLC	18-2
P1055	SoftPLC Parameter 46	-32768 to 32767	0		cfg	SPLC	18-2
P1056	SoftPLC Parameter 47	-32768 to 32767	0		cfg	SPLC	18-2

Param.	Description	Adjustable Range	Factory Setting	User Setting	Propr.	Grorps	Pag.
P1057	SoftPLC Parameter 48	-32768 to 32767	0		cfg	SPLC	18-2
P1058	SoftPLC Parameter 49	-32768 to 32767	0		cfg	SPLC	18-2
P1059	SoftPLC Parameter 50	-32768 to 32767	0		cfg	SPLC	18-2

Notes:
ro = Read-only parameter.
rw = Reading/writing parameter.
cfg = Configuration parameter, it can be changed only with stopped motor.
V/f = Parameter available in V/f mode.
Adj = Parameter available only in adjustable V/f mode.
VVW = Parameter available in VVW mode.
Vector = Parameter available in vector mode.
Sless = Parameter available only in sensorless mode.
Enc = Parameter available only in vector mode with encoder.

Fault/Alarm	Description	Possible Causes
F006: Input Voltage Imbalance or Phase Loss	The mains voltage imbalance is too high or phase loss at the supply line has occurred. **Note:** - This fault may not occur if the load at the motor shaft is too low or nonexistent. P0357 sets the time for the trip, and P0357 = 0 disables this fault.	■ A Phase Loss at the inverter input. ■ The input voltage imbalance is > 5 %.
F021: DC Link Undervoltage	A DC link undervoltage condition has occurred.	■ The input voltage is too low and the DC link voltage dropped below the minimum permitted value (monitor the P0004 parameter value): Ud < 223 V - 200-240 V three-phase input voltage; Ud < 170 V - 200-240 V single-phase input voltage (CFW700XXXXS2 or CFW700XXXXB2 models) (P0296 = 0); Ud < 385 V - 380 V input voltage (P0296 = 1); Ud < 405 V - 400-415 V input voltage (P0296 = 2); Ud < 446 V - 440-460 V input voltage (P0296 = 3); Ud < 487 V - 480 V input voltage (P0296 = 4). ■ Phase loss at the inverter input. ■ Pre-charge circuit failure. ■ Parameter P0296 was set to a value higher than the power supply rated voltage.
F022: DC Link Overvoltage	A DC link overvoltage condition has occurred.	■ Too high input voltage, resulting in a DC link voltage higher than the maximum permitted value: Ud > 400 V - 220-230 V models (P0296 = 0); Ud > 800 V - 380-480 V models (P0296 = 1, 2, 3, or 4). ■ The inertia of the driven-load is too high or the deceleration time is too short. ■ The parameter P0151, P0153 or P0185 setting is too high.
A046: High Load at the Motor	It is the motor overload alarm. **Note:** It can be disabled by setting P0348 = 0 or 2.	■ The settings of P0156, P0157 and P0158 are too low for the used motor. ■ There is excessive load at the motor shaft.
A047: IGBT Overload Alarm	It is the IGBT overload alarm. **Note:** It can be disabled by setting P0350 = 0 or 2.	■ The inverter output current is too high.
F048: IGBT Overload Fault	It is the IGBT overload fault.	■ The inverter output current is too high.
A050: IGBT High Temperature	The NTC temperature sensors located in the IGBTs detected a high temperature alarm. **Note:** It can be disabled by setting P0353 = 2 or 3.	■ High surrounding air temperature (>50 °C (122 °F)) and high output current. ■ Blocked or defective fan. ■ Very dirty heatsink.
F051: IGBT Overtemperature	The NTC temperature sensors located in the IGBTs detected a high temperature fault.	
F067: Inverted Encoder/ Motor Wiring	Fault related to the phase relationship between the encoder signals, if P0202 = 5 and P0408 = 2, 3 or 4. **Note:** - This fault can only occur during the self-tuning routine. - It is not possible to reset this fault. - In case of fault, turn off the power supply, solve the problem, and then turn it on again.	■ Output motor cables U, V, W are inverted. ■ Encoder channels A and B are inverted. ■ Error in the encoder mounting position.
F070: Overcurrent/ Short-circuit	An overcurrent or a short-circuit at the output, at the DC link or at the braking resistor, has occurred.	■ Short-circuit between two motor phases. ■ Short-circuit between the dynamic braking resistor connection cables. ■ Shorted IGBT modules.
F071: Output Overcurrent	An output overcurrent has occurred.	■ Excessive load inertia or too short acceleration ramp. ■ P0135, or P0169 and P0170 settings are too high.
F072: Motor Overload	The motor overload protection has tripped. **Note:** It can be disabled by setting P0348 = 0 or 3.	■ The settings of P0156, P0157 and P0158 are too low for the used motor. ■ There is excessive load at the motor shaft.
F074: Ground Fault	A ground fault occurred either in the cable between the inverter and the motor or in the motor itself. **Note:** It can be disabled by setting P0343 = 0.	■ Short-circuit to the ground in one or more output phases. ■ Motor cable capacitance is too large, resulting in current peaks at the output.

Fault/Alarm	Description	Possible Causes
F078: Motor Overtemperature	Fault related to the PTC temperature sensor installed in the motor. **Note:** - It can be disabled by setting P0351 = 0 or 3. - An analog input and an analog output must be set for the PTC function.	■ Excessive load at the motor shaft. ■ Severe duty cycle (too many starts / stops per minute). ■ Too high surrounding air temperature. ■ Loose connection or short-circuit (resistance < 100 Ω) in the wiring connected to the motor thermistors. ■ Not installed motor thermistors. ■ Blocked motor shaft.
F079: Encoder Signal Fault	Incorrect encoder signals.	■ Broken wiring between the motor encoder and the encoder interface accessory. ■ Defective encoder.
F080: CPU Watchdog	Microcontroller watchdog fault.	■ Electrical noise.
F084: Auto-Diagnosis Fault	Auto-Diagnosis Fault.	■ Defect in the inverter internal circuitry. ■ Firmware incompatible with an accessory.
A090: External Alarm	External alarm monitored through a digital input. **Note:** It is necessary to program a digital input for “No external alarm”.	■ A digital input (DI1 to DI8) programmed for “No external alarm” is open.
F091: External Fault	External fault monitored through a digital input. **Note:** It is necessary to program a digital input for “No external fault”.	■ A digital input (DI1 to DI8) programmed for “No external fault” is open.
A098: Activate General Enable	General enable signal is missing during the self-tuning.	■ The digital input programmed for “General Enable” is open.
F099: Invalid Current Offset	The current measurement circuit is presenting an abnormal value for null current.	■ Defect in the inverter internal circuitry.
A110: High Motor Temperature	Fault detected through PTC type temperature sensors installed in the motor. **Note:** - It can be disabled by setting P0351 = 0 or 2. - An analog input and an analog output must be set for the PTC function.	■ Excessive load at the motor shaft. ■ Severe duty cycle (too many starts / stops per minute). ■ Too high surrounding air temperature. ■ Not installed motor thermistors. ■ Blocked motor shaft.
A128: Serial Communication Timeout	It indicates that the inverter stopped receiving valid telegrams during a certain period. **Note:** It can be disabled by setting P0314 = 0.0 s	■ Check the wiring and the ground installation. ■ Make sure that the inverter has sent a new message within the time interval set at P0314.
A133: CAN Interface without Power Supply	It is the alarm indicating that the power supply is missing at the CAN controller.	■ Broken or disconnected cable. ■ The power supply is turned off.
A134: Bus Off	The inverter CAN interface has entered the buss off state.	■ Incorrect communication baud rate. ■ Two network slaves with the same address. ■ Wrong cable connection (inverted signals).
A135: CANopen Communication Error	It indicates a communication error alarm.	■ Communication problems. ■ Wrong master configuration/settings. ■ Incorrect configuration of the communication objects.
A136: Idle Master	The network master has entered the idle state.	■ PLC in IDLE mode. ■ PLC command register bit set to zero (0).
A137: DeviceNet Connection Timeout	It is the alarm indicating timeout of the DeviceNet I/O connections.	■ One or more allocated I/O connections have entered the timeout state.
A138: (2) Profibus DP Interface in Clear Mode	It indicates that the inverter received a command from the Profibus DP network master to enter the clear mode.	■ Verify the network master status, making sure it is in the execution mode (Run). ■ Refer to the Profibus DP communication manual for more information.
A139: (2) Offline Profibus DP Interface	It indicates an interruption in the communication between the Profibus DP network master and the inverter.	■ Verify whether the network master is correctly configured and operating normally. ■ Verify the network installation in a general manner - cable routing, grounding. ■ Refer to the Profibus DP communication manual for more information.
A140: (2) Profibus DP Module Access Error	It indicates an error in the access to the Profibus DP communication module data.	■ Verify whether the Profibus DP module is correctly fit into the slot 3. ■ Refer to the Profibus DP communication manual for more information.

Fault/Alarm	Description	Possible Causes
F150: Motor Overspeed	Overspeed fault. It trips when the actual speed exceeds the value of $P0134 \times \frac{(100\ \% + P0132)}{100\%}$ for more than 20 ms.	■ Wrong settings of P0161 and/or P0162. ■ Problem with a hoist-type load.
F151: FLASH Memory Module Fault	FLASH Memory Module (MMF-01) fault.	■ Defective FLASH memory module. ■ Check the connection of the FLASH memory module.
A152: High Internal Air Temperature	This alarm indicates that the internal air temperature is too high. **Note:** It can be disabled by setting P0353 = 1 or 3.	■ High surrounding air temperature (>50 °C (122 °F)) and high output current. ■ Defective internal fan (if existent). ■ High temperature (> 45 ºC) inside the cabinet.
F153: Internal Air Overtemperature	It indicates internal air overtemperature fault.	■ High surrounding air temperature (>50 °C (122 °F)) and high output current. ■ Defective internal fan (if existent).
F156: Undertemperature	The temperature sensors located in the IGBTs or in the rectifier detected a low temperature, below -30 °C (-22 °F), fault.	■ Surrounding air temperature ≤ -30 °C (-22 °F).
F157: Parameter Table Data Loss	There was a problem during the initialization, during the parameter table loading routine. Some recent parameter modifications may have been lost.	■ The control was switched off very fast while a parameter was being modified.
F158: Parameter Table Fault	There was a problem during the initialization, during the parameter table loading routine. All the parameters were lost and the factory settings were loaded.	■ Firmware updating fault. ■ Defective control board.
F160: Safety Stop Relays	Safety stop relay fault.	■ One of the relays is defective or it does not have +24 V applied to its coil.
A163: AI1 Broken Cable	It indicates that the AI1 current (4-20 mA or 20-4 mA) reference is out of the 4 to 20 mA range.	■ Broken AI1 cable. ■ Bad contact at the connection of the signal to the terminal strip.
A164: AI2 Broken Cable	It indicates that the AI2 current (4-20 mA or 20-4 mA) reference is out of the 4 to 20 mA range.	■ Broken AI2 cable. ■ Bad contact at the connection of the signal to the terminal strip.
A170: Safety Stop	The Safety Stop function is active.	■ The CFW700 went to the STO state.
A177: Fan Replacement	Fan replacement alarm (P0045 > 50000 hours). **Note:** This function can be disabled by setting P0354 = 0.	■ The heatsink fan maximum number of operating hours has been reached.
F179: Heatsink Fan Speed Fault	This fault indicates a problem with the heatsink fan. **Note:** This function can be disabled by setting P0354 = 0.	■ Dirt on the blades and in the bearings of the fan. ■ Defective fan. ■ Defective fan power supply connection.
F182: Pulse Feedback Fault	It indicates a fault in the output pulses feedback.	■ Defect in the inverter internal circuitry.
F183: IGBT Overload + Temperature	Overtemperature related to the IGBT overload protection.	■ Too high inverter surrounding temperature. ■ Operation with frequencies < 10 kHz with overload.
F185: Pre-Charge Contactor Fault	It indicates a fault at the pre-charge contactor.	■ Defective pre-charge contactor. ■ Open command fuse. ■ Phase loss at the L1/R or L2/S input.
F228: Serial Communication Timeout	Refer to the RS-232 / RS-485 Serial Communication Manual.	
F233: CAN interface without power supply	■ Refer to the CANopen Communication Manual and/or the DeviceNet Communication Manual.	
F234: Bus Off		
F235: CANopen Communication Error	■ Refer to the CANopen Communication Manual.	

Fault/Alarm	Description	Possible Causes
F236: Idle Master	■ Refer to the DeviceNet Communication Manual.	
F237: DeviceNet Connection Timeout		
F238: (2) Profibus DP Interface in Clear Mode	■ It indicates that the inverter received a command from the Profibus DP network master to enter the clear mode.	■ Verify the network master status, making sure it is in the execution mode (Run). ■ The fault indication will occur if P0313 = 5. ■ Refer to the Profibus DP communication manual for more information.
F239: (2) Offline Profibus DP Interface	■ It indicates an interruption in the communication between the Profibus DP network master and the inverter.	■ Verify whether the network master is correctly configured and operating normally. ■ Verify the network installation in a general manner - cable routing, grounding. ■ The fault indication will occur if P0313 = 5. ■ Refer to the Profibus DP communication manual for more information.
F240: (2) Profibus DP Module Access Error	■ It indicates an error in the access to the Profibus DP communication module data.	■ Verify whether the Profibus DP module is correctly fit into the slot 3. ■ The fault indication will occur if P0313 = 5. ■ Refer to the Profibus DP communication manual for more information.
A702: Disabled Inverter	■ Refer to the SoftPLC Manual.	
A704: Two Enabled Movements		
A706: Reference not Programmed for SoftPLC		

Notes:

(1) Very long motor cables, with more than 100 m (328.08 ft), presents a high parasitic capacitance to the ground. The circulation of a leakage current through this capacitance may cause the activation of the ground fault circuit, and consequently an F074 trip immediately after the inverter enabling.

POSSIBLE SOLUTION:

- To reduce the switching frequency (P0297).

(2) With the Profibus DP module connected into the slot 3 (XC43).

ATTENTION!

A bad contact in the HMI cable, or electric noise in the installation, can cause a failure in the communication between the HMI and the control board. In such case, the operation through the HMI becomes impossible and the HMI indicates the following message on the display:

1 SAFETY NOTICES

This Manual contains the information necessary for the correct use of the CFW700 Frequency Inverter.

It has been developed to be used by qualified personnel with suitable training or technical qualification for operating this type of equipment.

1.1 SAFETY NOTICES IN THIS MANUAL

The following safety notices are used in this manual:

DANGER!
The procedures recommended in this warning have the purpose of protecting the user against dead, serious injuries and considerable material damage.

ATTENTION!
The procedures recommended in this warning have the purpose of avoiding material damage.

NOTE!
The text intents to supply important information for the correct understanding and good operation of the product.

1.2 SAFETY NOTICES ON THE PRODUCT

The following symbols are attached to the product, serving as safety notices:


High voltages are present.


Components sensitive to electrostatic discharge.
Do not touch them.


Mandatory connection to the protective ground (PE).


Connection of the shield to the ground.


Hot surface.

1

1.3 PRELIMINARY RECOMMENDATIONS

DANGER!
Only qualified personnel familiar with the CFW700 Frequency Inverter and associated equipment should plan or implement the installation, start-up and subsequent maintenance of this equipment.

These personnel must follow all the safety instructions included in this manual and/or defined by local regulations.

Failure to comply with these instructions may result in life threatening and/or equipment damage.

NOTE!
For the purposes of this manual, qualified personnel are those trained to be able to:

1. Install, ground, energize and operate the CFW700 according to this manual and the effective legal safety procedures.

2. Use protection equipment according to the established standards.

3. Give first aid services.

DANGER!
Always disconnect the input power before touching any electrical component associated to the inverter.

Many components can remain charged with high voltages or remain in movement (fans) even after that AC power is disconnected or switched off.

Wait at least 10 minutes to assure a total discharge of the capacitors.

Always connect the equipment frame to the protection earth (PE) at the suitable connection point.

ATTENTION!
Electronic boards have components sensitive to electrostatic discharges. Do not touch directly on components or connectors. If necessary, touch the grounded metallic frame before or use an adequate grounded wrist strap.

Do not perform any high pot tests with the inverter!
If it is necessary consult WEG.

NOTE!
Frequency inverter may interfere with other electronic equipment. In order to reduce these effects, take the precautions recommended in the chapter 3 - Installation and Connection, of the user's manual.

NOTE!
Read the user's manual completely before installing or operating the inverter.

2 GENERAL INFORMATION

2.1 ABOUT THIS MANUAL

This manual presents the necessary information for the configuration of all of the functions and parameters of the CFW700 Frequency Inverter. This manual must be used together with the CFW700 user's manual.

The text intents to supply additional information to facilitate the use and programming of the CFW700 in specific applications.

2.2 TERMINOLOGY AND DEFINITIONS

2.2.1 Terms and Definitions Used in the Manual

Normal Duty Cycle (ND): It is the inverter operation regimen that defines the maximum current value for continuous operation I_{nom-ND} and overload of 110 % during 1 minute. It is selected by programming P0298 (Application)=0 (Normal Duty – ND). It must be used for driving motors that are not subject in that application to high torques in relation to their rated torque, when operating in permanent regimen, during start, acceleration or deceleration.

I_{nom-ND}: Inverter rated current for use with normal overload regimen (ND=Normal Duty).
Overload: 1.1 x I_{nom-ND} / 1 minute.

Heavy Duty Cycle (HD): It is the inverter operation regimen that defines the maximum current value for continuous operation I_{nom-HD} and overload of 150 % during 1 minute. It is selected by programming P0298 (Application)=1 (Heavy Duty (HD)). It must be used for driving motors that are subject in that application to high overload torques in relation to their rated torque, when operating in constant speed, during start, acceleration or deceleration.

I_{nom-HD}: Inverter rated current for use with heavy overload regimen (HD=Heavy Duty).
Overload: 1.5 x I_{nom-HD} / 1 minute.

Rectifier: The input circuit of the inverters that converts the input AC voltage into DC. It is formed by power diodes.

Pre-charge Circuit: It charges the DC Link capacitors with a limited current, thus avoiding current peaks when powering the inverter.

DC Link: This is the inverter intermediate circuit, with DC voltage and current, obtained from the rectification of the AC supply voltage, or from an external source; it supplies the output IGBTs inverter bridge.

U, V and W Arm: It is a set of two IGBTs of the phases U, V and W at the inverter output.

IGBT: "Insulated Gate Bipolar Transistor"; It is the basic component of the output inverter bridge. It operates like an electronic switch in the saturated (closed switch) and cut (open switch) modes.

Braking IGBT: Operates as a switch for the activation of the braking resistor. It is commanded by the DC Link level.

PTC: It's a resistor whose resistance value in ohms increases proportionally to the increase of the temperature; it is used as a temperature sensor in motors.

NTC: It's a resistor whose resistance value in ohms decreases proportionally to the temperature increase; it is used as a temperature sensor in power modules.

Keypad (HMI): Human-Machine Interface; It is the device that allows the control of the motor, the visualization and the modification of the inverter parameters. It presents keys for commanding the motor, navigation keys and a graphic LCD display.

MMF (Flash Memory Module): It is the nonvolatile memory that can be electrically written and erased.

RAM Memory: Random Access Memory (volatile).

PE: “Protective Earth”.

RFI Filter: “Radio Frequency Interference Filter”. It is a filter that avoids interference in the radiofrequency range.

PWM: “Pulse Width Modulation”. It is a pulsing voltage that supplies the motor.

Switching Frequency: It is the inverter bridge IGBTs commutation frequency, specified normally in kHz.

General Enable: When activated, it accelerates the motor with the acceleration ramp provided Run/Stop=Run. When deactivated, the PWM pulses are immediately blocked. It can be commanded through digital input programmed for that function or via serial.

Run/Stop: Inverter function that when activated (Run) accelerates the motor with the acceleration ramp until reaching the speed reference, and when deactivated (Stop) decelerates the motor with the deceleration ramp down to stop. It can be commanded through digital input programmed for that function or via serial. The HMI keys I and O work in a similar manner:
I =Run, O =Stop.

Heatsink: It is a metal part designed for dissipating the heat generated by the power semiconductors.

Amp, A: Ampères.

°C: Degrees Celsius.

°F: Fahrenheit degree.

AC: Alternating Current.

DC: Direct Current.

CFM: “Cubic feet per minute”; it is a flow measurement unit.

hp: “Horse Power”=746 Watts (power measurement unit, normally used to indicate the mechanical power of electric motors).

Hz: Hertz.

l/s: liters per second.

kg: kilogram=1000 gram.

kHz: kilohertz=1000 Hz.

mA: milliamp=0.001 Amp.

min: minute.

ms: millisecond=0.001 second.

Nm: Newton meter; torque measurement unit.

rms: “Root mean square”; effective value.

rpm: revolutions per minute: speed measurement unit.

s: second.

V: Volts.

Ω: Ohms.

2.2.2 Numerical Representation

The decimal numbers are represented by means of digits without suffix. Hexadecimal numbers are represented with the letter “h” after the number.

2.2.3 Symbols for the Parameter Properties Description

ro	Reading only parameter.
cfg	Parameter that can be changed only with a stopped motor.
V/f	Parameter visible on the keypad (HMI) only in the V/f mode: P0202=0, 1 or 2.
Adj	Parameter visible on the keypad (HMI) only in the V/f adjustable mode: P0202=2.
Vector	Parameter visible on the keypad (HMI) only in the vector modes with encoder or sensorless: P0202=4 or 5.
VVW	Parameter visible on the keypad (HMI) only in the VVW mode: P0202=3.
Sless	Parameter visible on the keypad (HMI) only in the vector sensorless mode: P0202=4.
Encoder	Parameter visible on the keypad (HMI) only in the vector with encoder mode: P0202=5.

3 ABOUT THE CFW700

The CFW700 is a high performance frequency inverter that makes it possible the control of speed and torque of three-phase AC induction motors. The principal characteristic of this product is the “Vectrue” technology, which presents the following advantages:

- Scalar control (V/f), VVW or vector control programmable in the same product.
- The vector control can be programmed as “sensorless” (which means that standard motors, without the need of encoder) or vector control with motor encoder.
- The “sensorless” vector control allows high torque and fast response, even at very slow speeds or during starting.
- The “Optimal Braking” function for the vector control allows a controlled motor braking, eliminating in some applications the braking resistor.
- The vector control “Self-Tuning” function allows the automatic setting of the regulators and control parameters, from the identification (also automatic) of the motor and load parameters.

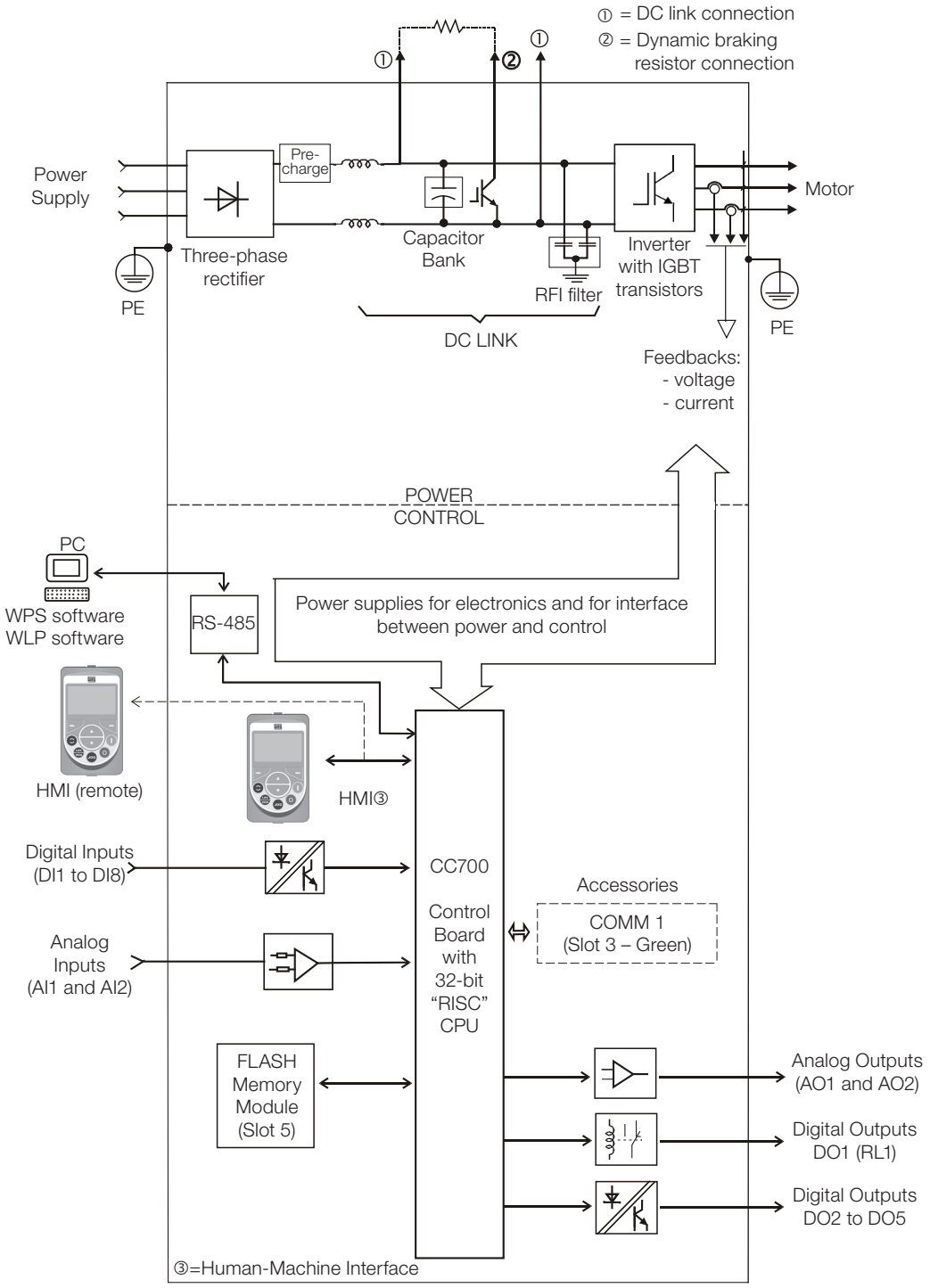
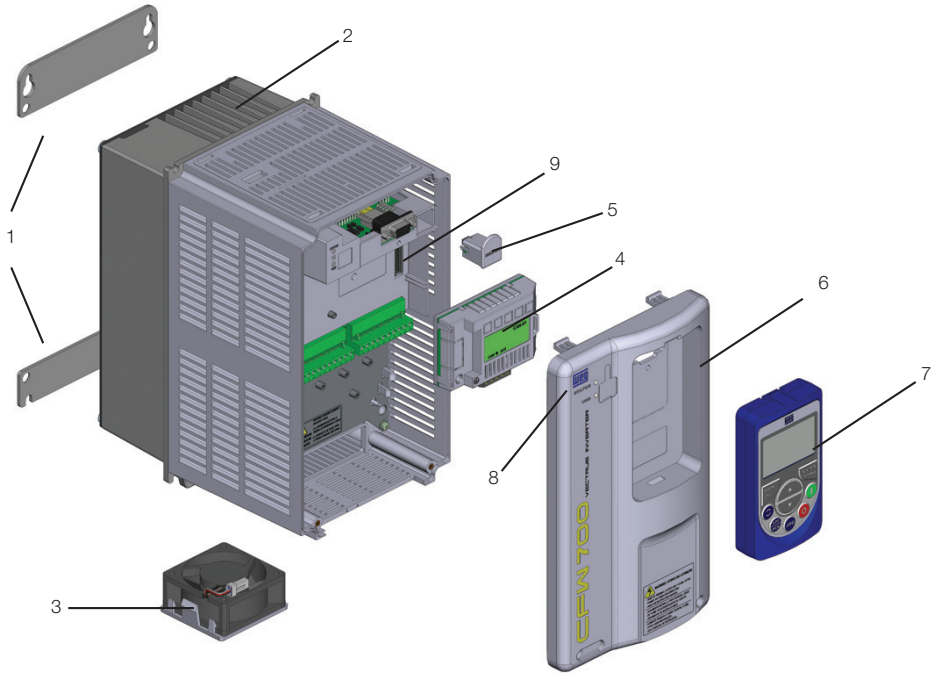
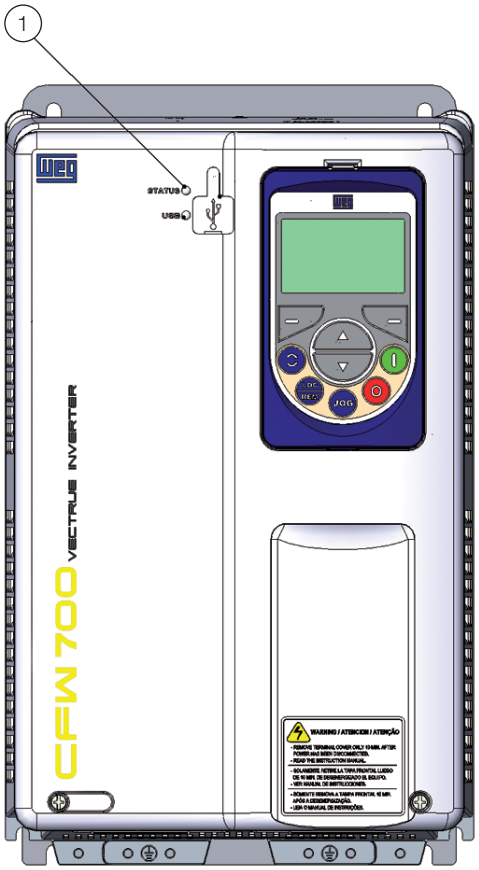


Figure 3.1: *CFW700 block diagram*



1 - Mounting supports (for surface mounting)
2 - Back side of the inverter (outside for flange mounting)
3 - Fan with fixing support
4 - Control accessory module (refer to section 7.2 - Accessories, of the CFW700 user's manual)
5 - FLASH memory module (not included)
6 - Front cover (sizes A, B and C)
7 - Keypad (HMI)
8 - Status LED (STATUS)
9 - CC700 control board

Figure 3.2: *CFW700 main components*



(1) Status LED
Green: Normal operation without fault or alarm
Yellow: In the alarm condition
Blinking red: In the fault condition

Figure 3.3: *LEDs*

4 KEYPAD (HMI)

The integral keypad can be used to operate and program (view / edit all parameters) of the CFW700 inverter. There are two operation modes in the keypad: monitoring and programming. The key functions and display indications of the keypad may change according to the operation mode. The programming mode consists of three levels.

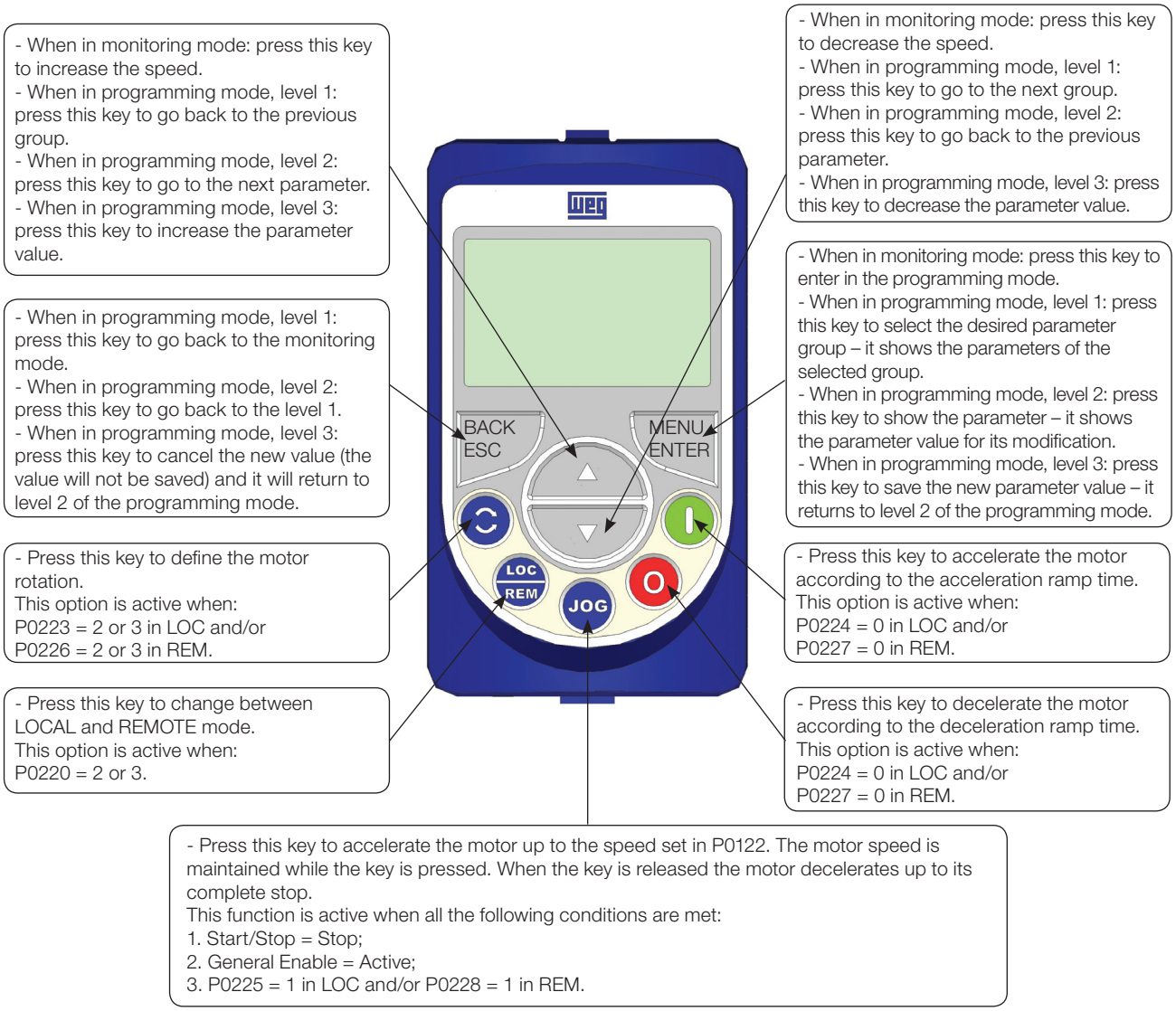


Figure 4.1: *HMI keys*

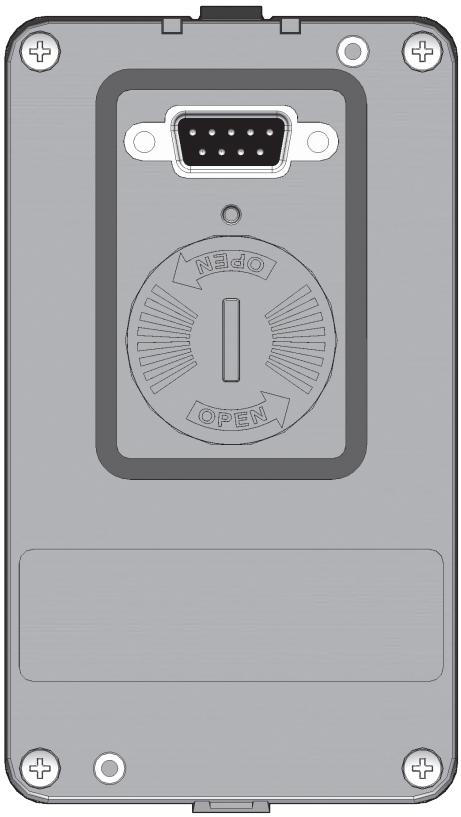


Figure 4.2: Back of the keypad (HMI)

Installation:

- The keypad (HMI) can be installed or removed with the inverter energized.

5 PROGRAMMING BASIC INSTRUCTIONS

5.1 PARAMETERS STRUCTURE

In order to make the programming of the inverter easier, the parameters of the CFW700 were divided into 10 groups that can be individually selected in the Menu area of the keypad. When the ENTER/MENU key is pressed on monitoring mode, the programming mode is set. In this mode, it is possible to select the desired group of parameters through the keys ▲ and ▼. Refer to the CFW700 user's manual for more details on the keypad keys programming. The parameter group structure is presented in the next item.

NOTE!
The inverter leaves the factory with frequency (V/f 50/60 Hz mode) and voltage adjusted according to the market.

The reset to the factory default may change the content of the parameters related to the frequency (50 Hz / 60 Hz). In the detailed description, some parameters present values in parentheses, which must be adjusted in the inverter for using the 50 Hz frequency.

5.2 GROUPS ACCESSED IN THE OPTION MENU IN THE MONITORING MODE

In the monitoring mode access the groups of the option “Menu” by pressing the ENTER/MENU “soft key”.

Table 5.1: *Parameter groups accessed in the option menu of the monitoring mode*

Group	Contained Parameters or Groups
PARAM	All the parameters.
READ	Parameters used only for reading.
MODIF	Only parameters whose contents are different from the factory settings.
BASIC	Parameters for simple applications: ramps, minimum and maximum speed, maximum current and torque boost. Presented in details in the CFW700 user’s manual at section 5.2.2 - Basic Application Menu.
MOTOR	Parameters related to the motor data control.
I/O	Groups related to digital and analog, inputs and outputs.
NET	Parameters related to the communication network.
HMI	Parameters for the keypad (HMI) configuration.
SPLC	Parameters related to the SoftPLC function.
STARTUP	Parameter for entering the “Oriented Start-up” mode.

5.3 PASSWORD SETTING IN P0000

In order to be able to change the content of the parameters, it is necessary to set correctly the password in P0000, as indicated below. Otherwise the content of the parameters can only be visualized.

It is possible to customize the password by means of P0200. Refer to the description of this parameter in the section 5.4 - HMI, of this manual.

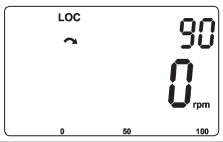
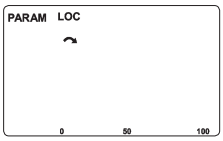
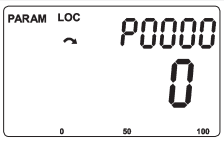
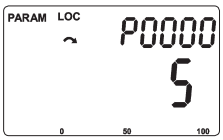
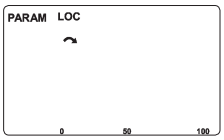
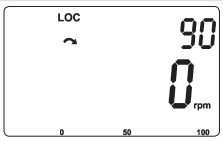
Seq.	Action/Result	Display Indication
1	- Monitoring mode. Press the ENTER/MENU key to enter into the 1° level of the programming mode.	
2	- The PARAM group is already available, press the ENTER/MENU key to access parameter P0000.	
3	- Press ENTER/MENU key again to access the parameter value.	
4	- Press the ▲ or ▼ keys to set the desired value.	
5	- Press ENTER/MENU key when the desired value is reached in order to confirm the modification.	
6	- Press the BACK/ESC key to go back to the 2° level of programming mode.	
7	- Press the BACK/ESC key in order to go back to the monitoring mode.	
8	- Monitoring mode.	

Figure 5.1: *Sequence for allowing parameter changes via P0000*

5.4 HMI

In the group “HMI” are the parameters related to the presentation of information on the keypad (HMI) display. See next the detailed description of the possible settings for those parameters.

P0200 – Password

Adjustable Range:	0 = Inactive 1 = Active 2 = Change Password	**Factory Setting:**	1
Properties:			
Access groups via HMI:	HMI		

Description:

It allows changing the password and/or setting its status, configuring it as active or inactive. For more details on each option, refer to the table 5.2 described next.

Table 5.2: *Options for the parameter P0200*

P0200	Kind of Action
0 (Inactive)	It allows parameter changes regardless of P0000.
1 (Active)	It does only allow parameter changes when the content of P0000 is equal to the password.
2 (Change Password)	It makes the value presented in P0000 the current password.

Follow the procedure below to change your password:

1. Enter the current password value (factory settings, P0000 = 5).
2. Set the password parameter to inactive (P0200 = 0).
3. Enter the new desired password value in P0000.
4. Set the password parameter to change password (P0200 = 2).
5. The setting is completed, the new password is active and P0200 is automatically set to 1 (Enables password).

P0205 – Main Display Parameter Selection

P0206 – Secondary Display Parameter Selection

P0207 – Bar Graph Parameter Selection

Adjustable Range:	0 to 1199	**Factory Setting:**	P0205=2 P0206=1 P0207=3
Properties:			
Access groups via HMI:	HMI		

Description:

These parameters define which parameters are displayed on the keypad in the monitoring mode.

More details on the programming can be seen in section 5.5 - Display Indications in the Monitoring Mode Settings.

P0208 – Main Display Scale Factor

P0211 – Secondary Display Scale Factor

Adjustable Range:	0.1 to 1000.0 %	**Factory Setting:**	100.0 %

P0210 – Main Display Decimal Point

P0212 – Secondary Display Decimal Point

Adjustable Range:	0 = wxyz 1 = wxy.z 2 = wx.yz 3 = w.xyz	**Factory Setting:**	0
Properties:			
Access groups via HMI:	HMI		

Description:

These parameters allow changing the range of the Main Display and the Secondary Display in order to convert motor variables such as speed (rpm) in production units such as meters/minutes or cubic feet/minutes for example.

P0209 – Main Display Engineering Unit

Adjustable Range:	0 = None 1 = V 2 = A 3 = rpm 4 = s 5 = ms 6 = N 7 = m 8 = Nm 9 = mA 10 = % 11 = ° C 12 = CV 13 = Hz 14 = HP 15 = h 16 = W 17 = kW 18 = kWh 19 = H	**Factory Setting:**	3
Properties:			
Access groups via HMI:	HMI		

Description:

This parameter selects the engineering unit to be presented in the main display. The content of this parameter is automatically adjusted to match the unit of the parameter selected by P0205 when its value is changed by the HMI.

P0213 – Bar Graph Full Scale

Adjustable Range:	1 to 65535	**Factory Setting:**	1
Properties:			
Access groups via HMI:	HMI		

Description:

This parameter sets the full scale of the Bar Graph parameter (selected by P0207).

P0216 – HMI Backlighting

Adjustable Range:	0 to 15	**Factory Setting:**	15
Properties:			
Access groups via HMI:	HMI		

Description:

It allows setting the keypad (HMI) display contrast level. Higher values configure a higher contrast level.

5.5 DISPLAY INDICATIONS IN THE MONITORING MODE SETTINGS

Every time the inverter is powered the display goes to the Monitoring Mode. To facilitate reading the parameters of the inverter, the display is designed to show three parameters at the same time according to the user's choice. Two of these parameters (Main Display and Secondary Display) are shown in numerical form and the other in a Bar Graph form. The selection of these parameters is done via P0205, P0206, P0207, as shown in figure 5.2.

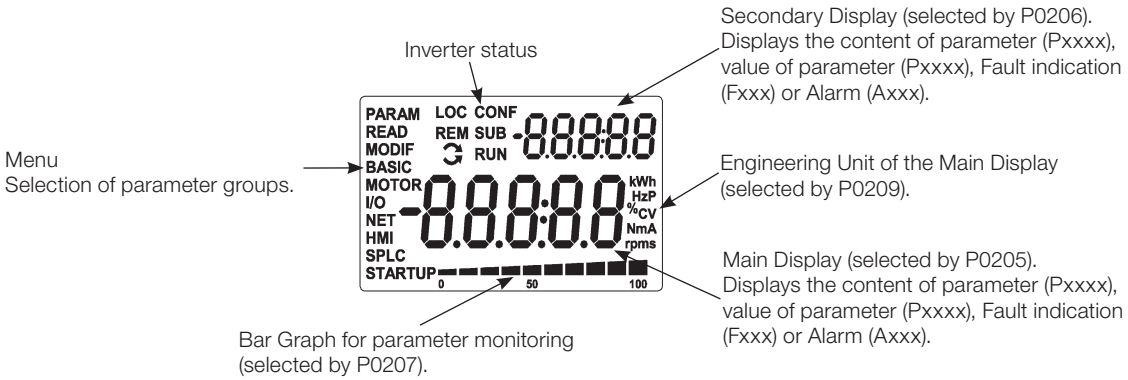


Figure 5.2: *Screen at startup and display indication*

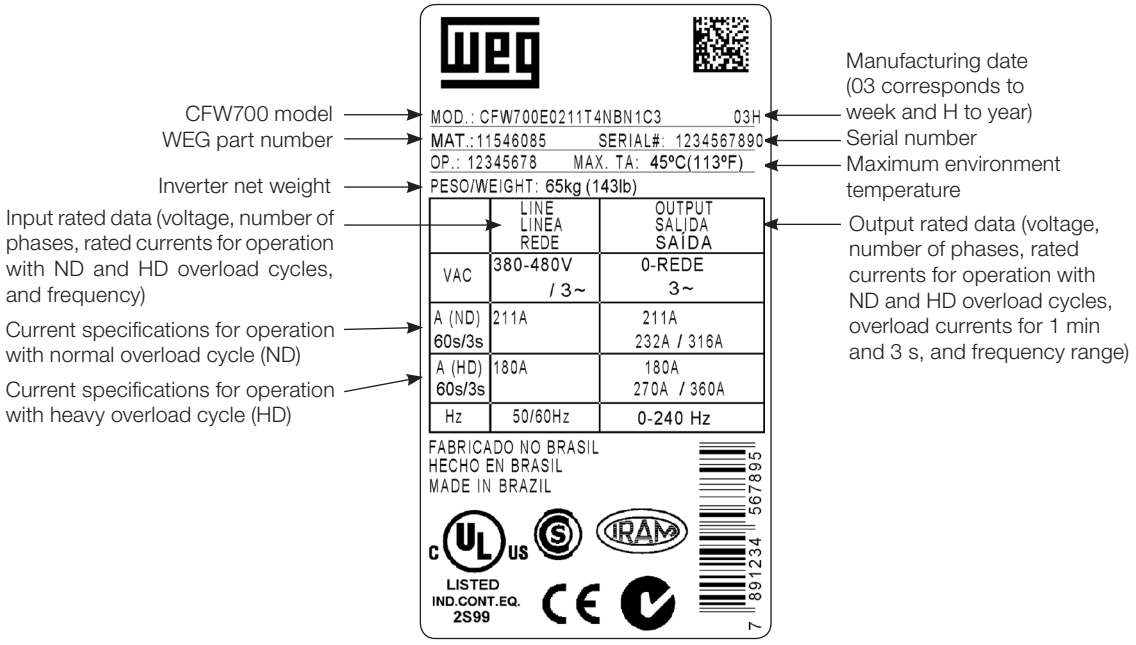
5.6 INCOMPATIBILITY BETWEEN PARAMETERS

If any of the combinations listed below occur, the CFW700 goes to the “Config” state.

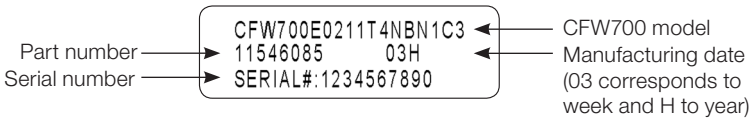
1. Two or more DIx (P0263...P0270) programmed for (8 = FWD/REV).
2. Two or more DIx (P0263 .... P0270) programmed for (9 = LOC/REM).
3. Two or more DIx (P0263 .... P0270) programmed for (14 = Ramp 2).
4. Two or more DIx (P0263 .... P0270) programmed for (15 = Speed/Torque).
5. Two or more DIx (P0263 .... P0270) programmed for (24 = Disable Flying Start).
6. Two or more DIx (P0263 .... P0270) programmed for (25 = DC Link Regulator).
7. Two or more DIx (P0263 .... P0270) programmed for (26 = Programming Off).
8. Two or more DIx (P0263 .... P0270) programmed for (27 = Load User 1).
9. Two or more DIx (P0263 .... P0270) programmed for (28 = Load User 2).
10. [P0202 programmed for (0=V/f 60 Hz) OR (1=V/f 50 Hz) OR (2=Adjustable V/f) OR (3=VVW)] AND [P0231=1 (No Ramp Ref.) OR P0231=2 (Max.Torque Cur) OR P0236=1 (No Ramp Ref.) OR P0236=2 (Max.Torque Cur) OR P0241=1 (No Ramp Ref.) OR P0241=2 (Max.Torque Cur) OR P0246=1 (No Ramp Ref.) OR P0246=2 (Max. Torque Cur)].
11. [P0202 programmed for (0=V/f 60 Hz) OR (1=V/f 50 Hz) OR (2=Adjustable V/f) OR (3=VVW)] AND [DIx (P0263... P0270) programmed for (16=JOG+) OR (17=JOG-).
12. [P0224 programmed for (1=DIx) OR P0227 programmed for (1=DIx)] AND [without DIx (P0263...P0270) programmed for (1=Run/Stop) AND without DIx (P0263...P0270) programmed for (2=General Enable) AND without DIx (P0263...P0270) programmed for (3=Fast Stop).

6 INVERTER MODEL AND ACCESSORIES IDENTIFICATION

In order to identify the model of the inverter, verify the code existent on the product identification labels: the complete one, located at the side of the inverter, or the abbreviated one, under the keypad (HMI). The figures below show examples of those labels.



(a) Nameplate affixed to the side of the inverter



(b) Nameplate located under the keypad

Figure 6.1 (a) and (b): *Nameplates*

Once the inverter model identification code is verified, one must interpret it in order to understand its meaning. Refer to the section 2.3 - Identification, of the CFW700 user's manual.

6.1 INVERTER DATA

In this group are the parameters related to the inverter information and characteristics, such as inverter model, accessories identified by the control circuit, software version, switching frequency, etc.

P0023 – Software Version

Adjustable Range:	0.00 to 655.35	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

It indicates the software version contained in the FLASH memory of the microcontroller located on the control board.

P0028 – Accessories Configuration

Adjustable Range:	0000h to FFFFh	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

Those parameters identify by means of a hexadecimal code the accessories that were found installed on the control module.

The next table shows the codes shown in those parameters, regarding the main CFW700 accessories.

Table 6.1: *CFW700 accessory identification codes*

Name	Description	Identification Code
		P0028
RS-485-01	RS-485 serial communication module.	CE--
RS-232-02	RS-232C serial communication module with keys for programming the microcontroller FLASH memory.	CC--
CAN/RS-485-01	CAN and RS-485 interface module.	CA--
CAN-01	CAN interface module.	CD--
MMF-01	FLASH Memory Module.	----(1)

For the FLASH memory module, the P0028 identification code will depend on the combination of these accessories, as presented in the next table.

Table 6.2: *Formation of the two first codes for P0028 parameter*

Bits							
7	6	5	4	3	2	1	0
∅	FLASH Memory Module	∅		0	0	0	0
2nd Hexadecimal Code				1st Hexadecimal Code			

(1) Bit 6: indicates the presence of the FLASH memory module (0=without memory module, 1=with memory module).

P0029 – Power Hardware Configuration

Adjustable Range:	Bit 0 to 5 = Rated Current Bit 6 and 7 = Rated Voltage Bit 8 = EMC Filter Bit 9 = Safety Relay Bit 10 = (0)24V/(1)DC Link Bit 11 = (0)RST/(1)DC Link Bit 12 = Dyn.Brak. IGBT Bit 13 = Special Bit 14 and 15 = Reserved	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

In a similar way than parameters P0028, the parameter P0029 identifies the inverter model and the present accessories.

The codification is formed by the combination of binary digits, and presented in the keypad (HMI) in hexadecimal format.

The bits that compose the code are explained in the next table.

Table 6.3: *Parameter P0029 code constitution*

Bits															
15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
1	1	0	with braking IGBT	0	with 24 V supply	with safety relay	with RFI filter	Voltage 00=200…240 V 01=380…480 V		Current					
4th Hexadecimal Code				3rd Hexadecimal Code				2nd Hexadecimal Code				1st Hexadecimal Code			

Bits 15, 14 and 13: are fixed in 110.

Bit 12: it indicates the presence of the dynamic braking IGBT (0 = with braking IGBT, 1 = without braking IGBT).

Bit 11: always 0.

Bit 10: indicates if the inverter has the DC/DC converter for receiving external 24 V electronics power supply (0=with DC/DC converter, 1=without DC/DC 24 V converter).

Bit 9: indicates the presence of the safety relay (0=without safety relay, 1=with safety relay).

Bit 8: indicates if the inverter is equipped with RFI suppressor filter (0=without RFI filter, 1=with RFI filter).

Bits 7 and 6: indicate the inverter power supply voltage (00=200...240 V, 01=380…480 V).

Bits 5, 4, 3, 2, 1 and 0: together with the voltage indication bits (7 and 6), they indicate the inverter rated current (ND). The next table presents the combinations available for those bits.

Table 6.4: *Current codification for the parameter P0029*

200 V...240 V

7	6	5	4	3	2	1	0	
0	0	0	0	0	0	0	0	2 A*
		0	0	0	0	0	1	6 A*
		0	0	0	0	1	0	7 A*
		0	0	0	0	1	1	10 A*
		0	0	0	1	0	0	7 A
		0	0	0	1	0	1	10 A
		0	0	0	1	1	0	13 A
		0	0	0	1	1	1	16 A
		0	0	1	0	0	0	24 A
		0	0	1	0	0	1	28 A
		0	0	1	0	1	0	33.5 A
		0	0	1	1	0	0	45 A
		0	0	1	1	0	1	54 A
		0	0	1	1	1	0	70 A
		0	1	0	0	0	0	86 A
		0	1	0	0	0	1	105 A
		0	1	0	0	1	0	180 A
		0	1	0	0	1	1	211 A
		0	1	0	1	0	0	142 A

380 V...480 V

7	6	5	4	3	2	1	0	
0	1	0	0	0	0	0	0	3.6 A
		0	0	0	0	0	1	5 A
		0	0	0	0	1	0	7 A
		0	0	0	1	0	0	10 A
		0	0	0	1	0	1	13.5 A
		0	0	1	0	0	0	17 A
		0	0	0	1	1	0	24 A
		0	0	0	1	1	1	31 A
		0	0	0	0	1	1	38 A
		0	0	1	0	1	0	45 A
		0	0	1	0	1	1	58.5 A
		0	0	1	1	0	0	70.5 A
		0	0	1	1	0	1	88 A
		0	1	0	0	0	0	105 A
		0	1	0	0	0	1	142 A
		0	1	0	0	1	0	180 A
		0	1	0	0	1	1	211 A

*** Models with single-phase/three-phase power supply.**

Example: For a 10 A, 380...480 V CFW700, with RFI suppressor filter, without safety relay and without external 24 V supply, the hexadecimal code presented in the keypad (HMI) for the parameter P0029 is C544 (refer to the table 6.5).

Table 6.5: *Example of the code at P0029 for a specific inverter model*

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	0	0	0	1	0	1	0	1	0	0	0	1	0	0
C				5				4				4			

P0295- ND/HD VFD Rated Current

Adjustable Range:	0 = 2 A / 2 A 1 = 3.6 A /3.6 A 2 = 5 A / 5 A 3 = 6 A / 5 A 4 = 7 A / 5.5 A 5 = 7 A / 7 A 6 = 10 A / 8 A 7 = 10 A / 10 A 8 = 13 A / 11 A 9 = 13.5 A / 11 A 10 = 16 A / 13 A 11 = 17 A / 13.5 A 12 = 24 A / 19 A 13 = 24 A / 20 A 14 = 28 A / 24 A 15 = 31 A / 25 A 16 = 33.5 A / 28 A 17 = 38 A / 33 A 18 = 45 A / 36 A 19 = 45 A / 38 A 20 = 54 A / 45 A 21 = 58.5 A / 47 A 22 = 70 A / 56 A 23 = 70.5 A / 61 A 24 = 86 A / 70 A 25 = 88 A / 73 A 26 = 105 A / 86 A 27= 105 A / 88 A 28= 142 A / 115 A 29= 180 A / 142 A 30= 211 A / 180 A	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

This parameter presents the inverter rated current for the normal overload regimen (ND) and for the heavy overload regimen (HD). The inverter operation mode, if it is ND or HD, is defined by the content of P0298.

P0296 – Line Rated Voltage

Adjustable Range:	0 = 200 - 240 V 1 = 380 V 2 = 400 - 415 V 3 = 440 - 460 V 4 = 480 V	**Factory Setting:**	According to the inverter model
Properties:	cfg		
Access groups via HMI:			

Description:

Setting according to the inverter power supply voltage.

The adjustable range depends on the inverter model, according to the table 6.6, which also presents the factory default value.

NOTE!
When adjusted via the keypad (HMI), this parameter may change automatically the following parameters: P0151, P0153, P0185, P0321, P0322 and P0323.

Table 6.6: *P0296 setting according to the CFW700 inverter model*

Inverter Model	Adjustable Range	Factory Setting
200-240 V	0 = 200 ... 240 V	0
380-480 V	1 = 380 V 2 = 400 / 415 V 3 = 440 / 460 V 4 = 480 V	3

P0297 – Switching Frequency

Adjustable Range:	0 = 1.25 kHz 1 = 2.5 kHz 2 = 5.0 kHz 3 = 10.0 kHz	**Factory Setting:**	2
Properties:	cfg		
Access groups via HMI:			

Description:

Refer to the allowed current for switching frequencies different from the default, in the tables available in chapter 8 - Technical Specifications, of the CFW700 user's manual.

The inverter switching frequency can be adjusted according to the needs of the application. Higher switching frequencies imply in lower motor acoustic noise, however, the selection of the switching frequency results in a compromise between the motor acoustic noises, the losses in the inverter IGBTs and the maximum allowed currents.

The reduction of the switching frequency reduces effects related to motor instability, which occur in specific application conditions. It also reduces the earth leakage current, being able to avoid the actuation of the faults F074 (Ground Fault) or F070 (Output Overcurrent/Short-circuit).

Note: The option 0 (1.25 kHz) is only allowed for the V/f or VVW control (P0202=0, 1, 2 or 3).

P0298 - Application

Adjustable Range:	0 = Normal Duty (ND) 1 = Heavy Duty (HD)	**Factory Setting:**	0
Properties:	cfg		
Access groups via HMI:			

Description:

Set the content of this parameter according to the application.

The **Normal Duty Regimen (ND)** defines the maximum current for continuous operation (I_{nom-ND}) and an **overload of 110 % during 1 minute**. It must be used for driving motors that are not subject in that application to high torques in relation to their rated torque, when operating in permanent regimen, during start, acceleration or deceleration.

The **Heavy Duty Regimen (HD)** defines the maximum current for continuous operation (I_{nom-HD}) and an **overload of 150 % during 1 minute.** It must be used for driving motors that are subject in that application to high overload torques in relation to their rated torque, when operating in constant speed, during start, acceleration or deceleration.

The I_{nom-ND} and I_{nom-HD} are presented in P0295. Refer to the CFW700 user's manual chapter 8 - Technical Specifications, for more details regarding these operation regimens.

7 STARTING-UP AND SETTINGS

In order to start-up in the several types of controls, beginning from the factory settings, consult the following sections:

- 9.5 - Start-up in the V/f Control Mode.
- 10.3 - VVW Control Mode Start-up.
- 11.9 - Start-up in the Vector Modes Sensorless and with Encoder.

In order to use previously loaded parameters, refer to the section 7.1 - Backup Parameters, described next.

7.1 BACKUP PARAMETERS

The CFW700 BACKUP functions allow saving the content of the current inverter parameters in a specific memory, or vice-versa (overwrite the contents of the current parameters with the memory contents). Besides, there is a function exclusive for software update, by means of the FLASH Memory Module.

P0204 – Load/Save Parameters

Adjustable Range:	0 = Not Used 1 = Not Used 2 = Reset P0045 3 = Reset P0043 4 = Reset P0044 5 = Load 60 Hz 6 = Load 50 Hz 7 = Load User 1 8 = Load User 2 9 = Save User 1 10 = Save User 2	**Factory Setting:**	0
Properties:	cfg		
Access groups via HMI:			

Description:

It makes it possible to save the actual inverter parameters in an area of the control module memory or the other way around, to load the contents of that area into the parameters. It also allows resetting the Time Enabled (P0043), kWh (P0044) and Fan Enabled Time (P0045) counters. The table 7.1 describes the actions performed by each option.

Table 7.1: *Parameter P0204 options*

P0204	Action
0, 1	**Not Used:** no action.
2	**Reset P0045:** resets the enabled fan hour counter.
3	**Reset P0043:** resets the enabled hours counter.
4	**Reset P0044:** resets the kWh counter.
5	**Load 60 Hz:** loads the 60 Hz factory settings into the inverter parameters.
6	**Load 50 Hz:** loads the 50 Hz factory settings into the inverter parameters.
7	**Load User 1:** loads the User 1 parameters into the current inverter parameters.
8	**Load User 2:** loads the User 2 parameters into the current inverter parameters.
9	**Save User 1:** saves the current inverter parameters into the User 1 parameter memory.
10	**Save User 2:** saves the current inverter parameters into the User 2 parameter memory.

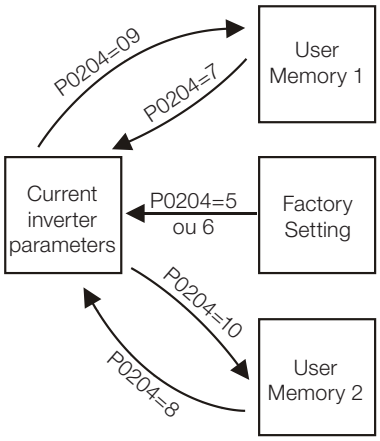


Figure 7.1: *Parameter transfer*

In order to load parameters from User 1 and/or User 2 to the CFW700 operation area (P0204=7 or 8), it is necessary that these areas had been saved previously.

The operation of loading one of those memories can also be performed via digital inputs (DIx). Refer to item 13.1.3 - Digital Inputs, for more details regarding this programming (P0204=9 or 10).

NOTE!
When P0204=5 or 6, the parameters P0296 (Rated voltage), P0297 (Switching frequency), P0308 (Serial address) are not changed by the factory settings.

P0318 – Copy Function MMF

Adjustable Range:	0 = Off 1 = VFD → MMF 2 = MMF → VFD 3 = VFD Synchronization → MMF 4 = MMF Format 5 = SoftPLC Program Copy	**Factory Setting:**	0
Properties:	cfg		
Access groups via HMI:			

Description:

This function allows saving the contents of the inverter writing parameters in the FLASH Memory Module (MMF), or vice-versa, and can be used to transfer the contents of the parameters from one inverter to another.

Table 7.2: *Parameter P0318 options*

P0318	Action
0	Inactive: no action.
1	Inverter → MMF: transfers the inverter current parameters contents to the MMF.
2	MMF → Inverter: transfers the contents of the parameters stored in the MMF to the inverter control board.
3	Updates the MMF automatically whenever any parameter of the CFW700 is changed.
4	Format the MMF.
5	Copy the SoftPLC program from the MMF to the CFW700.

After storing the parameters of one inverter in a FLASH memory module, it is possible to pass them to another inverter with this function.

NOTE!
During the inverter operation, the modified parameters are saved in the FLASH memory module regardless of user's command, when P0318 = 3. This assures that the MMF will always have an updated copy of the inverter parameters.

NOTE!
When the inverter is powered on and the memory module is present, the current values of its parameters is overridden if P0318 = 3. If you want to copy from another inverter, set P0318 to 0 before inserting the card.

NOTE!
When the inverter is powered on and the memory module is not detected, P0318 is not visible or changeable by the user and it is automatically set to 0.

8 AVAILABLE CONTROL TYPES

The inverter feeds the motor with variable voltage, current and frequency, by means of whose the control of the motor speed is obtained. The values applied to the motor follow a control strategy, which depends on the selected type of control and on the inverter parameter settings.

Choose the control type in function of the static and dynamic, torque and speed requirements of the driven load.

Control modes and their main characteristics:

- **V/f:** scalar control; it is the simplest control mode, by imposed voltage/frequency; with an open loop speed regulation or with slip compensation (programmable); it allows multimotor operation.
- **VVW:** Voltage Vector WEG; it allows a static speed control more accurate than the V/f mode; it adjusts itself automatically to the line variations, and also to the load variations, however it does not present fast dynamic response.
- **Sensorless Vector:** it is a field oriented control; without motor speed sensor; able to drive any standard motor; speed control range of 1:100; speed control static precision of 0.5 % of the rated speed; high control dynamics.
- **Vector with Encoder:** it is a field oriented control; it needs motor encoder; speed control down to 0 rpm; speed control static precision of 0.01 % of the rated speed; high static and dynamic performance of the speed and torque control.

All these control modes are described in details in the chapters 9 - Scalar Control (V/f), 10 - VVW Control and 11 - Vector Control, the related parameters and orientations regarding the use of each of these modes.

9 SCALAR CONTROL (V/f)

It consists of a simple control based on a curve that links output voltage and frequency. The inverter operates as a voltage source, generating frequency and voltage values according to that curve. It is possible to adjust this curve to standard 50 Hz or 60 Hz motors or to special ones through the adjustable V/f curve. Refer to the block diagram at the figure 9.1.

The advantage of the V/f control is that due to its simplicity just a few settings are necessary. The start-up is fast and simple, and the factory settings require generally few or no modifications.

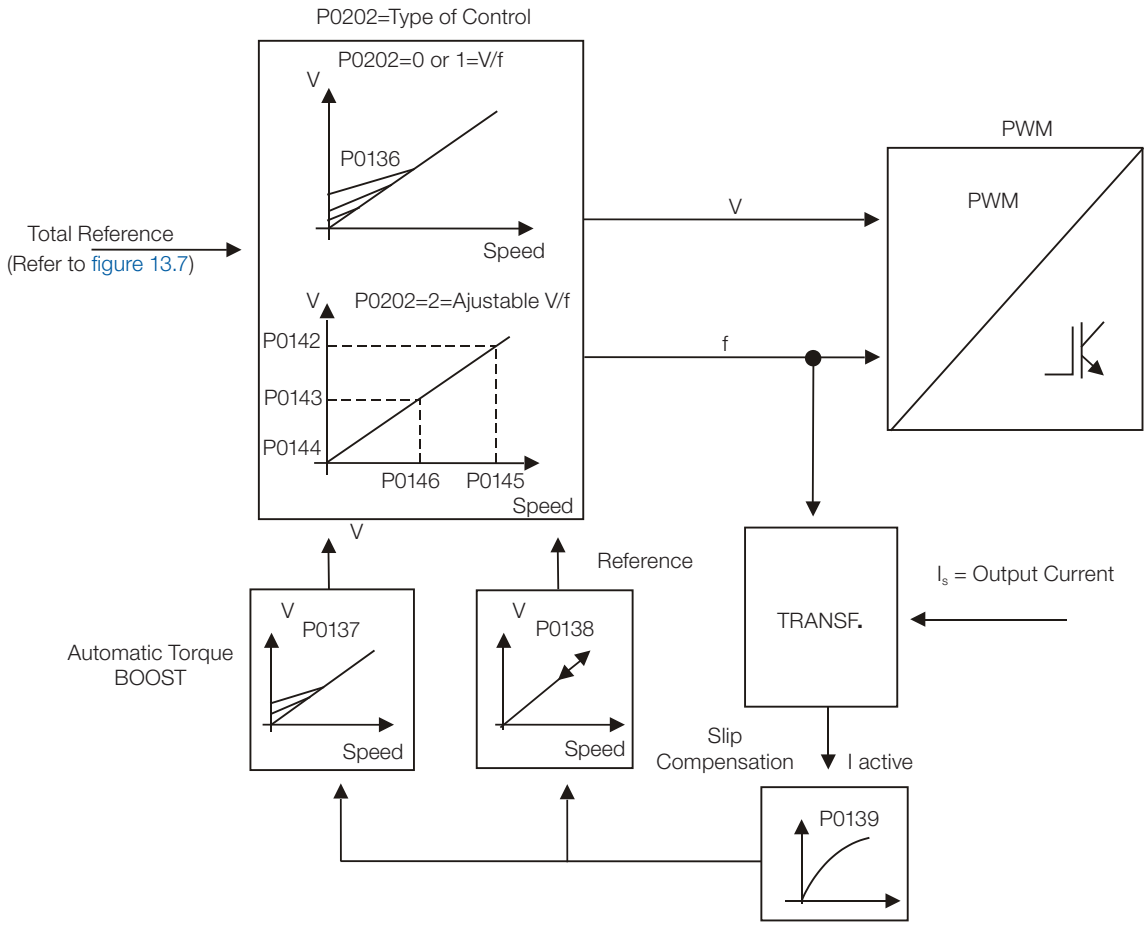


Figure 9.1: *V/f control block diagram*

The V/f or scalar control is recommended for the following cases:

- Operation of several motors with the same inverter (multimotor operation).
- The motor rated current is less than 1/3 of the inverter rated current.
- The inverter is, for test purposes, enabled without motor or with a small motor and no load.

The scalar control can also be used in applications that do neither require fast dynamic response, nor accuracy in the speed regulation, and also do not require high starting torque (the speed error is a function of the motor slip, and by programming the parameter P0138 – Slip Compensation – it is possible to get a accuracy of approximately 1 % at the rated speed with the load variation).

9.1 V/f CONTROL

P0136 - Manual Torque Boost

Adjustable Range:	0 to 9	**Factory Setting:**	1
Properties:	V/f		
Access groups via HMI:	BASIC		

Description:

It acts at low speeds, increasing the inverter output voltage in order to compensate the voltage drop across the motor stator resistance, with the purpose of keeping the torque constant.

The optimum setting is the lowest value of P0136 that allows a satisfactory starting of the motor. Values higher than the necessary will increase the motor current at low speeds, being able to lead the inverter to a fault (F048, F051, F071, F072, F078 or F183) or alarm (A046, A047, A050 or A110) condition.

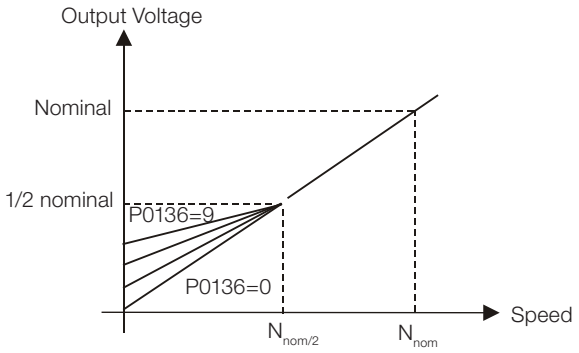


Figure 9.2: *Effect of P0136 on the V/f curve (P0202=0 or 1)*

P0137 – Automatic Torque Boost

Adjustable Range:	0.00 to 1.00	**Factory Setting:**	0.00
Properties:	V/f		
Access groups via HMI:			

Description:
The Automatic Torque Boost compensates the voltage drop on the stator resistance in function of the motor active current.

The criteria for adjusting P0137 are the same as for the parameter P0136.

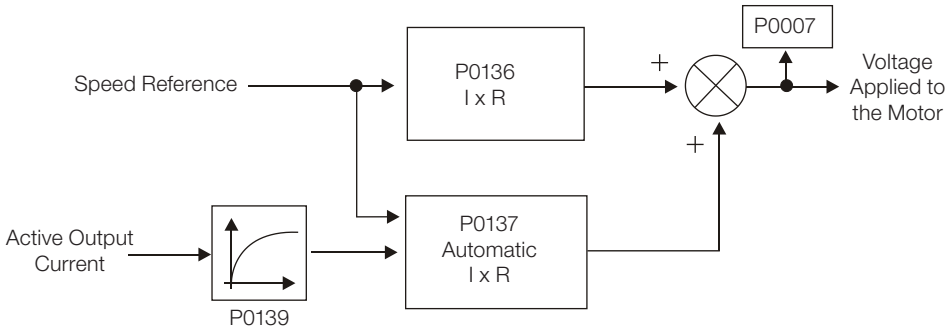


Figure 9.3: *Torque Boost block diagram*

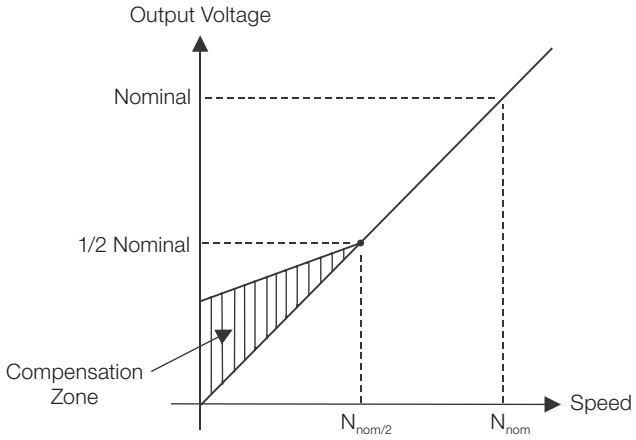


Figure 9.4: *Effect of P0137 on the V/f curve (P0202=0…2)*

P0138 – Slip Compensation

Adjustable Range:	-10.0 to +10.0 %	**Factory Setting:**	0.0 %
Properties:	V/f		
Access groups via HMI:			

Description:
The parameter P0138 is used in the motor slip compensation function, when adjusted to positive values. In this case it compensates the drop in the speed due to the application of load to the motor shaft. It increases the output frequency in function of the increase in the motor active current.

The setting of P0138 allows regulating the slip compensation precisely. Once P0138 is adjusted the inverter will keep the speed constant even with load variations by adjusting the voltage and frequency automatically.

Negative values are used in special applications where one wants to reduce the output speed in function of the increase in the motor current.

E.g.: Load distribution in motors operated in parallel.

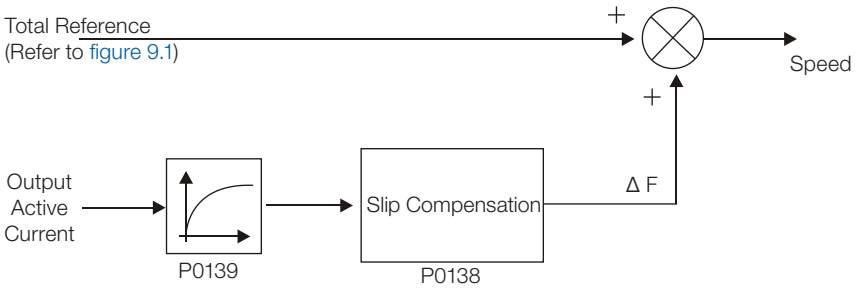


Figure 9.5: *Slip compensation block diagram*

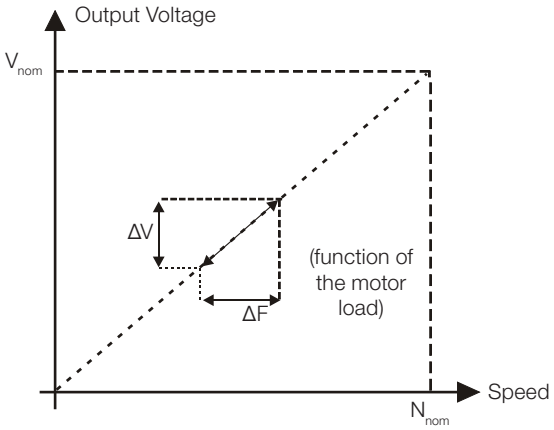


Figure 9.6: *V/f curve with slip compensation*

For the adjustment of the parameter P0138 to compensate the motor slip:

1. Run the motor with no load at approximately half the working speed.
2. Measure the motor or equipment speed with a tachometer.
3. Apply rated load to the equipment.
4. Increase the content of P0138 until the speed reaches the value measured before with no load.

P0139 – Output (Active) Current Filter

Adjustable Range:	0.0 to 16.0 s	**Factory Setting:**	0.2 s
Properties:	V/f and VVW		
Access groups via HMI:			

Description:
It sets the active current filter time constant.

It is used in the Automatic Torque Boost and Slip Compensation functions. Refer to the figures 9.3 and 9.5.

It sets the response time of the Slip Compensation and of the Automatic Torque Boost. Refer to the figures 9.3 and 9.5.

P0202 – Control Type

Adjustable Range:	0=V/f 60 Hz 1=V/f 50 Hz 2=V/f Adjustable 3=VVW (Voltage Vector WEG) 4=Sensorless 5=Encoder	**Factory Setting:**	0
Properties:	cfg		
Access groups via HMI:			

Description:

In order to get an overview of the control types, as well as orientation to choose the most suitable type for the application, refer to the chapter 8 - Available Control Types.

For the V/f mode, select P0202=0, 1 or 2:

Parameter P0202 setting for the V/f mode:

- P0202=0 for motors with rated frequency=60 Hz.
- P0202=1 for motors with rated frequency=50 Hz.

Notes:

- The correct setting of P0400 assures the application of the correct V/f ratio at the output, in case of 50 Hz or 60 Hz motors with voltage different from the inverter input voltage.
- P0202=2: for special motors with rated frequency different from 50 Hz or 60 Hz, or for the adjustment of special V/f curve profiles. Example: the approximation of a quadratic V/f curve for energy saving in variable torque loads like centrifuge pumps and fans.

9.2 ADJUSTABLE V/f CURVE

P0142 – Maximum Output Voltage

P0143 – Intermediate Output Voltage

P0144 – 3 Hz Output Voltage

Adjustable Range:	0.0 to 100.0 %	**Factory Setting:**	P0142 = 100.0 % P0143 = 50.0 % P0144 = 8.0 %

P0145 – Field Weakening Speed

P0146 – Intermediate Speed

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**	P0145 = 1800 rpm P0146 = 900 rpm
Properties:	Adj and cfg		
Access groups via HMI:			

Description:

This function allows the adjustment of the curve that links output voltage and frequency by means of parameters, as presented by the figure 9.7, in V/f mode.

It is necessary when the used motor has a rated frequency different from 50 Hz or 60 Hz, or when a quadratic V/f curve, for energy saving in the operation of centrifuge pumps and fans, is desired, or even in special applications, such as, for instance, when a transformer is used at the inverter output, between it and the motor.

The function is activated with P0202=2 (Adjustable V/f).

The factory setting of P0144 (8.0 %) is adequate for standard motors with rated frequency of 60 Hz. When using a motor with rated frequency (adjusted in P0403) different from 60 Hz, the default value for P0144 may become inadequate, being able to cause difficulties in the motor starting. A good approximation for the setting of P0144 is given by the formula:

$$P0144 = \frac{3}{P0403} \times P0142$$

If it is necessary to increase the starting torque, increase gradually the value of P0144.

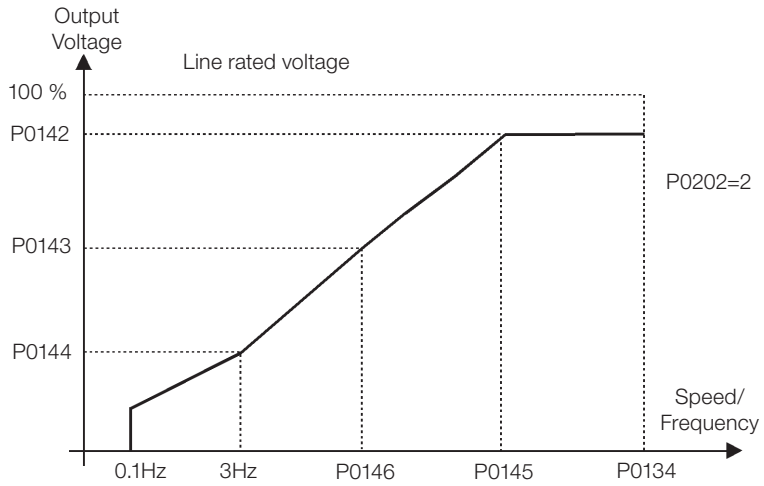


Figure 9.7: *V/f curve in function of P0142 to P0146*

9.3 V/f CURRENT LIMITATION

P0135 – Maximum Output Current

Adjustable Range:	0.2 to 2xI$_{nom-HD}$	**Factory Setting:**	1.5xI$_{nom-HD}$
Properties:	V/f and VVW		
Access groups via HMI:	BASIC		

P0344 – Current Limitation Configuration

Adjustable Range:	0=Hold - FL ON 1=Decel. - FL ON 2=Hold - FL OFF 3=Decel. - FL OFF	**Factory Setting:**	1
Properties:	V/f, cfg and VVW		
Access groups via HMI:			

Description:

It is the current limitation for the V/f control with actuation mode defined by P0344 (refer to the table 9.1) and the current limit defined by P0135.

Table 9.1: *Current limitation configuration*

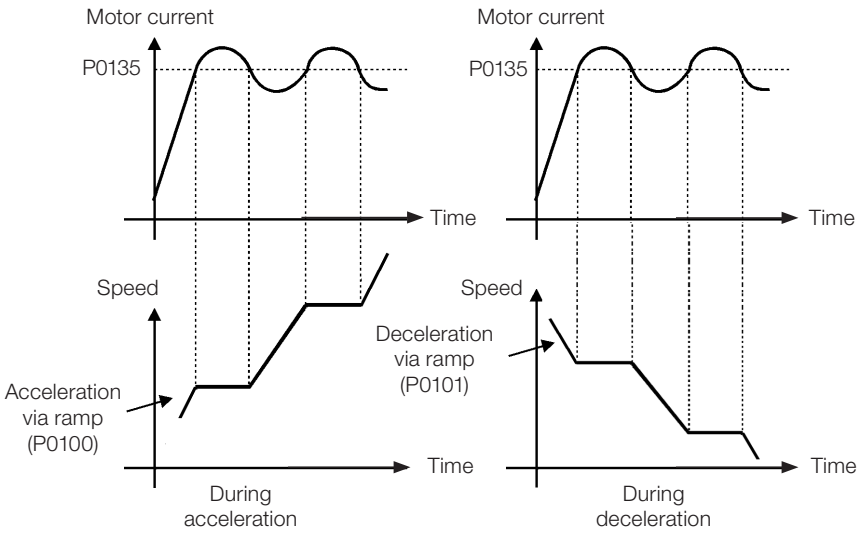
P0344	Function	Description
0 = Hold - FL ON	Current limitation of the “Ramp Hold” type. Active fast current limitation.	Current limitation according to the figure 9.8 **(a)**. Fast current limitation at the value 1.9xI$_{nom-HD}$ active.
1 = Decel. - FL ON	Current limitation of the “Ramp Deceleration” type. Active fast current limitation.	Current limitation according to the figure 9.8 **(b)**. Fast current limitation at the value 1.9 xI$_{nom-HD}$ active.
2 = Hold - FL OFF	Current limitation of the “Ramp Hold” type. Inactive fast current limitation.	Current limitation according to the figure 9.8 **(a)**.
3 = Decel. - FL OFF	Current limitation of the “Ramp Deceleration” type. Inactive fast current limitation.	Current limitation according to the figure 9.8 **(b)**.

Current limitation of the “Ramp Hold” type:

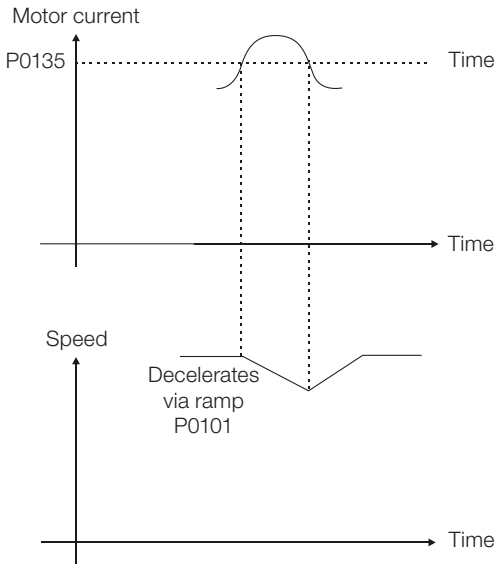
- It avoids the stalling of the motor during a torque overload at the acceleration or at the deceleration.
- Working: if the motor current exceeds the value adjusted in P0135 during the acceleration or the deceleration, the speed will no longer be increased (acceleration) or decreased (deceleration). When the motor current reaches a value below P0135 the motor will again accelerate or decelerate. Refer to the figure 9.8 **(a)**.
- It acts faster than the “Ramp Deceleration” mode.
- It acts in the motorization and braking modes.

Current limitation of the “Ramp Deceleration” type:

- It avoids the stalling of the motor during a torque overload at the acceleration or at constant speed.
- Working: if the motor current exceeds the value adjusted in P0135, the input of the speed ramp is set to zero forcing a deceleration. When the motor current reaches a value below P0135 the motor will accelerate again. Refer to the figure 9.8 **(b)**.



(a) "Ramp Hold"



(b) "Ramp Deceleration"

Figure 9.8 (a) and (b): *Current limitation via P0135 working modes*

9.4 V/f DC VOLTAGE LIMITATION

There are two functions in the inverter for limiting the DC link voltage during the motor braking. They act limiting the braking torque and power, avoiding therefore the tripping of the inverter by overvoltage (F022).

The overvoltage on the DC link is more common when a load with high inertia is driven or when a short deceleration time is programmed.

NOTE!
When using the dynamic braking the function “Ramp Hold” or “Ramp Acceleration” must be disabled. Refer to the P0151 description.

In the V/f mode, there are two types of function to limit the DC link voltage:

1 - “Ramp Hold”:

It is effective only during the deceleration.

Working: When the DC link voltage reaches the level adjusted in P0151, a command is sent to the “ramp” block, which inhibits the motor speed variation (“ramp hold”). Refer to the figures 9.9 and 9.10.

With this function an optimized deceleration time (minimum possible) for the driven load is obtained.

The use is recommended for loads running with high inertia moment referenced to the motor shaft, or loads with medium inertia, which require short deceleration ramps.

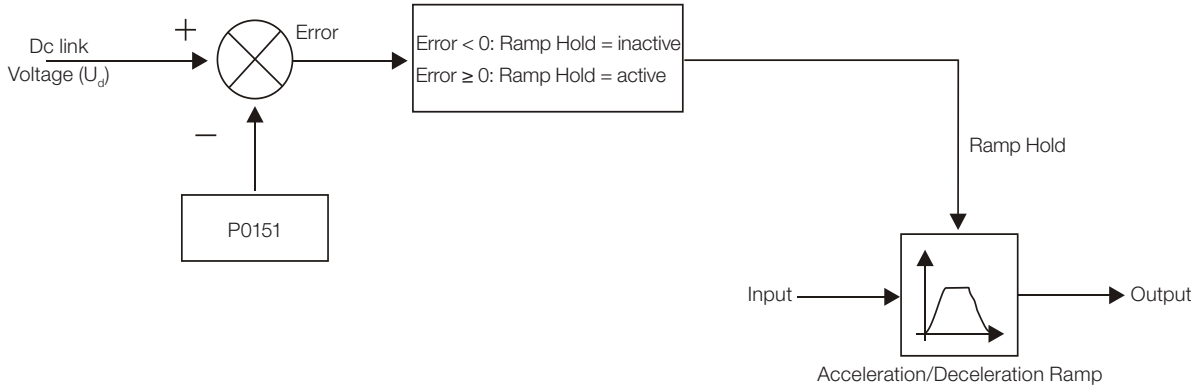


Figure 9.9: *Limitation of the DC link voltage using Ramp Acceleration function block diagram*

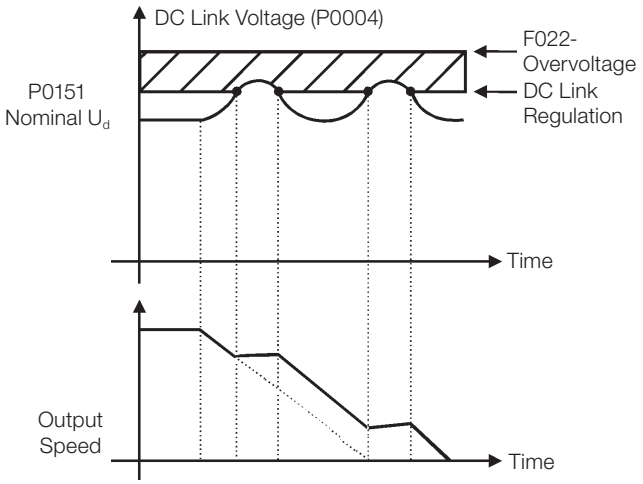


Figure 9.10: *Example of the DC link voltage limitation working with the Ramp Hold function*

2 - Ramp Acceleration:

It is effective in any situation, regardless of the motor speed condition, accelerating, decelerating or at constant speed.

Working: the DC link voltage is compared with the value adjusted in P0151, the difference between these signals is multiplied by the proportional gain (P0152) and the result is added to the ramp output. Refer to the figures 9.11 and 9.12.

In a similar manner as the Ramp Hold, with this function an optimized deceleration time (minimum possible) for the driven load is also obtained.

The use is recommended for loads that require braking torques in constant speed situation. Example: driving of loads with eccentric shafts such as the existent in pumpjacks.

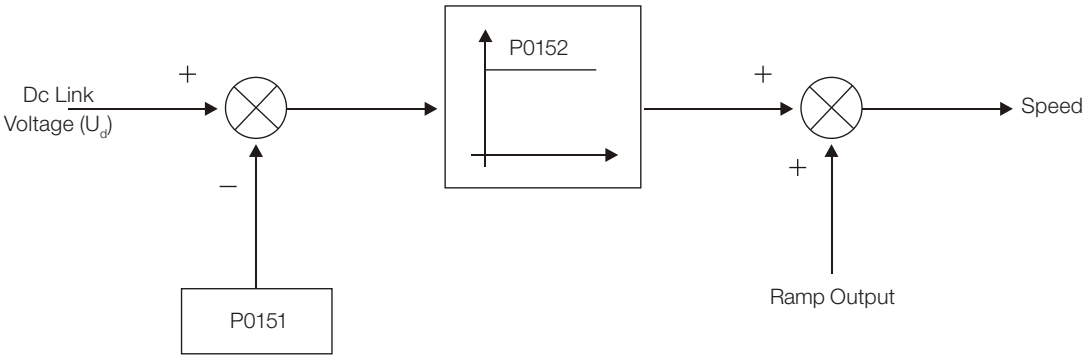


Figure 9.11: *Limitation of the DC link voltage using Ramp Acceleration function block diagram*

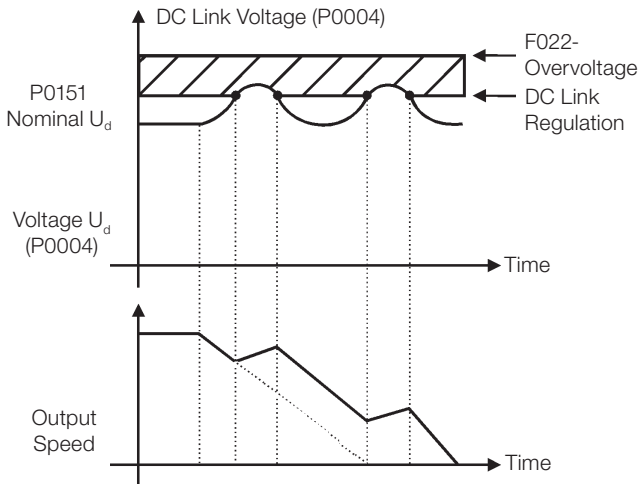


Figure 9.12: *Example of the DC link voltage limitation working with the Ramp Acceleration function*

P0150 – V/f DC Regulation Type

Adjustable Range:	0 = Ramp Hold 1 = Ramp Acceleration	**Factory Setting:**	0
Properties:	V/f, VVW and cfg		
Access groups via HMI:			

Description:

It selects the DC link voltage limitation function type in the V/f mode.

P0151 – V/f DC Regulation Level

Adjustable Range:	339 to 400 V 585 to 800 V 585 to 800 V 585 to 800 V 585 to 800 V	**Factory Setting:**	400 V (P0296 = 0) 800 V (P0296 = 1) 800 V (P0296 = 2) 800 V (P0296 = 3) 800 V (P0296 = 4)
Properties:	V/f and VVW		
Access groups via HMI:			

Description:

It is the actuation level of the DC link voltage limitation function for the V/f mode.

Setting of P0151 value:

1. The P0151 factory setting leaves inactive the DC link voltage limitation function for the V/f mode. In order to activate it, one must reduce the value of P0151 as suggested in the table 9.2.

Table 9.2: *Recommended actuation levels for the DC link regulation*

Inverter V_{nom}	220/230 V	380 V	400/415 V	440/460 V	480 V
P0296	0	1	2	3	4
P0151	375 V	618 V	675 V	748 V	780 V

2. In case DC link overvoltage (F022) keeps happening during the deceleration, reduce the value of P0151 gradually or increase the deceleration ramp time (P0101 and/or P0103).

3. If the supply line is permanently at a voltage level that results in a DC link voltage higher than the P0151 setting, it will not be possible to decelerate the motor. In this case, reduce the line voltage or increase the value of the P0151 setting.

4. If, even with the procedures above, it is not possible to decelerate the motor in the necessary time, use the dynamic braking (Refer to the chapter 14 - Dynamic Braking).

P0152 – V/f DC Regulation Proportional Gain

Adjustable Range:	0.00 to 9.99	**Factory Setting:**	1.50
Properties:	V/f and VVW		
Access groups via HMI:			

Description:

It defines the DC Link Voltage Regulator proportional gain (refer to the figure 9.11).

P0152 multiplies the DC link voltage error, i.e., Error = actual DC link voltage – (P0151), and it is normally used to prevent overvoltage in applications with eccentric loads.

9.5 START-UP IN THE V/f CONTROL MODE

NOTE!
Read the whole CFW700 user's manual before installing, powering or operating the inverter.

Sequence for installation, verification, powering and start-up:

1. **Install the inverter:** according to the chapter 3 - Installation and Connection, of the CFW700 user's manual, wiring all the power and control connections.

2. **Prepare the inverter and apply power:** according to the section 5.1 - Prepare for Start-Up, of the CFW700 user's manual.

3. **Adjust the password P0000=5:** according to the section 5.3 - Password Setting in P0000, of this manual.

4. **Adjust the inverter to operate with the application line and motor:** execute the Oriented Start-up routine according to item 5.2.1 - Oriented Start-up Menu, of the CFW700 user's manual. Refer to the section 11.7 - Motor Data, of this manual.

5. **Setting of specific parameters and functions for the application:** program the digital and analog inputs and outputs, HMI keys, etc., according to the application needs.

For applications:

- That are simple, which can use the factory settings programming for the digital and analog inputs and outputs, use the Menu “BASIC”. Refer to item 5.2.2 - Basic Application Menu, of the CFW700 user's manual.
- That require only the digital and analog inputs and outputs with programming different from the factory settings, use the Menu “I/O”.
- That need functions as Flying Start, Ride-Through, DC Braking, Dynamic Braking, etc., access and modify those functions parameters by means of the Menu “PARAM”.

10 VVW CONTROL

The VVW (Voltage Vector WEG) control mode uses a control method with intermediate performance between V/f and Sensorless Vector. Refer to the figure 10.1 block diagram.

The main advantage compared to the V/f control is the better speed regulation with higher torque capability at low speeds (frequencies below 5 Hz), allowing a sensible improvement of the inverter performance in permanent regimen. Comparing to the Sensorless Vector, the settings are simpler and easier.

The VVW control uses the stator current measurement, the stator resistance value (that can be obtained with the self-tuning routine) and the induction motor nameplate data to perform automatically the torque estimation, the output voltage compensation and consequently the slip compensation, replacing the function of the parameters P0137 and P0138.

In order to obtain a good speed regulation in permanent regimen, the slip frequency is calculated based on the load estimated torque, which considers the existent motor data.

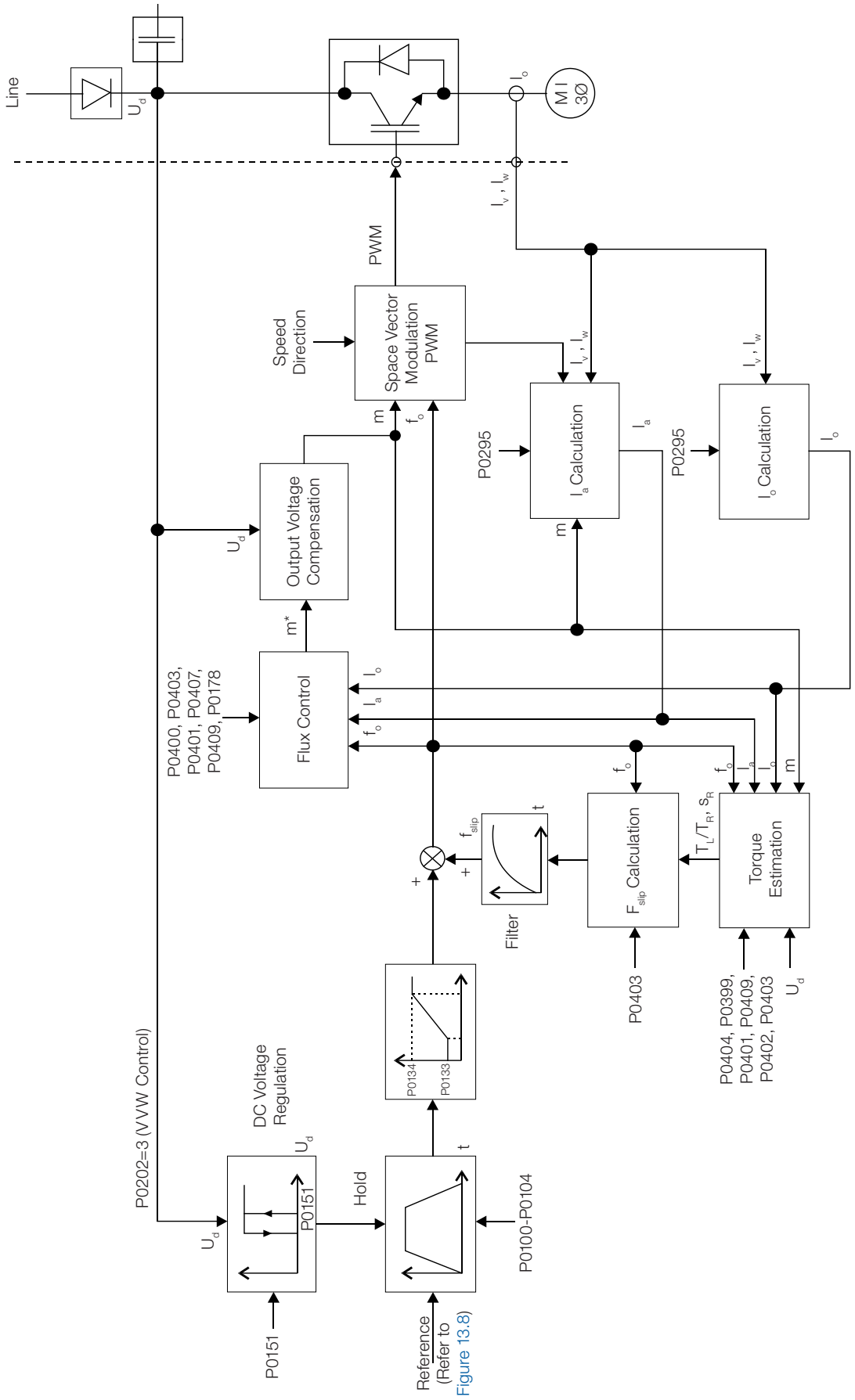


Figure 10.1: *VVW control block diagram*

10.1 VVW CONTROL

Only three parameters are related to this function: P0139, P0202 and P0397.

However, since the parameters P0139 and P0202 were already presented in the section 9.1 - V/f Control, only the parameter P0397 will be described next.

P0397 – Slip Compensation During Regeneration

Adjustable Range:	0 = Off 1 = On	**Factory Setting:**	1
Properties:	cfg and VVW		
Access groups via HMI:			

Description:

It enables or disables the slip compensation during the regeneration in the VVW control mode. Refer to the parameter P0138 in the section 9.1 - V/f Control, for more details on the slip compensation.

10.2 MOTOR DATA

The parameters for the used motor data setting are listed in this group. They must be adjusted according to the motor nameplate data (P0398 to P0406, except P0405) and by means of the Self-Tuning or from data of the motor data sheet (other parameters).

In this section only the parameters P0399 and P0407 will be presented, the others are presented in the section 11.7 - Motor Data.

P0398 – Motor Service Factor

Refer to the section 11.7 - Motor Data, for more information.

P0399 – Motor Rated Efficiency

Adjustable Range:	50.0 to 99.9 %	**Factory Setting:**	67.0 %
Properties:	cfg and VVW		
Access groups via HMI:	MOTOR		

Description:

It sets the motor rated efficiency.

This parameter is important for the VVW control precise operation. The inaccurate setting implies in incorrect calculation of the slip compensation and consequently an imprecise speed control.

P0400 – Motor Rated Voltage

P0401 – Motor Rated Current

P0402 – Motor Rated Speed

P0403 – Motor Rated Frequency

P0404 – Motor Rated Power

P0406 – Motor Ventilation

Refer to the section 11.7 - Motor Data, for more information.

P0407 – Motor Rated Power Factor

Adjustable Range:	0.50 to 0.99	**Factory Setting:**	0.68
Properties:	cfg and VVW		
Access groups via HMI:	MOTOR		

Description:

It is the motor power factor setting, according to the motor nameplate data (cos Ø).

This parameter is important for the VVW control operation. The inaccurate setting will imply in incorrect calculation of the slip compensation.

The default value of this parameter is adjusted automatically when the parameter P0404 is changed. The suggested value is valid for three-phase, IV pole WEG motors. For other motor types the setting must be done manually.

P0408– Run Self-Tuning

P0409 – Motor Stator Resistance (Rs)

P0410 – Motor Magnetizing Current (I_m)

Refer to item 11.8.5 - Self-Tuning, for more information.

10.3 VVW CONTROL MODE START-UP

NOTE!
Read the whole CFW700 user's manual before installing, powering or operating the inverter.

Sequence for installation, verification, powering and start-up:

1. **Install the inverter:** according to the chapter 3 - Installation and Connection, of the CFW700 user's manual, wiring all the power and control connections.

2. **Prepare the inverter and apply power:** according to the section 5.1 - Prepare for Start-up, of the CFW700 user's manual.

3. **Adjust the password P0000=5:** according to the section 5.3 - Password Setting in P0000, of this manual.

4. **Adjust the inverter to operate with the application line and motor:** by means of the “STARTUP” Menu access P0317 and change its content to 1, which makes the inverter initiate the “Oriented Start-up” routine.

The “Oriented Start-up” routine presents on the keypad (HMI) the main parameters in a logical sequence. The setting of these parameters prepares the inverter for operation with the application line and motor. Verify the step by step sequence in the figure 10.2.

The setting of the parameters presented in this operation mode results in the automatic modification of the content of other inverter parameters and/or internal variables, as indicated in the figure 10.2. In this way one gets a stable operation of the control circuit with adequate values to obtain the best motor performance.

During the “Oriented Start-up” routine the “Config” (Configuration) status will be indicated on the keypad (HMI).

Parameters related to the motor:

- Program the contents of parameters from P0398 to P0407 directly with the motor nameplate data. Refer to the section 11.7 - Motor Data.

- Options for the setting of parameter P0409:

  I – Automatic by the inverter, performing the self-tuning routine selected in P0408.
  II – From the motor test data sheet, supplied by the manufacturer. Refer to item 11.7.1 - Adjustment of the Parameters P0409 to P0412 Based on the Motor Data Sheet, in this manual.
  II – Manually, copying the parameters content of another CFW700 that runs an identical motor.

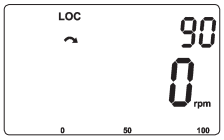
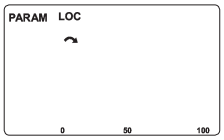
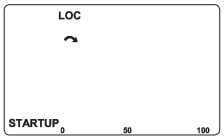
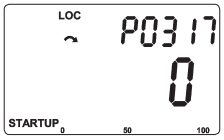
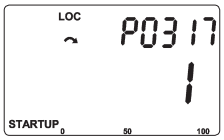
5. **Setting of specific parameters and functions for the application:** program the digital and analog inputs and outputs, HMI keys, etc., according to the application needs.

For applications:

- That are simple, which can use the factory settings programming for the digital and analog inputs and outputs, use the Menu “BASIC”. Refer to item 5.2.2 - Basic Application Menu, of the CFW700 user's manual.

- That require only the digital and analog inputs and outputs with programming different from the factory settings, use the Menu “I/O”.

- That need functions as Flying Start, Ride-Through, DC Braking, Dynamic Braking, etc., access and modify those function parameters by means of the Menu “PARAM”.

Step	Action/Result	Display indication
1	- Monitoring Mode. - Press the **ENTER/MENU** key to get into the first level of the programming mode.	
2	- The **PARAM** group is selected, press the ▲ or ▼ keys to select the **STARTUP** group.	
3	- Press **ENTER/MENU** when the group is selected.	
4	- The parameter **"P0317 – Oriented Start-up"** is then selected, press the **ENTER/MENU** to get into the parameter content.	
5	- Change the parameter P0317 to **"1 - Yes"**, by using the ▲ key.	
6	- Press **ENTER/MENU** to save.	
7	- In this moment the Oriented Start-up routine is initiated and the **"CONF"** status is indicated at the keypad (HMI). - The parameter **"P0000 - Access to Parameters"** is selected. Change the password to set the remaining parameters if necessary. - Press the ▲ key to the next parameter.	
8	- If necessary, change **"P0296 - Line Rated Voltage"**. This change will affect P0151, P0153, P0185, P0321, P0322, P0323 and P0400. - Press the ▲ key to the next parameter.	
9	- If necessary, change **"P0298 - Application"** parameter. This change will affect P0156, P0157, P0158, P0401, P0404 and P0410 (this last one only if P0202 = 0, 1 or 2 - V/f modes). The time and level of the IGBT overload protection will also be affected. - Press the ▲ key to the next parameter.	

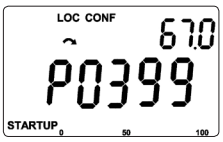
Step	Action/Result	Display indication
10	- Set parameter **"P0202 - Type of Control"** pressing **"ENTER/MENU"**. Press the ▲ key to select the desired option: **"[3]=VVW"**. Then, press **"ENTER/MENU"**. There are three options to exit the oriented start-up: 1 - Running the Self-tunning; 2 - Manual settings of parameters from P0409 to P0413; 3 - Changing P0202 from vector to V/Hz control. - Press the ▲ key to the next parameter.	
11	- If necessary, change **"P0398 - Motor Service Factor"** parameter. This change will affect the current and the time of the motor overload protection operation. - Press the ▲ key to the next parameter.	
12	- If necessary, change **"P0399 - Motor Rated Efficiency"** parameter. - Press the ▲ key to the next parameter.	
13	- If necessary, change **"P0400 - Motor Rated Voltage"** parameter. - This change corrects the output voltage by the factor "x = P0400/P0296". - Press the ▲ key to the next parameter.	
14	- If necessary, change **"P0401 - Motor Rated Current"** parameter. This change will affect P0156, P0157, P0158 and P0410. - Press the ▲ key to the next parameter.	
15	- If necessary, change **"P0404 - Motor Rated Power"** parameter. This change will affect P0410. - Press the ▲ key to the next parameter.	
16	- If necessary, change **"P0403 - Motor Rated Frequency"** parameter. This change will affect P0402. - Press the ▲ key to the next parameter.	
17	- If necessary, change **"P0402 - Motor Rated Speed"**. This change will affect P0122 to P0131, P0133, P0134, P0135, P0182, P0208, P0288 and P0289. - Press the ▲ key to the next parameter.	

Figure 10.2: VVW mode Oriented Start-up

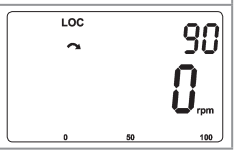
Step	Action/Result	Display indication
18	- If necessary, change **"P0405 - Encoder Pulses Number"** according to the encoder model. - Press the ▲ key to the next parameter.	
19	- If necessary, change **"P0406 - Motor Ventilation"** parameter. - Press the ▲ key to the next parameter.	
20	- If necessary, change **"P0407 - Motor Rated Power Factor"**. - Press the ▲ key to the next parameter.	
21	- In this moment the keypad presents the option to perform **"Self-tunning"**. The Self-tunning should be performed whenever it is possible. Press **"ENTER/MENU"** key to access parameter P0408 and press ▲ to select the option **"1=No rotation"**. Refer to item 11.8.5 - Self-Tuning, for more details. Then, press **"ENTER/MENU"** to start the Self-tunning. - The keypad will show **"CONF"** and **"RUN"** status simultaneously during the self-tunning. The **"RUN"** status is automatically off and parameter P0408 is automatically set back to zero.	
22	- Press **BACK/ESC** key to finish the start-up routine. - Press **BACK/ESC** key again to get back to the monitoring mode.	

Figure 10.2 (cont.): *VVW mode Oriented Start-up*

11 VECTOR CONTROL

It consists in the control type based on the separation of the motor current into two components:

- Flux producing current I_d (oriented with the motor electromagnetic flux).
- Torque producing current I_q (perpendicular to the motor flux vector).

The I_d current is related to the motor electromagnetic flux, while the I_q current is directly related to the torque produced at the motor shaft. With this strategy one gets the so called decoupling, i.e., one can control the motor flux and torque independently by controlling the I_d and I_q currents respectively.

Since these currents are represented by vectors that rotate at the synchronous speed, when observed from a stationary referential, a referential transformation is done so that they are changed to the synchronous referential. In the synchronous referential these values become DC values proportional the respective vector amplitudes. This simplifies considerably the control circuit.

When the I_d vector is aligned with the motor flux, it can be said that the vector control is orientated. Therefore it is necessary that the motor parameters be correctly adjusted. Some of those parameters must be programmed with the motor nameplate data and others obtained automatically through self-tuning or from the motor data sheet supplied by the manufacturer.

The figure 11.2 presents the block diagram for the vector control with encoder and the figure 11.1 for the sensorless vector control. The information of the speed, as well as of the currents measured by the inverter, will be used to obtain the correct vector orientation. In the vector with encoder control case, the speed is obtained directly from the encoder signal, while in the sensorless vector control there is an algorithm which estimates the speed, based in the output currents and voltages.

The vector control measures the current, separates the flux and torque portions and transforms these variables to the synchronous referential. The motor control is accomplished by imposing the desired currents and comparing them with the actual values.

11.1 SENSORLESS CONTROL AND WITH ENCODER

The Sensorless Vector Control is recommended for the majority of the applications, because it allows the operation in a speed variation range of 1:100, speed control with 0.5 % accuracy of rated speed, high starting torque and fast dynamic response.

Another advantage of this control type is the greater robustness against sudden line voltage and load changes, avoiding unnecessary overcurrent trips.

The necessary settings for the good operation of the sensorless vector control are done automatically. Therefore the used motor must be connected to the CFW700 inverter.

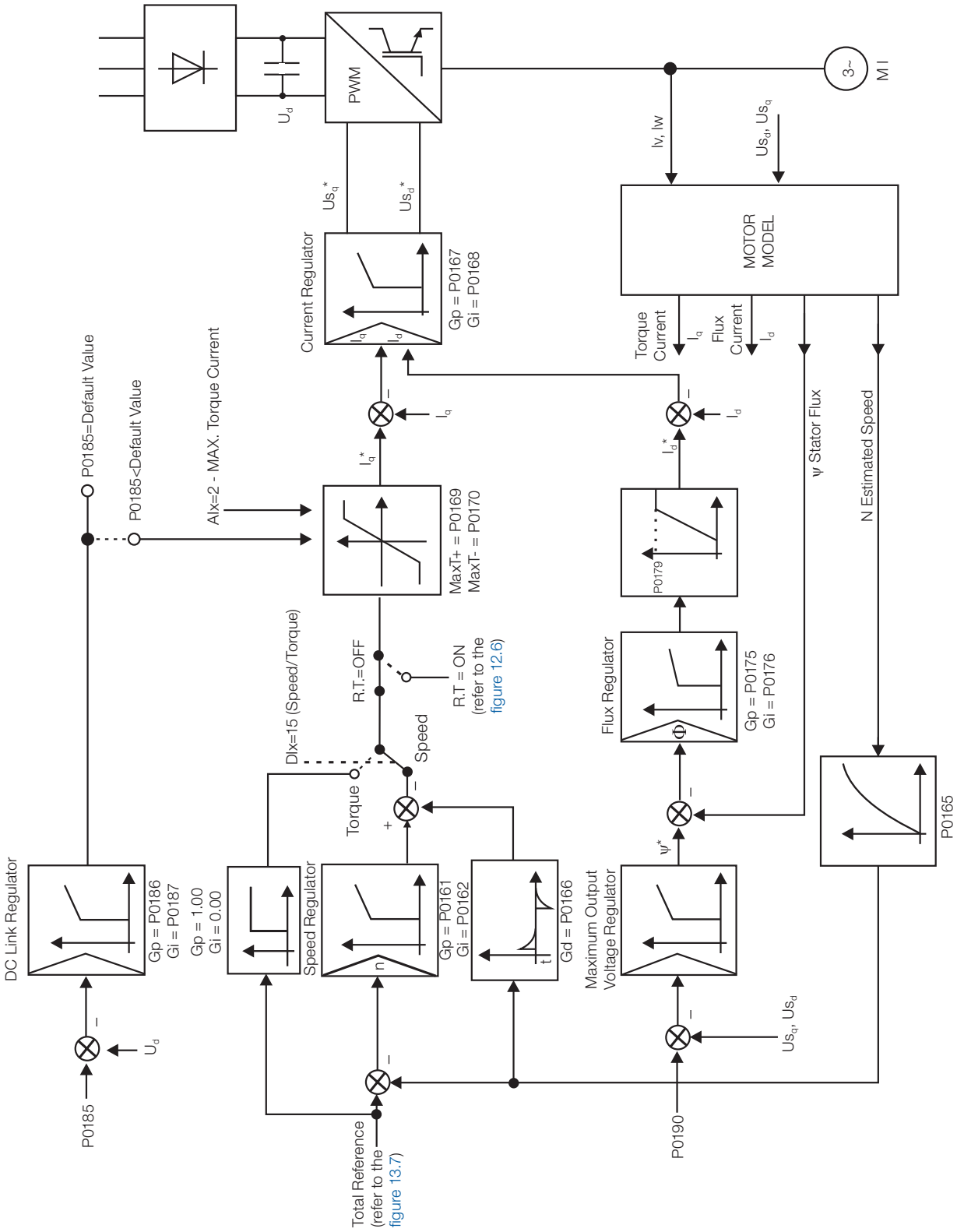


Figure 11.1: *Sensorless vector control block diagram*

The Vector Control with Encoder presents the same advantages of the sensorless control previously described, with the following additional benefits:

- Torque and speed control down to 0 (zero) rpm.
- Speed control accuracy of 0.01 % (if digital references are used, for instance via keypad (HMI), Profibus DP, DeviceNet, etc.).

Refer to the user's manual for more details about the installation and connection of the incremental encoder.

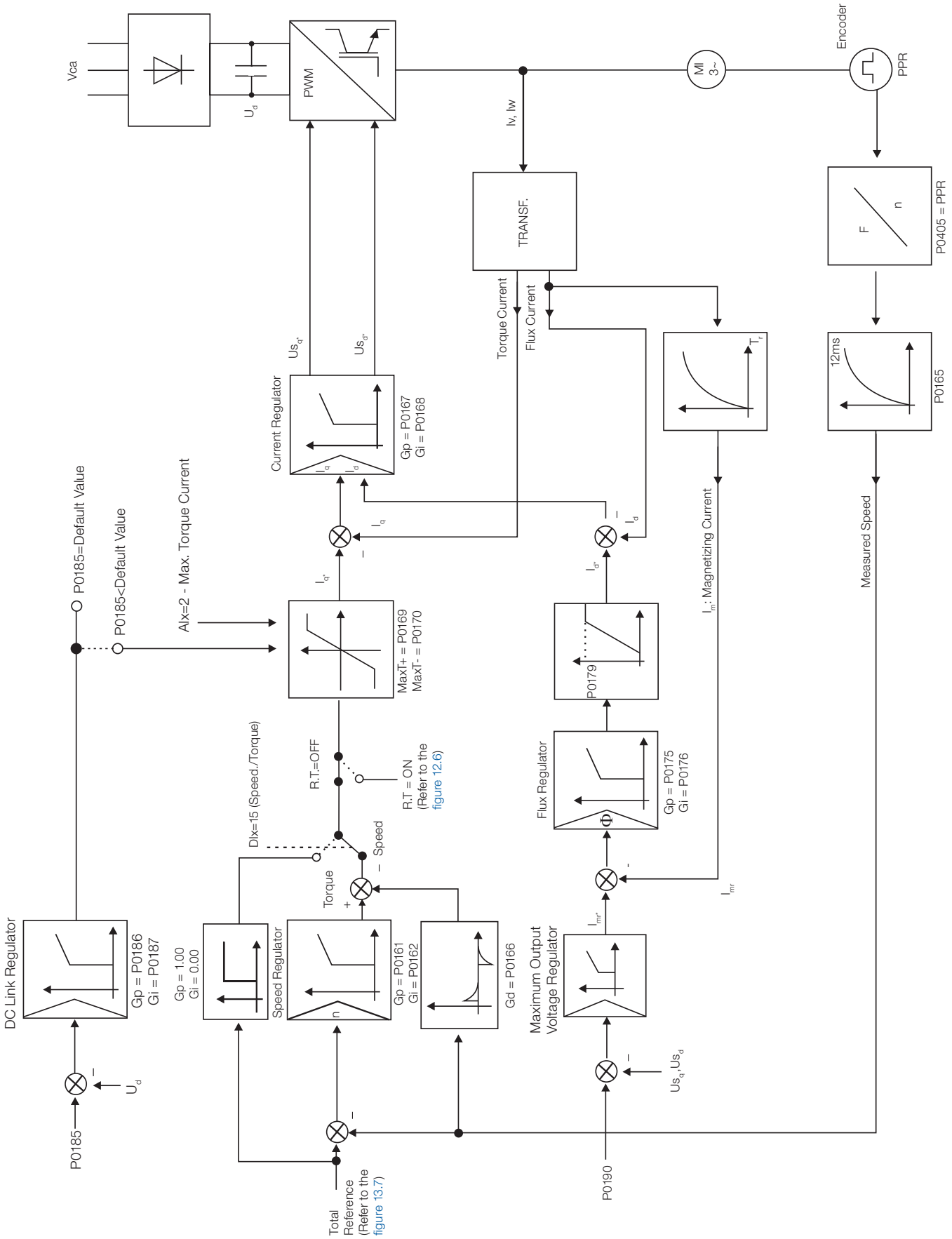


Figure 11.2: *Vector with encoder control block diagram*

11.2 I/f MODE (SENSORLESS)

NOTE!
It is activated automatically at low speeds if P0182>3 and when the Control Mode is Sensorless Vector (P0202=4).

The operation at the low speed region may present instability. In this region the motor operation voltage is also very low, being difficult to be measured accurately.

In order to keep a stable operation of the inverter in that region, the automatic commutation occurs, from sensorless mode to the so called I/f mode, which is a scalar control with imposed current. Scalar control with imposed current means a current control with a constant reference value, adjusted in a parameter and controlling only the frequency in an open loop.

The parameter P0182 defines the speed below which the transition to I/f mode occurs and the parameter P0183 defines the value of the current to be applied to the motor.

The minimum speed recommended for the operation of the Sensorless Vector Mode is 18 rpm for 60 Hz IV pole motors, and 15 rpm for 50 Hz IV pole motors. If P0182 ≤ 3 rpm the inverter will always operate in Sensorless Vector mode, i.e., the I/f function will be disabled.

11.3 SELF-TUNING

Some motor parameters that are not available on the motor nameplate, necessary for the operation of the sensorless vector or vector with encoder control, are estimated:

- Stator resistance.
- Motor flux leakage inductance.
- Rotor time constant T_r.
- Rated magnetizing current of the motor.
- Mechanic time constant of the motor and the driven load.

These parameters are estimated with the application of voltages and currents to the motor.

The parameters related to the regulators used by the vector control, as well as other control parameters, are adjusted automatically in function of the motor parameters estimated through the self-tuning routine. The best self-tuning results are obtained with a preheated motor.

The parameter P0408 controls the self-tuning routine. Depending on the chosen option some parameters can be obtained from tables that are valid for WEG motors.

In the option P0408=1 (No Rotation) the motor remains stopped throughout the self-tuning. The magnetizing current value (P0410) is obtained from a table, valid for WEG motors up to 12 poles.

In the option P0408=2 (Run for I_m) the value of P0410 is estimated with the motor rotating and the load decoupled from the motor shaft.

In the option P0408=3 (Run for T_m) the value of P0413 (Mechanic time constant – T_m) is estimated with the motor rotating. It must be done, preferably, with the load coupled to the motor.

NOTE!
Every time that P0408=1 or 2 the parameter P0413 (Mechanic time constant – T_m) will be adjusted for a value close to the motor rotor mechanic time constant. Therefore, the motor rotor inertia (table data valid for WEG motors), the inverter rated voltage and current, are taken into consideration.

P0408=2 (Run for I_m) in the vector with encoder mode (P0202=5): After finishing the self-tuning routine, couple the load to the motor and set P0408=4 (Estimate T_m). In this case P0413 will be estimated taking into account also the driven load.

If the option P0408=2 (Run for I_m) is executed with the load coupled to the motor, an incorrect value of P0410 (I_m) may be estimated. This will implicate in estimation error for P0412 (rotor time constant - T_r) and for P0413 (mechanic time constant – T_m). Overcurrent fault (F071) may also occur during the inverter operation.
Note: The term "load" includes everything that might be coupled to the motor shaft, for instance, gearbox, inertia disk, etc.

In the option P0408=4 (Estimate T_m) the self-tuning routine estimates only the P0413 (Mechanic time constant – T_m) value, with the motor rotating. It must be done, preferably, with the load coupled to the motor.

During its execution, the self-tuning routine can be canceled by pressing the O key, provided that the values of P0409 through P0413 be all different from zero.

For more details on the self-tuning parameters, refer to item 11.8.5 - Self-Tuning, in this manual.

Alternatives for the acquisition of the motor parameters:

Instead of running the self-tuning, it is possible to obtain the values for P0409 to P0412 in the following manner:

- From the motor test data sheet that can be supplied by its manufacturer. Refer to item 11.7.1 - Adjustment of the Parameters P0409 to P0412 Based on the Motor Data Sheet, of this manual.
- Manually, by copying the contents of the parameters from another CFW700 inverter that uses an identical motor.

11.4 OPTIMAL FLUX FOR SENSORLESS VECTOR CONTROL

NOTE!
Active function only on the Sensorless Vector mode (P0202=4), if P0406=2.

The Optimal Flux function can be used for driving some types of WEG motors **(*)** making it possible the operation at low speed with rated torque without the need of forced ventilation on the motor. The frequency range for operation is 12:1, i.e., from 5 Hz to 60 Hz for 60 Hz rated frequency motors and from 4.2 Hz to 50 Hz for 50 Hz rated frequency motors.

NOTE!
(*) WEG motors that can be used with the Optimal Flux function:

- Nema Premium Efficiency.
- Nema High Efficiency.
- IEC Premium Efficiency.
- IEC Top Premium Efficiency.
- Alto Rendimento Plus.

When this function is activating, the motor flux is controlled in a way to reduce their electric losses on slow speeds. That flux is dependent of the torque current filtered (P0009). The Optimal Flux function is unnecessary in motors with independent ventilation.

11.5 TORQUE CONTROL

In vector control modes sensorless or with encoder, it is possible to use the inverter in torque control mode instead of using it in speed control mode. In this case the speed regulator must be kept saturated and the imposed torque value is defined by the torque limits in P0169/P0170.

Performance of the torque control:
Vector control with encoder:
Torque control range: 10 % to 180 %.
Accuracy: ± 5 % of the rated torque.

Sensorless vector control:
Torque control range: 20 % to 180 %.
Accuracy: ± 10 % of the rated torque.
Minimum operating frequency: 3 Hz.

When the speed regulator is positively saturated, i.e., forward speed direction defined in P0223/P0226, the value for the torque current limitation is adjusted in P0169. When the speed regulator is negatively saturated, i.e., reverse speed direction, the value for the torque current limitation is adjusted in P0170.

The torque at the motor shaft (T_{motor}) in % is given by the formula:
(*) The equation below must be used for "+" torque. Replace P0169 by P0170 for "-" torque.

$$T_{motor} = \left(\frac{P0401 \times \frac{P0169^{(*)}}{100} \times K}{\sqrt{(P0401)^2 - \left(P0410 \times \frac{P0178}{100}\right)^2}} \right) \times 100$$

Where:
N_{nom} = motor synchronous speed,
N = motor current speed

$$K = \begin{cases} 1 \text{ for } N \leq \frac{P0190 \times N_{nom}}{P0400} \\ \frac{N_{nom}}{N} \times \frac{P0190}{P0400} \text{ for } N > \frac{P0190 \times N_{nom}}{P0400} \end{cases}$$

NOTE!
For torque control in the sensorless vector mode (P0202=4), observe:

- The torque limits (P0169/P0170) must be higher than 30 % to assure the motor starting. After the start and with the motor rotating above 3 Hz, they can be reduced, if necessary, to values below 30 %.
- For torque control applications with frequencies until to 0 Hz, use the vector with encoder control mode (P0202=5).
- In the vector with encoder control type set the speed regulator for the mode "optimized for torque control" (P0160=1), besides keeping it saturated.

NOTE!
The motor rated current must be equivalent to the CFW700 rated current, in order that the torque control has the best possible accuracy.

Settings for the torque control:

Torque limitation:

1. Via parameters P0169, P0170 (through the keypad (HMI), Serial or Fieldbus). Refer to item 11.8.6 - Torque Current Limitation.

2. Through the analog inputs AI1 or AI2. Refer to item 13.1.1 - Analog Inputs, option 2 (maximum torque current).

Speed reference:

3. Set the speed reference 10 %, or more, higher than the working speed. This assures that the speed regulator output remains saturated at the maximum value allowed by the torque limit adjustment.

NOTE!
The torque limitation with the saturated speed regulator has also a protection (limitation) function. E.g.: for a winder, when the material being wound brakes, the regulator leaves the saturated condition and starts controlling the motor speed, which will be kept at the speed reference value.

11.6 OPTIMAL BRAKING

NOTE!
Only activated on the Vector with Encoder mode (P0202=5 or 4), when P0184=0, P0185 is smaller than the standard value and P0404 < 21 (75 CV).

NOTE!
The occurrence of optimal braking may cause at the motor:

- Increase of the vibration level.
- Increase of the acoustic noise.
- Increase of the temperature.

Verify the impact of those effects in the application before using the optimal braking.

It is a function that helps the motor controlled braking, eliminating in many cases the need of additional braking IGBT and braking resistor.

The Optimal Braking makes it possible braking the motor with a higher torque than the one obtained with traditional methods, as for instance, the braking by the injection of direct current (DC braking). In the DC braking case, only the losses in the motor rotor are used to dissipate the energy stored as the mechanic load inertia, rejecting the total friction losses. With the Optimal Braking, in the other hand, the total losses in the motor, as well as the total inverter losses, are used. It is possible to get a braking torque roughly 5 times greater than with DC braking.

In the figure 11.3 the Torque x Speed curve of a typical 10 hp/7.5 kW IV pole motor is presented. The braking torque obtained at the rated speed, for an inverter with a torque limit (P0169 and P0170) adjusted in a value equal to the motor rated torque, is supplied by the TB1 point on the figure 11.3. The value of TB1 is on the function of the motor efficiency, and it is defined by the following expression, being despised the attrition losses:

$$TB1 = \frac{1-\eta}{\eta}$$

Where:
η = motor efficiency.

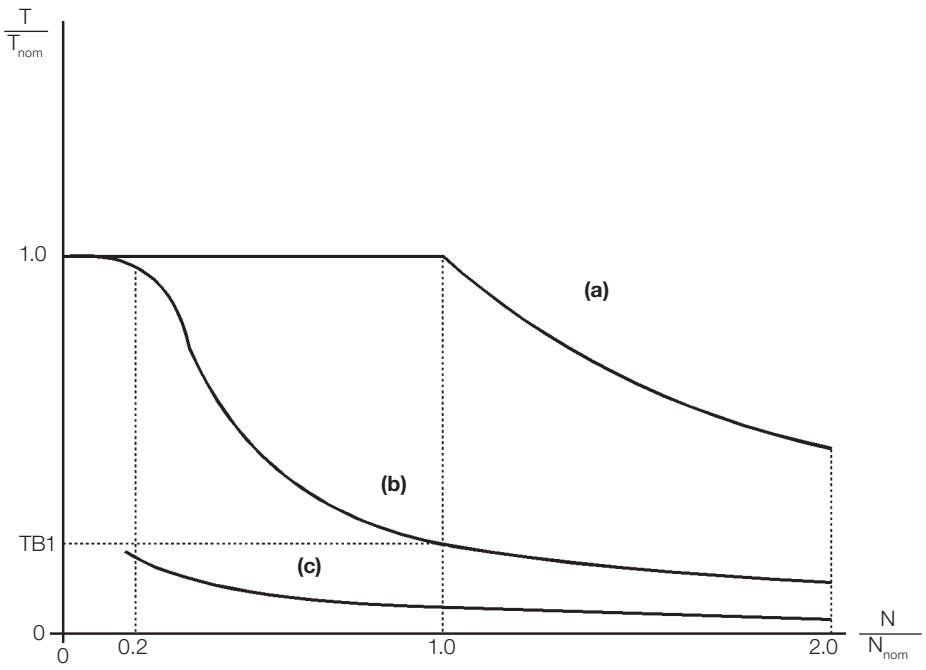
In the figure 11.3 case, the efficiency of the motor for the rated load is η=0.84 (or 84 %), which results in TB1=0.19 or 19 % of the motor rated torque.

The braking torque, starting from the TB1 point, varies in the inverse ratio of the speed (1/N). At low speeds, the braking torque reaches the torque limit of the inverter. In the figure 11.3 case, the torque reaches the torque limitation (100 %) when the speed is less than approximately 20 % of the rated speed.

It is possible to increase the braking torque by increasing the inverter current limitation during the optimal braking (P0169 – torque in the forward speed direction or P0170 – reverse).

Generally smaller motors have lower efficiency because they present more losses. Therefore, comparatively higher braking torque is obtained if they are compared to bigger motors.

Examples: 1 hp/0.75 kW, IV poles: η=0.76 resulting in TB1=0.32;
20 hp/15.0 kW, IV poles: η=0.86 resulting in TB1=0.16.



(a) Torque generated by the motor in normal operation, driven by the inverter in the "motor mode" (load resistant torque).
(b) Braking torque generated by the Optimal Braking use.
(c) Braking torque generated by the DC braking use.

Figure 11.3: *T x N curve for Optimal Braking with a typical 10 hp/7.5 kW motor, driven by an inverter with the torque adjusted at a value equal to the motor rated torque*

In order to use the Optimal Braking:

1. Activate the optimal braking by setting P0184=0 (DC Link Regulation Mode=with losses) and set the DC link regulation level in P0185, as presented in item 11.8.7 - DC Link Regulator, with P0202=5 or 4 and P0404 smaller than 21 (75hp).

2. In order to enable and disable the Optimal Braking via a digital input, set one of the inputs (DIx) for "DC Link Regulation". (P0263…P0270=16 and P0184=2).
   Results:
   DIx=24 V (closed): Optimal Braking is active, equivalent to P0184=0.
   DIx=0 V (open): Optimal Braking is inactive.

11.7 MOTOR DATA

In this group are listed the parameters for the setting of the used motor data. Adjust them according to the motor nameplate data (P0398 to P0406), except P0405, and by means of the self-tuning routine or with the data existent in the motor data sheet (the other parameters). In the Vector Control mode the parameters P0399 and P0407 are not used.

P0398 – Motor Service Factor

Adjustable Range:	1.00 to 1.50	**Factory Setting:**	1.00
Properties:	cfg		
Access groups via HMI:	MOTOR		

Description:

It is the continuous overload capability, i.e., a reserve of power that gives the motor the capability to withstand working in adverse conditions.

Set it according to the value informed on the motor nameplate.

It affects the motor overload protection.

P0399 – Motor Rated Efficiency

Refer to the section 10.2 - Motor Data, for more details.

P0400 – Motor Rated Voltage

Adjustable Range:	0 to 480 V	**Factory Setting:**	220 V (P0296=0) 440 V (P0296=1, 2, 3 or 4)
Properties:	cfg		
Access groups via HMI:	MOTOR		

Description:

Set it according to the motor nameplate data and to the motor cable wiring in the connection box.

This value cannot be higher than the rated voltage adjusted in P0296 (Line Rated Voltage).

NOTE!
In order to validate a new P0400 setting out of the Oriented Start-up Routine it is necessary to cycle the power of the inverter.

P0401 – Motor Rated Current

Adjustable Range:	0 to 1.3xI_{nom-ND}	**Factory Setting:**	1.0xI_{nom-ND}
Properties:	cfg		
Access groups via HMI:	MOTOR		

Description:

Set it according to the used motor nameplate data, taking into consideration the motor voltage.

In the Guided Start-up routine the value adjusted in P0401 automatically modifies the parameters related to the motor overload protection, according to the table 11.2.

P0402 – Motor Rated Speed

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**	1750 rpm (1458 rpm)
Properties:	cfg		
Access groups via HMI:	MOTOR		

Description:

Set it according to the used motor nameplate data.

For V/f and VVW controls the setting is from 0 to 18000 rpm.

For vector control the setting is from 0 to 7200 rpm.

P0403 – Motor Rated Frequency

Adjustable Range:	0 to 300 Hz	**Factory Setting:**	60 Hz (50) Hz
Properties:	cfg		
Access groups via HMI:	MOTOR		

Description:

Set it according to the used motor nameplate data.

For V/f and VVW controls the setting range goes up to 300 Hz.

For vector control the setting range is from 30 Hz to 120 Hz.

P0404 – Motor Rated Power

Adjustable Range:	0 to 25 (refer to the next table)	**Factory Setting:**	$Motor_{max-ND}$
Properties:	cfg		
Access groups via HMI:	MOTOR		

Description:

Set it according to the used motor nameplate data.

Table 11.1: *P0404 (Motor Rated Power) setting*

P0404	Motor Rated Power (hp)
0	0.33
1	0.50
2	0.75
3	1.0
4	1.5
5	2.0
6	3.0
7	4.0
8	5.0
9	5.5
10	6.0
11	7.5
12	10.0
13	12.5
14	15.0
15	20.0
16	25.0
17	30.0
18	40.0
19	50.0
20	60.0
21	75.0
22	100.0
23	125.0
24	150.0
25	175.0

NOTE!
When adjusted via keypad (HMI), this parameter may change the parameter P0329 automatically. Refer to item 12.5.2 - Vector Flying Start.

P0405 – Encoder Pulse Number

Adjustable Range:	100 to 9999 ppr	**Factory Setting:**	1024 ppr
Properties:	cfg		
Access groups via HMI:	MOTOR		

Description:

It sets the number of pulses per rotation (ppr) of the used incremental encoder.

P0406 – Motor Ventilation

Adjustable Range:	0 = Self-Ventilated 1 = Separated Ventilation 2 = Optimal Flux	**Factory Setting:**	0
Properties:	cfg		
Access groups via HMI:	MOTOR		

Description:

During the Oriented Start-up Routine, the value adjusted in P0406 changes the parameters related to the motor overload automatically, in the following manner:

Table 11.2: *Motor overload protection modification in function of P0406*

P0406	P0156 (Overl.Curr.100 %)	P0157 (Overl.Curr.50 %)	P0158 (Overl.Curr.5 %)
0	1.05xP0401	0.9xP0401	0.65xP0401
1	1.05xP0401	1.05xP0401	1.05xP0401
2	1.05xP0401	1.0xP0401	1.0xP0401

ATTENTION!
Refer to the section 11.4 - Optimal Flux for Sensorless Vector Control, for more details on the use of option P0406=2 (Optimal Flux).

P0407 – Motor Rated Power Factor

Refer to the section 10.2 - Motor Data, for more details.

P0408 – Run Self-Tuning

P0409 – Motor Stator Resistance (Rs)

P0410 – Motor Magnetization Current (I_m)

P0411 – Motor Flux Leakage Inductance (σIs)

P0412 – Lr/Rr Constant (Rotor Time Constant – T_r)

P0413 – T_m Constant (Mechanical Time Constant)

Self-Tuning function parameters. Refer to item 11.8.5 - Self-Tuning.

11.7.1 Adjustment of the Parameters P0409 to P0412 Based on the Motor Data Sheet

Being in the possession of the motor equivalent circuit data, it is possible to calculate the value to be programmed in the parameters from P0409 to P0412, instead of using the self-tuning to obtain them.

Input data:

Motor data sheet:

V_n = testing voltage to get the motor parameters in Volts.
f_n = testing frequency to get the motor parameters in Hz.
R_1 = resistance of the motor stator per phase, in Ohms.
R_2 = resistance of the motor rotor per phase, in Ohms.
X_1 = stator inductive reactance, in Ohms.
X_2 = rotor inductive reactance, in Ohms.
X_m = magnetizing inductive reactance, in Ohms.
I_o = motor no load current.
ω = angular speed.

$$\omega = 2 \times \pi \times f_n$$

$$P0409 = \frac{P0400 \times R_1}{V_n}$$

$$P0410 = \frac{V_n \times I_o \times 0.95}{P0400}$$

$$P0411 = \frac{P0400 \times [X_1 + (X_2 \times X_m)/(X_2 + X_m)]}{V_n \times \omega}$$

$$P0412 = \frac{P0400 \times (X_m + X_2)}{V_n \times \omega \times R_2}$$

11.8 VECTOR CONTROL

11.8.1 Speed Regulator

The parameters related to the CFW700 speed regulator are presented in this group.

P0160 – Speed Regulation Optimization

Adjustable Range:	0 = Normal 1 = Saturated	**Factory Setting:**	0
Properties:	cfg and Vector		
Access groups via HMI:			

Description:

Set P0160=1 (Saturated) for torque control in vector mode with encoder. For more details, refer to the section 11.5 - Torque Control, in this manual.

P0161 – Speed Regulator Proportional Gain

Adjustable Range:	0.0 to 63.9	**Factory Setting:**	7.4

P0162 – Speed Regulator Integral Gain

Adjustable Range:	0.000 to 9.999	**Factory Setting:**	0.023
Properties:	Vector		
Access groups via HMI:			

Description:

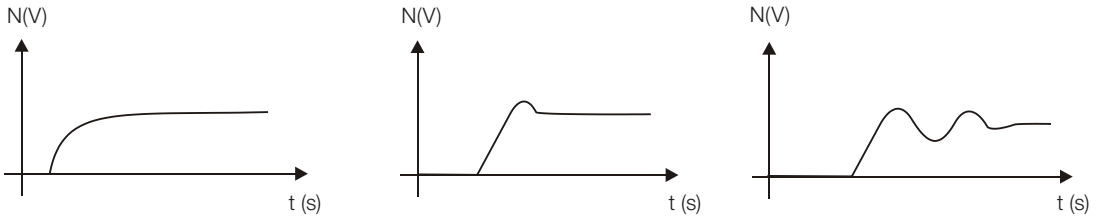
The speed regulator gains are calculated automatically in function of the parameter P0413 (T_m constant).

However, these gains can be adjusted manually in order to optimize the speed dynamic response, which becomes faster with their increase. Yet, if the speed begins to oscillate, they must be reduced.

In a general manner, one can say that the Proportional gain (P0161) stabilizes abrupt speed or reference changes, while the Integral gain (P0162) corrects the error between the reference and the speed, and improves the torque response at low speeds as well.

Procedure for Manual Optimization of the Speed Regulator:

1. Select the acceleration (P0100) and/or deceleration (P0101) time according to the application.
2. Adjust the speed reference for 75 % of the maximum value.
3. Configure an analog output (AOx) for Real Speed, by programming P0251 or P0254 in 2.
4. Disable the speed ramp (Run/Stop=Stop) and wait until the motor stops.
5. Enable the speed ramp (Run/Stop=Run). Observe with an oscilloscope the motor speed signal at the chosen analog output.
6. Verify among the options of the figure 11.4, which waveform best represents the observed signal.



(a) Low integral gain (P0162) and/or High proportional gain (P0161)

(b) Optimized speed regulator

(c) High integral gain (P0162) and/or low proportional gain (P0161)

Figure 11.4 (a) to (c): *Speed regulators response types*

7. Adjust P0161 and P0162 according to the response type presented in the figure 11.4.

(a) Reduce the proportional gain (P0161) and/or increase the integral gain (P0162).
(b) Speed regulator is optimized.
(c) Increase the proportional gain and/or reduce the integral gain.

P0163 – Local Reference Offset

P0164 – Remote Reference Offset

Adjustable Range:	-999 to 999	**Factory Setting:**	0
Properties:	Vector		
Access groups via HMI:			

Description:

It adjusts the analog inputs (AIx) speed reference offset. Refer to the figure 13.2.

P0165 – Speed Filter

Adjustable Range:	0.012 to 1.000 s	**Factory Setting:**	0.012 s
Properties:	Vector		
Access groups via HMI:			

Description:

It adjusts the speed filter time constant. Refer to the figure 13.2.

NOTE!
Generally, this parameter must not be changed. The increment in its value turns the system response slower.

P0166 – Speed Regulator Differential Gain

Adjustable Range:	0.00 to 7.99	**Factory Setting:**	0.00
Properties:	Vector		
Access groups via HMI:			

Description:

The differential action may minimize the effects of the application or removal of load, in the motor speed. Refer to the figure 11.2.

Table 11.3: *Differential gain action in the speed regulator*

P0166	Diferential Gain Actuation
0.00	Inactive
0.01 to 7.99	Active

11.8.2 Current Regulator

The parameters related to the CFW700 current regulator are presented in this group.

P0167 – Current Regulator Proportional Gain

Adjustable Range:	0.00 to 1.99	**Factory Setting:**	0.50

P0168 – Current Regulator Integral Gain

Adjustable Range:	0.000 to 1.999	**Factory Setting:**	0.010
Properties:	Vector		
Access groups via HMI:			

Description:

Parameters P0167 and P0168 are adjusted automatically as a function of the parameters P0411 and P0409.

NOTE!
Do not change these parameters values.

11.8.3 Flux Regulator

The parameters related to the CFW700 flux regulator are presented next.

P0175 – Flux Regulator Proportional Gain

Adjustable Range:	0.0 to 31.9	**Factory Setting:**	2.0

P0176 – Flux Regulator Integral Gain

Adjustable Range:	0.000 to 9.999	**Factory Setting:**	0.020
Properties:	Vector		
Access groups via HMI:			

Description:

These parameters are adjusted automatically in function of the parameter P0412. In general, the automatic setting is sufficient and the readjustment is not necessary.

These gains must only be readjusted manually when the flux current signal (Id*) is unstable (oscillating) and compromising the system operation.

NOTE!
For gains in P0175 > 12.0 the flux current (Id*) may become unstable.

Note:
(Id*) is observed at the analog outputs AO1 and/or AO2, by setting P0251=16 and/or P0254=16.

P0178 – Rated Flux

Adjustable Range:	0 to 120 %	**Factory Setting:**	100 %

P0179 – Maximum Flux

Adjustable Range:	0 to 120 %	**Factory Setting:**	120 %
Properties:	Vector		
Access groups via HMI:			

Description:

The parameter P0178 is the flux reference, while the parameter P0179 defines the maximum value for the flux (magnetization) current.

NOTE!
These parameters must not be modified.

P0190 – Maximum Output Voltage

Adjustable Range:	0 to 480 V	**Factory Setting:**	0.95 x P0296. Automatic setting during the Oriented Start-up Routine: 0.95xP0400.
Properties:	Vector		
Access groups via HMI:			

Description:

This parameter defines the value of the maximum output voltage. Its standard value is defined in the condition of the nominal supply voltage.

The voltage reference used in the regulator “Maximum output voltage” (see the illustration 11.1 or 11.2) is directly proportional to the voltage supply.

If this voltage increases, the output voltage will then be able to increase to the adjusted value in the parameter P0400 - Motor Rated Voltage.

If the voltage supply decreases, the maximum output voltage will decrease in the same proportion.

11.8.4 I/f Control

P0182 – Speed for I/f Control Activation

Adjustable Range:	0 to 90 rpm	**Factory Setting:**	18 rpm
Properties:	Sless		
Access groups via HMI:			

Description:

It defines the speed below witch the transition form the sensorless to the control I/f occurs.

The minimum recommended speed for the sensorless vector control operation is 18 rpm for 60 Hz rated frequency IV pole motors and 15 rpm for 50 Hz rated frequency IV pole motors.

NOTE!
For P0182 ≤ 3 rpm the I/f function will be disabled and the inverter will remain always in the sensorless vector mode.

P0183 – Current in the I/f Mode

Adjustable Range:	0 to 9	**Factory Setting:**	1
Properties:	Sless		
Access groups via HMI:			

Description:

It defines the current to be applied to the motor when the inverter is operating in the I/f mode, i.e., with the motor speed below the value defined by P0182.

Table 11.4: *Current applied in the I/f mode*

P0183	Current in the I/f Mode as a Percentage of P0410 (I_m)
0	100 %
1	111 %
2	122 %
3	133 %
4	144 %
5	155 %
6	166 %
7	177 %
8	188 %
9	200 %

11.8.5 Self-Tuning

In that group are the parameters that are related to the motor and can be estimated by the inverter during the self-tuning routine.

P0408 – Run Self-Tuning

Adjustable Range:	0 = No 1 = No Rotation 2 = Run for I_m 3 = Run for T_m 4 = Estimate T_m	**Factory Setting:**	0
Properties:	cfg, Vector and VVW		
Access groups via HMI:	MOTOR		

Description:
By changing from the factory setting to one of the 4 available options, it is possible to estimate the value of the parameters related to the motor being used. Refer to the next description for more details on each option.

Table 11.5: *Self-tuning options*

P0408	Self-tuning	Control Type	Estimate Parameter
0	No	–	–
1	No Rotation	Sensorless vector, with encoder or VVW	P0409, P0410, P0411, P0412 and P0413
2	Run for I_m	Sensorless vector or with encoder	
3	Run for T_m	Vector with encoder	
4	Estimate T_m	Vector with encoder	P0413

P0408=1 – No rotation: The motor stands still during the self-tuning. The P0410 value is obtained from a table, valid for WEG motors up to 12 poles.

NOTE!
Therefore P0410 must be equal to zero before initiating the self-tuning. If P0410≠0, the self-tuning routine will keep the existent value.

Note: When using another brand of motor P0410 must be adjusted with the adequate value (no load motor current) before initiating the self-tuning.

P0408=2 – Run for Im: The P0410 value is estimated with the motor rotating. It must be executed without load coupled to the motor. P0409, P0411 to P0413 are estimated with the motor standing still.

ATTENTION!
If the option P0408=2 (Run for I_m) is performed with the load coupled to the motor, an incorrect value of P0410 (Im) may be estimated. This will implicate in estimation error for P0412 (Rotor time constant - T_r) and for P0413 (Mechanic time constant – T_m). Overcurrent fault (F071) may also occur during the inverter operation.

Note: The term “load” includes everything that might be coupled to the motor shaft, for instance, gearbox, inertia disk, etc.

P0408=3 – Run for T_m: The value of P0413 (Mechanic time constant – T_m) is estimated, with the motor rotating. It must be done, preferably, with the load coupled to the motor. P0409 to P0412 are estimated with the motor standing still and P0410 is estimated in the same manner as with P0408=1.

P0408=4 – Estimate T_m: it estimates only the P0413 (Mechanic time constant – T_m) value, with the motor rotating. It must be done, preferably, with the load coupled to the motor.

NOTES!

- Every time that P0408=1 or 2:
  The parameter P0413 (Mechanic time constant – T_m) will be adjusted to a value close to the motor mechanic time constant. Therefore, the motor rotor inertia (table data valid for WEG motors), the inverter rated voltage and current are taken into consideration.
- Vector mode with encoder (P0202=5):
  When using P0408=2 (Run for I_m), one must, after finishing the self-tuning routine, couple the load to the motor and set P0408=4 (Estimate T_m) in order to estimate the value of P0413. In this case P0413 will also consider the driven load.
- VVW mode – Voltage Vector WEG (P0202=3):
  In the VVW control self-tuning routine only the value of the stator resistance (P0409) will be obtained. Therefore, the self-tuning will always be performed without rotating the motor.
- Better self-tuning results are obtained with the motor warm.

P0409 – Motor Stator Resistance (Rs)

Adjustable Range:	0.000 to 9.999 ohm	**Factory Setting:**	0.000 ohm
Properties:	cfg, Vector and VVW		
Access groups via HMI:	MOTOR		

Description:

It is the value estimated by the self-tuning.

NOTE!

The P0409 setting determines the value of the current regulator integral gain P0168. The parameter P0168 is recalculated every time the content of P0409 is modified via keypad (HMI).

P0410 – Motor Magnetization Current (I_m)

Adjustable Range:	0 to 1.25 x I_{nom-ND}	**Factory Setting:**	I_{nom-ND}
Properties:			
Access groups via HMI:	MOTOR		

Description:

It is the motor magnetization current value.

It can be estimated by the self-tuning routine when P0408=2 (Run for I_m) or obtained from an internal table based in standard WEG motors, when P0408=1 (No rotation).

When a standard WEG motor is not used and it is not possible to run the self-tuning with P0408=2 (Run for I_m), then adjust P0410 with a value equal to the motor no load current, before initiating the self-tuning.

For P0202=5 (vector mode with encoder), the value P0410 determines the motor flux, therefore it must be properly adjusted. If it is low, the motor will operate with a reduced flux compared to the rated condition, having, consequently, its torque capability reduced.

P0411 – Motor Flux Leakage Inductance (σIs)

Adjustable Range:	0.00 to 99.99 mH	**Factory Setting:**	0.00 mH
Properties:	cfg and Vector		
Access groups via HMI:	MOTOR		

Description:

It is the value estimated by the self-tuning.

The P0411 setting determines the current regulator proportional gain.

NOTE!
When adjusted via the keypad (HMI), this parameter may change the parameter P0167 automatically.

P0412 – Lr/Rr Constant (Rotor Time Constant – T_r)

Adjustable Range:	0.000 to 9.999 s	**Factory Setting:**	0.000 s
Properties:	Vector		
Access groups via HMI:	MOTOR		

Description:

The P0412 setting determines the flux regulator gains (P0175 and P0176).

The value of this parameter interferes in the speed accuracy in the sensorless vector control.

Normally the self-tuning is performed with the motor cold. Depending on the motor, the P0412 value may vary more or less with the motor temperature. Thus, for the sensorless vector control and normal operation with the motor warm, P0412 must be adjusted until the speed of the motor with load (measured at the motor shaft with a tachometer) stays equal to that one indicated on the keypad (HMI) (P0001).

This adjustment must be performed with half the rated speed.

For P0202=5 (vector with encoder), if P0412 is incorrect, the motor will loose torque. Thus, one must adjust P0412 so that at half the rated speed, and with stable load, the motor current (P0003) stays the lowest possible.

In the sensorless vector control mode the P0175 gain, provided by the self-tuning, will be limited in the range: 3.0 ≤ P0175 ≤ 8.0.

Table 11.6: *Typical rotor constant (T_r) values for WEG motors*

Motor Power (hp) / (kW)	T_r (s) Number of Poles			
	2 (50 Hz/60 Hz)	4 (50 Hz/60 Hz)	6 (50 Hz/60 Hz)	8 (50 Hz/60 Hz)
2 / 1.5	0.19 / 0.14	0.13 / 0.14	0.1 / 0.1	0.07 / 0.07
5 / 3.7	0.29 / 0.29	0.18 / 0.12	- / 0.14	0.14 / 0.11
10 / 7.5	- / 0.38	0.32 / 0.25	0.21 / 0.15	0.13 / 0.14
15 / 11	0.52 / 0.36	0.30 / 0.25	0.20 / 0.22	0.28 / 0.22
20 / 15	0.49 / 0.51	0.27 / 0.29	0.38 / 0.2	0.21 / 0.24
30 / 22	0.70 / 0.55	0.37 / 0.34	0.35 / 0.37	- / 0.38
50 / 37	- / 0.84	0.55 / 0.54	0.62 / 0.57	0.31 / 0.32
100 / 75	1.64 / 1.08	1.32 / 0.69	0.84 / 0.64	0.70 / 0.56
150 / 110	1.33 / 1.74	1.05 / 1.01	0.71 / 0.67	- / 0.67
200 / 150	- / 1.92	- / 0.95	- / 0.65	- / 1.03
300 / 220	- / 2.97	1.96 / 2.97	1.33 / 1.30	- / -
350 / 250	- / -	1.86 / 1.85	- / 1.53	- / -
500 / 375	- / -	- / 1.87	- / -	- / -

NOTE!
When adjusted via the keypad (HMI), this parameter may change automatically the following parameters: P0175, P0176, P0327 and P0328.

P0413 – T_m Constant (Mechanical Time Constant)

Adjustable Range:	0.00 to 99.99 s	**Factory Setting:**	0.00 s
Properties:	Vector		
Access groups via HMI:	MOTOR		

Description:

The P0413 setting determines the speed regulator gains (P0161 and P0162).

When P0408=1 or 2, it must be observed:

- If P0413=0, the time constant T_m will be obtained in function of the inertia of the programmed motor (table value).
- If P0413>0, the value of P0413 will not be changed by the self-tuning.

Sensorless vector control (P0202=4):

- When the P0413 value obtained through the self-tuning provides inadequate speed regulator gains (P0161 and P0162), it is possible to change them by setting P0413 via keypad (HMI).
- The P0161 gain provided by the self-tuning or through P0413 change, will be limited to the range: 6.0 ≤ P0161 ≤ 9.0.
- The P0162 value varies in function of the P0161 value.
- In case it be necessary to increase even more these gains, they must be adjusted directly at P0161 and P0162.

Note: Values of P0161>12.0 may turn the torque current (I_q) and the motor speed unstable (oscillating).

Vector control with encoder (P0202=5):

- The P0413 value is estimated by the self-tuning when P0408=3 or 4.
- The measurement procedure consists in accelerating the motor up to 50 % of the rated speed, applying a current step equal to the motor rated current.
- In case that it is not possible to submit the load to this type of request, adjust P0413 via keypad (HMI), refer to item 11.8.1 - Speed Regulator.

11.8.6 Torque Current Limitation

The parameters placed in this group define the torque limitation values.

P0169 – Maximum "+" Torque Current

P0170 – Maximum "-" Torque Current

Adjustable Range:	0.0 to 350.0 %	**Factory Setting:**	125.0 %
Properties:	Vector		
Access groups via HMI:			

Description:

These parameters limit the value of the motor current component that produces "+" torque (P0169) or "-" torque (P0170). The setting is expressed as a percentage of rated motor current (P0401).

In case that any Analog Input (AIx) be programmed for the option 2 (Maximum Torque Current), P0169 and P0170 become inactive and the current limitation will be specified by the AIx. In this case the limitation value can be monitored at the parameter correspondent to the programmed AIx (P0018 or P0019).

In the torque limitation condition the motor current can be calculated by:

$$I_{motor} = \sqrt{\left(\frac{P0169 \text{ or } P0170^{(*)}}{100} \times P0401\right)^2 + (P0410)^2}$$

The maximum torque developed by the motor is given by:

$$T_{motor}(\%) = \left\{ \frac{P0401 \times \frac{P0169^{(*)} \text{ or } P0170 \times K}{100}}{\sqrt{(P0401)^2 - \left(P0410 \times \frac{P0178}{100}\right)^2}} \right\} x100$$

Where:
N_{nom} = motor synchronous speed,
N = motor current speed

$$K = \begin{cases} 1 \text{ for } N \leq \frac{P0190 \times N_{nom}}{P0400} \\ \frac{N_{nom}}{N} \times \frac{P0190}{P0400} \text{ for } N > \frac{P0190 \times N_{nom}}{P0400} \end{cases}$$

(*) In case that the torque current limitation be provided by an analog input, replace P0169 or P0170 by P0018 or P0019 according to the programmed AIx. For more details refer to item 13.1.1 - Analog Inputs.

11.8.7 DC Link Regulator

For the deceleration of high inertia loads or with short deceleration times, the CFW700 has available the DC Link Regulation function, which avoids the tripping of the inverter by overvoltage in the DC link (F022).

P0184 – DC Link Regulation Mode

Adjustable Range:	0 = With losses 1 = Without losses 2 = Enable/Disable DIx	**Factory Setting:**	1
Properties:	cfg and Vector		
Access groups via HMI:			

Description:

It enables or disables the Optimal Braking function (section 11.6 - Optimal Braking) in the DC voltage regulation, according to the next table.

Table 11.7: *DC link regulation modes*

P0184	Action
0 = With losses (Optimal Braking)	The Optimal Braking is active as described at P0185. This assures the minimum possible deceleration time without using dynamic or regenerative braking.
1 = Without losses	Automatic control of the deceleration ramp. The Optimal Braking is inactive. The deceleration ramp is automatically adjusted in order to keep the DC link below the level adjusted in P0185. This procedure avoids the overvoltage fault at the DC link (F022). It can also be used with eccentric loads.
2 = Enable/Disable via DIx	■ DIx = 24 V: Braking actuates as described for P0184=1. ■ DIx = 0 V: The Without Losses Braking stays inactive. The DC link voltage will be controlled by the parameter P0153 (Dynamic Braking).

P0185 – DC Link Voltage Regulation Level

Adjustable Range:	339 to 400 V 585 to 800 V 585 to 800 V 585 to 800 V 585 to 800 V	**Factory Setting:**	P0296=0: 400 V P0296=1: 800 V P0296=2: 800 V P0296=3: 800 V P0296=4: 800 V
Properties:	Vector		
Access groups via HMI:			

Description:

This parameter defines the DC link voltage regulation level during the braking. During the braking, the time of the deceleration ramp is automatically extended, thus avoiding an overvoltage fault (F022). The setting of the DC link regulation can be done in two manners:

1. With losses (Optimal Braking) – set P0184=0.

   1.1. P0404 < 20 (60 hp): In this way the current flux is modulated in a way to increase the losses of the motor, increasing the break torque. A better operation can be obtained with motors of smaller efficiency (small motors).

   1.2. P0404 > 20 (60 hp): the current flux will be increased up to the maximum value defined on P0169 or P0170, as the speed is reduced. The break torque in the weakness field area is small.

2. Without losses – set P0184=1. Activates only the DC link voltage regulation.

NOTE!
The factory setting for P0185 is adjusted at the maximum, which disables the DC link voltage regulation. In order to activate it, set P0185 according to the table 11.8.

Table 11.8: *DC link voltage regulation recommended levels*

Inverter V_{nom}	200 ... 240 V	380 V	400 / 415 V	440 / 460 V	480 V
P0296	0	1	2	3	4
P0185	375 V	618 V	675 V	748 V	780 V

P0186 – DC Link Voltage Regulation Proportional Gain

Adjustable Range:	0.0 to 63.9	**Factory Setting:**	18.0

P0187 – DC Link Voltage Regulation Integral Gain

Adjustable Range:	0.000 to 9.999	**Factory Setting:**	0.002
Properties:	Vector		
Access groups via HMI:			

Description:

These parameters adjust the DC link voltage regulator gain.

Normally the factory settings are adequate for the majority of the applications, not being necessary to adjust them.

11.9 START-UP IN THE VECTOR MODES SENSORLESS AND WITH ENCODER

NOTE!
Read the whole CFW700 user's manual before installing, powering or operating the inverter.

Sequence for installation, verification, powering and start-up:

1. **Install the inverter:** according to the chapter 3 - Installation and Connection, of the CFW700 user's manual, wiring all the power and control connections.

2. **Prepare the inverter and apply power:** according to the section 5.1 - Prepare for Start-up, of the CFW700 user's manual.

3. **Adjust the password P0000=5:** according to the section 5.3 - Password Setting in P0000, of this manual.

4. **Adjust the inverter to operate with the application line and motor:** by means of the “STARTUP” Menu access **P0317** and change its content to 1, which makes the inverter initiate the “Oriented Start-up” routine.

The “Oriented Start-up” routine presents on the keypad (HMI) the main parameters in a logical sequence. The setting of these parameters prepares the inverter for operation with the application line and motor. Verify the step by step sequence in the figure 11.5.

The setting of the parameters presented in this operation mode results in the automatic modification of the content of other inverter parameters and/or internal variables, as indicated in the figure 11.5. In this way one gets a stable operation of the control circuit with adequate values to obtain the best motor performance.

During the “Oriented Start-up” routine the “Config” (Configuration) status will be indicated on the keypad (HMI).

Parameters related to the motor:

- Program the contents of parameters from P0398, P0400 to P0406 directly with the motor nameplate data.

- Options for the setting of parameters P0409 to P0412:
  - Automatic, with the inverter executing the self-tuning routine as selected in one of the P0408 options.
  - From the motor data sheet supplied by its manufacturer. Refer to the procedure in item 11.7.1 - Adjustment of the Parameters P0409 to P0412 Based on the Motor Data Sheet, of this manual.
  - Manually, copying the contents of the parameters from another CFW700 inverter, which uses an identical motor.

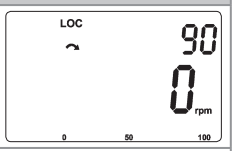
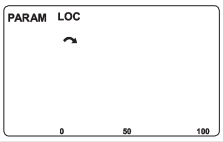
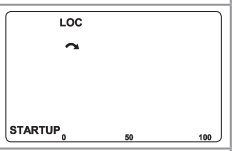
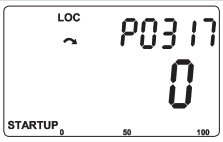
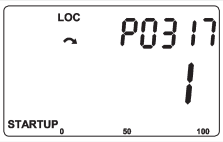
5. **Setting of specific parameters and functions for the application:** set the digital and analog inputs and outputs, HMI keys, etc., according to the application needs.

For applications:

- That are simple, which can use the factory settings programming for the digital and analog inputs and outputs, use the Menu “BASIC”. Refer to item 5.2.2 - Basic Application Menu, of the CFW700 user's manual.

- That require only the digital and analog inputs and outputs with programming different from the factory settings, use the Menu “I/O”.

- That need functions as Flying Start, Ride-Through, DC Braking, Dynamic Braking, etc., access and modify those function parameters by means of the Menu “PARAM”.

Seq.	Action/Result	Display Indication
1	- Monitoring Mode. - Press **ENTER/MENU** key to go to the 1st level of the programming mode.	
2	- The **PARAM** group is selected, press the ▲ or ▼ keys to select the **STARTUP** group.	
3	- Press **ENTER/MENU** when the group is selected.	
4	- The parameter **"P0317 - Oriented Start-up"** is then selected, press the **ENTER/MENU** to get into the parameter content.	
5	- Change the parameter P0317 to **"1 - Yes"**, by using the ▲ key.	
6	- Press **ENTER/MENU** to save.	
7	- In this moment the Oriented Start-up routine is initiated and the **"CONF"** status is indicated at the keypad (HMI). - The parameter **"P0000 - Access to Parameters"** is selected. Change the password to set the remaining parameters if necessary. - Press the ▲ key to the next parameter.	
8	- - If necessary, change **"P0296 - Line Rated Voltage".** This change will affect P0151, P0153, P0185, P0321, P0322, P0323 and P0400. - Press the ▲ key to the next parameter.	

Seq.	Action/Result	Display Indication
9	- If necessary, change **"P0298 - Application"** parameter. This change will affect P0156, P0157, P0158, P0401, P0404 and P0410 (P0410 only will affect if P0202 = 0, 1, 2 or 3). The time and level of the IGBT overload protection will also be affected. - Press the ▲ key to the next parameter.	
10	- Set parameter **"P0202 - Type of Control"** pressing **"ENTER/MENU"**. Press the ▲ key to select the desired option: **"[4]=Sensorless"** or **"[5]=Encoder"**. This change resets P0410. Then, press **"ENTER/MENU"**. - There are three options to exit the oriented start-up: 1 - Running the Self-tunning; 2 - Manual settings of parameters from P0409 to P0413; 3 - Changing P0202 from vector to scalar control. - Press the ▲ key to the next parameter.	
11	- If necessary, change **"P0398 - Motor Service Factor"** parameter. This change will affect the current and the time of the motor overload protection operation. - Press the ▲ key to the next parameter.	
12	- If necessary, change **"P0400 - Motor Rated Voltage"** parameter. - This change corrects the output voltage by the factor "x = P0400/P0296". - Press the ▲ key to the next parameter.	
13	- If necessary, change **"P0401 - Motor Rated Current"** parameter. This change will affect P0156, P0157, P0158 and P0410. - Press the ▲ key to the next parameter.	

Figure 11.5: *Vector mode Oriented Start-up*

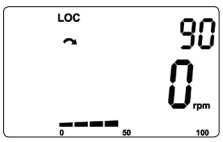
Seq.	Action/Result	Display Indication
14	- If necessary, change **"P0404 - Motor Rated Power"** parameter. This change will affect P0410. - Press the ▲ key to the next parameter.	
15	- If necessary, change **"P0403 - Motor Rated Frequency"** parameter. This change will affect P0402. - Press the ▲ key to the next parameter.	
16	- If necessary, change **"P0402 - Motor Rated Speed"**. This change will affect P0122 to P0131, P0133, P0134, P0135, P0182, P0208, P0288 and P0289. - Press the ▲ key to the next parameter.	
17	- If necessary, change **"P0405 - Encoder Pulses Number"** according to the encoder model. - Press the ▲ key to the next parameter.	
18	- If necessary, change **"P0406 - Motor Ventilation"** parameter. - Press the ▲ key to the next parameter.	
19	- In this moment the keypad presents the option to perform **"Self-tuning".** The Self-tuning should be performed whenever it is possible. Press **"ENTER/MENU"** key to access parameter P0408 and press ▲ to select the desired option. Refer to item 11.8.5 - Self-Tuning, for more details. Then, press **"ENTER/MENU"** to start the Self-tuning. The keypad will show **"CONF"** and **"RUN"** status simultaneously during the self-tuning. At the end of the Self-Tuning the **"RUN"** status is automatically set to off and the parameter P0408 is automatically reset.	
20	- Press **BACK/ESC** key to finish the start-up routine. - Press **BACK/ESC** key again to get back to the monitoring mode.	

Figure 11.5 (Cont.): *Vector mode Oriented Start-up*

12 FUNCTIONS COMMON TO ALL THE CONTROL MODES

This section describes the functions that are common to all the CFW700 inverter control modes (V/f, VVW, Sensorless, and Encoder).

12.1 RAMPS

The inverter RAMPS functions allow the motor to accelerate and decelerate in a faster or a slower manner.

P0100 – Acceleration Time

P0101 – Deceleration Time

Adjustable Range:	0.0 to 999.0 s	**Factory Setting:**	20.0 s
Properties:			
Access groups via HMI:	BASIC		

Description:

These parameters define the time to accelerate (P0100) lineally from 0 to the maximum speed (defined in P0134) and decelerate (P0101) lineally from the maximum speed down to 0.

Note: The setting 0.0 s means that the ramp is disabled.

P0102 – Acceleration Time 2

P0103 – Deceleration Time 2

Adjustable Range:	0.0 to 999.0 s	**Factory Setting:**	20.0 s
Properties:			
Access groups via HMI:			

Description:

Those parameters allow a second ramp to be configured for the motor acceleration (P0102) or deceleration (P0103), which is activated via an external digital command (defined by P0105). Once this command is activated, the inverter ignores the times of the first ramp (P0100 or P0101) and starts obeying the value adjusted at the second ramp. Refer the example for external command via DIx showed next in the figure 12.1.

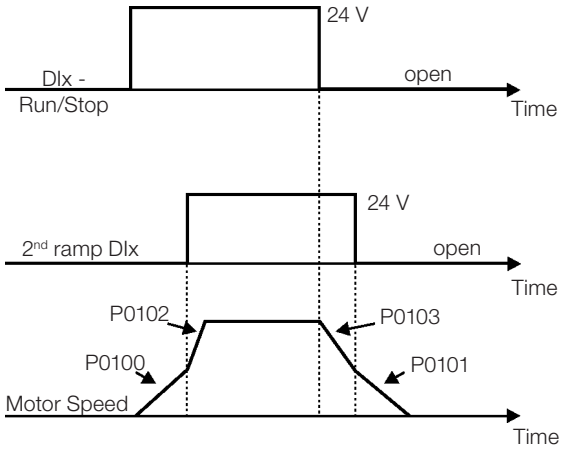


Figure 12.1: *Second ramp actuation*

In this example, the commutation to the 2nd ramp (P0102 or P0103) is done by means of one of the digital inputs from DI1 to DI8, provided that it had been programmed for 2nd ramp function (refer to item 13.1.3 - Digital Inputs, for more details).

Note: The setting 0.0 s means that the ramp is disabled.

P0104 – Ramp

Adjustable Range:	0 = Linear 1 = S Curve	**Factory Setting:**	0
Properties:			
Access groups via HMI:			

Description:

This parameter allows that the acceleration and deceleration ramps have a nonlinear profile, similar to an “S”, as showed in the figure 12.2 next.

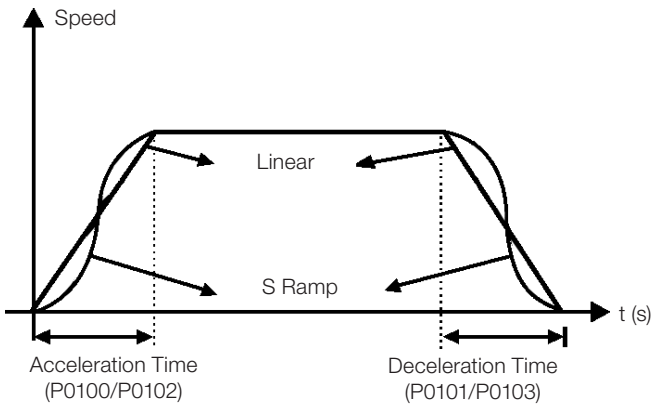


Figure 12.2: *S or linear ramp*

The S ramp reduces mechanic shock during accelerations/decelerations.

P0105 – 1st/2nd Ramp Selection

Adjustable Range:	0 = 1st Ramp 1 = 2nd Ramp 2 = DIx 3 = Serial 4 = CANopen/DeviceNet/Profibus DP 5 = SoftPLC	**Factory Setting:**	2
Properties:	cfg		
Access groups via HMI:			

Description:

It defines the source of the command that will select between the Ramp 1 and the Ramp 2.

Notes:

- "Ramp 1" means that the acceleration and deceleration ramps are following the values programmed in P0100 and P0101.
- "Ramp 2" means that the acceleration and deceleration ramps are following the values programmed in P0102 and P0103.
- It is possible to monitor the set of ramps being used in a defined moment at the parameter P0680 (Logical status).

12.2 SPEED REFERENCES

This parameter group makes it possible that the reference values for the motor speed and for the functions JOG, JOG+ and JOG- be established. It is also possible to define if the reference value will be kept when the inverter is switched off or disabled. For more details refer to the figures 13.7 and 13.8.

P0120 – Speed Reference Backup

Adjustable Range:	0 = Inactive 1 = Active	**Factory Setting:**	1
Properties:			
Access groups via HMI:			

Description:

This parameter defines if the speed reference backup function is active or inactive.

If P0120=Inactive, then the inverter will not save the speed reference when it is disabled. Thus, when the inverter is enabled again the speed reference will assume the value of the minimum speed limit (P0133).

This backup function applies to the references via keypad (HMI), Serial, CANopen/DeviceNet, SoftPLC.

P0121 – Keypad Reference

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**	90 rpm
Properties:			
Access groups via HMI:			

Description:

When the ▲ and ▼ HMI keys are active (P0221 or P0222=0), this parameter sets the value of the motor speed reference.

The value of P0121 will be kept with the last adjusted value when the inverter is disabled or powered off, provided that the parameter P0120 is configured as Active (1).

P0122 – JOG Speed Reference

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**	150 rpm (125 rpm)
Properties:			
Access groups via HMI:			

Description:

During the JOG command the motor accelerates up to the value defined in P0122 following the adjusted acceleration ramp.

The source of the JOG command is defined in the parameters P0225 (Local Situation) or P0228 (Remote Situation).

If the JOG command source has been defined for the digital inputs (DI1 to DI8), one of these inputs must be programmed as presented in the table 12.1.

Table 12.1: *JOG command via digital input selection*

Digital Input	Parameters
DI1	P0263 = 6 (JOG)
DI2	P0264 = 6 (JOG)
DI3	P0265 = 6 (JOG)
DI4	P0266 = 6 (JOG)
DI5	P0267 = 6 (JOG)
DI6	P0268 = 6 (JOG)
DI7	P0269 = 6 (JOG)
DI8	P0270 = 6 (JOG)

For more details refer to the figure 13.5 **(h)**.

The speed direction is defined by the parameters P0223 or P0226.

The JOG command is effective only with the motor stopped.

For the JOG+ refer to the description below.

P0122 – JOG+ Speed Reference

P0123 – JOG- Speed Reference

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**	150 rpm (125 rpm)
Properties:	Vector		
Access groups via HMI:			

Description:

The JOG+ or JOG- commands are always carried out via digital inputs.

One DIx input must be programmed for JOG+ and another for JOG- as presented in the table 12.2 next:

Table 12.2: *Selection of the JOG+ and JOG- commands via digital inputs*

Digital Input	Funtion	
	JOG+	JOG -
DI1	P0263=10	P0263=11
DI2	P0264=10	P0264=11
DI3	P0265=10	P0265=11
DI4	P0266=10	P0266=11
DI5	P0267=10	P0267=11
DI6	P0268=10	P0268=11
DI7	P0269=10	P0269=11
DI8	P0270=10	P0270=11

During the JOG+ or JOG- commands the values of P0122 and P0123 are, respectively, added or subtracted from the speed reference to generate the total reference (refer to the figure 13.7).

For the JOG option refer to the previous parameter description.

12.3 SPEED LIMITS

The parameters of this group have the purpose of acting as motor speed limits.

P0132 – Maximum Overspeed Level

Adjustable Range:	0 to 100 %	**Factory Setting:**	10 %
Properties:	cfg		
Access groups via HMI:			

Description:

This parameter sets the highest speed allowed for the motor to operate, and must be adjusted as a percentage of the maximum speed limit (P0134).

When the actual speed exceeds the value of P0134 + P0132 longer than 20 ms, the CFW700 will disable the PWM pulses and indicate the fault (F150).

In order to disable this function, set P0132=100 %.

P0133 – Minimum Speed Reference Limit

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**	90 rpm (75 rpm)

P0134 – Maximum Speed Reference Limit

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**	1800 pm (1500 rpm)
Properties:			
Access groups via HMI:	BASIC		

Description:

They define the maximum/minimum values for the motor speed reference when the inverter is enabled. They are valid for any type of reference signal. For details on the actuation of P0133, refer to the parameter P0230 (Dead Zone of the Analog Inputs).

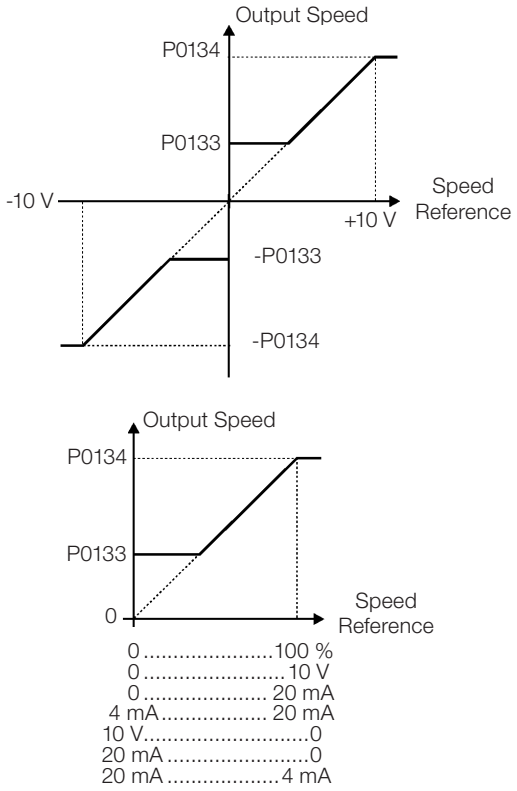


Figure 12.3: *Speed limits considering the "Dead Zone" active (P0230=1)*

12.4 ZERO SPEED LOGIC

This function allows the configuration of a speed in which the inverter will enter a stop condition (general disable).

P0217 – Zero Speed Disable

Adjustable Range:	0 = Inactive 1 = Active	**Factory Setting:**	0
Properties:	cfg		
Access groups via HMI:			

Description:

When active, it disables the inverter after the speed reference (N*) and the actual speed (N) become lower than the value adjusted in the parameter P0291.

The inverter is enabled again when one of the conditions defined by the parameter P0218 is satisfied.

DANGER!
Be careful when approaching the motor while it is in the disable condition. It may get back to operation at any moment because of the process conditions. In case you want to handle or perform any type of maintenance, remove power from the inverter.

P0218 – Condition to Leave the Zero Speed Disable

Adjustable Range:	0 = Reference or Speed 1 = Reference	**Factory Setting:**	0
Properties:			
Access groups via HMI:			

Description:

It specifies if the condition to leave the zero speed disable will be only the speed reference or also the actual speed.

Table 12.3: *Condition to leave the N=0 disable*

P0218 (P0217 = 1)	Inverter Leaves the Condition of Disable by N=0
0	P0001 (N*) > P0291 or P0002 (N) > P0291
1	P0001 (N*) > P0291

In order the inverter can exit the blocked condition when the PID Regulator application is active and in Auto mode, besides the programming at P0218, it is necessary that the PID error (the difference between the setpoint and the process variable) is greater than the value set in P1028. Refer to the chapter 19 - Applications, for more details.

P0219 – Delay for Zero Speed Disable

Adjustable Range:	0 to 999 s	**Factory Setting:**	0 s
Properties:			
Access groups via HMI:			

Description:

It defines whether or not the Zero Speed Disable function will be timed.

If P0219=0, the function works without timing.

If P0219>0, the function will be configured with timing, and the counting of the time adjusted in this parameter will be initiated after the Speed Reference and the Actual Motor Speed become lower than the value adjusted in P0291. When the counting reaches the time defined in P0219, the inverter will be disabled. If during the time counting any of the conditions that cause the zero speed disable ceases being fulfilled, then the time counting will be reset and the inverter continues enabled.

P0291 – Zero Speed Zone

Refer to item 13.1.4 - Digital Outputs / Relays, for more details.

12.5 FLYING START / RIDE-THROUGH

The FLYING START function allows starting a motor that is spinning freely, accelerating it from the speed it is found.

The other function, RIDE-THROUGH, allows the recovery of the inverter, without being disabled by undervoltage, when a failure in the voltage supply occurs.

Since these functions work in different manners depending on the used control mode (V/f, VVW or Vector), they will be described in full detail next, for each one of the modes.

P0320 – Flying Start/Ride-Through

Adjustable Range:	0 = Off 1 = Flying Start 2 = Flying Start / Ride-Through 3 = Ride-Through	**Factory Setting:**	0
Properties:	cfg		
Access groups via HMI:			

Description:

The parameter P0320 selects the functions Flying Start and Ride-Through use. More details in the subsequent sections.

12.5.1 V/f or VVW Flying Start

In the V/f or VVW modes, the inverter imposes a fixed frequency at the start, defined by the speed reference, and applies a voltage ramp defined at the parameter P0331. The Flying Start function will be activated after the time adjusted in P0332 elapses (to allow the motor demagnetization), every time a “Run” command is driven.

12.5.2 Vector Flying Start

12.5.2.1 P0202=4

The behavior of the Flying Start function (FS) in the sensorless mode during acceleration and reacceleration can be understood from the figure 12.4.

The figure 12.4 **(b)** shows the behavior of the speed reference when the FS function is started with stopped motor shaft and small P0329 value (not optimized).

Operation analysis:

1. The frequency correspondent to the P0134 adjustment is applied, with approximately the motor nominal current (I/f control).
2. The frequency is reduced down to zero using the ramp given by: P0329 x P0412.
3. If the speed is not found during this frequency scan, a new scan in the opposite speed direction is initiated, in which the frequency goes from -P0134 to zero. After this second scan the FS is finished and the control mode changes to vector sensorless.

The figure 12.4 **(c)** shows the speed reference when the FS function is initiated with the motor shaft already running in the desired direction, or with stopped shaft and an already optimized P0329.

Operation analysis:

1. The frequency correspondent to the P0134 adjustment is applied, with approximately the motor nominal current.
2. The frequency is reduced using the ramp given by: P0329 x P0412 until reaching the motor speed.
3. In this moment the control mode changes to vector sensorless.

NOTE!
In order that the motor speed is found in the first scan, proceed with the P0329 setting in the following manner:

1. Increase P0329 using 1.0 steps.
2. Enable the inverter and observe the motor shaft movement during the FS process.
3. If the shaft rotates in both directions, stop the motor and repeat the steps 1 and 2.

NOTE!
The used parameters are P0327 to P0329 and the not used ones are P0182, P0331 and P0332.

NOTE!
When the general enable command is activated, the motor magnetization will not occur.

NOTE!
For a better performance of the function, the activation of the braking without losses is recommended by setting the parameter P0185 according to the table 11.8.

P0327 – FS I/f Current Ramp

Adjustable Range:	0.000 to 1.000 s	**Factory Setting:**	0.070 s

Description:

It defines the time for the I/f current to change from 0 to the level used in the frequency sweep (f). It is determined by: P0327=P0412/8.

P0328 – Flying Start Filter

Adjustable Range:	0.000 to 1.000 s	**Factory Setting:**	0.085 s

Description:

It establishes the time of permanence in the condition that indicates that the speed of the motor was found. It is defined by: P0328=(P0412/8 + 0.015 s).

P0329 – FS I/f Frequency Ramp

Adjustable Range:	2.0 to 50.0	**Factory Setting:**	6.0
Properties:	Sless		
Access groups via HMI:			

Description:

It defines the rate of frequency variation used in the motor speed search.

P0329 is determined in function of P0404, as showed in the next table:

Table 12.4: *P0329 value in function of P0404*

P0404	0...20	21...23	24...25
P0329	6.0	7.0	8.0

The frequency variation rate is determined by: (P0329 x P0412).

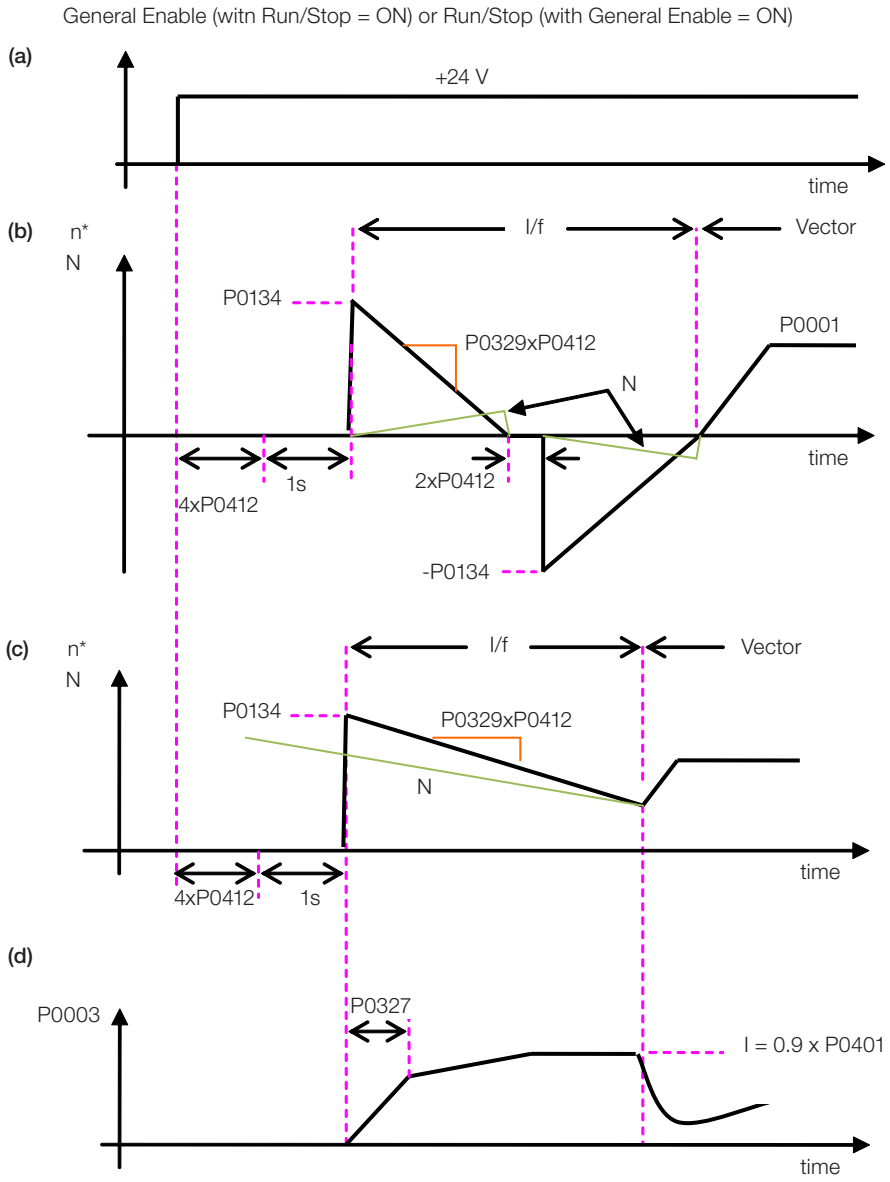


Figure 12.4 (a) to (d): *Influence of P0327 and P0329 during Flying Start (P0202 = 4)*

If it is wished to deactivate momentarily the Flying Start function, one can program one of the digital inputs P0263 to P0270 as 15 (Disab.FlyStart). Refer to item 13.1.3 - Digital Inputs.

12.5.2.2 P0202=5

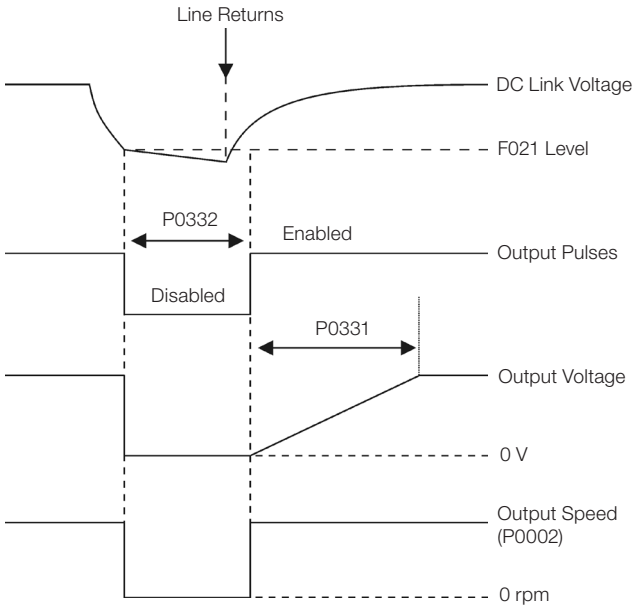
During the time period when the motor is being magnetized, the identification of the motor speed occurs. Once the magnetization is finished, the motor will be operated starting from that speed until reaching the speed reference indicated in P0001.

The parameters P0327 to P0329, P0331 and P0332 are not used.

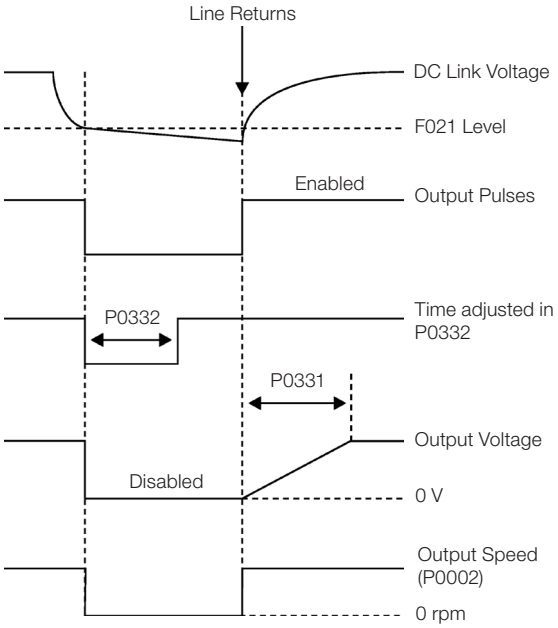
12.5.3 VVW or V/f Ride-Through

The Ride-Through function in the V/f mode will disable the output pulses (IGBT) of the inverter as soon as the input voltage reaches a value below the undervoltage level. The undervoltage fault (F021) does not occur and the DC link voltage will decrease slowly until the line voltage returns.

If the line takes too long to return (more than 2 seconds), the inverter may indicate F021 (DC link undervoltage). If the line voltage returns before a fault, the inverter will enable the pulses again, imposing the speed reference instantaneously (as in the Flying Start function) and applying a voltage ramp with the time defined by P0331. Refer to the figures 12.5 **(a)** and **(b)**.



(a) with the line returning before the time adjusted in P0332



(b) with the line returning after the time adjusted in P0332, but before 2 s (for P0332 ≤ 1 s), or before 2 x P0332 (for P0332 > 1 s)

Figure 12.5 (a) and (b): *Ride-Through actuation in V/f or VVW modes*

The actuation of the Ride-Through function can be visualized at the outputs DO1/RL1, DO2, DO3, DO4 and/or DO5 (P0275 to P0279), provided that they have been programmed in “22=Ride-Through”.

P0331 – Voltage Ramp

Adjustable Range:	0.2 to 60.0 s	**Factory Setting:**	2.0 s
Properties:	V/f and VVW		
Access groups via HMI:			

Description:

This parameter sets the necessary time for the output voltage to reach the rated voltage value.

It is used by the Flying Start function as well as by the Ride-Through function (both in V/f or VVW modes), together with the parameter P0332.

P0332 – Dead Time

Adjustable Range:	0.1 to 10.0 s	**Factory Setting:**	1.0 s
Properties:	V/f and VVW		
Access groups via HMI:			

Description:

The parameter P0332 sets the minimum time that the inverter will wait to activate the motor again, which is necessary for the motor demagnetization.

In the Ride-Through function case, the time is counted starting from the line drop. However in the Flying Start function actuation, the counting begins after the “Run/Stop=Run” command is given.

For the correct operation, this time must be adjusted to twice the motor rotor constant (see table available at P0412 in item 11.8.5 - Self-Tuning).

12.5.4 Vector Ride-Through

Different from the V/f and VVW modes, in the vector mode the Ride-Through function tries to regulate the DC link voltage during the line failure. The energy necessary to keep the aggregate working is obtained from the motor kinetic energy (inertia) by means of its deceleration. Thus, at the line return the motor is reaccelerated to the speed defined by the reference.

After the line failure (t0), the DC link voltage (U_d) starts diminishing according to a rate depending on the motor load condition, being able to reach the undervoltage level (t2) if the Ride-Through function is not working. The typical necessary time for this to occur, with rated load, is from a magnitude of 5 to 15 ms.

With the Ride-Through function active, the line loss is detected when the U_d voltage reaches a value below the “DC Link Power Loss” value (t1), defined at the parameter P0321. The inverter initiates a controlled deceleration of the motor immediately, regenerating energy to the DC link in order to keep the motor operating with the U_d voltage regulated at the value “DC Link Ride-Through” (P0322).

In case that the line does not return, the aggregate remains in this condition the longest possible time (depends on the energetic balance) until undervoltage (F021 in t5) occurs. If the line returns before the undervoltage occurrence (t3), the inverter will detect its return when the U_d voltage reaches the “DC Link Power Back” (t4) level, defined at the parameter P0323. The motor is then reaccelerated, following the adjusted ramp, from the actual speed value to the value defined by the speed reference (P0001) (refer to the figure 12.6).

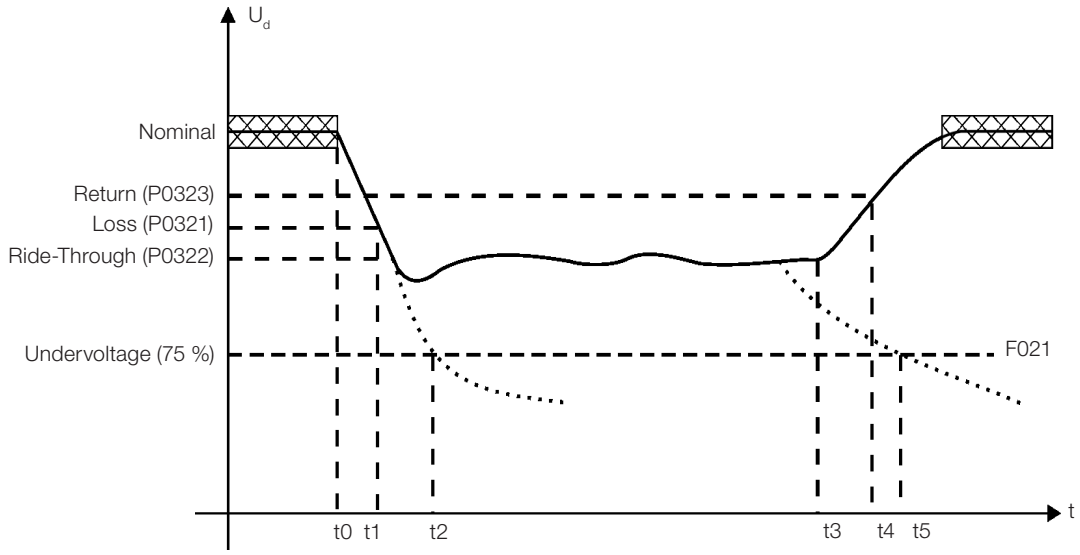


Figure 12.6: *Ride-Through function actuation in vector mode*

- t0 – Line loss.
- t1 – Line loss detection.
- t2 – Undervoltage actuation (F021 without Ride-Through).
- t3 – Line return.
- t4 – Line return detection.
- t5 – Undervoltage actuation (F021 with Ride-Through).

If the line voltage produces an U_d voltage between the values adjusted in P0322 and P0323, the fault F150 may occur, the values of P0321, P0322 and P0323 must be readjusted.

NOTE!
When one of the functions, Ride-Through or Flying Start, is activated, the parameter P0357 (Line Phase Loss Time) is ignored, regardless of the adjusted time.

NOTE!
Cautions with the application:
- Use oversized high-speed fuses or regular fuses to limit the inrush current when the line returns.

NOTE!
The Ride-Through function activation occurs when the power supply voltage is lower than the value (P0321/1.35). U_d=Vac x 1.35

P0321 – DC Link Power Loss

Adjustable Range:	178 to 282 V 308 to 616 V 308 to 616 V 308 to 616 V 308 to 616 V	**Factory Setting:**	P0296 = 0: 252 V P0296 = 1: 436 V P0296 = 2: 459 V P0296 = 3: 505 V P0296 = 4: 551 V

P0322 – DC Link Ride-Through

Adjustable Range:	178 to 282 V 308 to 616 V 308 to 616 V 308 to 616 V 308 to 616 V	**Factory Setting:**	P0296 = 0: 245 V P0296 = 1: 423 V P0296 = 2: 446 V P0296 = 3: 490 V P0296 = 4: 535 V

P0323 – DC Link Power Back

Adjustable Range:	178 to 282 V 308 to 616 V 308 to 616 V 308 to 616 V 308 to 616 V	**Factory Setting:**	P0296 = 0: 267 V P0296 = 1: 462 V P0296 = 2: 486 V P0296 = 3: 535 V P0296 = 4: 583 V
Properties:	Vector		
Access groups via HMI:			

Description:

- P0321 - defines the U_d voltage level under which the line loss will be detected.
- P0322 - defines the U_d voltage level that the inverter will try to keep regulated, so that the motor keeps operating.
- P0323 - defines the U_d voltage level at which the inverter will identify the return of the line, and from where the motor must be reaccelerated.

NOTE!
These parameters work together with the parameters P0325 and P0326 for the Ride-Through in vector control.

P0325 – Ride-Through Proportional Gain

Adjustable Range:	0.0 to 63.9	**Factory Setting:**	22.8

P0326 – Ride-Through Integral Gain

Adjustable Range:	0.000 to 9.999	**Factory Setting:**	0.128
Properties:	Vector		
Access groups via HMI:			

Description:

These parameters configure the vector mode Ride-Through PI controller, which is responsible for keeping the DC link voltage at the level set in P0322.

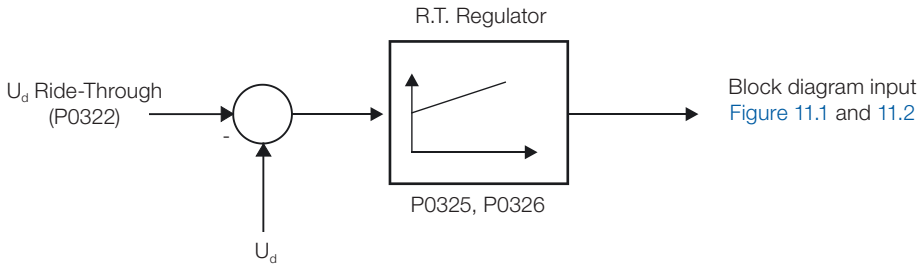


Figure 12.7: *Ride-Through PI controller*

Normally the factory settings for P0325 and P0326 are adequate for the majority of the applications. Do not change these parameters.

12.6 DC BRAKING

NOTE!
The DC Braking on the start and/or stop will not be active if P0202=5 (Vector with Encoder mode).

NOTE!
The DC Braking at start does not act when the Flying Start function is active (P0320=1 or 2).

The DC Braking consists in the application of direct current to the motor, allowing its fast stopping.

Table 12.5: *Parameters related to the DC braking*

Control Mode	DC Braking at Starting	DC Braking at Stopping
V/f scalar	P0299 and P0302	P0300, P0301 and P0302
VVW	P0302 and P0299	P0300, P0301 and P0302
Sensorless Vector	P0299 and P0372	P0300, P0301 and P0372

P0299 - Starting DC-Braking Time

Adjustable Range:	0.0 to 15.0 s	**Factory Setting:**	0.0 s
Properties:	V/f, VVW and Sless		
Access groups via HMI:			

Description:
This parameter sets the DC braking time at starting.

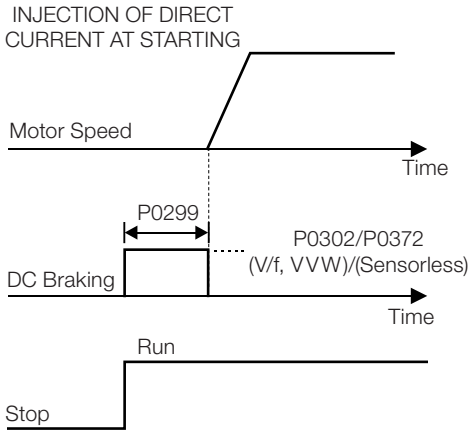


Figure 12.8: *DC braking operation at starting*

P0300 – Stopping DC-Braking Time

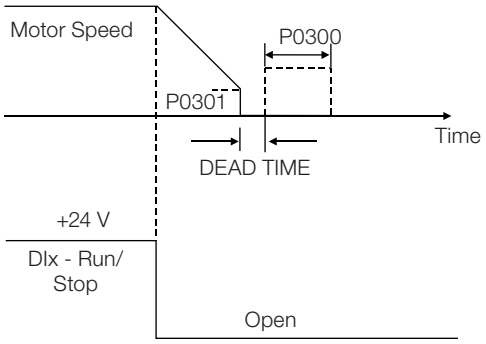
Adjustable Range:	0.0 to 15.0 s	**Factory Setting:**	0.0 s
Properties:	V/f, VVW and Sless		
Access groups via HMI:			

Description:

This parameter sets the DC braking time at stopping.

The figure 12.9 presents the DC braking operation via ramp disabling (refer to P0301).

(a) V/f scalar



(b) VVW and Sensorless Vector

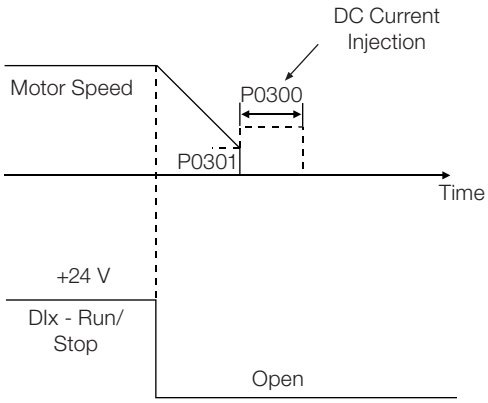


Figure 12.9 (a) and (b): *DC braking operation at the ramp disabling (via ramp disable)*

The figure 12.10 presents the DC braking operation via general disabling. This condition does only work in the V/f scalar mode.

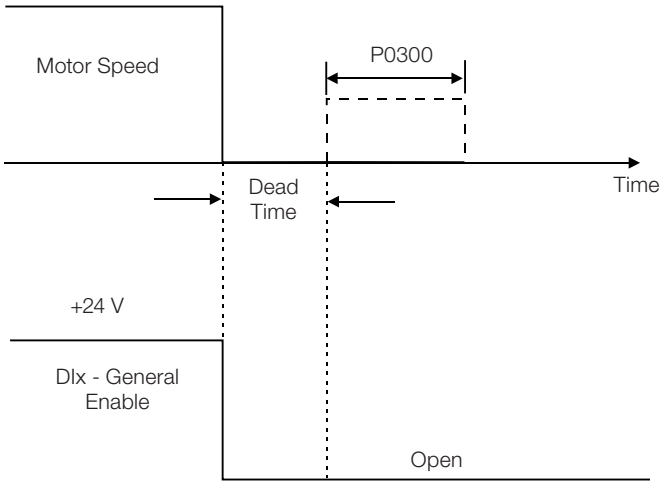


Figure 12.10: *DC braking operation via general disabling – V/f mode*

For the V/f scalar control mode there is a “dead time” (motor rotates free), before starting the DC braking. This time is necessary to the demagnetization of the motor and it is proportional to its speed.

During the DC braking the inverter indicates the “RUN” status at the keypad (HMI).

During the braking process, if the inverter is enabled, the braking is interrupted and the inverter will operate normally again.

ATTENTION!
The DC braking may continue active after the motor has already stopped. Be careful with the motor thermal sizing for short period cyclic braking.

P0301 – DC-Braking Speed

Adjustable Range:	0 to 450 rpm	**Factory Setting:**	30 rpm
Properties:	V/f, VVW and Sless		
Access groups via HMI:			

Description:

This parameter establishes the beginning point for the DC braking application at stopping. Refer to the figures 12.9 **(a)** and **(b)**.

P0302 – DC-Braking Voltage

Adjustable Range:	0.0 to 10.0 %	**Factory Setting:**	2.0 %
Properties:	V/f and VVW		
Access groups via HMI:			

Description:

This parameter adjusts the DC voltage (braking torque) applied to the motor during the braking.

The adjustment must be done by increasing gradually the P0302 value, which varies from 0 to 10 % of the rated voltage, until getting the desired braking.

This parameter works only for the V/f scalar and VVW control modes.

P0372 – DC-Braking Current for Sensorless

Adjustable Range:	0.0 to 90.0 %	**Factory Setting:**	40.0 %
Properties:	Sless		
Access groups via HMI:			

Description:

This parameter adjusts the current level (DC braking torque) applied to the motor during the braking.

The programmed current level is a percentage of the inverter rated current.

This parameter works only in the Sensorless Vector control mode.

12.7 SKIP SPEED

The parameters of this group prevent the motor from operating permanently at speed values where, for instance, the mechanic system enters in resonance (causing exaggerated vibration or noise).

P0303 – Skip Speed 1

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**	600 rpm

P0304 – Skip Speed 2

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**	900 rpm

P0305 – Skip Speed 3

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**	1200 rpm

P0306 – Skip Band

Adjustable Range:	0 to 750 rpm	**Factory Setting:**	0 rpm
Properties:			
Access groups via HMI:			

Description:

This actuation of these parameters occurs as presented in the figure 12.11 next.

The passage through the avoided speed range (2xP0306) takes place by means of the acceleration/deceleration ramps.

The function does not operate properly if two bands of “Skip Speed” overlap.

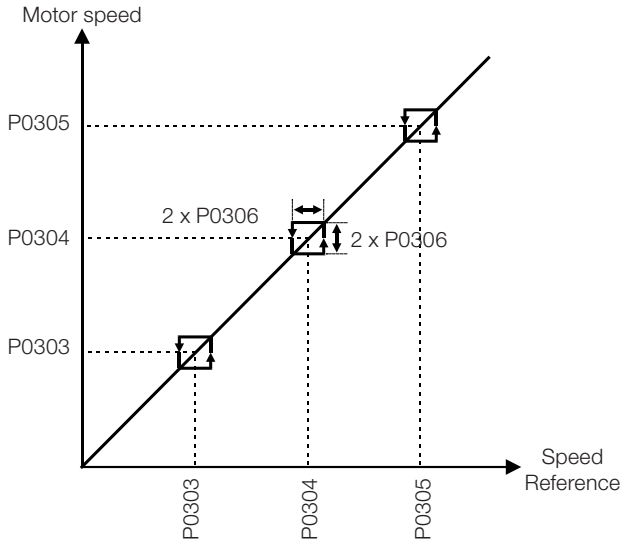


Figure 12.11: *“Skip Speed” actuation curve*

12.8 SEARCH OF ZERO OF THE ENCODER

The zero search function attempts to synchronize the minimum counting or the maximum counting visualized in the parameter P0039 - Encoder Pulse Counter, with the pulse of zero of the encoder.

The function is activated by setting P0191=1. It will just be executed once, when happening the first zero pulse after the activation of the function.

Among the actions accomplished are: the parameter P0039 is reduced to zero (or fitting with the value of 4xP0405), and the parameter P0192 starts to indicate P0192=Completed.

P0191 – Encoder Zero Search

Adjustable Range:	0 = Inactive 1 = Active	**Factory Setting:**	0
Properties:			
Access groups via HMI:			

Description:

On the inverter initialization, the parameter P0191 starts on zero. By setting to one, it activates the operation of the zero search function, while the parameter P0192 stays on zero (Inactive).

P0192 – Encoder Zero Search Status

Adjustable Range:	0 = Inactive 1 = Finished	**Factory Setting:**	0
Properties:	ro		
Access groups via HMI:	READ		

Description:

On the inverter initialization, this parameter starts on zero.

When the value is changed to 1 (Finished), it indicates that the zero search function was executed, and this function returns to the state of Inactive, although P0191 continues equal to one (Active).

13 DIGITAL AND ANALOG INPUTS AND OUTPUTS

This section presents the parameters for the configuration of the CFW700 inputs and outputs, as well as the parameters for the command of the inverter in the Local or Remote Situations.

13.1 I/O CONFIGURATION

13.1.1 Analog Inputs

Two analog inputs (AI1 and AI2) are available in the CFW700 standard configuration.

With those inputs it is possible, for instance, the use of an external speed reference or the connection of a sensor for the temperature measurement (PTC). The details for those configurations are described in the following parameters.

P0018 – AI1 Value

P0019 – AI2 Value

Adjustable Range:	-100.00 to 100.00 %	**Factory Setting:**	
Properties:	ro		
Access groups via HMI:	READ or I/O		

Description:

These read only parameters indicate the value of the analog inputs AI1 and AI2, as a percentage of the full scale. The indicated values are the ones obtained after the offset action and the multiplication by the gain. Refer to the description of the parameters P0230 to P0240.

P0230 – Analog Input Dead Zone

Adjustable Range:	0 = Inactive 1 = Active	**Factory Setting:**	0
Properties:			
Access groups via HMI:	I/O		

Description:

This parameter acts only for the analog inputs (AIx) programmed as speed reference, and it defines if the Dead Zone at those inputs is Active (1) or Inactive (0).

If the parameter is configured as Inactive (P0230=0), the signal at the analog input will work on the Speed Reference starting from the minimum value (0 V / 0 mA / 4 mA or 10 V / 20 mA), and will be directly related to the minimum speed programmed at P0133. Refer to the figure 13.1 **(a)**.

If the parameter is configured as Active (P0230=1), the signal at the analog inputs will have a Dead Zone, where the Speed Reference remains in the minimum value (P0133), even with the variation of the input signal. Refer to the figure 13.1 **(b)**.

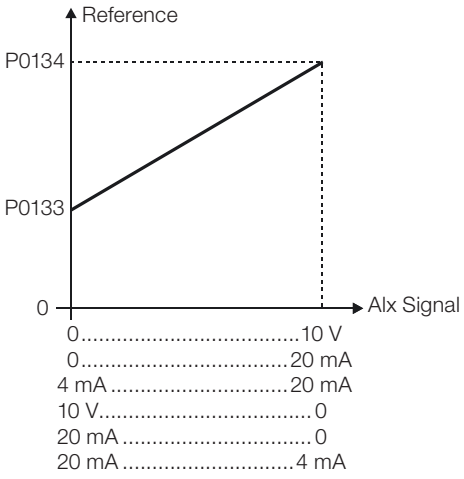


Figure 13.1 (a): *Analog input actuation with Dead Zone Inactive*

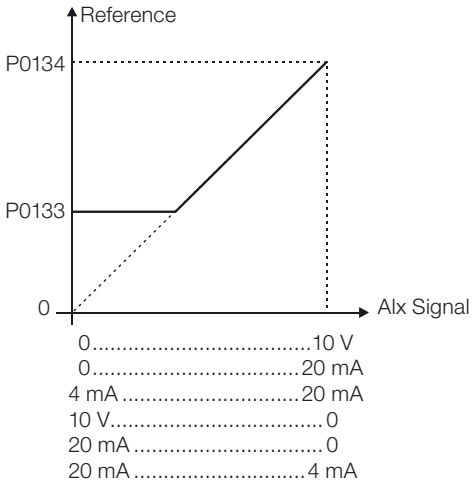


Figure 13.1 (b): *Analog input actuation with Dead Zone Active*

In case that the analog inputs AI1 and AI2 are programmed for -10 V to +10 V (P0233 and P0238 configured in 4), there will be curves identical to those of the figure 13.1 above; only when AI1 or AI2 is negative the speed direction will be inverted.

P0231 – AI1 Signal Function

P0236 – AI2 Signal Function

Adjustable Range:	0 = Speed Reference 1 = N* without Ramp 2 = Maximum Torque Current 3 = SoftPLC 4 = PTC 5 = Application Function 1 6 = Application Function 2 7 = Application Function 3 8 = Application Function 4 9 = Application Function 5 10 = Application Function 6 11 = Application Function 7 12 = Application Function 8	**Factory Setting:**	0
Properties:	cfg		
Access groups via HMI:	I/O		

Description:

The functions of the analog inputs are defined in those parameters.

When the option 0 (Speed Reference) is selected, the analog inputs are able to supply the reference for the motor, subject to the specified limits (P0133 and P0134) and to the ramp action (P0100 to P0103). Therefore, it is also necessary to configure the parameters P0221 and/or P0222, selecting the use of the desired analog input. For more details refer to the description of those parameters in the section 13.2 - Local and Remote Command, and to the figure 13.7 in this manual.

The option 1 (No Ramp Reference – valid only for the vector mode) is used generally as an additional reference signal, for instance in applications using a dancer. Refer to the figure 13.7, option without acceleration and deceleration ramp.

The option 2 (Maximum Torque Current) makes it possible that the forward and reverse torque current limit control be done by means of the selected analog input. In this case P0169 and P0170 are not used.

The adjustment done at the analog input AI1 or AI2 can be monitored via parameters P0018 or P0019 respectively. The value presented at this parameter will be the maximum torque current expressed as a percentage of the motor rated current (P0401). The indication range will be from 0...200 %. When the analog input is equal to 10 V (maximum), the corresponding monitoring parameter will show 200 %, and the value of the maximum forward and reverse torque current will be 200 %. In order that the expressions which determine the total current and the maximum torque developed by the motor (section 11.5 - Torque Control, and item 11.8.6 - Torque Current Limitation) remain valid, replace P0169, P0170 by P0018 or P0019.

The option 3 (SoftPLC) sets the input to be used by the programming done in the SoftPLC reserved memory area. Refer to the SoftPLC manual for more details.

The option 4 (PTC) configures the input for motor temperature monitoring by means of a PTC type sensor, when it is present in the motor. Therefore it is also necessary to configure one analog output (AO) as a current source for feeding the PTC. More details of this function are described in the section 15.2 - Motor Overtemperature Protection.

The options 5 to 12 (Application Function) sets the input to be used by the applications. For more details, refer to chapter 19 - Applications.

P0232 – AI1 Gain

P0237 – AI2 Gain

Adjustable Range:	0.000 to 9.999	**Factory Setting:**	1.000

P0234 – AI1 Offset

P0239 – AI2 Offset

Adjustable Range:	-100.00 to 100.00 %	**Factory Setting:**	0.00 %

P0235 – AI1 Filter

P0240 – AI2 Filter

Adjustable Range:	0.00 to 16.00 s	**Factory Setting:**	0.00 s
Properties:			
Access groups via HMI:	I/O		

Description:

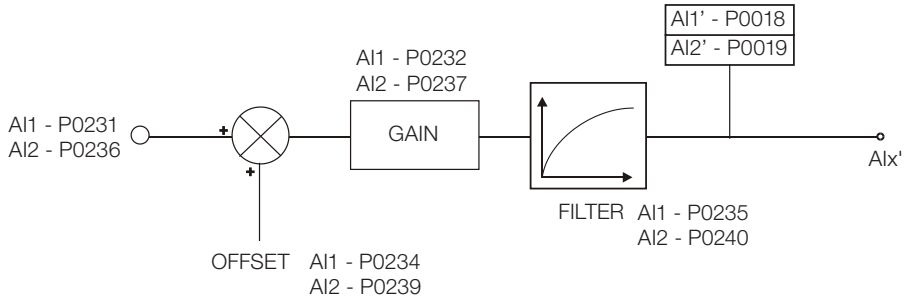


Figure 13.2: *Analog input block diagram*

The AIx' internal value is the result of the following equation:

$$AIx' = AIx + \left(\frac{OFFSET}{100} \times 10\ V \right) \times Gain$$

For instance: AIx = 5 V, OFFSET = -70 % and Gain = 1.000:

$$AIx' = 5 + \left(\frac{(-70)}{100} \times 10\ V \right) \times 1 = -2\ V$$

AIx' = -2 V means that the motor will rotate in the reverse direction with a reference in module equal to 2 V, provided that the AIx function is "Speed Reference". For the AIx function "Maximum Torque Current", negative values are clipped at 0.0 %.

For the filter parameters (P0235 and P0240), the adjusted value corresponds to the RC constant used for filtering the signal read at the input.

P0233 – AI1 Signal Type

P0238 – AI2 Signal Type

Adjustable Range:	0 = 0 to 10 V / 20 mA 1 = 4 to 20 mA 2 = 10 V / 20 mA to 0 3 = 20 to 4 mA 4 = -10 V to +10 V	**Factory Setting:**	0
Properties:	cfg		
Access groups via HMI:	I/O		

Description:

These parameters configure the signal type (if it is current or voltage) that will be read at each analog input, as well as its range. Refer to the tables 13.1 and 13.2 for more details on this configuration.

Table 13.1: *DIP Switches related to the analog inputs*

Parameter	Input	Switch	Location
P0233	AI1	S1.2	Control Board
P0238	AI2	S1.1	

Table 13.2: *Configuration of the analog input signals*

P0238, P0233	Input Signal	Switch Position
0	(0 to 10) V / (0 to 20) mA	Off/On
1	(4 to 20) mA	On
2	(10 to 0) V / (20 to 0) mA	Off/On
3	(20 to 4) mA	On
4	(-10 to +10) V	Off

When current signals are used at the input, the switch corresponding to the desired input must be set in the "ON" position.

Inverse reference is obtained with the options 2 and 3, i.e., maximum speed is obtained with minimum reference.

13.1.2 Analog Outputs

In the CFW700 standard configuration are available 2 analog outputs (AO1 and AO2). The parameters related to those outputs are described next.

P0014 – AO1 Value

P0015 – AO2 Value

Adjustable Range:	0.00 to 100.00 %	**Factory Setting:**	
Properties:	ro		
Access groups via HMI:	I/O or READ		

Description:

Those read only parameters indicate the value of the analog outputs AO1 and AO2, as a percentage of the full scale. The indicated values are those obtained after the multiplication by the gain. Refer to the description of the parameters P0251 to P0256.

P0251 – AO1 Function

P0254 – AO2 Function

Adjustable Range:	0 = Speed Reference 1 = Total Reference 2 = Real Speed 3 = Torque Current Reference 4 = Torque Current 5 = Output Current 6 = Active Current 7 = Output Power 8 = Torque Current > 0 9 = Motor Torque 10 = SoftPLC 11 = PTC 12 = Motor Ixt 13 = Encoder Speed 14 = P0696 Value 15 = P0697 Value 16 = Id* Current 17 = Application Function 1 18 = Application Function 2 19 = Application Function 3 20 = Application Function 4 21 = Application Function 5 22 = Application Function 6 23 = Application Function 7 24 = Application Function 8	**Factory Setting:**	P0251=2 P0254=5
Properties:			
Access groups via HMI:	I/O		

Description:

These parameters set the functions of the analog outputs.

P0252 – AO1 Gain

P0255 – AO2 Gain

Adjustable Range:	0.000 to 9.999	**Factory Setting:**	1.000
Properties:			
Access groups via HMI:	I/O		

Description:

They adjust the analog output gains. Refer to the figure 13.3.

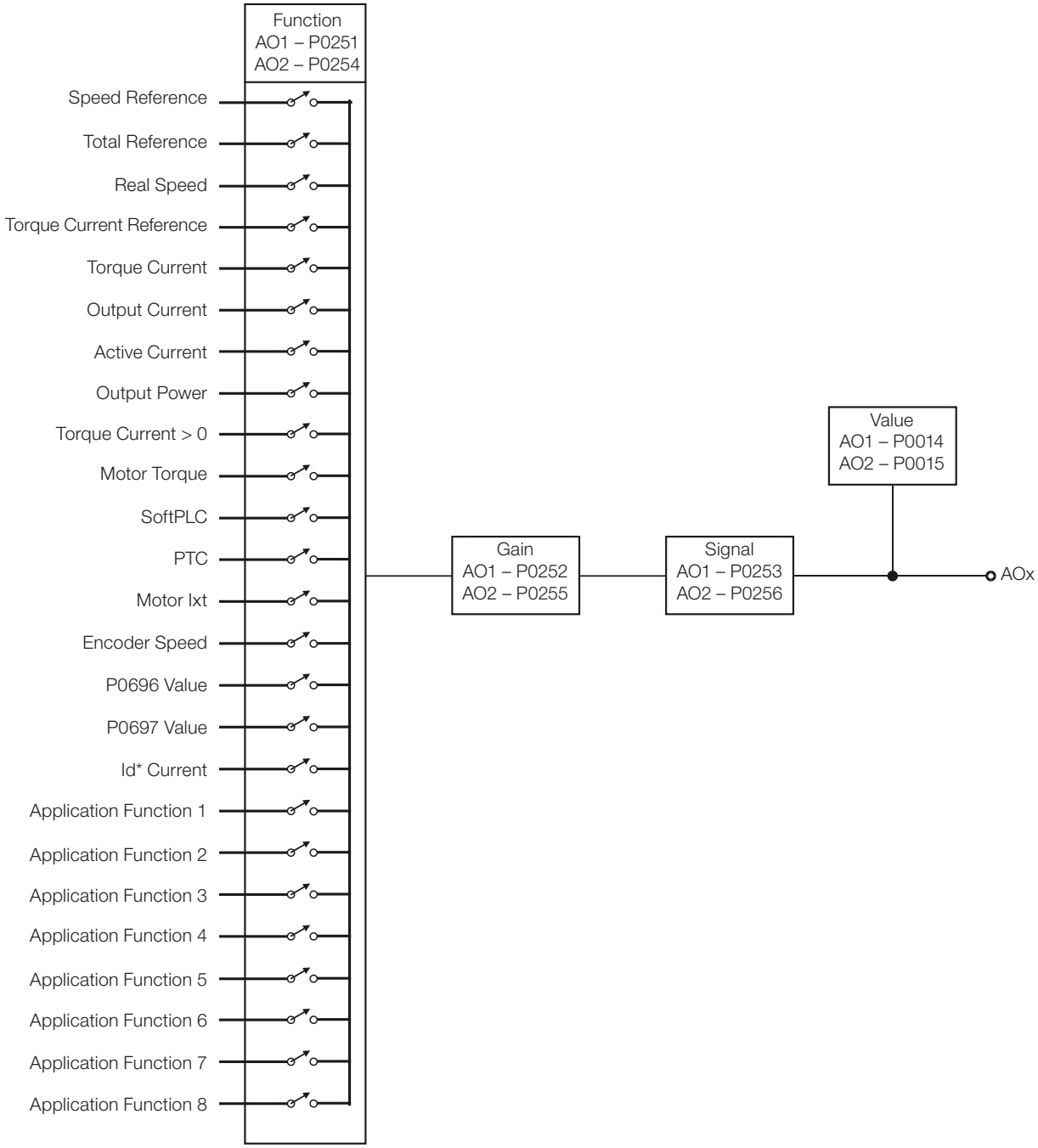


Figure 13.3: *Analog output block diagram*

Table 13.3: Full scale

Scale of the Analog Output Indications	
Variable	**Full Scale (*)**
Speed Reference	P0134
Total Reference	
Real Speed	
Encoder Speed	
Torque Current Reference	2.0 x I_{nomHD}
Torque Current	
Torque Current > 0	
Motor Torque	2.0 x I_{nom}
Output Current	1.5 x I_{nomHD}
Active Current	
Output Power	1.5 x √3 x P0295 x P0296
Motor Ixt	100 %
SoftPLC	32767
P0696 Value	
P0697 Value	

(*) When the signal is inverse (10 to 0 V, 20 to 0 mA or 20 to 4 mA) the values in the table become the beginning of the scale.

P0253 – AO1 Signal Type

P0256 – AO2 Signal Type

Adjustable Range:	0 = 0 to 10 V / 20 mA 1 = 4 to 20 mA 2 = 10 V / 20 mA to 0 3 = 20 to 4 mA	**Factory Setting:**	0
Properties:	cfg		
Access groups via HMI:	I/O		

Description:

These parameters configure if the analog output signal will be in current or voltage, with direct or inverse reference.

In order to adjust these parameters, it is also necessary to set the “DIP switches” of the control board according to the tables 13.4 and 13.5.

Table 13.4: DIP switches related to the analog outputs

Parameter	Output	Switch	Location
P0253	AO1	S1.3	Control Board
P0256	AO2	S1.4	

Table 13.5: Configuration of the analog outputs AO1 and AO2 signals

P0253, P0256	Output Signal	Switch Position
0	(0 to 10) V / (0 to 20) mA	On / Off
1	(4 to 20) mA	Off
2	(10 to 0) V / (20 to 0) mA	On / Off
3	(20 to 4) mA	Off

For AO1 and AO2, when current signals are used, the switch corresponding to the desired output must be set in the “OFF” position.

13.1.3 Digital Inputs

The CFW700 has 8 digital inputs in the standard version. The parameters that configure those inputs are presented next.

P0012 – DI8 to DI1 Status

Adjustable Range:	Bit 0 = DI1 Bit 1 = DI2 Bit 2 = DI3 Bit 3 = DI4 Bit 4 = DI5 Bit 5 = DI6 Bit 6 = DI7 Bit 7 = DI8	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ or I/O	

Description:

By means of this parameter it is possible to visualize the status of the 8 control board digital inputs (DI1 to DI8).

The indication is done by means of the numbers 1 and 0, representing respectively the “Active” and “Inactive” states of the inputs. The state of each input is considered as one digit in the sequence where DI1 represents the least significant digit.

Example: In case the sequence **10100010** is presented on the keypad (HMI), it will correspond to the following status of the DIs:

Table 13.6: *Digital inputs status*

DI8	DI7	DI6	DI5	DI4	DI3	DI2	DI1
Active (+24 V)	Inactive (0 V)	Active (+24 V)	Inactive (0 V)	Inactive (0 V)	Inactive (0 V)	Active (+24 V)	Inactive (0 V)

P0263 – DI1 Function

P0264 – DI2 Function

P0265 – DI3 Function

P0266 – DI4 Function

P0267 – DI5 Function

P0268 – DI6 Function

P0269 – DI7 Function

P0270 - DI8 Function

Adjustable Range:	0 = Not used 1 = Run/Stop 2 = General Enable 3 = Fast Stop 4 = FWD/REV 5 = LOC/REM 6 = JOG 7 = SoftPLC 8 = Ramp 2 9 = Speed/Torque 10 = JOG+ 11 = JOG- 12 = No Ext. Alarm 13 = No Ext. Fault 14 = Reset 15 = Disable FlyStart 16 = DC Link Regul. 17 = Program. Off 18 = Load User 1 19 = Load User 2 20 = Application Function 1 21 = Application Function 2 22 = Application Function 3 23 = Application Function 4 24 = Application Function 5 25 = Application Function 6 26 = Application Function 7 27 = Application Function 8	**Factory Setting:**	P0263=1 P0264=4 P0265=0 P0266=0 P0267=6 P0268=8 P0269=0 P0270=0
Properties:	cfg		
Access groups via HMI:	I/O		

Description:

Those parameters make it possible to configure the functions of the digital inputs, according to the listed range.

Some notes regarding the Digital Input functions are presented next.

- **Run/Stop:** In order to assure the correct operation of this function, it is necessary to program P0224 and/or P0227 in 1.
- **Local/Remote:** When programmed, this function activates “Local” when 0 V is applied to the input, and “Remote” when +24 V are applied. It is also necessary to program P0220=4 (DIx).
- **Speed/Torque:** This function is valid for P0202=4 or 5 (Sensorless Vector Control or Vector with Encoder), and “Speed” is selected with 0 V applied to the input, whereas “Torque” by applying 24 V.

When **Torque** is selected, the speed regulator parameters P0161 and P0162 become inactive **(*)**. Thus the Total Reference becomes the Torque Regulator input. Refer to the figures 11.1 and 11.2.

(*) The speed regulator of the PID type is converted into a P type, with proportional gain 1.00 and a null integral gain.

When **Speed** is selected, the gains of the speed regulator become again defined by P0161 and P0162. In the applications with torque control it is recommended to follow the method described at the parameter P0160.

- **DC Link Regulation:** It must be used when P0184=2. For more details, refer to this parameter description in item 11.8.7 - DC Link Regulator, of this manual.

- **JOG+ and JOG-:** Those are functions valid only for P0202=5 or 4.

- **Disables Flying-Start:** It is valid for P0202≠5. By applying +24 V to the digital input programmed for this purpose, the Flying-Start function is disabled. By applying 0 V, the Flying-Start function is enabled again, provided that P0320 be equal to 1 or 2. Refer to the section 12.5 - Flying Start/Ride-Through.

- **Load User 1:** This function allows the selection of the user memory 1, in a similar process than P0204=7, with the difference that the user memory is loaded from a transition of the DIx programmed for this function.

When the state of the DIx changes from low level to high level (transition from 0 V to 24 V), the user memory 1 is loaded, provided that the contents of the inverter actual parameters had been previously transferred to the parameter memory 1 (P0204=9).

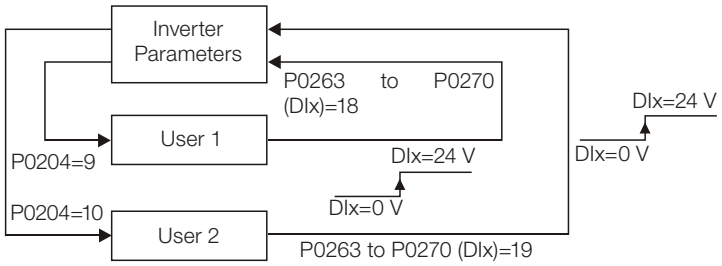


Figure 13.4: *Details on the working of the Load User 1 or 2 function*

- **Load User 2:** This function allows the selection of the user memory 2, in a similar process than P0204=8, with the difference that the user memory is loaded from a transition of the DIx programmed for this function.

When the state of the DIx changes from low level to high level (transition from 0 V to 24 V), the user memory 2 is loaded, provided that the contents of the inverter actual parameters had been previously transferred to the parameter memory 2 (P0204=10).

NOTES!
Make sure that when using those functions the parameter sets (user memory 1, 2) be totally compatible with the application (motors, Run/Stop commands, etc.).

It will not be possible to load the user memory with the inverter enabled.

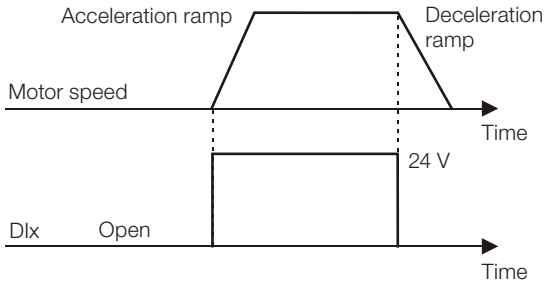
If two parameter sets from different motors were saved in the user memories 1 and 2, the correct current values must be adjusted at the parameters P0156, P0157 and P0158 for each user memory.

- **Parametrization Blocking:** When this function is programmed and the digital input is with +24 V, parameter changes will not be allowed, regardless of the values set at P0000 and P0200. When the DIx input is with 0 V, the parameter changes will be conditioned to the P0000 and P0200 settings.

- **No External Alarm:** This function will indicate “External Alarm” (A090) on the keypad (HMI) display when the programmed digital input is open (0 V). If +24 V is applied to the input, the alarm message will disappear automatically from the keypad (HMI) display. The motor keeps working normally, regardless of the state of that input.

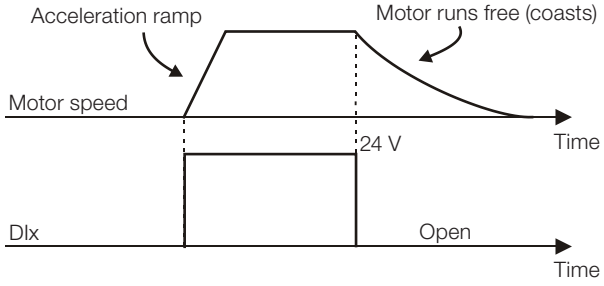
- **Application Function:** Sets the input to be used by the applications. For more details, refer to chapter 19 - Applications.

(a) RUN/STOP



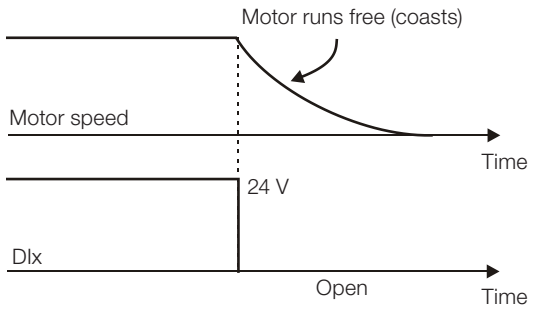
Note: All the digital inputs programmed for General Enable, Fast Stop, Forward Run or Reverse Run must be in the ON state, so that the CFW700 operates as described above.

(b) GENERAL ENABLE

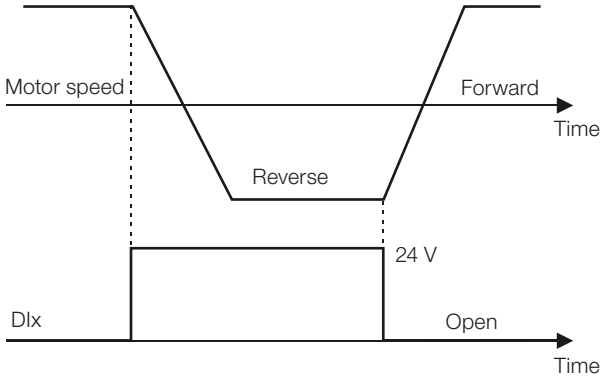


Note: All the digital inputs programmed for Run/Stop, Fast Stop, Forward Run or Reverse Run must be in the ON state, so that the CFW700 operates as described above.

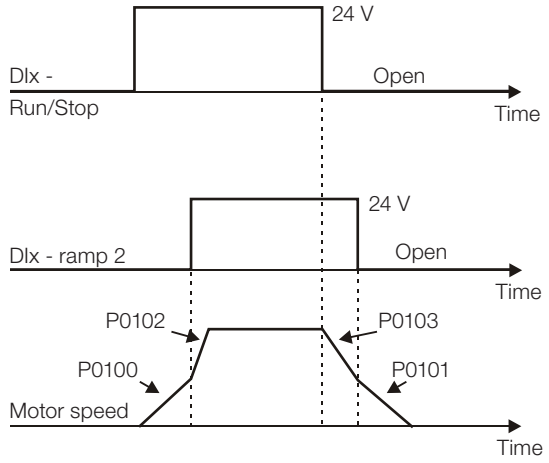
(c) NO EXTERNAL FAULT



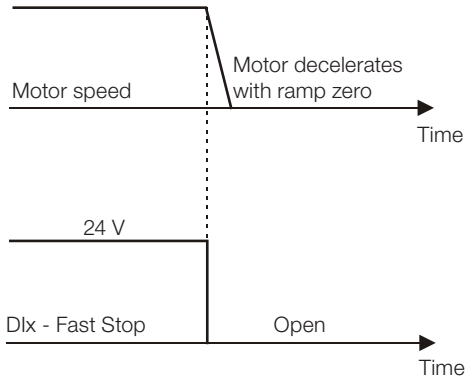
(d) FWD/REV



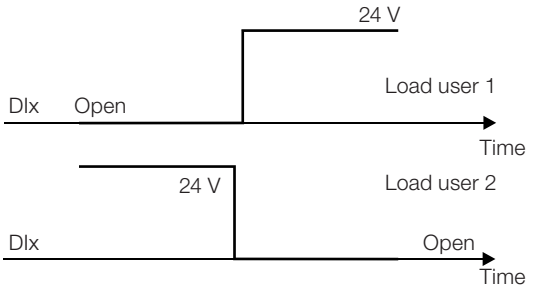
(e) RAMP 2



(f) FAST STOP



(g) LOAD USER VIA DIx



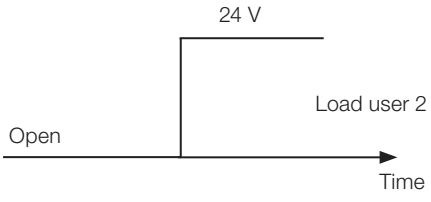
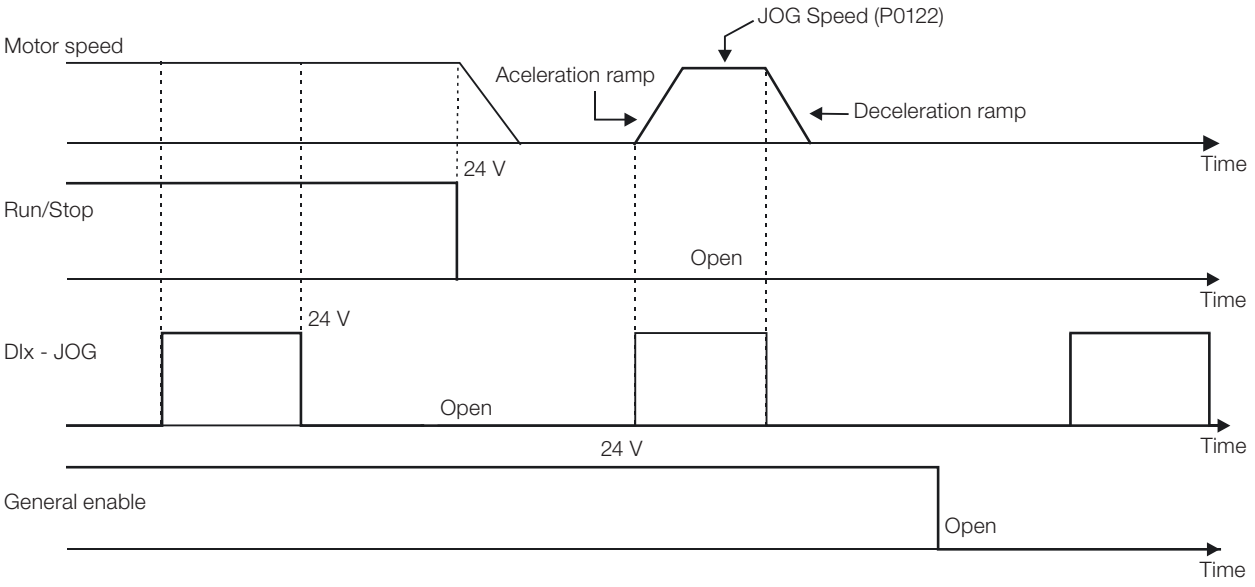
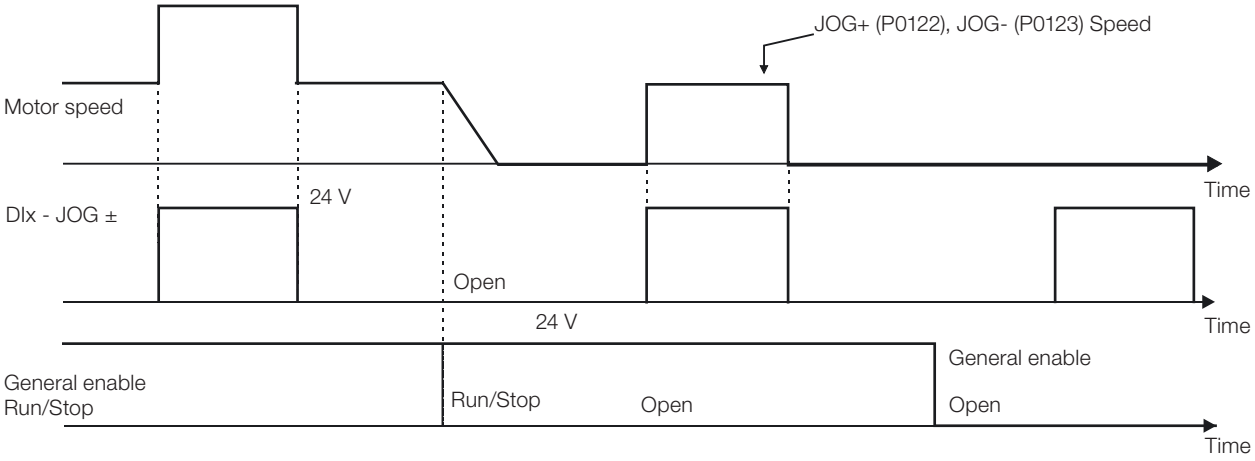


Figure 13.5 (a) to (g): Details on the operation of the digital input functions

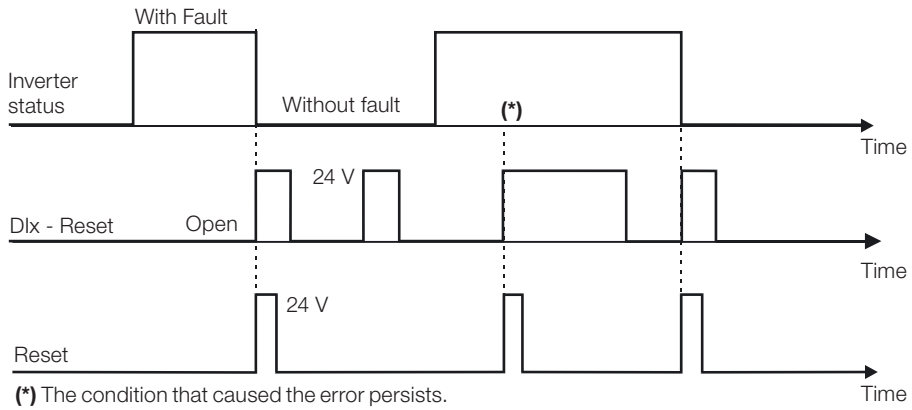
(h) JOG



(i) JOG + and JOG -



(j) RESET



(*) The condition that caused the error persists.

Figure 13.5 (h) to (j) (cont.): *Details on the operation of the digital input functions*

13.1.4 Digital Outputs / Relays

The CFW700 has one digital output relay and 4 open collector outputs available in the control board as standard. The next parameters configure the functions related to those outputs.

P0013 – DO5 to DO1 Status

Adjustable Range:	Bit 0 = DO1 Bit 1 = DO2 Bit 2 = DO3 Bit 3 = DO4 Bit 4 = DO5	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ or I/O	

Description:

By means of this parameter it is possible to visualize the status of the control board 5 digital outputs (DO1 to DO5).

The indication is done by means of the numbers “1” and “0”, representing respectively the “Active” and “Inactive” states of the outputs. The state of each output is considered as one digit in the sequence where DO1 represents the least significant digit.

Example: In case the sequence **00010010** is presented on the keypad (HMI), it will correspond to the following status of the DOs:

Table 13.7: *Digital outputs status*

DO5	DO4	DO3	DO2	DO1
Active (+24 V)	Inactive (0 V)	Inactive (0 V)	Active (+24 V)	Inactive (0 V)

P0275 – DO1 Function (RL1)

P0276 – DO2 Function

P0277 – DO3 Function

P0278 – DO4 Function

P0279 – DO5 Function

Adjustable Range:	0 = Not Used 1 = N* > Nx 2 = N > Nx 3 = N < Ny 4 = N = N* 5 = Zero Speed 6 = Is > Ix 7 = Is < Ix 8 = Torque > Tx 9 = Torque < Tx 10 = Remote 11 = Run 12 = Ready 13 = No Fault 14 = No F070 15 = No F071 16 = No F006/21/22 17 = No F051 18 = No F072 19 = 4-20 mA OK 20 = P0695 Value 21 = Forward 22 = Ride-Through 23 = Pre-Charge OK 24 = Fault 25 = Enabled Time > Hx 26 = SoftPLC 27 = N>Nx/Nt>Nx 28 = F > Fx (1) 29 = F > Fx (2) 30 = STO 31 = No F160 32 = No Alarm 33 = No Fault and No Alarm 34 = Application Function 1 35 = Application Function 2 36 = Application Function 3 37 = Application Function 4 38 = Application Function 5 39 = Application Function 6 40 = Application Function 7 41 = Application Function 8	**Factory Setting:**	P0275=13 P0276=2 P0277=1 P0278=0 P0279=0
Properties:	cfg		
Access groups via HMI:	I/O		

Description:

They program the functions of the digital outputs, according to the options presented previously.

When the condition declared by the function is true, the digital output will be activated.

Example: Is>Ix function – when Is>Ix then DOx=saturated transistor and/or relay with the coil energized, and when Is≤Ix then DOx=open transistor and/or relay with the coil not energized.

Some notes regarding the Digital and Relay Outputs are presented next.

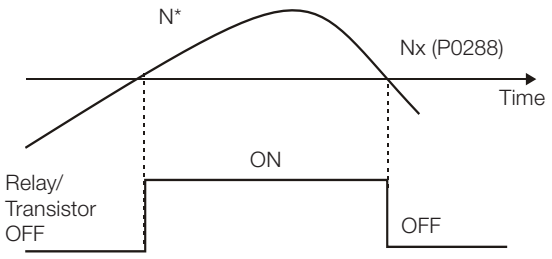
- **Not Used:** it means that the digital outputs will remain always in a resting state, i.e., DOx=open transistor and/or relay with the coil not energized.
- **Zero Speed:** it means that the motor speed is below the value adjusted in P0291 (Zero Speed).
- **Torque > Tx and Torque < Tx:** they are valid only for P0202=5 or 4 (Vector Control). In those functions "Torque" corresponds to the motor torque as indicated at parameter P0009.
- **Remote:** it means that the inverter is operating in Remote situation.
- **Run:** it corresponds to enabled inverter. In this moment the IGBTs are commutating, and the motor may be at any speed, including zero.
- **Ready:** it corresponds to the inverter without fault and without undervoltage.
- **No Fault:** it means that the inverter is not disabled by any type of fault.
- **No F070:** it means that the inverter is not disabled by the F070 fault (Overcurrent or Short-circuit).
- **No F071:** it means that the inverter is not disabled by the F071 fault (Output Overcurrent).
- **No F006+F021+F022:** it means that the inverter is not disabled by the F006 fault (Input Voltage Imbalance or Phase Loss), neither by F021 (DC Link Undervoltage), nor by F022 (DC Link Overvoltage).
- **No F051:** it means that the inverter is not disabled by the F051 fault (IGBT Overtemperature).
- **No F072:** it means that the inverter is not disabled by the F072 fault (Motor Overload).
- **4 - 20 mA OK:** it means that the current reference (4 to 20 mA) at the analog inputs AIx is inside the 4 to 20 mA range.
- **P0695 Value:** it means that the state of the digital output will be controlled by P0695, which is written via the network. Refer to the CFW700 Serial communication manual for more details on this parameter.
- **Forward:** it means that when the motor is rotating in the forward direction the DOx=saturated transistor and/or relay with the coil energized, and when the motor is rotating in the reverse direction, the DOx=open transistor and/or relay with the coil not energized.
- **Ride-Through:** it means that the inverter is executing the Ride-Through function.
- **Pre-charge OK:** it means that the DC Link voltage is above the pre-charge voltage level.
- **Fault:** it means that the inverter is disabled by any type of fault.
- **N > Nx and Nt > Nx:** (valid only for P0202=5 – Vector with Encoder) it means that both the conditions must be satisfied so that DOx=saturated transistor and/or relay with the coil energized. In other words, it is enough that the condition N>Nx be not satisfied (regardless of the Nt>Nx condition) so that DOx=open transistor and/or relay with the coil not energized.
- **SoftPLC:** it means that the digital output state will be controlled by the programming done in the memory area reserved to the SoftPLC function. Refer to the SoftPLC manual for more details.
- **STO:** it signalizes the STO state (Safety Stop active).
- **No F160:** it signalizes that the inverter is not disabled by F160 fault (Safety Stop Relay).
- **No Alarm:** it means that the inverter is not in the alarm condition.

- **No Fault and No Alarm:** it means that the inverter is not disabled by any type of fault and it is not in alarm condition.

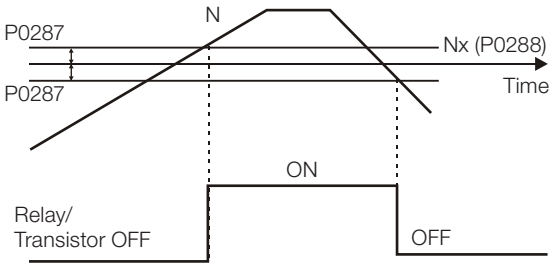
Definitions of the symbols used in the function:

N = P0002 (Motor Speed).
N* = P0001 (Speed Reference).
Nx = P0288 (Nx Speed) – It is a reference point of the speed selected by the user.
Ny = P0289 (Ny Speed) – It is a reference point of the speed selected by the user.
Ix = P0290 (Ix Current) – It is a reference point of the current selected by the user.
Is = P0003 (Motor Current).
Torque = P0009 (Motor Torque).
Tx = P0293 (Tx Torque) – It is a reference point of the torque selected by the user.
Nt = Total Reference (refer to the figure 13.7).
Hx = P0294 (Hx Time).
F = P0005 (Motor Frequency).
Fx = P0281 (Fx Frequency) – It is a reference point of the motor frequency selected by the user.

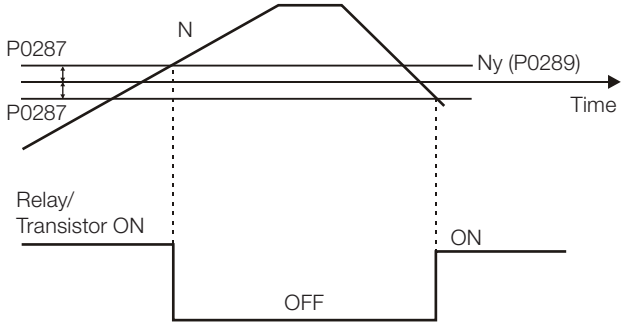
(a) N* > Nx



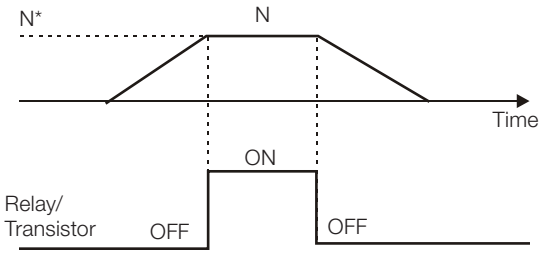
(b) N > Nx



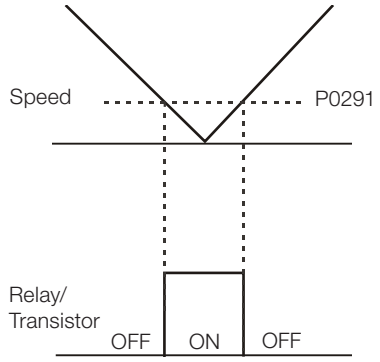
(c) N < Ny



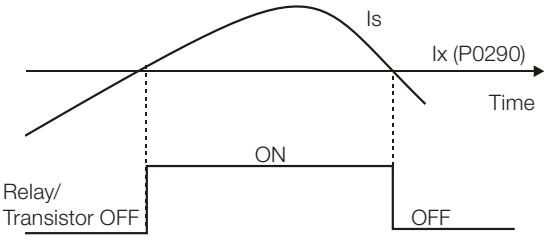
(d) N = N*



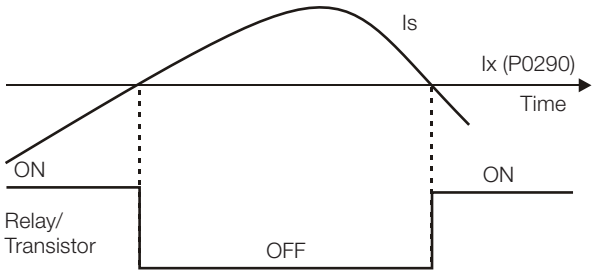
(e) N = 0 (Zero) Speed



(f) Is > Ix



(g) Is < Ix



(h) Torque > Tx

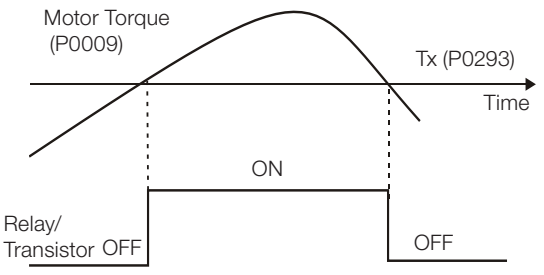
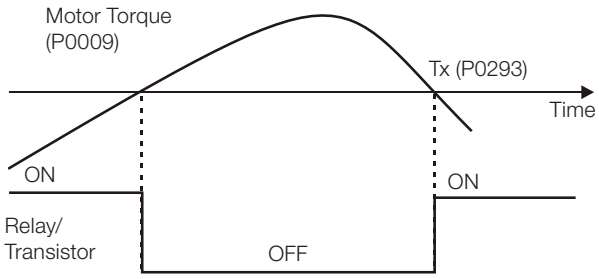
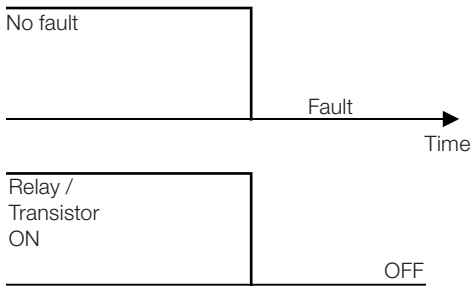


Figure 13.6 (a) to (h): *Details on the operation of the digital and relay output functions*

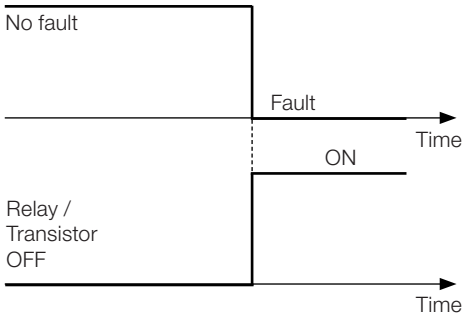
(i) Torque <Tx



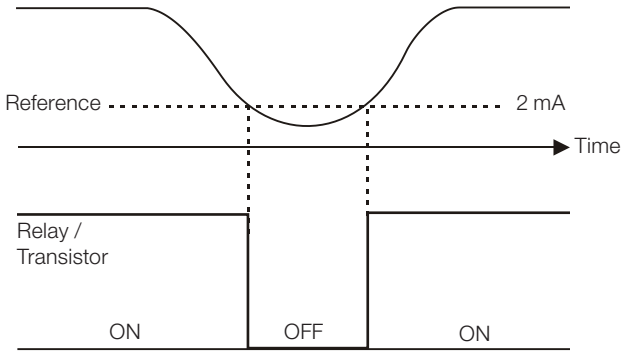
(j) No fault



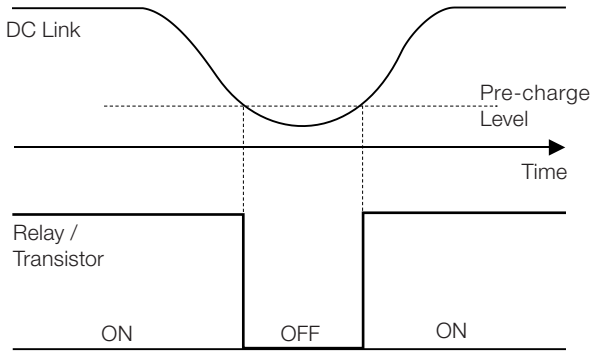
(k) Fault



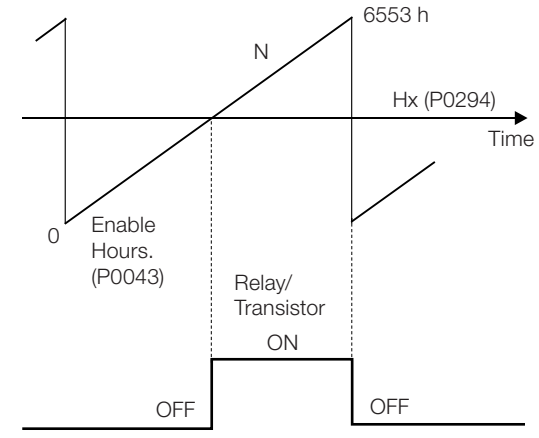
(l) 4-20 mA Reference OK



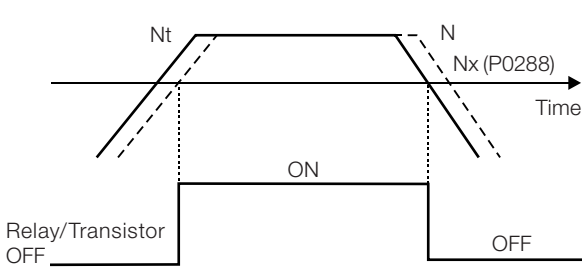
(m) Pre-Charge Ok



(n) Enabled Time > Hx



(o) N > Nx and Nt > Nx



(p) F > Fx (1)

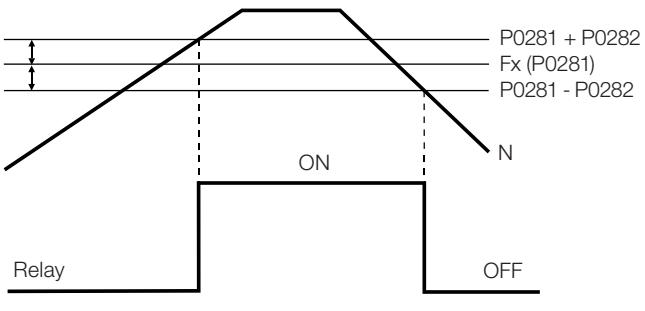


Figure 13.6 (i) to (p) (cont.): *Details on the operation of the digital and relay output functions*

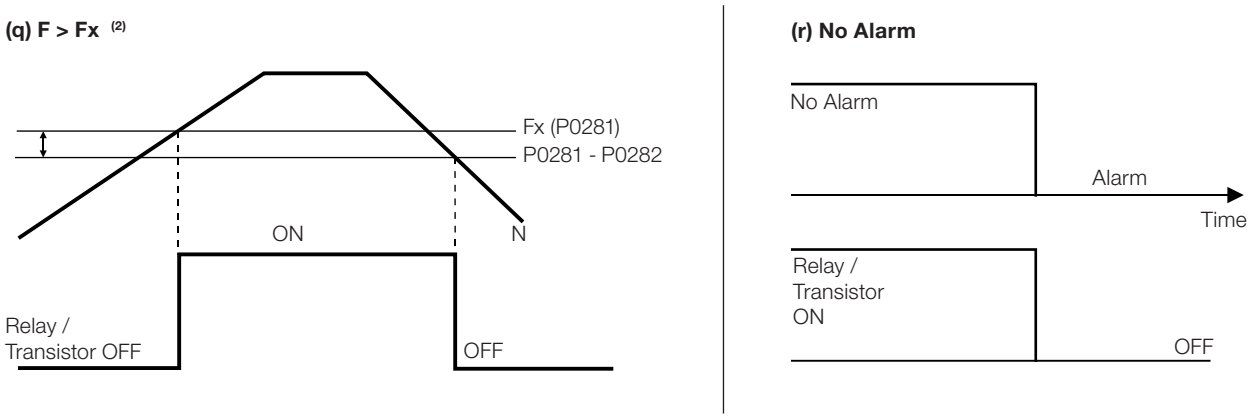


Figure 13.6 (q) and (r) (cont.): *Details on the operation of the digital and relay output functions*

P0281 – Fx Frequency

Adjustable Range:	0.0 to 300.0 Hz	**Factory Setting:**	4.0 Hz
Properties:			
Access groups via HMI:			

Description:

It is used in the digital output and relay functions:

F > Fx(1) and F > Fx (2)

P0282 – Fx Hysteresis

Adjustable Range:	0.0 to 15.0 Hz	**Factory Setting:**	2.0 Hz
Properties:			
Access groups via HMI:			

Description:

It is used in the digital output and relay functions:

F > Fx(1) and F > Fx (2)

P0287 – Nx/Ny Hysteresis

Adjustable Range:	0 to 900 rpm	**Factory Setting:**	18 rpm (15 rpm)
Properties:			
Access groups via HMI:			

Description:

It is used in the **N > Nx** and **N < Ny** functions of the digital and relay outputs.

P0288 – Nx Speed

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**	120 rpm (100 rpm)

P0289 – Ny Speed

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**	1800 rpm (1500 rpm)
Properties:			
Access groups via HMI:			

Description:

They are used in the **N* > Nx, N > Nx,** and **N < Ny** functions of the digital and relay outputs.

P0290 – Ix Current

Adjustable Range:	0 to 2 x $I_{nom\text{-}ND}$	**Factory Setting:**	1.0 x $I_{nom\text{-}ND}$
Properties:			
Access groups via HMI:			

Description:

It is used in the **Is > Ix** and **Is < Ix** functions of the digital and relay outputs.

P0291 – Zero Speed

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**	18 rpm (15 rpm)
Properties:			
Access groups via HMI:			

Description:

It specifies the value in rpm below which the actual speed will be considered null for the Zero Speed Disable function.

This parameter is also used by the functions of the digital and relay outputs.

P0292 – N = N* Band

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**	18 rpm (15 rpm)
Properties:			
Access groups via HMI:			

Description:

It is used in the **N = N*** function of the digital and relay outputs.

P0293 – Tx Torque

Adjustable Range:	0 to 200 %	**Factory Setting:**	100 %
Properties:			
Access groups via HMI:			

Description:

It is used in the **Torque > Tx** and **Torque < Tx** functions of the digital and relay outputs.

In those functions the motor torque indicated in P0009 is compared with the value adjusted in P0293.

The setting of this parameter is expressed as a percentage of the motor rated current (P0401=100 %).

P0294 – Hx Time

Adjustable Range:	0 to 6553 h	**Factory Setting:**	4320 h
Properties:			
Access groups via HMI:			

Description:

It is used in the **Enabled Hours > Hx** function of the digital and relay outputs.

13.2 LOCAL AND REMOTE COMMAND

In those parameter groups one can configure the origin of the main inverter commands when in the LOCAL or in the REMOTE situation, as the Speed Reference, Speed Direction, Run/Stop and JOG.

P0220 – LOCAL/REMOTE Selection Source

Adjustable Range:	0 = Always Local 1 = Always Remote 2 = Local/Remote Key Local 3 = Local/Remote Key Remote 4 = DIx 5 = Serial Local 6 = Serial Remote 7 = CANopen / DeviceNet / Profibus DP Local 8 = CANopen / DeviceNet / Profibus DP Remote 9 = SoftPLC Local 10 = SoftPLC Remote	**Factory Setting:**	2
Properties:	cfg		
Access groups via HMI:	I/O		

Description:

It defines the origin of the command that will select between the LOCAL situation and the REMOTE situation, where:

- LOCAL: Means Local Default situation.
- REMOTE: Means Remote Default situation.
- DIx: Refer to item 13.1.3 - Digital Inputs.

P0221 – Speed Reference Selection – LOCAL Situation

P0222 – Speed Reference Selection – REMOTE Situation

Adjustable Range:	0 = HMI 1 = AI1 2 = AI2 3 = AI1+AI2 > 0 (Sum AIs>0) 4 = AI1+AI2 (Sum AIs) 5 = Serial 6 = CANopen/DeviceNet/Profibus DP 7 = SoftPLC	**Factory Setting:**	P0221=0 P0222=1
Properties:	cfg		
Access groups via HMI:	I/O		

Description:

They define the origin of the Speed Reference in the LOCAL situation and in the REMOTE situation.

Some notes about the options for those parameters:

- The AIx' designation refers to the analog signal obtained after the addition of the AIx input to the offset and its multiplication by the applied gain (refer to item 13.1.1 - Analog Inputs).
- The value of the reference adjusted with the  and  is contained in the parameter P0121.

P0223 – FORWARD/REVERSE Selection - LOCAL Situation

P0226 – FORWARD/REVERSE Selection - REMOTE Situation

Adjustable Range:	0 = Forward 1 = Reverse 2 = Forward/Reverse Key (FWD) 3 = Forward/Reverse Key (REV) 4 = DIx 5 = Serial (FWD) 6 = Serial (REV) 7 = CANopen/DeviceNet/Profibus DP (FWD) 8 = CANopen/DeviceNet/Profibus DP (REV) 9 = SoftPLC (FWD) 10 = SoftPLC (REV) 11 = AI2 Polarity	**Factory Setting:**	P0223=2 P0226=4
Properties:	cfg		
Access groups via HMI:	I/O		

Description:

They define the origin of the "Speed Direction" command in the LOCAL situation and in the REMOTE situation, where:

- FWD: Means Forward Default situation.
- REV: Means Reverse Default situation.
- DIx: Refer to item 13.1.3 - Digital Inputs.

P0224 – Run/Stop Selection – LOCAL Situation

P0227 – Run/Stop Selection – REMOTE Situation

Adjustable Range:	0 = Keys I, O 1 = DIx 2 = Serial 3 = CANopen/DeviceNet/Profibus DP 4 = SoftPLC	**Factory Setting:**	P0224=0 P0227=1
Properties:	cfg		
Access groups via HMI:	I/O		

Description:

They define the origin of the Run/Stop command in the LOCAL situation and in the REMOTE situation.

P0225 – JOG Selection – LOCAL Situation

P0228 – JOG Selection – REMOTE Situation

Adjustable Range:	0 = Inactive 1 = JOG Key 2 = DIx 3 = Serial 4 = CANopen/DeviceNet/Profibus DP 5 = SoftPLC	**Factory Setting:**	P0225=1 P0228=2
Properties:	cfg		
Access groups via HMI:	I/O		

Description:

They define the origin of the JOG command in the LOCAL situation and in the REMOTE situation.

P0229 – Stop Mode Selection

Adjustable Range:	0 = Ramp to Stop 1 = Coast to Stop 2 = Fast Stop 3 = By Ramp with Iq* 4 = Fast Stop with Iq*	**Factory Setting:**	0
Properties:	cfg		
Access groups via HMI:			

Description:

It defines the motor stop mode when the inverter receives the “Stop” command. The table 13.8 describes the options of this parameter.

Table 13.8: Stop mode selection

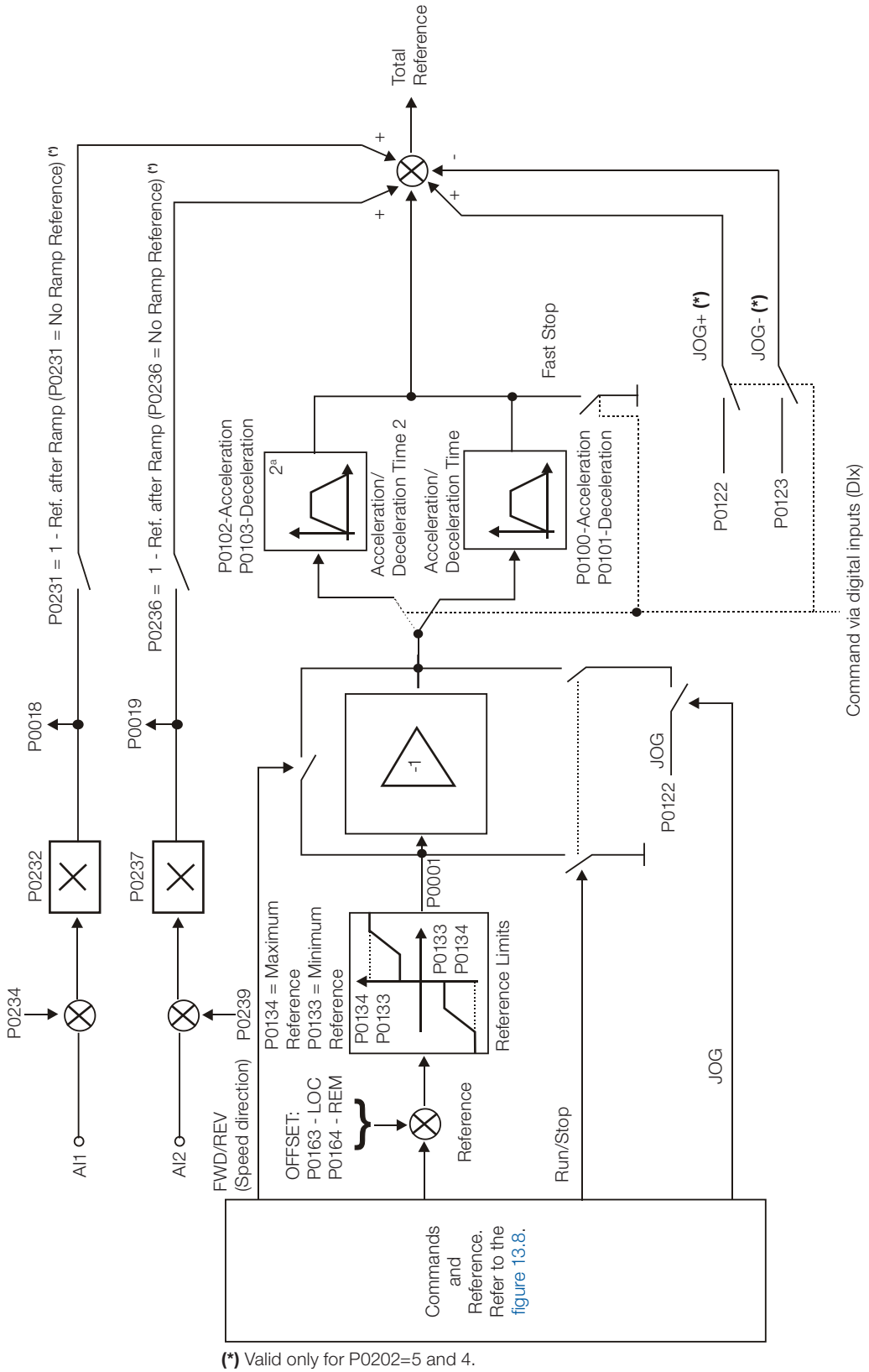
P0229	Description
0 = Ramp to Stop	The inverter will apply the ramp programmed P0101 and/or P0103.
1 = Coast to Stop	The motor will run free until stopping.
2 = Fast Stop	The inverter will apply a null ramp (time = 0.0 second), in order to stop the motor in the shortest possible time.
3 = By Ramp with Iq* reset	The inverter will apply the deceleration ramp programmed in P0101 or P0103, and will reset the torque current reference.
4 = Fast Stop with Iq* reset	The inverter will apply a null ramp (time = 0.0 second), in order to stop the motor in the shortest possible time, and will reset the torque current reference.

NOTE!
When the control modes V/f or VVW are selected, the use of the option 2 (Fast Stop) is not recommended.

NOTE!
When the Coast to Stop mode, is programmed and the Flying-Start function is not enabled, then start the motor again only if it is standing still.

NOTE!
Options 3 and 4 will operate only with P0202=5.

The difference in behavior, compared to the options 0 and 2, is in the torque current reference (Iq*) reset. This reset occurs during the inverter state transition from Run to Ready, after executing a Stop command. The purpose of the options 3 and 4 is to avoid that a high current reference value is stored in the speed regulator when, for instance, using a mechanical brake to stop the motor shaft before its speed is null.



(*) Valid only for P0202=5 and 4.

Figure 13.7: *Speed Reference block diagram*

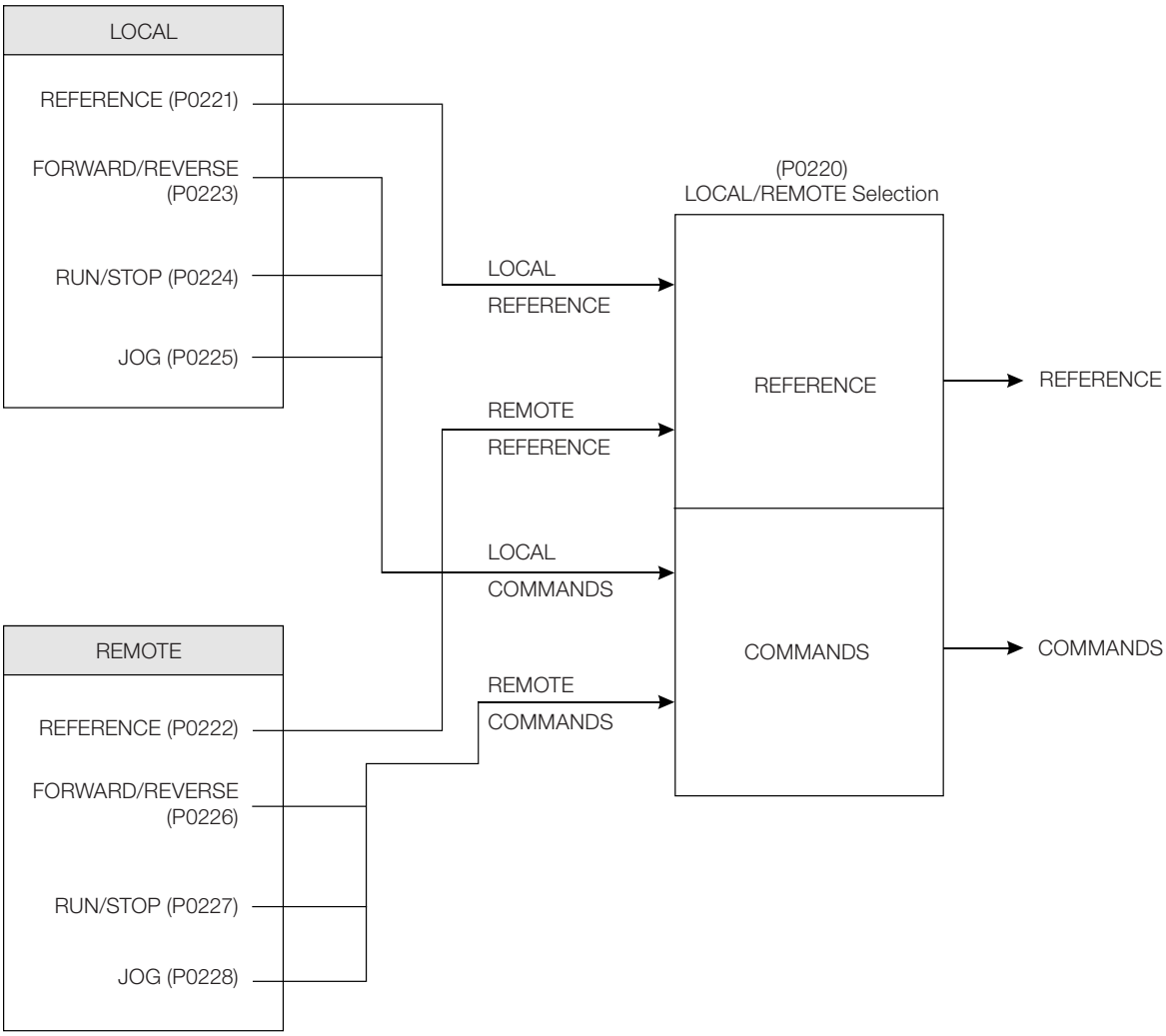


Figure 13.8: *Local/Remote situation block diagram*

14 DYNAMIC BRAKING

The braking torque that can be obtained through the application of frequency inverters without dynamic braking resistors varies from 10 % to 35 % of the motor rated torque.

In order to obtain higher braking torques, resistors for dynamic braking are used. In this case the regenerated energy is dissipated on the resistor mounted externally to the inverter.

This type of braking is used in the cases when short deceleration times are wished or when high inertia loads are driven.

For the vector control mode there is the possibility of the use of the “Optimal Braking”, eliminating in many cases the need of the dynamic braking.

The Dynamic Braking function can only be used if a braking resistor has been connected to the CFW700, and if the parameters related to it have been adjusted properly.

See next the description of the parameters in order to know how to program each one.

P0153 – Dynamic Braking Level

Adjustable Range:	339 to 400 V 585 to 800 V 585 to 800 V 585 to 800 V 585 to 800 V	**Factory Setting:**	P0296=0: 375 V P0296=1: 618 V P0296=2: 675 V P0296=3: 748 V P0296=4: 780 V
Properties:			
Access groups via HMI:			

Description:

The parameter P0153 defines the voltage level for the braking IGBT actuation, and it must be compatible with the power supply voltage.

If P0153 is adjusted at a level very close to the overvoltage (F022) actuation level, the fault may occur before the braking resistor is able to dissipate the regenerated energy.

The next table presents the overvoltage trip level.

Table 14.1: *Overvoltage (F022) trip levels*

Inverter V_{nom}	P0296	F022
220/230 V	0	> 400 V
380 V	1	> 800 V
400/415 V	2	
440/460 V	3	
480 V	4	

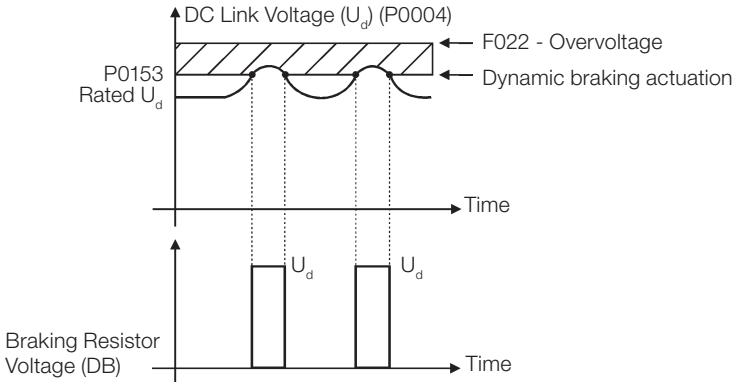


Figure 14.1: *Dynamic Braking actuation curve*

Steps to enable the dynamic braking:

- Connect the braking resistor. Refer to item 3.2.3.2 - Dynamic Braking (standard built-in for sizes A, B, C and D and optional built-in for size E - CFW700...DB...), of the user's manual.
- Set P0151 at the maximum value: 400 V (P0296=0) or 800 V (P0296=1, 2, 3 or 4), according to the case, in order to prevent the activation of the DC voltage regulation before the dynamic braking.

15 FAULTS AND ALARMS

The troubleshooting structure of the inverter is based on the indication of faults and alarms.

In a fault event the IGBTs firing pulses are disabled and the motor coasts to stop.

The alarm works as a warning to the user that critical operation conditions are occurring and a fault may occur if the situation does not change.

Refer to the CFW700 user's manual chapter 6 - Troubleshooting and Maintenance, and the section Quick Parameter Reference, Faults and Alarms of this manual to obtain more information regarding the Faults and Alarms.

15.1 MOTOR OVERLOAD PROTECTION

The Motor Overload protection is based on the use of curves that simulate the heating and cooling of the motor in overload events, according to IEC 60947-4-2 and UL 508C standards. The fault and alarm codes for the motor overload protection are F072 and A046, respectively.

The motor overload is given in function of the reference value In x SF (motor rated current multiplied by the service factor), which is the maximum value at which the protection must not actuate because the motor is able to operate indefinitely with this current value without suffering damages.

However, for that protection to act in an appropriate manner, the thermal image of the motor, which corresponds to the heating up and cooling down times of the motor, is estimated.

The thermal image, in its turn, depends on the motor thermal constant, which is estimated based on the motor power and number of poles.

The thermal image is important to allow that a derating in the fault actuation time be given, so that shorter actuation times be obtained when the motor is hot.

This function applies a derating in the fault actuation time depending on the output frequency supplied to the motor, because for the self-ventilated ones there will be less ventilation on the frame at lower speeds, and the motor will be subject to more heating. Thus, it becomes necessary to reduce the fault actuation time in order to prevent the motor from burning.

In order to assure more protection in case of restart, this function keeps the information regarding the motor thermal image in the CFW700 nonvolatile memory. Therefore, after the inverter restart, the function will use the value saved in the thermal memory to perform a new overload evaluation.

The parameter P0348 configures the desired protection level for the motor overload function. The possible options are: Fault and Alarm, only Fault, only Alarm, and disabled motor overload protection. The actuation level for the motor overload alarm (A046) is adjusted via P0349.

In order to get more information, refer to parameters P0156, P0159, P0348 and P0349 in the section 15.3 - Protections.

NOTE!
In order to assure the conformity of the CFW700 motor overload protection with the UL508C standard, observe the following:

- The “TRIP” current is equal to 1.25 times the motor nominal current (P0401) set in the “Oriented Start-up” menu.
- The maximum allowed value for P0159 (Motor Tripping Class) is 3 (Class 20).
- The maximum allowed value for P0398 (Motor Service Factor) is 1.15.

15.2 MOTOR OVERTEMPERATURE PROTECTION

ATTENTION!
The PTC must have a reinforced insulation against the live parts of the motor and of the installation.

This protection performs the motor overtemperature protection by means of the alarm (A110) and the fault (F078) indication.

The motor must have a PTC type temperature sensor. An analog output supplies constant current for the PTC (2 mA), while an inverter analog input reads the voltage across the PTC and compares it with the limit values for fault and alarm. Refer to the table 15.1. When those values are exceeded, the alarm or fault indication occurs.

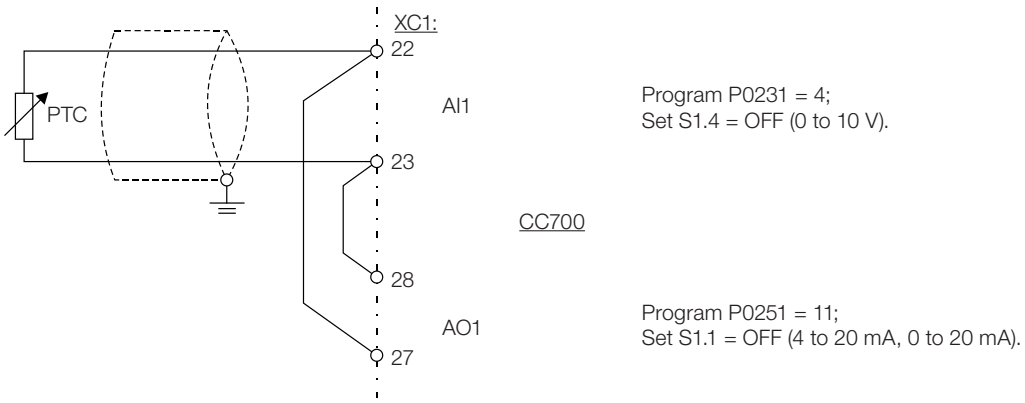
The analog outputs AO1 and AO2 of the control module can be used to supply the constant current for the PTC. Therefore it is necessary to configure the DIP switches of the output for current and to set the output function parameter for 11=PTC.

The analog inputs AI1 and AI2 of the control module can be used to read the PTC voltage. Therefore it is necessary to configure the input DIP switch for voltage and to set the input function parameter for 4=PTC. Refer to the parameter P0351 on the section 15.3 - Protections.

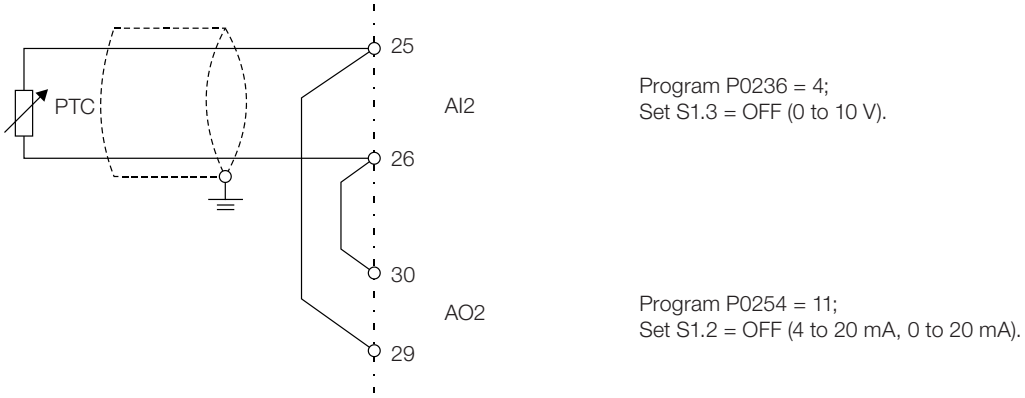
NOTE!
In order that this function works properly, it is important to keep gains and offset of the analog input and output in the default values.

Table 15.1: *A110 and F078 trip levels*

Action	PTC	AI Voltage
A110 occurs during the temperature increase	R_{PTC}>3.51 kΩ	V_{AI}>7.0 V
F078 trips during the temperature increase	R_{PTC}>3.9 kΩ	V_{AI}>7.8 V
Resets A110 alarm	150 Ω < R_{PTC}<1.6 kΩ	0.3<V_{AI}<3.2 V
Allows the reset of the F078 fault	150 Ω < R_{PTC}<1.6 kΩ	0.3<V_{AI}<3.2 V
F078 trips (minimum resistance detection)	R_{PTC}<60 Ω	<0.12 V



(a) AO1, AI1



(b) AO2, AI2

Figure 15.1 (a) to (b): *PTC connection examples*

15.3 PROTECTIONS

The parameters related to motor and inverter protections are found in this group.

P0030 – IGBTs Temperature

P0034 – Internal Air Temperature

Adjustable Range:	-20.0 to 150.0 °C	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

These parameters present, in Celsius degrees, the heatsink temperature (P0030) and also of the internal air (P0034).

They are useful to monitor the temperature on the main inverter sections in case of an occasional inverter overheating.

P0156 – 100 % Speed Overload Current

P0157 – 50 % Speed Overload Current

P0158 – 5 % Speed Overload Current

Adjustable Range:	0.1 to 1.5 x I_{nom-ND}	**Factory Setting:**	P0156=1.05x I_{nom-ND} P0157=0.9x I_{nom-ND} P0158=0.65x I_{nom-ND}
Properties:			
Access groups via HMI:			

Description:

These parameters are used for the motor overload protection (I x t – F072).

The motor overload current (P0156, P0157 and P0158) is the value from which the inverter starts considering that the motor is operating with overload.

The bigger the difference between the motor current and the overload current, the faster F072 trip will occur.

The parameter P0156 (Motor Overload Current at 100 % of its Rated Speed) must be adjusted 5 % higher than the motor rated current (P0401).

The overload current is given as a function of the speed being applied to the motor, according to the overload curve. The parameter P0156, P0157 and P0158 are the three points used to form the motor overload curve, as presented in the figure 15.2.

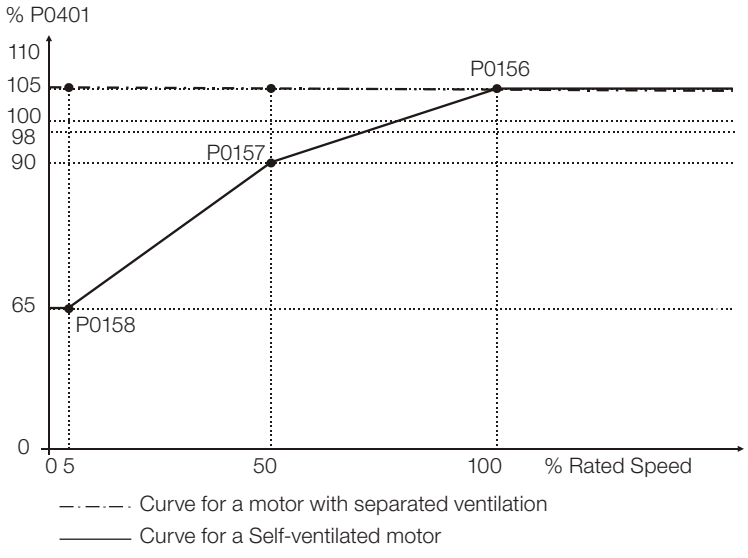


Figure 15.2: *Overload protection levels*

With the setting of the overload current curve, it is possible to set an overload value that varies according to the operation speed of the motor (factory setting), improving the protection for self-ventilated motors, or a constant overload level for any speed applied to the motor (motors with separated ventilation).

This curve is adjusted automatically when P0406 (Motor Ventilation) is set during the “Oriented Start-up” routine (refer to this parameter description in the section 11.7 - Motor Data).

P0159 – Motor Tripping Class

Adjustable Range:	0 = Class 5 1 = Class 10 2 = Class 15 3 = Class 20 4 = Class 25 5 = Class 30 6 = Class 35 7 = Class 40 8 = Class 45	**Factory Setting:**	1
Properties:	cfg		
Access groups via HMI:			

Description:

This parameter sets the motor thermal class, and the time for the correct actuation of the F072 fault depends on it. The higher the thermal class, the longer the fault actuation time will be.

ATTENTION!
The incorrect selection of the thermal class may cause the burning of the motor.

ATTENTION!
In order the CFW700 motor overload protection is in accordance with UL508C, the thermal class should be ≤20 (P0159 ≤ 3).

The necessary data for choosing the thermal class are the following:

- Motor rated current (I_n).
- Blocked rotor current (I_p).
- Blocked rotor time (T_{RB})**(*)**.
- Service factor (SF).

(*) It must be verified if the given blocked rotor time is for hot or cold motor, so that the correspondent thermal class curves be used.

With those values, the overload current and the overload time must be calculated using the following equations:

$$\text{Overload Current} = \frac{I_p}{I_n \times FS} \times 100\ (\%)$$

$$\text{Overload Time} = T_{BR}\ (s)$$

These equations provide the limit conditions for the error actuation, i.e., the motor cannot work with a longer fault actuation time than this one, because of burning risk. Thus, a thermal class immediately inferior must be chosen so that the motor protection is assured.

Example: For a motor with the following characteristics,

I_n = 10,8 A
T_{RB} = 4 s (hot motor blocked rotor time)
$I_p / I_n = 7,8 \Rightarrow I_p = 7,8 \times 10,8\ A = 84,2\ A$
FS = 1,15

One gets,

$$\text{Overload Current} = \frac{I_p}{I_n \times FS} = \frac{84,2}{10,8 \times 1,15} \times 100 = 678\ \%$$

Overload Time = T_{RB} = 4 s

After this, it is only necessary to plot the calculated values on the motor overload graph (figures 15.3 **(a)** or 15.3 **(b)**), and to select the thermal class curve immediately below the calculated point.

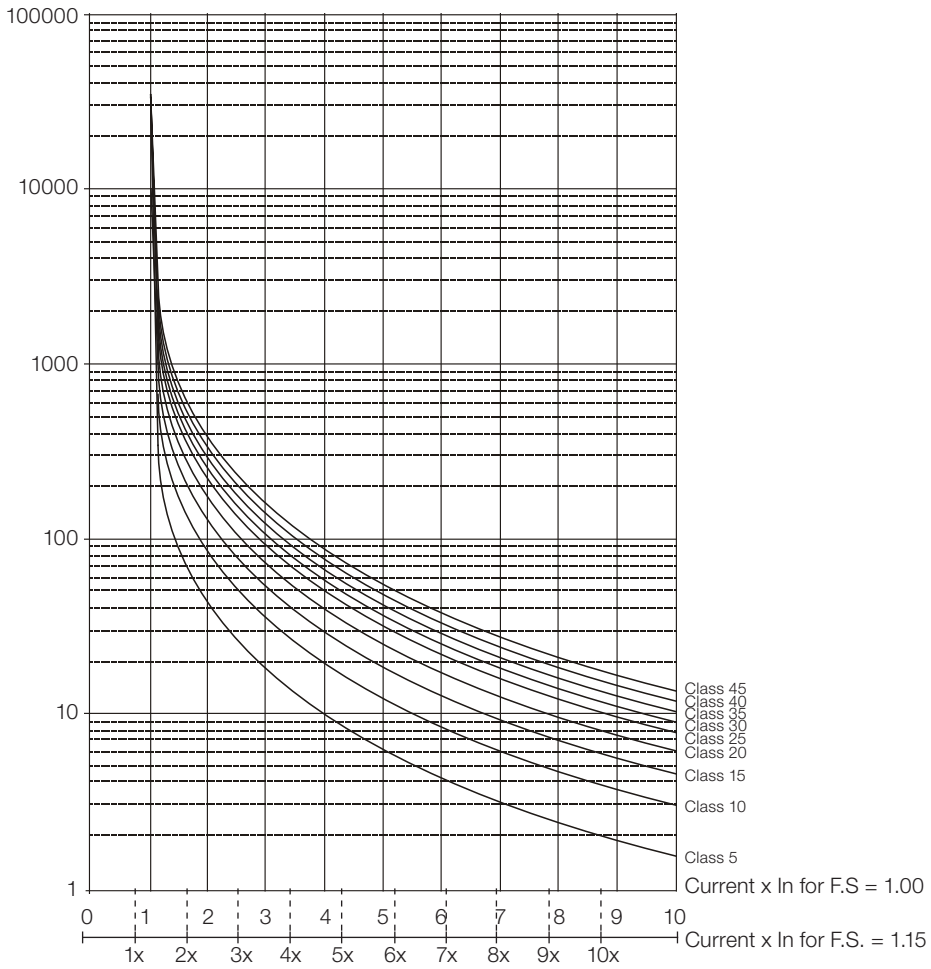


Figure 15.3 (a): *Cold motor overload curves for loads of the HD and ND types*

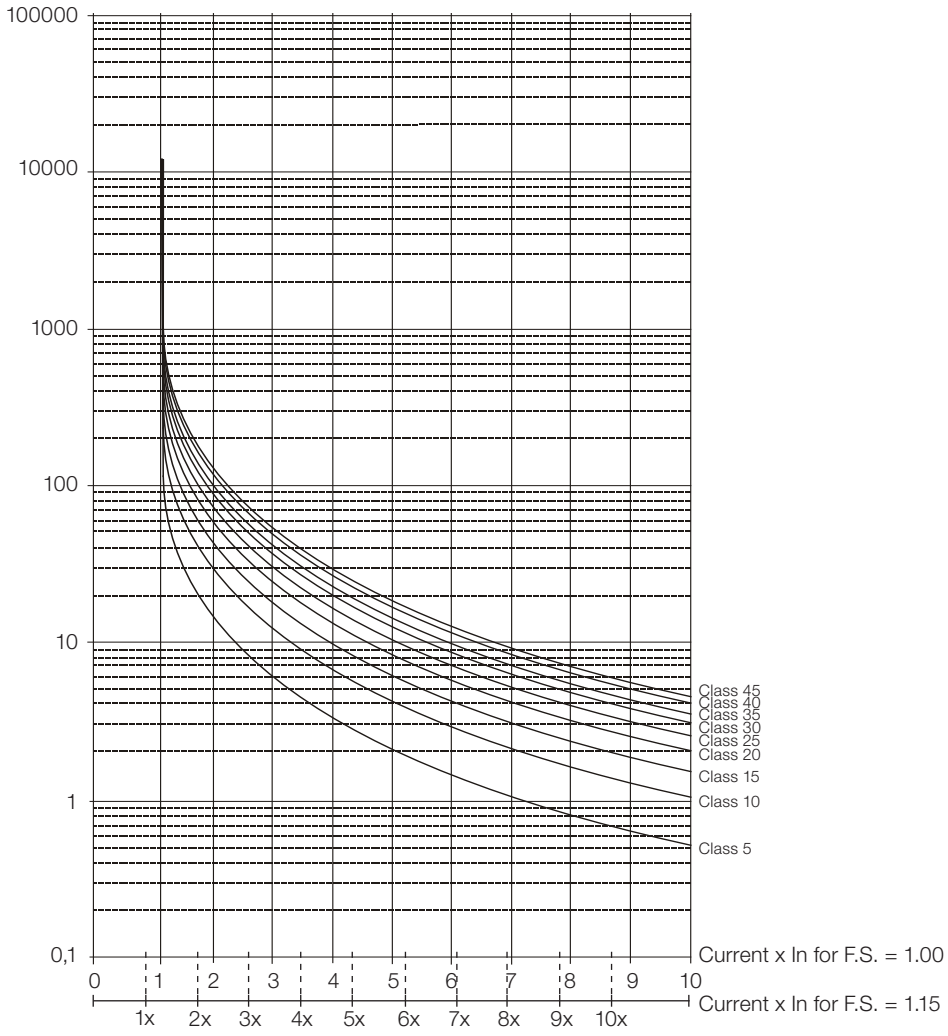


Figure 15.3 (b): *Hot motor overload curves for loads of the HD and ND types*

For the previous example, by plotting the 678 % value (x axis) of the Overload Current with the 4 seconds (y axis) of the Overload Time in the graph of the figure 15.3 **(b)** (hot motor), the thermal class to be selected will be the class 15 (t15).

P0340 – Auto-Reset Time

Adjustable Range:	0 to 255 s	**Factory Setting:**	0 s
Properties:			
Access groups via HMI:			

Description:

When a fault occurs (except F067 – Inverted Encoder/Motor Wiring and F099 – Invalid Current Offset), the inverter can reset itself automatically after the time set in P0340 has elapsed.

NOTE!
The faults F051, F078 and F156 allow a conditional Reset, i.e., the Reset will only occur if the temperature gets back to the normal operation range.

If after Auto-Reset, the same fault is repeated three times consecutively, the Auto-Reset function will be disabled. A fault is considered consecutive if it happens again within 30 seconds after the Auto-Reset.

Therefore, if a fault occurs four consecutive times, the inverter will remain disabled (general disable) and the fault will remain being indicated.

If P0340 ≤ 2, auto-reset will not occur.

P0343 – Ground Fault Configuration

Adjustable Range:	0 = Off 1 = On	**Factory Setting:**	1
Properties:	cfg		
Access groups via HMI:			

Description:

This parameter enables the Ground Fault Detection, which will be responsible for the F074 (Ground Fault) actuation.

Thus if wished, it is possible to inhibit the Ground Fault (F074) occurrence by setting P0343=Off.

P0348 – Motor Overload Configuration

Adjustable Range:	0 = Off 1 = Fault/Alarm 2 = Fault 3 = Alarm	**Factory Setting:**	1
Properties:	cfg		
Access groups via HMI:			

Description:

This parameter allows the desired protection level for the motor overload function to be configured. Refer to the table below for details on the actuation of each one of the available options.

Table 15.2: *Actions for the parameter P0348 options*

P0348	Action
0 = Off	The overload protection is disabled. Faults or alarms will not be generated for the motor operation in overload conditions.
1 = Fault/Alarm	The inverter will display an alarm (A046) when the motor overload reaches the level programmed in P0349, and will generate a fault (F072) when the motor overload reaches the overload protection tripping level.
2 = Fault	Only the fault (F072) will be generated when the motor overload reaches the overload protection trip level, and the inverter will be disabled.
3 = Alarm	Only the alarm (A046) is generated when the motor overload reaches the value programmed in P0349 and the inverter continues operating.

The trip level of the overload protection is calculated internally by the CFW700, taking into account the motor current, its thermal class and its service factor. Refer to the parameter P0159 in this section.

P0349 – I x t Alarm Level

Adjustable Range:	70 to 100 %	**Factory Setting:**	85 %
Properties:	cfg		
Access groups via HMI:			

Description:

This parameter defines the level for the motor overload protection alarm actuation (A046), it is expressed as a percentage of the trip level of the overload integrator.

It will only be effective if P0348 is programmed in 1 (Fault/Alarm) or 3 (Alarm).

P0350 – IGBT Overload Configuration

Adjustable Range:	0 = Fault is active, with switching frequency reduction 1 = Fault and alarm are active, with switching frequency reduction 2 = Fault is active, without switching frequency reduction 3 = Fault and alarm are active, without switching frequency reduction	**Factory Setting:**	1
Properties:	cfg		
Access groups via HMI:			

Description:

The inverter overload function operates separately from the motor overload protection, and it has the purpose of protecting the IGBTs and rectifiers in case of overload, avoiding that damage due to overtemperature at their junctions occurs.

Thus, the parameter P0350 allows configuring the desired protection level for this function, even with the automatic reduction of the switching frequency, in order to avoid the fault occurrence. The next table describes each of the available options.

Table 15.3: *Actions for the parameter P0350 options*

P0350	Action
0	It enables F048 – IGBT Overload Fault. In order to avoid the occurrence of the fault, the switching frequency is reduced automatically to 2.5 kHz. **(*)**
1	It enables the fault F048 and the alarm A047 – IGBT Overload Alarm. In order to avoid the occurrence of the fault, the switching frequency is reduced automatically to 2.5 kHz. **(*)**
2	It enables F048. Without the reduction of the switching frequency.
3	It enables the alarm A047 and the fault F048. Without the reduction of the switching frequency.

(*) It reduces the switching frequency when:
- The output current exceeds 1.5 x $I_{nom\text{-}HD}$ (1.1 x $I_{nom\text{-}ND}$); **or**
- The temperature at the IGBT case is less than 10 °C from the maximum temperature; **and**
- P0297=2 (5 kHz).

P0351 – Motor Overtemperature Configuration

Adjustable Range:	0 = Off 1 = Fault/Alarm 2 = Fault 3 = Alarm	**Factory Setting:**	1
Properties:	cfg		
Access groups via HMI:			

Description:

This parameter is useful when the motor is equipped with PTC type temperature sensors, allowing the configuration of the protection level for the motor overtemperature function. The details on the actuation of the available options are in the table 15.4. Refer also to the section 15.2 - Motor Overtemperature Protection.

Table 15.4: *Actions for the parameter P0351 options*

P0351	Action
0 = Off	The overtemperature protection is disabled. Faults or alarms for the motor operation in the overtemperature condition will not be generated.
1 = Fault / Alarm	The inverter will show an alarm (A110) and will generate a fault (F078) when the motor reaches the overtemperature actuation values. Once a fault is generated, the inverter will be disabled.
2 = Fault	Only the fault (F078) will be generated when the motor reaches the overtemperature protection trip level, and the inverter will be disabled.
3 = Alarm	Only the alarm (A110) will be generated when the motor reaches the protection actuation level, and the inverter remains operating.

P0352 – Fan Control Configuration

Adjustable Range:	0 = Heatsink fan and internal fan are OFF 1 = Heatsink fan and internal fan are ON 2 = Heatsink fan and internal fan are controlled via software 3 = Heatsink fan is controlled via software and internal fan is OFF 4 = Heatsink fan is controlled via software and internal fan is ON 5 = Heatsink fan is ON and internal fan is OFF 6 = Heatsink fan is ON and internal fan is controlled via software 7 = Heatsink fan is OFF and internal fan is ON 8 = Heatsink fan is OFF and internal fan is controlled via software	**Factory Setting:**	2
Properties:	cfg		
Access groups via HMI:			

Description:

The CFW700 is equipped with two fans: an internal fan and a heatsink fan, and the activation of both will be controlled via software by means of the inverter programming.

The options available for the setting of this parameter are the following:

Table 15.5: *Options of the parameter P0352*

P0352	Action
0 = HS-OFF, Int-OFF	Heatsink fan is always OFF. Internal fan is always OFF.
1 = HS-ON, Int-ON	Heatsink fan is always ON. Internal fan is always ON.
2 = HS-CT, Int-CT	Heatsink fan is controlled via software. Internal fan is controlled via software.
3 = HS-CT, Int-OFF	Heatsink fan is controlled via software. Internal fan is always OFF.
4 = HS-CT, Int-ON	Heatsink fan is controlled via software. Internal fan is always ON.
5 = HS-ON, Int-OFF	Heatsink fan is always ON. Internal fan is always OFF.
6 = HS-ON, Int-CT	Heatsink fan is always ON. Internal fan is controlled via software.
7 = HS-OFF, Int-ON	Heatsink fan is always OFF. Internal fan is always ON.
8 = HS-OFF, Int-CT	Heatsink fan is always OFF. Internal fan is controlled via software.

P0353 – IGBTs/Air Overtemperature Configuration

Adjustable Range:	0 = IGBTs: fault and alarm, Internal air: fault and alarm 1 = IGBTs: fault and alarm, Internal air: fault 2 = IGBTs: fault, Internal air: fault and alarm 3 = IGBTs: fault, Internal air: fault	**Factory Setting:**	0
Properties:	cfg		
Access groups via HMI:			

Description:

The overtemperature protection is carried out by means of the measurement of the temperature with the IGBTs and power board internal air NTCs, being able to generate alarms and faults.

In order to configure the desired protection, set P0353 according to the table below.

Table 15.6: *Options of the parameter P0353*

P0353	Action
0 = HS-F/A, Air-F/A	Enables fault (F051) – IGBT Overtemperature and alarm (A050) – IGBT High Temperature. Enables fault (F153) – Internal Air Overtemperature and alarm (A152) – High Internal Air Temperature.
1 = HS-F/A, Air-F	Enables fault (F051) and alarm (A050) for IGBTs overtemperature. Enables only fault (F153) for internal air overtemperature.
2 = HS-F, Air-F/A	Enables only fault (F051) for IGBT overtemperature. Enables fault (F153) and alarm (A152) for internal air overtemperature.
3 = HS-F, Air-F	Enables only fault (F051) for IGBT overtemperature. Enables only fault (F153) for internal air overtemperature.

P0354 – Fan Speed Configuration

Adjustable Range:	0 = Inactive 1 = Fault	**Factory Setting:**	1
Properties:	cfg		
Access groups via HMI:			

Description:

When the heatsink fan speed reaches a value below ¼ of the rated speed the fault F179 (Heatsink Fan Speed Fault) will be generated. This parameter makes it possible that the generation of this fault be disabled, as presented in the next table.

Table 15.7: *Actions for the parameter P0354 options*

P0354	Action
0 = Inactive	The heatsink fan speed fault protection is disabled.
1 = Fault	It enables the fault (F179). The inverter will be disabled if the fault occurs.

P0356 – Dead Time Compensation

Adjustable Range:	0 = Off 1 = On	**Factory Setting:**	1
Properties:	cfg		
Access groups via HMI:			

Description:

This parameter must be kept always in 1 (On). Only in special maintenance cases the value 0 (Off) can be used.

P0357 – Line Phase Loss Time

Adjustable Range:	0 to 60 s	**Factory Setting:**	3 s
Properties:			
Access groups via HMI:			

Description:

It configures the time for the line phase loss indication (F006).

If P0357=0, the function remains disabled.

16 READ ONLY PARAMETERS

In order to facilitate the visualization of the main reading variables of the inverter, the group “READ” can be accessed directly.

It is important to point out that all the parameters of that group can only be visualized on the keypad (HMI) display, and that they do not allow changes by the user.

P0001 – Speed Reference

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

This parameter presents, regardless of the origin source, the value of the speed reference in rpm (factory setting).

It is also possible to change the speed reference (P0121) through this parameter, when P0221 or P0222=0.

P0002 – Motor Speed

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

This parameter indicates the motor actual speed value in rpm (factory setting), with a 0.5 second filter.

It is also possible to change the speed reference (P0121) through this parameter, when P0221 or P0222=0.

P0003 – Motor Current

Adjustable Range:	0.0 to 4500.0 A	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

It indicates the inverter output current in Amps (A).

P0004 – DC Link Voltage (U_d)

Adjustable Range:	0 to 2000 V	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

It indicates the DC Link actual dc voltage in volts (V).

P0005 – Motor Frequency

Adjustable Range:	0.0 to 1020.0 Hz	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

It indicates the inverter output frequency in Hertz (Hz).

P0006 – VFD Status

Adjustable Range:	0 = Ready 1 = Run 2 = Undervoltage 3 = Fault 4 = Self-Tuning 5 = Configuration 6 = DC Braking 7 = STO	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

It indicates one of the 8 possible inverter states. The description of each state is presented in the next table.

In order to facilitate the visualization, some inverter status are also showed on the keypad (HMI) (figure 5.2, section 5.5 - Display Indications in the Monitoring Mode Settings). The states 3 to 7 are presented in an abbreviated form, as follows:

Table 16.1: *Description of the inverter status*

State	Abbreviated Form on the Keypad (HMI)	Description
Ready		It indicates that the inverter is ready to be enabled.
Run	RUN	It indicates that the inverter is enabled.
Undervoltage	SUB	It indicates that the inverter is with insufficient line voltage for operation (undervoltage), and does not accept enabling commands.
Fault	Fxxx, where xxx is the number of the occurred fault	It indicates that the inverter is in the fault state.
Self-Tuning	CONF RUN	It indicates that the inverter is executing the self-tuning routine.
Configuration	CONF	It indicates that the inverter is in the Oriented Start-up routine or with incompatible parameter programming. Refer section 5.6 - Incompatibility Between Parameters.
DC Braking	RUN	It indicates that the inverter is applying DC braking to stop the motor.
STO		It indicates that the Safety Stop is active (the 24 Vdc voltage from the safety relays coils has been removed).

P0007 – Motor Voltage

Adjustable Range:	0 to 2000 V	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

It indicates the output line voltage, in Volts (V).

P0009 – Motor Torque

Adjustable Range:	-1000.0 to 1000.0 %	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

It indicates the torque developed by the motor, calculated as follows:

$$P0009 = \frac{Tm \times 100}{I_{TM}} \times Y$$

$$I_{TM} = \left(P0401^2 - \left(\frac{P0410 \times P0178}{100} \right)^2 \right)^{1/2}$$

$$Y = 1 \text{ for } N \leq \frac{P0190 \times N_{nom}}{P0400}$$

$$Y = \frac{N_{nom}}{N} \times \frac{P0190}{P0400} \quad \text{for } N > \frac{P0190 \times N_{nom}}{P0400}$$

Where:
N_{nom} = Motor synchronous speed.
N = Motor actual speed.
T_m = Motor torque current.
I_{TM} = Rated motor torque current.

P0010 – Output Power

Adjustable Range:	0.0 to 6553.5 kW	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:
It shows the inverter instantaneous output power, in kilowatt (kW).

NOTE!
The value indicated in this parameter is calculated indirectly, and must not be used to measure the energy consumption.

P0012 – DI8 to DI1 Status

Refer to item 13.1.3 - Digital Inputs.

P0013 – DO5 to DO1 Status

Refer to item 13.1.4 - Digital Outputs / Relays.

P0014 – AO1 Value

P0015 – AO2 Value

P0018 – AI1 Value

P0019 – AI2 Value

P0023 – Software Version

Refer to the section 6.1 - Inverter Data, for more details.

P0028 – Accessories Configuration

P0029 – Power Hardware Configuration

Refer to the section 6.1 - Inverter Data.

P0030 – IGBTs Temperature

P0034 – Internal Air Temperature

Refer to the section 15.3 - Protections.

P0036 – Heatsink Fan Speed

Adjustable Range:	0 to 15000 rpm	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

It indicates the fan actual speed, in revolutions per minute (rpm).

P0037 – Motor Overload Status

Adjustable Range:	0 to 100 %	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

It indicates the actual overload percentage of the motor. When this parameter reaches 100 % the fault “Motor Overload” (F072) will occur.

P0038 – Encoder Speed

Adjustable Range:	0 to 65535 rpm	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

It indicates the encoder actual speed, in revolutions per minute (rpm), through a 0.5 second filter.

P0039 – Encoder Pulse Counter

Adjustable Range:	0 to 40000	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

This parameter shows the counting of the pulses of the encoder. The counting can be increased from 0 to 40000 (Hourly turn) or decreased from 40000 to 0 (rotate Counterclockwise).

P0042 – Powered Time

Adjustable Range:	0 to 65535 h	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

It indicates the total number of hours that the inverter remained powered.

This value is kept even when power is removed from the inverter.

P0043 – Enabled Time

Adjustable Range:	0.0 to 6553.5 h	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

It indicates the total number of hours that the inverter remained enabled.

It indicates up to 6553.5 hours, and then it gets back to zero.

By setting P0204=3, the value of the parameter P0043 is reset to zero.

This value is kept even when power is removed from the inverter.

P0044 – kWh Output Energy

Adjustable Range:	0 to 65535 kWh	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

It indicates the energy consumed by the motor.

It indicates up to 65535 kWh, and then it gets back to zero.

By setting P0204=4, the value of the parameter P0044 is reset to zero.

This value is kept even when power is removed from the inverter.

NOTE!
The value indicated in this parameter is calculated indirectly, and must not be used to measure the energy consumption.

P0045 – Enabled Fan Time

Adjustable Range:	0 to 65535 h	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

It indicates the total number of hours that the heatsink fan remained enabled.

It indicates up to 65535 hours, and then it gets back to zero.

By setting P0204=2, the value of the parameter P0045 is reset to zero.

This value is kept even when power is removed from the inverter.

P0048 – Present Alarm

P0049 – Present Fault

Adjustable Range:	0 to 999	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

They indicate the alarm (P0048) or fault (P0049) number that occasionally is present at the inverter.

In order to understand the meaning of the codes used for faults and alarms, refer to the chapter 15 - Faults and Alarms, in this manual and the chapter 6 - Troubleshooting and Maintenance, of the user's manual.

16.1 FAULT HISTORY

In this group are described the parameters that record the last faults occurred in the inverter, together with other relevant information for the fault interpretation, as current, motor speed, etc.

NOTE!
If the fault occurs simultaneously with the CFW700 power up or reset, the parameters regarding this fault, as current, motor speed, etc., may contain invalid information.

P0050 – Last Fault

P0054 – Second Fault

P0058 – Third Fault

P0062 – Fourth Fault

P0066 – Fifth Fault

Adjustable Range:	0 to 999	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

They indicate the codes from the last to the fifth fault that have occurred.

The recording system is the following:

Fxxx → P0050 → P0054 → P0058 → P0062 → P0066

P0090 – Last Fault Current

Adjustable Range:	0.0 to 4500.0 A	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

It is the record of the current supplied by the inverter at the moment of the last fault occurrence.

P0091 – Last Fault DC Link Voltage

Adjustable Range:	0 to 2000 V	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

It is the record of the inverter DC link voltage at the moment of the last fault occurrence.

P0092 – Last Fault Speed

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

It is the record of the motor speed at the moment of the last fault occurrence.

P0093 – Last Fault Reference

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

It is the record of the speed reference at the moment of the last fault occurrence.

P0094 – Last Fault Frequency

Adjustable Range:	0.0 to 1020.0 Hz	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

It is the record of the inverter output frequency at the moment of the last fault occurrence.

P0095 – Last Fault Motor Voltage

Adjustable Range:	0 to 2000 V	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

It is the record of the motor voltage at the moment of the last fault occurrence.

P0096 – Last Fault DIx Status

Adjustable Range:	Bit 0 = DI1 Bit 1 = DI2 Bit 2 = DI3 Bit 3 = DI4 Bit 4 = DI5 Bit 5 = DI6 Bit 6 = DI7 Bit 7 = DI8	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

It indicates the state of the digital inputs at the moment of the last fault occurrence.

The indication is done by means of an hexadecimal code, which when converted to binary will indicate the states “active” and “inactive” of the inputs through numbers 1 and 0.

Example: If the code presented for the parameter P0096 on the keypad (HMI) is 00A5, it will correspond to the sequence **10100101**, indicating that the inputs 8, 6, 3 and 1 were active at the moment of the last fault occurrence.

Table 16.2: *Example of correspondence between the P0096 hexadecimal code and the DIx states*

0				**0**				**A**				**5**			
0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1
No relation with the DIx (always zero)								DI8 Active (+24 V)	DI7 Inactive (0 V)	DI6 Active (+24 V)	DI5 Inactive (0 V)	DI4 Inactive (0 V)	DI3 Active (+24 V)	DI2 Inactive (0 V)	DI1 Active (+24 V)

P0097 – Last Fault DOx Status

Adjustable Range:	Bit 0 = DO1 Bit 1 = DO2 Bit 2 = DO3 Bit 3 = DO4 Bit 4 = DO5	**Factory Setting:**
Properties:	ro	
Access groups via HMI:	READ	

Description:

It indicates the state of the digital outputs at the moment of the last fault occurrence.

The indication is done by means of an hexadecimal code, which when converted to binary will indicate the states “active” and “inactive” of the outputs through numbers 1 and 0.

Example: If the code presented for the parameter P0097 on the keypad (HMI) is 001C, it will correspond to the sequence **00011100**, indicating that the outputs 5, 4, and 3 were active at the moment of the last fault occurrence.

Table 16.3: *Example of correspondence between the P0097 hexadecimal code and the DOx states*

0				**0**				**1**				**C**			
0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0
No relation with the DOx (always zero)								No relation with the DOx (always zero)			DO5 Active (+24 V)	DO4 Active (+24 V)	DO3 Active (+24 V)	DO2 Inactive (0 V)	DO1 Inactive (0 V)

17 COMMUNICATION

For the exchange of information through communication networks, the CFW700 has several standardized communication protocols, like MODBUS, CANopen, DeviceNet, Profibus.

For more details regarding the inverter configuration for operating with those protocols, refer to the CFW700 communication manual. The parameters related to the communication are explained next.

17.1 RS-232 AND RS-485 SERIAL INTERFACE

P0308 – Serial Address

P0310 – Serial Baud Rate

P0311 – Serial Interface Byte Configuration

P0314 – Serial Watchdog

P0316 – Serial Interface Status

P0682 – Serial Control Word

P0683 – Serial Speed Reference

Those are parameters for the configuration and operation of the RS-232 and RS-485 serial interfaces. For a detailed description, refer to the RS-232/RS-485 communication manual, supplied in electronic format on the CD-ROM that comes with the product.

17.2 CAN INTERFACE – CANOPEN/DEVICENET

P0684 – CO/DN/DP Control Word

P0685 – CO/DN/DP Speed Reference

P0700 – CAN Protocol

P0701 – CAN Address

P0702 – CAN Baud Rate

P0703 – Bus Off Reset

P0705 – CAN Controller Status

P0706 – Received CAN Telegrams

P0707 – Transmitted CAN Telegrams

P0708 – Bus Off Counter

P0709 – Lost CAN Messages

P0710 – DeviceNet I/O Instances

P0711 – DeviceNet Reading Word # 3

P0712 – DeviceNet Reading Word # 4

P0713 – DeviceNet Reading Word # 5

P0714 – DeviceNet Reading Word # 6

P0715 – DeviceNet Writing Word # 3

P0716 – DeviceNet Writing Word # 4

P0717 – DeviceNet Writing Word # 5

P0718 – DeviceNet Writing Word # 6

P0719 – DeviceNet Network Status

P0720 – DeviceNet Master Status

P0721 – CANopen Com. Status

P0722 – CANopen Node Status

Those are parameters for the configuration and operation of the CAN interface. For a detailed description, refer to the CANopen communication manual or to the DeviceNet communication manual, supplied in electronic format on the CD-ROM that comes with the product.

17.3 PROFIBUS DP INTERFACE

Parameters related to the Profibus DP interface of the Slot 3.

P0740 - Profibus Communication Status

P0741 – Profibus Data Profile

P0742 – Profibus Reading # 3

P0743 – Profibus Reading # 4

P0744 – Profibus Reading # 5

P0745 – Profibus Reading # 6

P0746 – Profibus Reading # 7

P0747 – Profibus Reading # 8

P0748 – Profibus Reading # 9

P0749 – Profibus Reading # 10

P0750 – Profibus Writing # 3

P0751 – Profibus Writing # 4

P0752 – Profibus Writing # 5

P0753 – Profibus Writing # 6

P0754 – Profibus Writing # 7

P0755 – Profibus Writing # 8

P0756 – Profibus Writing # 9

P0757 – Profibus Writing # 10

P0918 – Profibus Address

P0922 – Profibus Telegram Selection

P0944 – Fault Counter

P0947 – Fault Number

P0963 – Profibus Baud Rate

P0964 – Drive Identification

P0965 – Profile Identification

P0967 – Control Word 1

P0968 – Status Word 1

Those are parameters for the configuration and operation of the Profibus DP interface. For a detailed description, refer to the Profibus DP communication manual, supplied in electronic format on the CD-ROM that comes with the product.

17.4 COMMUNICATION STATES AND COMMANDS

P0313 – Communication Error Action

P0680 – Status Word

P0681 – Motor Speed in 13 Bits

P0695 – Settings for the Digital Outputs

P0696 – Value 1 for Analog Outputs

P0697 – Value 2 for Analog Outputs

Those parameters are used for monitoring and controlling the CFW700 inverter by means of communication interfaces. For a detailed description, refer to the communication manual of the user interface. These manuals are supplied in electronic format on the CD-ROM that comes with the product.

18 SOFTPLC [50]

The SoftPLC function allows the frequency inverter to assume PLC (Programmable Logical Controller) functions. For more details regarding the programming of those functions in the CFW700, refer to the CFW700 SoftPLC manual. The parameters related to the SoftPLC are described next.

P1000 – SoftPLC Status

Adjustable Range:	0 = No Applicative 1 = Installing App. 2 = Incompatible App. 3 = Stopped Applicative 4 = Applicative Running	**Factory Setting:**	
Properties:	ro		
Access groups via HMI:	SPLC or READ		

Description:

It allows the user to visualize the current SoftPLC status. If there is no installed applicative, the parameters from P1001 to P1059 will not be showed on the keypad.

If this parameter presents the option 2 (“Incompat. App.”), it indicates that the version that has been loaded in the flash memory board is not compatible with the current CFW700 firmware.

In this case it is necessary to recompile the project in the WLP software with the new CFW700 version and download it again. If this is not possible, the upload of this applicative with the WLP can be done since the password of the applicative software is known or it is not enabled.

P1001 – SoftPLC Command

Adjustable Range:	0 = Stop Applicative 1 = Run Applicative 2 = Delete Applicative	**Factory Setting:**	0
Properties:			
Access groups via HMI:	SPLC		

Description:

It allows stopping, running or excluding the installed applicative, however, the motor must be disabled.

P1002 – Scan Cycle Time

Adjustable Range:	0.0 to 999.9 ms	**Factory Setting:**	
Properties:	ro		
Access groups via HMI:	SPLC or READ		

Description:

It consists in the applicative scanning time. The bigger the applicative, the longer the scanning time will be.

P1003 – SoftPLC Applicative Selection

Adjustable Range:	0 = User 1 = PID 2 = EP 3 = Multispeed 4 = 3-Wire Start/Stop 5 = FWD Run/ REV Run	**Factory Setting:**	0
Properties:	cfg		
Access groups via HMI:	SPLC		

Description:

It allows the user to select the CFW700 built in applications.

Table 18.1: *Parameter P1003 option description*

P1003	Description
0	The application that will run in the SoftPLC is that loaded by the user via ladder programming.
1	The application that will run in the SoftPLC is the PID regulator. It can be used to control a closed loop process. This application sets proportional, integral and derivative regulator superimposed to the regular speed control of the CFW700 inverter.
2	The application that will run in the SoftPLC is the electronic potentiometer. It allows the motor speed reference settings via two digital inputs, one for accelerating the motor and another to decelerate the motor.
3	The application that will run in the SoftPLC is the multispeed. It allows speed reference settings based on to the values defined in some parameters (P1011 to P1018) with a logical combination of the digital inputs DI4, DI5 and DI6, limited to 8 pre-programmed speed references. Advantages such as stability of fixed pre-programmed references and electrical noise immunity (isolated digital inputs DIx) are noted in this kind of application.
4	The application that will run in the SoftPLC is the 3-Wire Start/Stop. It allows the inverter to start/stop as with a retention contact and an emergency button.
5	The application that will run in the SoftPLC is the FWD/REV command. It gives the user the combination of two inverter commands in a single digital input (forward/reverse and start/stop).

NOTE!
Refer to SoftPLC manual for more information about the CFW700 user applications.

From P1010 to P1059 – SoftPLC Parameters

Adjustable Range:	-32768 to 32767	**Factory Setting:**	0
Properties:	cfg		
Access groups via HMI:	SPLC		

Description:

They consist of parameters defined by the selected application in parameter P1003.

19 APPLICATIONS

19.1 INTRODUCTION

The CFW700 has some features that allow better matching the inverter commands to the application. These features were grouped into a set of applications and can be as simple as the forward and reverse command, or more elaborated such as a PID controller.

The applications were implemented using the SoftPLC function, in other words, ladder programming applicative built-in to the CFW700 inverter. It allows the user that has the WLP and the built-in implemented applicative to change it and use it as an user applicative.

Parameter P1003 allows selecting an application and uploading it to the CFW700. The CFW700 has following applications built-in:

- PID Regulator.
- Electronic Potentiometer (EP).
- Multispeed.
- 3-Wire Start/Stop.
- Forward/Reverse Run.

19.2 PID REGULATOR APPLICATION

19.2.1 Description and Definitions

The CFW700 has the PID REGULATOR application that can be used to control a closed loop process. This application sets proportional, integral and derivative regulator superimposed to the regular speed control of the CFW700 inverter. Refer to the block diagram in the figure 19.1.

The CFW700 will compare the setpoint with the process variable and control the motor speed trying to eliminate any error and keeping the process variable equal to the setpoint. The setting of the P, I and D gains determines how fast the inverter will respond to eliminate this error.

Application examples:

- Flow control or pressure in a pipe system.
- Temperature of a furnace or oven.
- Dosing of chemicals in tanks.

The following example defines the terms used by the PID controller.

A pump used in a water pumping system where is necessary to control the pressure of the pipe. A pressure transducer is installed in the pipe and supplies an analog feedback signal to the CFW700, which is proportional to the water pressure. This signal is called the process variable, and can be visualized at the parameter P1012. A setpoint is programmed in the CFW700 via keypad (P1025), through an analog input (such as a 0-10 V or 4-20 mA signal) or via communication network. The setpoint is the desired water pressure value that the pump is supposed to produce, regardless of the consumption variations at the pump output at any time.

It is necessary to set the parameter P0221 or P0222 to 7=SoftPLC for the operation of the PID Regulator application.

Definitions:

- The Function 1 of the Application at parameters P0231 or P0236 represents the value of the PID Setpoint.
- The Function 2 of the Application at parameters P0231 or P0236 represents the value of the PID Feedback.
- The Function 1 of the Application at parameters P0251 or P0254 represents the value of the PID Setpoint.
- The Function 2 of the Application at parameters P0251 or P0254 represents the value of the PID Feedback.
- The Function 1 of the Application at parameters P0263 to P0270 represents the value of the Manual/Auto command.
- The Function 1 of the Application at parameters P0275 to P0279 represents the VP>VPx logical condition.
- The Function 2 of the Application at parameters P0275 to P0279 represents the VP<VPy logical condition.

The PID setpoint can receive an analog input signal (AI1 or AI2). It is necessary to set P1016 to 1 = AIx and select which analog input will be used. The analog inputs are set at P0231 (AI1) or P0236 (AI2) and it is necessary to program it to 5 = Function 1 of the Application in order to enable the analog inputs for the operation. The following alarm message will be displayed in case it is not properly done: “A770: Set AI1 or AI2 for Function 1 of the Application”.

The PID setpoint value can be presented via analog output AO1 or AO2. It is necessary to set P0251 (AO1) or P0254 (AO2) to 17 = Function 1 of the Application. The full scale value of the variable is 100.0 % and corresponds to 10 V or 20 mA.

The PID feedback can receive an analog input signal (AI1 or AI2). It is necessary to set P0231 (AI1) or P0236 (AI2) to 6 = Function 2 of the Application in order to enable the analog inputs for the operation. The following alarm message will be displayed in case it is not properly done: “A772: Set AI1 or AI2 for Function 2 of the Application”.

In case the analog inputs (AI1 and AI2) are programmed with the same function, PID Setpoint or Feedback, the following alarm message will be displayed and the application will not be enabled: “A774: AI1 and AI2 were set for the same function”.

The value of the PID feedback can be presented via analog output AO1 or AO2. It is necessary to set P0251 (AO1) or P0254 (AO2) to 18 = Function 2 of the Application. The full scale value of the variable is 100.0 % and corresponds to 10 V or 20 mA.

The Manual/Auto control is done by a digital input (DI1 to DI8). It is necessary to set one of the DI parameters (P0263 to P0270) to 20 = Function 1 of the Application. If more than one digital input is set for this function, the logic operation will consider only the command of the high priority level digital input, where: DI1>DI2>DI3>DI4>DI5> DI6>DI7>DI8. If any of the digital inputs is set, the PID controller will work only in automatic (Auto) mode.

The Manual/Auto input is active when it is in 24 V indicating automatic control and it is inactive in 0 V indicating manual operation.

The digital outputs (DO1 to DO5) can be programmed to trigger comparison logics with the process variable (PV). In order to do that, it is necessary to set one of the DO’s parameters (P0275 to P0279) to 34 = Function 1 of the Application (VP>VPx) or 35 = Function 2 of the Application (VP<VPy).

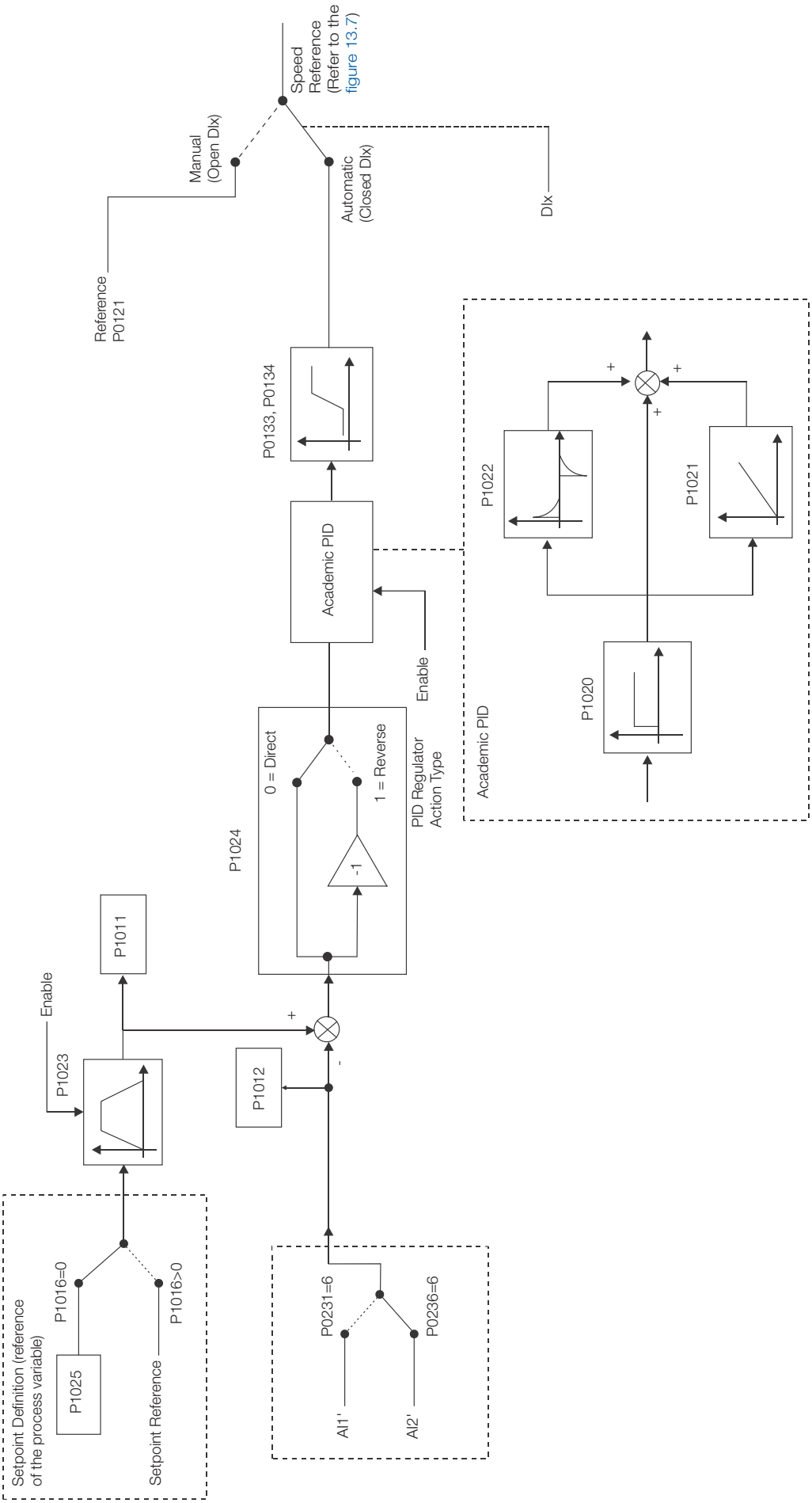


Figure 19.1: *PID Regulator block diagram*

19.2.2 PID Operation

Before doing a detailed description of the parameters related to this function, a step by step guide for putting the PID into operation will be presented.

NOTE!
In order that the PID function works properly, it is fundamental to verify if the inverter is configured correctly to drive the motor at the desired speed. Therefore, verify the following settings:

- Torque boost (P0136 and P0137) and slip compensation (P0138), if it were in the V/f control mode.
- Having run the self-tuning if it were in the vector mode.
- Acceleration and deceleration ramps (P0100 to P0103) and current limit (P0135 for V/f and VVW control, or P0169/P0170 for vector control).

Setting up the PID Regulador Application

1. **Selecting the application:**
   When the PID Regulator application is enabled, setting P1003 = 1, the default applicative is loaded in the SoftPLC function, making it available for use in the CFW700.

2. **Setting the digital input for the Manual/Auto command:**
   It is necessary to define one digital input for the Manual/Auto command of the PID regulator. In order to do that, one of the DI parameters selection (P0263 to P0270) should be set to 20 = Function 1 of the Application. Recommendation: set the DI3 (P0265 = 20) to do the Manual/Auto command.

3. **Setting the analog input of the PID feedback:**
   The PID feedback (process variable measurement) is always done via one of the analog inputs by programming parameters P0231 (AI1) or P0236 (AI12) to 6 = Function 2 of the Application.
   The AI2 (P0236 = 6) will be selected in this guide.

4. **Setting the PID feedback scale:**
   The transducer (sensor) to be used for the process variable feedback must have a full scale value of at least 1.1 times the highest value to be controlled.

Example: If it is necessary to control a pressure of 20 bar, the sensor to be chosen should have a full scale value of at least 22 bar (1.1 x 20).

Once the sensor is chosen, the type of signal to be read at the input must be selected (current or voltage) and the corresponding dip-switch (S1.1 or S1.2) must be set accordingly.

In this guide, a 4-20 mA sensor signal will be chosen (set P0238 = 1 and S1.1 = ON).

Then, the gain (P0237) and offset (P0239) of the feedback signal can be set for adjusting the process variable.

If an offset adjustment is needed, the parameter P0239 must be set according to the detailed description presented on item 13.1.1 - Analog Inputs.

After setting the PID feedback scale, the parameter P1018 will be displayed in the “wxy.z” format. This value corresponds to 100.0 % of analog input, with 1.000 gain (P0237) and 0.00 % offset (P0239) corresponding to 10 V / 20 mA.

Example: If the sensor range is 0-25 bar, set P1018 to 25.0, P0237 to 1.000 and P0239 to 0.00 %, so that when the analog input value is 100.0 %, P1012 will present 25.0. The “bar” engineering unit is not in the list of available units, therefore, it is not possible to show it on the keypad.

5. Setting the PID setpoint:

The PID setpoint can be set via the keypad, analog inputs, serial interface or network as available at P1016. The setpoint is selected via the keypad (P1016 = 0) in this guide. Therefore, the PID setpoint value will be set via parameter P1025 according to the following equation:

$$\text{Setpoint (\%)} = \frac{\text{Desired value (process variable)}}{\text{PID feedback sensor full scale}} \times 100.0\ \%$$

Example: a 4-20 mA pressure transducer with 25 bar output full scale (i.e. 4 mA = 0 bar and 20 mA = 25 bar), P0237 = 1.000 and P0239 = 0.00 %. If it is necessary to control 20.0 bar, the following setpoint should be set:

$$\text{Setpoint (\%)} = \frac{20.0}{25.0} \times 100.0\ \% = 80.0\ \%$$

6. Setting the PID regulator action type:

The action type must be direct (P1024 = 0) when it the motor speed is increased to increase the process variable. Otherwise, select reverse (P1024 = 1).

Examples:

a) Direct: a pump driven by an inverter is filling a reservoir and the PID control is regulating the level of this reservoir. In order to increase the level (process variable), the flow needs to be increased by increasing the motor speed.

b) Reverse: a fan driven by an inverter is cooling a cooling tower and the PID control is regulating the temperature of this cooling tower. In order to increase the temperature (process variable), it is necessary to reduce the ventilation by reducing the motor speed.

7. Setting the speed reference:

When the PID regulator application operates in local mode, P0221 must be set to 7 = SoftPLC. When the PID regulator application operates in remote mode, P0222 must be set to 7 = SoftPLC.

NOTE!
If the PID regulator application has been selected to operate in local mode and the DI1 (P0263) has been selected to Manual/Auto command, the inverter will go to the “configuration (CONF)” state and it will be necessary to change the default setting of P0227.

8. Speed Limits:

Set P0133 and P0134 according to the application remembering that the PID controller is designed to work with inputs and outputs referenced from 0.0 to 100.0 %. This output value is converted to operate in the range set at P0133 and P0134 in order to avoid speed ranges where there is no contribution to the control of the process variable.

9. Setting the reading parameters of the keypad monitoring screen:

The monitoring mode screen of the CFW700 keypad can be configured to display the control variables of the PID regulator in numerical form. The example below was chosen to show the PID feedback or the process variable, the PID setpoint and motor speed.

Example:

a) Reading parameter 1 to show the process variable:
- Set P0205 to 1012 which corresponds to the P1012 parameter of the PID regulator application.
- Set P0208 to 100.0 %.
- Set P0209 to 0 (none).
- Set P0210 to 1 (wxy.z).

b) Reading parameter 2 to show the PID setpoint:
- Set P0206 to 1011 which corresponds to the P1011 parameter of the PID regulator application.
- Set P0211 to 100.0 %.
- Set P0212 to 1 (wxy.z).

c) Reading parameter 3 to show the motor speed:
   - Set P0207 to 0002 which corresponds to the P0002 parameter of the CFW700.
   - Set P0213 to 1800 rpm.

Operation setup

Check the status of the PID regulator application in parameter P1000. The PID regulator will be in operation if P1000 value is 4. If P1000 value is 3, the PID regulator application is stopped and it is necessary to change the command value of the SoftPLC at parameter P1001 to 1 (run application). Any value other than 3 or 4 indicates that the applicative cannot go into operation. For more details, refer to the CFW700 SoftPLC manual.

1. **Manual Operation (DIx is open):** keeping DIx open (Manual), check the process variable indication on the keypad (P1012) based on an external measurement of the feedback signal value (transducer) at the AI2.

Then vary the speed reference (P0121) to get the desired process variable, only then, switch to automatic mode.

NOTE!
If the setpoint is defined by P1025, the CFW700 will automatically set P1025 value with P1012 instantaneous value when changing from manual to automatic mode (since P1026 = 1). In this case, the switching from manual to automatic is smooth (no sudden change of speed).

2. **Automatic Operation (DIx is closed):** close DIx and perform the dynamic adjustment of the PID regulator, i.e., proportional gain (P1020), integral gain (P1021) and differential gain (P1022), checking whether the regulation is being done correctly. In order to do that, it is necessary to compare the setpoint and process variable and check if the values are close. See also how quickly the motor responds to fluctuations of the process variable.

It is important to know that the PID gains setup is a step that requires some attempts to reach the desired response time. If the system responds rapidly and oscillates near the setpoint, then the proportional gain is too high. If the system responds slow and takes time to reach the setpoint, then the proportional gain is too low and should be increased. If the process variable does not reach the required value (setpoint), then the integral gain should be adjusted.

The following figure presents a simplified connection diagram of the CFW700 working as a PID regulator and also the parameters setup of this sample.

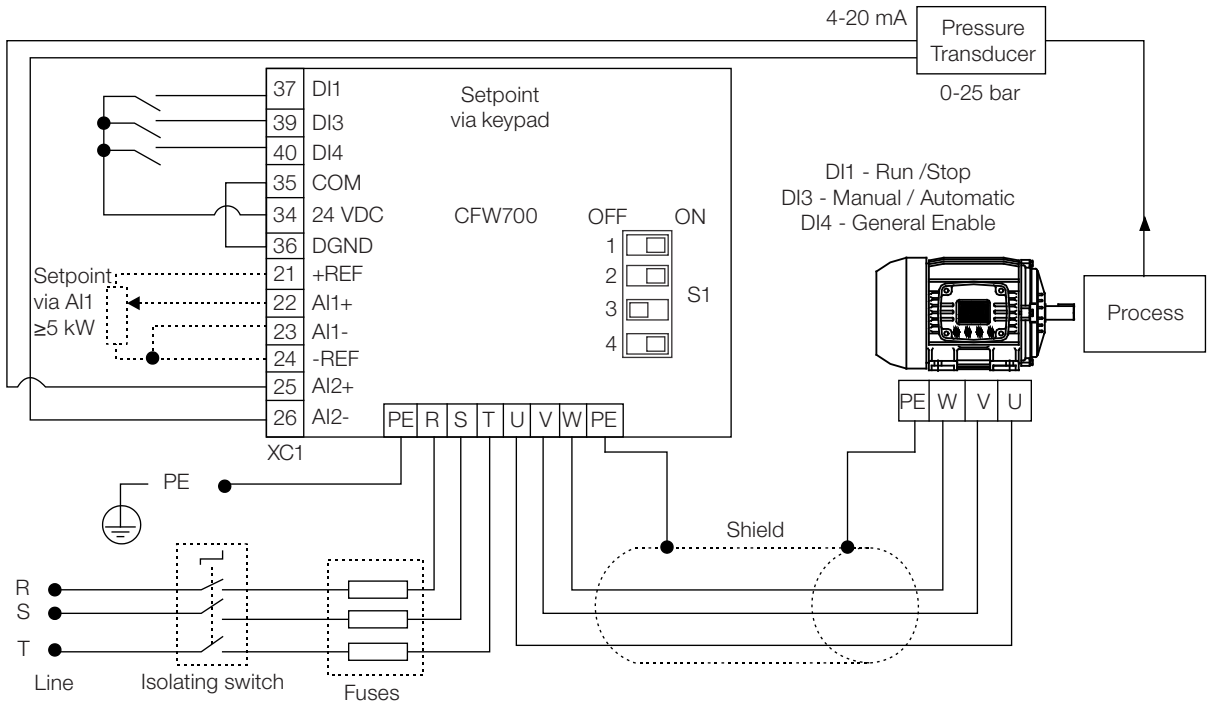


Figure 19.2: *Example of a CFW700 application as a PID regulator*

Table 19.1: Example of a CFW700 application as a PID regulator

Parameter	Description
P1003=1	Selection of the PID regulator application
P0205=1012	Selection of the main parameter (Process variable)
P0206=1011	Selection of the secondary parameter (PID Setpoint)
P0207=0002	Selection of the bar graph parameter (Motor Speed)
P0208=100.0 %	Main display scale factor
P0209=0	Main display engineering unit: none
P0210=1	Main display decimal point: wxy.z
P0211=100.0 %	Secondary display scale factor
P0212=1	Secondary display decimal point: wxy.z
P0213=1800	Bar graph full scale
P0220=1	LOC/REM selection: Remote operation
P0222=7	REM speed reference: SoftPLC
P0263=1	DI1 function: Start/Stop
P0265=20	DI3 function: Function 1 of the application (Manual/Auto)
P0266=2	DI4 function: General enable
P1024=0	PID regulator action type: direct
P0236=6	AI2 function: Function 2 of the application
P0237=1.000	AI2 gain
P0238=1	AI2 signal type: 4 to 20 mA
P0239=0.00 %	AI2 offset
P0240=0.15 s	AI2 filter
P1018=25.0	PID feedback scale
P1016=0	PID setpoint selection: keypad
P1025=80 %	PID setpoint
P1026=1	Automatic setting of P1025: Active
P1027=1	PID setpoint backup via P1025: Active
P1023=3.0 s	PID setpoint filter
P0133=1000 rpm	Minimum speed reference
P0134=1800 rpm	Maximum speed reference
P1020=1.000	PID proportional gain
P1021=0.430	PID integral gain
P1022=0.000	PID differential gain
P0217=0	Zero speed disable: Inactive
P1001=1	SoftPLC command: Run program

19.2.3 Sleep Mode

The sleep mode is a useful resource for saving energy when using the PID regulator.

In many PID applications energy is wasted by keeping the motor turning at the minimum speed when, for instance, the pressure or the tank level keeps increasing.

The sleep mode works together with the zero speed disable function.

In order to activate the sleep mode, enable the zero speed disable by programming P0217=1 (Active). The disable condition is the same as for the zero speed disable without PID. Refer to the section 12.4 - Zero Speed Logic.

In order to leave the zero speed disable mode, when in automatic PID mode, besides the condition programmed in P0218, it is necessary that the PID error (the difference between the setpoint and the process variable) is greater than the value programmed in P1028.

DANGER!
While in the sleep mode, the motor may turn at any moment because of the process conditions. If it is wished to handle the motor or to perform any type of maintenance, remove the power from the inverter.

19.2.4 Monitoring Mode Screens

When PID regulator application is used, the monitoring screen can be configured to show the main variables in numerical form, which may or may not have engineering units.

An example of the keypad with this setting can be seen in figure 19.3, which are shown: the process variable and the setpoint, both without engineering unit (referenced to 25.0 bar) and the motor speed on the bar graph in percentage (%). Refer to section 5.4 - HMI.

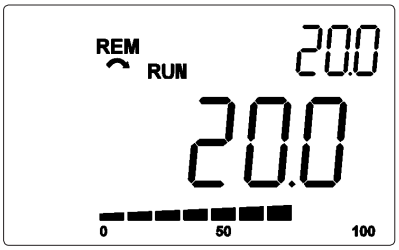


Figure 19.3: *Keypad monitoring mode for the PID regulator application*

19.2.5 Connection of a 2-Wire Transducer

In the 2-wire configuration the transducer signal and its supply share the same wires. The figure 19.4 illustrates this type of connection.

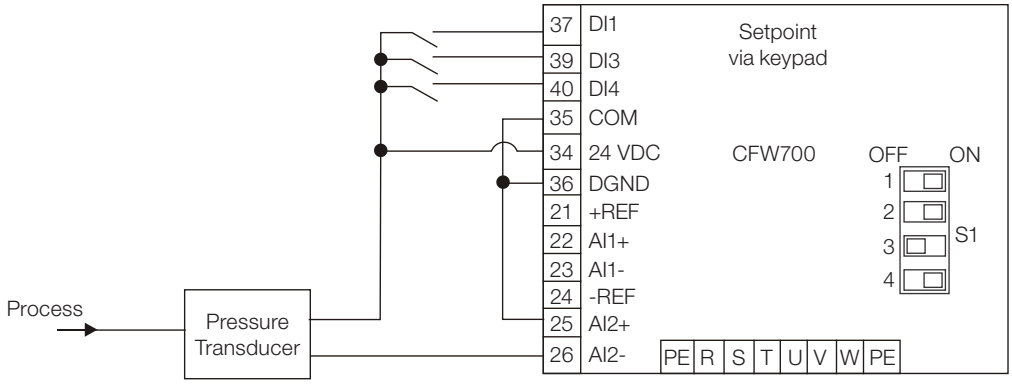


Figure 19.4: *Connection of a 2-wire transducer to the CFW700*

19.2.6 Academic PID

The PID regulator implemented in the CFW700 is the academic type. The equations that characterize the Academic PID, which is the base of this function algorithm, are presented next.

The transfer function in the Academic PID regulator frequency dominion is:

$$y(s) = Kp \times e(s) \times [\ 1 + \frac{1}{sTi} + sTd\ ]$$

By replacing the integrator by a sum and the derivative by the incremental quotient, one gets an approximation for the discrete transfer equation (recursive) presented next:

$$y(k) = y(k-1) + Kp[(1 + Ki.Ta + Kd/Ta).e(k) – (Kd/Ta).e(k-1)]$$

Being:
y(k): current PID output can vary from 0.0 to 100.0 %.
y(k-1): PID previous output.
Kp (Proportional gain): Kp = P1020.
Ki (Integral gain): Ki = P1021 x 100 = [1/Ti x 100].
Kd (Differential gain): Kd = P1022 x 100 = [Td x 100].
Ta = 0.05 sec (PID regulator sampling time).

e(k): actual error [SP*(k) – X(k)].
e(k-1): previous error [SP*(k-1) – X(k-1)].
SP*: the reference can carry from 0.0 to 100.0 %.
X: process variable (or feedback), read through one of the analog inputs (AIx), can vary from 0.0 to 100.0 %.

19.2.7 Parameters

The parameters related to the PID Regulator are now described in a detail form.

P0100 – Acceleration Time

P0101 – Deceleration Time

P0133 – Minimum Speed

P0134 – Maximum Speed

P0221 – LOC Reference Selection

P0222 – REM Reference Selection

P0231 – AI1 Signal Function

P0232 – AI1 Gain

P0233 – AI1 Signal Type

P0234 – AI1 Offset

P0235 – AI1 Filter

P0236 – AI2 Signal Function

P0238 – AI2 Signal Type

P0239 – AI2 Offset

P0240 – AI2 Filter

P0251 – AO1 Function

P0252 – AO1 Gain

P0253 – AO1 Signal Type

P0254 – AO2 Function

P0255 – AO2 Gain

P0256 – AO2 Signal Type

P0263 – DI1 Function

P0264 – DI2 Function

P0265 – DI3 Function

P0266 – DI4 Function

P0267 – DI5 Function

P0268 – DI6 Function

P0269 – DI7 Function

P0270 – DI8 Function

P0275 – DO1 Function (RL1)

P0276 – DO2 Function

P0277 – DO3 Function

P0279 – DO5 Function

P1000 – SoftPLC Status

P1001 – SoftPLC Command

P1002 – Scan Cycle Time

P1003 – SoftPLC Applicative Selection

NOTE!
For more details, refer to chapters 12 - Functions Common to all the Control Modes, and 18 - SoftPLC [50].

P1010 – Version of the PID Regulator Application

Adjustable Range:	0.00 to 10.00	**Factory Setting:**	-
Properties:	ro		
Access groups via HMI:	SPLC		

Description:

Read only parameter that presents the software version of the PID regulator application developed for the SoftPLC function of the CFW700.

P1011 – PID Setpoint

Adjustable Range:	0.0 to 3000.0	**Factory Setting:**	-
Properties:	ro		
Access groups via HMI:	SPLC		

Description:

Read only parameter that presents, in the wxy.z form without engineering unit, the setpoint value of the PID regulator according to the scale defined at P1018.

P1012 – PID Feedback

Adjustable Range:	0.0 to 3000.0	**Factory Setting:**	-
Properties:	ro		
Access groups via HMI:	SPLC		

Description:

Read only parameter that presents, in the wxy.z form without engineering unit, the feedback value or the process variable of the PID regulator according to the scale defined at P1018.

P1013 – PID Output

Adjustable Range:	0.0 to 100.0 %	**Factory Setting:**	-
Properties:	ro		
Access groups via HMI:	SPLC		

Description:

Read only parameter that presents, in percentage (%), the PID regulator output value.

P1016 – PID Setpoint Selection

Adjustable Range:	0 = HMI 1 = AIx 2 = Serial/USB 3 = CO/DN/DP	**Factory Setting:**	0
Properties:	ro		
Access groups via HMI:	SPLC		

Description:

Defines the source of the PID regulator setpoint.

Notes:

- "HMI" means that the PID regulator setpoint will be the value of P1025 parameter.
- "AI" means that the PID regulator setpoint will come from an analog input. It is necessary to set P0231 (AI1) or P0236 (AI2) to 5 = Function 1 of the Application in order to enable its operation. The following alarm message will be displayed in case it is not properly done: "A770: Set AI1 or AI2 for Function 1 of the Application".
- "Serial/USB" means that the setpoint of the PID regulator will be the value of P0683 proportionally referenced to the percentage value with one decimal point, i.e., 100.0 % corresponds to 1000 in P0683.
- "CO/DN/DP" means that the setpoint of the PID regulator will be the value of P0685 proportionally referenced to the percentage value with one decimal point, i.e., 100.0 % corresponds to 1000 in P0685.

P1018 – PID Feedback Scale

Adjustable Range:	0.0 to 3000.0	**Factory Setting:**	100.0
Properties:			
Access groups via HMI:	SPLC		

Description:

Defines how the PID Feedback or Process Variable will be presented in P1012 (as well as the PID setpoint in P1011), i.e., the full scale of the PID feedback or process variable that corresponds to 100.0 % in the analog input used as the PID regulator feedback.

The variable will always be with one decimal point "wxy.z", i.e., one place after the dot.

Example: The pressure transducer is a 4-20 mA with 0-25 bar range. Set P1019 to 25.0.

P1020 – PID Proportional Gain

P1021 – PID Integral Gain

P1022 – PID Differential Gain

Adjustable Range:	0.000 to 30.000	**Factory Setting:**	P1020=1.000 P1021=0.430 P1022=0.000
Properties:			
Access groups via HMI:	SPLC		

Description:

These parameters define the PID regulator application gains and they should be set according to the application being controlled.

Examples of initial settings for some applications are presented in table 19.2.

Table 19.2: Recommended settings for the PID regulator gains

Variable	Gains		
	Proportional P1020	Integral P1021	Derivative P1022
Pneumatic system pressure	1	0.430	0.000
Pneumatic system flow	1	0.370	0.000
Hydraulic system pressure	1	0.430	0.000
Hydraulic system flow	1	0.370	0.000
Temperature	2	0.040	0.000
Level	1	See note below	0.000

NOTE!
For the level control, the integral gain settings will depend on the time it takes for the reservoir to go through the minimum acceptable level to the desired level, with the following conditions:

1. The time for the direct action should be measured with the maximum input flow and minimum output flow.

2. The time for the reverse action should be measured with minimum input flow and maximum output flow.

An equation to calculate the initial value of P1021 as a function of the system response time is presented next:

P1021=0.50 / t,

Where: t=time (in seconds).

P1023 – PID Setpoint Filter

Adjustable Range:	0.00 to 650.00 s	**Factory Setting:**	0.25 s
Properties:			
Access groups via HMI:	SPLC		

Description:
This parameter sets the value of the constant time of the setpoint filter of the PID regulator and has the purpose of reducing abrupt changes in the PID setpoint value.

P1024 – PID Regulator Action Type

Adjustable Range:	0 = Direct 1 = Reverse	**Factory Setting:**	0
Properties:			
Access groups via HMI:	SPLC		

Description:
The PID action type should be selected as “Direct” when it is necessary that the motor speed is increased in order to increment the process variable. Otherwise, the “Reverse” should be selected.

Table 19.3 : Selecting the PID action type

Motor Speed	Process Variable	Selection
Increases	Increases	Direct
	Decreases	Reverse

This characteristic varies with the process type, but direct feedback is most used.

For temperature control or level process, the selection of the action type will depend on the configuration.

Example: if the inverter runs the motor that removes fluid from the reservoir in a control level, the action type is reverse as the inverter should increase the motor speed in order to decrease the level of fluid. In case the inverter is running the motor that is adding fluid in the reservoir, the action type is direct.

P1025 – PID Setpoint via Keypad Keys (HMI)

Adjustable Range:	0.0 to 100.0 %	**Factory Setting:**	0.0 %
Properties:			
Access groups via HMI:	SPLC		

Description:

This parameter allows the adjustment of the PID regulator setpoint through the keypad keys, since P1016 = 0 and it is operating in Auto mode. If the operation is in Manual mode, the keypad reference is set in P0121.

The value of P1025 is kept with the last value set (backup) even after disabling or resetting the inverter (with P1027 = 1 - Active).

P1026 – Automatic Setting of the PID Setpoint via Keypad (P1025)

Adjustable Range:	0 = Off 1 = On	**Factory Setting:**	1
Properties:	cfg		
Access groups via HMI:	SPLC		

Description:

When the PID regulator setpoint is done via the keypad (P1016 = 0) and P1026 is 1 (active), when switching from manual to automatic, the percentage value of the manual setpoint that corresponds to the PID regulator output from 0.0 to 100.0 % will be loaded at P1025. It avoids PID oscillations when switching from manual to automatic.

P1027 – PID Setpoint Backup via Keypad (P1025)

Adjustable Range:	0 = Off 1 = On	**Factory Setting:**	1
Properties:			
Access groups via HMI:	SPLC		

Description:

This parameter sets whether the backup function of the PID setpoint via keypad is active or inactive.

If P1027 = 0 (Inactive), the inverter will not save the value of the PID setpoint when disabled. Therefore, when the inverter is enabled again, the PID setpoint value is 0.0 %.

P1028 – PID Output N=0

Adjustable Range:	0.0 to 100.0 %	**Factory Setting:**	0.0 %
Properties:			
Access groups via HMI:	SPLC		

Description:

The P1028 parameter works together with the P0218 parameter (Condition to Leave the Zero Speed Disable), providing additional requirement for leaving the condition. Thus, it is necessary that the error of the PID (the difference between the setpoint and process variable) is greater than the value programmed in P1028 for the inverter to operate the motor again, this state is known as “wake up”.

P1031 – X Process Variable Value

P1032 – Y Process Variable Value

Adjustable Range:	0.0 to 100.0 %	**Factory Setting:**	P1031=90.0 % P1032=10.0 %
Properties:			
Access groups via HMI:	SPLC		

Description:

These parameters are used at the digital outputs functions for signaling/alarm, and will show:
Process Variable > VPx (Function 1 of the Application) and
Process Variable < VPy (Function 2 of the Application).

19.3 ELECTRONIC POTENTIOMETER APPLICATION (EP)

19.3.1 Description and Definitions

The CFW700 has the ELECTRONIC POTENTIOMETER (EP) function that allows the speed reference to be adjusted via two digital inputs, one for accelerating and another for decelerating the motor.

With the inverter enabled and the DIx digital input set to “Function 1 of the Application (Accelerate)” activated, the motor is accelerated according to the programmed acceleration ramp up to the maximum speed. If only the DIx digital input set to “Function 2 of the Application (Decelerate)” is active and the inverter is enabled, the motor speed is decreased according to the programmed deceleration ramp up to minimum speed. If both inputs are active, the motor will decelerate for safety reasons. With the inverter disabled, DIx digital inputs are ignored unless both are active, which the speed reference is set to 0 rpm. The following figure illustrates this condition.

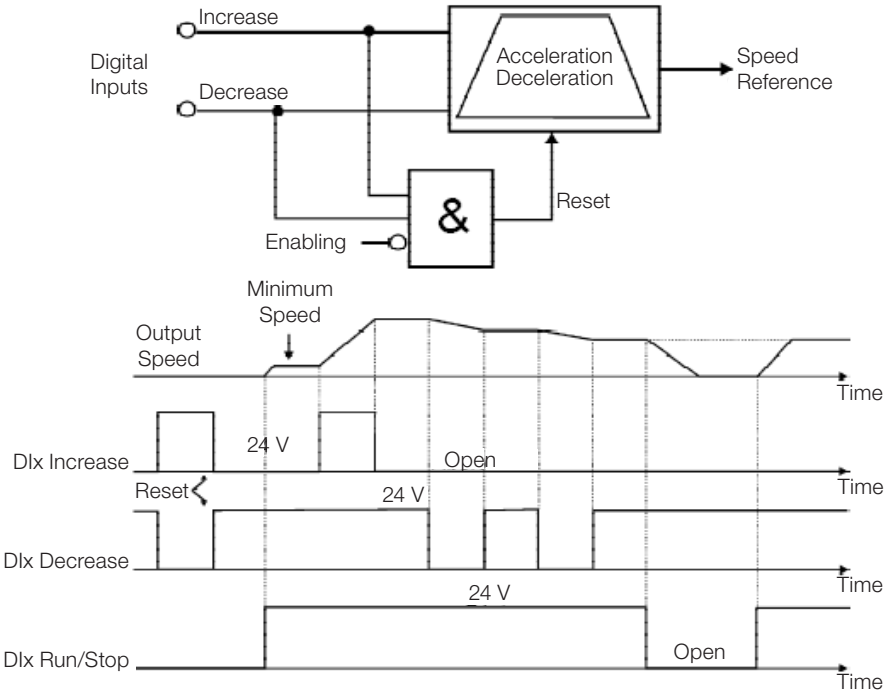


Figure 19.5: *Operation of the Electronic Potentiometer Application (EP)*

It is necessary to set P0221 or P0222 to 7 = SoftPLC for the operation of the electronic potentiometer application.

Definitions:

- The Function 1 of the Application at P0263 to P0270 represents the Accelerate command.
- The Function 2 of the Application at P0263 to P0270 represents the Decelerate command.

The accelerate command is done by one of the digital inputs (DI1 to DI8). It is necessary to set one of the DI’s parameters (P0263 to P0270) to 20 = Function 1 of the Application. If more than one digital input is set for this function, the logic operation will consider only the command of the high priority level digital input, where: DI1>DI2>DI3>DI4>DI5>DI6>DI7>DI8. If any of the digital inputs is set, the following alarm message will be displayed: “A750: Set a DI for Function 1 of the Application (Accelerate)” and the operation of the application will not be enabled.

The decelerate command is also done by one of digital inputs (DI1 to DI8). However, it is necessary to set one the DI’s parameters (P0263 to P0270) to 21 = Function 2 of the Application. If more than one digital input is set for this function, the logic operation will consider only the command of the high priority level digital input, where: DI1>DI2>DI3>DI4>DI5>DI6>DI7>DI8. If any of the digital inputs is set, the following alarm message will be displayed: “A752: Set a DI for Function 2 of the Application (Decelerate)” and the operation of the application will not be enabled.

The Accelerate input is active when 24 V is applied and inactive when 0 V is applied. Otherwise, the Decelerate input is active when 0 V is applied and inactive when 24 V is applied.

Parameter P1011 shows the current value of the speed reference in rpm and it helps to keep the speed reference value when there is no accelerate or decelerate command.

Parameter P1012 sets if the speed reference backup is enabled or if it will go to 0 rpm in a new inverter enabling.

19.3.2 Operation

Before making a detailed description of the parameters related to this application, a step by step guide for showing the operation of the electronic potentiometer application is presented next.

NOTE!
For the proper implementation of the electronic potentiometer application (EP), it is essential to check if the inverter is properly configured to run the motor at the desired speed. Thus, check the following settings:

- Torque boosts (P0136 and P0137) and slip compensation (P0138) if in V/f control mode.
- Run the auto tuning if in vector mode.
- Acceleration and deceleration ramps (P0100 to P0103) and current limiting (P0135 for V/f and VVW control, or P0169/P0170 for vector control).

Setting up the Electronic Potentiometer Application

1. **Selecting the application:**
   When the electronic potentiometer application is enabled, setting P1003 = 2, the default applicative is loaded in the SoftPLC function, making it available for use in the CFW700.

2. **Setting the digital input for the Accelerate command:**
   It is necessary to define which digital input will do the Accelerate command of the electronic potentiometer application. In order to do that, one of the DI parameters selection (P0263 to P0270) should be set to 20 = Function 1 of the Application.
   Recommendation: set the DI3 (P0265 = 20) to do the Accelerate command.

3. **Setting the digital input for the Decelerate command:**
   It is necessary to define which digital input will do the Decelerate command of the electronic potentiometer application. In order to do that, one of the DI parameters selection (P0263 to P0270) should be set to 21 = Function 2 of the Application.
   Recommendation: set the DI4 (P0266 = 21) to do the Decelerate command.

4. **Setting the speed reference source:**
   In case the electronic potentiometer application should operate in local mode, P0221 must be set to 7 = SoftPLC.
   When the electronic potentiometer application should operate in remote mode, P0222 must be set to 7 = SoftPLC.

5. **Setting the reference backup:**
   Determine if the value of the speed reference will be hold (P1012 = 1) or not (P1012 = 0) in case of a new energization of the inverter.

6. **Speed References Limits:**
   Set P0133 and P0134, according to the application.

NOTE!
In case the electronic potentiometer application has been selected to operate in local mode and DI1 (P0263) has been selected to accelerate or decelerate, the inverter can go to the “configuration (CONF)” state and it will be necessary to change the default set of parameter P0227.

Operation Setup

Check the status of the electronic potentiometer application in parameter P1000. The electronic potentiometer will be in operation if P1000 value is 4. If P1000 value is 3, the electronic potentiometer application is stopped and it is necessary to change the command value of the SoftPLC in parameter P1001 to 1 (run application). Any value other than 3 or 4 indicates that the applicative cannot go into operation. For more details, refer to the CFW700 SoftPLC manual.

19.3.3 Parameters

The parameters related to the Electronic Potentiometer Application (EP) are presented next in detail.

P0100 – Acceleration Time

P0101 – Deceleration Time

P0102 – Acceleration Time 2

P0103 – Deceleration Time 2

P0133 – Minimum Speed

P0134 – Maximum Speed

P0221 – LOC Reference Selection

P0222 – REM Reference Selection

P0263 – DI1 Function

P0264 – DI2 Function

P0265 – DI3 Function

P0266 – DI4 Function

P0267 – DI5 Function

P0268 – DI6 Function

P0269 – DI7 Function

P0270 – DI8 Function

P1000 – SoftPLC Status

P1001 – SoftPLC Command

P1002 – Scan Cycle Time

P1003 – SoftPLC Applicative Selection

NOTE!
For more details, refer to chapters 12 - Functions Common to all the Control Modes, and 18 - SoftPLC [50].

P1010 – Version of the Electronic Potentiometer Application (EP)

Adjustable Range:	0.00 to 10.00	**Factory Setting:**	-
Properties:	ro		
Access groups via HMI:	SPLC		

Description:

Read only parameter that presents the software version of the electronic potentiometer application developed for the SoftPLC function of the CFW700.

P1011 – EP Speed Reference

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**	-
Properties:	ro		
Access groups via HMI:	SPLC		

Description:

Read only parameter that presents, in rpm, the current speed reference value of the electronic potentiometer application.

P1012 – EP Speed Reference Backup

Adjustable Range:	0 = Off 1 = On	**Factory Setting:**	1
Properties:			
Access groups via HMI:	SPLC		

Description:

This parameter sets whether the backup function of the electronic potentiometer speed reference is active or inactive.

If P1012 = 0 (Inactive), the inverter will not save the value of the speed reference when disabled. Therefore, when the inverter is enabled again, the speed reference value will be the minimum speed set in P0133.

19.4 MULTISPEED APPLICATION

19.4.1 Description and Definitions

The CFW700 has the MULTISPEED application that allows the speed reference to be set by the values defined at parameters P1011 to P1018 through the logical combination of digital inputs DI4, DI5 and DI6, having the limit of eight pre-programmed speed references. It brings advantages such as stability of the pre-programmed fixed references and electrical noise immunity (isolated digital inputs DIX).

The speed reference selection is done by the logical combination of the digital inputs DI4, DI5 and DI6. Their respective parameters (P0266, P0267 and P0268) must be set to “Function 1 of the Application (Multispeed)”. If any digital input is set to “Function 1 of the Application”, the following alarm message will be displayed “A750: Set a DI for Multispeed” and the speed reference of the inverter will not be enabled.

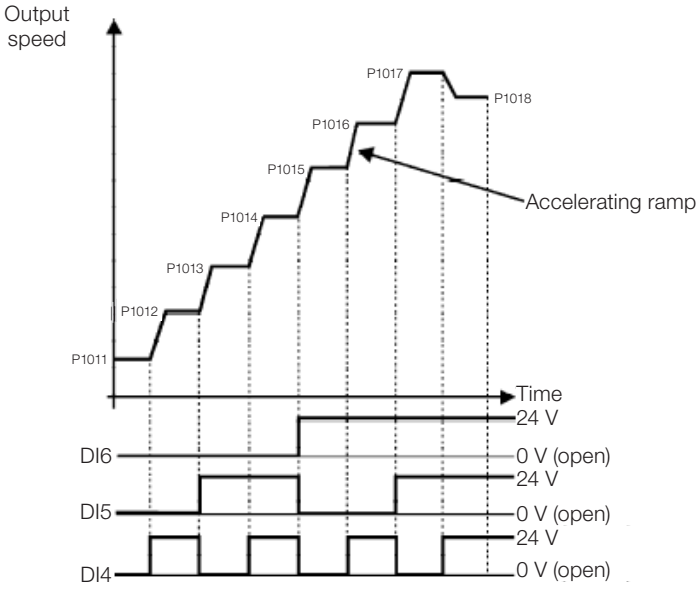


Figure 19.6: *Operation of the Multispeed Application*

For the operation of the multispeed application, it is necessary to set the parameter P0221 or P0222 to 7 = SoftPLC.

Definition:

- The Function 1 of the Application in the parameters P0266 to P0268 represents the Multispeed command.

The speed reference selection works according to the table below:

Table 19.4: *Multispeed reference*

DI6	DI5	DI4	Speed Reference
0 V	0 V	0 V	P1011
0 V	0 V	24 V	P1012
0 V	24 V	0 V	P1013
0 V	24 V	24 V	P1014
24 V	0 V	0 V	P1015
24 V	0 V	24 V	P1016
24 V	24 V	0 V	P1017
24 V	24 V	24 V	P1018

If any digital input is selected for Multispeed, it should be considered as 0 V.

The parameters P1011 to P1018 define the speed reference value when the Multispeed is operating.

19.4.2 Operation Setup

Setting up the Multispeed Application

1. **Selecting the application:**
   When enabling the multispeed, setting P1003 to 3, the standard applicative is loaded to the SoftPLC function, making it available for use in the CFW700.

2. **Enabling the digital inputs for Multispeed:**
   In order to make the speed reference selection in the multispeed application, it is necessary to define the digital input function (DI4, DI5 and/or DI6). In order to do that, it is necessary to set their respective parameters (P0266, P0267 and P0268) to 20 = Function 1 of the Application.

3. **Setting the speed reference source:**
   In case the multispeed application should operate in local mode, P0221 must be set to 7 = SoftPLC. When the multispeed application should operate in remote mode, P0222 must be set to 7 = SoftPLC.

4. **Setting the speed references of the Multispeed:**
   Set the speed references values in the parameters P1011 to P1018.

5. **Speed References Limits:**
   Set P0133 and P0134, according to the application.

NOTE!
For the proper implementation of the multispeed application, it is essential to check if the inverter is properly configured to run the motor at the desired speed. Thus, check the following settings:

- Torque boosts (P0136 and P0137) and slip compensation (P0138) if in V/f control mode.
- Run the auto tuning if in vector mode.
- Acceleration and deceleration ramps (P0100 to P0103) and current limiting (P0135 for V/f and VVW control, or P0169/P0170 for vector control).

Operation setup

Check the status of the multispeed application in the parameter P1000. The multispeed will be in operation if P1000 value is 4. If P1000 value is 3, the multispeed application is stopped and it is necessary to change the command value of the SoftPLC in parameter P1001 to 1 (run application). Any value other than 3 or 4 indicates that the applicative cannot go into operation. For more details, refer to the CFW700 SoftPLC manual.

19.4.3 Parameters

The parameters related to the Multispeed Application are presented next.

P0100 – Acceleration Time

P0101 – Deceleration Time

P0102 – Acceleration Time 2

P0103 – Deceleration Time 2

P0133 – Minimum Speed

P0134 – Maximum Speed

P0221 – LOC Reference Selection

P0222 – REM Reference Selection

P0266 – DI4 Function

P0267 – DI5 Function

P0268 – DI6 Function

P1000 – SoftPLC Status

P1001 – SoftPLC Command

P1002 – Scan Cycle Time

P1003 – SoftPLC Applicative Selection

NOTE!
For more details, refer to chapters 12 - Functions Common to all the Control Modes, and 18 - SoftPLC [50].

P1010 – Version of the Multispeed Application

Adjustable Range:	0.00 to 10.00	**Factory Setting:**	-
Properties:	ro		
Access groups via HMI:	SPLC		

Description:

Read only parameter that presents the software version of the multispeed application developed for the SoftPLC function of the CFW700.

P1011 – Multispeed Reference 1

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**	90 rpm
Properties:	ro		
Access groups via HMI:	SPLC		

Description:

Sets the speed reference 1 for the multispeed application.

P1012 – Multispeed Reference 2

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**	300 rpm
Properties:			
Access groups via HMI:	SPLC		

Description:

Sets the speed reference 2 for the multispeed application.

P1013 – Multispeed Reference 3

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**	600 rpm
Properties:			
Access groups via HMI:	SPLC		

Description:

Sets the speed reference 3 for the multispeed application.

P1014 – Multispeed Reference 4

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**	900 rpm
Properties:			
Access groups via HMI:	SPLC		

Description:

Sets the speed reference 4 for the multispeed application.

P1015 – Multispeed Reference 5

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**	1200 rpm
Properties:			
Access groups via HMI:	SPLC		

Description:

Sets the speed reference 5 for the multispeed application.

P1016 – Multispeed Reference 6

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**	1500 rpm
Properties:			
Access groups via HMI:	SPLC		

Description:

Sets the speed reference 6 for the multispeed application.

P1017 – Multispeed Reference 7

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**	1800 rpm
Properties:			
Access groups via HMI:	SPLC		

Description:

Sets the speed reference 7 for the multispeed application.

P1018 – Multispeed Reference 8

Adjustable Range:	0 to 18000 rpm	**Factory Setting:**	1650 rpm
Properties:			
Access groups via HMI:	SPLC		

Description:

Sets the speed reference 8 for the multispeed application.

19.5 3-WIRE START/STOP COMMAND APPLICATION

19.5.1 Description and Definitions

The CFW700 has the 3-WIRE START/STOP application that allows the inverter to be set as direct online start with emergency button and retention contact.

This way, the digital input (DIx) programmed to “Function 1 of the Application (Start)” will be able to enable the inverter with a single pulse in case the DIx set to “Function 2 of the Application (Stop)” is active. The inverter disables the ramp when the digital input Stop is inactive. The picture below show how it works.

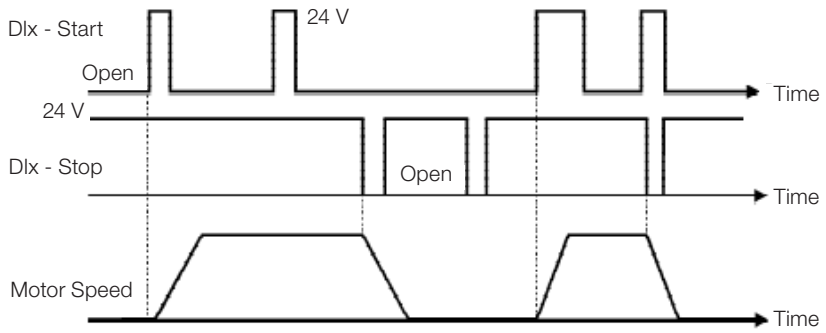


Figure 19.7: *Operation of the 3-Wire Start/Stop Application*

It is necessary to set the parameter P0224 or P0227 to 4=SoftPLC for the operation of the 3-Wire Start/Stop application.

Definitions:

- The Function 1 of the Application at parameters P0263 to P0270 represents the Start command.
- The Function 2 of the Application at parameters P0263 to P0270 represents the Stop command.

The Start command is done by one of the digital inputs (DI1 to DI8). It is necessary to set one of the DI's parameters (P0263 to P0270) to 20 = Function 1 of the Application. If more than one digital input is set for this function, the logic operation will consider only the command of the high priority level digital input, where: DI1>DI2>DI3>DI4>DI5>DI6>DI7>DI8. If any of the digital inputs is set, the following alarm message will be displayed: "A750: Set a DI for Function 1 of the Application (Start)" and the operation of the application will not be enabled.

The Stop command is also done by one of digital inputs (DI1 to DI8). However, it is necessary to set one the DI's parameters (P0263 to P0270) to 21 = Function 2 of the Application. If more than one digital input is set for this function, the logic operation will consider only the command of the high priority level digital input, where: DI1>DI2>DI3>DI4>DI5>DI6>DI7>DI8. If any of the digital inputs is set, the following alarm message will be displayed: "A752: Set a DI for Function 2 of the Application (Stop)" and the operation of the application will not be enabled.

Both Start and Stop inputs are active when 24 V is applied and inactive when 0 V is applied.

With the inverter enabled in local or remote mode, with no fault, without undervoltage, no A750 and A752 alarm, the "General Enable" command is performed in the inverter. In case some digital input is set to "General Enable" function, the inverter will effectively be enabled when the two command sources are active.

19.5.2 Operation Setup

Setting up the 3-Wire Start/Stop Application

1. **Selecting the application:**
   When the 3-Wire Start/Stop application is enabled, setting P1003 = 4, the default applicative is loaded in the SoftPLC function, allowing its use in the CFW700.

2. **Setting the digital input for the Start command:**
   It is necessary to define one digital input for the Start command of the 3-Wire Start/Stop application. In order to do that, one of the DI parameters selection (P0263 to P270) should be set to 20 = Function 1 of the Application.
   Recommendation: set the DI3 (P0265 = 20) to do the Start.

3. **Setting the digital input for the Stop command:**
   It is necessary to define which digital input will do the Stop command of the 3-Wire Start/Stop application. In order to do that, one of the DI parameters selection (P0263 to P0270) should be set to 21 = Function 2 of the Application.
   Recommendation: set the DI4 (P0266 = 21) to do the Stop command.

4. **Setting the Start/Stop source:**
   In case the 3-Wire Start/Stop should operate in local mode, P0224 must be set to 4 = SoftPLC. When the 3-Wire Start/Stop application should operate in remote mode, P0227 must be set to 4 = SoftPLC.

NOTE!
For the proper implementation of the 3-Wire Start/Stop application, it is essential to check if the inverter is properly configured to run the motor at the desired speed. Thus, check the following settings:

- Torque boosts (P0136 and P0137) and slip compensation (P0138) if in V/f control mode.
- Run the auto tuning if in vector mode.
- Acceleration and deceleration ramps (P0100 to P0103) and current limiting (P0135 for V/f and VVW control, or P0169/P0170 for vector control).

NOTE!
In case the 3-Wire Start/Stop application has been selected to operate in local mode and DI1 (P0263) has been selected to start or stop command, the inverter can go to the “configuration (CONF)” state and it will be necessary to change the default set of parameter P0227.

Operation setup

Check the status of the 3-Wire Start/Stop application in the P1000 parameter. The 3-Wire Start/Stop will be in operation if P1000 value is 4. If P1000 value is 3, the 3-Wire Start/Stop application is stopped and it is necessary to change the command value of the SoftPLC at parameter P1001 to 1 (run application). Any value other than 3 or 4 indicates that the applicative cannot go into operation. For more details, refer to the CFW700 SoftPLC manual.

19.5.3 Parameters

The parameters related to the 3-Wire Start/Stop Application are presented next.

P0224 – LOC Run/Stop Selection

P0227 – REM Run/Stop Selection

P0263 – DI1 Function

P0264 – DI2 Function

P0265 – DI3 Function

P0266 – DI4 Function

P0267 – DI5 Function

P0268 – DI6 Function

P0269 – DI7 Function

P1000 – SoftPLC Status

P1001 – SoftPLC Command

P1002 – Scan Cycle Time

P1003 – SoftPLC Applicative Selection

NOTE!
For more details, refer to chapters 12 - Functions Common to all the Control Modes, and 18 - SoftPLC [50].

P1010 – Version of the 3-Wire Start/Stop Application

Adjustable Range:	0.00 to 10.00	**Factory Setting:**	-
Properties:	ro		
Access groups via HMI:	SPLC		

Description:

Read only parameter that presents the software version of the 3-Wire Start/Stop application developed for the SoftPLC function of the CFW700.

19.6 FORWARD/REVERSE RUN APPLICATION

19.6.1 Description and Definitions

The CFW700 has the FORWARD/REVERSE RUN application that allows the combination of two inverter commands (Forward/Reverse and Start/Stop) in a single digital input.

This way, the digital input (DIx) programmed to “Function 1 of the Application (Forward)” combines the forward rotation with the start/stop command and the input (DIx) programmed to “Function 2 of the Application (Reverse)” combines the reverse rotation with the start/stop command. The picture below show how it works.

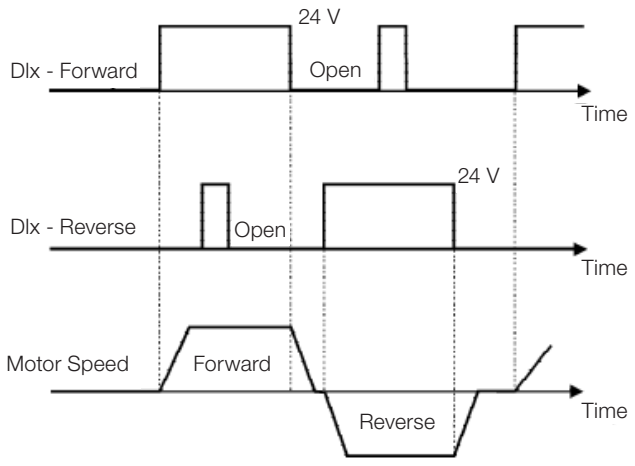


Figure 19.8: *Operation of the Forward/Reverse Run Application*

It is necessary to set the parameter P0223 to 9 = SoftPLC (CW) or 10 = SoftPLC (CCW) together with P0224 to 4 = SoftPLC, or else, it is necessary to set P0226 to 9 = SoftPLC (CW) or 10 = SoftPLC (CCW) together with P0227 to 4 = SoftPLC for the operation of the Forward/Reverse Run application. The following alarm message will be displayed in case the Local FWD/REV selection is not set (P0223): “A760: Set Local FWD/REV to SoftPLC” and the operation of the application will not be enabled if the Local Run/Stop selection (P0224) has been set to SoftPLC. The same applies to the Remote FWD/REV (P0226), i.e., the following alarm message will be displayed: “A762: Set Remote FWD/REV to SoftPLC” and the operation of the application will not be enabled if the Remote Run/Stop selection (P0227) has been set to SoftPLC.

Definitions:

- The Function 1 of the Application at parameters P0263 to P0270 represents the Forward command.
- The Function 2 of the Application at parameters P0263 to P0270 represents the Reverse command.

The Forward command is done by one of the digital inputs (DI1 to DI8). It is necessary to set one of the DI’s parameters (P0263 to P0270) to 20 = Function 1 of the Application. If more than one digital input is set for this function, the logic operation will consider only the command of the high priority level digital input, where: DI1>DI2>DI3>DI4>DI5>DI6>DI7>DI8. If any of the digital inputs is set, the following alarm message will be displayed: “A750: Set a DI for Function 1 of the Application (Forward)” and the operation of the application will not be enabled. It is defined that the forward command rotation will always be “clockwise”.

The Reverse command is also done by one of digital inputs (DI1 to DI8). However, it is necessary to set one the DI’s parameters (P0263 to P0270) to 21 = Function 2 of the Application. If more than one digital input is set for this function, the logic operation will consider only the command of the high priority level digital input, where: DI1>DI2>DI3>DI4>DI5>DI6>DI7>DI8. If any of the digital inputs is set, the following alarm message will be displayed: “A752: Set a DI for Function 2 of the Application (Reverse)” and the operation of the application will not be enabled. It is defined that the reverse command rotation will always be “counterclockwise”.

Both Forward and Reverse inputs are active when 24 V is applied and inactive when 0 V is applied.

With the inverter enabled in local or remote mode, with no fault, without undervoltage, no A750, A752, A760 and A762 alarms, the “General Enable” command is performed in the inverter. In case some digital input is set to “General Enable” function, the inverter will effectively be enabled when the two command sources are active.

With the forward digital input active and the reverse digital input inactive, the forward and start commands are performed. If the reverse digital input is active, nothing is changed in the operation of the inverter. When both commands are inactive, the start command is removed and the motor will be decelerated to 0 rpm. However, when the reverse digital input is active and the forward digital input is inactive, the reverse and start command are performed. If the forward digital input is active, nothing is changed in the operation of the inverter. When both commands are inactive, the start command is removed and the inverter decelerates to 0 rpm. In case both forward and reverse digital inputs are active at the same time, the forward command will be generated.

19.6.2 Operation Setup

Setting up the Forward/Reverse Run Application

1. **Selecting the application:**
   When the Forward/Reverse Run application is enabled, setting P1003 = 5, the default applicative is loaded in the SoftPLC function, allowing its use in the CFW700.

2. **Setting the digital input for the Forward command:**
   It is necessary to define one digital input for the Forward command of the Forward/Reverse Run application. In order to do that, one of the DI parameters selection (P0263 to P0270) should be set to 20 = Function 1 of the Application.
   Recommendation: set the DI3 (P0265 = 20) to do the Forward.

3. **Setting the digital input for the Reverse command:**
   It is necessary to define one digital input for the Reverse command of the Forward/Reverse Run application. In order to do that, one of the DI parameters selection (P0263 to P0270) should be set to 21 = Function 2 of the Application.
   Recommendation: set the DI4 (P0266 = 21) to do the Reverse.

4. **Setting the Forward/Reverse and the Start/Stop source:**
   In case the Forward/Reverse Run application should operate in local mode, P0223 must be set to 9 = SoftPLC (CW) or 10 = SoftPLC (CCW) together with P0224 to 4 = SoftPLC. When the Forward/Reverse Run application should operate in remote mode, P0226 must be set to 9 = SoftPLC (CW) or 10 = SoftPLC (CCW) together with P0227 to 4 = SoftPLC .

NOTE!
For the proper implementation of the Forward/Reverse Run application, it is essential to check if the inverter is properly configured to run the motor at the desired speed. Thus, check the following settings:

- Torque boosts (P0136 and P0137) and slip compensation (P0138) if in V/f control mode.
- Run the auto tuning if in vector mode.
- Acceleration and deceleration ramps (P0100 to P0103) and current limiting (P0135 for V/f and VVW control, or P0169/P0170 for vector control).

NOTE!
In case the Forward/Reverse Run application has been selected to operate in local mode and DI1 (P0263) has been selected to forward or reverse command, the inverter can go to the “configuration (CONF)” state and it will be necessary to change the default set of parameter P0227.

Operation setup

Check the status of the Forward/Reverse Run application in the P1000 parameter. The Forward/Reverse Run will be in operation if P1000 value is 4. If P1000 value is 3, the Forward/Reverse Run application is stopped and it is necessary to change the command value of the SoftPLC at parameter P1001 to 1 (run application). Any value other than 3 or 4 indicates that the applicative cannot go into operation. For more details, refer to the CFW700 SoftPLC manual.

19.6.3 Parameters

The parameters related to the Forward/Reverse Run Application are presented next.

P0223 – LOC FWD/REV Selection

P0224 – LOC Run/Stop Selection

P0226 – REM FWD/REV Selection

P0227 – REM Run/Stop Selection

P0263 – DI1 Function

P0264 – DI2 Function

P0265 – DI3 Function

P0266 – DI4 Function

P0267 – DI5 Function

P0268 – DI6 Function

P0269 – DI7 Function

P0270 – DI8 Function

P1000 – SoftPLC Status

P1001 – SoftPLC Command

P1002 – Scan Cycle Time

P1003 – SoftPLC Applicative Selection

NOTE!
For more details, refer to chapters 12 - Functions Common to all the Control Modes, and 18 - SoftPLC [50].

P1010 – Version of the Forward/Reverse Run Application

Adjustable Range:	0.00 to 10.00	**Factory Setting:**	-
Properties:	ro		
Access groups via HMI:	SPLC		

Description:
Read only parameter that presents the software version of the Forward/Reverse Run application developed for the SoftPLC function of the CFW700.

20 MAINTENANCE

20.1 PREVENTIVE MAINTENANCE

DANGER!
Always turn off the mains power supply before touching any electrical component associated to the inverter.

High voltage may still be present even after disconnecting the power supply.

To prevent electric shock, wait at least 10 minutes after turning off the input power for the complete discharge of the power capacitors.

Always connect the equipment frame to the protective ground (PE). Use the adequate connection terminal at the inverter.

ATTENTION!
The electronic boards have electrostatic discharge sensitive components.

Do not touch the components or connectors directly. If necessary, first touch the grounded metallic frame or wear a ground strap.

Do not perform any withstand voltage test!
If necessary, consult WEG.

The inverters require low maintenance when properly installed and operated. The table 20.1 presents the main procedures and time intervals for preventive maintenance. The table 20.2 provides recommended periodic inspections to be performed every 6 months after the inverter start-up.

Table 20.1: *Preventive maintenance*

Maintenance		Interval	Instructions
Fan replacement		After 50000 operating hours. (1)	Replacement procedure showed in figures 20.1 and 20.2.
Electrolytic capacitors	If the inverter is stocked (not being used): “Reforming”	Every year from the manufacturing date printed on the inverter identification label (refer to the chapter 6 - Inverter Model and Accessories Identification).	Apply power to the inverter (voltage between 220 and 230 Vac, single-phase or three-phase, 50 or 60 Hz) for at least one hour. Then, disconnect the power supply and wait at least 24 hours before using the inverter (reapply power).
	Inverter is being used: replace	Every 10 years.	Contact WEG technical support to obtain replacement procedures.

(1) The inverters are set at the factory for automatic fan control (P0352=2), which means that they will be turned on only when the heatsink temperature exceeds a reference value. Therefore, the operating hours of the fan will depend on the inverter usage conditions (motor current, output frequency, cooling air temperature, etc.). The inverter stores the number of fan operating hours in the parameter P0045. When this parameter reaches 50000 operating hours, the keypad display shows the alarm A177.

Table 20.2: Recommended periodic inspections - Every 6 months

Component	Abnormality	Corrective Action
Terminals, connectors	Loose screws	Tighten
	Loose connectors	
Fans / Cooling system	Dirty fans	Cleaning
	Abnormal acoustic noise	Replace the fan. Refer to the figures 20.1 and 20.2. Check the fan connections.
	Blocked fan	
	Abnormal vibration	
	Dust in the cabinet air filter	Cleaning or replacement
Printed circuit boards	Accumulation of dust, oil, humidity, etc.	Cleaning
	Odor	Replacement
Power module / Power connections	Accumulation of dust, oil, humidity, etc.	Cleaning
	Loose connection screws	Tighten
DC bus capacitors (DC link)	Discoloration / odor / electrolyte leakage	Replacement
	Expanded or broken safety valve	
	Frame expansion	
Power resistors	Discoloration	Replacement
	Odor	
Heatsink	Dust accumulation	Cleaning
	Dirty	

20.2 CLEANING INSTRUCTIONS

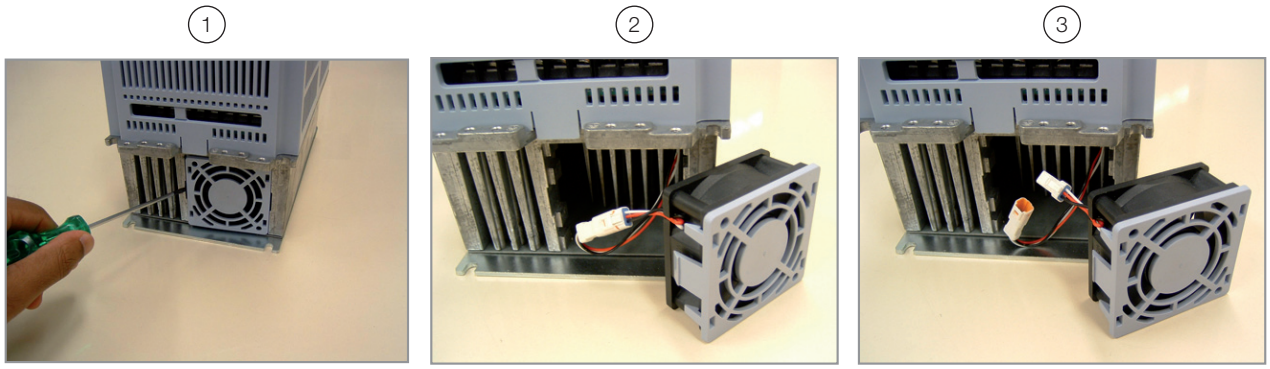
When it is necessary to clean the inverter, follow the instructions below:

Ventilation system:

- Disconnect the inverter power supply and wait at least 10 minutes.
- Remove the dust from the cooling air inlet by using a soft brush or a flannel.
- Remove the dust from the heatsink fins and from the fan blades by using compressed air.

Electronic boards:

- Disconnect the inverter power supply and wait at least 10 minutes.
- Remove the dust from the electronic board by using an anti-static brush or an ion air gun (Charges Burtes Ion Gun - reference A6030-6DESCO).
- If necessary, remove the boards from the inverter.
- Always wear a ground strap.

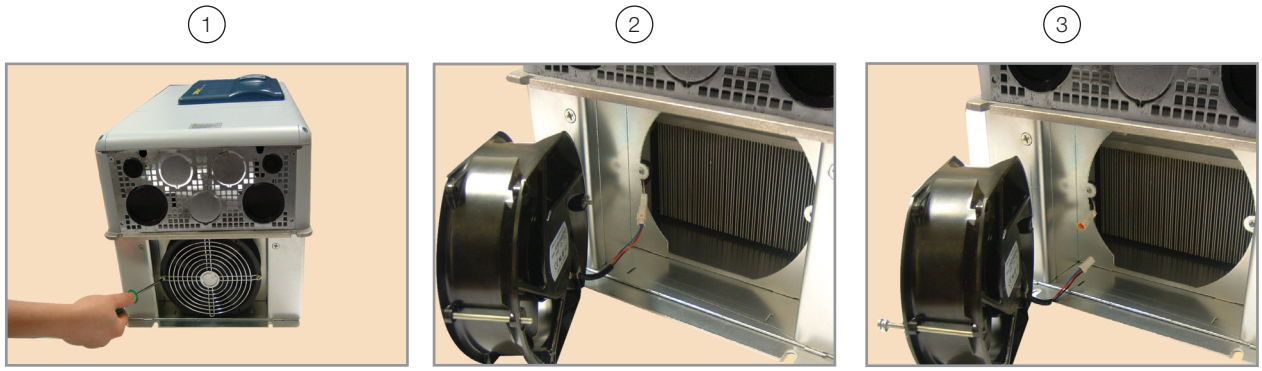


Releasing the latches of the fan cover

Fan removal

Cable disconnection

(a) Models up to 105 A



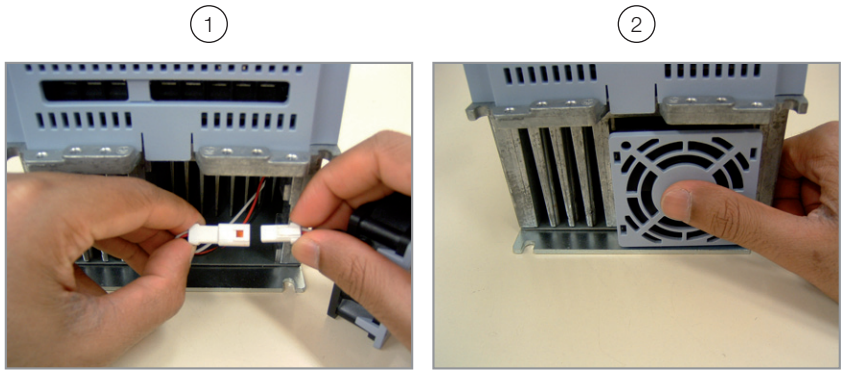
Fan grill screws removal

Fan removal

Cable disconnection

(b) Models 142 A, 180 A and 211 A

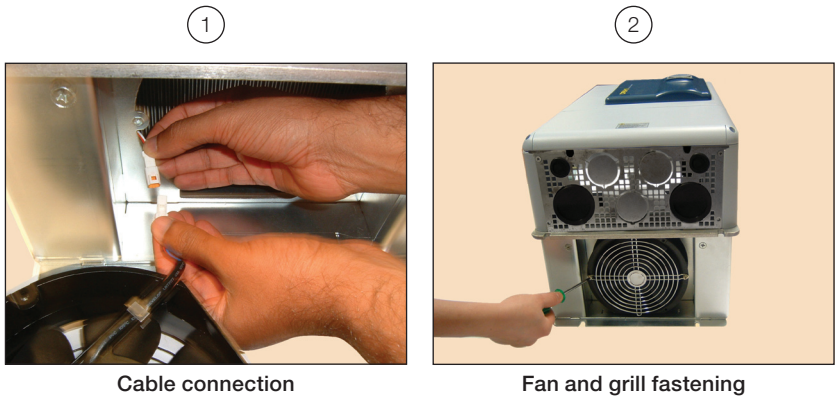
Figure 20.1 (a) and (b): *Fan removal*



Cable connection

Fan fitting

(a) Models up to 105 A



Cable connection

Fan and grill fastening

(b) Models 142 A, 180 A and 211 A

Figure 20.2 (a) and (b): *Fan installation*