INVERGEN

Installation and Firmware Manual

1. Preface

Certain operations may cause danger or a hazard during installation, operation or thereafter. Appropriate warning signs have been placed in documentation and on the equipment, wherever such a situation may arise.

1.1 Symbols

DANGER Indicates possibility of death or serious injury

CAUTION Indicates possibility of injury or damage

PROHIBITED ACTION

ACTION REQUIRED

1.2 Standards Compliance

Standard	Description
EN 61800-5-1	Adjustable speed electrical power drive systems – part 5-1 Safety requirements - Electrical, thermal and energy
EN 61800-5-2	Adjustable speed electrical power drive systems – part 5-2: Safety requirements – Functional Safety
EN 61800-3	Adjustable speed electrical power drive systems – part 3: EMC requirements and specific test methods

2 SAFETY

The INVERGEN drive is designed and built in accordance with state-of-the-art technology and the recognised safety rules and regulations. However, the use of such devices may cause functional hazards to the life of the user or third parties, or damages to the system and other material property. The following safety instructions have been created by the manufacturer for the product. They can be supplemented by local, country- or application-specific safety instructions.

2.1 Target Group

This instruction manual is exclusively for electrical personnel. Electrical personnel for the purpose of this instruction manual must have the following qualifications:

- Knowledge and understanding of the safety instructions.
- Skills for installation and assembly.
- Start-up and operation of the product.
- Understanding of the function in the used machine.
- Detection of hazards and risks of the electrical drive technology.
- Knowledge of *DIN IEC 60364-5-54*.
- Knowledge of national safety regulations. (ex *DGUV regulation 3*).

2.2 Connections

Danger Risk of life due to Electric shock.

- For any work on the unit switch off the supply voltage and secure it against switching on.
- Wait till the drive has stopped in order. Regenerative energy could be generated.
- Wait till the DC-Link capacitors are discharged (5 minutes).

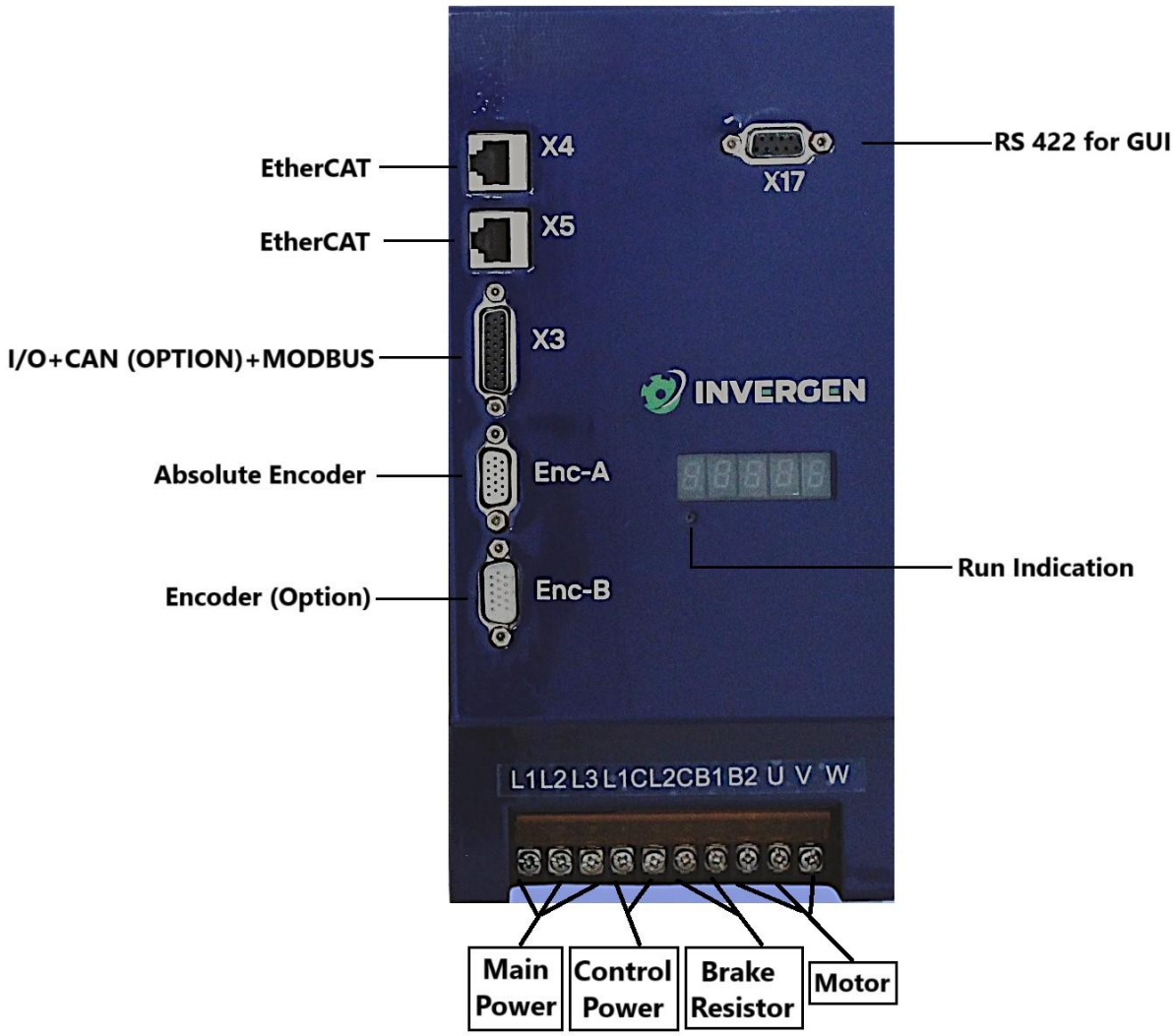
2.3 Start-up and operation

The drive converter must not be started until it is determined that the installation complies with the machine directive as per EN 60204-1.

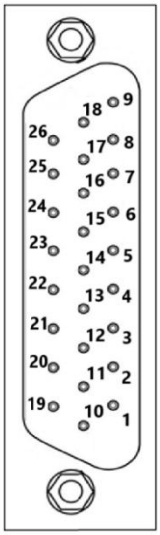
Caution Hazards caused by unintentional operation of the drive.

- Ensure proper parameterization before drive start-up.
- This is especially the case where a drive is replaced in an existing set up.

3.0 Drive Connections and layout (Frame A)



3.1 IO + CAN (option) + Modbus X3

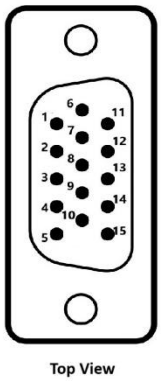


Top View

Dsub 26 pin 3 row Receptacle

Pin no	Description	
1.	IN7	Digital Inputs. Actuation by 0V or 24V. Actuation selection by jumper J6.
2.	IN6	
3.	IN5	
4.	IN4	
5.	IN3	
6.	IN2	
7.	IN1	
8.	CANH/485-A	
9.	GND	For use with Analog o/p.
10.	AN1+	Analog input 0-10V.
11.	AN1-	
12.	AN2+	Analog input 0-10V.
13.	AN2-	
14.	AO1	Analog output 0-10V wrt GND.
15.	AO2	
16.	GND	For use with Analog o/p.
17.	OP2	Digital output 2
18.	CANL/485-B	
19.	Relay NC contact	
20.	Relay NO contact	
21.	Relay Pole	
22.	OP1	Digital output 2
23.	24V	
24.	COM	
25.	24V	
26.	COM	

3.2 Encoder A ENC-A



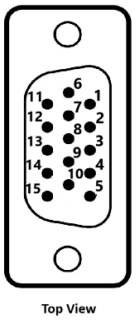
Top View

Dsub 15 pin 3 row Receptacle

Pin no	Description	
1.	A+	For incremental encoder interface
2.	A-	
3.	B+	
4.	B-	
5.	N+/DAT+	DAT+, DAT- for Tamagawa encoder.*
6.	N-/DAT-	N+,N- : index for incremental encoder
7.	COM	
8.	5V	
9.	-	
10.	N+/DAT+	DAT+, DAT- for Tamagawa encoder.*
11.	N-/DAT-	N+,N- : index for incremental encoder
12.	-	
13.	COM	
14.	5V	
15.	-	

** Tamagawa encoder refers to 23b absolute encoder with serial interface.*

3.3 Encoder B ENC-B

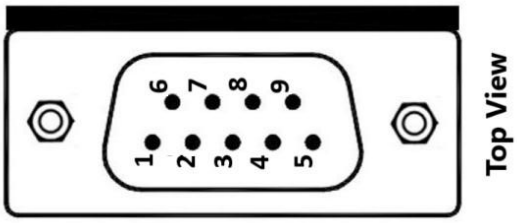


Dsub 15 pin 3 row Header

Pin no	Description	
1.	BO+	For incremental encoder interface
2.	BO-	
3.	NO+	
4.	NO-	
5.	Z+	
6.	Z-	
7.	COM	
8.	5V	
9.	AO+	Incremental encoder output. ⚠ *Warning: Do not connect encoder input here.*
10.	AO-	
11.	A+	
12.	A-	
13.	B+	
14.	B-	
15.		

3.4 RS422 interface X17

Dsub 9 pin 2 row Receptacle



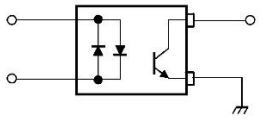
Pin no	Description
1.	-
2.	RX-B
3.	TX-B
4.	-
5.	-
6.	-
7.	GND
8.	TX-A
9.	RX-A

For interface to INVERGEN GUI and scope – MOTOWIZ.

3.5 Specifications

Mains input Voltage:	3ph, 400V, 50-60 Hz, +10% to -15%
Control Supply voltage (L1C, L2C):	400V, 50-60Hz, +10% to -15%
Encoder supply (internal):	5V, 0.3A
Voltage for digital inputs/outputs:	24, 100mA
Analog input:	2nos, 0 – 10V
Differential mode input impedance:	200k
Common mode input impedance:	133k
Analog output:	2nos, 0 – 10V, 10mA
Digital inputs:	7nos, 0-24V, 8mA each
Digital outputs:	2nos, 0-24V
RS485 (Modbus RTU):	1nos
CAN (optional):	1nos
Ethercat (optional)	
Relay:	1 Form C
Contact rating:	30V, 8A

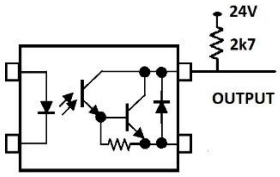
3.51 Digital Inputs



Opto isolated input

Input current = 8mA/input at 24V actuation voltage
Actuation voltage: 0V or 24V selected by **jumper J6**

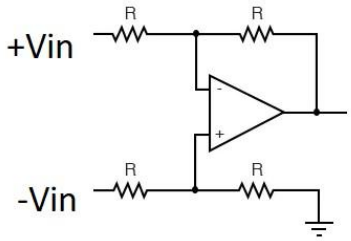
3.5.2 Digital Outputs



Only for resistive load.

3.5.3 Analog inputs

0-10V non isolated differential inputs.



3.6 Control & encoder cables

For encoder and control wiring, use shielded twisted pair cable suitable for high frequency operation.

Firmware and Parameters

4 Parameter setup with INVERGEN GUI - MOTOWIZ

- See MOTOWIZ user manual for details.

4.1 Parameter Summary

Display and Status (Read only) – Group0

Display	Parameter
di-00	Set Frequency(Hz)
di-01	Ramp out frequency(Hz)
di-02	Output frequency(Hz)
di-03	Encoder A frequency(Hz)
di-04	Encoder B frequency(Hz)
di-05	Output current(A)
di-06	Peak output current(A)
di-07	Output voltage uncompensated(V)
di-08	CRC reject count
di-09	DC bus voltage(V)
di-10	DC bus voltage peak(V)
di-11	DC bus voltage at power up(V)
di-12	Position actual value(rad)
di-13	Set Speed(rpm)
di-14	Ramp out speed(rpm)
di-15	Output speed(rpm)
di-16	Encoder A speed(rpm)
di-17	Encoder B speed(rpm)
di-18	Ref Torque (%)
di-19	Actual Torque (%)
di-20	Torque limit For(A)
di-21	Torque limit Rev(A)
di-22	Heatsink temperature(C)
di-23	Motor temperature(C)
di-24	Encoder A Pos Elec(rad)
di-25	Encoder A position(rad)
di-26	Encoder B Pos GF(rad)
di-27	Encoder B position(rad)
di-28	Analog input1 volts(V)
di-29	Analog input1 ref(%)

di-30	Analog input2 volts(V)
di-31	Analog input2 ref(%)
di-32	Analog input ref(%)
di-33	Analog output value(V)
di-34	Iout/Ioverload
di-35	delta speed(rpm)
di-36	Overload counter
di-37	status word
di-38	status word1
di-39	control word status
di-40	brake control status
di-41	touch probe status
di-42	internal status word
di-43	digital input state
di-44	digital output state
di-45	Error code
di-47	Control firmware version
di-48	XMC firmware version
di-49	Resolver board firmware version
di-50	Control board production number
di-51	Drive production number

Motor Data – Group1

Display	Parameter	Range	Default Value
md-00	Motor type	0 - 2 0:asynch,1:PMSM	1
md-01	Damping Factor	0-100.0	200
md-02	Rated Current(A)	0.1 - 1000.0	5
md-03	Rated Speed(rpm)	1 - 128000	1500
md-04	Pole Pairs	2 - 100	4
md-05	Rated Voltage(V)	1 - 830	230
md-06	Rated Power Factor	0.01 - 1.00	0.86
md-07	Magnetizing Current (%)	0 - 100.0	0
md-08	Rated Torque(Nm)	0 - 3200.000	5
md-09	Max Torque (%)	0 - 6000.0	300
md-10	Max Current (%)	0 - 300.0	300
md-11	Back Emf Constant(Vpk/krpm)	0 - 60000.000	110
md-12	Inductance d axis(mH)	0.001 - 6000.000	10
md-13	Inductance q axis(mH)	0.001 - 6000.000	10
md-14	Stator Res(L-N)(E)	0.0001 - 6.0000	3
md-15	Rotor Res(L-N)(E)	0.0001 - 6.0000	3
md-16	Stator Ind(L-N)(mH)	0.001 - 6000.000	64
md-17	Leakage Ind(L-N)(mH)	0.001 - 6000.000	3.2
md-18	Inertia Motor(kg-cm2)	0 - 20000000.00	2

Motor Control – Group2

Display	Parameter	Range	Default Value
mc-00	Kp current gain q axis	0 - 214748.3647	0.0001
mc-01	Ki current gain q axis(ms)	0 - 2147483.647	0.001
mc-02	Kp current gain d axis	0 - 214748.3647	0.0001
mc-03	Ki current gain d axis(ms)	0 - 2147483.647	0.001
mc-04	Set velocity filter time(s)	0 - 60.000	2
mc-05	DC bus compensation	0 - 2	0
mc-06	DC bus reference(V)	200 - 830	300
mc-07	Motor Control mode	0 - 3	2
mc-08	DC brake enable	0 - 1	0
mc-09	DC brake volts(V)	0 - 100	10
mc-10	DC brake time(s)	0 - 25.0	2
mc-11	DC brake act frequency(Hz)	0 - 2000.0	2

Control – Group3

Display	Parameter	Range	Default Value
Co-00	Control word	0 - 65535	0
Co-01	Mode of operation	0 - 255	2
Co-02	Velocity resolution	0 - 13	10
Co-03	Position counts per rev	0 - 2^30	65535
Co-04	Position fb source	0 - 1	0
Co-05	Speed fb source	0 - 1 0:EncA,1:EncB	0
Co-06	Default rotation direction	0 - 1 0:FWD,1:REV	1
Co-07	Position interpolator	0 - 65535	0
Co-08	Velocity interpolator	0 - 65535	0
Co-09	Torque interpolator	0 - 65535	0
Co-10	Target Torque (%)	-32767 - 32767	0
Co-11	Torque offset (%)	-32767 - 32767	0
Co-12	Target velocity(rpm)	-536870912 - 536870912	0
Co-13	Velocity offset/feed forward (%)	0 - 100 %	0
Co-14	Velocity ff filter time(ms)	0 - 60.000	0.01
Co-15	Target Position(rad)	-536870912 - 536870912	9
Co-16	Control word mask	0 - 65535	65535
Co-17	Control word internal	0 - 65535	0
Co-18	State Machine	0 - 65535	0
Co-19	Acceleration for(rev/s2)	1 - 10737418.24	20

Co-20	Acceleration rev(rev/s2)	1 - 10737418.24	20
Co-21	Deceleration for(rev/s2)	1 - 10737418.24	20
Co-22	Deceleration rev(rev/s2)	1 - 10737418.24	20
Co-23	For acc rate ls(rev/s3)	50 - 134217728	100
Co-24	For acc rate hs(rev/s3)	50 - 134217728	100
Co-25	For dec rate ls(rev/s3)	50 - 134217728	100
Co-26	For dec rate hs(rev/s3)	50 - 134217728	100
Co-27	Rev acc rate ls(rev/s3)	50 - 134217728	100
Co-28	Rev acc rate hs(rev/s3)	50 - 134217728	100
Co-29	Rev dec rate ls(rev/s3)	50 - 134217728	100
Co-30	Rev dec rate hs(rev/s3)	50 - 134217728	100
Co-31	Ramp select	0 - 15 0:linear,1:Scurve	0
Co-32	Torque limit select(%)	0 - 65535	1

Position – Group4

Display	Parameter	Range	Default Value
Po-00	Position control select	0 - 1 0:disable,1:enable	0
Po-01	Kp pos control gain(rpm)	0 - 6500.0	10
Po-02	Kp zero speed gain(rpm)	0 - 6500.0	10
Po-03	Kp reduced gain (%)	0 - 100.0	0
Po-04	Kp speed for red gain(rpm)	0 - 128000	3000
Po-05	Following error window	0 - 2147483647	5000
Po-06	Following error timeout(ms)	0 - 65535	0
Po-07	Positioning window	0 - 2147483647	5000
Po-08	Positioning window time(ms)	0 - 65535	5000
Po-09	Position ref filter time(ms)	0 - 60.000	1
Po-10	Set position limit pos	-536870912 - 536870912	536870912

Po-11	Set position limit neg	-536870912 - 536870912	536870912
Po-12	Position control Status	0 - 65535	0
Po-13	Profile velocity(rpm)	0 - 128000	0
Po-14	Max profile velocity(rpm)	0 - 128000	1000
Po-15	End velocity(rpm)	0 - 128000	0
Po-16	Absolute pos modes	0 - 255	0
Po-17	Pos gear ratio numerator	0 - 2147483647	1
Po-18	Pos gear ratio denominator	0 - 2147483647	1
Po-19	Positioning mode	0 - 255	1
Po-20	Time delay after which ff torque ac	0 - 10	1

Velocity – Group5

Display	Parameter	Range	Default Value
vl-00	min velocity forward(rpm)	0-128000	0
vl-01	max velocity forward(rpm)	0-128000	2000
vl-02	min velocity reverse(rpm)	0-128000	0
vl-03	max velocity reverse(rpm)	0-128000	2000
vl-04	target velocity(rpm)	-128000 to 128000	0
vl-05	target velocity high res(rpm)	-536870912 - 536870912	0
vl-06	Speed ref control word	0-65535	1
vl-07	Speed ref filter time(ms)	0-60.000	0
vl-08	Kp speed	0-107374.1823	0.01
vl-09	Ki speed(ms)	0-1073741.823	0.25
vl-10	Variable Kp gain	0-10.000	0
vl-11	Variable Kp max	0-500.0	0
vl-12	Speed for max Kp,Ki	0-1000.0	5
vl-13	Speed for normal Kp,Ki	0-1000.0	10
vl-14	Kp at speed for max Kp,Ki	0-65535	0
vl-15	Ki at speed for max Kp,Ki	0-65535	0
vl-16	Preset Speed1(rpm)	-30000 - 30000	0
vl-17	Preset Speed2(rpm)	-30000 - 30000	0

vl-18	Preset Speed3(rpm)	-30000 - 30000	0
vl-19	Preset Speed4(rpm)	-30000 - 30000	0
vl-20	Preset Speed5(rpm)	-30000 - 30000	0
vl-21	Preset Speed6(rpm)	-30000 - 30000	0
vl-22	Preset Speed7(rpm)	-30000 - 30000	0

Torque – Group6

Display	Parameter	Range	Default Value
To-00	Torque limit forward(%)	0-1000	100
To-01	Torque limit reverse(%)	0-1000	100
To-02	Load inertia(kg-cm2)	0-20000000.00	0
To-03	Torque ref filter time(ms)	0-60.000	0
To-04	Torque feedforward(ff)	0-1	0
To-05	Torque ff filter time(ms)	0-60.000	0
To-06	Torque ff delay time(ms)	0-60.000	0
To-07	Torque ff gain(%)	0-6000.0	100

Digital Outputs – Group7

Display	Parameter	Range	Default Value
Do-00	Comparator ref A1	0-64	0
Do-01	Comparator ref A2	0-64	0
Do-02	Comparator ref A3	0-64	0
Do-03	Comparator ref B1	0 - 2147483647	0
Do-04	Comparator ref B2	0 - 2147483647	0
Do-05	Comparator ref B3	0 - 2147483647	0
Do-06	Operator for Comp1	0-65535	0
Do-07	Operator for Comp2	0-65535	0
Do-08	Operator for Comp3	0-65535	0
Do-09	Configure OP1	0-65535	0
Do-10	Configure OP2	0-65535	0
Do-11	Configure Relay	0-65535	0
Do-12	Comparator B inp scale B1_scale	-536870912 - 536870912	0
Do-13	Comparator B inp scale B2_scale	-536870912 - 536870912	0
Do-14	Comparator B inp scale B3_scale	-536870912 - 536870912	0
Do-15	Hysteresis Comp1	0 - 214748.3647	0
Do-16	Hysteresis Comp2	0 - 214748.3647	0
Do-17	Hysteresis Comp3	0 - 214748.3647	0

Do-18	Comparator o/p filter flt1(ms)	1-65535	1
Do-19	Comparator o/p filter flt2(ms)	1-65535	1
Do-20	Comparator o/p filter flt3(ms)	1-65535	1
Do-21	Digital o/p ext source	0-7	0
Do-22	Digital o/p inversion	0-7	0
Do-23	Digital o/p source select	0-127	0

Digital Inputs – Group8

Display	Parameter	Range	Default Value
Di-00	Digital input invert	0-2048	0
Di-01	Digital input select	0-65535	0
Di-02	Digital inputs ext src	0-127	0
Di-03	Digital input filter(ms)	0-2000	0
Di-04	Run	0-7	0
Di-05	Fault Reset	0-7	0
Di-06	FOR	0-7	0
Di-07	REV	0-7	0
Di-08	Stop	0-7	0
Di-09	Start posi/homing	0-7	0
Di-10	Halt	0-7	0
Di-11	Speed invert	0-7	0
Di-12	Mask1 input	0-7	0
Di-13	Mask1 value	0-65535	0
Di-14	Mask2 input	0-7	0
Di-15	Mask2 value	0-65535	0
Di-16	Multi step input 1	0-7	0
Di-17	Multi step input 2	0-7	0
Di-18	Multi step input 3	0-7	0
Di-19	Command Pulse direction	0-1	0
Di-20	Command Pulse mode	0-2	0
Di-21	Command Pulse Select	0-1	0
Di-22	Reserved1	-	0

Homing – Group9

Display	Parameter	Range	Default Value
Ho-00	Homing offset	-536870912 - 536870912	0
Ho-01	Homing method	1-35	1
Ho-02	Homing speed(rpm)	0 - 2147483647	800

Ho-03	Speed after hom sw release(rpm)	0 - 2147483647	400
Ho-04	Homing acceleration(rev/s2)	0 - 21474836.47	20
Ho-05	Negative limit switch source	0-7	1
Ho-06	Positive limit switch source	0-7	1
Ho-07	Home switch source	0-65535	0
Ho-08	Touch probe mode	0-65535	0
Ho-09	Touch probe status	0-65535	0
Ho-10	Touch probe pos edge	0-65535	0
Ho-11	Touch probe neg edge	0-65535	0
Ho-12	home mode input sel	1-127	0
Ho-13	Excluded modes for lim sw	0-65535	0
Ho-14	Excluded modes for sw lims	0-65535	0
Ho-15	limit switch operation	0-65535	0

Encoder A – Group10

Display	Parameter	Range	Default Value
EA-00	Encoder select	0-20	0
EA-01	Encoder index offset	0-65535	0
EA-02	Gear Numerator	0-65535	0
EA-03	Gear denominator	0-65535	1
EA-04	Encoder timeout(ms)	0-60.000	3
EA-05	Speed filter time(ms)	0-256.000	4
EA-06	Encoder PPR	0 - 2147483647	1024
EA-07	Encoder status	0-65535	0
EA-08	Encoder error	0-65535	0
EA-09	Encoder Initialization	0 - 2	0

Encoder B – Group11

Display	Parameter	Range	Default Value
Eb-00	Encoder select	0-20	0
Eb-01	Encoder index offset	0-65535	0
Eb-02	Gear Numerator	1 - 2147483647	1
Eb-03	Gear denominator	1 - 2147483647	1
Eb-04	Encoder unit time(ms)	0-6000.000	3
Eb-05	Speed filter time(ms)	1-6000.000	4
Eb-06	Encoder PPR	0-200000	1024
Eb-07	Encoder status	0-65535	0

Eb-08	Encoder error	0-65535	0

Protections – Group12

Display	Parameter	Range	Default Value
Pr-00	Motor protection current at standst	1-1000.0	100
Pr-01	Motor protection min current(%)	1-500.0	150
Pr-02	Motor protection time at max curre	1-25.5	0.2
Pr-03	Motor protection time at min curre	1-25.5	1
Pr-04	Motor protection recovery time(s)	1-600.0	0.5
Pr-05	Overload warning level(%)	1-100.0	80
Pr-06	Overload stop mode	0 - 1	0
Pr-07	Software sw limit left	-536870912 - 536870912	536870912
Pr-08	Software sw limit right	-536870912 - 536870912	536870912
Pr-09	SW limit stop mode	0-8	7
Pr-10	Fieldbus watchdog time(ms)	0-16000	1000
Pr-11	Fieldbus watchdog stop mode	0-8	7
Pr-12	Preset Overspeed level	0-800.0	200
Pr-13	Preset Overspeed stop mode	0-8	7
Pr-14	External error source	0-65535	0
Pr-15	External error stop mode	0-8	7
Pr-16	Braking transistor activation	0-1 0:disable,1:enable	0
Pr-17	Braking transistor act level(V)	300-1500	780
Pr-18	Encoder A stop mode	0-8	7
Pr-19	Encoder B stop mode	0-8	7
Pr-20	Max acc/dec rate(rev/s3)	1 - 21474836.48	5
Pr-21	Max acc/dec stop mode	0-8	7

Pr-22	Max speed difference level(%)	0-800.0	5
Pr-23	Max speed difference time(ms)	0-65535	25
Pr-24	Speed difference stop mode	0-8	7
Pr-25	Speed difference selection	0-3	1
Pr-26	Input phase failure detection	0-1 0:disable,1:enable	0
Pr-27	Fault Reaction time(ms)	0-30000	1000
Pr-28	Source for ending fault react	0-8	0
Pr-29	Fault velocity(rpm)	-128000 to 128000	0
Pr-30	Fault acceleration(rev/s2)	1-1073741824	2000
Pr-31	Fault deceleration(rev/s2)	1-1073741824	2000
Pr-32	Fault acc jerk ls(rev/s3)	50 - 134217728	50
Pr-33	Fault acc jerk hs(rev/s3)	50 - 134217728	50
Pr-34	Fault dec jerk ls(rev/s3)	50 - 134217728	50
Pr-35	Fault dec jerk hs(rev/s3)	50 - 134217728	50
Pr-36	Fault ramp select	0-15	0
Pr-37	Overspeed percentage	0-100.0	90
Pr-38	Overspeed stop mode	0-8	7
Pr-39	For limit switch stop mode	0-8	7
Pr-40	Rev limit switch stop mode	0-8	7
Pr-41	Safety stop mode	0-8	7
Pr-42	Quick stop option code	0-8	7

Analog inputs and outputs – Group13

Display	Parameter	Range	Default Value
An-00	AN1 filter time(ms)	0-65535	1
An-01	AN1 offset(V)	-10.00-10.00	5
An-02	AN1 gain	0-20.000	1
An-03	AN2 filter time(ms)	0-65535	1
An-04	AN2 offset(V)	-10.00-10.00	5
An-05	AN2 gain	0-20.000	1

An-06	ANOUT1 parameter sel	0-15	1
An-07	ANOUT1 offset(V)	0-100%	0
An-08	ANOUT1 gain	0-20.000	1
An-09	ANOUT2 parameter sel	0-15	1
An-10	ANOUT2 offset(V)	0-100%	0
An-11	ANOUT2 gain	0-20.000	1

Brake Control – Group14

Display	Parameter	Range	Default Value
bc-00	Stalled motor de energization time(ms)	0-10000	0
bc-01	Brake activation delay time(ms)	0-10000	0
bc-02	Brake activation speed(rpm)	30-3000	30

Special - Trial Run - Group15

Display	Parameter	Range	Default Value
SP-00	Jog Speed(rpm)	0-128000	0
SP-01	Jog Accel/Decel time(rev/s2)	1-10737418.24	20
SP-02	Distance travelled(encoder count)	0-2147483647	1024
SP-03	Time interval between steps(s)	0-65535	1000
SP-04	Speed in step mode(rpm)	0-128000	1500
SP-05	Step rise/fall time(s)	1-10737418.24	20
SP-06	EEPROM default	0-2	0
SP-07	Power up Display	0-5000	0
SP-08	Switching frequency(KHz)	2-40	8
SP-09	Inverter Rated Current(A)	1-1000.0	6.5
SP-10	Reserved Setup	0-65535	0

4.2 Parameter Explanations

4.2.1 Display and Status – Group 0

di-0	Set Frequency(Hz)
Frequency ref in Hz.	
Read only.	

di-1	Ramp out frequency(Hz)
Output of ramp generator or S curve output.	
Read only.	

di-2	Output frequency(Hz)
Inverter output frequency in Hz.	
Read only.	

di-3	Encoder A frequency(Hz)
Encoder A feedback frequency (Hz) which is used as velocity loop ref. If motor has absolute encoder feedback, this is the output frequency of the absolute encoder.	
Read only.	

di-4	Encoder B frequency(Hz)
Encoder B output frequency. Only incremental encoder interface option is available for encoder B.	
Read only.	

di-5	Output Current(A)
Motor output current. Averaging time constant: 0.5s	
Read only.	

di-6	Peak output current(A)
Peak output current in a 2s window. Averaging time constant: 1ms.	
Read only.	

di-7	Output voltage uncompensated
NA.	
Read only.	
di-8	CRC reject count
This counter increments in case of a CRC mismatch in the frame received from the absolute encoder. A rapid increment of this counter, indicates improper EMC layout or an improper encoder cable.	
Read only.	

di-9	DC bus voltage
DC bus voltage. Averaging time constant: 1s	
Read only.	

di-10	DC bus voltage peak
Peak DC bus voltage in a 2s window.	
Read only.	

di-11	DC bus voltage at power up
DC bus voltage before a RUN command is given.	
Read only.	

di-12	Position actual value
Raw encoder count. Eg: For a 23b absolute encoder, this value has a range: 0 - 8388608	
Read only.	

di-13	Set speed(rpm)
Speed ref in rpm.	
Read only.	

di-14	Ramp out speed(rpm)
Output of ramp generator or S curve in rpm.	
Read only.	

di-15	Output speed(rpm)
Inverter output speed in rpm.	
Read only.	

di-16	Encoder A speed(rpm)
Encoder A feedback speed (rpm) which is used as velocity loop ref. If motor has absolute encoder feedback, this is the output speed of the absolute encoder.	
Read only.	

di-17	Encoder B speed(rpm)
Encoder B feedback speed (rpm).	
Read only.	

di-18	Ref Torque (%)
Percentage value of torque current reference	
Read only.	

di-19	Actual Torque (%)
Percentage value of actual torque current.	
Read only.	

di-20	Torque limit For(A)
Set value of torque limit in the forward direction.	
Read only.	

di-21	Torque limit Rev(A)
Set value of torque limit in the reverse direction.	
Read only.	

di-22	Heatsink temperature
Inverter heatsink temperature.	
Read only.	

di-23	Motor Temperature
Disabled in the current model.	
Read only.	

di-24	Encoder A Pos Elec(rad)
Encoder A electrical position in rads. Electrical position = Mechanical position * Pole pairs	
Read only.	

di-25	Encoder A Pos Mech(rad)
Encoder A mechanical position in rads. In one rotation of motor shaft, max value = 2π	
Read only.	

di-26	Encoder B Pos with GF(rad)
Encoder B mechanical position * Encoder B gear ratio.	
Read only.	

di-27	Encoder B Pos
Encoder B mechanical position in rads.	
Read only.	

di-28	Analog input1 voltage (V)
Voltage at analog input1.	
Read only.	

di-29	Analog input1 ref (%)
Analog input1 percentage ref. This percentage ref is multiplied by rated speed to get Speed ref.	
Read only.	

di-30	Analog input2 voltage (V)
Voltage at analog input2.	
Read only.	

di-31	Analog input2 ref (%)

Analog input2 percentage ref. This percentage ref is multiplied by rated speed to get Speed ref.
Read only.

di-34	Iout/Ioverload
Ratio = I peak / I protection,min (Parameter: 12.1)	
Read only.	

di-35	Delta speed
Difference between target velocity and output of ramp generator.	
Read only.	

di-36	Overload counter
This counter counts up during overload condition. Each count = 1ms. For eg if count is 90, overload condition has been present since 90ms.	
Read only.	

di-37	**Status word** *as per IEC 61800-7-201*
bit 0	Ready to switch on
bit 1	Switched on
bit 2	Output enabled
bit 3	Fault
Bit 4	Voltage enable
Bit 5	Quick stop
Bit 6	Switch on disabled
Bit 7	Warning
Bit 8	-
Bit 9	Remote
Bit 10	Target reached
Bit 11	Internal limit active
Bit 12	oms1
Bit 13	Following error in position mode
Bit 14	Ms1
Bit 15	Ms2
Read only.	

di-38	Status word1 (For internal use)
bit 0	PWM (1: PWM present at drive output, 0: absent)
bit 1	Sc (Short circuit trip)
bit 2	Ov (Over voltage trip)
bit 3	Uv (DC bus under voltage trip)
Bit 4	Oc (over current trip)
Bit 5	Ot (over temperature trip)
Bit 6	Old (over load trip)
Bit 7	trip_flag (1: in a trip state, 0: no trip present)
Bit 8	trip_display (1: display trip on drive display)
Bit 9	stop_for_isr (1: stop active)

Bit 10	Ramp_stop_cmd (1: Ramp stop command)
Bit 11	Direction (direction of rotation 1: forward, 2: reverse)
Bit 12	after_fault_init(1: pre charge delay does not occur after trip)
Bit 13	Fault_reset_active
Bit 14	Speed_invert(1: Invert set speed)
Bit 15	-
Read only.	

di-39	Control word status
Control word status = control word (Co-00) & control word mask(Co-16)	
Read only.	

di-40	Brake control status
tbd	
Read only.	

di-41	Touch probe status
tbd	
Read only.	

di-42	Internal status word
For factory use.	
Read only.	

di-43	Digital input state
bit 0	Input-1
bit 1	Input-2
bit 2	Input-3
bit 3	Input-4
Bit 4	Input-5
Bit 5	Input-6
Bit 6	Input-7
Read only.	

di-44	Digital output state
bit 0	Digital output1
bit 1	Digital output2
bit 2	Relay
bit 3	Pre charge status
Bit 4	Drive ready
Read only.	

di-45	Error code
bit 0	Supervision1
bit 1	Supervision2
bit 2	Supervision3
bit 3	Analog Input Fault
bit 4	Under Voltage (DC bus)
bit 5	Over Voltage (DC bus)
bit 6	Over Current
bit 7	Short Circuit
bit 8	Over Temperature – inverter heatsink
bit 9	Counter Overflow
bit 10	Current Limit

bit 11	Over Speed
bit 12	Encoder Loss
bit 13	Maximum Acceleration/Deceleration
bit 14	EEPROM Read Error (E2PROM_read_err)
bit 15	Speed Difference

di-47	**Control firmware version**
di-48	**XMC firmware version**
di-49	**Resolver board firmware version**
di-50	**Control board production number**
di-51	**Drive production number**
Read only.	

4.2.2 Motor Control – Group 2

mc-00 **mc-02**	**Kp current gain q axis** **Kp current gain d axis**	
Range: 0 - 214748.3647	Default: 0.0001	Run Lock
Proportional gains of the current controllers. A bandwidth of 1000hz is the default set value. *In most applications current controller gains need not be changed.* There is no change in these values if motor data parameters are modified. These values can be recalculated based on motor parameters by writing to Reserved setup : 5792		

mc-01 **mc-03**	**Ki current gain q axis(ms)** **Ki current gain d axis(ms)**	
Range: 0 - 2147483.647	Default: 0.001ms	Run Lock
Integral gains of the current controllers. Bandwidth of current controller is independent of current controller Ki gains. *In most applications current controller gains need not be changed.* There is no change in these values if motor data parameters are modified. These values can be recalculated based on motor parameters by writing to Reserved setup : 5792		

mc-04	**Set velocity filter time(s)**	
Range: 0 – 60.000s	Default: 0	Run Lock
This is the filter time constant of the input filter for Set velocity.		

4.2.3 Control – Group 3

Co-00	Control Word		
Range: 0 – 65535	Default: 0	Run Lock	Object: 0x6040
Writing to the controlword results in changes to the state machine. However write to the control can be masked off by control word mask. Control word status (di-39) = Control word (Co-00) & Control word mask (Co-16). Control word status (di-39) is the actual control word in the drive.			

Bits11-15	Bit10	Bit9	Bit8	Bit7	Bits4-6	Bit3	Bit2	Bit1	Bit0 LSB
ms	reserved	oms	halt	Fault reset	oms	Enable op	Quick stop	Enable voltage	Switch on

As per IEC61800-7-201

ms: manufacturer specific
oms: operation mode specific

The internal control word can be changed by the Control word (Co-00) and the digital inputs.
A clash between control word input (Co-00) and digital inputs can be avoided by using Control word mask (Co-16).
Ex: If a RUN command is to be accepted only from the digital inputs and not from the Control word (Co-00), the control word mask (Co-16) could be set to: 0xfff7. Now, enable output (bit3) cannot be modified by Control word (Co-00).
Note: Bit 11 of control word is used to update Kp (vl-08), Ki (vl-09) gains of velocity loop based on load inertia and damping factor.
0: Kp , Ki are not updated based on load inertia and damping factor.
1: Kp , Ki are updated based on load inertia and damping factor.

Co-01	Mode of operation		
Range: 0 – 65535	Default: 2	Run Lock	Object: 0x6060

Mode of operation	Co-01
-128 to -1	Manufacturer specific
0	No mode change/No mode assigned
1	Profile position mode
2	Velocity mode
3	Profile velocity mode
4	Torque profile mode
5	Reserved
6	Homing mode
7	Interpolated position mode
8	Cyclic sync position mode
9	Cyclic sync velocity mode
10	Cyclic sync torque mode
12-127	Reserved

As per IEC61800-7-201 table - 53

Co-04 Co-05	Position feedback source Speed feedback source	
Range: 0 – 1	Default: 0	Run Lock
Source of position feedback. 0: Encoder A 1: Encoder B *Note: In the current version, the source of position and velocity feedback is locked to Encoder A.*		

Co-06	Default direction of rotation	
Range: 0 – 1	Default: 0	Run Lock
Source of position feedback. 0: Forward direction 1: Reverse direction		

Co-07 Co-08 Co-09	Position Interpolator Velocity Interpolator Torque Interpolator	
Range: 0 – 1	Default: 0	Run Lock
Pending		

Co-10	Target torque (%)		
Range: -32767 to 32767%	Default: 0	Run unlock	Object: 0x6071
This is the set torque (as a percentage of the rated torque) in the cyclic synchronous torque mode and profile torque mode. The value is set by a higher controller and acceleration and deceleration are bypassed.			

Co-11	Torque offset/feed forward (%)		
Range: -32767 to 32767%	Default: 0	Run unlock	Object: 0x60b2
This value is added to the target torque. In cyclic synchronous position mode and cyclic synchronous velocity mode it is the input value for torque feed forward. In cyclic Synchronous torque mode it contains the commanded additive torque of the drive, which is added to the target torque value.			

Co-12	Target velocity (rpm)		
Range: -536870.912 to 536870.912 rpm	Default: 0	Run unlock	Object: 0x6042
This the target velocity. A positive value means forward direction and a negative value means a negative direction.			

Co-13	Velocity offset/feed forward(rpm)		
Range: -536870.912 to 536870.912 rpm	Default: 0	Run unlock	Object: 0x60B1
This value is added to the target velocity. In cyclic synchronous position mode, it contains the input value for velocity feed forward. In cyclic synchronous velocity mode it contains the commanded offset of the drive device.			

Co-15	Target position(rads)		
Range: -53687.0912 to 53687.0912 rads	Default: 0	Run unlock	Object: 0x607A
This is the commanded position in the position profile mode. The value is absolute or relative based on the abs/rel flag in the control word.			

Co-16	Control word mask	
Range: 0 - 65535	Default: 0	Run lock
Control word internal = Control word & Control word mask. Bits set to 0 in the control word mask cannot be changed by the control word. For eg if a digital input is used to write to the control word, the corresponding bits can be set to 0 in the control word mask.		

Co-17	Control word internal	
Range: 0 - 65535	Default: 0	Run lock
Control word internal = Control word & Control word mask. Control word internal is the actual control word inside the drive.		

Eg: **RUN and STOP by digital input.**
Set Control word mask – Co-16, bits 0(Switch on), 1(enable voltage) and 3(enable operation) = 0 so that these can be set by digital input. Since quick stop (bit 2) is not used, bit2 = 0 in control word mask. Control word mask(Co-16) = xxxx0000(binary value).

Eg: **Fault reset command by control word only. Start and stop by digital inputs.**
Same as above, only set bit 7 = 1 in control word mask. To give reset command write 128 to the control word Co-00.

Eg: **RUN and STOP are by control word.**
Control word mask (Co-16) = 15(0xf)
For RUN, Co-00 = 15 (Enable operation)
For STOP, Co-00 = 7 (Disable operation)

Co-18	State machine	
Range: 0 - 65535	Default: 0	Run lock

Bit	Function	Value
0	Shutdown mode	0: direct change to ready to switch on 1: ramp down as per bits 4,5
1	Disable operation mode	0: direct change to switched on 2: ramp down as per bits 6,7
2	Fault reaction mode	0: If fault occurs direct change to fault mode 1: Fault reaction depends on fault and settings
3	RUN latch	0: disable 1: enable
4,5	Shutdown ramp mode	0: Fault reaction ramp 10: Standard Ramp
6,7	Disable operation mode	0: Fault reaction ramp 10: Standard Ramp
8	Enable velocity ramp options	0: Ramp generator options disabled 1: Ramp generator options enabled
9	Enable Quick stop	0: Quick stop disabled 1: Quick stop enabled

Note: Bit 8(Enable velocity ramp options) affects operation of bits 4,5,6,8 of control word Co-00. Bits 4, 5, 6 are operation mode specific and bit 8 is halt in Co-00(control word).

Co-19 **Co-20** **Co-21** **Co-22**	**Acceleration forward (rev/s^2)** **Acceleration reverse (rev/s^2)** **Deceleration forward (rev/s^2)** **Deceleration reverse (rev/s^2)**	
Range: 0.01 – 10737418.24	Default: 20	Run unlock
These are the acceleration and deceleration parameters in rev/s^2 required to accelerate or decelerate to the rated speed of the motor. Ex: If a 2000 rpm motor is required to be accelerated to rated speed in 10s, the setting for acceleration time should be (2000/60)rps/10s = 3.33 rev/s^2.		

Co-23 Co-24 Co-25 Co-26 Co-27 Co-28 Co-29 Co-30	**Forward acceleration rate ls (rev/s^3)** **Forward acceleration rate hs (rev/s^3)** **Forward deceleration rate hs (rev/s^3)** **Forward deceleration rate ls (rev/s^3)** **Reverse acceleration rate ls (rev/s^3)** **Reverse acceleration rate hs (rev/s^3)** **Reverse deceleration rate hs (rev/s^3)** **Reverse deceleration rate ls (rev/s^3)**	
Range: 0.50 – 1342177.28	Default: 100	Run lock
When s curve is selected in ramp options (Co-31 – Ramp select), the rate of acceleration/deceleration starts from a low value to the set value (Co-19 to Co-22) to avoid jerk. Ex: If the drive is required to accelerate to 50 rev/s^2 in 5s, parameters Co-23(Forward acceleration rate ls) and Co-24(Forward acceleration rate hs) are set to: 50/5 = 10 rev/s^3. The same applies for reverse acceleration with parameters Co27 and Co28. Again the same applies for deceleration in forward and reverse direction with parameters Co-27 to Co-30.		

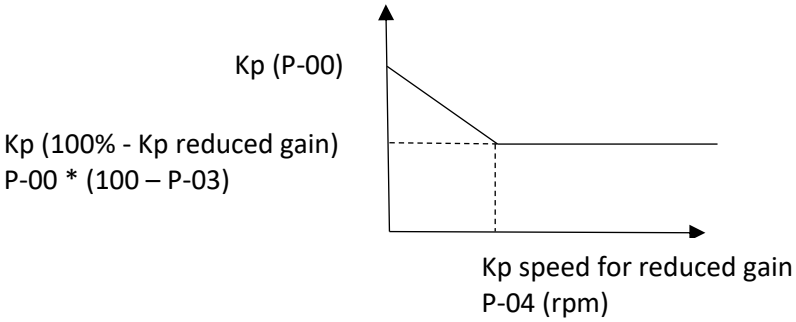
Co-31	**Ramp select**	
Range: 0 - 15	Default: 0	Run lock
0: For linear acceleration/deceleration ramp.		
1: For scurve with settings as per parameters Co-23 to Co-30.		

4.2.3 Position – Group 4

Po-00	Position mode select	
Range: 0 - 2	Default: 0	Run lock
0: Position controller is off.		
1: Position controller is automatically enabled or disabled depending upon the selected mode in Co-01. Position controller is on in: • Profile position mode • Homing mode • Cyclic synchronous position mode		
2: Position controller is on.		

Po-01	Position control gain Kp (rpm)	
Range: 0 – 6500.0	Default: 10.0	Run unlock
This is a P controller. Output of P controller = Kp (rpm) * Position error * Gear ratio. For ex: If position error = 8° and Kp = 2000, output of P controller = (8°/360°)*2000 = 44.44rpm. Assuming, gear ratio = 1. Here, gear ratio = Eb-02(Gear numerator)/Eb-03(Gear denominator).		

Po-02	Kp zero speed gain (rpm)	
Range: 0 – 6500.0	Default: 10.0	Run unlock
This is the additional gain multiplier at 0 speed. This parameter improves standstill control of the motor.		



Po-03	Kp reduced gain (%)	
Range: 0 – 100.0	Default: 0	Run lock
Kp can be reduced continuously from its zero speed value to a value set by Po-03 and at speed set by Po-04. For example, if Kp reduced gain (Po-03) = 80% and Kp speed for reduced gain (Po-04) = 100rpm and position control gain (Po-00) = 10, position gain will reduce from 10 to a value 8 which will be come up at 100 rpm. At speeds above 100 rpm, position control gain = 8 rpm.		

Po-04	Kp speed for reduced gain (rpm)

Range: 0 – 128000	Default: 3000	Run lock
Description in Po-03.		

Po-05	Following error window	
Range: 0 – 2147483647	Default: 0	Run lock
The following error is the difference between the position reference and the actual position. If exceeded for more than the following error timeout (Po-06), a following error trip is generated. For ex if a 23b encoder is used, max encoder count in 1 rev = 8388608. The following error is set < 8388608. The value of following error window is in encoder counts.		

Po-06	Following error time out (ms)	
Range: 0 – 65535	Default: 0	Run lock
Description is in Po-05.		

Po-07	Positioning window	
Range: 0 – 2147483647	Default: 5000	Run lock
Bit 10 of status word (di-37) is set when a position remains in the positioning window for a time as set in Positioning window time (Po-08). The positioning widow is in encoder counts. Positioning window width = Target position ± Positioning window (Po-07)		

Po-08	Positioning window time (ms)	
Range: 0 – 65535	Default: 1	Run lock
Description is in Po-07.		

Po-09	Position ref filter time (ms)	
Range: 0 – 60.000	Default: 0	Run lock
This is the filter at the position input and output of the filter is the Position reference for the position loop.		

Po-10	Position limit (positive)	
Range: -536870912 to 536870912	Default: 536870912	Run lock
All actual positions should be within the range – [Position limit (pos), Position limit (neg)]. Beyond this range, drive decelerates to 0 speed.		

Po-11	Position limit (negative)	
Range: -536870912 to 536870912	Default: -536870912	Run lock
Description is in Po-10.		

Po-13	Profile velocity (rpm)		
Range: 0 - 128000	Default: 0	Run unlock	Object: 0x6081
This parameter defines the **maximum allowable velocity** in either direction when the servo drive operates in **Profile Position Mode**.			

Po-14	Maximum profile velocity (rpm)		
Range: 0 - 1000	Default: 0	Run lock	Object: 0x607f
This parameter defines the **maximum allowable velocity** in either direction when the servo drive operates in **Profile Position Mode**. It acts as a safety limit for all motion profiles, overriding the specified **Profile Velocity** (0x6081) if the calculated motion trajectory would exceed this value. The value must be set based on the system's mechanical and safety requirements.			

Po-15	End velocity (rpm)		
Range: 0 - 128000	Default: 0	Run lock	Object: 0x6082
This is the **velocity at the end of the motion profile** in **Profile Position Mode**. It determines the speed the motor will have when it reaches the target position. Typically, this value is set to zero for precise positioning, but it can be non-zero in cases where continuous motion or subsequent operations require the motor to maintain a specific velocity after reaching the target position.			

Po-19	Positioning mode	
Range: 0 – 2	Default: 0	Run lock
When profile positioning mode is selected (Co – 01), the sub modes of operation are: 0: Profile positioning mode 1: Positioning by multi speed inputs. Also known as index positioning mode. 2: Positioning by command pulses.		

Po-20	Time delay after which feed forward toque is active (ms)	
Range: 0 – 10ms	Default: 0	Run lock
This is the time delay in activating feed forward torque. This prevents peaks in feed forward torque signal.		

4.2.4 Velocity – Group 5

vl-00 **vl-01** **vl-02** **vl-03**	**Minimum velocity forward (rpm)** **Maximum velocity forward (rpm)** **Minimum velocity reverse (rpm)** **Maximum velocity reverse (rpm)**		
Range: 0 – 12800rpm	Default: 0 Default: 2000 Default: 0 Default: 200	Run lock	Object: 0x6046
These are the **minimum and maximum allowable velocity** limits for the system in **Velocity Modes of Operation**, such as **Profile Velocity Mode** and **Velocity Control Mode**. These limits ensures that the commanded velocity remains within safe operating ranges, protecting the motor and mechanical system. This parameter is not applicable in non-velocity modes, such as Position or Torque modes.			

vl-04	**Target velocity (rpm)**		
Range: -107374.0000 to 107374.0000	Default: 0	Run unlock	Object: 0x6042
This parameter defines the **desired velocity** for the servo drive when operating in **Velocity Modes** such as **Profile Velocity Mode** or **Velocity Control Mode**. The motor will accelerate or decelerate to this target velocity based on the configured acceleration and deceleration parameters. • **Positive Values**: Indicate motion in the forward direction. • **Negative Values**: Indicate motion in the reverse direction.			

Speed ref control word:

Bits: 6 5-4 3-2 1-0(LSB)

Ref Select	**Operator**	**Speed ref B**	**Speed ref A**
0: Speed ref A 1: Speed ref B	00: No operation 01: Multiply 02: Add 03: Subtract	00: external 01: AN1 02: AN2 03: Command pulse input	00: external 01: AN1 02: AN2 03: Command pulse input

vl-06	**Speed reference control word**	
Range: 0 - 65535	Default:1	Run unlock
The source of velocity reference is determined by this parameter. For ex, set values to select: Speed ref A only as analog input: 0b000xx01 = 0x1 Speed ref B as command pulse input: 0b10011xx = 0xc *Note: external means a speed ref from a master control and written to target velocity.*		

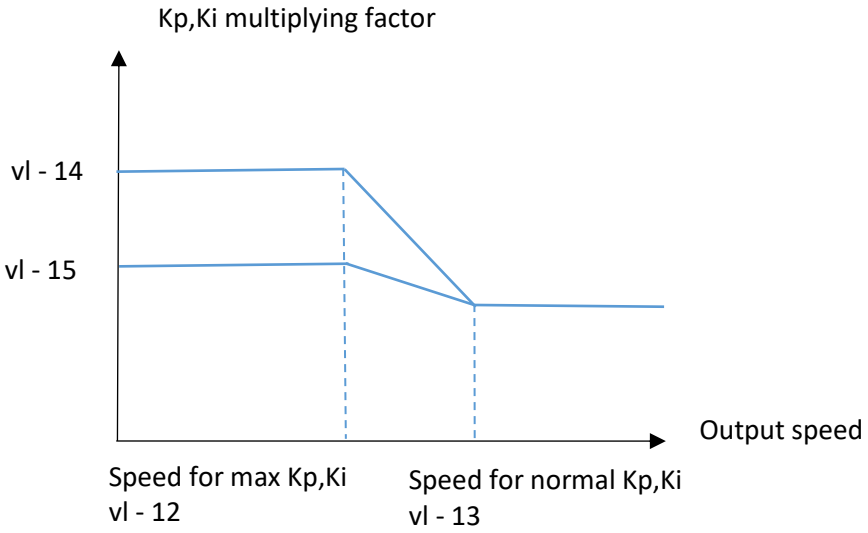
vl-07	**Speed reference filter time (ms)**	
Range: 0 – 60.000	Default: 0	Run unlock
The selected speed reference is filtered and the time constant is defined by this parameter.		

vl - 08 vl - 09	Kp speed Ki speed(ms)	
Range: 0 – 107374.1823 Range: 0 – 1073741.823	Default: 0.01 Default: 0.25	Run lock
These are the proportional and integral gains of the PI controller of the velocity loop. The velocity loop gains depend upon the load inertia (To-02) + rotor inertia (md-18), damping factor (md-01) and encoder filter (Ea – 05 or Eb – 05). A velocity feed forward value based upon the rate of change of position can be optionally added. Kp speed and Ki speed are inversely dependent to damping factor (md – 01). Higher the damping factor (md – 01), slower the system response and vice versa. To update Kp speed based on load inertia , damping factor (md – 01) or encoder filter time (Ea - 05 or Eb – 05), set Bit 11 of control word = 1. Now, any change in any one of the above parameters recalculates Kp speed and Ki speed.		

vl - 08 vl - 09	Kp speed Ki speed(ms)	
Range: 0 – 107374.1823 Range: 0 – 1073741.823	Default: 0.01 Default: 0.25	Run lock
These are the proportional and integral gains of the PI controller of the velocity loop. The velocity loop gains depend upon the load inertia (To-02) + rotor inertia (md-18), damping factor (md-01) and encoder filter (Ea – 05 or Eb – 05). A velocity feed forward value based upon the rate of change of position can be optionally added. Kp speed and Ki speed are inversely dependent to damping factor (md – 01). Higher the damping factor (md – 01), slower the system response and vice versa. To update Kp speed based on load inertia , damping factor (md – 01) or encoder filter time (Ea - 05 or Eb – 05), set Bit 11 of control word = 1. Now, any change in any one of the above parameters recalculates Kp speed and Ki speed.		

vl - 10 vl - 11	Variable Kp gain Variable Kp max (%)	
Range: 0 – 10.000 Range: 0 – 500.0 %	Default: 0 Default: 0	Run lock
Based on the difference between velocity reference and actual velocity in the PI controller, the proportional gain can be increased, limited by - Variable Kp max (vl – 11). Gain added to proportional gain = Variable Kp gain (vl – 10) * (Velocity ref – Velocity feedback) Maximum value of this gain is limited by Variable Kp max (vl -11). **For ex:** Kp speed (vl – 10) = 1.6 Velocity ref = 1500 rpm Velocity feedback = 1300 rpm Rated speed = 2000 rpm Variable Kp gain = 5.0 Variable Kp max = 100% Speed difference = (1500 – 1300)*100/2000 = 10% Variable factor = 10% * Variable Kp_gain = 10 * 5 = 50% This variable factor is limited to a max value of 100% Proportional gain = (1 + 0.5) *1.6 = 2.4		

vl - 12 vl - 13 vl - 14 vl - 15	Speed for max Kp,Ki Speed for normal Kp,Ki Kp multiplier at speed for max Kp, Ki (%) Ki multiplier at speed for max Kp, Ki (%)	
Range: 0 – 1000.0 Range: 0 – 1000.0 Range: 0 - 65535 Range: 0 - 65535	Default: 5 Default: 10 Default: 0 Default: 0	Run lock
The proportional and integral gains of the velocity loop can be set to a higher value at lower speeds, which, after achieving speed for normal Kp , Ki (vl – 13) revert back to their original values. For ex: Kp = 4.0, Ki = 0.0025 Speed for normal Kp,Ki(vl-13) = 20% of rated rpm = 400 rpm Speed for max Kp,Ki(vl-12) = 10% of rated rpm = 200 rpm Multiplier for max Kp = 120%(value used = 1.2) Multiplier for max Ki = 120%(value used = 1.2) At output speed = 200rpm, Kp = 1.2 * 4 = 4.8 Ki = 1.2 * 0.0025 = 0.003 At output speed = 400rpm, Kp = 4 and Ki = 0.0025 For speed change : 200 rpm to 400 rpm, Kp change: 4.8 to 4.0, Ki change: 0.003 to 0.0025		

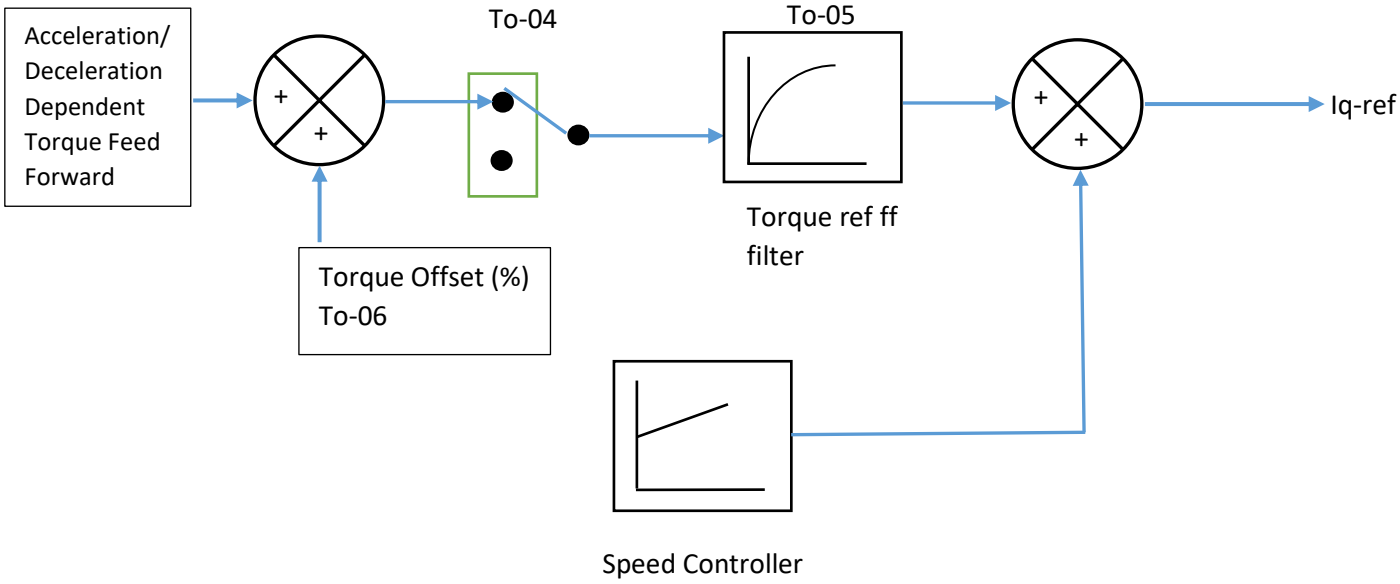


vl - 16 vl - 17 vl - 18 vl – 19 vl – 20 vl – 21 vl – 22	Preset speed1 (rpm) Preset speed2 (rpm) Preset speed3 (rpm) Preset speed4 (rpm) Preset speed 5 (rpm) Preset speed 6 (rpm) Preset speed7 (rpm)	
Range: -30000 to 30000	Default: 0	Run lock
Multi step speeds are configured in digital input parameters: **Di – 16, Di – 17 and Di – 18**. These speeds are active only in velocity control mode and profile velocity mode.		

4.2.5 Torque – Group 6

To – 00 To – 01	Torque limit forward (%) Torque limit reverse (%)		
Range: 0 - 1000	Default: 100	Run lock	Object: 0x60E0 Object: 0x60E1
These limits as percentage of rated torque prevent mechanical damage. Typically, these limits are set lower than rated maximum torque.			

To – 02	Load inertia (kg – cm^2)	
Range: 0 – 20000000.00	Default: 0	Run lock
This is the load inertia as estimated by the inertia test. Steps for load inertia estimation: 1. Set **Inertia estimation enable (Mc – 07)** = 1 2. Give run command. 3. The motor will accelerate to maximum forward velocity (vl – 01) and then decelerate to zero speed. If required max velocity can be limited to a lower value depending upon the load and then restored. 4. The value of load inertia is saved in parameter To – 02.		



To – 03	Torque ref filter (ms)	
Range: 0 – 60.000	Default: 0	Run lock
A low pass filter is connected to the output of the velocity loop PI controller. High frequency components in the torque ref can be filtered out with this parameter.		

To – 04	Torque feed forward	
Range: 0 – 1	Default: 0	Run lock
0: Disable torque feed forward control 1: Enable torque feed forward control		

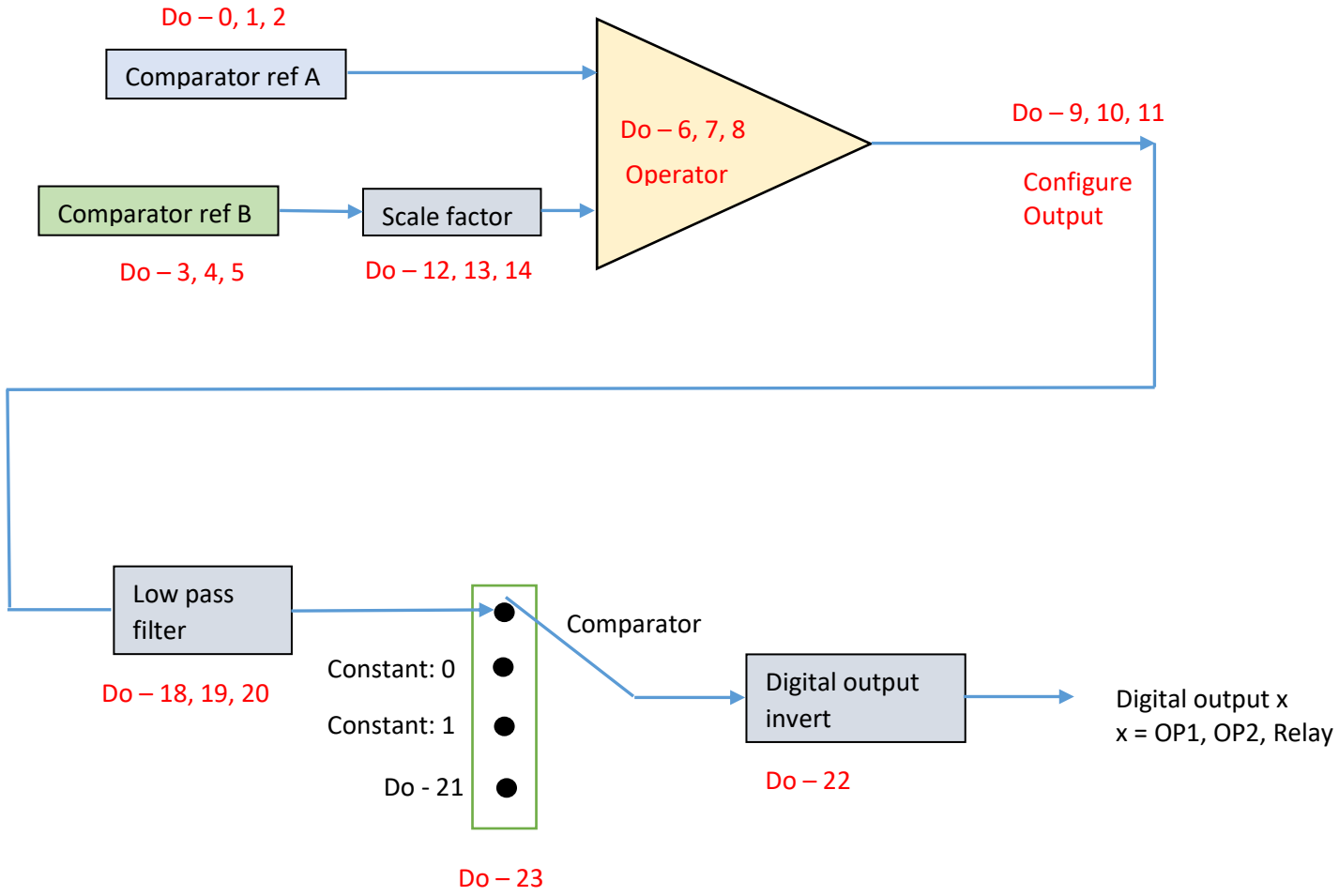
To – 05	Torque feed forward filter time (ms)	
Range: 0 – 60.000	Default: 0	Run lock
This is the time constant of the low pass filter at the output of torque feed forward block.		

To – 06	Torque offset (%)		
Range: 0 – 100.0%	Default: 0	Run lock	Object: 0x60b2
In cyclic synchronous position mode and cyclic synchronous velocity mode, this object contains the input value for torque feed forward. In cyclic synchronous torque mode it contains the commanded additive torque of the drive, which is added to the target torque value.			

To - 07	Torque feed forward gain (%)	
Range: 0 – 6000.0	Default: 100.0	Run lock
This is the gain of the feed forward value.		

4.2.6 Digital Outputs – Group 7

- 3 comparators can be used to generate digital outputs: OP1, OP2 and 1 relay output.
- Both analog and digital comparisons can be performed with hysteresis.
- Comparator ref A for the 3 comparators can be chosen from any of the parameters of Di group.
- Comparator ref B is a constant value and it has a scale factor. If scale factor = 0, comparator ref A and comparator ref B are directly compared. If scale factor ≠ 0, comparator ref B is divided by the scale factor.
- Comparator operation takes place only if the Operator for comparison (Do-6, 7, 8) is not equal to 0. If 0, the comparator code section is bypassed.



Comparators: 3nos

Comparator ref A	Comparator ref B	Scale factor (only for B)	Operator
Do – 0,1,2	Do – 3,4,5	Do – 12,13,14	Do – 6,7,8
Select from: 0 – 51 (Di group)	0 - 2147483647	-536870912 to 536870912	**0 : No op**
Note: A scale value = 0 implies that there is a digital comparison. A non-zero scale value means that there is an analog comparison. *Hysteresis value = Do - 15, 16, 17. An integer hysteresis value is used in digital comparison. For ex 2.5 is taken as 2 for digital comparison. A float value is used for analog comparison.*			**1: A >= B True** **A < B - H False**
			2: A <= B True **A > B + H False**
			3: A == B True (dig compare) **B – H/2 <= A <= B + H/2 True (anlg compare)** **Else false**
			4: A == B False (dig compare) **B - H/2 <= A <= B + H/2 False (anlg compare)** **Else True**
			5: A & B(bitwise AND) = True if result != 0
			6: A | B(bitwise OR) = True if result != 0

Configure comparator outputs OP1, OP2, Relay (Do - 9, 10, 11):

OR	AND	Comparator 3	Comparator 2	Comparator 1
Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

For ex:
If desired output at OP1 is OR of comparators 1 and 2, set Do – 9 = 0b10011
If desired output at OP1 is AND of comparators 1, 2 and 3, set Do – 9 = 0b01111

Digital output source select (Do – 23):

00: Comparator output 01: Constant 0 02: Constant 1 03: bit 2 of Do-21 (ext source)	00: Comparator output 01: Constant 0 02: Constant 1 03: bit 1 of Do-21 (ext source)	00: Comparator output 01: Constant 0 02: Constant 1 03: bit 0 of Do-21 (ext source)
Bits : 5-4	**Bits :3-2**	**Bits : 1-0**
Relay	OP2	OP1

Note: If output source (Do – 23) is selected as 03 the bit (0, 1 or 2) of Do – 21 is expected to be written by an external source.
Each one of the digital outputs and the relay output can be configured to steer output as shown above.

For ex:
Do - 0, 1, 2 = 43. Parameter digital input (di-43) is selected as comparator ref A for all 3 comparators
Do - 3, 4, 5 = 42. Comparator ref B = 0b101010

Do - 12, 13, 14 = 0. No scaling of comparator ref B for digital comparison
Do - 15,6,17 = 1.0 is taken as int value 1 for hysteresis.
Do - 6, 7, 8 = 1 for operator >= for all 3 comparators
Do - 9 Config OP1 = 17 = 0b10001. OP1 = comparator1 output
Do - 10 Config OP2 = 19 = 0b10011 OP2 = comp1 | comp2
Do - 11 Relay OP3 = 21 = 0b10111 Relay = comp1 | comp2 | comp3

Now if di -43 = 42, OP1 = 1, OP2 =1, Relay = 1 and digital output state (di-44 = 7)
If di-43 = 50, OP1 = 1, OP2 = 1, Relay = 1.
If di-43 = 41, all outputs remain 1 due to hysteresis.
If di-42 = 40, all outputs are 0.

Another ex:
Do - 0, 1, 2 = 0 parameter digital input (di-0) is selected as comparator ref A.
Do - 3, 4, 5 = 600 Comparator ref B
Do - 12, 13, 14 = 100 scaling. So, comparator ref B = 6.00
Do - 15, 16, 17(hysteresis) = 0.3
Do - 6,7,8 = 1 selects operator >= for all 3 comparators

Do - 9 Config OP1 = 17 = 0b10001. OP1 = comparator1 output
Do - 10 Config OP2 = 19 = 0b10011 OP2 = comp1 | comp2
Do - 11 Relay OP3 = 21 = 0b10111 Relay = comp1 | comp2 | comp3

If di-0 = 6.00 OP1 = 1, OP2 =1, Relay =1 and digital output state (di-44 = 7)
If di - 0 = 6.1 OP1 = 1, OP2 =1, Relay =1 and digital output state (di-44 = 7)
If di-0 = 5.9 OP1 = 1, OP2 =1, Relay =1 and digital output state (di-44 = 7)
If di-0 - 5.8 OP1 = 0, OP2 =0, Relay =0 and digital output state (di-44 = 0)

Do - 00 **Do – 01** **Do - 02**	**Comparator ref A1** **Comparator ref A2** **Comparator ref A3**	
Range: 0 – 64	Default: 0	Run unlock
Comparator ref A.		

Do – 03 **Do – 04** **Do – 05**	**Comparator ref B1** **Comparator ref B2** **Comparator ref B3**	
Range: 0 – 2147483647	Default: 0	Run unlock
Comparator ref B.		

Do – 06 **Do – 07** **Do – 08**	**Operator for comparator 1** **Operator for comparator 2** **Operator for comparator 3**	
Range: 0 – 65535	Default: 0	Run unlock
0: **No operation** **1:** **>=** **2:** **<=** **3:** **==** **4:** **!=** **5:** **AND** **6:** **OR**		

Do – 09 Do – 10 Do – 11	Configure output OP1 Configure output OP2 Configure output relay	
Range: 0 – 65535	Default: 0	Run unlock
Configure as shown.		

Do – 12 Do – 13 Do – 14	Comparator B1 scale Comparator B2 scale Comparator B3 scale	
Range: -536870912 to 536870912	Default: 0	Run unlock
Scale factor for ref B input. Ref B is divided by this scale factor. See more.		

Do – 15 Do – 16 Do – 17	Hysteresis for comp1 Hysteresis for comp2 Hysteresis for comp3	
Range: 0 – 214748.3647	Default: 0	Run unlock
This is the comparator hysteresis.		

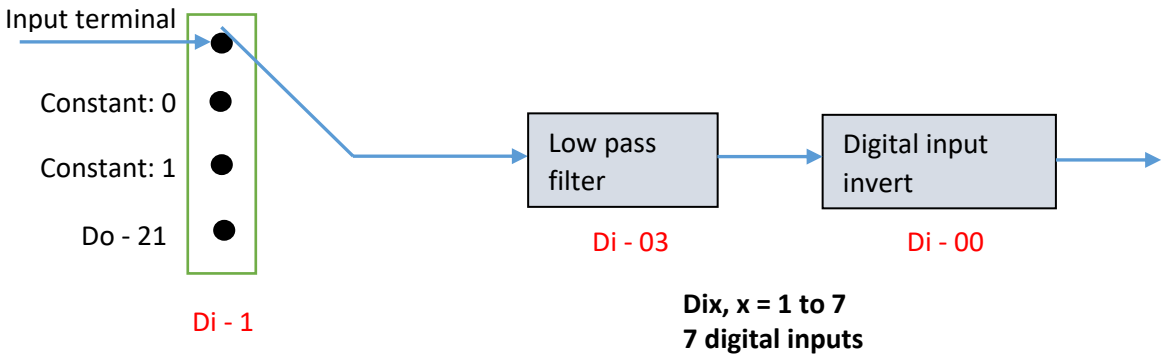
Do – 18 Do – 19 Do – 20	Comparator output filter 1 (ms) Comparator output filter 2 (ms) Comparator output filter 3 (ms)	
Range: 1 – 65535	Default: 1	Run unlock
Time constant of the low pass filter at the comparator output.		

Do – 21	Digital output external source	
Range: 0 – 7	Default: 0	Run unlock
This value is expected to be written by an external source.		

Do – 22	Digital output inversion	
Range: 0 – 7	Default: 0	Run unlock
Bits set to 1 are inverted. Bit 0: OP1 Bit 1: OP2 Bit 2: Relay For ex to invert all outputs , set Do – 22 = 0x7 To take all outputs without inversion, set Do – 22 = 0.		

Do – 23	Digital output source select	
Range: 0 – 127	Default: 0	Run unlock
See description.		

4.2.7 Digital Inputs – Group 8



Di – 00	Digital input invert	
Range: 0 – 2048	Default: 0	Run unlock

Bits that are 1 are inverted before being processed.

IN7	IN6	IN5	IN4	IN3	IN2	IN1
Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0

Di – 01	Digital input select	
Range: 0 – 65535	Default: 0	Run unlock

Each digital input (Di1 to Di7) can be configured as follows:

IN7	IN6	IN5	IN4	IN3	IN2	IN1
Bits: 13-12	Bits: 11-10	Bits: 9-8	Bits: 7-6	Bits: 5-4	Bits: 3-2	Bits: 1-0
0: terminal select 1: constant 0 2: constant 1 3: Di – 2						

If option 3: Di – 2 is selected, the mapped bit from Di-2 is used as input.

Di – 02	Digital input external source	
Range: 0 – 127	Default: 0	Run unlock

These bits are transferred to the digital input if selected in Di – 01.
For ex:
Di - 01 = 0x3, Di – 02 = 0x1
Digital input1 value = 1.

IN7	IN6	IN5	IN4	IN3	IN2	IN1
Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0

Di – 03	Digital input filter (ms)	
Range: 0 – 2000	Default: 0	Run unlock
Time constant of the low pass filter at the digital inputs.		

Digital input functions that can be assigned to input terminals:

Di – 04	Run	
Di – 05	Fault reset	
Di – 06	Forward	
Di – 07	Reverse	
Di – 08	Homing start	
Di – 09	Halt	
Di – 12	Mask1 input	
Di – 14	Mask2 input	
Di – 16	Multi step input 1	
Di – 17	Multi step input 2	
Di - 18	Multi step input 3	
Range: 0 – 7	Default: 0	Run unlock

Values assigned to this parameter are input terminal numbers.
For ex:
Di – 04 = 3, means that Run command is assigned to terminal number 3.

Mask1 input: When activated, the mask 1 value in Di – 13 is ORed with the control word.
Mask2 input: When activated, the mask 2 value in Di – 15 is ORed with the control word.

Note: For halt, the drive is stopped according to the halt option.

Di – 13 Di – 15	Mask1 value Mask2 value	
Range: 0 – 65535	Default: 0	Run unlock
See description in Di – 12, Di – 14.		

Di – 19	Command pulse direction	
Range: 0 – 1	Default: 0	Run lock
0: No change in direction of rotation, which is as per Command pulse mode (Di – 20). 1: Reverse direction of rotation after being processed by command pulse mode (Di – 20).		

Di – 20	Command pulse mode	
Range: 0 – 2	Default: 0	Run lock

Di - 20	A	B	Direction	Remark
0	Pulses (leading)	Pulses	FWD	QEP mode
	Pulses	Pulses (leading)	REV	QEP mode
1	Pulses	-	FWD	
	-	Pulses	REV	
2	Pulses	0	FWD	
	Pulses	1	REV	

Note: Pulse inputs are given to encoder B.

Important:

If in positioning mode (Co – 01 = 3), set Po – 19 = 2 for positioning with command pulses.

If in velocity mode (Co – 01 = 2), speed ref word (vl – 06) has to be configured for command pulses.

4.2.9 Encoder A – Group 10

This is the source of motor feedback.

Ea - 00	Encoder select	
Range: 0 – 20	Default: 0	Run lock
In the present firmware version, only absolute encoder (Tamagawa) selection is available.		

Ea - 01	Encoder index offset	
Range: 0 – 655.35	Default: 0	Run lock

This is the offset between the electrical 0 position of the motor and the electrical angle of the encoder.

For the same motor do not change this angle.
If motor parameters are over written from a csv file, this value will change. Ensure that this value is retained.
For Invergen supplied motors, this angle is noted on the motor name plate. This value just needs to be entered in Ea – 01.

To determine this angle on a new motor:

1. Decouple the motor from the load.
2. Set Ea – 09 = 1 to enable encoder initialization.
3. Disable speed difference trip. Pr24 = 7.
4. Give RUN command, and motor will align to the electrical 0.
5. Note value of Di – 24 (Encoder electrical pos in rads).
6. Take 3 readings.
7. Average value of the 3 readings is entered in Ea – 01. The difference between the readings will be very small.
8. Set Ea – 09 = 0 and Pr24 = 1 for normal operation.

Ea - 04	Encoder timeout (ms)	
Range: 0 – 60.000	Default: 3	Run lock
For a tamagawa encoder or equivalent which has an asynchronous communication with the drive, this is the time duration, after which an encoder feedback loss trip occurs if there is no response from the drive.		

Ea - 05	Encoder filter time (ms)	
Range: 0 – 256.000	Default: 4	Run lock

This is the velocity feedback low pass filter.
Any change in this value, affects PI values of velocity loop (vl – 08 , vl – 09)

Ea - 06	Encoder PPR	
Range: 0 – 2147483647	Default: 1024	Run lock
These are the rated pulses per revolution of the encoder.		

Ea - 09	Encoder initialization	
Range: 0 – 2	Default: 0	Run lock
0: Encoder initialization disabled. Normal operation. 1: Encoder initialization enabled. See Ea – 01. 2: Encoder loss sensing disabled in normal mode of operation.		

4.2.10 Encoder B – Group 11

Encoder B is the secondary encoder which can be used as a velocity or position reference.

Eb - 00	**Encoder select**	
Range: 0 – 20	Default: 0	Run lock
Currently this encoder is hard coded as an incremental encoder in quadrature mode.		

Eb – 02 **Eb - 03**	**Gear numerator** **Gear denominator**	
Range: 1 – 2147483647	Default: 1 Default: 1	Run lock
A dynamic gear ratio = Gear numerator/Gear denominator is multiplied to the encoder B ref. In position mode, the gear ratio is multiplied to the position ref from encoder B. In velocity mode, it is multiplied to the velocity ref from encoder B.		

Eb - 04	**Encoder unit time (ms)**	
Range: 0 – 6000.000	Default: 3	Run lock
This is the sampling interval of the encoder. After every sampling interval, the encoder value is accurately latched for processing.		

Eb - 05	**Speed filter time (ms)**	
Range: 0 – 6000.000	Default: 4	Run lock
This is the time constant of the low pass filter at the encoder output.		

Eb - 06	**Encoder PPR**	
Range: 0 - 200000	Default: 1024	Run lock
These are the rated pulses per revolution of the encoder.		

4.2.11 Protections – Group 12

Pr - 01	Motor protection minimum current (A)	
Range: 1 – 500.0	Default: 150	Run lock
This is the minimum current after which overload protection timer starts.		

Pr - 02	Motor protection time at max current (s)	
Range: 1 – 25.5	Default: 0.2	Run lock
If current exceeds max current (md - 10), drive trips in over current after the time set in Pr – 02.		

Pr - 03	Motor protection time at min current (s)	
Range: 1 – 25.5	Default: 1	Run lock
At minimum current (Pr – 01), drive trips in OC after the time set in Pr – 03.		

Pr - 04	Motor protection recovery time (s)	
Range: 1 – 600.0	Default: 0.5	Run lock
If the current changes to a value outside the protection range [Pr – 01, md – 10], this is the time required to reset the overload timer.		

Pr - 12	Over speed level (%)	
Range: 1 – 800.0	Default: 5	Run lock
If absolute value of motor speed (encoder A rpm) exceeds this value (as percentage of rated speed), drive trips in Over speed. For ex: Rated speed of motor = 2000 rpm, Over speed level = 200% Over speed trip occurs if motor speed > 4000rpm.		

Pr - 13	Over speed stop mode	
Range: 0 - 8	Default: 7	Run lock
0 – 6: Drive coasts to stop on trip. 7: deactivate over speed trip.		

Pr - 20	Maximum acc/dec rate (rev/s^3)	
Range: 1 – 21474836.48	Default: 5	Run lock
If motor acceleration or deceleration exceeds this value, drive trips in “Max acc/dec”. In other words, this is the maximum jerk level.		

Pr - 21	Maximum acc/dec trip stop mode	
Range: 0 - 8	Default: 7	Run lock
0 – 6: Drive coasts to stop on trip. 7: deactivate trip.		

Pr - 22	Maximum speed difference level (%)	
Range: 0 – 800.0	Default: 5	Run lock
Speed difference (%) = (Ramp output speed – Actual speed)/Rated speed If Speed difference (%) > Max speed difference level (%) for a time greater than max speed difference time (Pr – 23), drive trips in Max speed difference.		

Pr - 23	Maximum speed difference time (ms)	
Range: 0 – 65535	Default: 25	Run lock
See Pr – 22.		

Pr - 24	Speed difference stop mode	
Range: 0 – 8	Default: 0 - 8	Run lock
0 – 6: Drive coasts to stop on trip. 7: deactivate trip.		

4.2.12 Analog inputs and outputs – Group 13

Analog input range: 0 – 10V

An – 00 **An – 03**	**Analog input1 filter time (ms)** **Analog input2 filter time (ms)**	
Range: 0 – 65535	Default: 1	Run unlock
This is the time constant of the analog input filter.		

An – 01 **An – 04**	**Analog input1 offset (V)** **Analog input2 offset (V)**	
Range: -10.000 to 10.000	Default: 5	Run unlock
Analog input for processing = (analog input (volts) – offset)*gain		

An – 02 **An – 05**	**Analog input1 gain** **Analog input2 gain**	
Range: 0 – 20.000	Default: 1	Run unlock
This is the gain of the analog input block.		

For ex:
Input voltage range is 1.0V to 5.5V
Speeds range required: 0 to Rated speed.
For this, set offset (An – 01) = 1.0V
Gain = 10V/4.5V = 2.22

An – 06 **An – 09**	**Anout1 parameter select** **Anout2 parameter select**	
Range: 0 – 15	Default: 1	Run unlock
Parameter for analog output: 0: Set speed 1: Ramp out speed 2: Output speed 3: Encoder A speed 4: Encoder B speed 5: Output current 6: DC bus 7: Ref torque 8: Actual torque 9: Encoder A position 10: Encoder B position **Analog output = selected parameter * Gain/Rated value + offset** For ex: Output current = 3.0A, Rated current = 6A Offset = 10% , Gain = 0.4 Analog output voltage = 3.0 *0.4 * 10V/6.0 + 0.1 * 10V = 3V		

An – 07 An – 10	Anout1 offset (%) Anout2 offset (%)	
Range: 0 – 100	Default: 0	Run unlock
This is the offset value added to the analog output.		

An – 08 An – 11	Anout1 gain Anout2 gain	
Range: 0 – 20.000	Default: 0	Run unlock
See example above.		

4.2.13 Special Parameters – Group 15

Sp - 06	EEPROM default	
Range: 0 – 2	Default: 0	Run lock + system lock
0: Normal operation 1: Write default values to the eeprom.		

Sp - 07	Power up display	
Range: 0 – 5000	Default: 0	Run unlock

Any parameter of any group can be displayed at power up.

Group from which parameter is displayed	Sp – 07 value
0 --- Display & status	Parameter number
1 --- Motor data	Parameter number + 52
2 --- Motor Control	Parameter number + 71
3 -- Control	Parameter number + 83
4 --- Position	Parameter number + 116
5 --- Velocity	Parameter number + 137
6 --- Torque	Parameter number + 160
7 --- Digital output	Parameter number + 168
8 --- Digital input	Parameter number + 192
10 --- Homing	Parameter number + 216
11 --- Encoder A	Parameter number + 232
12 --- Encoder B	Parameter number + 242
13 --- Protections	Parameter number + 251
14 --- Analog inputs and outputs	Parameter number + 294
15 --- Brake control	Parameter number + 306
16 --- Special Parameters	Parameter number + 309

For ex:
To display output current on power up , Sp – 07 = 5
To display Control word (Co -00) – Group number = 3 and parameter number = 0.
So, Sp – 07 = 83 + 0 = 83 from above table.