Application Note

Document Number	YEUA2406DWEZ-01
Application	**Electronic Line Shaft (ELS)**
Industry	Miscellaneous
Yaskawa Product	GA700 in Closed Loop Vector control mode

1 Overview

The software contains two functionalities: Speed synchronous run and angular synchronous operation of n drives (Figure 2). Switching between both functions can be done via DWEZ parameter, via digital input or serial communication.

The Electronic Line Shaft (ELS) function allows a drive to precisely follow a master encoder or another drive. The follower can match its position (phase angle) to the master within several encoder counts. The DriveWorksEZ Pro program even manages that multiple slave drives can follow one master drive in angular synchronism (Figure 1).

This function can be used in applications, which have mechanically and rigidly coupled loads driven by more than one motor (e. g. big rack and pinion applications).

The gear ratio between the master and the follower is infinitely adjustable. The gear ratio adjustment can be added to the speed reference via parameter, analogue input, or serial communication. The drive can also be run in a pure speed follower mode for applications which do not require matched position.

More information about the used blocks can be seen in the DWEZ Help.

The program must be tested by the customer. Yaskawa recommends that the customer must fully test all functionality, failure scenarios, and edge-cases before drives with this program are delivered to end user. Yaskawa is not liable for any issues that may arise from incorrect or incomplete implementation of the DWEZ program.
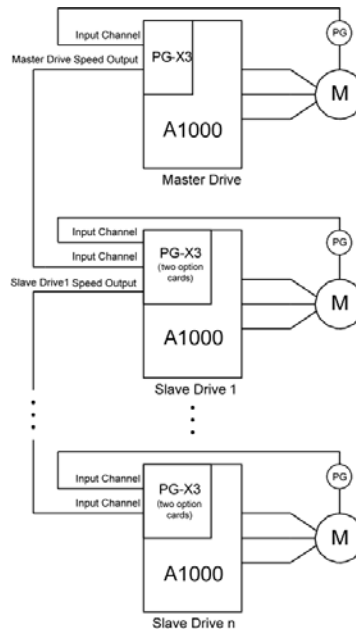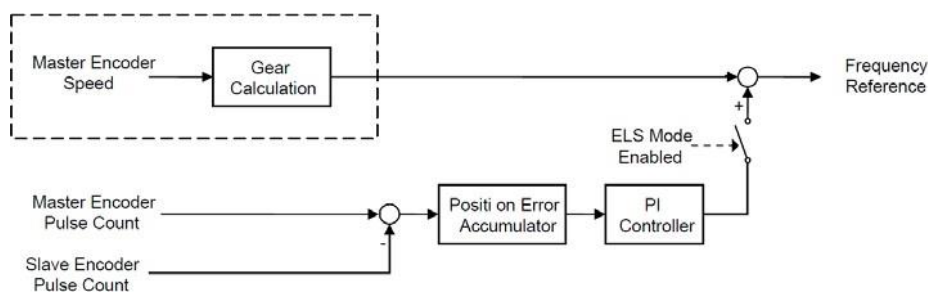
Figure 1: Basic Principle

Figure 2: Block diagram for the ELS part of the program.

2 Detailed Functions

Slave drive follows master drive with a defined gear ratio (Speed follower)

• The frequency reference for the slave drive is taken from the master encoder signal, multiplied by a gear ratio. The gear ratio is set by a DWEZ parameter, analogue input or by serial communication.

• If the gear ratio is changed during run, the drive will accelerate/decelerate to the new frequency reference value using the active ramp parameter settings

• If the gear ration is 100% then master speed and slave speed have the same speed values. If gear ratio is 50% then the speed of the slave drive will be 50% lower than the master speed.

• Using the Q1-10 parameter the slave speed reference can also be changed from DWEZ to frequency reference set in B1-01 parameter (Follower mode is disabled then and the drive runs with the normal frequency reference).

• The speed follower operation can be set by Q1-10 parameter. The drive follows the master encoder speed in both directions or the drive follows the master encoder speed but ignores the master encoder direction (motion is always in the forward direction).

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• The drive follows the master encoder position (both directions).

• Errors in speed and rotor position between master and slave motor are compensated by adding the output of a PI controller to the frequency reference of the slave drive.

• This PI controller gets as input the difference between the master and slave encoder signal. The output of this position control can be taken limited proportional to the master encoder speed or unlimited (100% of PI output).

• The position difference between the master and slave drive can be set by analogue input, DWEZ parameter or by serial communication.

• Using the Q1-15 parameter the user defined deviation can be set directly as degree.

• Max. user defined deviation between master and slave drive is ±179,9°

• The deviation between master and slave during ELS is displayed in monitor U8-22 in encoder counts and in monitor U8-23 in degree.

The program insists of seven pages, described in the table below.

Name	Description
Customer Deviation	Set the deviation between master and slave motor
calc_Deviation	Calculation of deviation between master and slave motor incl. correction of Z-pulse influence
Real Deviation	Calculation and scaling of the deviation. Used for input of the ELS PI-controller. Will be displayed as number of counts and in degree.
ELS	Correction of actual deviation. Not available in Speed Follower mode.
Frequency	Scaling of master drive speed, gear ratio. Selection of frequency reference source.
Alarm and Fault	Enable the deviation alarm and deviation fault.
PG Setup	Preset of PG settings

The DWEZ digital inputs are used like follows:

Terminal input number	Description
S7	Enable the customer defined offset between master and slave by analogue input AI2
S8	Enable the ELS functionality

The DWEZ analogue inputs are used like follows:

Terminal input number	Description
AI2	Set the customer defined offset between master and slave
AI3	Set gear ratio

DWEZ parameter settings

Parameter No.	MEMOBUS Address	Parameter Name	Description	Range / Unit	Default	Function Block	Pre-set	Control Mode	
								V/f w. PG	CLV
Q1-01	1600h	PG Pulse	Set number of PG pulses (10,24% = 1024 Pulses)	0,00 to 655,35%	0,00%	Q1-01	10,24	A	A
Q1-02	1601h	Alarm	Set DWEZ Alarm when deviation bigger Q1-02 (0,23% = 23 counts)	0,00 to 655,35%	0,00%	Q1-02	00,23	A	A
Q1-03	1602h	Fault	Set DWEZ Fault when deviation bigger Q1-03 (0,46% = 46 counts)	0,00 to 655,35%	0,00%	Q1-03	00,46	A	A
Q1-06	1605h	Scaling Master Speed	Scale 100% master speed to 100% slave speed	0,00 to 655,35%	0,00%	Q1-06	4,00	A	A
Q1-07	1606h	Gear Ratio	Set the gear ratio between master and slave	0,00 to 655,35%	0,00%	Q1-07	0,00	A	A
Q1-10	1609h	LOGIC Inputs	Set the bits of LOG Para 1 to LOG Para 8	0 to FFh	0	Q1-10	0h	A	A
Q1-14	160Dh	Deviation in Counts	Set user defined deviation between master and slave (1024 = 1024 counts/pulses)	±9999	0	Q1-14	0	A	A
Q1-15	160Eh	Deviation in degree	Set use defined deviation between master and slave in degree	±360,0	0,0°	Q1-15	0,0	A	A
Q1-23	1616h	Custom Param 14 Scale	Parameter Q1-14 scaling to Counts	10 to 39999	11000	Q1-14	2500	A	A

Parameter No.	MEMOBUS Address	Parameter Name	Description	Range / Unit	Default	Function Block	Preset	V/f w. PG	CLV
								Control Mode	
Q1-24	1617h	Custom Param 15 Scale	Parameter Q1-15 scaling to degree	10 to 39999	11000	Q1-15	18791	A	A
Q1-26	1619h	Custom Param 14-15 Unit	The unit setting of the custom monitor is invalid while using LED operator.	0 to FFFF	0	Q1-14	B	A	A
Q2-23	1656h	ELS Counts	Custom Monitor 24 Scale to number of counts	10 to 39999	11000	U8-24	2500	A	A
Q2-24	1657h	ELS Degree	Custom Monitor 25 Scale to degree	10 to 39999	11000	U8-25	18791	A	A
Q2-26	1659h	Custom Monitor 24-25 Unit	Unit of function block U8-25	0 to FFFF	0	U8-25	B	A	A
Q3-01	1680h	Max. allowed Fault time	On-delay time for the TMR 1 block	0 to 600,0	0,0 sec	TRM 1	1,0	A	A
Q4-03	16C2h	Scale Multiplier	Scale Multiplier	±9999	1	Scale1	4	A	A
Q4-04	16C3h	Scale Devisor	Scale Devisor	1 to 9999	1	Scale1	1	A	A
Q4-05	16C4h	Scale Bias	Scale Bias	±99,99	0,00%	Scale1	-0,01	A	A

Parameter No.	MEMOBUS Address	Parameter Name	Description	Range / Unit	Default	Function Block	Preset	Control Mode	
								V/f w. PG	CLV
Q4-12	16CBh	Scale Multiplier	Scale Multiplier	±9999	1	Scale2	1	A	A
Q4-13	16CCh	Scale Devisor	Scale Devisor	1 to 9999	1	Scale2	2	A	A
Q4-14	16CDh	Scale Bias	Scale Bias	±99,99	0,00%	Scale2	0,00	A	A
Q4-06	16C5h	Upper Limit 1	Upper Limit P-Gain to 4	0,00 to 655,35%	0,00%	LIM1	16,00	A	A
Q4-07	16C6h	Lower Limit 1	Lower Limit P-Gain to 1	0,00 to 655,35%	0,00%	LIM1	4,00	A	A
Q4-11	16CAh	Limit Properties Bits 1,0	LIM1 bipolar Bits = 00(bin)	0h to 7Fh	0h	LIM1	8h	A	A
Q4-08	16C7h	Upper Limit 2	Limit user set deviation to +179,9°	0,00 to 655,35%	0,00%	LIM2	20,47	A	A
Q4-09	16C8h	Lower Limit 2	Limit user set deviation to -179,9°	0,00 to 655,35%	0,00%	LIM2	0,00	A	A
Q4-11	16CAh	Limit Properties Bits 3,2	LIM2 bipolar Bits = 10(bin)	0h to 7Fh	0h	LIM2	8h	A	A

Parameter No.	MEMOBUS Address	Parameter Name	Description	Range / Unit	Default	Function Block	Preset	Control Mode	
								V/f w. PG	CLV
Q6-01	1740h	PI Properties	Selects how the PI block is configured (Setting 2 = PI output is direct acting, signed)	0 to 7	0	PI	2	A	A
Q6-02	1741h	PI Logic Input Select	Defines the action of the two logic inputs	0 to 127	16	PI	10	A	A
Q6-03	1742h	PI Proportional Gain	Proportional gain for the PI control	0,00 to 25,00	1,00	PI	3,00	A	A
Q6-04	1743h	PI Integral Time	Integral time for the PI control	0,0 to 360,0 sec	1,0	PI	0,0	A	A
Q6-05	1744h	PI Integral Limit	Integral limit for the PI control	0,0 to 300,0%	100,0%	PI	2,0	A	A
Q6-06	1745h	PI Output Limit	Output limit for the PI control	0,0 to 300,0%	100,0%	PI	2,0	A	A
Q6-07	1746h	PI Output Gain	Output gain for the PI control	0,00 to 25,00	1,00	PI	1,00	A	A
Q4-01	16C0h	RAMP	Soft-Starter (avoid quick changes of customer def. deviation)	0.0 to 600.0 sec	0.0	RAMP	5.0	A	A

Parameter No.	MEMOBUS Address	Parameter Name	Description	Range / Unit	Default	Function Block	Preset	Control Mode	
								V/f w. PG	CLV
LOG1	1649h	LOG Par 1	Enable ELS functionality	True to False	False	LOG1	False	A	A
LOG2	1649h	LOG Par 2	Enable Alarm and Fault function	True to False	False	LOG2	False	A	A
LOG3	1649h	LOG Par 3	Enable frequency reference always in forward direction when run speed follower	True to False	False	LOG3	False	A	A
LOG4	1649h	LOG Par 4	Enable frequency reference source set in B1-01	True to False	False	LOG4	False	A	A
LOG5	1649h	LOG Par 4	Enable customer defined deviation by number of counts	True to False	False	LOG5	False	A	A
RCOL1	1908h	RCOL1	Enable deviation via PLC	True to False	False	RCOL1	False	A	A
RCOL2	1B09h	RCOL2	Enable ELS via PLC	True to False	False	RCOL2	False	A	A
RCON4	1B05h	RCON4	Set gear ratio	±15bit	0,00%	RCON4	0,00%	A	A

Parameter No.	MEMOBUS Address	Parameter Name	Description	Range / Unit	Default	Function Block	Preset	Control Mode	
								V/f w. PG	CLV
H3-11	419h	Terminal A2 Gain	Set deviation by analogue input in counts. (+10V = 2047 counts)	±999,9	100,0%	AI2	204,7	A	A
H3-12	41Ah	Terminal A2 Bias	Set deviation by analogue input in counts. (0V = -2047 counts)	±999,9	0,0%	AI2	-204,7	A	A
H3-07	415h	Terminal A3 Gain	Set gear ratio by analogue input (+10V = +100%)	±999,9	100,0%	AI3	100,0	A	A
H3-08	416h	Terminal A3 Bias	Set gear ratio by analogue input (0V = -100%)	±999,9	0,0%	AI3	-100,0	A	A
Q2-01	1640h	Max. Pulses Ch1	Sets maximum pulse number for slave PG	1 to 65535	1	PGCH1	1024	A	A
Q2-02	1641h	Max. Pulses Ch2	Sets maximum pulse number for master PG	1 to 65535	1	PGCH2	1024	A	A
F1-21	3BCh	PG Channel 1 Selection	Selects the type of slave encoder for the PG card in port C	0 to 1	0	PGCH1	1	A	A
F1-37	3BDh	PG Channel 2 Selection	Selects the type of master encoder for the PG card in port B	0 to 1	0	PGCH2	1	A	A

3 Additional Information

The DWEZ preset parameters are decided to match a maximum output frequency of 50Hz with a 1024 pulse PG.

The slave drive needs the DWEZ "ELS-Software" as well as two PG-X3 option cards, one for closed loop operation and one for the input of the position signal from the master drive.

The maximum customer-defined position offset is limited to 179.9°. Set C1-01/02 to 3 seconds or less to ensure that the slave can follow the Master. Set C2-parameters to 0.0 seconds.