

## GA800 AC Drive

### Electronic Line Shaft with Alignment

## Custom Software Supplement

Software  
Number: VSAA10020  
Drive Models: GA80Uxxxxxxx

To properly use the product, read this manual thoroughly and retain for easy reference, inspection, and maintenance. Ensure the end user receives this manual.



# 1 Preface and Safety

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## ◆ Supplemental Information - Applicable Documents

The contents of this supplement apply to the product instructions in [Table 1.1](#).

**Table 1.1 Affected Documents**

Drive Series	Document
GA800	Installation & Primary Operation (TOEPC71061737)
	Technical Reference (SIEPC71061737)
	Quick Setup Procedure (TOEPC71061748 and TOEPC71061750)

## ◆ Supplemental Safety Information

Read and understand this manual and the GA800 Installation & Primary Operation manual before you install, operate, or do maintenance on this drive. Install the drive as specified by the GA800 Installation & Primary Operation manual and local codes. Observe all safety messages in this manual and the standard drive manuals.

Refer to the GA800 Installation & Primary Operation and Technical Reference for safety information and start-up instructions.

This supplement describes the effects of the Electronic Line Shaft with Alignment custom software on the standard drive parameters and functions.

- Custom software adds functionality to a standard AC drive to enhance or enable use in a specific application.
- The software is loaded to the flash ROM area of the control board, and replaces the standard drive software.

## ◆ Support

You must provide the unique part number shown on the drive nameplate when you want Yaskawa support for a drive with custom software.

The custom software described in this supplement is flashed to the control board memory and the operation of parameters, functions, and monitors are different than the standard drive software.

Refer to Yaskawa office locations listed on the back cover of this supplement for contact information.

# 2 Product Overview

## ◆ About this Product

This custom software is designed specifically for use in electronic line shaft with alignment applications.

## ◆ Applicable Models

This custom software is available for the GA800 drive models in [Table 2.1](#).

Table 2.1 Applicable Models

Voltage Class	Models
240 V Three-Phase	GA80U2xxxxxx
480 V Three-Phase	GA80U4xxxxxx

### 3 Electronic Line Shaft

#### ◆ Overview

The Electronic Line Shaft (ELS) function allows a drive to precisely follow the speed, direction, and phase of a master encoder (PG) signal. The follower can match its position (phase angle) to the master within several quadrature encoder counts.

The ELS function is used in applications where the machinery being driven requires two mechanically isolated and motor-driven moving parts to maintain a constant position relationship. The gear ratio between the master and the follower is infinitely adjustable.

**NOTICE** *Damage to Equipment. Do not use Electronic Line Shaft functionality to drive two or more motors that are mechanically coupled to the same driven load. Equipment damage may occur if the ELS function is used with two or more motors mechanically coupled to drive the same load.*

In addition, a gear ratio adjustment (draw) can be added to the speed reference via parameter, analog input, multi-function input MOP, or serial communication. It is also possible to run the drive in a pure speed follower mode for applications that do not require matched position.

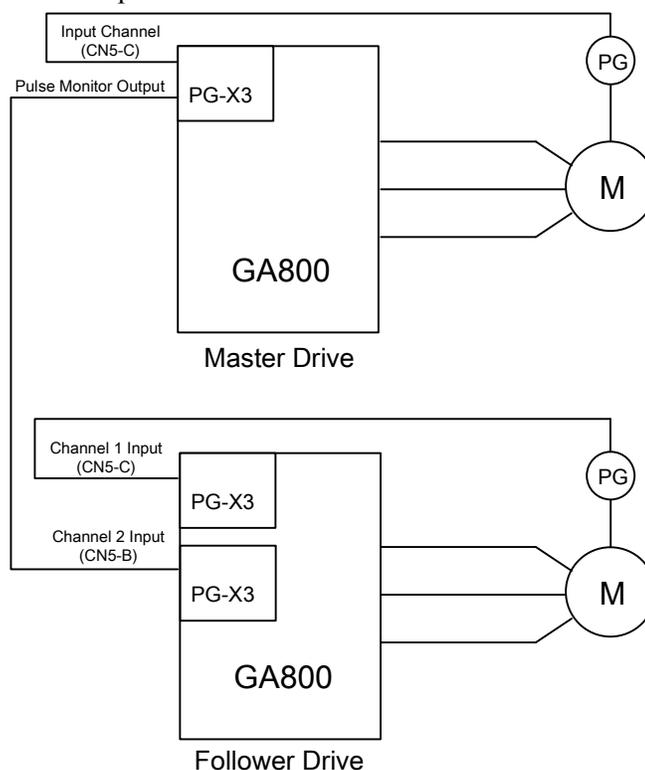
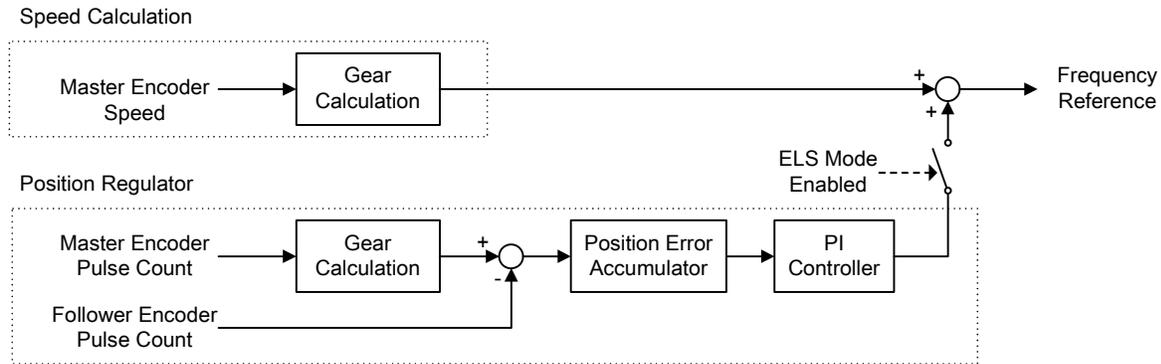


Figure 3.1 Typical Configuration Connection

#### ◆ Basic Concepts and Principles

The master encoder signal is fed into a PG option card installed in the CN5-B option card port (PG Channel 2) of the follower. When using V/f w/PG, CLV, or CLV/PM control methods, the follower encoder signal is fed into a PG option card installed in the CN5-C option card port (PG Channel 1) of the follower and the master encoder speed is multiplied by the programmed gear ratio to determine the frequency reference of the follower.

When the drive is configured for ELS modes [ $bA-01 = 4, 5$ ], the error between the master and follower position is determined. This is fed into a PI controller, which is added to the previously calculated frequency reference. When the drive is configured only as a speed follower (non-ELS modes), the position regulator is disabled.



**Figure 3.2 Simplified Block Diagram of ELS Function**

ELS also offers a signed-run mode. When  $bA-01 = 5$  [*Electronic Line Shaft - Sign Run*], ELS functions identically to standard ELS [ $bA-01 = 4$ ], with the following differences:

- When a reverse Run command is given, the follower will match the velocity and phase of the master, but in the opposite direction. If the master runs in the forward direction, the follower will run in reverse direction. If the master runs in the reverse direction, the follower will run in the forward direction.
- When a forward Run command is present, the follower will run in the same direction as the master.

#### ◆ Changes from the Standard Product

- The Motor 2 Selection multi-function input setting is deleted (only Motor 1 can be used).
- The follower drive uses acceleration and deceleration times of zero during Electronic Line Shaft operation [ $bA-01 = 4, 5$ ].
- PG 2 parameters  $F1-31$ ,  $F1-32$ ,  $F1-36$ , and  $F1-37$  are always available and do not require Motor 2 selection via digital input.

#### ◆ Limitations

- When you use ELS modes [ $bA-01 = 4, 5$ ], it is recommended to use Closed Loop Vector [ $A1-02 = 3$ ] or PM Closed Loop Vector [ $A1-02 = 7$ ] control methods.
- When you use ELS or Speed Follower modes [ $bA-01 > 0$ ], you cannot use EZ Vector Control method [ $A1-02 = 8$ ].
- When you use ELS modes [ $bA-01 = 1, 4, 5$ ], you must install master and follower encoder feedback cards and set to quadrature encoder input [ $F1-21$  and  $F1-37 = 1$ ].
- When you use Speed Follower Both Directions mode [ $bA-01 = 1$ ], you must set the master encoder input to quadrature encoder input [ $F1-37 = 1$ ].
- When you use ELS modes [ $bA-01 = 4, 5$ ], the gear ratio must be exactly expressed, including remainder, to prevent phase drift (error).
- You must use the correct option card port for each encoder (PG) input. (CN5-B: Master Encoder, CN5-C: Follower Encoder)
- PG-F3 option card support for the master drive encoder is limited to EnDat 2.1/01, EnDat 2.2/01, and HIPERFACE encoders. EnDat 2.2/22 Encoders [ $F1-50 = 1$ ] do not support pulse monitor signal outputs and cannot be used in this application.

## ◆ Related Parameters and Functions

Table 3.1 Related Parameters

No. (Hex.)	Name	Description	Default (Range)
A1-01 (0101) RUN	Access Level Selection	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Sets user access to parameters. The access level controls which parameters the keypad will display, and which parameters the user can set.</p> <p><b>0 : Operation Only</b> Access to A1-00, A1-01, A1-04 [Password], and the U Monitors.</p> <p><b>1 : User Parameters</b> Access to A1-00, A1-01, A1-04, and parameters registered to A2-01 to A2-32 [User Parameters 1 to 32].</p> <p><b>2 : Advanced Level</b> Access to all parameters, but not Expert Mode parameters.</p> <p><b>3 : Expert Level</b> Access to all parameters including Expert Mode parameters.</p>	3 (0 - 3)
F1-01 (0380)	Encoder 1 Pulse Count (PPR)	<p>Advanced Level Control [A1-01 = 2]: <b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Expert Level Control [A1-01 = 3]: <b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Sets the number of output pulses for each motor revolution.</p>	1024 ppr (1 - 60000 ppr)
F1-02 (0381)	Encoder Signal Loss Detect Sel	<p>Advanced Level Control [A1-01 = 2]: <b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Expert Level Control [A1-01 = 3]: <b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Sets the method to stop the motor or let the motor continue operating when the drive detects PGo [Encoder (PG) Feedback Loss].</p> <p><b>0 : Ramp to Stop</b> <b>1 : Coast to Stop</b> <b>2 : Fast Stop (Use C1-09)</b> <b>3 : Alarm Only</b> <b>4 : No Alarm Display</b></p>	1 (0 - 4)
F1-05 (0384)	Encoder 1 Rotation Selection	<p>Advanced Level Control [A1-01 = 2]: <b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Expert Level Control [A1-01 = 3]: <b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Sets the output sequence for the A and B pulses from the encoder, assuming that the motor is operating in the forward direction.</p> <p><b>0 : Pulse A leads in FWD Direction</b> <b>1 : Pulse B leads in FWD Direction</b></p>	Determined by A1-02 (0, 1)
F1-14 (038D)	Encoder Open-Circuit Detect Time	<p>Advanced Level Control [A1-01 = 2]: <b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Expert Level Control [A1-01 = 3]: <b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Sets the length of time that the drive must not receive a pulse signal to cause PGo [Encoder (PG) Feedback Loss].</p> <p><b>Note:</b> Motor speed and load conditions can cause ov [Overvoltage] and oC [Overcurrent] faults. If A1-02 = 0 [Control Method Selection = V/f], you must set H6-01 = 3 [Terminal RP Pulse Train Function = Speed Feedback (V/F Control)] to enable this parameter.</p>	2.0 s (0.0 - 10.0 s)
F1-21 (03BC)	Encoder 1 Signal Selection	<p>Advanced Level Control [A1-01 = 2]: <b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Expert Level Control [A1-01 = 3]: <b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Sets the number of channels for the signal to the encoder option card.</p> <p><b>0 : A Pulse Detection</b> <b>1 : AB Pulse Detection</b></p>	1 (0, 1)
F1-31 (03B0) */	Encoder 2 Pulse Count (PPR)	<p>Advanced Level Control [A1-01 = 2]: <b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Expert Level Control [A1-01 = 3]: <b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Sets the number of output pulses for each motor revolution for motor 2.</p>	1024 ppr (1 - 60000 ppr)

### 3 Electronic Line Shaft

No. (Hex.)	Name	Description	Default (Range)
F1-32 (03B1) *1	Encoder 2 Rotation Selection	Advanced Level Control [A1-01 = 2]: <input type="checkbox"/> V/f <input type="checkbox"/> CL-V/f <input type="checkbox"/> OLV <input type="checkbox"/> CLV <input type="checkbox"/> AOLV <input type="checkbox"/> OLV/PM <input type="checkbox"/> AOLV/PM <input type="checkbox"/> CLV/PM <input type="checkbox"/> EZOLV Expert Level Control [A1-01 = 3]: <input type="checkbox"/> V/f <input type="checkbox"/> CL-V/f <input type="checkbox"/> OLV <input type="checkbox"/> CLV <input type="checkbox"/> AOLV <input type="checkbox"/> OLV/PM <input type="checkbox"/> AOLV/PM <input type="checkbox"/> CLV/PM <input type="checkbox"/> EZOLV Sets the output sequence for the A and B pulses from the encoder for motor 2. This parameter assumes that the motor is operating in the forward direction. <b>0 : Pulse A leads in FWD Direction</b> <b>1 : Pulse B leads in FWD Direction</b>	0 (0, 1)
F1-36 (03B5) *1	Encoder 2 PCB Disconnect Detect	Advanced Level Control [A1-01 = 2]: <input type="checkbox"/> V/f <input type="checkbox"/> CL-V/f <input type="checkbox"/> OLV <input type="checkbox"/> CLV <input type="checkbox"/> AOLV <input type="checkbox"/> OLV/PM <input type="checkbox"/> AOLV/PM <input type="checkbox"/> CLV/PM <input type="checkbox"/> EZOLV Expert Level Control [A1-01 = 3]: <input type="checkbox"/> V/f <input type="checkbox"/> CL-V/f <input type="checkbox"/> OLV <input type="checkbox"/> CLV <input type="checkbox"/> AOLV <input type="checkbox"/> OLV/PM <input type="checkbox"/> AOLV/PM <input type="checkbox"/> CLV/PM <input type="checkbox"/> EZOLV Sets the function that enables and disables detection of a disconnected encoder connection cable to cause PGoH [Encoder (PG) Hardware Fault] for motor 2. <b>0 : Disabled</b> <b>1 : Enabled</b>	1 (0, 1)
F1-37 (03BD) *1	Encoder 2 Signal Selection	Advanced Level Control [A1-01 = 2]: <input type="checkbox"/> V/f <input type="checkbox"/> CL-V/f <input type="checkbox"/> OLV <input type="checkbox"/> CLV <input type="checkbox"/> AOLV <input type="checkbox"/> OLV/PM <input type="checkbox"/> AOLV/PM <input type="checkbox"/> CLV/PM <input type="checkbox"/> EZOLV Expert Level Control [A1-01 = 3]: <input type="checkbox"/> V/f <input type="checkbox"/> CL-V/f <input type="checkbox"/> OLV <input type="checkbox"/> CLV <input type="checkbox"/> AOLV <input type="checkbox"/> OLV/PM <input type="checkbox"/> AOLV/PM <input type="checkbox"/> CLV/PM <input type="checkbox"/> EZOLV Sets the number of channels for the signal to the encoder option card for motor 2. <b>0 : A Pulse Detection</b> <b>1 : AB Pulse Detection</b>	1 (0, 1)
F1-50 (03D2)	PG-F3 Option Encoder Type	<input type="checkbox"/> V/f <input type="checkbox"/> CL-V/f <input type="checkbox"/> OLV <input type="checkbox"/> CLV <input type="checkbox"/> AOLV <input type="checkbox"/> OLV/PM <input type="checkbox"/> AOLV/PM <input type="checkbox"/> CLV/PM <input type="checkbox"/> EZOLV Sets the type of encoder connected to the PG-F3 option. <b>0 : EnDat Sin/Cos</b> <b>1 : EnDat Serial Only</b> <b>2 : HIPERFACE</b>	0 (0 - 2)

\*1 Normally, access to this parameter is restricted if Motor 2 is not selected. This restriction is removed when  $bA-01 > 0$ .

## ◆ Additional Parameters, Monitors, and Registers

Table 3.2 Additional Parameter Group

Parameter Group	Name
bA	Electronic Line Shaft

Table 3.3 Additional Parameters

No. (Hex.)	Name	Description	Default (Range)
bA-01 (0D00)	Follower Mode Selection	<input type="checkbox"/> V/f <input type="checkbox"/> CL-V/f <input type="checkbox"/> OLV <input type="checkbox"/> CLV <input type="checkbox"/> AOLV <input type="checkbox"/> OLV/PM <input type="checkbox"/> AOLV/PM <input type="checkbox"/> CLV/PM <input type="checkbox"/> EZOLV Sets the follower mode. <b>0 : Disabled</b> Follower mode is disabled and the follower drive runs from the normal frequency reference [b1-01]. <b>1 : Speed – Both Directions</b> The follower drive follows the master encoder speed in both directions. (Follower Run command direction has no effect) <b>2 : Speed – Forward Direction</b> The follower drive follows the master encoder speed only when the master is running in the forward direction. Follower direction is determined by follower Run command direction. <b>3 : Speed – Absolute Value</b> The follower drive follows the master encoder speed but ignores the master encoder direction (motion is always in the direction of the follower Run command). <b>4 : Electronic Line Shaft</b> The follower drive follows the master encoder speed and position (both directions). The drive treats a reverse Run command the same as a forward Run command. <b>5 : Electronic Line Shaft – Sign Run</b> The follower drive follows the master encoder speed and position (both directions). When a forward Run command is present the drive follows the master in the same direction. When a reverse Run command is present the drive follows in the opposite direction of the master.	0 (0 - 5)
bA-02 (0D01) RUN	Ratio Numerator Upper 4 Digits	<input type="checkbox"/> V/f <input type="checkbox"/> CL-V/f <input type="checkbox"/> OLV <input type="checkbox"/> CLV <input type="checkbox"/> AOLV <input type="checkbox"/> OLV/PM <input type="checkbox"/> AOLV/PM <input type="checkbox"/> CLV/PM <input type="checkbox"/> EZOLV Sets the upper 4 digits of the primary gear ratio numerator.	1000 (0 - 9999)

No. (Hex.)	Name	Description	Default (Range)
bA-03 (0D02) RUN	Ratio Denominator Upper 4 Digits	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Sets the upper 4 digits of the primary gear ratio denominator.	1000 (0 - 9999)
bA-04 (0D03) RUN	Ratio Numerator Lower 4 Digits	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Sets the lower 4 digits of the primary gear ratio numerator.	0 (0 - 9999)
bA-05 (0D04) RUN	Ratio Denominator Lower 4 Digits	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Sets the lower 4 digits of the primary gear ratio denominator.	0 (0 - 9999)
bA-06 (0D05) RUN	Ratio 2 Numerator	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Sets the numerator of the secondary gear ratio. Active when a multi-function digital input is set to D1 (Ratio 2 Select) and the input is closed.	1 (1 - 65535)
bA-07 (0D06) RUN	Ratio 2 Denominator	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Sets the denominator of the secondary gear ratio. Active when a multi-function digital input is set to D1 (Ratio 2 Select) and the input is closed.	1 (1 - 65535)
bA-08 (0D07)	Position Error Accumulation Sel	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Sets when the position error accumulator is enabled in the follower drive. <b>0 : Only During Run</b> Position error is only calculated when the follower drive is running (not during High Slip Braking). <b>1 : Always</b> Position error is calculated whenever power is applied to the follower drive. <b>Note:</b> This parameter is effective in ELS modes only.	0 (0 - 1)
bA-09 (0D08) RUN	Position Units Selection	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Sets the units used for the follower drive Position Error Monitor (UF-07). <b>0 : Encoder Counts</b> Position error is displayed in quadrature follower encoder counts (cnts). <b>1 : Motor Revs</b> Position error is displayed in follower motor revolutions (0.001rev). <b>2 : Motor Degrees</b> Position error is displayed in follower motor degrees (0.1deg). <b>3 : Motor Radians</b> Position error is displayed in follower motor radians (0.001rad). <b>Note:</b> This parameter is effective in ELS modes only.	0 (0 - 3)
bA-10 (0D09) RUN	Digital Ratio Adjustment	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Sets the digital gear ratio adjustment of the follower drive. The gear ratio adjustment is also influenced by the analog, MOP and communication gear ratio adjustments.	0.00% (-99.99 - +99.99%)
bA-11 (0D0A) RUN	MOP Adjust Time	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Sets the time for the MOP ratio adjustment to change by 100.00% when the MOP Adjust Increase or MOP Adjust Decrease multi-function input is closed.	50.0 s (0.0 - 6000.0 s)
bA-12 (0D0B) RUN	Gear Ratio Adjustment Ramp Time	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Sets the time for the composite gear ratio adjustment of the follower drive to change by 100.00%.	10.0 s (0.0 - 6000.0 s)
bA-13 (0D0C)	Advance/Retard Mode Selection	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Sets the advance/retard functionality of the follower drive. <b>0 : Continuous</b> The follower will advance or retard continuously while the Advance Follower or Retard Follower multi-function input is closed. Parameter <i>bA-14</i> sets amount of advance/retard encoder counts per second. <b>1 : Step</b> The follower will advance or retard by the amount set in parameter <i>bA-14</i> each time the Advance Follower or Retard Follower multi-function input is closed. <b>Note:</b> This parameter is effective in ELS modes only.	0 (0 - 1)
bA-14 (0D0D) RUN	Advance/Retard Amount	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Sets the number of quadrature follower encoder counts the follower will advance/retard per second when <i>bA-13</i> = 0 [Advance/Retard Mode Selection = Continuous]. Sets the step amount of the advance/retard function when <i>bA-13</i> = 1 [Advance/Retard Mode Selection = Step]. <b>Note:</b> This parameter is effective in ELS modes only.	2048 cnts (0 - 65535 cnts)

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No. (Hex.)	Name	Description	Default (Range)
bA-15 (0D0E)	Follower Deviation Level	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Sets the amount of position error in quadrature follower encoder counts that will activate the follower deviation detection.</p> <p><b>Note:</b> This parameter is effective in ELS modes only.</p>	4096 cnts (0 - 65535 cnts)
bA-16 (0D0F)	Follower Deviation Selection	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Selects the follower drive action when the position error is more than the setting of <i>bA-15 [Follower Deviation Level]</i>.</p> <p><b>0 : No Detection</b> The drive continues to run.</p> <p><b>1 : Alarm Only</b> The drive continues to run and an <i>FDEV</i> alarm flashes on the keypad.</p> <p><b>2 : Coast to Stop (Fault)</b> The <i>FDEV</i> fault is displayed, the drive fault contact is activated, and the motor coasts to stop.</p>	2 (0 - 2)
bA-17 (0D10)	MOP Adjustment Memory @Power Off	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Sets whether the drive memorizes the MOP gear adjustment when the drive loses power.</p> <p><b>0 : Disabled</b> The drive does not memorize MOP adjustment at power down.</p> <p><b>1 : Enabled</b> The drive memorizes MOP adjustment at power down.</p>	0 (0 - 1)
bA-18 (0D11) RUN	Position P Gain	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Sets the proportional gain of the position regulator PI loop.</p> <p><b>Note:</b> This parameter is effective in ELS modes only.</p>	5.00 (0.00 - 100.00)
bA-19 (0D12) RUN	Position I Time	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Sets the integral time of the position regulator PI loop.</p> <p><b>Note:</b> This parameter is effective in ELS modes only.</p>	0.00 s (0.00 - 50.00 s)
bA-20 (0D13) RUN	Position Regulator Filter Time	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Sets the filter time of the position regulator output. This is a first order lag filter.</p> <p><b>Note:</b> This parameter is effective in ELS modes only.</p>	0.00 s (0.00 - 1.50 s)
bA-21 (0D14) RUN	Position PI Limit	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Sets the limit (+/-) of the position regulator output. Set as a percentage of E1-04 [<i>Maximum Output Frequency</i>].</p> <p><b>Note:</b> This parameter is effective in ELS modes only.</p>	8.00% (0.00 - 10.00%)
bA-22 (0D15) RUN	Position Regulator Trim Mode	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Selects how the drive uses the position regulator output to trim the follower drive speed reference (master encoder frequency).</p> <p><b>0 : Constant</b> The position regulator output is independent of the master encoder speed reference.</p> <p><b>1 : Proportional to Master Speed</b> The position regulator output is proportional to the master encoder speed reference.</p> <p><b>Note:</b> This parameter is effective in ELS modes only.</p>	0 (0 - 1)
bA-23 (0D16) RUN	Speed Proportional Lower Limit	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Sets the lower limit of the position regulator trim when <i>bA-22 = 1 [Position Regulator Trim Mode = Proportional to Master Speed]</i>.</p> <p>Set in terms of percentage of follower reference after gear ratio adjustment. Refer to Function Description on page 12 for examples of how this factors into calculations</p>	10.00% (0.00 - 10.00%)
bA-24 (0D17) RUN	Ratio Change Speed Agree Width	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Sets the frequency width used to determine "Speed Agree" when the drive is accelerating or decelerating due to one of the following:</p> <ul style="list-style-type: none"> <li>• Gear ratio change</li> <li>• Change in state of the Follower Disable multi-function input</li> <li>• Change in state of the Run command</li> </ul>	0.5 Hz (0.0 - 20.0 Hz)

Table 3.4 Additional Multi-Function Digital Input Setting Values

Setting Value	Function	Description
D0	Follower Disable	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Closed: Follower mode [bA-01] is disabled and the follower drive will follow the normal frequency reference (based on b1-01 setting) and use the selected Accel/Decel times.
D1	Ratio 2 Select	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Closed: Gear Ratio 2 [bA-06 and bA-07] is selected. When in either ELS mode [bA-01 = 4 or 5], the follower drive will clear its position error and follow the C1-03 and C1-04 Accel/Decel times to ramp to the new ratio. Upon reaching speed agree, the position loop will re-enable.
D2	Advance Follower	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Closed: Follower position is advanced relative to the master encoder. No position error is accumulated. Refer to bA-13 and bA-14 for additional information. <b>Note:</b> This function is available in ELS modes only.
D3	Retard Follower	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Closed: Follower position is retarded relative to the master encoder. No position error is accumulated. Refer to bA-13 and bA-14 for additional information. <b>Note:</b> This function is available in ELS modes only.
D4	MOP Adjust Increase	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Closed: The MOP ratio adjustment is increased. Refer to bA-11 and bA-17 for additional information.
D5	MOP Adjust Decrease	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Closed: The MOP ratio adjustment is decreased. Refer to bA-11 and bA-17 for additional information.
D6	MOP Adjust Reset	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Closed: The MOP ratio adjustment is reset to zero. Refer to bA-11 and bA-17 for additional information.
D7	Position Error Reset	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Closed: Position error is reset to zero. <b>Note:</b> This function is available in ELS modes only.
D8	Position Regulator Integral Reset (Position Reg Integral Reset)	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Closed: Position regulator integral is reset to zero. <b>Note:</b> This function is available in ELS modes only.

Table 3.5 Additional H2-xx: Multi-Function Output Setting Values

Setting Value	Function	Description
D0	Follower Position Deviation	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Closed: The position error is more than the Follower Deviation Level [bA-15]. <b>Note:</b> This function is available in ELS modes only.
1D0	!Follower Position Deviation	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Open: The position error is more than the Follower Deviation Level [bA-15]. <b>Note:</b> This function is available in ELS modes only.

Table 3.6 Additional H2-xx: Multi-Function Analog Input Setting Values

Setting Value	Function	Description	Analog Input Scaling
29	Analog Ratio Adjustment	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Input value is added to the digital, MOP and network communication ratio adjustment to form the total gear ratio adjustment.	Full scale: 100.00%

Table 3.7 Additional Monitor Group

Parameter Group	Name
UF	Special Application

Table 3.8 Additional Monitors

No. (Hex.)	Name	Description	MFAO Signal Level
UF-01 (0D23)	Master Encoder Fref	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Displays the frequency of the master encoder before gear ratios and MOP gains are applied. Unit: 0.1 Hz <b>Note:</b> Display/Modbus values are limited to -3276.8 to 3276.7 *1.</p>	Full scale: Maximum Output Frequency (E1-04)
UF-02 (0D24)	Fref After Gear	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Displays the frequency of the master encoder after the active gear ratio [bA-02 to bA-07] is applied. Unit: 0.1 Hz <b>Note:</b> Display/Modbus values are limited to -3276.8 to 3276.7 *1.</p>	Full scale: Maximum Output Frequency (E1-04)
UF-03 (0D25)	Gear Ratio Adjust	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Displays the total gear ratio adjustment (sum of digital, analog, MOP and communication adjustments). Unit: 0.01%</p>	Full scale: 100.00%
UF-04 (0D26)	Fref After Adjust	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Displays the frequency from the master encoder after the digital, analog, MOP and network communication gear ratio adjustments are applied. Unit: 0.1 Hz <b>Note:</b> Display/Modbus values are limited to -3276.8 to 3276.7 *1.</p>	Full scale: Maximum Output Frequency (E1-04)
UF-05 (0D27)	Master Counts /5ms	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Displays the number of quadrature encoder counts per 5 ms from the master drive. Unit: cnts <b>Note:</b> 1. This monitor is available in ELS modes only. 2. This monitor is representative only and should be used only to confirm that encoder counts are being received</p>	Full scale: Counts/5ms at Maximum Output Frequency (E1-04)
UF-06 (0D28)	Follower Counts /5ms	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Displays the number of quadrature encoder counts per 5 ms from the follower drive. Unit: cnts <b>Note:</b> 1. This monitor is available in ELS modes only. 2. This monitor is representative only and should be used only to confirm that encoder counts are being received</p>	Full scale: Counts/5ms at Maximum Output Frequency (E1-04)
UF-07 (0D29)	Position Error	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Displays the position error between the master and follower encoders in quadrature follower encoder counts. Unit: bA-09 *2 <b>Note:</b> 1. This monitor is available in ELS modes only. 2. Modbus values are limited to -3276.8 to 3276.7. Display values are limited to -9999 to 99999 *1.</p>	Full scale: Counts/5ms at Maximum Output Frequency (E1-04)
UF-08 (0D2A)	Position P Output	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Displays the proportional gain contribution of the position PI regulator. Unit: 0.01% <b>Note:</b> This monitor is available in ELS modes only.</p>	Full scale: 100.00%
UF-09 (0D2B)	Position I Output	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Displays the output of the integrator of the position PI regulator. Unit: 0.01% <b>Note:</b> This monitor is available in ELS modes only.</p>	Full scale: 100.00%
UF-10 (0D2C)	Position PI Output	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Displays the output of the position PI regulator. Unit: 0.01% <b>Note:</b> This monitor is available in ELS modes only.</p>	Full scale: 100.00%

\*1 When the internal value is greater than the maximum/minimum value that can be displayed on the keypad, the monitor will display the maximum/minimum value and the monitor display name will flash, alternating between “OVER” and the monitor name.

\*2 Unit is dependent on the setting of the Position Units Selection [bA-09].

When reading by network communication (register 0D30), the unit is fixed at quadrature encoder counts.

Table 3.9 Additional MEMOBUS Registers

Register No. (Hex.)	Description	Scaling
0D30	<p><b>Network Communication Gear Ratio Adjustment</b></p> <p>Allows gear ratio adjustment via network communication. The total gear ratio adjustment is the sum of the analog, digital, MOP and network communication ratio adjustments. Data is interpreted as signed, so the adjustment can be set from -327.67% to 327.67%.</p> <p><b>Note:</b> The ENTER command is not required when writing to this register</p> <p><b>Note:</b> The ENTER command is not required when writing to this register.</p>	1 = 0.01%
0D31	<p><b>Network Communication Advance/Retard Counts</b></p> <p>Allows for advancement/retardment of the follower drive via network communication. Data is interpreted as signed, so the advance/retard counts can be set from -32768 to 32767. This is set in quadrature follower encoder counts. After this register is set, its data returns to zero automatically.</p> <p><b>Note:</b></p> <ol style="list-style-type: none"> <li>This register is available in ELS modes only.</li> <li>The ENTER command is not required when writing to this register.</li> </ol>	1 = 1 quadrature encoder count

## ◆ Troubleshooting

Table 3.10 Additional Faults

Code (MEMOBUS)	Name Description	Causes	Possible Solutions
FDEV (0x0473)	<p>Follower Position Deviation</p> <p>The position error is more than <math>ba-15</math> [Follower Deviation Level] and <math>ba-16 = 2</math> [Follower Deviation Selection = Coast to Stop].</p>	There is mechanical binding in the follower motor.	Confirm the machinery is operating correctly and the follower motor is not binding.
		Parameter $ba-15$ [Follower Deviation Level] setting is too low.	Increase $ba-15$ .
		The master encoder is rotating, the follower is stopped, and $ba-08 = 1$ [Position Error Accumulation Selection = Error Is Always Accumulated].	If the application requires that the master encoder rotate while the follower is stopped, set $ba-08 = 0$ [Position Error Accumulation Selection = Position Error Only during Run].
		The master input frequency is more than the follower maximum frequency [E1-04].	Set $E1-04 = 10\%$ faster than the maximum master input frequency.
<p><b>Note:</b></p> <ul style="list-style-type: none"> <li>Do a Fault Reset to clear the fault.</li> <li>The drive can also detect this code as an alarm with MEMOBUS code (0x0082).</li> </ul>			
PL (0x0474)	<p>Loss of Position</p> <p>The follower drive lost its position information. This has occurred because one of the following conditions exist:</p> <ul style="list-style-type: none"> <li>The position error is more than 268,435,456 counts.</li> <li>The pulse frequency after the gear ratio is so high that the follower cannot run at this speed without exceeding the encoder option card hardware limitation (300 kHz).</li> </ul>	There is mechanical binding in the follower motor.	Confirm the machinery is operating correctly and the follower motor is not binding.
		The master encoder is rotating, the follower is stopped, and $ba-08 = 1$ [Position Error Accumulation Selection = Error Is Always Accumulated].	If the application requires that the master encoder rotate while the follower is stopped, set $ba-08 = 0$ [Position Error Accumulation Selection = Position Error Only during Run].
		The desired follower speed is too high for the PPR of the installed encoder.	Replace the encoder of the follower motor with a lower PPR model.
<p><b>Note:</b></p> <p>Do a Fault Reset to clear the fault.</p>			

Table 3.11 Additional Operator Programming Errors

Code (MEMOBUS)	Name Description	Causes	Possible Solutions
oPE40 (0x0040)	<p>ELS Encoder Option Card Error</p> <p>An additional encoder card is required in the appropriate slot(s) for the selected ELS mode set in <math>ba-01</math> and follower control mode set in <math>A1-02</math>.</p>	Parameter $ba-01 = 4, 5$ [ELS modes] and a PG-X3 or PG-B3 card is not installed in both the CN5-B and CN5-C option card slots.	Install the encoder (PG) option card into the correct option card slot(s). Select the correct ELS mode in $ba-01$ .
		Parameter $ba-01 = 1, 2, \text{ or } 3$ and a PG-X3 or PG-B3 card is not installed in the CN5-B option card slot.	
oPE41 (0x0041)	<p>ELS Setup Error</p> <p>The selected ELS mode in <math>ba-01</math> requires AB Pulse detection or ELS is enabled while the drive is in EZ Drive mode.</p>	Parameter $ba-01 = 4, 5$ [ELS modes] and the master or follower encoder input is set to single channel [F1-21 or F1-37 = 0].	Select AB Pulse detection for the appropriate channel(s) [F1-21 or F1-37 = 1] or select the appropriate ELS mode in $ba-01$ .
		Parameter $ba-01 = 1$ and master encoder input is set to single channel [F1-37 = 0].	
		Parameter $ba-01 \neq 0$ and $A1-02 = 8$ [EZ Drive]. ELS is not compatible with EZ Drive operation.	Set $ba-01 = 0$ while in EZ Drive or select an alternate control method.

## ◆ Function Description

When Follower Mode Selection  $bA-01 = 1$  to  $3$  [*Speed Follower Mode*] the drive will follow the speed of the master encoder signal. The Run command direction and the master encoder direction set the drive run direction, the same way that the drive operates from a bipolar analog frequency reference. Using the gear ratio parameters  $bA-02$  to  $bA-05$ , the drive can run at a ratio of the master speed. You can use the Ratio 2 Select multi-function input [ $H1-0x = D1$ ] to select the alternate gear ratio [ $bA-06$  and  $bA-07$ ]. The basic gear ratio formula is:

Follower Frequency Reference = Master Encoder Frequency Reference x (Numerator / Denominator)

The Master Encoder Frequency Reference formula is:

$$\frac{\text{Master Encoder Pulse Frequency}}{\text{Master Encoder PPR (F1-31)}} \times \frac{\text{Follower Motor Poles (E2-04)}}{2} = \text{Master Encoder Frequency Reference (UF-01)}$$

For the primary gear ratio, the formula is:

$$\text{Master Encoder Frequency Reference (UF-01)} \times \frac{\overbrace{\text{X X X X}}^{bA-02} \overbrace{\text{X X X X}}^{bA-05}}{\overbrace{\text{X X X X}}^{bA-03} \overbrace{\text{X X X X}}^{bA-05}} = \text{Follower Frequency Reference (UF-02)}$$

The pairs of numerator and denominator parameters are used together to form an 8-digit number divided by an 8-digit number. For ratios that can be expressed using 4-digit numbers or less, use  $bA-02/bA-03$ . Gear ratio 2 can only be expressed as a 16-bit integer (0 - 65535) divided by a 16-bit integer (0 - 65535).

The gear ratio needed for the application must be able to be exactly expressed by the above formula. This includes the complete remainder. If the ratio cannot be exactly expressed, the follower will drift in phase over time. You can use the Simple Automatic Alignment function to correct for drift over time if alignment sensors, for example proximity sensors, from both the master and follower systems are available as digital inputs to the follower drive.

You can further adjust the ratio using the Digital Ratio Adjustment, the Analog Ratio Adjustment [ $H3-02/H3-06/H3-10 = 29$ ], the MOP Adjust multi-function inputs [ $H1-0x = D4$  to  $D6$ ] and the Network Communication Gear Ratio Adjustment (register 0D30). These adjustments are summed and added to 100% to produce the total gear ratio adjustment, which is multiplied by the incoming master speed reference (after gear ratio calculation).

When Follower Mode Selection  $bA-01 = 4$  or  $5$  [*ELS modes*], the drive will track follower position relative to the master encoder. A PI regulator is applied to the position error. The output of the PI regulator is used to trim the speed reference calculated from the master encoder signal, gear ratio parameters and gear ratio adjustment. In this manner, the position of the follower motor will be synchronized with the position of the master. Use the Advance Follower [ $H1-0x = D2$ ] and Retard Follower [ $H1-0x = D3$ ] multi-function inputs to change the position of the follower relative to the master.

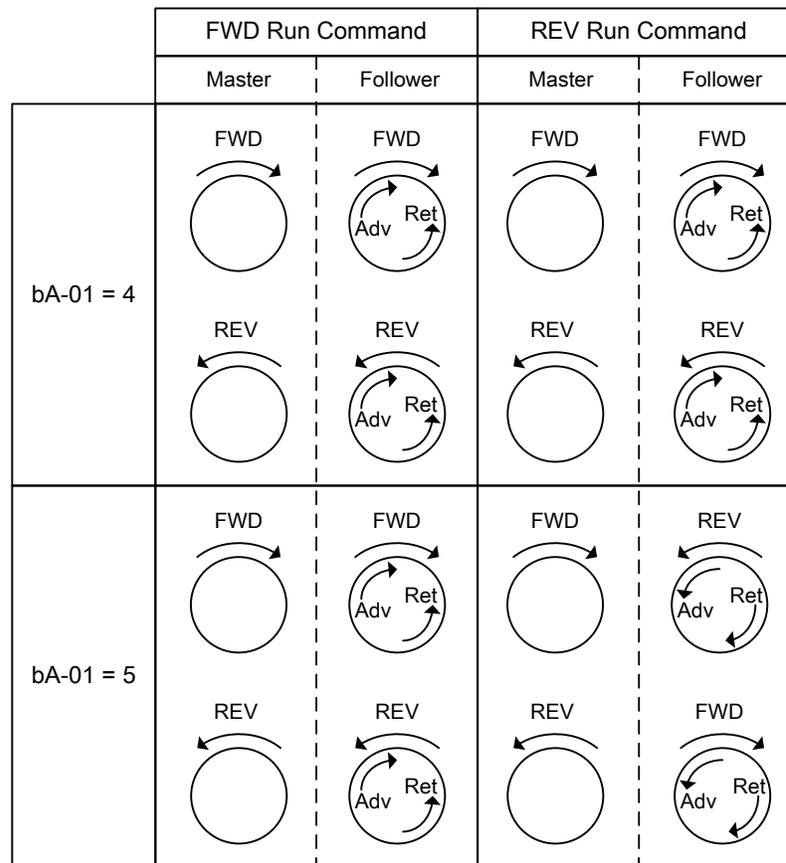
When the gear ratio of the drive is changed during run (either due to the gear ratio parameters being changed during run or because of a change of state of the Ratio 2 Select multi-function input), the drive will ramp to the new ratio using Accel/Decel Time 2 [ $C1-03/C1-04$ ]. If ELS mode is selected, the position error will be held to zero during the ratio change until the drive re-enters Speed Agree based on  $bA-24$  [*Ratio Change Speed Agree Width*].

In standard ELS mode [ $bA-01 = 4$ ], the follower motor direction is always the same as the master encoder direction. Forward and reverse Run commands are treated identically. When Follower Mode Selection  $bA-01 = 5$  [*ELS - Sign Run mode*], the drive behaves identically to when  $bA-01 = 4$  [*Standard ELS mode*], except when the drive receives a reverse Run command. A reverse Run command will cause the follower drive to match speed and position in the opposite direction of the master. The table below shows the direction of the Follower depending on the direction of the Master,  $bA-01$  setting,  $b1-04$  (reverse operation prohibit selection) setting, and the forward run / reverse run digital input signal.

**Table 3.12 Follower Rotation Directions for Various Settings and Master Directions**

b1-04 (Reverse Operation)	Digital Input Signal	bA-01 = 1 Speed Follower – Both Directions		bA-01 = 2 Speed Follower – Forward Direction		bA-01 = 3 Speed Follower – Absolute Value		bA-01 = 4 Electronic Line Shaft		bA-01 = 5 Electronic Line Shaft – Sign Run	
		Master: FWD	Master: REV	Master: FWD	Master: REV	Master: FWD	Master: REV	Master: FWD	Master: REV	Master: FWD	Master: REV
b1-04 = 0 Enabled	FWD	FWD	REV	FWD	NONE	FWD	FWD	FWD	REV	FWD	REV
	REV	REV	FWD	NONE	REV	REV	REV	FWD	REV	REV	FWD
b1-04 = 1 Disabled	FWD	FWD	NONE	FWD	NONE	FWD	FWD	FWD	NONE	FWD	NONE
	REV	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE

In the Standard ELS mode, when an Advance Follower input [ $HI-0x = D2$ ] is active, the follower drive moves in the absolute positive direction with respect to the follower and in the absolute negative direction when the Retard Follower input is active. These functions behave the same way in ELS – Sign Run mode when there is a forward Run command. When there is a reverse Run command during ELS – Sign Run mode, the Advance Follower input will move the follower drive in the absolute negative direction while the Retard Follower input will move the follower drive in the absolute positive direction. The diagrams below outline the Follower direction and Advance/Retard behavior for *bA-03* settings and forward / reverse Run command selections.



**Figure 3.3 Follower Direction and Advance/Retard Behavior**

When the drive is in LOCAL Mode (digital input or keypad button) or when the drive has a forward or reverse jog command, the frequency reference switches back to standard frequency reference and the drive uses the selected Accel / Decel times.

**Note:**

- In ELS mode, the Position P Gain setting [*bA-18*] is scaled in relation to the drive Max Frequency [*E1-04*]. If you change *E1-04*, the proportional contribution of the position regulator will be influenced. (The integral contribution is also influenced because it is directly proportional to the proportional contribution).
- You must set the Maximum Output Frequency [*E1-04*] of the follower drive higher than the maximum input frequency from the master source for proper position control. As a general rule, set *E1-04* in the follower to be 10% greater than the maximum input frequency of the master source (or at least equal to *bA-21* [*Position PI Limit*]). An incorrect setting can cause large continuous amounts of Position Error [*UF-07*].
- You must know the exact gear ratio (including remainder) and able to be express it using the gear ratio parameters. Errors in the gear ratio settings will cause follower motor drift.
- Examples for applications of *bA-23* [*Speed Proportional Position Trim Lower Limit*]. For the bullet points below, assume *E1-04* = 60 Hz and *bA-23* = 10.00%.
  - With Speed Proportional Position Trim disabled, a PI output of 10% adds 60 Hz \* 10% = 6 Hz, regardless of the value of follower reference after gear ratio.
  - With Speed Proportional Position Trim enabled, and follower reference after gear ratio of 30 Hz, a PI output of 10% adds 60 Hz \* 10% \* (30 Hz / 60 Hz) = 3 Hz.
  - With Speed Proportional Position Trim enabled, for any follower reference below, the *bA-23* value multiplied by *E1-04* (10% \* 60 Hz = 6 Hz), the trim amount is limited to *bA-23*. In this case, a PI output of 10% adds 60 Hz \* 10% \* 10% = 0.6 Hz.

◆ Block Diagram

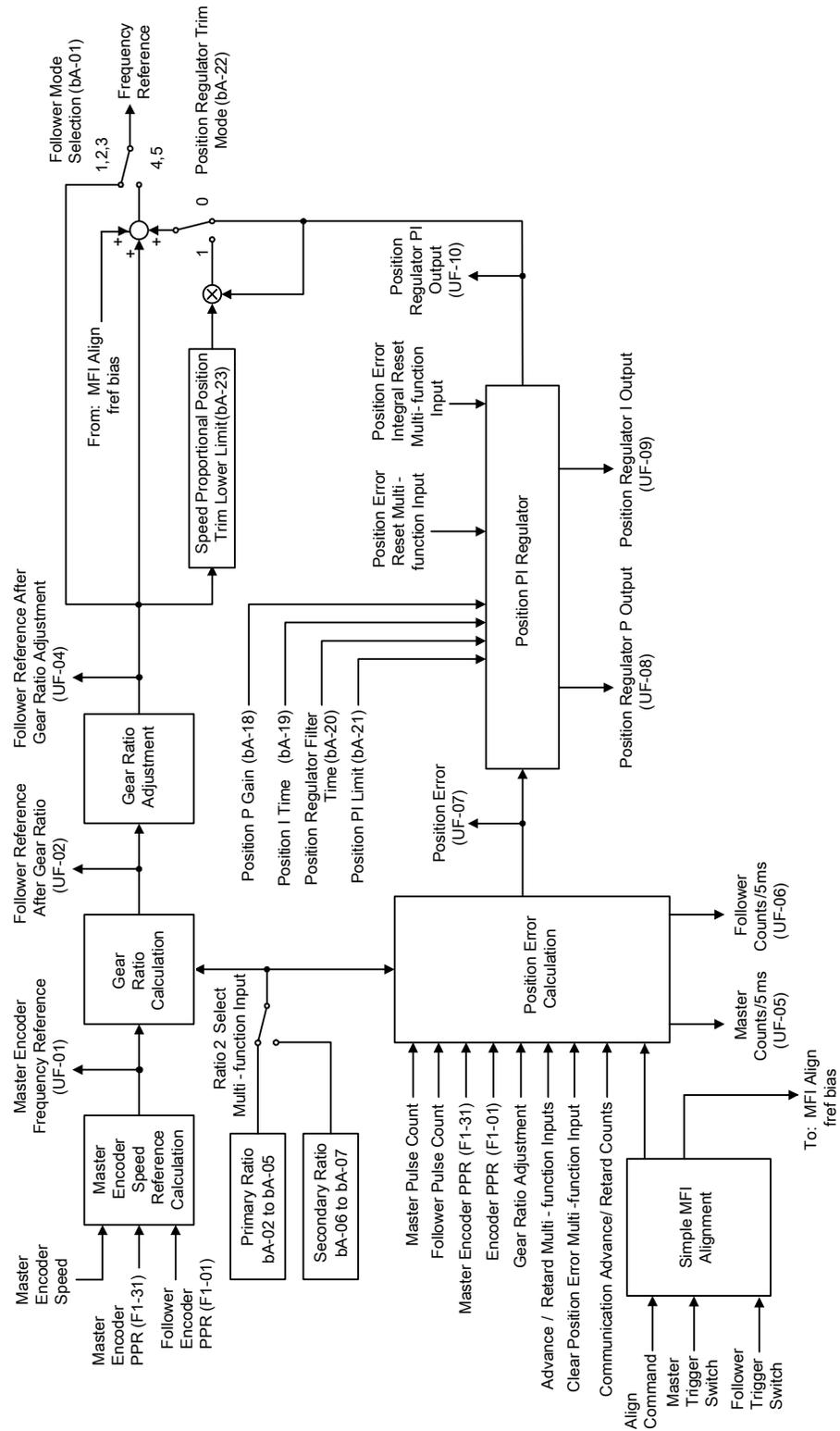


Figure 3.4 ELS Software Block Diagram

## 4 Simple Automatic Alignment

### ◆ Overview

This software adds the ability for an automatic alignment using two proximity switches connected to the drive multi-function digital inputs.

### ◆ Basic Concepts and Principles

This software adds an automatic alignment feature to the base electronic line shaft software. This is accomplished by using two proximity switches connected to the trigger inputs on the follower drive. One switch identifies the position of the master, and the other switch identifies the position of the follower. When the alignment feature is activated and the machine is running, the drive measures and compensates for the distance between the trigger switches.

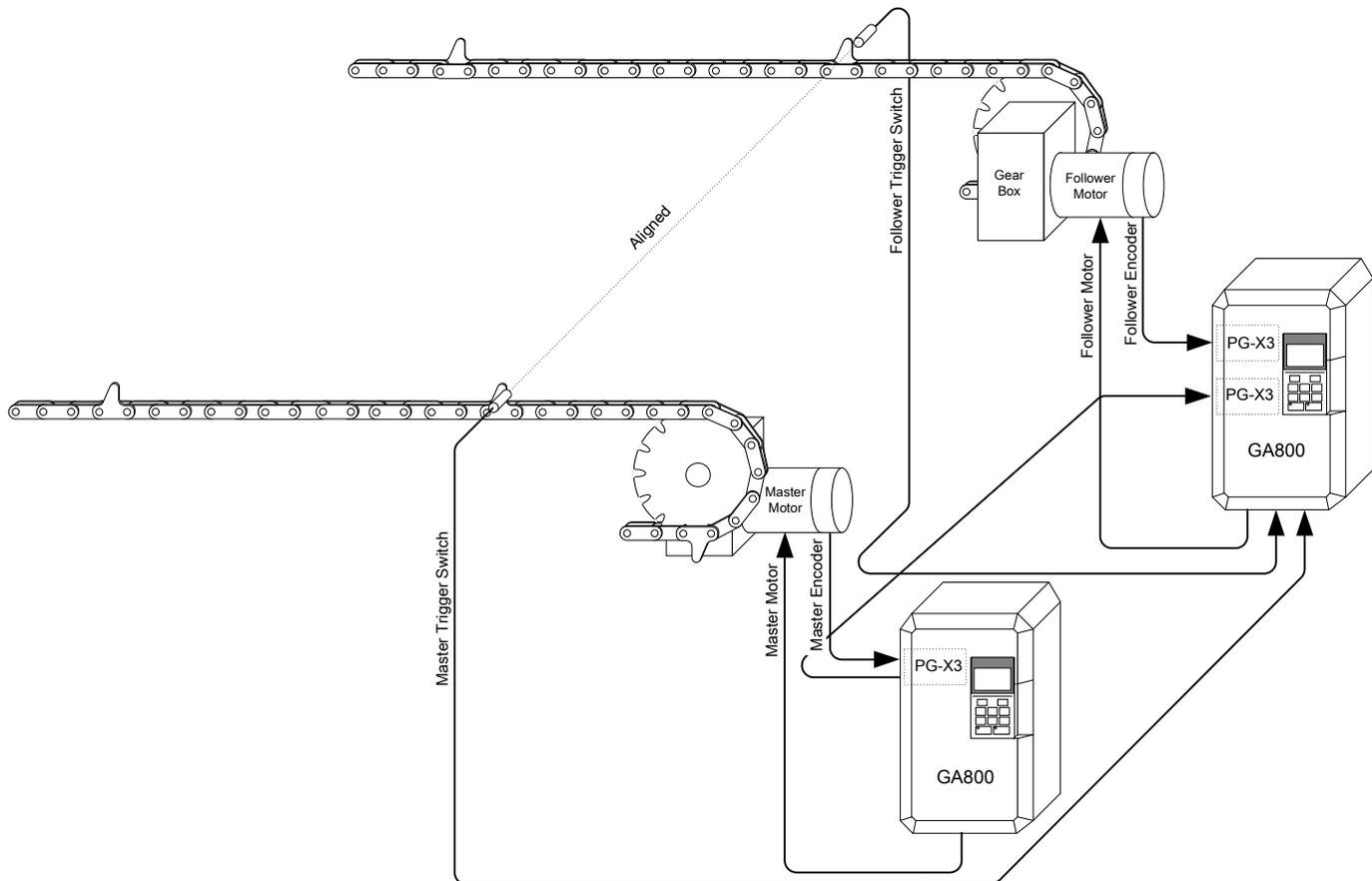


Figure 4.1 Simple Automation Alignment Diagram

### ◆ Limitations

- Alignment accuracy decreases at higher speeds. This is caused by latency in the trigger switches and the drive digital inputs and internal scan rate.
- If the “Position Error Reset” digital input is activated when an alignment is being performed, the drive can experience a step-change in frequency reference.

### ◆ Additional Parameters

Table 4.1 Additional Parameter Group

Parameter Group	Name
bA	Electronic Line Shaft

Table 4.2 Additional Parameters

No. (Hex.)	Name	Description	Default (Range)
bA-25 (0D18)	Alignment Select	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Enables and disables the alignment feature.</p> <p><b>0 : Alignment Disabled</b>  <b>1 : Manual Align</b>  <b>2 : Auto Align at Start</b>  <b>3 : Continuous Align</b>  <b>4 : Window Align</b></p>	0 (0 - 4)
bA-26 (0D19) RUN	Alignment Trim Rate	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Sets the amount of speed added to or subtracted from the follower drive during an alignment procedure.</p> <p><b>Note:</b>  You should not change this parameter during Alignment Operation because it can cause overshoot of the target Alignment.</p>	6.0 Hz (0.1 - 30.0 Hz)
bA-27 (0D1A)	Alignment Offset	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Sets an offset value to correct for the physical misalignment of the trigger inputs, set in terms of follower revolutions. A positive offset value identifies that the follower signal is expected before the master (assuming standard settings and forward run command). A negative offset value identifies that the master signal is expected before the follower signal.</p>	0.00 rev (-99.99 to 99.99 rev)
bA-28 (0D1B) RUN	Alignment Check	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Used with a digital output to detect if the master and the follower trigger pulses are within a preset window of follower counts. When the number of follower quadrature encoder counts between the two trigger inputs is less than this value, the "In Alignment" digital output will activate [<math>H2-0x = D2</math>].</p>	100 cnts (0 - 65535 cnts)
bA-29 (0D1C)	Trigger Switch Type	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Sets the normal (not activated) state of the Master and Follower trigger switches.</p> <p><b>0 : Both NO</b>  <b>1 : Master NO Follower NC</b>  <b>2 : Master NC Follower NO</b>  <b>3 : Both NC</b></p>	0 (0 - 3)
bA-30 (0D1D)	Align Fault Select	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Sets the reaction of the drive when the distance (follower motor revolutions) between the two trigger inputs is more than the value of <i>bA-31</i>.</p> <p><b>0 : Disabled</b>  <b>1 : Ignore First Trigger</b>  <b>2 : Fault</b></p>	0 (0 - 2)
bA-31 (0D1E)	Maximum Alignment Distance	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Sets the maximum number of follower motor revolutions between the trigger inputs before the drive will detect Alignment Fault [<i>bA-30</i>].</p>	1000 rev (1 - 5000 rev)
bA-32 (0D1F) RUN	Maximum Alignment Speed	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Sets the maximum follower speed that will be allowed for an alignment to occur. This can prevent alignment at high speeds where accuracy is decreased. A setting of 0.0 Hz disables this function</p>	0.0 Hz (0.0 - 400.0 Hz)
bA-33 (0D20) RUN	Align Trigger Window	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Sets the maximum amount of alignment error allowed before the Window Counts increment (in follower revolutions). During an alignment check, if the alignment error is more than the value of this parameter, the <i>UF-12</i> Window Counts monitor increments. If the alignment error is equal to or less than the value of this parameter, the <i>UF-12</i> Window Counts monitor is decremented.</p> <p><b>Note:</b>  This parameter is effective only when <math>bA-25 = 4</math> [<i>Alignment Select = Window Align</i>].</p>	2.00 rev (0.00 - 100.00 rev)
bA-34 (0D21) RUN	Align Trigger Count	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Sets the number of Window Counts [<i>UF-12</i>] necessary to trigger an alignment.</p> <p><b>Note:</b>  This parameter is effective only when <math>bA-25 = 4</math> [<i>Alignment Select = Window Align</i>].</p>	3 (1 - 100)
bA-35 (0D22)	Repeat Trigger Select	<p><b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b></p> <p>Selects the way the drive handles consecutive triggers.</p> <p><b>0 : Last Trigger</b>  If consecutive master triggers (or follower triggers) occur before a corresponding follower trigger (or master trigger) occurs, the drive uses the last master trigger (or follower trigger) for alignment.</p> <p><b>1 : First Trigger</b>  If consecutive master triggers (or follower triggers) occur before a corresponding follower trigger (or master trigger) occurs, the drive uses the first master trigger (or follower trigger) for alignment. This setting is used for compatibility with the Electronic Line Shaft software for the F7 drive.</p>	0 (0 - 1)

## 4 Simple Automatic Alignment

**Table 4.3 Additional H1-xx Multi-Function Digital Input Setting Values**

Setting Value	Function	Description
D9	Follower Trigger	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> This input is connected to a switch that detects the position of the follower machine. This input is configurable using <i>bA-29</i> .
DA	Master Trigger	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> This input is connected to a switch that detects the position of the master machine. This input is configurable using <i>bA-29</i> .
DB	Align Follower Command	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Commands the align function to begin when <i>bA-25 = 1 or 2</i> . This input is edge triggered (open to closed transition). When a digital input is programmed to this setting, it enables the align function when <i>bA-25 = 3 or 4</i> . When this input is open, the drive will measure alignment and display it in monitor <i>UF-11</i> but the drive will not attempt to correct the alignment. When <i>bA-25 = 3 or 4</i> and no digital input is programmed to this setting, alignment is always enabled.

**Table 4.4 Additional H2-xx Multi-Function Output Setting Values**

Setting Value	Function	Description
D1	Align Complete	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Closes when a successful alignment operation completes. Opens when the follower is stopped, faulted, or electronic line shaft position error is cleared or disabled. Also opens when the drive receives an advance/retard command. For <i>bA-25 = 1, 2</i> , opens after the next Align Follower Command digital input is given. For <i>bA-25 = 3, 4</i> , opens after the next Master Trigger or Follower Trigger digital input occurs.
D2	In Alignment	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Closes when both trigger inputs are received AND the distance between them is less than the <i>bA-28</i> value. Opens when: 1. The first trigger has been received, and the accumulated distance is more than the sum of the <i>bA-27</i> and <i>bA-28</i> distances. 2. When the follower is stopped, faulted, or electronic line shaft position error is cleared or disabled. 3. The drive receives an advance/retard command.
1D1	!Align Complete	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Opens when a successful alignment operation completes. Closes when the follower is stopped, faulted, or electronic line shaft position error is cleared or disabled. Also closes when the drive receives an advance/retard command. For <i>bA-25 = 1, 2</i> , closes after the next Align Follower Command digital input is given. For <i>bA-25 = 3, 4</i> , closes after the next Master Trigger or Follower Trigger digital input occurs.
1D2	!In Alignment	<b>V/f</b> <b>CL-V/f</b> <b>OLV</b> <b>CLV</b> <b>AOLV</b> <b>OLV/PM</b> <b>AOLV/PM</b> <b>CLV/PM</b> <b>EZOLV</b> Opens when both trigger inputs are received AND the distance between them is less than the <i>bA-28</i> value. Closes when: 1. The first trigger has been received, and the accumulated distance is more than the sum of the <i>bA-27</i> and <i>bA-28</i> distances. 2. When the follower is stopped, faulted, or electronic line shaft position error is cleared or disabled. 3. The drive receives an advance/retard command.

## ◆ Troubleshooting

**Table 4.5 Additional Faults**

Code (MEMOBUS)	Name Description	Causes	Possible Solutions
AF (0x0475)	Alignment Fault	The distance between the master and the follower is more than the allowable amount [ <i>bA-31</i> ].	Check the machine integrity.
		Malfunctioning or incorrectly wired trigger switches.	Check the trigger switches for correct wiring and operation.
<b>Note:</b> Do a Fault Reset to clear the fault.			

## ◆ Alignment Enable Function Description

To enable the alignment function, program both the master and the follower trigger multi-function digital input functions to the *H1-xx* parameters, and set Alignment Select parameter *bA-25*  $\neq 0$ .

The alignment function will NOT operate when:

- The drive is in a fault condition
- The drive is not running
- The follower is ramping between forward and reverse Run commands
- Electronic Line Shaft is disabled via multi-function input [ $H1-xx = D0$ ]
- Electronic Line Shaft is disabled via parameter [ $bA-01 < 4$ ]
- The drive is in LOCAL Mode
- A “Jog” is being commanded of the follower drive
- The drive is ramping to speed due to a gear ratio change or Line Shaft being re-enabled
- A position error is being cleared via multi-function input [ $H1-xx = D7$ ].

### ◆ Alignment Select Function Description

The alignment select parameter [ $bA-25$ ] enables and disables the alignment feature. When  $bA-25 = 0$ , the drive will not do an alignment and the two digital outputs associated with alignment [ $H2-0x = D1$  and  $H2-0x = D2$ ] are de-energized.

- When  $bA-25 = 0$  – **Disabled**. The drive will NOT do an alignment.
- When  $bA-25 = 1$  – **Manual Align**. The drive must see the rising edge of the align command [ $H1-xx = DB$ ] to start the alignment process. The drive will not try another alignment until there is another rising edge on the align command.
- When  $bA-25 = 2$  – **Auto Align at Start**. The drive will immediately begin the alignment process when the Run command is applied. The drive will respond to the align command as specified in [ $bA-25 = 1$ ].
- When  $bA-25 = 3$  – **Continuous Alignment**. The drive will immediately begin the alignment process when the Run command is applied. Each time the drive receives two valid trigger inputs, the drive will automatically restart the alignment process. If the drive has not completed the previous alignment, it will ignore trigger pulses.
- When  $bA-25 = 4$  – **Window Alignment**. The drive will do an alignment at start. The drive will measure alignment during subsequent trigger pulses. When the alignment is off by more than the  $bA-33$  setting, the  $UF-12$  count will increment. When the alignment is within the  $bA-33$  setting, the  $UF-12$  count will decrement. When the  $UF-12$  count =  $bA-34$ , the drive will do alignment and reset  $UF-12$  to zero.

### ◆ Alignment Process Function Description

The alignment function can align the follower to the master using fixed trigger positions. This process does not control the master drive. All correction is made by the follower drive. The amount of the correction is controlled by the quadrature counts that are accumulated from the time when the first or leading trigger starts the process and continues until the trailing trigger stops it. Parameter  $bA-26$  [*Alignment Trim Rate*] controls the speed of the correction. The drive makes the correction when the trailing trigger input activates. The rate at which the drive accelerates or decelerates during the alignment procedure is fixed. For a 1024 PPR encoder, the ramp rate is approximately 20 Hz/1 sec. The alignment process is intended to be done at low speed, but will function when the triggers provide at least a 15 millisecond signal so that the follower drive can see the trigger inputs.

**Note:**

If consecutive master triggers occur before a follower trigger occurs, the drive uses the first master trigger and ignores subsequent master triggers. If consecutive follower triggers occur before a master trigger occurs, the drive uses the first follower trigger and ignores subsequent master triggers.

**Maximum alignment speed:** If an alignment is in process and the follower needs to run faster to “catch up” to the master, it will only be allowed to compensate at a rate of up to 95% of the follower maximum frequency setting. If the follower is already running at or above the 95% speed level, the alignment function will not complete.

**Minimum alignment speed:** If an alignment is in process, and the follower needs to slow down in order for the master to “catch up”, the follower drive could run in reverse. If reverse on the follower is disabled [ $b1-04 = 1$ ], the follower drive will only be allowed to run at a minimum of zero speed (no reverse).

### ◆ Alignment Fault Select Function Description

When the Alignment Fault Select parameter is set to “disabled” [ $bA-30 = 0$ ], there is no settable limit to the number of follower motor revolutions that can elapse between master and follower trigger inputs.

## 4 Simple Automatic Alignment

### Note:

To prevent internal overflow, the maximum number of encoder counts allowed between the two trigger inputs is 268,435,456. (65536 motor revolutions with a 1024 PPR encoder)

When the Alignment Fault Select parameter is set to Ignore First Pulse [ $bA-30 = 1$ ], it will disregard the first trigger input (regardless of master or follower) after the  $bA-31$  distance (either direction) is elapsed. As shown in the timing diagrams below, if the align command is asserted between the time that the master and follower trigger inputs are read before the  $bA-31$  distance elapses, the drive will disregard the first input and wait for two valid trigger inputs. When using this mode, it is useful to program the  $bA-31$  distance to 50% to 90% the total trigger-to-trigger distance.

When the Alignment Fault Select parameter is set to Fault [ $bA-30 = 2$ ], the drive will fault out on an “AF – Alignment Fault” and coast to stop after the  $bA-31$  distance (follower motor revolutions) has elapsed after the first trigger input (regardless of master or follower). When using this mode, it is useful to set  $bA-31$  to a larger value than the normal trigger-to-trigger distance.

### ◆ Align Complete / In Alignment Multi-function Digital Outputs Function Description

The Align Complete” digital output [ $H2-0x = D1$ ] closes after the drive completes a successful align procedure. The Align Complete digital output de-energizes when the drive detects the rising edge of an Align Follower Command. If the drive is set to reset position error at stop [ $bA-08 = 0$ ], the Align Complete digital output will also de-energize when the Run command is removed or if electronic line shaft is disabled [ $H1-xx = D0$ ]. If the drive is set to accumulate position error at all times [ $bA-08 = 1$ ], the Align Complete will de-energize only if electronic line shaft is disabled or if the drive receives another align command.

The “In Alignment” digital output [ $H2-0x = D2$ ] identifies when the trigger inputs are activated within a settable quadrature encoder count range. The In Alignment output will energize when the triggers are within the  $bA-31$  setting and will de-energize when the  $bA-31$  setting is exceeded. This output will only change state after the trailing trigger activates.

### ◆ Position Error Clear Function Description

This software has the ability to clear a position error. If  $bA-08 = 0$ , and High Slip Braking is activated, it will clear the position error.

### ◆ Block Diagrams

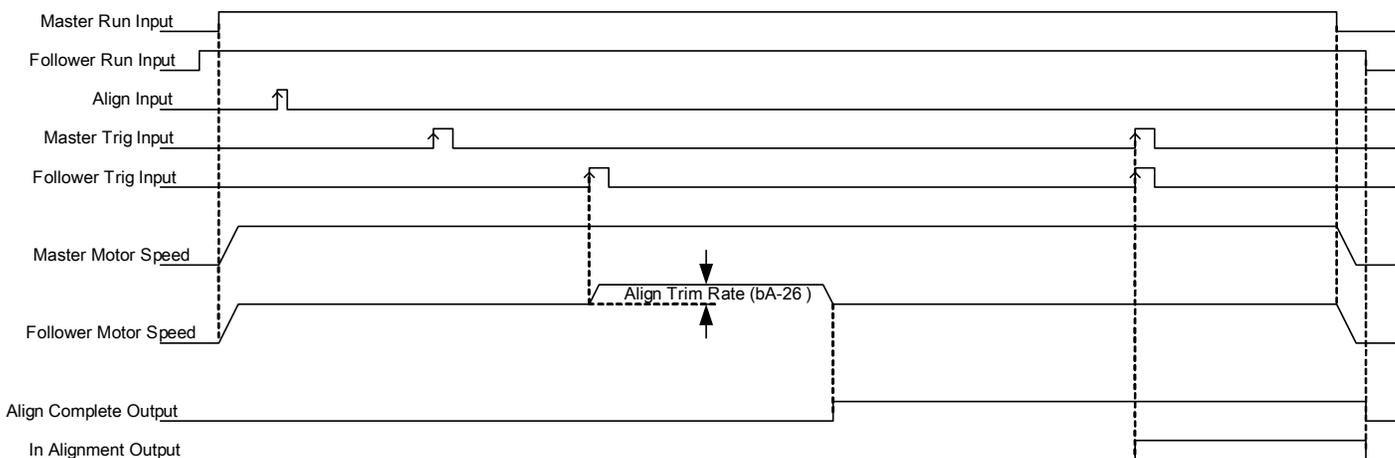
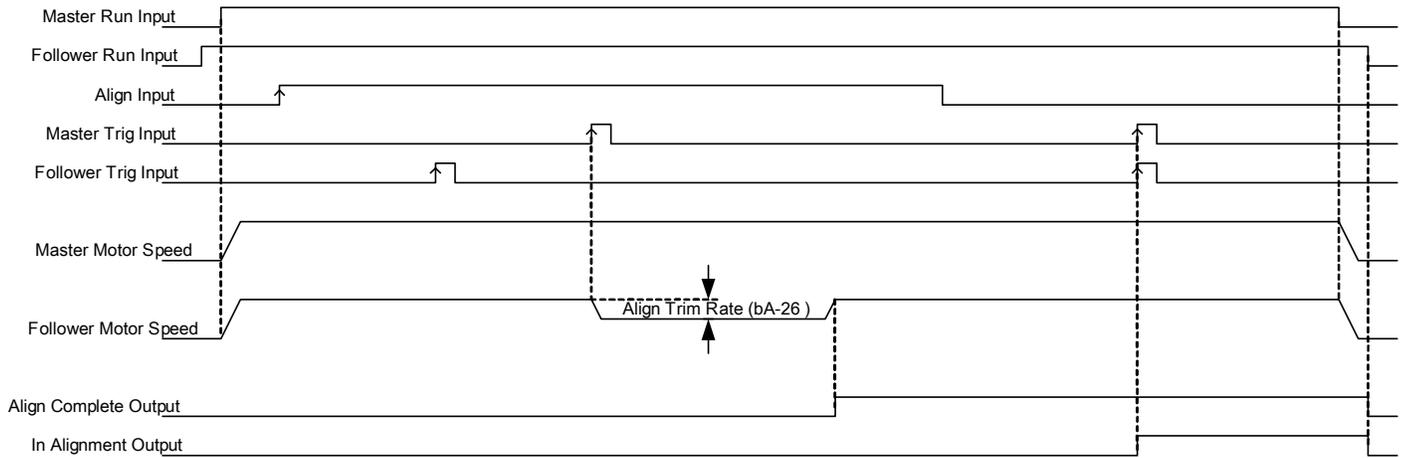


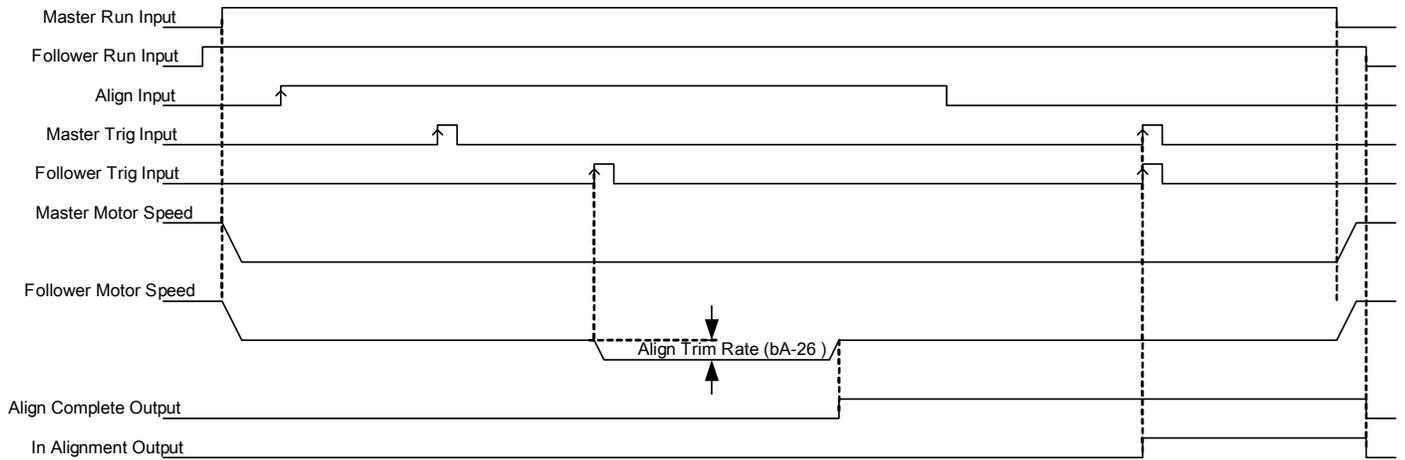
Figure 4.2 Forward Run - Alignment - Master Before Follower



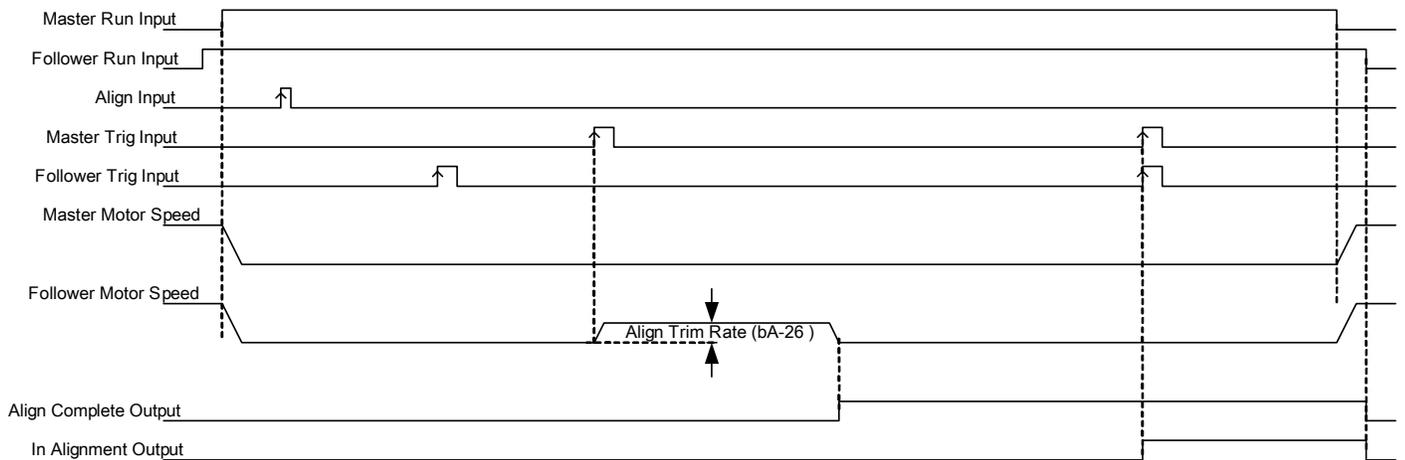
**Figure 4.3 Forward Run - Alignment - Follower Before Master**

**Note:**

The "Align Input" edge is triggered. It does not matter if the input is maintained or momentary.

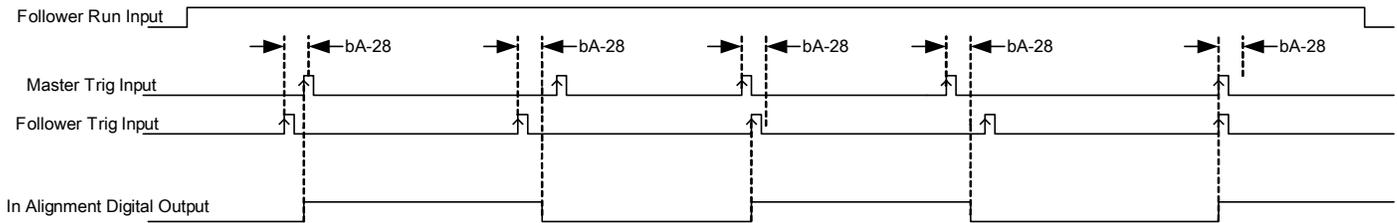


**Figure 4.4 Reverse Run - Alignment - Master Before Follower**

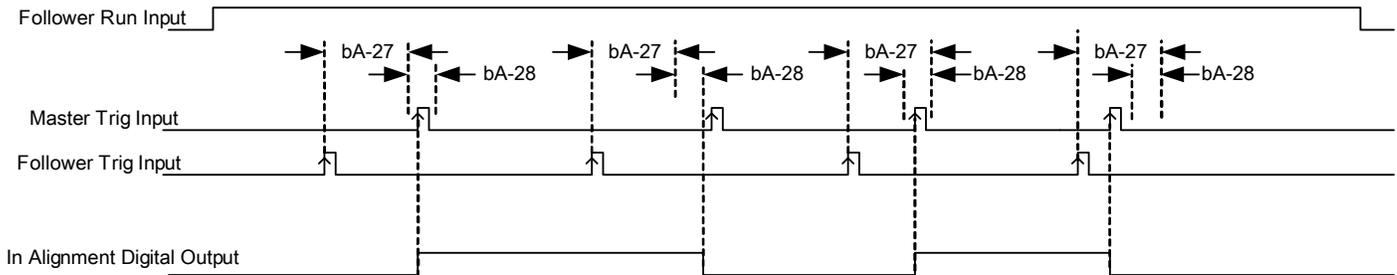


**Figure 4.5 Reverse Run - Alignment - Follower Before Master**

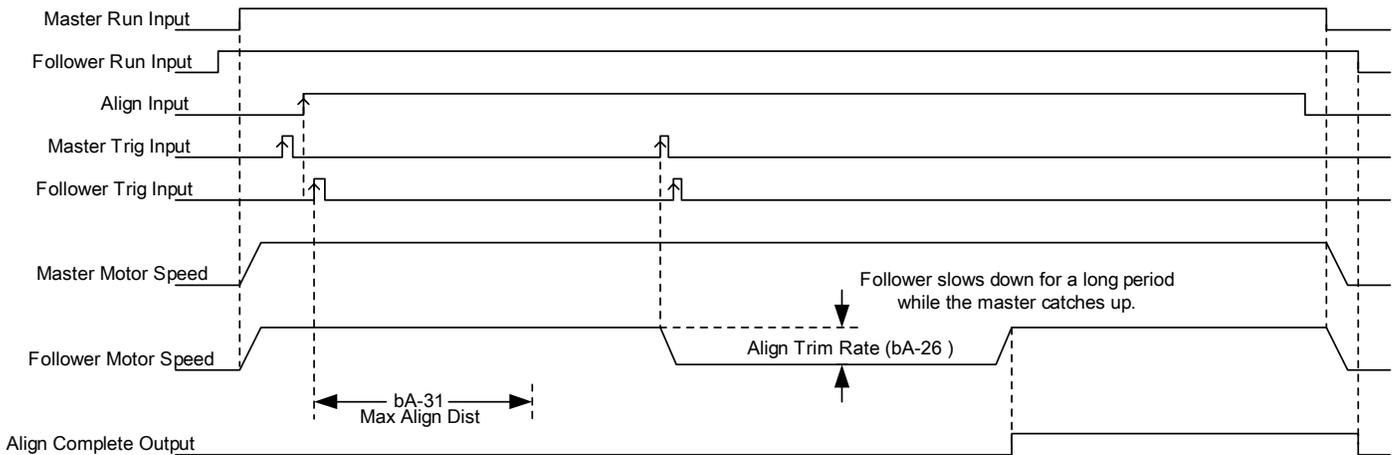
## 4 Simple Automatic Alignment



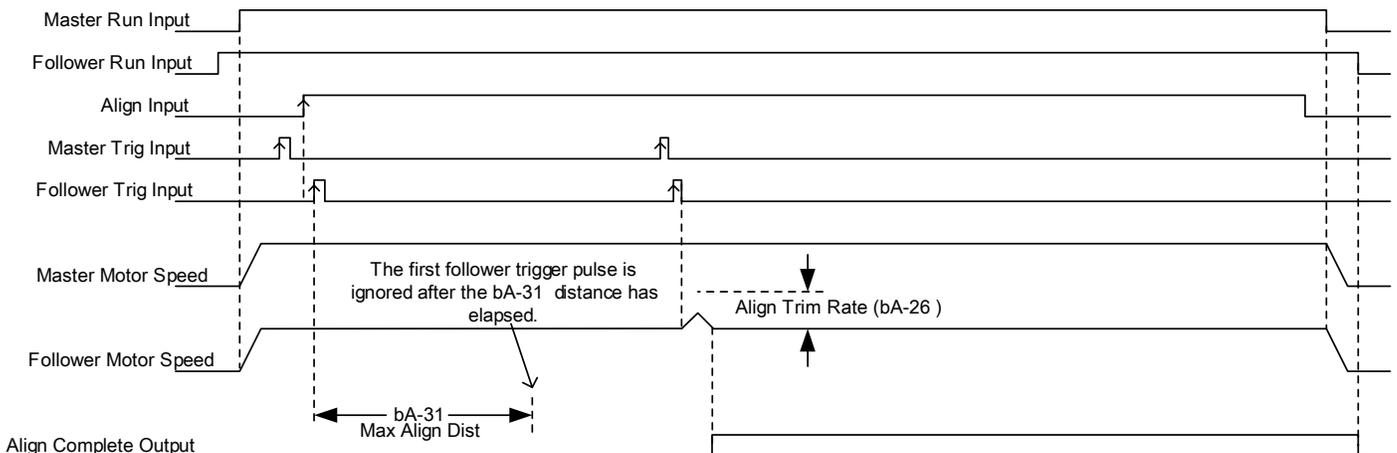
**Figure 4.6 In Alignment (Digital Output) Function, No Offset (bA-27 = 0.00 revs, bA-28 = 4096 cnts)**



**Figure 4.7 In Alignment (Digital Output) Function, with Offset (bA-27 = +3.00 revs, bA-28 = 4096 cnts)**



**Figure 4.8 Alignment Fault Select = Disabled (bA-30 = 0)**



**Figure 4.9 Alignment Fault Select = Ignore 1st Pulse (bA-30 = 1)**

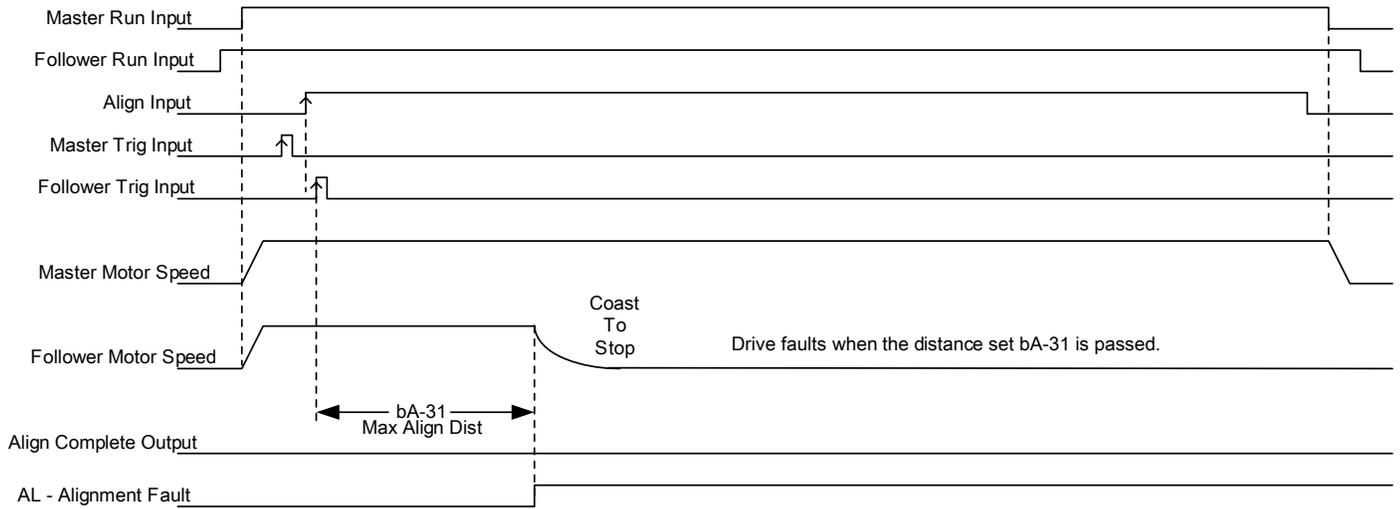


Figure 4.10 Alignment Fault Select = Fault (bA-30= 2)

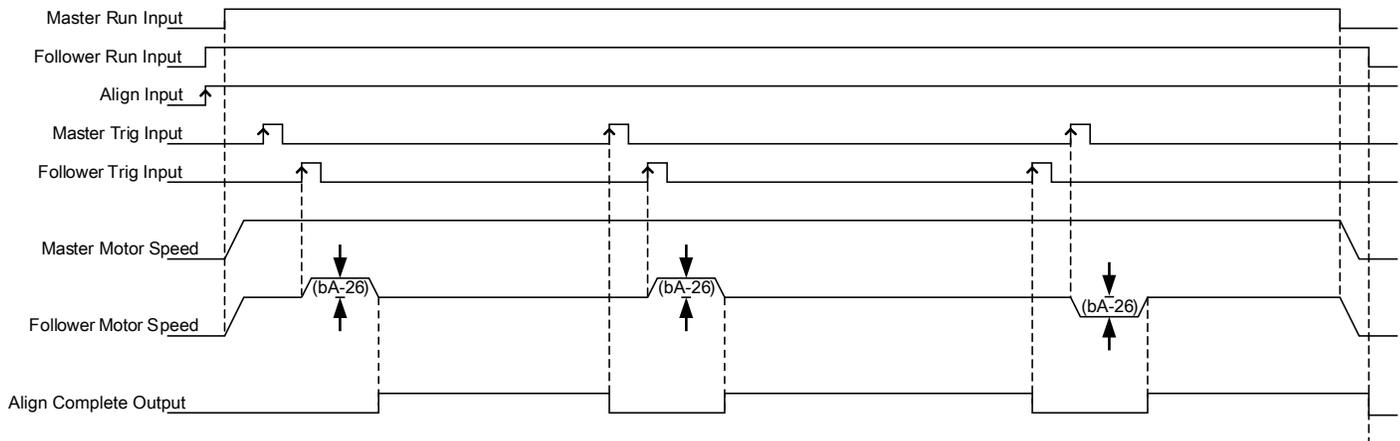


Figure 4.11 Continuous Alignment (bA-25 = 3)

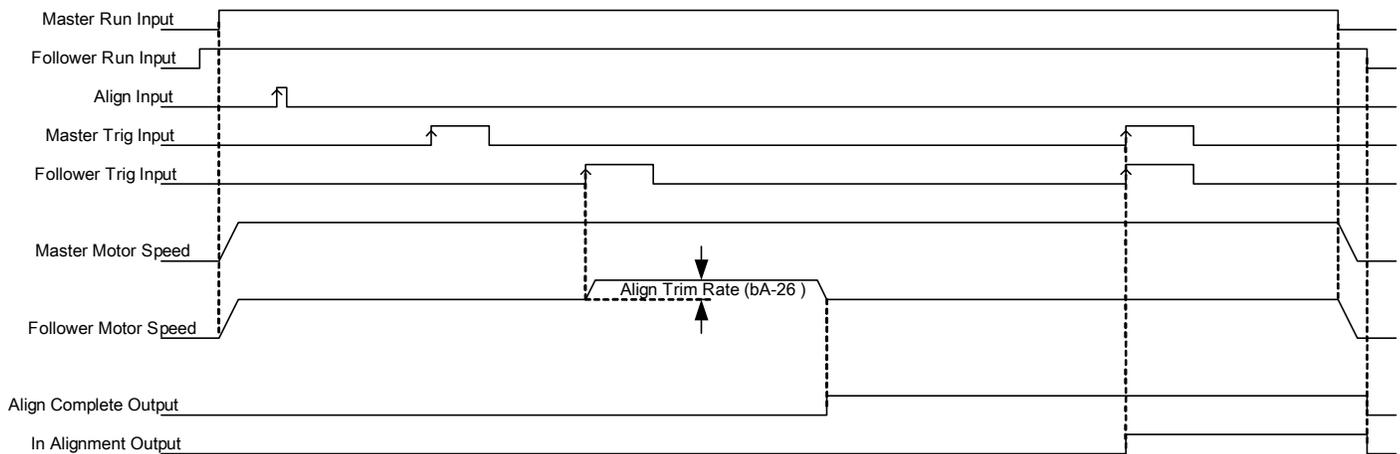
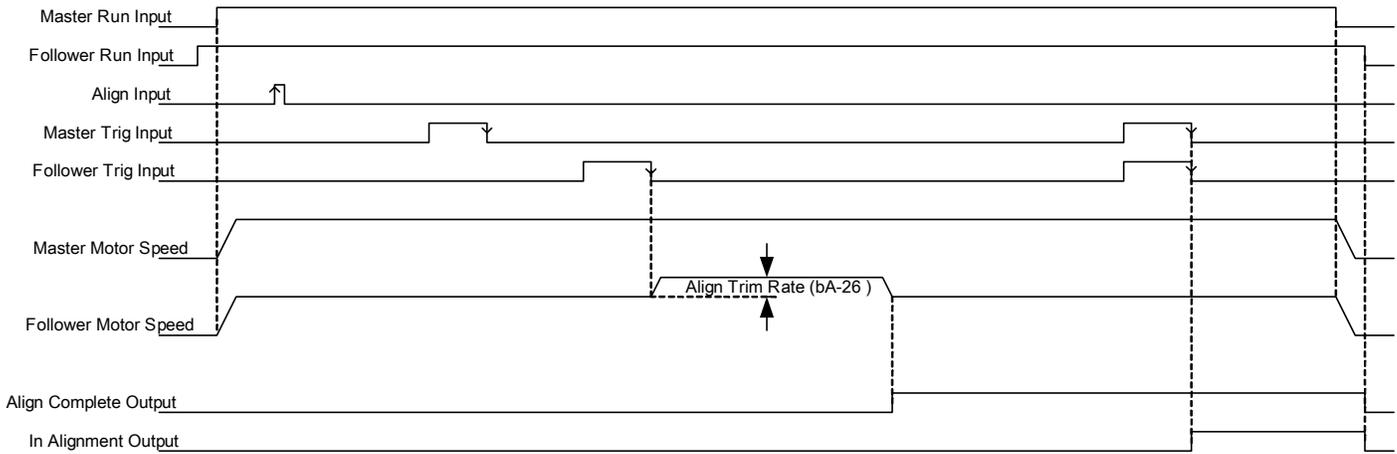
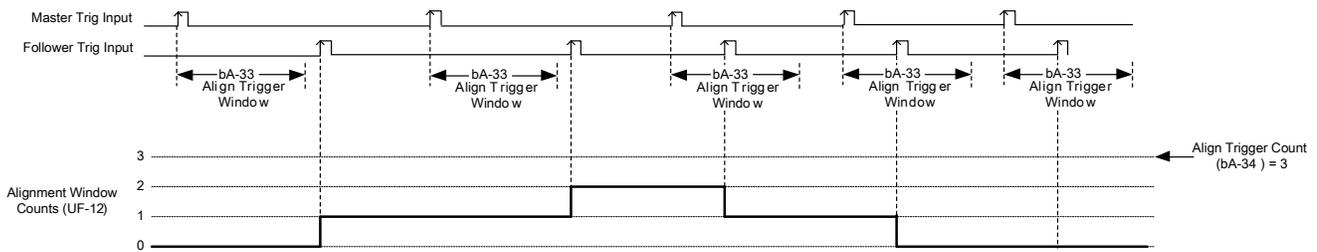


Figure 4.12 Normally Open Trigger Inputs (bA-29 = 0)

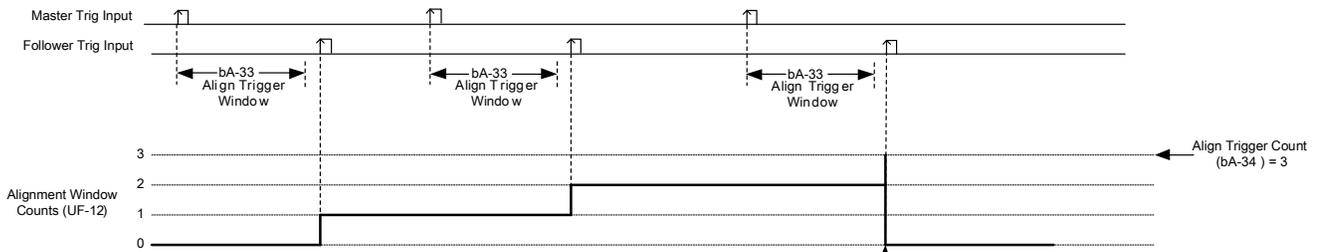
## 4 Simple Automatic Alignment



**Figure 4.13 Normally Closed Trigger Inputs (bA-29 = 3)**



Alignment is not performed because UF-12 never reaches bA-34



Alignment is performed

**Figure 4.14 bA-25 = 4 Window Alignment Mode**

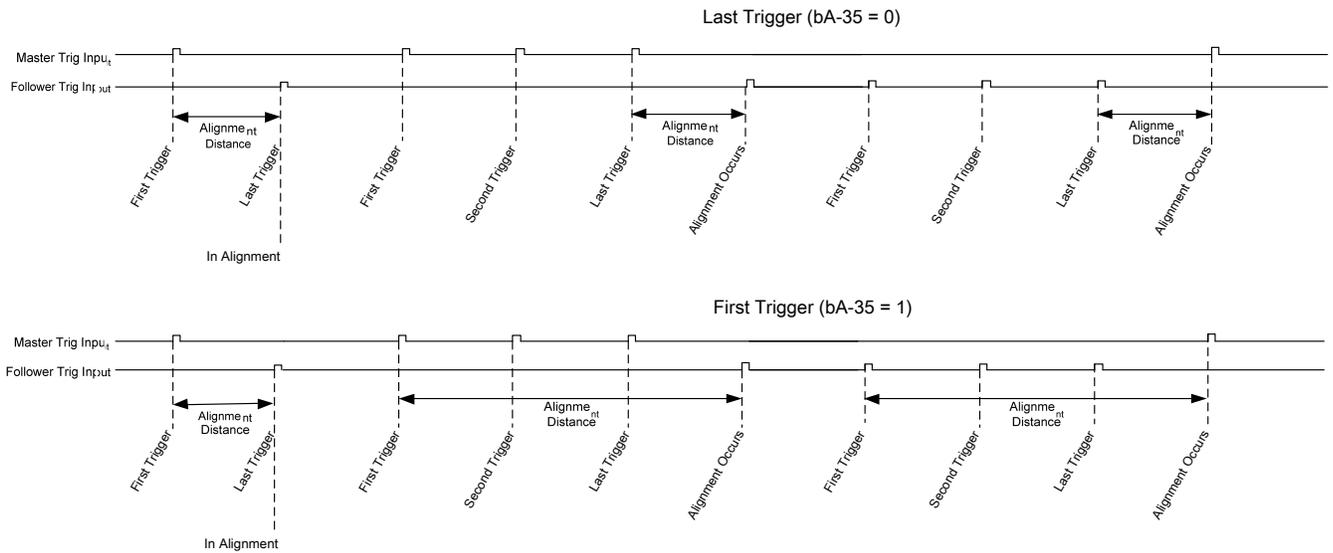


Figure 4.15 Last and First Triggers

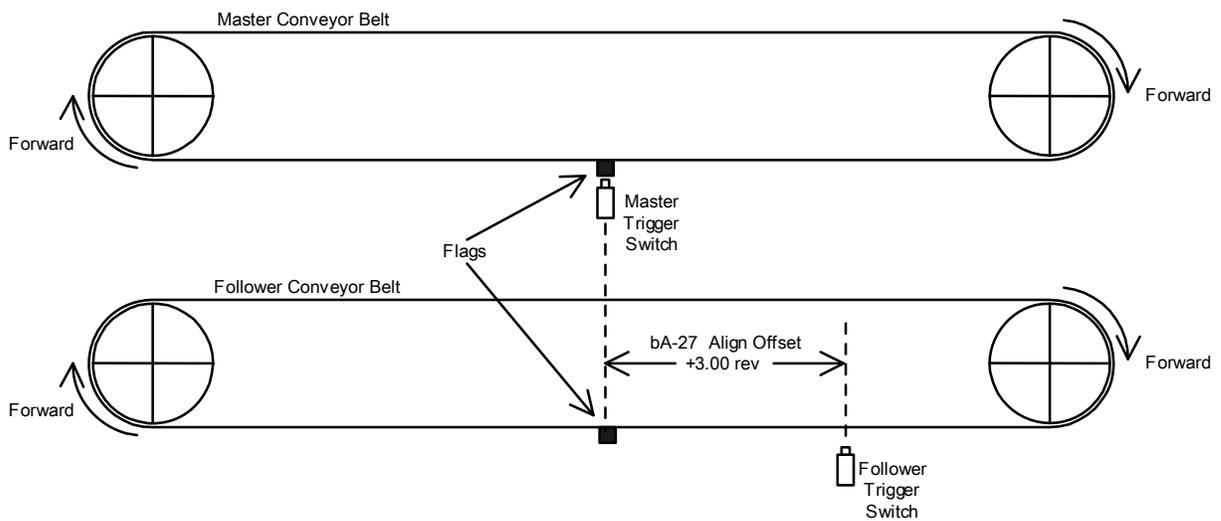


Figure 4.16 Two Aligned Conveyor Belts with Different Trigger Switch Positions Corrected with bA-27

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## Revision History

Date of Publication	Revision Number	Software Number	Revised Content
November 2020	-	VSAA10020	First release.



# GA800 AC Drive

## Electronic Line Shaft with Alignment

### Custom Software Supplement

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