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YASKAWA

Motion Control
G7 Drive Software
Technical Manual



Software Number: VSG13306X, Drive Models: CIMR-G7UXXXXX-117
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This document is intended to provide proper installation and use of the Yaskawa drive with custom software. This document is a supplement to the standard drive technical manual. It describes the effects on the drive parameters and functions with the software installed. Read and understand this document and the standard drive technical manuals before attempting to install, adjust, operate, inspect or maintain the drive. ***Observe all cautions and warnings in this document and the standard drive technical manuals.*** *Custom software is written to add 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. Custom software can add new functions, modify standard functions, or even inhibit standard functions. It can be used to modify display text or parameter names. Custom software is usually loaded to the drive before delivery. The control board and drive nameplate are assigned unique part numbers and the software is registered, archived, and retrievable.*

When seeking support for a drive with custom software, it is imperative to provide the unique part number shown on the drive nameplate. The software has been flashed to the control board memory and the operation of parameters, functions, and monitors is different from the standard drive software, as described herein.

1.0 Overview

The drive becomes a simple position regulator. The software does this by internally taking control of the drive's frequency reference. All time-critical calculations are completed in a scan that is 2.5 ms or faster.

This software gives the G7 simple position control capability.

- Linear Absolute Motion
- Rotary Absolute Motion
- Relative Motion w/o Memory
- Relative Motion with Memory
- All position commands and position feedback monitors are displayed in engineering units. A parameter selects from the following list of engineering units: "inches," "feet," "centimeters," "meters," "degrees," "revolutions," or none.
- Position command via modbus registers.
- Absolute Incremental Encoder Support "TR ISI style Absolute Encoder"
- Momentary or Maintained Move Command
- Several different homing sequences to choose from.
- Serial Communications Compatible
- Incremental Encoder
- Dual Incremental Encoders
- Absolute Gray-Code Encoder Support (18 bit)
- 16 Preset Positions Plus Home
- Distance Command via High-speed Frequency Reference Register (in engineering units)
- "Pre-Activation" Digital Output (settable in engineering units)
- Ability to monitor and command a 32 bit (31 bits + sign) bi-polar position over network communication.
- An additional "Distance Select" selection is added, which when selected, re-purposes two existing Modbus registers to be combined into one 32 bit (31 bits + sign) position register.
- Two read-only 16 bit Modbus registers are added to monitor position with offset (distance from home) in encoder quadrature counts, for a total of 32 bits (31 bits + sign).
- A read-only 16 bit Modbus motion control status register is added sequentially after the 32 bit position registers so that the position and the status of the drive can be read with one Modbus "Read Multiple" command.

2.0 Changes from Standard Product

- Due to parameter limitations, the “User” access level and all of the associated “A2” parameters are deleted.
- 3-Wire control is not allowed when the motion software is enabled.
- Parameter b1-01 (Reference Source) is only effective when motion control is disabled (P1-01 = 0). When motion control is enabled, parameter b1-01 is ignored, and the frequency reference originates from the motion control routine.
- Parameters d2-02 and d2-03 are disabled, which fixes the minimum output speed at 0%.
- Accel and Decel ramp switching via multifunction digital input or via speed sensing is disabled when a move is in progress. Accel and Decel ramp switch is controlled by the motion software during a move.
- Encoder direction selection F1-05 is not available when encoder type is “Serial Abs Ch1” (P3-01 = 3).
- PG Channel 2 parameters F1-21 and F1-22 have no effect when motion control is enabled.
- All 230V units will have a default carrier frequency of 2.0 kHz. The maximum carrier frequency setting on models G7U2075 and smaller is limited to 4.0 kHz.

3.0 Limitations

- The Motion Control algorithm is only available when the drive is in the Flux Vector control method (A1-02 = 3).
- The distance from home cannot exceed 10^9 encoder counts.
- The 32 bit position monitor registers should be read using a “Read Multiple” Modbus command (03h) to ensure that the data from high and low words are read together for an accurate reporting of position.
- Using the 32 bit position command, the drive can now operate in a position beyond what the digital operator can display.
- The drive must be re-homed after a PG Open (PGo) fault occurs.

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4.0 Related Parameters and Functions

Function P1 – Motion Setup

Function P2 – Homing Setup

Function P3 – Advanced Motion Setup

Function P4 – Preset Position Setup

4.1 Parameters

Parameter Number	Modbus Address	Parameter Name ***Digital Operator Display***	Description	Range	Default	Change During Run	Control Mode				
							V/f	V/f w/ PG	O.L.V.	Flux Vector	O.L.V. 2
P1-01	600h	Motion Type ***Motion Type***	0: Disabled 1: Linear Absolute 2: Rotary Absolute 3: Relative Mem Off 4: Relative Mem On	0 ~ 4	0	N	-	-	-	A	-
P1-02	601h	Distance Select ***Distance Select***	0: Preset P4-XX 1: Modbus (061Ch and 061Dh) (1) 2: Hi-Speed Option Card Frequency Reference Register (2) A multifunction input selection of "Distance Select" will override this parameter. 3: Modbus 32-Bit (061Ch and 061Dh) (3)	0 ~ 3	0	N	-	-	-	A	-
P1-03	602h	Move Command Type ***Move Cmd. Type***	0: Maintained – Move command must be maintained for the entire move. 1: Rising Edge – Move command is edge-triggered. 2: Falling Edge – Move command is edge-triggered.	0 ~ 2	0	N	-	-	-	A	-
P1-04	603h	Positioning Proportional Gain ***Pos P Gain***	Proportional gain used for the position controller.	1.0 ~ 20.0	1.0	Y	-	-	-	A	-
P1-05	604h	Decel Start Compensation Distance ***Decel Comp Dist***	Starts the deceleration ramp early. Increase if there is overshoot, decrease if there is undershoot.	0 ~ 65535 cts	0	Y	-	-	-	A	-
P1-06	605h	Positioning Speed Compensation ***Pos Spd Comp***	Provides fine adjustment for the automatically calculated positioning speed.	10.0 ~ 200.0 %	100.0	Y	-	-	-	A	-
P1-07	606h	Triangle Move Compensation ***Trig Mov Comp***	Determines response for a triangular move. Increase if overshooting, decrease if undershooting when performing a "Triangle" move instead of a "Trapezoid" move.	0.0 – 10.0	1.0	Y	-	-	-	A	-

4.1 Parameters (Continued)

Parameter Number	Modbus Address	Parameter Name ***Digital Operator Display***	Description	Range	Default	Change During Run	Control Mode				
							V/f	V/f w/ PG	O.L.V.	Flux Vector	O.L.V. 2
P1-08	607h	In Position Window ***In Posit. Window***	Controls when the "Move Complete" digital output turns on. Also determines when another edge-triggered move will be accepted.	0 ~ 65,535 cts	200.0	Y	-	-	-	A	-
P1-09	608h	Counts Per Unit ***Counts Per Unit***	This parameter is multiplied by the distance command, in order to determine move length in counts.	1 ~ 65,535 cts	4096	N	-	-	-	A	-
P1-10	609h	Distance Display Units ***Distance Units***	0: none 1: in (inches) 2: ft (feet) 3: cm (centimeters) 4: m (meters) 5: ^{o} (degrees) 6: rev (revolutions)	0 ~ 6	0	N	-	-	-	A	-
P2-01	60Ah	Homing Type ***Homing Type***(5)	0: Home Negative 1: Home Neg with Backup 2: Home Positive 3: Home Pos with Backup 4: Negative with Marker Pulse 5: Positive with Marker Pulse 6: Manual	0 ~ 6	1	N	-	-	-	A	-
P2-02	60Bh	Homing Speed ***Homing Speed***	Speed reference used during course homing.	0.0 ~ 400.0 Hz	10.0	Y	-	-	-	A	-
P2-03	60Ch	Homing Back-Up Speed ***Homing BU Speed***	Speed reference used during the back-up portion of the homing routine.	0.00 ~ 20.00 Hz	2.00	Y	-	-	-	A	-
P2-04	60Dh	Homing Final Speed ***Homing Final Spd***	Speed referenced used during the final portion of the homing routine.	0.00 ~ 20.00 Hz	1.00	Y	-	-	-	A	-
P2-05	60Eh	Switch Type ***Switch Type***	Sets the normal (not activated) state of the home and over-travel limit switches. 0: Both NO 1: OT NO Home NC 2: OT NC Home NO 3: Both NC	0 ~ 3	0	N	-	-	-	A	-
P2-06	60Fh	Home Offset Distance ***Home Offset Dist***	Distance from the home limit switch that is considered home.	-99.99 ~ 99.99 Units (4)	0.00	N	-	-	-	A	-
P2-08	611h	Pre-Action Distance ***Pre Act Dist***	During a move, when the machine is this distance from the destination, a digital output (H2-0X = 46) will activate until the "In Position" window is reached.	0.00 ~ 500.00 Units (4)	0.00	Y	-	-	-	A	-
P3-01	614h	Position Encoder Source ***Encoder Source***	0: PG-X2, PG-B2, or PG-W2 Channel 1 1: PG-W2 Channel 2 2: Absolute Gray Code (connected via DI-16H2) 3: TR Encoder Channel 1 4: TR Encoder Channel 2	0 ~ 4	0	N	-	-	-	A	-

4.1 Parameters (Continued)

Parameter Number	Modbus Address	Parameter Name ***Digital Operator Display***	Description	Range	Default	Change During Run	Control Mode				
							V/f	V/f w/ PG	O.L.V.	Flux Vector	O.L.V. 2
P3-02	615h	Positioning Encoder Pulses Per Revolution ***Second Encoder PPR***	Encoder pulses per revolution when P3-01 = 1, encoder counts per revolution when P1-01 = 2.	60 ~ 10,000 PPR	1024	N	-	-	-	A	-
P3-03	616h	Positioning Encoder Numerator ***Second Encoder NUM***	Machine mounted encoder ratio numerator. Used in conjunction with P3-04. Effective only when a second machine-mounted encoder is used.	1 ~ 65,535	1	N	-	-	-	A	-
P3-04	617h	Positioning Encoder Denominator ***Second Encoder DEN***	Machine mounted encoder ratio denominator. Used in conjunction with P3-03. Effective only when a second machine-mounted encoder is used.	1 ~ 65,535	1	N	-	-	-	A	-
P3-07 (6)	61Ah	Length Of One Rotation (Encoder Revolutions) ***Len 1 Rotate REV***	Sets the distance of one complete revolution of the rotary machine. Effective only when P1-01 = 2. One Rotation (counts) = (P3-07 * F1-01* 4) + P3-08	0 ~ 9999 Rev	0	N	-	-	-	A	-
P3-08 (6)	61Bh	Length Of One Rotation (Encoder Counts) ***Len 1 Rotate CTS***	Sets the distance of one complete revolution of the rotary machine. Effective only when P1-01 = 2. One Rotation (counts) = (P3-07 * F1-01* 4) + P3-08	0 ~ 40,000 cts	0	N	-	-	-	A	-
P4-01	106h	Position 1 ***Position 1***	Position Reference in units. Position Ref. (counts) = P4-01 * P1-09.	0.00 – 655.35 Units (4)	0.00	Y	-	-	-	A	-
P4-02	107h	Position 2 ***Position 2***	Position Reference in units. Position Ref. (counts) = P4-02 * P1-09.	0.00 – 655.35 Units(4)	0.00	Y	-	-	-	A	-
P4-03	108h	Position 3 ***Position 3***	Position Reference in units. Position Ref. (counts) = P4-03 * P1-09.	0.00 – 655.35 Units (4)	0.00	Y	-	-	-	A	-
P4-04	109h	Position 4 ***Position 4***	Position Reference in units. Position Ref. (counts) = P4-04 * P1-09.	0.00 – 655.35 Units (4)	0.00	Y	-	-	-	A	-
P4-05	10Ah	Position 5 ***Position 5***	Position Reference in units. Position Ref. (counts) = P4-05 * P1-09.	0.00 – 655.35 Units (4)	0.00	Y	-	-	-	A	-
P4-06	10Bh	Position 6 ***Position 6***	Position Reference in units. Position Ref. (counts) = P4-06 * P1-09.	0.00 – 655.35 Units (4)	0.00	Y	-	-	-	A	-
P4-07	10Ch	Position 7 ***Position 7***	Position Reference in units. Position Ref. (counts) = P4-07 * P1-09.	0.00 – 655.35 Units (4)	0.00	Y	-	-	-	A	-
P4-08	10Dh	Position 8 ***Position 8***	Position Reference in units. Position Ref. (counts) = P4-08 * P1-09.	0.00 – 655.35 Units (4)	0.00	Y	-	-	-	A	-
P4-09	10Eh	Position 9 ***Position 9***	Position Reference in units. Position Ref. (counts) = P4-09 * P1-09.	0.00 – 655.35 Units (4)	0.00	Y	-	-	-	A	-

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4.1 Parameters (Continued)

Parameter Number	Modbus Address	Parameter Name ***Digital Operator Display***	Description	Range	Default	Change During Run	Control Mode				
							V/f	V/f w/ PG	O.L.V.	Flux Vector	O.L.V. 2
P4-10	10Fh	Position 10 ***Position 10***	Position Reference in units. Position Ref. (counts) = P4-10 * P1-09.	0.00 – 655.35 Units (4)	0.00	Y	-	-	-	A	-
P4-11	110h	Position 11 ***Position 11***	Position Reference in units. Position Ref. (counts) = P4-11 * P1-09.	0.00 – 655.35 Units (4)	0.00	Y	-	-	-	A	-
P4-12	111h	Position 12 ***Position 12***	Position Reference in units. Position Ref. (counts) = P4-12 * P1-09.	0.00 – 655.35 Units (4)	0.00	Y	-	-	-	A	-
P4-13	112h	Position 13 ***Position 13***	Position Reference in units. Position Ref. (counts) = P4-13 * P1-09.	0.00 – 655.35 Units (4)	0.00	Y	-	-	-	A	-
P4-14	113h	Position 14 ***Position 14***	Position Reference in units. Position Ref. (counts) = P4-14 * P1-09.	0.00 – 655.35 Units (4)	0.00	Y	-	-	-	A	-
P4-15	114h	Position 15 ***Position 15***	Position Reference in units. Position Ref. (counts) = P4-15 * P1-09.	0.00 – 655.35 Units (4)	0.00	Y	-	-	-	A	-
P4-16	115h	Position 16 ***Position 16***	Position Reference in units. Position Ref. (counts) = P4-16 * P1-09.	0.00 – 655.35 Units (4)	0.00	Y	-	-	-	A	-

(1) When P1-02 = 1, the actual commanded destination is calculated as follows:
Destination = modbus register 61CH * P1-09 / 100

(2) Actual destination (in encoder quadrature counts) is calculated as follows:

$$\textit{Destination} = \frac{\textit{Frequency Reference (Hi-speed register)}}{\textit{100}} \times \textit{P1 - 09}$$

(3) When P1-02 = 3, the actual commanded destination is the combined value of Modbus registers 61Ch (low word) and 61Dh (high word). Parameter P1-09 has no effect as this is strictly a command in encoder quadrature counts. Speed for this profile is set by d1-01, the acceleration time is set by C1-01, and the deceleration time is set by C1-02.

(4) The units text displayed in the digital operator is determined by parameter P1-10. Actual destination in encoder counts is calculated by multiplying the preset position reference by P1-09.

(5) When parameter P3-01 = 3 or 4 (encoder type = TR Encoder), the Homing Type (P2-01) parameter has no effect. Instead, when a home command is issued, the drive is base-blocked and then the position is read from the encoder via channel 2 on the PG-W2 option board. This will only happen if the drive does not have a run command.

(6) If P3-01 = 1, then parameter P3-02 is used in place of parameter F1-01 when determining actual distance.

4.2 Modified Existing Parameters

Parameter Number	Modbus Address	Parameter Name	Description	Range	Default	Change During Run	Control Mode				
							V/f	V/f w/ PG	O.L.V.	Flux Vector	O.L.V. 2
C1-01 ~ C1-08	200h ~ 207h	Accel Time 1 ~ Decel Time 8	Acceleration and Deceleration Times	0.0 ~ 6000.0 Sec.	**2.0**	Y	-	-	-	A	-
C2-01 ~ C2-03	20bh ~ 20dh	S-Crv @ Acc Start S-Crv @ Acc End S-Crv @ Dec Start	S-curve Times	0.00 ~ 2.50 Sec.	**0.00**	N	-	-	-	A	-
d1-09 ~ d1-16	280h ~ 291h	Frequency Ref. 9 ~ Frequency Ref. 16	Digital Preset Speeds	0.00 ~ 400.00 Hz	**6.09 ~ 6.16**	Y	-	-	-	A	-
L3-04	492h	Stall Prevention During Decel	0: Disabled 1: General Purpose 2: Intelligent	0 ~ 2	**0**	N	-	-	-	A	-

Note: Stall prevention during decel increases the deceleration distance even when the bus voltage remains at the nominal level. For this reason, it is important to leave L3-04 set to "Disabled" (0).

4.3 Modbus Registers

Modbus Address	Description	Scaling
061Ch	Modbus Communication Speed Reference during a Move. Effective only when P1-02 = 2.	0.01 Hz 100 = 1.00 Hz
061Dh	Modbus Communication Position Reference (Engineering Units) Actual position reference in encoder counts = 61Dh * P1-09. Range is: 0.00 ~ 655.35 units. Effective only when P1-02 = 2.	0.01 Units 100 = 1.00 Units
061Ch	Modbus 32-bit Communication Position Reference (low word). Effective only when P1-02 = 3.	Quadrature Encoder Counts
061Dh	Modbus 32-bit Communication Position Reference (high word). Effective only when P1-02 = 3.	
0734h	32 Bit Distance From Home (low word) Distance from home (+ home offset) for absolute applications, or distance from start of previous move for relative applications. Read only.	Quadrature Encoder Counts
0735h	32 Bit Distance From Home (high word) Distance from home (+ home offset) for absolute applications, or distance from start of previous move for relative applications. Read only.	
0736h	Motion Control Modbus Status Register Bits 0 ~ 5 are a copy of the information in monitor U1-11. Bits 6 ~ C behave the same as the motion control digital outputs (H2-0X = 40 ~ 46). Read only. Bit 0: Digital Output Status – M1-M2 Bit 1: Digital Output Status – M3-M4 Bit 2: Digital Output Status – M5-M6 Bit 3: Digital Output Status – P3-C3 Bit 4: Digital Output Status – P4-C4 Bit 5: Not Used Bit 6: Not Used Bit 7: Digital Output Status – MA-MB-MC (fault) Bit 8: Move In Progress Bit 9: Move Complete Bit A: Homing Complete Bit B: Homing Needed Bit C: At Home Bit D: Learn Successful Bit E: Pre-Action Output Bit F: Not Used	(N/A)

Note: The ENTER command is not required when writing to these registers.

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4.4 Monitors

Parameter Number	Modbus Address	Parameter Name ***Digital Operator Display***	Description	Analog Monitor Scaling	Units	Control Mode				
						V/f	V/f w/ PG	O.L.V.	Flux Vector	O.L.V. 2
U1-90	720h	Distance From Home (Fine) ***Dist From Home f***	Distance from home (+ home offset) for absolute applications, or distance from start of previous move for relative applications. Displayed with fine resolution (0.01 units).	N/A	0.01 Units (7)	-	-	-	A	-
U1-91	721h	Distance To Go (Fine) ***Dist To Go f***	Distance from the destination. Displayed with fine resolution (0.01 units).	N/A	0.01 Units (7)	-	-	-	A	-
U1-92	722h	Commanded Destination (Fine) ***Commanded Dest f***	Commanded destination. Displayed with fine resolution (0.01 units).	N/A	0.01 Units (7)	-	-	-	A	-
U1-93	723h	Distance From Home (Coarse) ***Dist From Home c***	Distance from home (+ home offset) for absolute applications, or distance from start of previous move for relative applications. Displayed with coarse resolution (1 unit).	N/A	1 Unit (8)	-	-	-	A	-
U1-94	724h	Distance To Go (Coarse) ***Dist To Go c***	Distance from the destination. Displayed with coarse resolution (1 unit).	N/A	1 Unit (8)	-	-	-	A	-
U1-95	725h	Commanded Destination (Coarse) ***Commanded Dest c***	Commanded destination. Displayed with coarse resolution (1 unit).	N/A	1 Unit (8)	-	-	-	A	-
U1-96	726h	Commanded Speed Reference ***Cmd Speed Ref***	Commanded speed for the selected destination.	N/A	0.01 Hz	-	-	-	A	-
U1-97	727h	Raw Gray Code Encoder Position ***Raw Gray Pos.***	Position of the gray code absolute encoder in “tens” of counts.	N/A	1 dct (deka-count)	-	-	-	A	-
U1-99	729h	TR Absolute Incremental Encoder Position Request. ***Ser Enc Pos Req***	TR Absolute Incremental Encoder Position Request. Used by the drive to request absolute position information from the encoder. (Analog output only, no display)	10V = Request Position	-	-	-	-	-	-

(7) The actual units text displayed in the digital operator is determined by parameter P1-10. Actual distance in encoder counts is calculated by multiplying the monitor output by P1-09. If the monitor is in excess of 327.67 units, the display will be clamped at 327.67 units. If the monitor is less than -99.99 units, the display will be clamped at -99.99 units.

(8) The actual units text displayed in the digital operator is determined by parameter P1-10. Actual distance in encoder counts is calculated by multiplying the monitor output by P1-09. If the monitor is in excess of 32,767 units, the display will be clamped at 32,767 units. If the monitor is less than -9999 units, the display will be clamped at -9999 units.

4.5 Multifunction Digital Input Settings (H1-XX)

Setting	Description
80	Move – Move to commanded position. (For absolute rotary motion (P1-01 = 2), direction will always be forward.)
81	Move (Invert) – Move to commanded position * (-1). (For absolute rotary motion (P1-01 = 2), direction will always be reverse.)
82	Home Command – Starts the homing sequence, must be maintained until “Home Complete” output comes on.
83	Home Switch – Indicates a “Home” or fixed position of the machine. Also used to indicate “Home” when using the “Manual” homing routine (P2-01 = 6).
84 (9)	Positive Over-travel Limit Switch – Drive will ramp to zero speed and display “POSOT - Pos Ovr Travel.” Drive can be jogged but no moves can be commanded. Re-homing is required (if applicable).
85 (9)	Negative Over-travel Limit Switch – Drive will ramp to zero speed and display “NEGOT - Neg Ovr Travel.” Drive can be jogged but no moves can be commanded. Re-homing is required (if applicable).
86	Learn Position – Allows the storage of the current position. Must be maintained for 1 second.
87	Distance Select A – Used to select the commanded distance / move profile.
88	Distance Select B – Used to select the commanded distance / move profile.
89	Distance Select C – Used to select the commanded distance / move profile.
8A	Distance Select D – Used to select the commanded distance / move profile.
8B	Disable Motion Control NOTE: All position information is cleared, requiring another homing routine once re-enabled.

(9) When using either of the over-travel switches/inputs, it is STRONGLY recommended that the switch be maintained beyond the trigger point of the switch, all the way to the end of the mechanical limit. If this cannot be accomplished, an External Fault input is a better choice. If either of the over-travel inputs is used, it is recommended that additional digital inputs be programmed to Jog Fwd or Jog Rev in order to jog the machine back out of the over-travel condition.

Note: See Section 2 of the G7 technical manual for a complete description of how to interface with the digital input terminals. Be aware of different types of proximity switches (sinking or sourcing).

4.6 Multifunction Digital Output Settings (H2-XX)

Setting	Description
40	Move In Progress - Closed: Drive is completing the specified move profile. Deactivates at the end of a move when machine is within the specified “in position” window AND the motor speed is below the DC Injection at start frequency (B2-01).
41	Move Complete - Closed: Move routine is complete and is within the specified “in position” window AND motor speed is below the DC Injection start frequency. Deactivates when the move command is removed. If a momentary move command is utilized (P1-03 = 1 or 2), this output deactivates when another “move” command is given.
42	Homing Complete - Closed: A homing routine has been completed. Drive knows its position relative to the home switch, and has moved to the home + home offset position (P2-06).
43	Homing Needed – Closed: A successful homing routine has NOT been completed.
44	At Home – Closed: The drive is within +/- the “in position” of home (home + home offset).
45	Learn Successful – Closes when the drive has successfully learned the present position. Opens when the learn command is removed.
46	Pre-Action – Closes when distance from commanded destination is less than parameter P2-08. Opens when distance from commanded destination is less than P1-08.

4.7 Multifunction Analog Input Settings (H3-05/H3-09)

Setting	Description ***Digital Operator Display***
20	Absolute Incremental Encoder Drive Disable. Used by the absolute incremental encoder to disable the drive when transferring position information. ***Ser Enc Drv Dis***

4.8 Faults

Fault Display	Description	Cause	Countermeasures
OPE03 ***Terminal***	Multifunction Input Selection Error (10)	Motion control is enabled (P1-01 > 0) AND 3-wire control is enabled. (One of the H1 parameters is set to "0 – 3-Wire Control."	Disable the motion control by setting P1-01 = 0, or reprogram the H1 parameter that is set to "0."
		Motion control is enabled (P1-01 > 0) AND Motor 2 Select is programmed into an H1 parameter.	Disable the motion control by setting P1-01 = 0, or reprogram the H1 parameter that is set to "16."
OPE05 ***Sequence Select***	Option Card Selection Error	Distance Select is programmed for Option Card Fref (P1-02 = 2) and no communications option is installed at connector 2CN.	Re-program parameter P1-02 or install communications option board.
OPE12 ***Motion Ctrl Stup***	Motion control setup error	Absolute Encoder is selected (P3-01 = 2) and motion type is not "Linear Absolute" (P1-01 $\geq$ 2).	Adjust motion type or encoder type.
		Absolute Encoder is selected (P3-01 = 2) and a DI-16H2 option board is not installed.	Adjust motion type or encoder type, or install a DI-16H2 option board.
		The numerator (P3-03) is set more than 100 times greater than the denominator (P3-04).	Adjust the numerator and the denominator.
		Encoder type is set to "Serial Abs Ch1" and encoder rotation is set to CW. (P3-01 = 3 and F1-05 = 1)	Adjust parameter F1-05 back to zero and change PG Ch.1 feedback wiring.
2ENFL ***Second Enc. Fault***	There is a problem with the encoder connected to either the second channel of the PG-W2 (Terminals 10 – 15) or with the absolute encoder connected to the DI-16H2.	Incremental encoder connected to the second channel of the PG-W2 (Terminals 10 – 15) has opposite rotation from the motor encoder.	Switch the polarity of the incremental encoder connected to the second channel by swapping terminals 10 and 11 on the PG-W2 card.
		Absolute encoder has either "rolled over" and no longer contains valid position data, or has opposite rotation from the motor encoder.	Mechanically reset the absolute encoder, or force the encoder to count in the opposite direction.
POSOF ***Position Ovrflow***	The internal register that tracks position has exceeded its limits during a motion-control move.	The distance from home (or home + home offset) has exceeded 10^9 encoder counts.	Re-home and verify position of moving equipment.
SENCF ***Ser Enc Fault***	Absolute Incremental Encoder Fault	The drive did not receive valid data / control signals from the absolute incremental encoder within 35 seconds after power up or home command.	Check encoder and wiring. Check that an analog input and output are programmed and wired properly for a absolute incremental encoder.

(10) An OPE03 error can be caused by many other conditions as well. These conditions are listed in Section 7 of the G7 technical manual (TM.G7.01).

4.9 Alarms

Alarm Display	Description	Cause	Countermeasures
RHS ***Run Homing Seq***	Run homing sequence	A move or learn command was given before the drive has been homed. This will only occur when P1-01 = 1 or 2.	Perform a homing routine.
POSOT ***Pos Ovr Travel***	Positive Over-travel	The machine has moved past the positive over-travel switch.	Drive can be moved out of positive over-travel using the “Jog Reverse” input.
NEGOT ***Neg Ovr Travel***	Negative Over-travel	The machine has moved past the negative over-travel switch.	Drive can be moved out of negative over-travel using the “Jog Forward” input.
SENCR ***Serial Encoder Reading***	The drive is receiving position information from the absolute incremental encoder. All run commands are ignored during this time.	Absolute incremental encoder is reporting its position by bringing a multifunction input (A2 or A3) above 9V.	Wait for the absolute incremental encoder to finish homing (35 sec. max), or troubleshoot analog input wiring.

5.0 Function Descriptions

5.1 Types of Motion:

LINEAR ABSOLUTE MOTION: Linear absolute motion is used in applications such as: ball screws, linear slides, and transfer stations. With this type of motion, a home switch and a homing sequence or an absolute encoder are required. All position references are with relation to the actual home position + home offset.

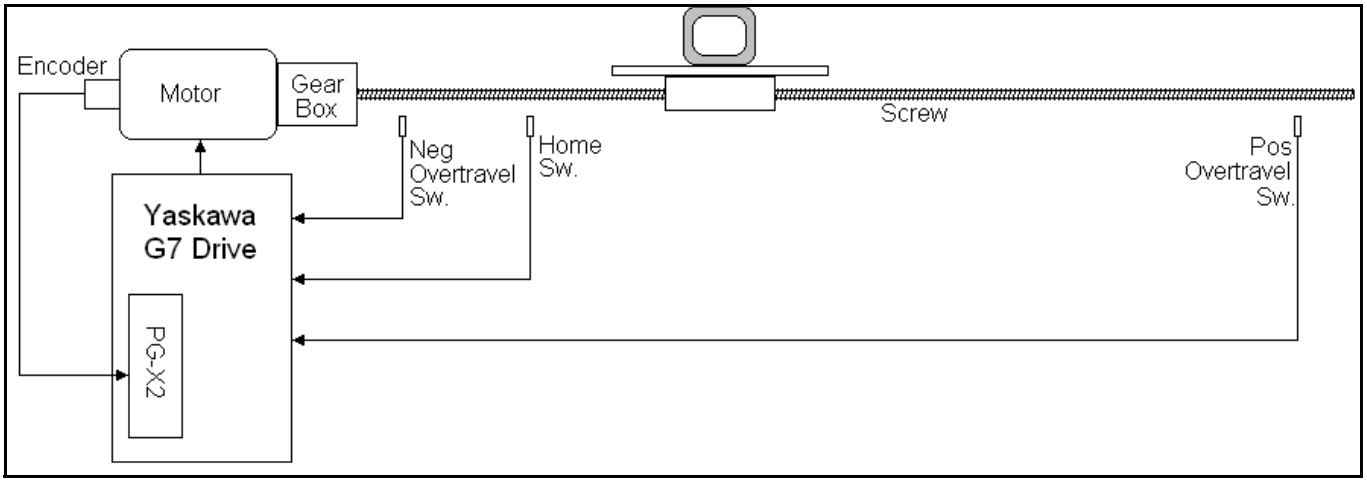


Figure 1: Linear Absolute Motion Example – Ball Screw

ROTARY ABSOLUTE MOTION: Rotary absolute motion would be used in applications such as: index turntables, turret winders and dial tables. With this type of motion, a home switch and a homing sequence are required. All position references are with relation to the actual home position + home offset.

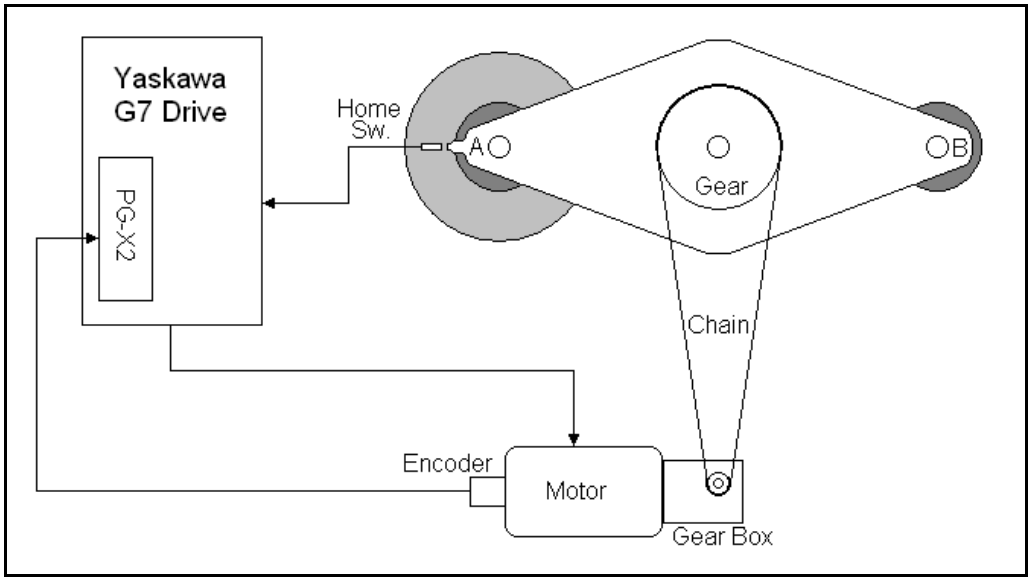


Figure 2: Rotary Absolute Motion Example – Turret Winder

RELATIVE MOTION: Relative motion is used in applications such as cut-to-length and metering pumps. This type of motion can be used with or without a homing sequence. When the motion type is “Relative Mem Off” (P1-01 = 3), the move distance is measured from the position at the time of the move command. When the motion type is “Relative Mem On” (P1-01 = 4), the distance is measured from the destination of the previous move. If a conveyor with pockets or “flights” is being indexed, “Relative Mem On” is the appropriate motion type.

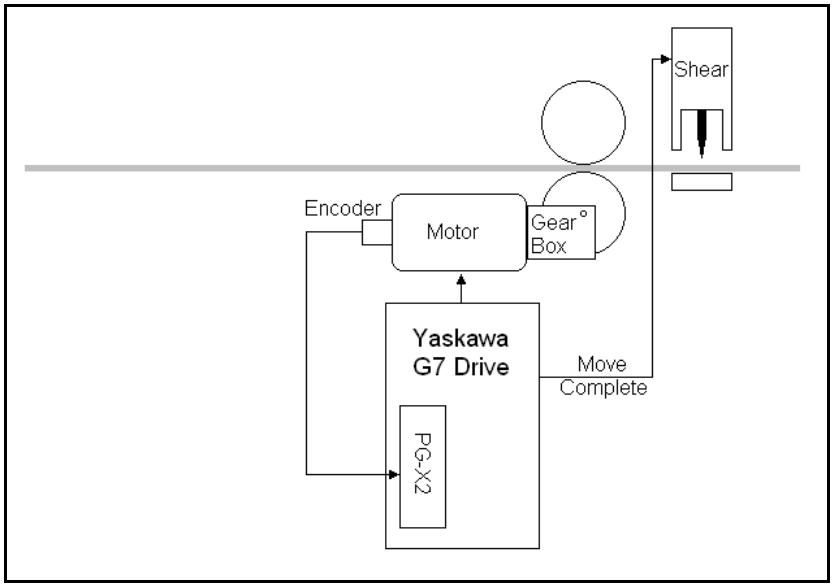


Figure 3: Relative Motion Example – Cut To Length

5.2 Commanded Position:

DIGITAL PRESET: Up to 16 different digital preset positions can be programmed. Each position is set in user selectable units, set up by parameters P1-09 and P1-10. Distance in encoder counts can be calculated by multiplying the digital preset value by parameter P1-09 (counts per rev). Encoder counts refer to the counts after quadrature. The counts after quadrature are four times that of the “Pulses Per Revolution” rating of all compatible encoders except the absolute gray code type. For the gray code type, encoder counts are NOT multiplied by 4. Move velocity is determined by a different parameter for each digital preset position. Accel and Decel rates will be one of 4 different sets as shown in Table 1 on the next page.

MODBUS DISTANCE: One 16 bit modbus register is used to command a speed during a move, and one 16 bit modbus register is used to command a position. Modbus register 061Ch holds the speed reference (in 0.01 Hz), and register 061Dh holds the position reference in engineering units (061Dh * P1-09). These registers can be written by using the drive’s built-in modbus communications, or by other optional protocols such as DeviceNet, Ethernet, Profibus or Modbus Plus. Accel and Decel rates are determined by parameters C1-01 and C1-02.

HIGH SPEED OPTION CARD REGISTER (Frequency Reference): In this mode, the option card’s frequency reference is redefined and used as the commanded distance. The commanded position originates from the “Frequency Reference” channel of the option card. The position reference is scaled as follows: Commanded Position (in encoder counts) = Frequency Reference * P1-09. Move velocity is determined by parameter d1-09 and Accel and Decel rates are determined by parameters C1-01 and C1-02.

For example: If P1-09 = 4096 counts / unit, and the frequency reference over the option PCB is 15.00 Hz, the result is a move that is exactly 61,440 encoder counts (4096 * 15.00 = 61,440). When motion control is disabled, the high-speed frequency reference channel returns to normal operation as an actual frequency reference.

Table 1: Profile Selection Information

Distance Select D [11]	Distance Select C [11]	Distance Select B [11]	Distance Select A [11]	Parameter P1-02 Setting	Position Reference Source	Accel / Decel Parameters	Maximum Speed Used
Open	Open	Open	Open	0	Parameter P4-01	C1-01 and C1-02	d1-09
				1	Modbus Address 061Dh 100 = 1.00 Units [12]		Modbus Addr. 061Ch
				2	High Speed Option PCB (Profibus) Frequency Reference Register [13] [14] (in XXX.XX Units)		d1-09
				3	Modbus Addresses 061Ch (Low Word) 061Dh (High Word)		
Open	Open	Open	Closed	N/A	P4-02	C1-03 and C1-04	d1-10
Open	Open	Closed	Open	N/A	P4-03	C1-05 and C1-06	d1-11
Open	Open	Closed	Closed	N/A	P4-04	C1-07 and C1-08	d1-12
Open	Closed	Open	Open	N/A	P4-05	C1-01 and C1-02	d1-13
Open	Closed	Open	Closed	N/A	P4-06	C1-03 and C1-04	d1-14
Open	Closed	Closed	Open	N/A	P4-07	C1-05 and C1-06	d1-15
Open	Closed	Closed	Closed	N/A	P4-08	C1-07 and C1-08	d1-16
Closed	Open	Open	Open	N/A	P4-09	C1-01 and C1-02	d1-09
Closed	Open	Open	Closed	N/A	P4-10	C1-03 and C1-04	d1-10
Closed	Open	Closed	Open	N/A	P4-11	C1-05 and C1-06	d1-11
Closed	Open	Closed	Closed	N/A	P4-12	C1-07 and C1-08	d1-12
Closed	Closed	Open	Open	N/A	P4-13	C1-01 and C1-02	d1-13
Closed	Closed	Open	Closed	N/A	P4-14	C1-03 and C1-04	d1-14
Closed	Closed	Closed	Open	N/A	P4-15	C1-05 and C1-06	d1-15
Closed	Closed	Closed	Closed	N/A	P4-16	C1-07 and C1-08	d1-16

[11] Programmable using the multifunction digital input parameters H1-01 ~ H1-10.

[12] When P1-02 = 1, the actual commanded destination is calculated as follows:

Destination = modbus register 61CH * P1-09 / 100

[13] Actual destination (in encoder quadrature counts) is calculated as follows when b1-01 = 3:

$$\textbf{\textit{Destination}} = \frac{\textbf{\textit{Frequency Reference (Hi-speed register)}}}{\textbf{\textit{100}}} \times \textbf{\textit{P1 - 10}}$$

[14] When motion control is disabled, the option card frequency reference register returns to its normal function.

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5.3 Encoders:

SINGLE INCREMENTAL ENCODER: The encoder used for positioning is mounted to the motor and serves two purposes. One is to provide velocity feedback for the Flux Vector control method and the other is to provide position information to the motion control software. In order for this to work, there needs to be a “positive drive” setup, such as a direct-coupled gear box or a cogged timing belt between the motor and the load. When this scheme is employed, there is no compensation for backlash or slack in the mechanical system. The drive requires one of the following encoder feedback cards: PG-X2, PG-B2 or PG-W2.

Note: Wiring for the encoder marker pulse (Z+ and Z-) is only required if using a “Homing w/marker” homing routine (P2-01 = 4 or 5).

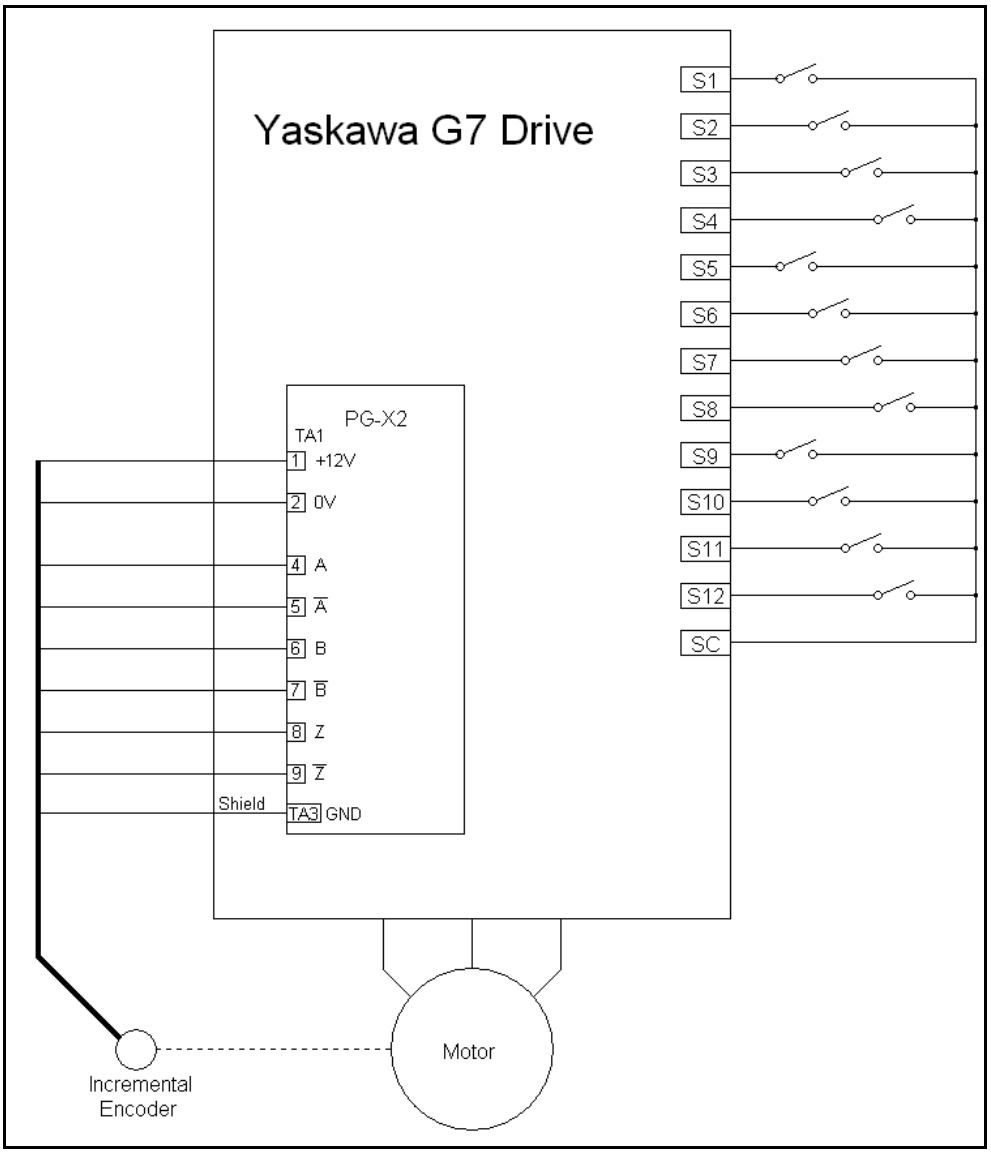


Figure 4: Single Incremental Encoder Wiring (P3-01 = 0)

DUAL INCREMENTAL ENCODERS: The encoder used for positioning is mounted elsewhere on the machine. Using this scheme, the need for a “positive drive” setup is somewhat reduced. A second motor-mounted encoder is required. The ratio between the motor and the machine-mounted encoder must be entered into parameters P3-03 and P3-04, and the PPR of the encoder must be entered into P3-02. The drive requires a PG-W2 encoder feedback card.

Note: Wiring for the encoder marker pulse (Z+ and Z-) is only required if using a “Homing w/marker” homing routine (P2-01 = 4 or 5).

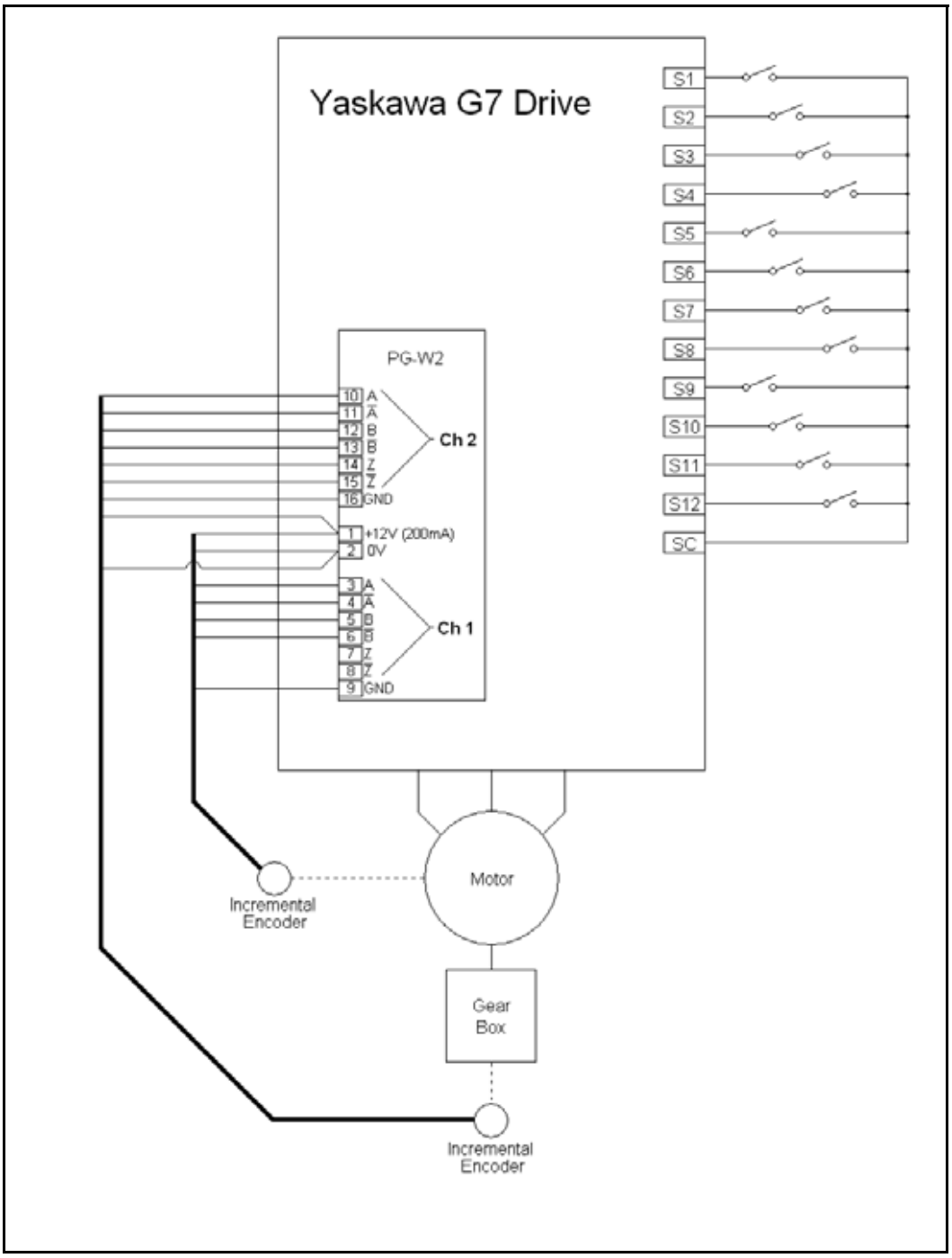


Figure 5: Dual Incremental Encoder Wiring (P3-01 = 1)

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ABSOLUTE (GRAY CODE): The encoder can be either machine-mounted or motor-mounted. The motion type has to be “Linear Absolute” with this style of encoder. If the absolute encoder is machine-mounted, the ratio between the motor and the encoder must be entered into parameters P3-03 and P3-04, and the encoder counts per revolution must be entered into P3-02. The encoder requires a DI-16H2 digital input option card and an external power supply for the encoder. Encoder outputs must be 24VDC and capable of “sinking” current when a logic “low” is present on the output. This software was tested with a Danaher / Dynapar brand 12-bit by 12-bit gray code encoder, part number: ai2512122b121.

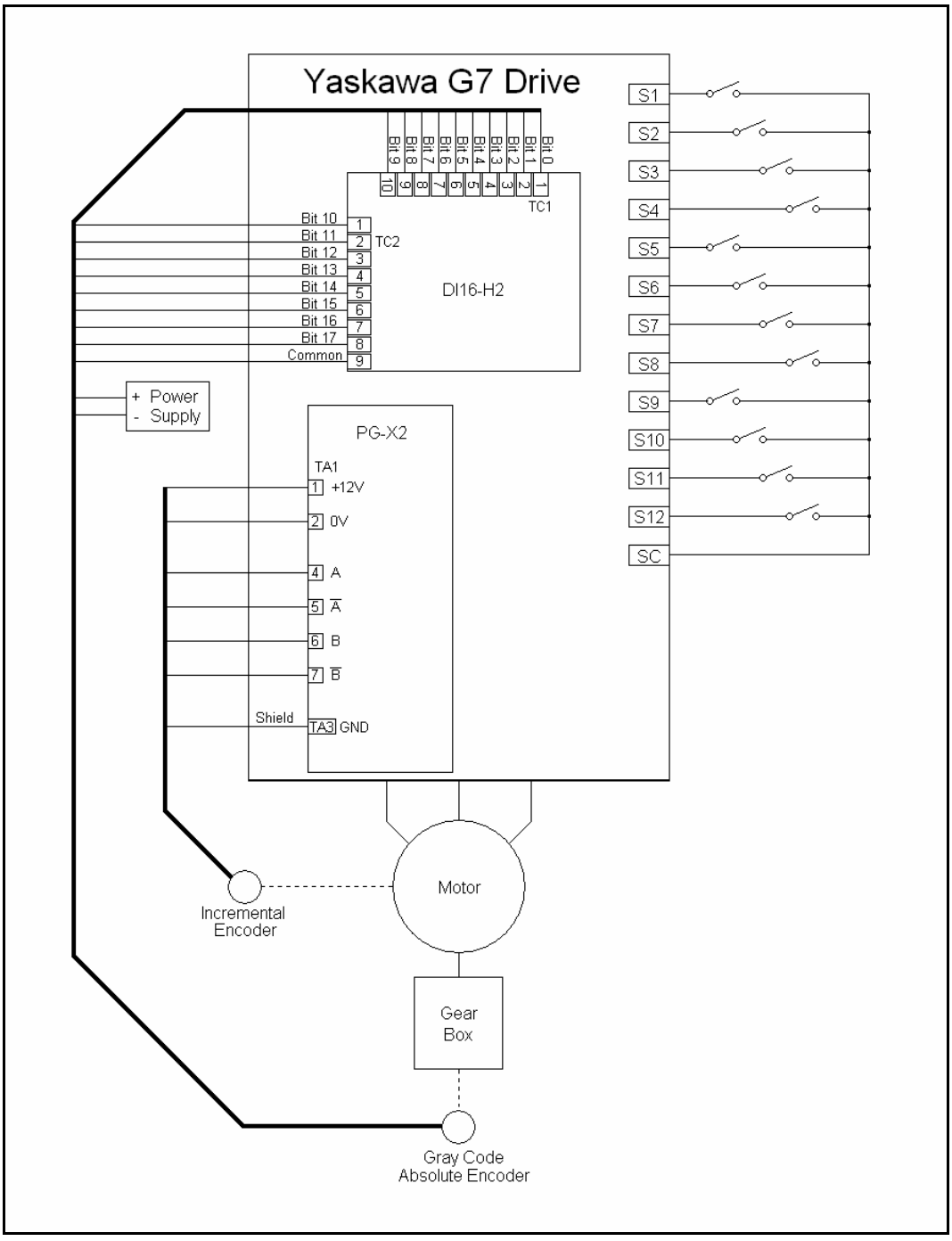


Figure 6: Gray Code Absolute Encoder Wiring (P3-01 = 2)

ABSOLUTE INCREMENTAL ENCODER: For use with a TR-electronic, series “CE-65” serial (ISI) encoder. Upon power-up, the drive must read the actual position of the absolute incremental encoder. This process usually is completed within a few seconds. As an option, the encoder can be monitored and configured directly using a PC, an RS-232 to RS-485 converter, and the TR Electronic EPROGW32 program.

Note: The wiring below is for a “TR Electronic” brand encoder model #: CD65M-G/S-4096/4096-D23BB-R10NR/ N7 4096 counts / rev, +/-2048 revolutions (multi-turn).

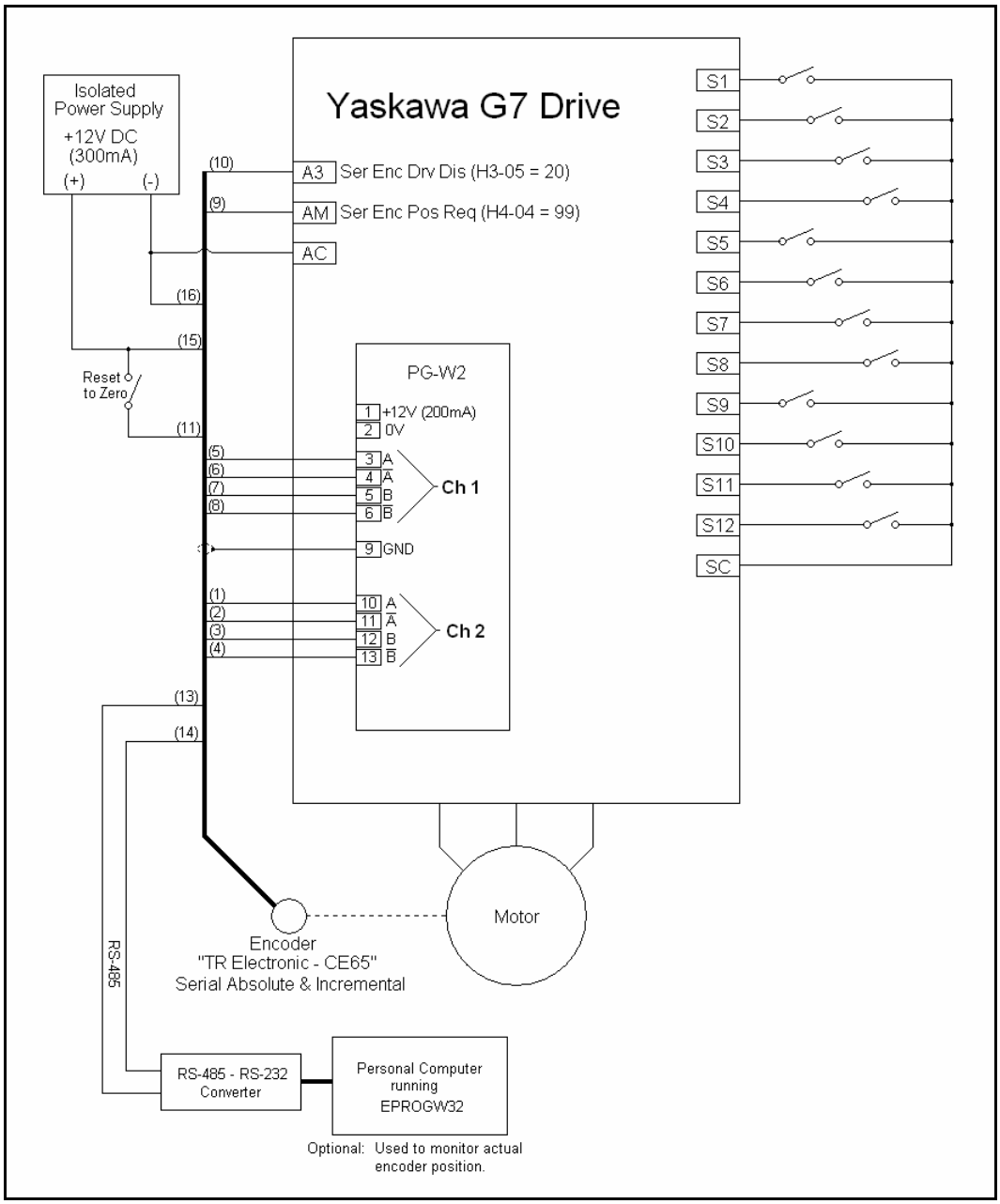


Figure 7a: Absolute Incremental Encoder Wiring (P3-01 = 3)

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ABSOLUTE INCREMENTAL ENCODER W/SEPARATE INCREMENTAL ENCODER: For use with a TR-electronic, series “CE-65” serial (ISI) encoder. Upon power-up, the drive must read the actual position of the serial encoder. This process usually is completed within a few seconds. As an option, the encoder can be monitored and configured directly using a PC, an RS-232 to RS-485 converter, and the TR Electronic EPROGW32 program.

Note: The wiring below is for a “TR Electronic” brand encoder model #: CE65M-G-4096/4096-D23BB-R10HR/HX 4096 counts / rev, +/-2048 revolutions (multi-turn).

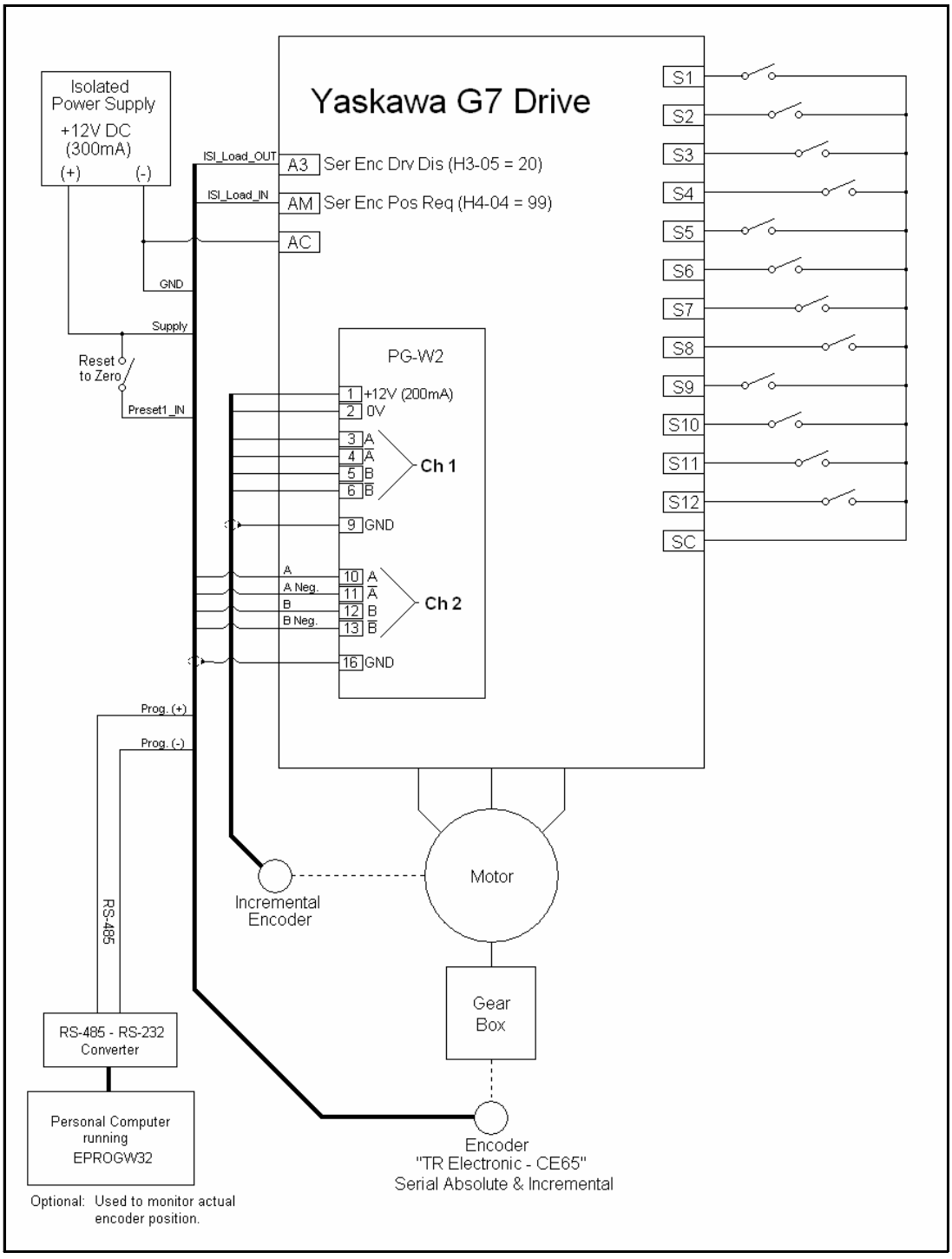


Figure 7b: Absolute Incremental Encoder Wiring – Dual Encoders (P3-01 = 4)

5.4 Motion and Velocity Profile:

COMMANDED POSITION: The commanded position is determined by the multifunction inputs and by the setting of parameter P1-02.

MOVE VELOCITY: The speed of the move is determined by one of the “d1” parameters, as shown in Table 1. The drive will attempt to perform a trapezoidal move. If due to the accel and decel rates, move velocity and commanded position the drive cannot reach the full move velocity, the move will be triangular. If an alternate frequency reference or jog is commanded via multifunction inputs during a move, the drive will run at the new commanded or jog speed until it is no longer activated, at which time the move will be canceled, and the drive will ramp to zero speed. The position is tracked when operating at an alternate commanded frequency reference or in local mode. If the internal register that tracks position (or position + home offset) exceeds 10^9 encoder counts, the drive / machine will need to be re-homed. If motion control is disabled (either via parameter P1-01 or the “Motion Disable” multifunction input), the drive no longer tracks position and may need to be re-homed depending on encoder type and move type.

POSITIONING ROUTINE: When a move is commanded, the drive will accelerate on the selected acceleration ramp up to the commanded move velocity. During this time the drive is calculating both when to start the deceleration ramp and the optimum positioning speed, based on the current position, current velocity, selected decel rate and position regulator gain. When the “begin decel” point is reached, the drive’s speed reference will be clamped at the calculated positioning speed and the drive will decelerate on the selected deceleration ramp. Once the machine speed is at or below the positioning speed, the speed will be completely controlled by the position regulator, with a speed limit of positioning speed. When the machine then enters the “In Position” window and the motor speed is below the DC injection start frequency (b2-01), the “In Position” digital output is activated and the drive seeks to resolve all position errors.

A run command must be present prior to commanding a move. If the move is commanded before the run command, the move command is ignored and the drive remains at zero speed. If the run command is removed during a move, parameter b1-03 determines the stopping method. If the stopping method is “Ramp To Stop,” the decel rate used is the one selected at the beginning of the move.

The motion and velocity profile is latched in at the beginning of the move. If the position, velocity or accel/decel is changed during the move, it will be ignored until the next move command is given.

If an absolute move is commanded before the drive has been homed, a warning is displayed (RHS Run Homing Sequence) and the drive remains at zero speed.

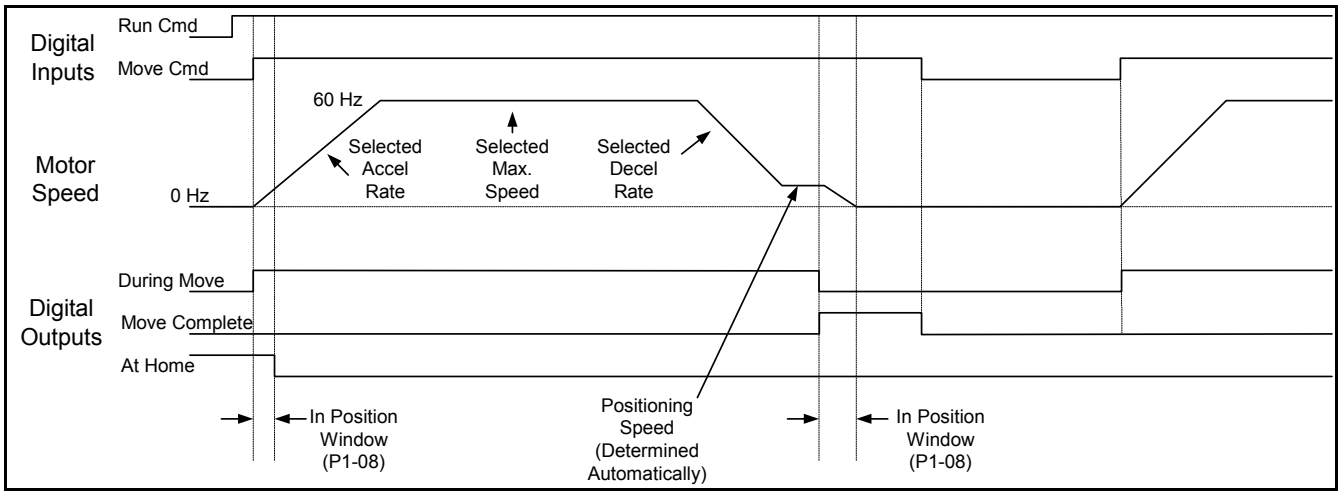


Figure 8: Typical move profile from “home” to a positive position, maintained move command (P1-03 = 0)

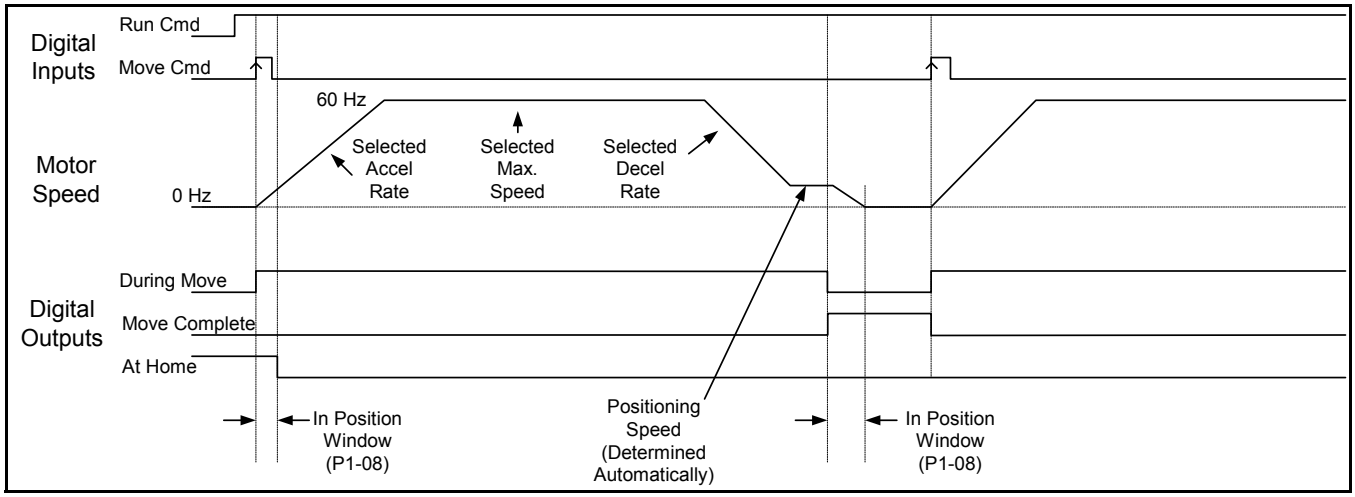


Figure 9: Typical move profile from "home" to a positive position, move command type – Rising Edge (P1-03 = 1)

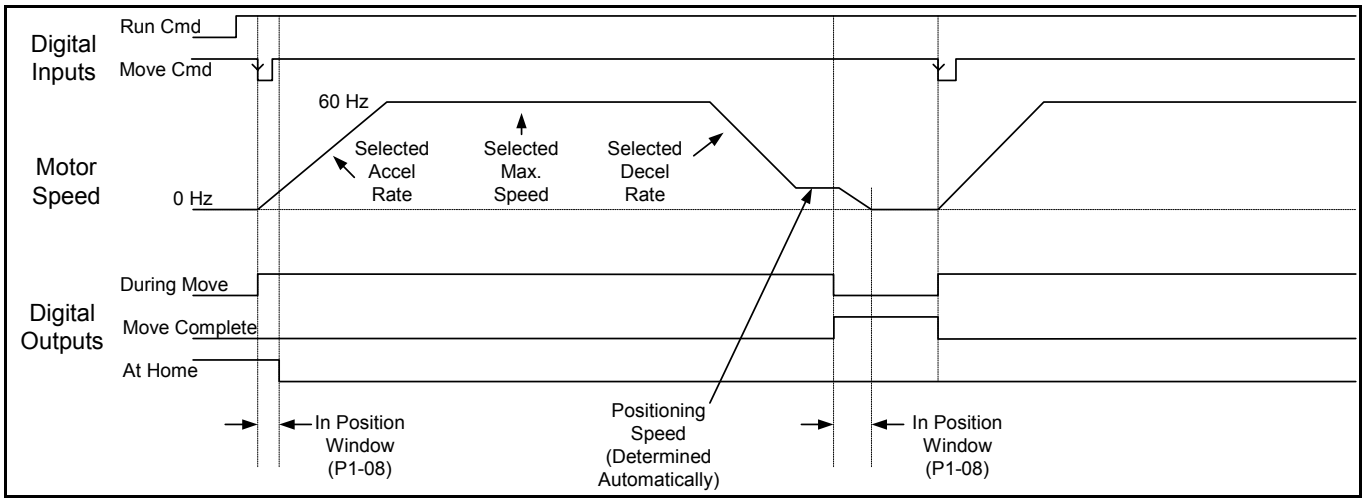


Figure 10: Typical move profile from "home" to a positive position, move command type – Falling Edge (P1-03 = 2)

5.5 Homing:

Homing is required in order to orient the drive to the mechanical system. A homing routine may or may not be required depending on the motion type and encoder type. If the selected motion type is absolute linear or absolute rotary (P1-01 = 1 or 2), and an absolute encoder is not present, homing will be required at power-up, when motion control is re-enabled after being disabled, when motion type is changed (P1-01), or when encoder type is changed (P3-01). Switching the drive into “Local” mode will not require the drive to be re-homed.

Accel and decel rates used during all homing stages are determined by parameters C1-07 and C1-08 except where noted.

HOME NEGATIVE: When the “Home Command” input is closed, the drive will accelerate using the C1-07 ramp in the negative (reverse) direction at the homing speed. As soon as the home switch is activated, the drive records the position as home then decelerates using the decel rate specified in parameter C1-08. The drive then performs a move to “home + home offset” using d1-16 as the speed, and C1-01 and C1-02 as the accel and decel ramps.

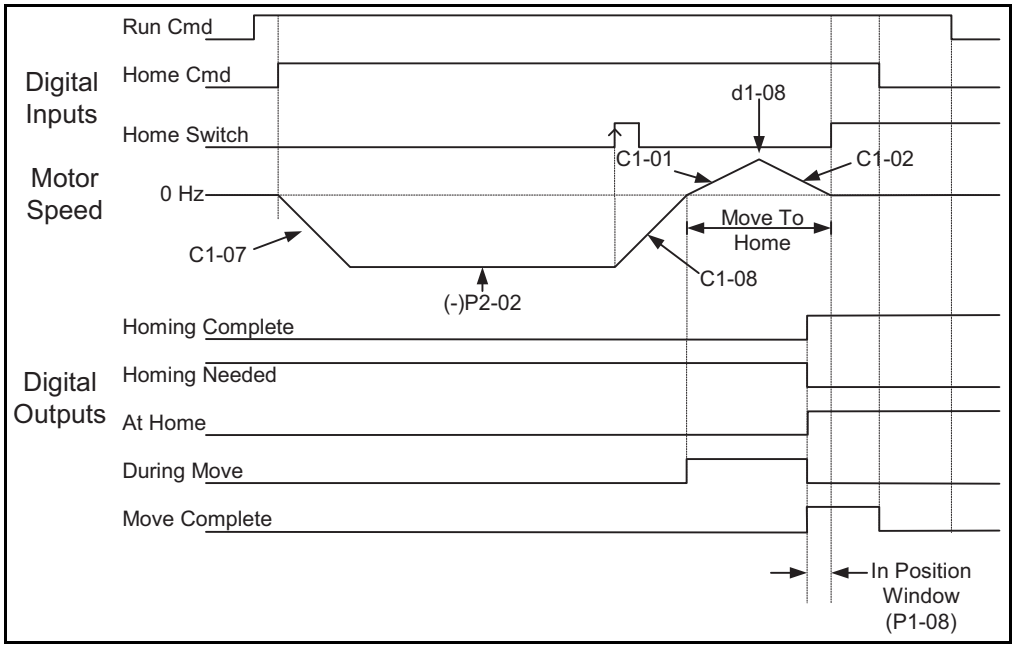


Figure 11: Home Negative Timing Chart (P2-01 = 0)

HOME NEGATIVE WITH BACKUP: When the “Home Command” input is closed, the drive will accelerate using the C1-07 ramp in the negative (reverse) at the homing speed. When the home switch is activated, the drive will then proceed positive (forward) at the homing backup speed until the home switch is deactivated. The drive will then switch back into reverse and proceed at the homing final speed. As soon as the home switch is reactivated, the drive records the position as home and decelerates to zero speed. The drive then performs a move to “home + home offset” using d1-16 as the speed, and C1-01 and C1-02 as the accel and decel ramps. When complete the homing needed output is deactivated and the homing complete output is activated.

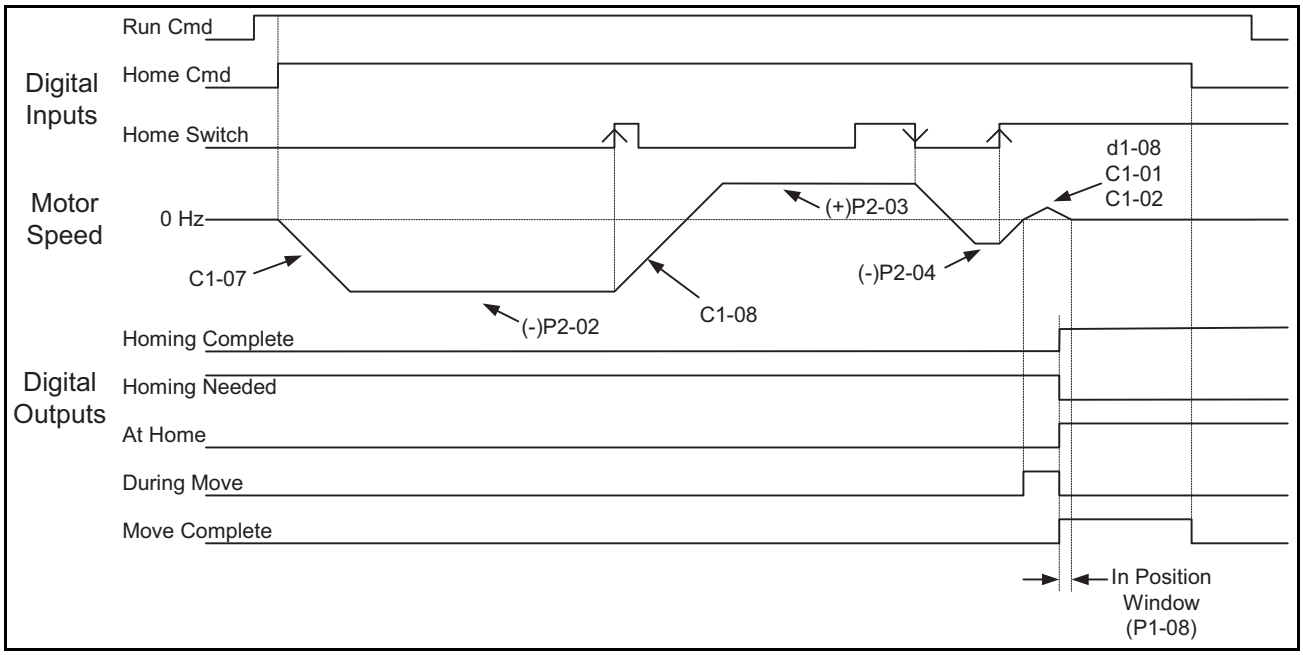


Figure 12: Home Negative with Backup Timing Chart (P2-01 = 1)

HOME POSITIVE: Same sequence as “Home Negative,” but the drive proceeds in the positive (forward) direction at the homing speed.

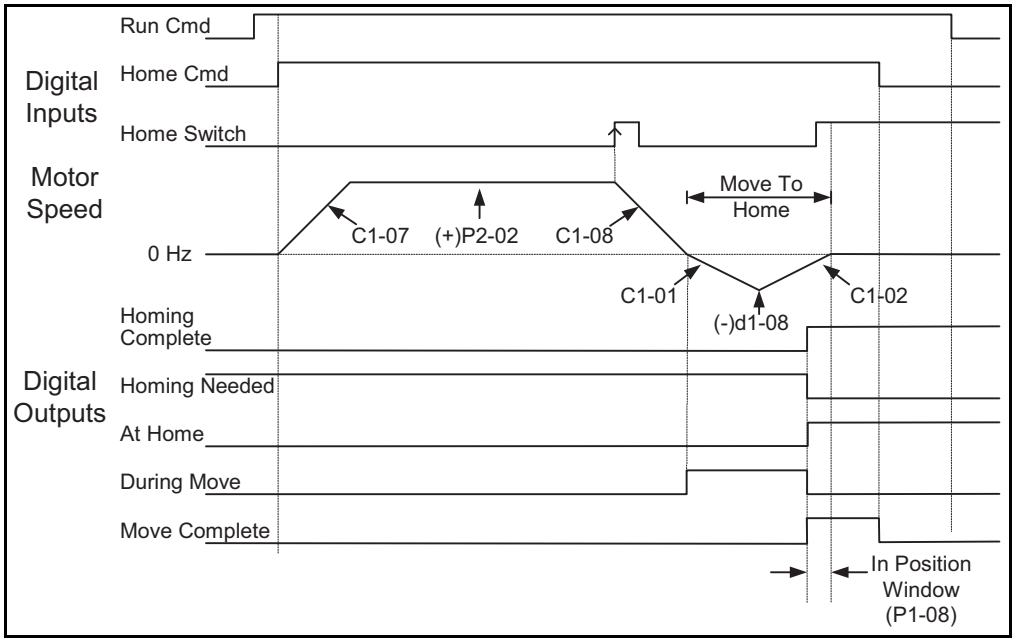


Figure 13: Home Positive Timing Chart (P2-01 = 2)

HOME POSITIVE WITH BACKUP: Same sequence as “Home Negative with Backup,” but all directions are opposite.

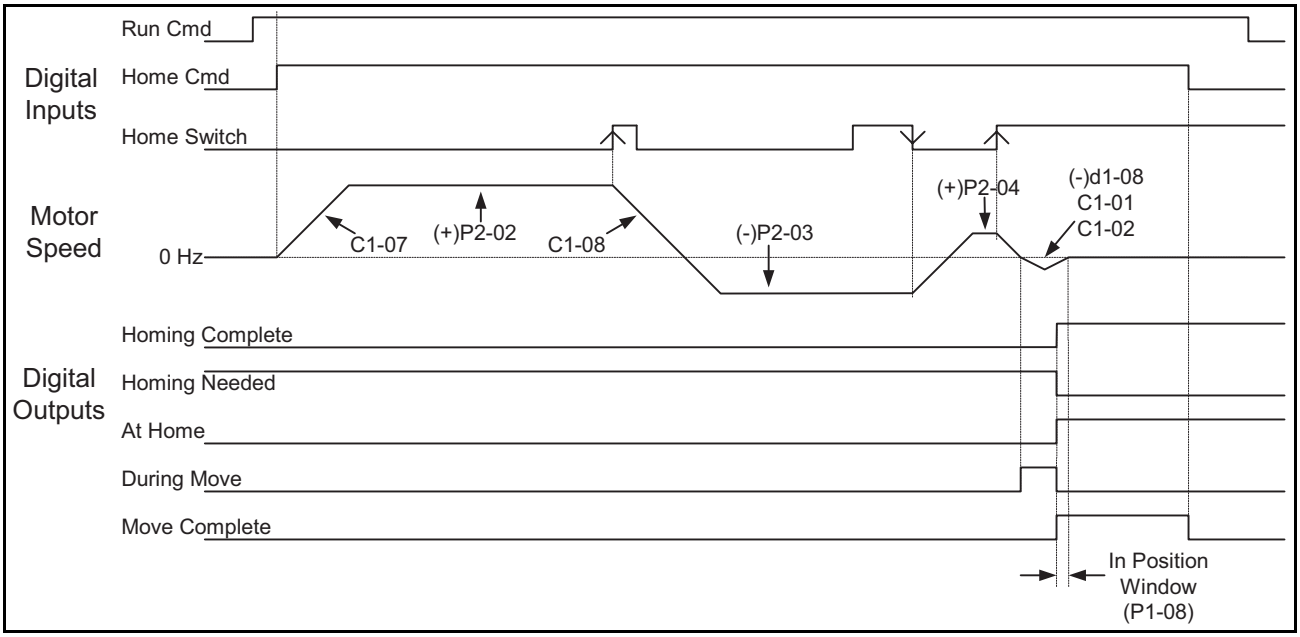


Figure 14: Home Positive with Backup Timing Chart (P2-01 = 3)

HOME NEGATIVE WITH MARKER: When the “Home Command” input is closed and a run command is issued, the drive will proceed in the negative (reverse) direction at the homing speed. When the drive sees the leading edge of the home switch it continues in reverse and starts looking for a marker pulse from the encoder. As soon as the drive receives the marker pulse, it records the position as home then decelerates using the decel rate specified in parameter C1-08. The drive then performs a move to “home + home offset.”

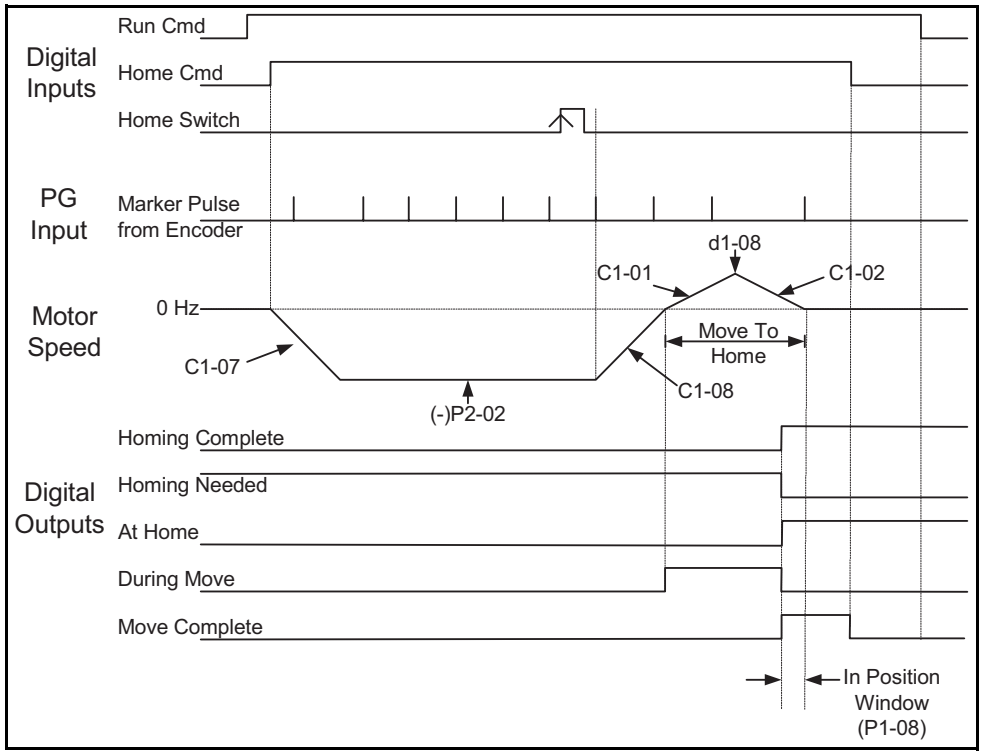


Figure 15: Home Negative with Marker Pulse Timing Chart (P2-01 = 4)

HOME POSITIVE WITH MARKER: Same sequence as “Home Negative with Marker,” but the drive proceeds in the positive (forward) direction at the homing speed.

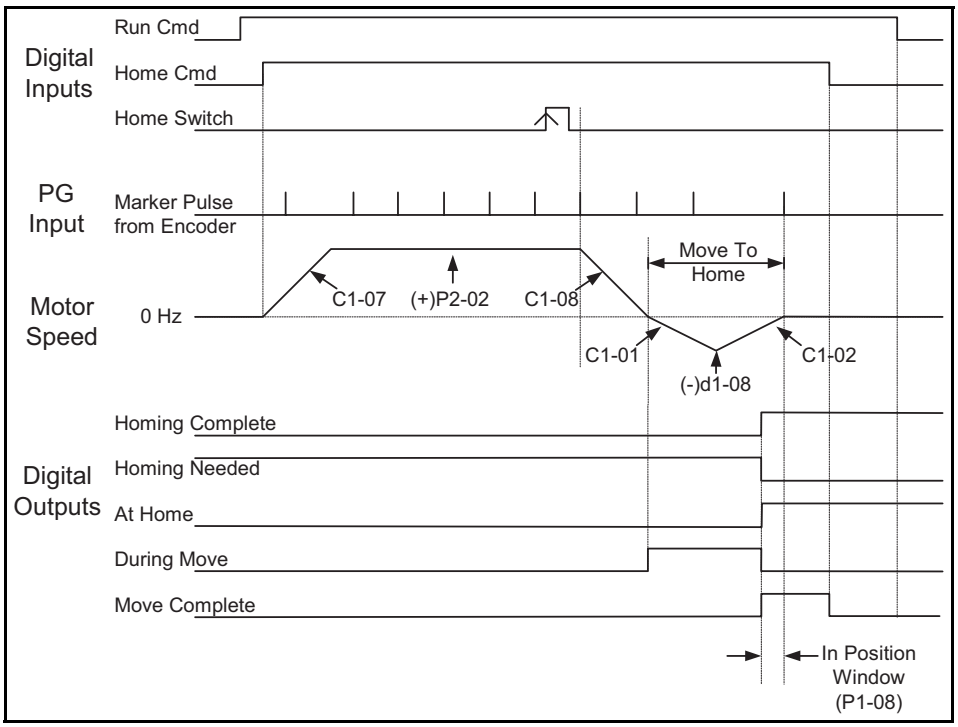


Figure 16: Home Positive with Marker Pulse Timing Chart (P2-01 = 5)

MANUAL HOME: When this homing method is selected, whatever position the drive is in when a rising edge of the home switch is detected is considered home. A “move to home at end of homing routine” is not performed in this mode. If a rising edge of the home switch is detected during a move, the position at the rising edge becomes the new home and the move is canceled.

HOME OFFSET: Sometimes it is desirable to have the home (zero) position at a different place than the home switch. The home offset parameters store the distance between the home switch position and the desired actual home position.

MOVE TO HOME AT END OF HOMING ROUTINE: When a homing routine is complete, the drive completes a move to the newly found home position (home switch + home offset). The speed of the move is determined by parameter d1-08, and uses parameters C1-01 and C1-02 as the accel and decel rates. The “Homing Needed” and “Home Complete” digital outputs will change as soon as the move to home is complete.

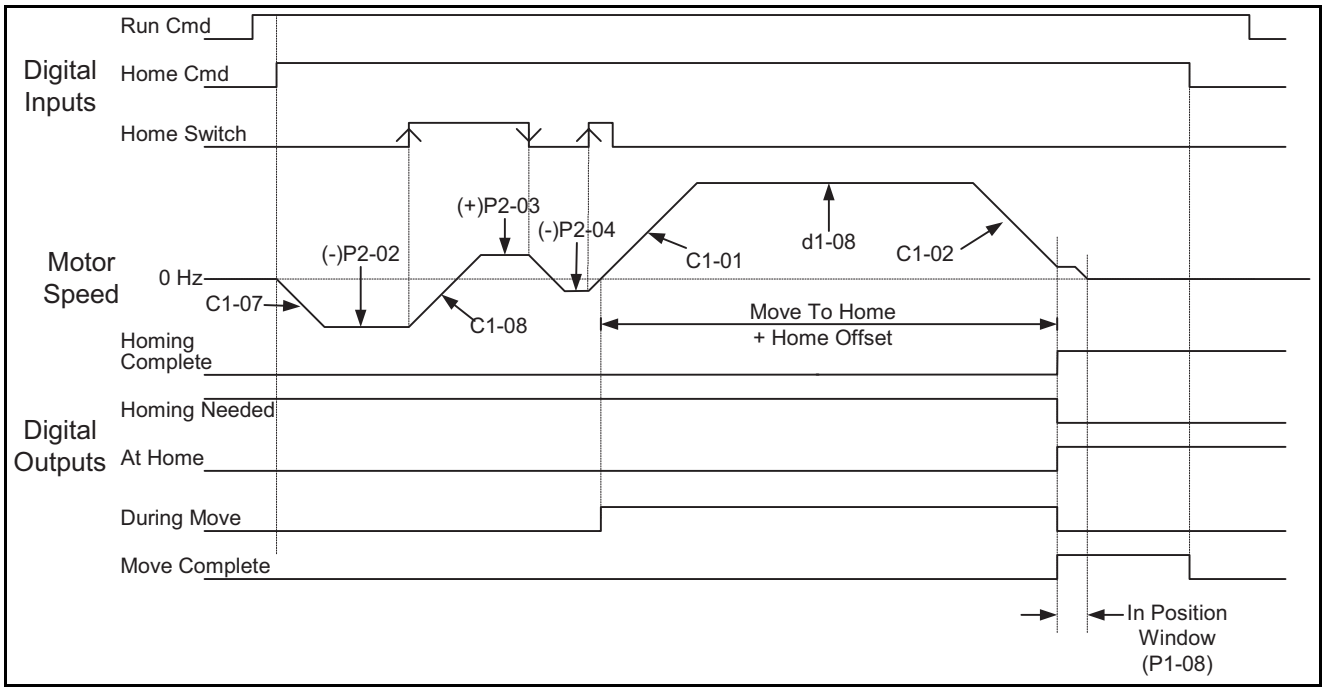


Figure 17: Home Negative with Backup plus home offset (P2-01 = 1 and P2-06 > 0)

ALREADY ON HOME SWITCH: If a homing sequence is initiated and the home switch is already activated, the drive will “back off” of the home switch and then proceed with the normal homing sequence. If the homing type is either “Home Positive with Backup” or “Home Negative with Backup,” an abbreviated homing routine is run instead.

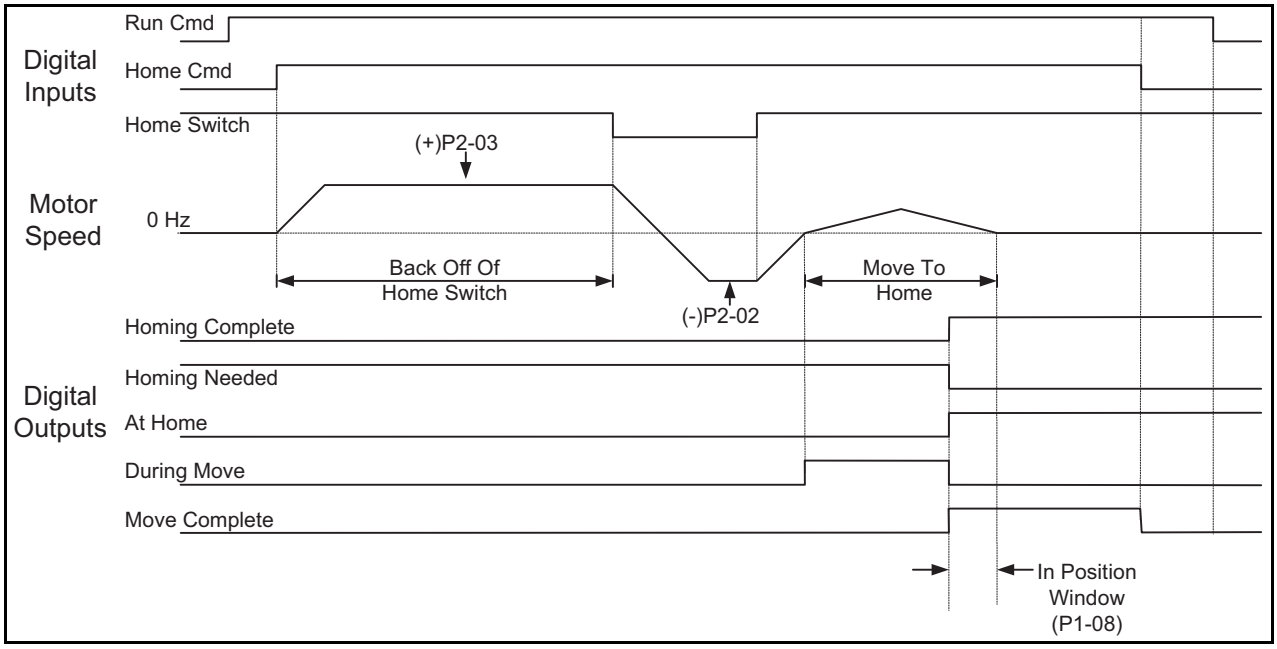


Figure 18: Home Negative, starting on home switch (P2-01 = 0)

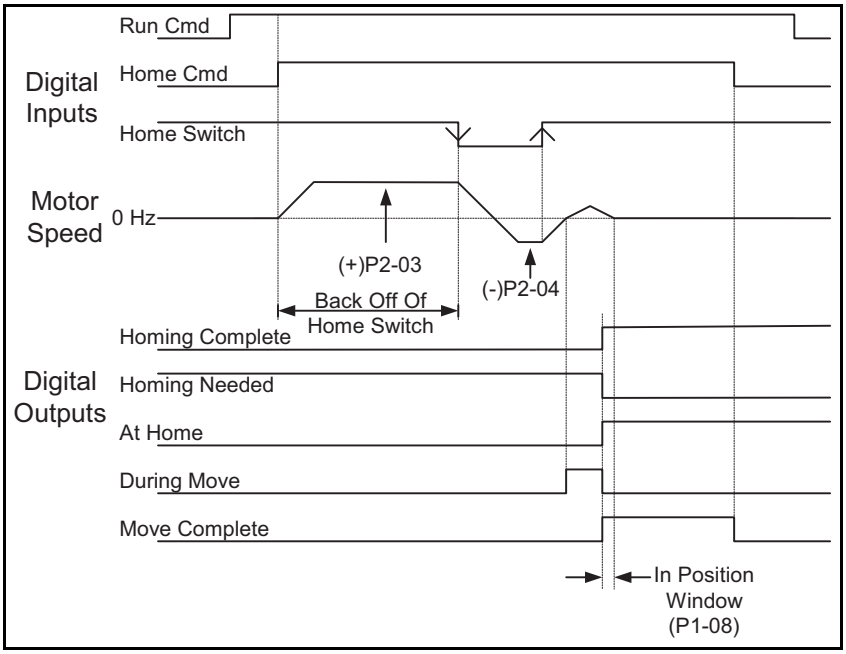


Figure 19: Home Negative with Backup, starting on home switch (P2-01 = 1)

HOMING WHEN REVERSE OPERATION IS DISABLED: When reverse operation is prohibited (b1-04 = 1), homing can be affected. The only homing routines that could be effectively used in this condition will be “Home Forward” and ”Home Forward with Marker.” If any other homing type is selected when reverse is disabled, the homing routine will not complete. Normally, when the home switch is activated at the beginning of a homing routine, the drive would “back off” of the home switch. Since backing up is not allowed, the drive instead will move forward until the next leading edge of the home switch is encountered.

If the motion type is “Rotary Absolute” P1-01 = 2, when the rising edge of the home switch is encountered, the drive will then perform a “move to home,” which will result in more forward motion beyond the home switch. If the “home offset” P2-06 is set to 0, the machine will move one complete revolution at the end of the homing routine.

If motion type is “Relative” or “Relative with Memory” (P1-01 = 3 or 4), when the rising edge of the home switch is encountered, the drive simply ramps to stop and does not attempt to “move to home,” but instead simply records the “home” position.

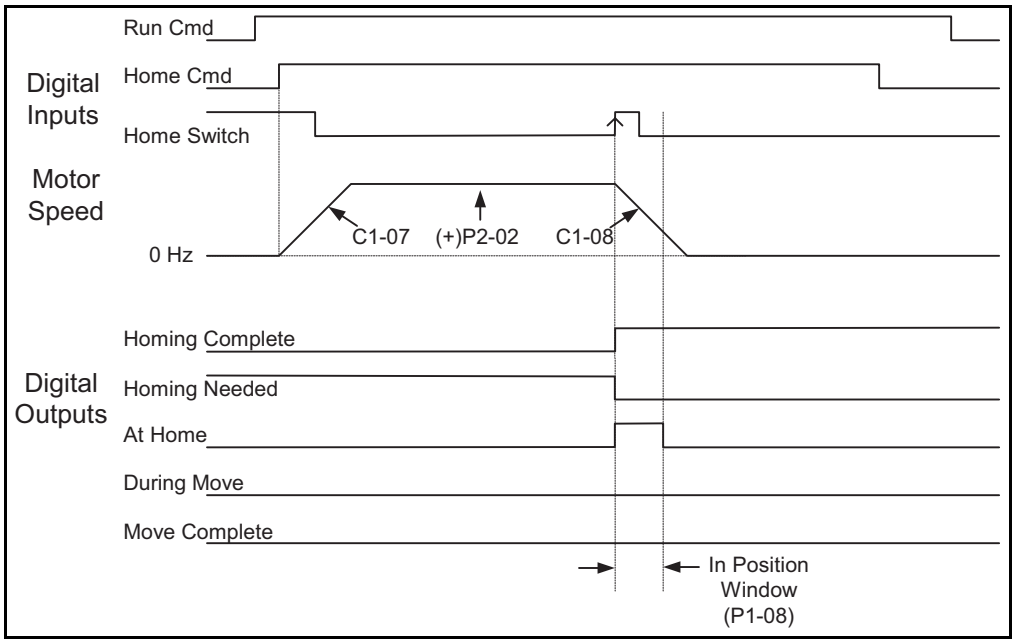


Figure 20: Home Positive Timing Chart, reverse prohibit, starting on home switch, relative or relative with memory motion type (P2-01 = 2, b1-04 = 1)

HOMING WHEN USING AN ABSOLUTE INCREMENTAL ENCODER: This software was designed around a “TR Electronic” brand encoder model #: CD65M-G/S-4096/4096-D23BB-R10NR/N7. Please consult Yaskawa if another brand / model number of encoder is used. When P3-01 = 3 or 4 (Absolute Incremental Encoder), and the drive is first powered up, it reads the actual position from the serial encoder as follows:

1. Homing begins by the drive closing its “Position Request” output to the encoder using the analog output on terminal FM. This will occur automatically at drive power-up or when the “Home Command” digital input is closed.
2. The encoder responds by closing its “Drive Disable” output to the drive. This signal is run into the analog input terminal A2 or A3. The drive will then not operate as long as the “Drive Disable” is high, as the encoder will not work in its incremental mode. The drive will then clear its pulse counter registers. At this time the “SENCR – Serial Encoder Reading” warning will flash on the display.
3. When the drive is ready to begin counting its absolute position, it opens the “Position Request” output to the encoder. The encoder will then output its absolute position by sending the number of pulses it is from its zero count. The drive will count the pulses in quadrature. The drive will also monitor the direction (phase) of the A and B channels. If, during the sending of the absolute position, the encoder is rotated, the encoder may need to subtract pulses to relate its position by reversing the polarity of the A and B channel phasing.
4. When the encoder has relayed its exact position to the drive, the encoder will open its “Drive Disable” output telling the drive to use the pulse count at that time as the absolute position. The drive will clear the base-block and begin looking at the encoder for incremental feedback.

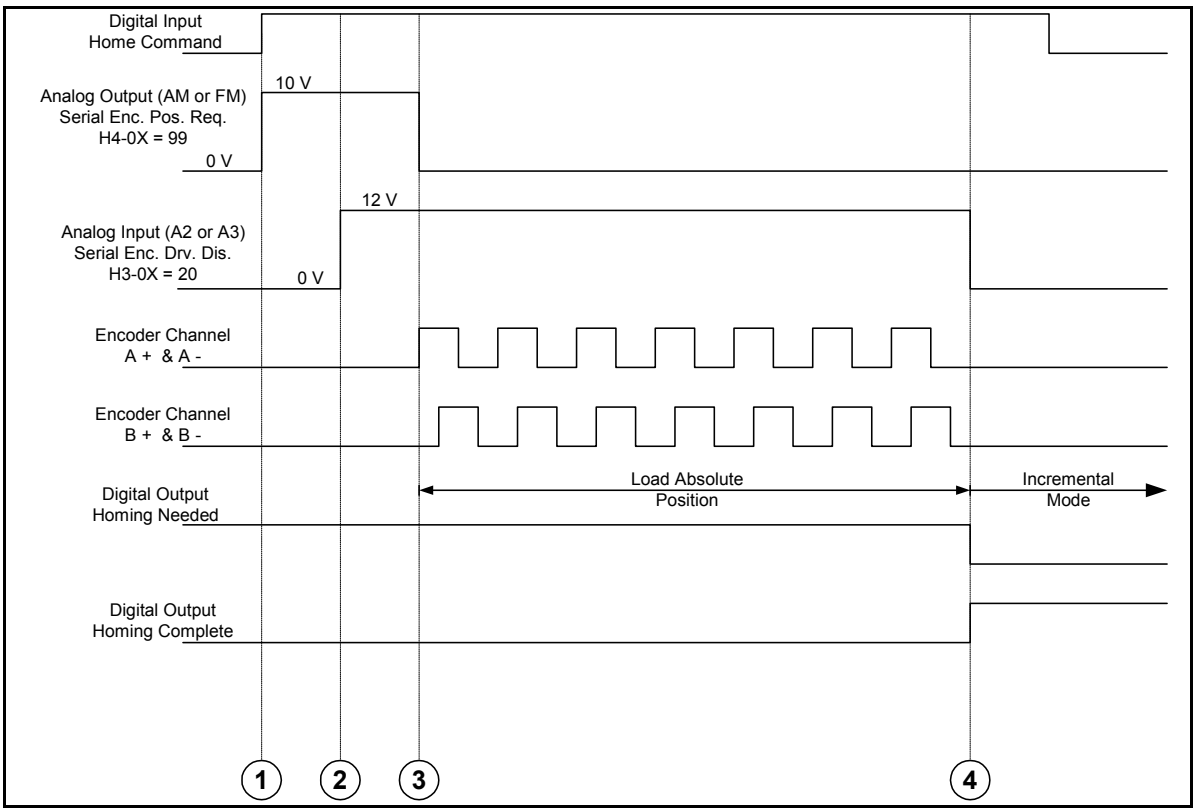


Figure 21: Absolute Incremental Encoder Homing Routine

5.6 Learn Mode:

DIGITAL PRESET POSITION LEARN MODE

Note: If the home offset is utilized, it must to be set prior to using digital preset learn. First, perform a homing routine so the drive knows the actual position of the home switch. Then, select the preset position to be learned using the multifunction inputs (see Table 1). Next, jog the machine into position. Close the "Learn" digital input for more than one second.

Avoid excessive use of the "Learn" mode, as the drive's EEPROM can only be written to 100,000 times.

Note: If using any form of serial communications, when the "Learn" function is used, all parameters that were changed using the "accept" command are written to EEPROM when the "Learn" function is used.

5.7 Motion Control Disable:

If the motion control is disabled, either by setting P1-01 = 0 or by closing the "Motion Disable" digital input, the drive will respond like a drive with standard software installed. When motion control is re-enabled, homing will again be required.

Normal drive frequency references will override the motion control software, including Jog Forward and Jog Reverse. When the frequency reference is overridden, the drive will still track position. If the motion control software is overridden with a jog or other frequency reference when in the middle of a move, the move is canceled, and the drive ramps to the new reference. If the position of the drive is too far from home (exceeds internal limits), the drive will need to be re-homed before any moves will be allowed.

The maximum distance from home is +/- 10^9 encoder quadrature counts. The home offset also has to be taken into account for this calculation. The above number, using a 1024 PPR encoder, results in 244,140 motor revolutions, which is about 135 minutes of run time @ 1800 RPM.

5.8 Over-travel:

The over-travel multifunction inputs are active only when the motion control is not disabled (P1-01 = 0 or by multifunction digital input). If an over-travel switch is activated during a homing routine or a move, the drive will decelerate to zero speed and display an over-travel warning. When an over-travel input is active and the over-travel warning is displayed, the "Home Complete" output will be removed, and additional home or move commands are ignored. The drive must be moved out of the over-travel condition manually, typically by using the Jog Forward or Jog Reverse multifunction digital inputs. If the motion type and/or encoder type requires a home, the drive will have to be re-homed after the over-travel has been cleared. The "Learning" function is also disabled during the over-travel condition.

5.9 Pre-Action:

This function allows a digital output to indicate when the machine is a given distance (set by P2-08) from its destination during a move. The "Pre-Action" digital output (H2-0X = 46) closes when distance from commanded destination is less than distance indicated in parameter P2-08 AND there is a move in progress. It will open when distance from commanded destination is less than in position window (P1-08) or the move is canceled.

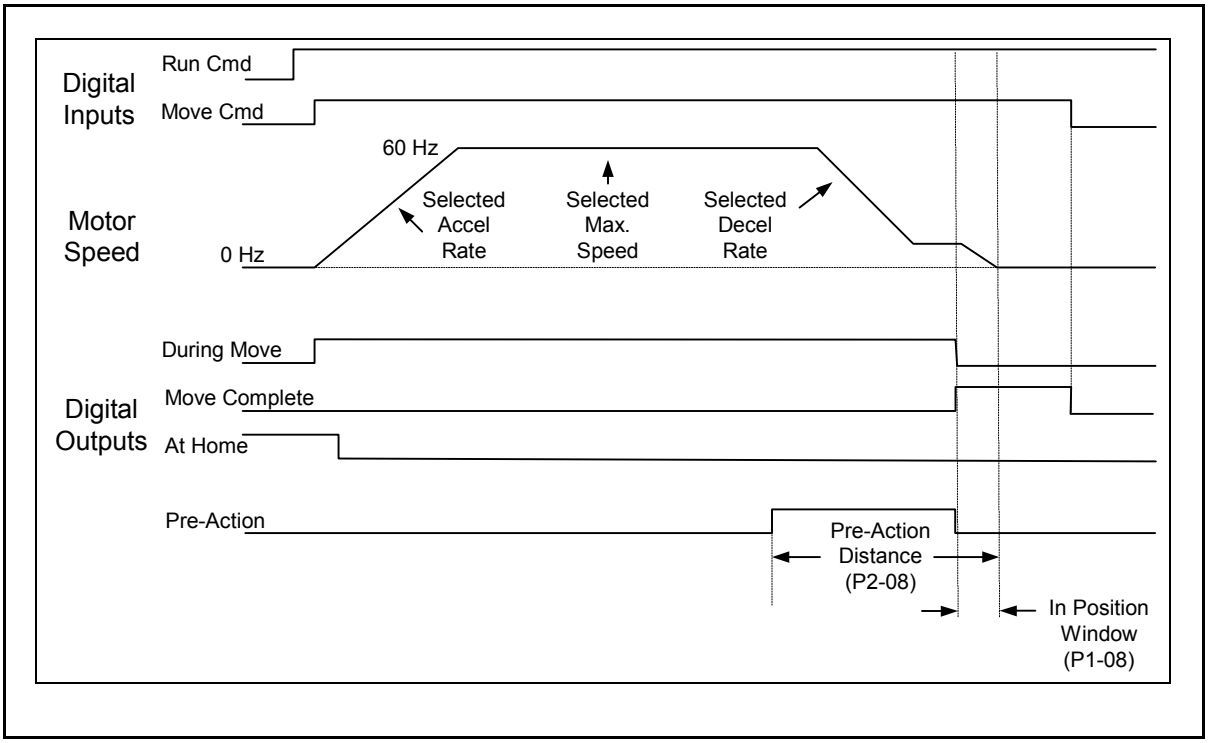


Figure 22: Pre-Action Digital Output

5.10 32-bit Position Command

A 32-bit position can be commanded by setting parameter P1-02 = 3 and loading the desired position into Modbus registers 061Ch and 061Dh. See Example 1 below for the calculations involved. The position command is NOT set in engineering units (P1-09), but instead in encoder quadrature counts (encoder PPR * 4). Multi-step distance selections will override this position command (see Table 1).

Example 1- Split a 32-bit position reference into two 16-bit words:

Desired Position Reference: 10,234,567 encoder counts

Step 1: Divide the position reference by 65,536 and drop the remainder (decimal portion).
Position Reference / 65,536 = 10,234,566 / 65,536 = 156.17 → **156**
Step 2: Multiply the result of Step 1 by 65,536.
Step 1 result * 65,536 = 156 * 65,536 = 10,223,616
Step 3: Subtract the result of Step 2 from the desired position reference.
Position Reference - Step 2 Result = 10,234,567 - 10,223,616 = **10,951**

Low Word (061Ch) = Step 3 Result = 10,951
High Word (061Dh) = Step 1 Result = 156

Note: Negative numbers can be entered as the two's compliment.

5.11 32-bit Distance from Home

The distance from home (including home offset) can be monitored by reading Modbus addresses 0734h and 0735h and combining them into one number as shown in example 2. This number represents the number of encoder quadrature counts (encoder PPR * 4) from the home + home offset position, and is only valid after a homing routine has been completed. In order to ensure that the data from the two 16 bit registers remain synchronized, they should be read using a "Read Multiple" (03h) Modbus command.

Example 2 - Combine two 16-bit words into a single 32-bit number:

Low Word (0734h) = 12,345
High Word (0735h) = 9,876

Step 1: Multiply the High Word by 65,536.
High Word * 65,536 = 9,876 * 65,536 = 647,233,536
Step 2: Add the Low Word to the result of Step 1.
Low Word + Step 1 Result = 12,345 + 647,233,536 = **647,245,881**

5.12 Motion Control Modbus Status Register

The Modbus register 0736h is added to provide a status word that encompasses the status of the drive's digital outputs (programmed by the H2-0x parameters) and all of the motion control specific logic outputs.

6.0 Appendices

Appendix A: Absolute Encoder Considerations

- Up to 18 bits of gray code information can be interfaced to the drive.
- Available ONLY for “Linear Absolute” (P1-01 = 1) applications.
- Cannot be used with any “option board required” communications, like Profibus, DeviceNet, Modbus Plus, or Ethernet, as these option boards utilize the 2CN port which is needed for the DI-16H2 board.
- Requires a DI-16H2 option card installed at 2CN on the drive.
- In addition to the gray code encoder, requires a separate motor-mounted incremental encoder AND a PG-X2 option card installed at 4CN on the drive.
- Logic Levels: +24 VDC (true) and 0 VDC (false).
- Gray code encoder MUST be capable of “sinking” current on its outputs.
- Mountable directly on machine or on motor (gear ratio available).
- Rollover protection.
- Tested with a Dynapar ai2512122B121 multi-turn gray code encoder. This encoder has 12 bits of resolution per revolution and 12 bits of revolutions.
- External power supply required to power absolute encoder.

Table A1: Absolute Encoder Wire Color Chart For Dynapar ai2512122B121

Signal		Color	Pin
Counts	S0	Brown	2
	S1	Green	21
	S2	Yellow	3
	S3	Grey	22
	S4	Pink	4
	S5	Violet	23
	S6	Grey / Pink	5
	S7	Red / Blue	24
	S8	White / Green	6
	S9	Brown / Green	25
	S10	White / Yellow	7
	S11	Yellow / Brown	26
Revolutions	M0	White / Grey	8
	M1	Grey / Brown	27
	M2	White / Pink	9
	M3	Pink / Brown	28
	M4	White / Blue	14
	M5	Brown / Blue	33
	M6	White / Red	15
	M7	Brown / Red	34
	M8	White / Black	16
	M9	Brown / Black	35
	M10	Grey / Green	17
	M11	Yellow / Grey	36
Misc. Control	Alarm	Pink / Green	18
	Direction	Yellow / Pink	10
	Latch	Green / Blue	30
	Tristate	Yellow / Blue	12
Power	Vcc	Red / Blue	13
	Vcc	White	31
	Common	Blue	1
	Common	Black	20

Table A2: Wiring Table - DI-16H2 option card to Absolute Gray Code Encoder (Dynapar ai2512122B121)

DI-16H2 Option Card		More Resolution <----------> More Revolutions									
		Revolutions: 64		Revolutions: 256		Revolutions: 512		Revolutions: 1024		Revolutions: 4096	
		Counts / Revolution: 4096		Counts / Revolution: 1024		Counts / Revolution: 512		Counts / Revolution: 256		Counts / Revolution: 64	
		P3-02 = 4096		P3-02 = 1024		P3-02 = 512		P3-02 = 256		P3-02 = 64	
Function	Terminal	Signal	Wire Color	Signal	Wire Color	Signal	Wire Color	Signal	Wire Color	Signal	Wire Color
Bit 0	TC1-1	S0	Brown	S2	Yellow	S3	Grey	S4	Pink	S6	Grey / Pink
Bit 1	TC1-2	S1	Green	S3	Grey	S4	Pink	S5	Violet	S7	Red / Blue
Bit 2	TC1-3	S2	Yellow	S4	Pink	S5	Violet	S6	Grey / Pink	S8	White / Green
Bit 3	TC1-4	S3	Grey	S5	Violet	S6	Grey / Pink	S7	Red / Blue	S9	Brown / Green
Bit 4	TC1-5	S4	Pink	S6	Grey / Pink	S7	Red / Blue	S8	White / Green	S10	White / Yellow
Bit 5	TC1-6	S5	Violet	S7	Red / Blue	S8	White / Green	S9	Brown / Green	S11	Yellow / Brown
Bit 6	TC1-7	S6	Grey / Pink	S8	White / Green	S9	Brown / Green	S10	White / Yellow	M0	White / Grey
Bit 7	TC1-8	S7	Red / Blue	S9	Brown / Green	S10	White / Yellow	S11	Yellow / Brown	M1	Grey / Brown
Bit 8	TC1-9	S8	White / Green	S10	White / Yellow	S11	Yellow / Brown	M0	White / Grey	M2	White / Pink
Bit 9	TC1-10	S9	Brown / Green	S11	Yellow / Brown	M0	White / Grey	M1	Grey / Brown	M3	Pink / Brown
Bit 10	TC2-1	S10	White / Yellow	M0	White / Grey	M1	Grey / Brown	M2	White / Pink	M4	White / Blue
Bit 11	TC2-2	S11	Yellow / Brown	M1	Grey / Brown	M2	White / Pink	M3	Pink / Brown	M5	Brown / Blue
Bit 12	TC2-3	M0	White / Grey	M2	White / Pink	M3	Pink / Brown	M4	White / Blue	M6	White / Red
Bit 13	TC2-4	M1	Grey / Brown	M3	Pink / Brown	M4	White / Blue	M5	Brown / Blue	M7	Brown / Red
Bit 14	TC2-5	M2	White / Pink	M4	White / Blue	M5	Brown / Blue	M6	White / Red	M8	White / Black
Bit 15	TC2-6	M3	Pink / Brown	M5	Brown / Blue	M6	White / Red	M7	Brown / Red	M9	Brown / Black
Bit 16	TC2-7	M4	White / Blue	M6	White / Red	M7	Brown / Red	M8	White / Black	M10	Grey / Green
Bit 17	TC2-8	M5	Brown / Blue	M7	Brown / Red	M8	White / Black	M9	Brown / Black	M11	Yellow / Grey
Common	TC2-9	Common	Blue	Common	Blue	Common	Blue	Common	Blue	Common	Blue

Note: An external +24V power supply is required when using with this encoder. The power supply is connected as follows: +24V to Red and 0V to Black.

Appendix B: Serial Communications Considerations

- Motion control software will function with all option card-based serial communications.
- Motion control software will function with the internal Modbus serial communication.
- Reference source (b1-01) should be set to desired reference when motion control is disabled.
- Sequence source (b1-02) should be set to the desired source for run/stop, move, distance select, etc.
- Position Reference Source (P1-02) should be set to the desired source for the position reference.
- Position Reference Source (P1-02) will be overwritten if a digital preset position is selected via multifunction digital inputs. See Table 1 Profile Selection Information for more details.
- All digital output logic and position monitors are available through serial communications.
- If an option board is required for serial communications (Profibus, Modbus Plus, DeviceNet, Ethernet), an absolute gray code encoder cannot be used.
- If the learn function is used while serial communications is being employed (even if it is not for control of the drive), keep in mind that all parameter values written to the drive will be memorized to EEPROM each time the learn function is activated.