

iDrive start up guide for rotary servo motors

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Bayside Motion Group

DISCLAIMER: This document does not replace the need to “fully” apply the applicable motor and drive manuals. The purpose of this document is only to enhance the content in the iDrive product manual with respect to servo motor programming and start up. This document is based on the manual, hardware/software versions and information available at the time of writing.

iDrive phasing standard for encoder commutation (No Hall)

This information is necessary for integration with custom/3rd party motors & cables, and for troubleshooting standard Bayside motors & cables.

The motor/feedback must be wired to the drive such that POSITIVE COMMAND = CW ROTATION for proper torque commutation and operation. This is called the **positive torque sequence**. This is met by the following conditions:

- Encoder: With CW rotation, channel A leads B by 90 degrees for encoder counting in the positive numerical direction.
- Motor: With CW rotation, back EMF W-V leads U-V by 60 degrees.
- Refer to the attached phasing diagrams for details and test procedure.

Note that certain combinations of motor and encoder wiring result in normal commutation, but in the negative torque sequence. This means a positive command = CCW rotation. Although commutation is normal, the negative torque sequence is not recommended, due to potential tech support confusion versus the iDrive standard of positive torque sequence.

In addition to proper motor/encoder wiring, the following parameters are critical for normal commutation: Encoder increments, Encoder type, Rated frequency @ Rated speed (determines pole pairs) and Motor type.

Other motor/encoder wiring combinations, or incorrect commutation parameters can result in pole finding commutation errors, locked rotor or cogging behaviour, unstable response or runaway.

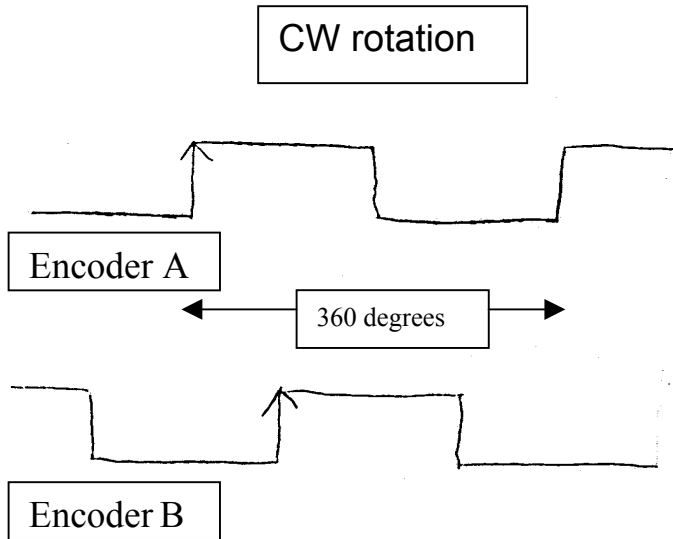
Bayside cables for iDrive

The plug&play sensor cables are internally wired with the proper encoder phasing. Motor power cables are connectorized on the motor end and flying leads on the drive end.

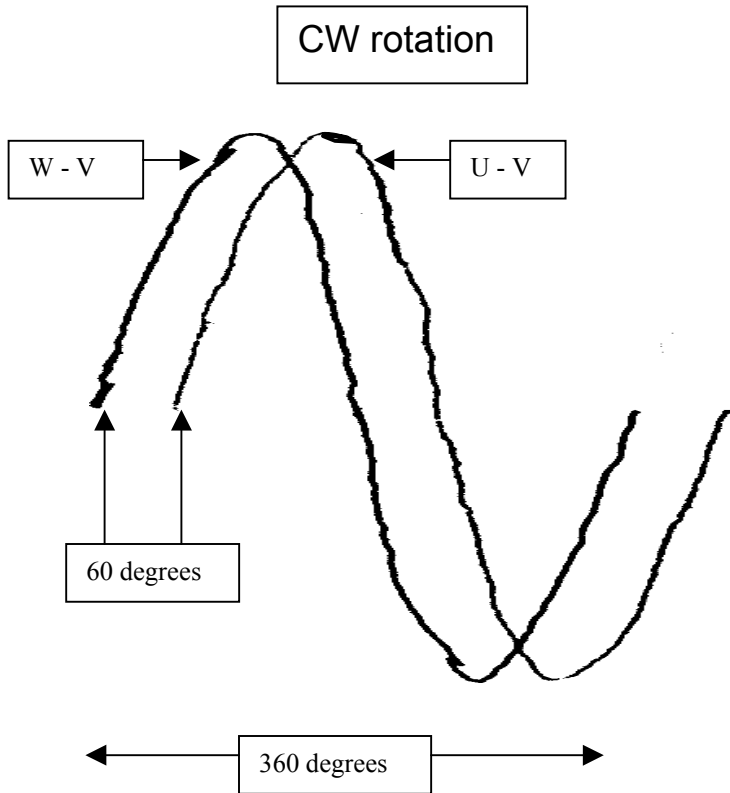
For proper UVW phasing, the flying motor leads must be connected to the drive as follows:

Motor type	drive U terminal	drive V terminal	drive W terminal
Standard C/D winding	Black 1	Black 2	Black 3
Standard A/B winding	Black 1	Black 3	Black 2

iDrive phasing standard for CW shaft rotation
Encoder and UVW relationships (No Hall)
For positive command = CW rotation



- Encoder phasing:
- Encoder power on
 - CW shaft rotation
 - Encoder A leads B for positive direction Idrive encoder counting
 - Idrive J4: A = pin 1, B = pin 2, Common = pin 15



- Back EMF phasing:
- Drive off, motor leads disconnected
 - Oscilloscope connections: W = probe tip, V = common, U = probe tip
 - Rotate shaft CW steadily
 - W - V leads U - V by 60 degrees
 - Formula: [time shift divided by total period time] multiplied by 360.

PROGRAMMING:

Motor file parameters

Note that an important distinction is made between “motor” parameters and all other parameters. Parameters unique and specific to the connected motor are defined as “motor” parameters. These parameters are used by the iDrive to configure optimal motor vector and commutation control, current loop gain normalization and motor protection (current, speed, thermal overload). All other parameters are not motor specific, and therefore, the responsibility of the user for proper implementation.

The iDrive with universal field oriented vector control is designed to control both asynchronous (induction) motors and synchronous (permanent magnet commutated) motors i.e. servo motors. Induction motor control models and application parameter sets are generally more numerous and complicated. For servo motor control, the iDrive motor parameter set is reduced.

Note: Contact Bayside, or check our web site, for availability of downloadable motor files for catalog motors and stages.

Motor parameter number	Parameter Name	Parameter Entry/Comments
3	Maximum torque current	Entered as a percentage of rated motor current, within the drive’s peak current capability. Enter <u>lessor</u> of the following: [motor peak/motor rated x 100] or [drive peak/motor rated x 100]. Note: iDrive amp unit is Arms/phase based on 3-phase operation. Motors rated for “six step” operation (dc amps) should be converted as follows: Arms = 0.82 x Adc.
5	Maximum speed	Enter the lessor of the max. motor RPM or max. RPM as limited by the encoder frequency. Max. encoder limited RPM = 150,000 Hz x 60 divided by encoder lines /rev. If using an external encoder signal divider/multiplier, lines/rev are after any external div/mult conversions.
8	Overspeed error	Enter 1.10 x max. speed (P5). Sets the error trigger point.
*** Following parameters best entered via Motor Settings window in this order ***		
105	Motor type	Enter 1 = synchronous
---	Units	Select rotary
101	Rated speed of motor	For servo motors, enter the Maximum motor RPM @ rated voltage.
100	Rated frequency of motor or Number of pole pairs	If setting up parameters via the motor icon, number of “pole pairs” is entered (frequency internally calculated). If creating a direct loadable motor file, P100 = [P101 divided by 60] x 0.5 x Pole Count.
102	Rated voltage of motor	Entered the rated motor winding voltage in Vdc. Note: Drive bus voltage must equal rated motor voltage to prevent speed/torque limitations due to voltage mismatch.
103	Rated current of motor	Enter the rated current of the motor in Arms for 3-phase sinusoidal operation. Motors rated for “six step” operation (dc amps) should be converted as follows: Arms = 0.82 x Adc.
71	Encoder signal type	1 = digital TTL encoder, 0 = analog sin/cos encoder. Note: this is the signal type as “seen” by the iDrive after any external encoder signal conversion e.g. sin/cos to digital TTL via external interpolator.
70	Encoder increments (lines or pulses)	Enter the encoder lines/rev (pulses/rev) as “seen” by the iDrive after any external encoder signal division or multiplication. Lines (pulses) is the pre quadrature resolution.
107	Pole finding method	Enter 1 for encoder only commutation (pole finding via test motion).

	(pole position angle of encoder)	Enter 5 for Hall startup, US single-ended signal, P106 Hall offset Enter 6 for Hall startup, EU differential signal, P106 Hall offset 0 and 2 are sin/cos encoder modes pending drive firmware version. 3 and 4 are resolver modes for future availability.
106	Correction angle of encoder (Hall/pole position offset)	Not used for encoder only commutation (no comm tracks). Reserved for FUTURE Hall/Encoder and Resolver commutation mode.
111	Ls inductance, L-N	Enter the inductance in Henries. For L-L motor spec, L-N = 0.5 L-L.
112	Rs resistance, L-N	Enter the resistance in Ohms. For L-L motor spec, L-N = 0.5 L-L.
*** end Motor Settings window ***		
109	Pole angle finding start signal	Enter 0 for test motion activation on first enable signal. Enter 1 for test motion activation on power up. Refer to current manual or connected drive version choices for other available activation modes.
120	Motor thermal protection	To activate, enter 2 for servo motors. This is I2T type protection. In general, multiple (redundant) forms of thermal protection are recommended. Note that PTC thermistor signals are NOT directly compatible with the iDrive actively sourced digital inputs. An external PTC analog signal/switch output convertor would be required. Another possibility is that all digital inputs are needed for other more critical application functions.
121	Motor thermal category	Enter 0 for maximum I2T protection curve (shortest trigger time). P121 can be increased as long as the actual motor temperature is not exceeded e.g. to eliminate nuisance tripping cases.

EXAMPLE MOTOR PARAMETER SET:

Motor file for BM060-1C1 with BDx071 drive (10Arms peak 10s current, 115Vac/160Vdc).

Motor specs:

Rated for six step operation.

160 VDC winding

2000 line/rev TTL encoder, no external signal convertor

Max speed = 5400 rpm

Continuous current = 2 amps, 0.82×2 amps = 1.65Arms

Peak current = 6 amps

R line-line = 12 ohms

L line-line = 12 mH

Pole count = 6

Par #	Value	Parameter Description
3	300	Maximum torque current in percent of rated
5	4500	Maximum speed (encoder freq limited)
8	4950	Over-speed error (set 10% higher than Max speed)
70	2000	Encoder increments
71	1	Encoder type
100	270	Rated frequency of motor
101	5400	Rated speed of motor (max no-load speed)
102	160	Rated voltage of motor
103	1.65	Rated current of motor
105	1	Motor type
107	1	Pole Finding Method = encoder commutation
109	0	Start encoder commutation on initial enable

111	.006	Stator inductance L-N in Henries
112	6	Stator resistance L-N in ohms
120	2	Motor protection function
121	0	Heating class of the motor

Pole Angle Finding (Commutation) Evaluation for Hall less motors:

This refers to the specific motor motion initialization that must be done automatically, every time after power-up or initial enable of the drive. This is necessary to synchronize the arbitrary encoder position (count) to the motor’s optimal electrical commutation angle – a specific displacement between the permanent magnet rotor position and a defined stator electrical state. The pole angle finding (PAF) accuracy is critical for establishing the optimal torque generation conditions and subsequent motor performance. The PAF with default values for P126 (pulse width) and P127 (pulse amplitude) should work well for a majority of applications. For applications with high friction, or very low friction (e.g. air bearing), it may be necessary to adjust one or both parameters. **Consult with an iDrive specialist before changing P126/127.**

The PAF bidirectional test motion algorithm (quick mini shaft movement) is generally capable of working well even under the following conditions: one sided obstructions (e.g. hard stop), torque disturbances and unequal directional loading (e.g. gravity application).

From commutation theory, optimal commutation torque angle is 90 electrical degrees. Angle accuracy within +/- 10-15 degrees is quite acceptable for a majority of applications. Symptoms of poor PAF accuracy include:

- Rotor lock or jerky behaviour
- Rough/bumpy shaft rotation
- Higher than expected current draw
- Poor speed/position loop tuning results
- PAF related drive errors (if any)

Tuning iDrive servo control loops

The iDrive control structure is cascade current, speed and position loops, in respective order. The current loop is the inner most loop. **Because the current loop is the inner most loop, special care must be taken that this loop ONLY be retuned if absolutely necessary. An incorrectly tuned current loop will degrade the performance of the whole system.**

With cascade control, the tuning is performed from inner most loop outward. The general procedure for tuning is as follows:

Step:

1. Evaluate factory set current loop step response if desired (optional). Optimize current loop response only if necessary.
2. If iDrive used in speed or position mode, evaluate factory set speed loop step response. Optimize speed loop response for connected load (or avg. load if varying load application) as necessary.
3. If iDrive used in position mode, evaluate factory set position loop response to most aggressive move profile as desired. Optimize position loop response for connected load (or avg. load if varying load application) as necessary.

Note that the torque mode configuration activates only the current loop (any speed or position loops are closed externally). This is why it is not necessary to do any other loop tuning in this mode. However, for start-up testing and servo analysis/troubleshooting purposes, it can be useful to run the drive in speed/position mode. In this case, the corresponding loops must be evaluated/tuned as necessary.

Only persons experienced in servo motor control should perform servo loop tuning procedures.

Before performing any tuning procedures, ensure the following checks are performed:

1. All relevant instruction/information from the applicable product manuals has been applied. Special attention given to electrical noise control: cable shielding, shield termination, component/system grounding, bonding etc.
2. Servo motor/encoder wired per iDrive phasing standard.
3. Correct motor parameters entered.

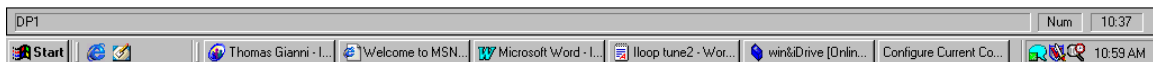
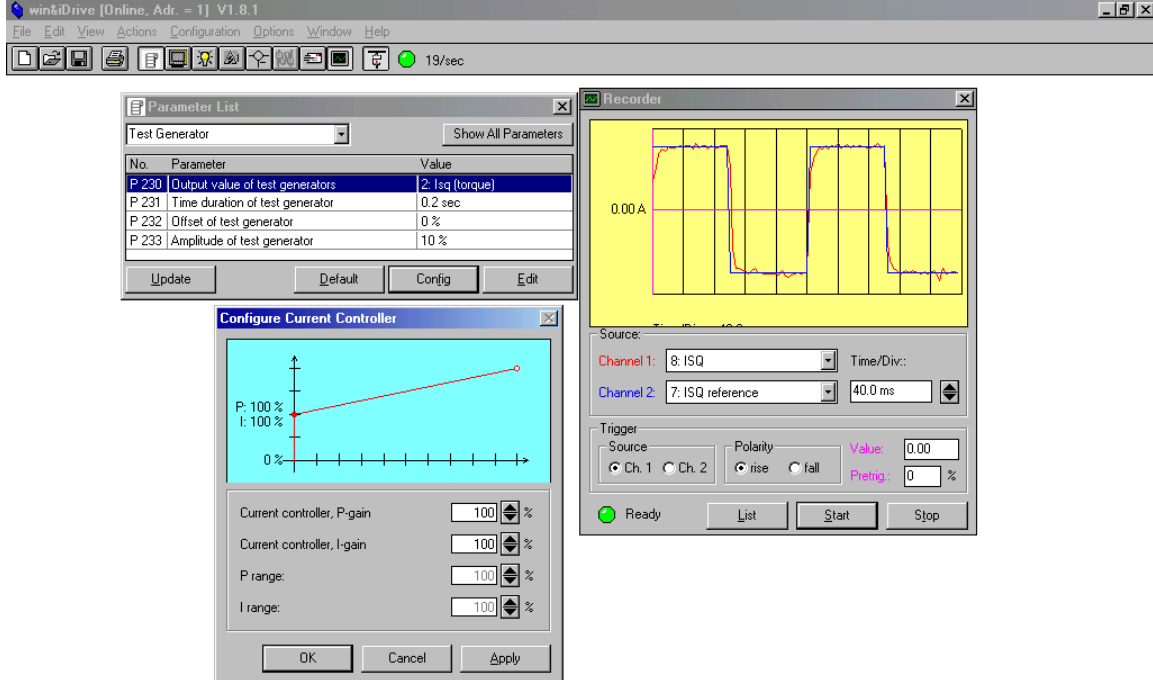
Tuning Procedures

CAUTION: SUDDEN BIDIRECTIONAL MOTOR ROTATION OCCURS!

Current Loop: (retune only if necessary as previously explained)

Step

1. Motor can be tuned loaded or unloaded.
2. If pole angle finding set to 0, program a digital input for enable function and wire accordingly.
3. Set P22 = 1 and set control mode to speed/encoder (P23 = 2).
4. Cycle power to the drive, waiting at least 5 seconds before reapplying.
5. Set up test generator parameters as shown in the sample Test Generator screen. The preferred method of data entry is to highlight one of the four parameters and click Config. Enter the data in the graphical screen view. Note: Forgetting to highlight one of the parameters may cause the software to lock up.
6. Confirm test generator setting with Apply and close window.
7. Enable the drive (if applicable) and press the RUN key. Motor should now begin the bidirectional tuning motion.
8. Open the recorder (oscilloscope) utility.
9. Set up recorder as shown in sample Recorder screen. Start recorder.
10. Evaluate factory default step response (P75,P76 = 100%). If similar to sample response trace, no further adjustment necessary.
11. NOTE: for a majority of general motion control applications, fully optimized current loop tuning is not required. If the default factory tuning response is poor or fine-tuning required, adjust P-gain and I-gain accordingly.
12. If a good tune is not achievable, recheck the motor parameters, especially Resistance and Inductance. Other possibilities include: mismatched motor-drive (voltage, current); electrical noise interference; faulty motor or drive. Also try repeating entire procedure after power reset of drive and software (close/reopen).
13. Turn off Test Generator when done (P230 =0).



Speed Loop:

Step

1. Motor must be tuned under actual loaded condition(s).
2. If pole angle finding set to 0, program a digital input for enable function and wire accordingly.
3. Set P22 = 1 and set control mode to speed/encoder (P23 = 2).
4. Cycle power to the drive, waiting at least 5 seconds before reapplying.
5. Set up for test generator mode: Ramps P1, P2 = 0, Nmin (P4) = 0, S-ramp P90 = 0.
6. Set up test generator parameters as shown in the sample Test Generator screen. The preferred method of data entry is to highlight one of the four parameters and click Config. Enter the data in the graphical screen view. Note: Forgetting to highlight one of the parameters may cause the software to lock up.
7. Confirm test generator setting with Apply and close window.
8. Enable the drive (if applicable) and press the RUN key. Motor should now begin the bidirectional tuning motion.
9. Open the recorder (oscilloscope) utility.
10. Set up recorder as shown in sample Recorder screen. Start recorder.
11. Evaluate factory default step response (P72 = 3%, P73 = 0.5%). If similar to sample response trace, no further adjustment necessary. Special attention should be given to the stability and settling time in comparison to the application requirements.
12. If the default factory tuning response is poor or fine-tuning required, adjust P-gain and I-gain accordingly.

1. If a good tune is not achievable, recheck the motor parameters, especially Resistance and Inductance. Other possibilities include: mechanical/load problem, undersized motor or drive; mismatched motor-drive (voltage, current); electrical noise interference; faulty motor or drive. Also try repeating entire procedure after power reset of drive and software (close/reopen).
2. Turn off Test Generator when done (P230 =0).



Parameter List

Test Generator Show All Parameters

No.	Parameter	Value
P 230	Output value of test generators	4: Speed
P 231	Time duration of test generator	0.5 sec
P 232	Offset of test generator	0 %
P 233	Amplitude of test generator	10 %

Update Default Config Edit

Recorder

Source:

Channel 1: 4: Encoder speed Time/Div.: 100 ms

Channel 2: 3: Ramp output

Trigger:

Source: Ch. 1 Ch. 2 Polarity: rise fall Value: 0 Pretrig: 0 %

Idle List Start Stop

Configure Speed Controller

Speed controller, P-gain: 15.00 %

Speed controller, I-gain: 3.50 %

P range: 20 %

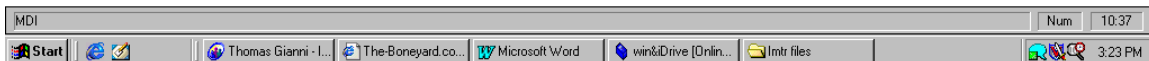
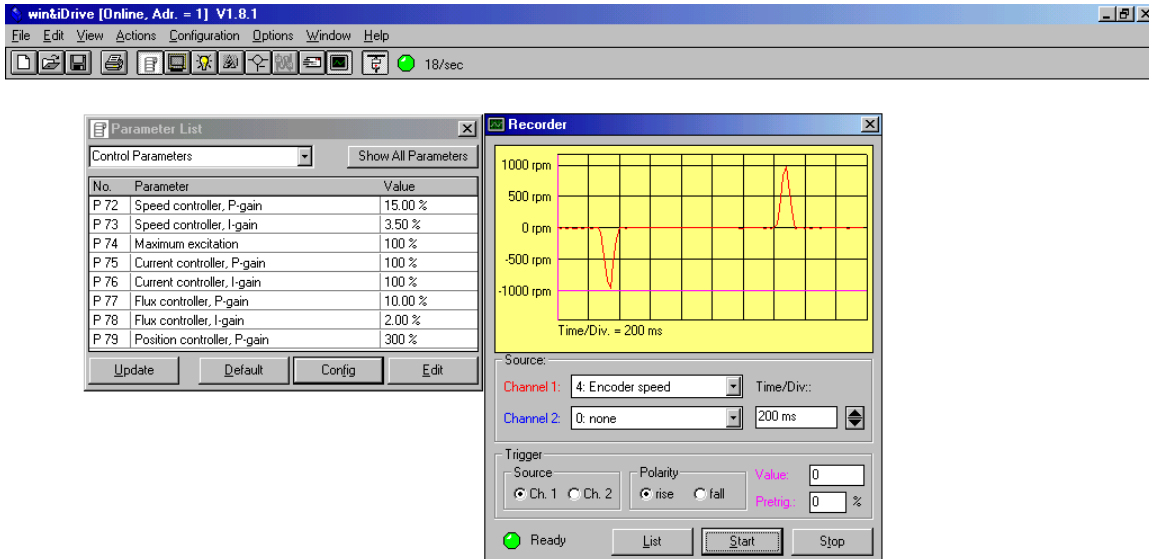
I range: 5 %

OK Cancel Apply



Position Loop:

The current iDrive version does not allow position step tuning via the Test Generator with position step response trace capture. To evaluate/tune the position loop, a basic position test program, like the one shown, can be used. Accel/Decel (P603/P604) should be set at least equal to the maximum for the



application. This method is sufficient for most applications.

Step

1. While position test programming running:
2. Open the recorder (oscilloscope) utility.
3. Set up recorder as shown in sample Recorder screen. Start recorder.
4. Evaluate factory default position response (P79 = 100%). If similar to sample response trace, no further adjustment necessary. Special attention should be given to the stability and settling time in comparison to the application requirements.
5. If the default factory tuning response is poor or fine-tuning required, adjust the P-gain accordingly.
6. If a good tune is not achievable, recheck the motor parameters, especially Resistance and Inductance. Other possibilities include: mechanical/load problem, undersized motor or drive; mismatched motor-drive (voltage, current); electrical noise interference; faulty motor or drive. Also try repeating entire procedure after power reset of drive and software (close/reopen).

THE iDrive IS NOW READY FOR APPLICATION PROGRAMMING AND NORMAL OPERATION.

Sample Position Tuning Program:

; Basic Rotary Position Sample Program, bi-directional
; motion, no homing, +/- 8000 counts.
; IMPORTANT: 1. For stable/best response, speed loop
; (P72,73) and position loop (P79) must be tuned properly
; for connected motor/load. 2. P5 can be increased as required
; for the application. Not to exceed the encoder frequency
; limit of connected motor/encoder combination
; (or value in motor file). 3. P603 accel and P604 decel
; limited by motor/drive/load.
; created 2/11/03 Bayside Motion Group

Par #	Value	Parameter Description
5	1000	Maximum speed (see header note)
20	7	Display = position units
22	2	Input = digital inputs
23	5	Control mode = positioning
24	1	Enable after power on
40	1	L5 = enable (need for P109 = 0)
41	24	L6 = start sequence command
42	0	L7 = none assigned
43	0	L8 = none assigned
44	0	L9 = none assigned
600	0	Position units = encoder counts (AqB)
603	200	Acceleration in RPM/sec
604	200	Deceleration in RPM/sec
620	9	Sequence control method
621	4	Sequence stop method
622	0	Torque hold mode
623	0	Position sequence first block
624	1	Position sequence last block
700	8000	Position reference 1 in counts
701	1000	Positioning velocity 1 in RPM
702	100	Position delay time 1 in sec i...idd
705	-8000	Position reference 2 in counts
706	1000	Positioning velocity 2 in RPM
707	100	Position delay time 2 in sec

Other sample configuration test programs (not for tuning)

; KEYPAD Speed Mode set-up parameters:
; IMPORTANT: 1. For stable/best response, speed loop
; (P72, P73) must be tuned properly for connected motor/load.
; 2. P5 can be increased as required for the application.
; Not to exceed the encoder frequency limit of connected
; motor/encoder combination (or value in motor file).
; created 2/06/03 Bayside Motion Group

Par #	Value	Parameter Description
1	0	Ramp-up time 0..P6 = no delay
2	0	Ramp-down time P7..0 = no delay
4	0	Minimum speed = 0 RPM
5	1000	Max speed in RPM (see header note!)
20	0	Choice of the display value = RPM
22	0	Input source = keypad
23	2	Control mode = speed w/encoder
24	0	Enable after power on = off
36	0	Filter time constant of analog input= zero
40	0	L5 = none assigned
41	0	L6 = none assigned
42	0	L7 = none assigned
43	0	L8 = none assigned
44	0	L9 = none assigned
109	1	Start encoder commutation on power up (P40=0)

; Basic Analog Torque Mode set-up parameters: command signal
; with L5 enable switch.
; IMPORTANT: P35 can be increased as required for application.
; Should not exceed P3 of motor file: maximum allowable torque
; current of motor-drive system (combination).
; Use with motor file parameters for connected motor type
; created 1/31/03 Bayside Motion Group

Par #	Value	Parameter Description
20	2	Choice of the display value = motor current
22	1	Input source = analog command
23	4	Control mode = torque with encoder
24	1	Enable after power on = active
32	2	Analog input range = 0 to +/- 10V
33	0	Add analog input = no
34	0	Torque at 0V = 0%
35	100	Torque at 10V = 100% default (see header note)
36	0	Filter time constant of analog input = zero
40	1	Function of digital input L5 = enable (for P109=0)
41	0	Function of digital input L6 = none assigned
42	0	Function of digital input L7 = none assigned
43	0	Function of digital input L8 = none assigned
44	0	Function of digital input L9 = none assigned

; Basic Analog Speed Mode set-up parameters: external command
; signal with L5 enable switch.
; IMPORTANT: 1. For stable/best response, speed loop
; (P72, P73) must be tuned properly for connected motor/load.
; 2. P5 can be increased as required for the application.
; Not to exceed the encoder frequency limit of connected
; motor/encoder combination (or value in motor file).
; created 1/31/03 Bayside Motion Group

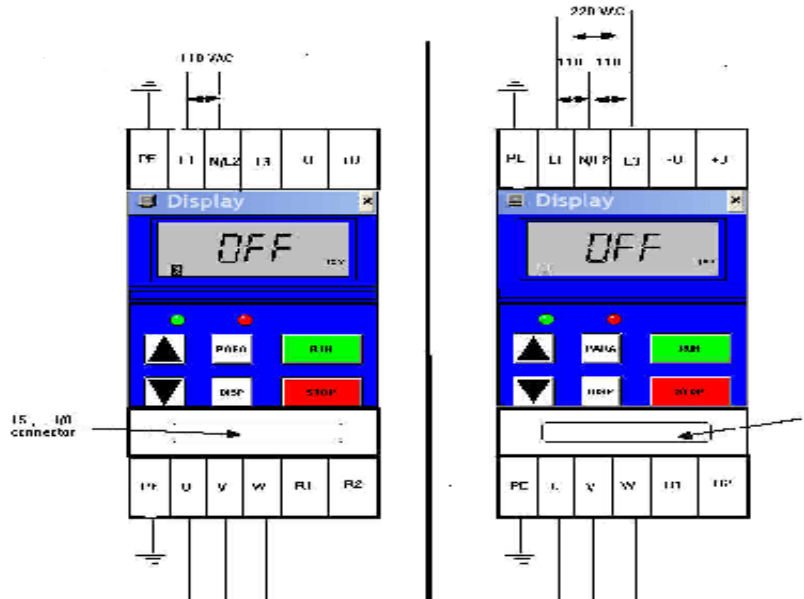
Par #	Value	Parameter Description
1	0	Ramp-up time 0..P6 = no delay
2	0	Ramp-down time P7..0 = no delay
4	0	Minimum speed = 0 RPM
5	1000	Max speed in RPM (see header note!)
20	0	Choice of the display value = RPM
22	1	Input source = analog command
23	2	Control mode = speed w/encoder
24	1	Enable after power on = active
30	0	Speed at 0V = in RPM
31	1000	Speed at 10V = in RPM (can increase to P5)
32	2	Analog input range = +/- 10V
33	0	Add analog input = no
36	0	Filter time constant of analog input= zero
40	1	L5 = enable (for P109=0)
41	0	L6 = none assigned
42	0	L7 = none assigned
43	0	L8 = none assigned
44	0	L9 = none assigned

Bayside Plug&Play Quickstart:

- Bayside BM/GM motor with encoder
- Plug&Play cables
- Bayside BM/GM catalog motor files (.txt file)
- Bayside sample configuration file (keyspdmd.txt)

A. Wiring

1. Connect AC line per diagram.
2. Connect sensor cable.
3. Connect motor cable: wire flying leads to UVW per the wiring table for A/B vs. C/D winding type.
4. Connect serial cable with RS232/485 adapter in drive end.
5. Apply AC power, Drive display should show OFF, Red LED on and Green LED flashing.



B. Programming

1. Ensure starting with factory default parameter values by powering down drive and while holding down the PARA key, back up after 20 second delay.
2. Install win&I-drive software and open.
3. Click online icon (extreme right icon on main screen top). LED will turn green on successful connection.
4. Load .txt files: First, load corresponding BM/GM motor file (after opening the file and reading the notes) via File > Load From Text File command. Note that a read error usually leaves the parameter at the factory default or previous value. A P3 (maximum torque current percentage) or P103 (motor rated current) read error usually indicates the drive model is undersized relative to the motor peak or continuous rating. In this case, if possible, P3 or P103 must be manually set as required by the application sizing within the drive limit as explained in the PROGRAMMING section (assuming application does not require a larger drive). Next, load the Keypad Speed Mode file (keyspdmd.txt) after opening and reading the notes.
5. To accept parameter changes, power drive down and back up after a 20 second delay. Small bidirectional motor motion on power up is the pole angle finding initialization. **If displays comes up with error E 11**, most likely, P3 is set too high (due to internal rounding error after invalid P3 value read). Calculate valid P3 per PROGRAMMING section, enter and repeat step 5. If still E 11, try slightly lower value of P3 in case of internal rounding error.

C. Run motor (factory default tuning)

1. Press RUN key. Use up and down arrow keys to vary speed between 0 and 1000 rpm in CW shaft direction.
2. Reverse direction of rotation by pressing RUN key for more than 1 second.
3. Follow complete start up guide for adaptation of parameters for actual application.