POWERTEC
INDUSTRIAL MOTORS, INC.

Application Note
Electronic Line Shafting

I. **Application Summary:** Powertec FlexMax drives and brushless motors can provide precise speed and position following from a master drive with many slaves. This feature is built into each FlexMax drive and requires no options or accessories to accomplish other than the cable to carry master shaft information to the slave drives.

II. **FastLink Setup:** FastLink is a simple-to-use 4 Mb/sec proprietary communications link that provides master drive information to slaves.

   A. **Master Drive:** The master drive requires only that the set up be appropriate to ELS operation. There are two ways to get the master shaft position information into the slaves. One is the encoder repetition output and the other is the FastLink output. By far, the simplest solution is to use the FastLink.

   B. **Set up of Master FastLink operation:** Go to Menu 10 (Drive Parameters) and set parameter 18110 (Drive FastLink) to "Master[XT-OUT]" (or 1 if using keypad). This is the only setup required for the master drive. The pulse information passed to the slave will be based on the default 2048 ppr if using the standard resolver on the master, at any rate, it will be the value in Menu 30 (encoder parameters), parameter 20011 (encoder pulses).

   C. **Slave Drive:** Each slave will be connected to the master via a Fast Link cable. This cable looks like a standard RJ-14

telephone cable BUT IT IS NOT. The cable needs to be a shielded type, available from Powertec, and is typically 24" long. Successive drives are "daisy chained" using these cables so the drives need to mounted close to each other in an enclosure. See the attached sketch indicating the proper layout. Another difference between this and standard RJ-14 cable is that the connections are "pin-to-pin" rather than "mirrored" as they are in standard telephone cable. Each drive has an "in" and "out" FastLink connector, so one drive can simply be daisy-chained to the next. If more than four slaves are necessary in the system, contact the factory. There are several ways to expand the line shaft to more drives when needed.

D. **Set up of Slave Drives for FastLink Operation:** As with the master, go to Menu 10 (Drive Parameters) and set parameter 18110 (Drive FastLink) to "Slave[XT-IN]" (or 2 if using keypad). Next set parameter 20023 (Drive configuration) to "ELS" (note: drive must be reset before changes in "Drive Configuration" become active). Then go to Menu 180 (ELS) and set parameter 32000 (ELS pulses master) to 2048 (or the correct ppr for the encoder being used on the master). Set parameter 32009 (ELS Master Sel) to FastLink. You have a choice of encoder (if you are following an encoder input) or the FastLink. The default ramping rate (parameter 32014) for changes in ratio of the line shaft following (when changes of ratio are commanded) is 1.0000 every 8 milliseconds. (8 milliseconds is the scan rate for this parameter when changed). This is quite fast. It means than when a slave is enabled and a master is already running, the slave will ramp from a following ratio of zero to a following ratio of 1.0000 in 8 milliseconds. If you change the slave ratio while running to 1.5000, it will change to the new ratio within 4 milliseconds. It is recommended that the slave be set to 0.01 for this value,

but your application may require that this be faster. For instance. If you have a line that starts from zero and must stay in sync from zero, then the slaves MUST BE IN RUN before the master is enabled. Of course when the slave is put in run, it will not turn because there are no master pulses yet. Furthermore, since the slave will ramp its ratio from zero at the rate in parameter 32014, the slave will ramp from zero to a ratio of 1.0000 in 800 ms if 32014 is set to .01. In such a case, the master must be delayed on start for at least 800 ms AFTER enabling/run the slaves). Finally, go to Menu 181 (Elect L Shaft Ratio) and set parameter 32001 (ELS Ratio [0]) to the desired speed ratio. The ratio may be set from –8.000000 to +7.900000 (negative ratios for slave direction of rotation opposite master). Up to four preset ratios may be set and selected by parameter 32006 (default is 0) or by digital input.

III. **Set up for ELS when using Encoder Repetition rather than FastLink.** This is really quite simple and requires only that the master and slave drives FastLink be selected OFF (parameter 18110) which is the default configuration for the drive.

   A. **Master Configuration:** The encoder repetition output cable must be wired according to the manual, and jumper S1 on the EXP-BRS resolver/FastLink expansion board must be on. Menu 120, parameter 20035 (Enable encoder repetition) must be set to "Encoder only" (keypad: 1) or "Encoder+index" (keypad: 3) to enable the function. You can actually set the ppr output for this independently of the feedback encoder (or resolver) being used on the master. In other words, you can set 500 ppr in Menu 120, parameter 20030 if you like, even though the master may have a 4096 digital encoder for feedback. Normally, it is best to set this value at the same value as the master feedback.

B. Slave Configuration: If resolvers are used, it is necessary to have two cables coming into the rear of the back shell of the connector XFR since both the resolver input pins and the encoder repetition input pins are on XFR. Set parameter 20023 (Drive configuration) to "ELS" (note: drive must be reset before changes in "Drive Configuration" become active). Now go to Menu 180, parameter 32009 (ELS Master SEL and set this to "encoder" as the source for the line shaft information. Of course set parameter 32000 to the ppr you selected from the master as the encoder repetition ppr. This ability to set a different encoder repetition ppr from the master gives some flexibility in applications where the slave drive is not actually following the master drive, but following a pulses source like an encoder or other encoder repetition source. Set the rest of the parameters in Menus 180 and 181 per the instructions for the FastLink slave configuration.

IV. **Using the DIGIMAX device from Powertec:** See the application note titled "DIGIMAX Use with FlexMax Drives" for details on how this is accomplished. The FlexMax drive has "step and direction" inputs that allow any 5vdc pulse device to make the drive behave as if it was a stepper. In other words, one pulse in commands the drive to move the motor one pulse of feedback. If the master has a 2048 digital encoder (or a standard resolver), then one pulse in will cause the drive to move one encoder "edge". For a 2048 encoder, there are two channels, and a rising and trailing edge for each of the two channels, therefore 4 edges per pulse. In other words, a 2048 encoder has 8192 edges per revolution. If 8192 pulses were put into the step input and the ratio was set to 1.0000, the motor shaft would move 1 revolution. For more information on Step and Direction and Digimax operation see the "DIGIMAX Use with FlexMax Drives" Application Note.

Connection of multiple drives using FastLink

Master		Slave		Slave		Slave		Slave
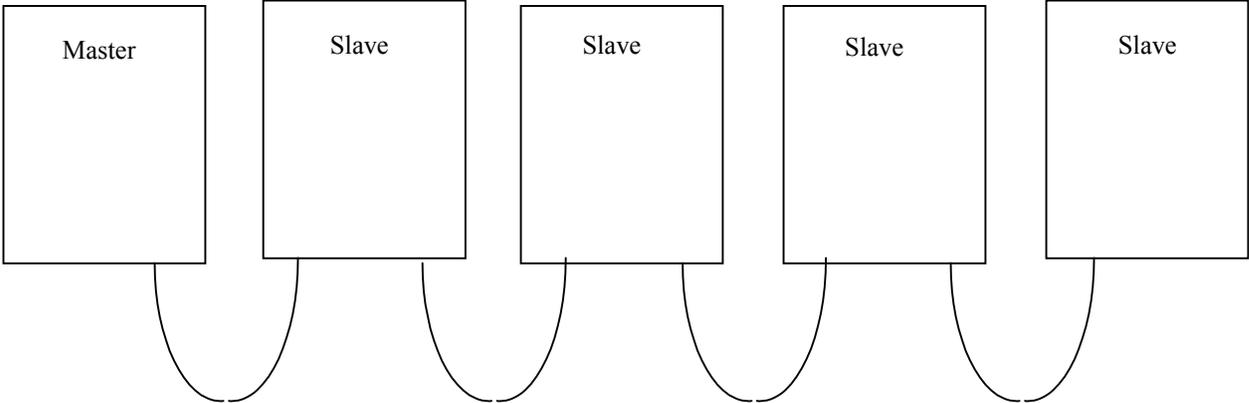
Cables used are Shielded and have RJ-14 connectors on the end, connections are pin-to-pin and a standard RJ-14 telephone extension cable cannot be used.