

INTROLOC 1
Digital Speed Controller
and Synchronizer



Dec., 1992

IMPORTANT

This control has been designed as a component intended to be implemented in a control system. Introl Design, Inc. has no control over the numerous control schemes, therefore it is the responsibility of the user to install this device in a system with the safeguards in place to prevent personal injury or equipment damage. The user should comply with the National Electrical Code as well as any local or other applicable codes. Although every effort has been made to assure the accuracy of the information contained in this manual, Introl Design, Inc. accepts no liability whatsoever with respect to the information provided herein. There are no implied warranties of merchantability or fitness for a particular purpose that apply to the control described in this manual.

Revisions

Revision	Date	Description
01	8/93	Manual rewritten
02	12/15/93	Serial communication section added Updates/amendments made to pages: 3, 4
03	6/20/94	Manual reprinted Updates/amendments made to pages: 3, 4, 11, 13, 16, 20, 22, 23, 25, 27, 29, 30, 31, 34, 35, 36
04	7/13/94	Updates/amendments made to pages: 20, 21, 30, 31

CONTENTS

For simplification and ease of understanding, this manual is divided in to 4 sections.

1. General information that applies to all modes of operation.
2. Speed (Master) Mode - setup, tuning and operation.
3. Follower (Ratio) Mode - setup, tuning and operation.
4. Position Synchronizer Mode - setup, tuning and operation.

Introduction	2
Specifications	3
Installation	4
Programming Section	6
Speed Controller Mode	8
Setup	8
Tuning	12
Operation	13
Follower (Ratio) Mode	15
Setup	16
Tuning	20
Operation	22
Position Synchronizer Mode	24
Setup	25
Tuning	30
Operation	31
Inputs	34
Serial Communication	39
Troubleshooting	46
Connection Diagrams	48

INTRODUCTION

The INTROLOC 1 is a 6 decade high resolution digital speed and position controller designed and manufactured by Introl Design Inc., Lockport, NY, USA. Introl has developed a sophisticated, yet simple to use INTROLOC 1 bearing in mind the difficulties one experiences trying to stabilize or speed match a line. The INTROLOC 1 allows bidirectional and unidirectional speed control, ratioed follower and position synchronization. Device assignment can be programmed directly through the front panel keypad or through the multidrop RS 422 serial interface. The INTROLOC 1 with its isolated reference output will interface with every type of variable speed drive to allow a multi axis control environment. The display of the INTROLOC 1 can be setup to read speed, ratio (lay) or phase relationship with an option to alternate between display options at run time for quick verification. There are no potentiometers to adjust, no jumper programming, everything is programmable for ease of setup, replacement and reducing down time. Two level programmable security is provided to limit unauthorized access through the front panel keypad.

The INTROLOC 1 will perform excellently with servos as well as the slowest response drives. The bidirectional ratioed follower mode promises a low cost, precision traverse controller for wire and cable winding machinery with optional inverse ratio calculation. When in the follower mode, in situations where the master is operating at line speed, the INTROLOC 1 can start the follower drive from rest and arrive to synch speed smoothly and in a well behaved manner. The INTROLOC 1 will maintain absolute relative position to the lead (master) motor regardless of direction and or speed changes of the master motor. The position synchronizer mode can be set up for constant update to compensate for material stretch or slip.

- Precision speed control (speed regulator) for metering pumps, extruders, conveyors etc.
- Accurate ratioed speed follower for winder traverse, printing press, assembly and packaging lines, transfer conveyors and takeaways.
- Excellent synchronizer for multi color printing press, rotary cutters, filler lines, assembly and packaging lines.

Please fill out the following information from the back of the unit. You will need this information anytime you call for service.

Device Model Number _____
 Serial Number _____
 Date of Purchase and or _____
 installation

SPECIFICATIONS

Input Power	120/240 vac \pm 15%, single phase, 50/60 Hz. or 12 to 15 vdc. 10 VA max.		
Control Options	Unidirectional or bidirectional closed loop or open loop as: <ol style="list-style-type: none"> 1. Speed regulator. 2. Ratioed Follower 3. Follower with position synchronizer. 		
Response	10 millisecond control loop update.		
Tuning	Feed Forward - open loop gain and open loop integration rate. PID - separately programmable gain, integral, rate and error correction factor to achieve stability and response.		
Presets	Speed/Ratio, manual set point, jog, 8 preprogrammable set points. 6 decade programmable .000001 to 999999. Not to exceed 50 kHz feedback frequency.		
Accel/Decel	0 to 600 seconds. Ramp disable input will stop ramp and maintain the velocity at which the slave was running.		
Inputs	<p>Reference and Feedback - 0-50 kHz single or dual channel, quadrature type encoders or zero speed pickups (TTL, open collector sinking with pull up or open emitter (sourcing) with pull downs). 5 to 48 vdc or magnetic pick up.</p> <p>Position Sensing Device - Open collector (sinking) proximity or encoder reference pulse. (Channel Z or marker). 0-50 Hz.</p>		
Control Inputs	5-15 volt current sinking or contact closure must be able to sink 10 ma minimum.		
	<u>Speed Mode</u>	<u>Ratio Mode</u>	<u>Synch Mode</u>
	Run/Stop	Run/Stop	Run/Stop
	Jog	Jog	Jog
	Ramp Disable	Hold Update	Hold Update
	Forward/Reverse	Forward/Reverse	Forward/Reverse
	Memory Select	Memory Select	Phase
	Increase Speed	Increase Ratio	
	Decrease Speed	Decrease Ratio	
Accuracy	\pm 1 encoder pulse.		
Following Error Storage	\pm 8,300,000 In feedback pulse unit.		

SPECIFICATIONS

Outputs	Status Outputs - Ramp done (@ speed or in synch), zero speed, open collector 50 ma @ 24 vdc.	
	Analog Output - 0 to ± 10 vdc or 0 to ± 20 vdc 12 bit resolution isolated.	
	Output Power - 5 vdc @ 500 ma used for master and slave encoder power. 10-15 vdc nonregulated @ 100 ma used for proximity pickups.	
Serial Interface	RS 422, 300 to 4800 baud to control and program.	
Operating Temperature	0 to 55° C	
Humidity	0 to 90% non-condensing.	
Physical Dimensions	5.375" \times 3.00" \times 7.35"	Bezel Size : 6.625" W \times 4.00" H

INSTALLATION

This section provides information and directions on installing and wiring the INTROLOC 1. The procedures given in this section must be read and carefully followed to insure a safe and trouble free operation of the system.

The installation of this device must conform with local and national electrical codes.

WARNING: Hazardous potentials may exist during some parts of the setup. This device should be installed by qualified electrical maintenance personnel.

1. All units have been factory set to operate on 120 vac unless otherwise specified on the unit. To convert from 120 vac to 240 vac, or from 240 to 120, please follow the directions below. If the internal line fuse needs to be replaced, refer to steps A and B.

All models of the INTROLOC 1 can be powered from an external 12 to 15 vdc power source. For DC power input, connect (+) to terminal 20 and common (-) to 21.

- A. Remove the top cover by removing the screw at the rear of the device. Slide the cover all the way to the back and up.
- B. Remove the three screws holding the top half of the pc board to the lower board. Slide the top pc board toward the front of the controller and flip toward the front.
- C. Make the jumper connection by the fuse as follows:

120 vac	D to E, B to A.
240 vac	D to C, B to C.

<continued>

INSTALLATION (continued)

- D. Reinstall the top board and cover.
 - E. Make a note of the voltage change on the device for future reference.
2. Select a location to install the controller.
If this device is being mounted in an enclosure door, prior to making a cutout make sure when the door is closed it will not interfere with any equipment mounted inside the enclosure.
 3. Refer to the end of this manual for cutout and hole pattern to be made in the enclosure door or shell.
 4. Slide the unit into the mounting hole and fasten the unit with four 8-32 screws through the drilled panels.
 5. Before connecting the INTROLOC 1 to the drive it is necessary to adjust the drive so it can perform favorably with an external speed pot.
 - A. Set the accel and decel of the drive to minimum (fastest rate).
 - B. Set the IR compensation, if it exists to minimum.
 - C. Set the response of the drive to a moderate setting where it does not run rough.
 - D. Adjust the external speed potentiometer to 9 vdc at the wiper (reference to the drive). Adjust the max speed to achieve the maximum operation speed. For bidirectional operation make sure the motor reverses direction as the polarity of reference changes.
 - E. Set the minimum speed of the drive to zero or bypass. Some drives reference common is passed through a minimum speed potentiometer on the drive. It may be necessary to connect the reference common to the common of the drive instead. Consult your drive manual.
 6. Wiring has been simplified by the use of terminal blocks that snap apart. After wiring, the blocks are snapped together. To remove the unit, remove power and separate the plugs leaving the wiring intact to the rear plug section.

WARNING: There are two separate terminal blocks provided at the rear of the INTROLOC 1. The lower 24 pin terminal (TB2) is used for power and all discrete input/outputs. The upper 8 pin terminal (TB1) is isolated from the lower terminal to provide isolated speed reference to the drive. DO NOT MAKE ANY CONNECTIONS BETWEEN UPPER TERMINAL TO LOWER OR TO EARTH GROUND.

Select a connection diagram provided at the end of this manual that fits to your application and wire accordingly. Wire gauge of 18 AWG is recommended.

To avoid noise problems, keep the signal wires away from other wires carrying high current and use shielded cables where designated. All AC/DC relays, solenoids used as part of the system must be suppressed. See page 49.

PROGRAMMING SECTION

Before proceeding with the next step, you must know the following machine parameters: gear ratios, encoder type and resolution.

The following steps describe the mode selection and programming procedures. All mode selections are accessible directly through the front panel keypad or through the RS 422 serial communications port. Each step is demonstrated as they will appear on the display of the device in abbreviated English. For simplicity each step is numbered in this manual. These steps will be referred to by number and or function throughout this manual.

- A. The factory default parameters are suitable for most applications and will provide a starting point for others. To restore the default parameters at anytime press **•** and hold, power up. When "DEFAULT" is displayed, depression of **ENTER** will continue restoring the factory parameters. Depression of any other key will resume normal operation.
- B. Turn the power on and press **MENU** until "CODE" is displayed.
- C. Program "8788" then press the **ENTER** key to allow access to the setup parameters. During setup, depending on the mode selected, some steps will become invisible since it does not apply to the selected mode. Pressing **PHASE** will exit the setup mode.

Page 8 demonstrates an overall view of the INTROLOC 1 setup parameters. The values entered are the factory default parameters and are to be used as reference only. All of the setup parameters and presets are stored in nonvolatile memory with 30 year data retention (no battery backup needed). Each of the setup parameters are described in the selected mode of operation as they apply to that mode.

Speed controller mode see page 8.

Follower (ratio) mode see page 15.

Synchronizer mode see page 24.

1	Ctrl.SPEED	Ctrl.rAt, o	<p> PHASE TO EXIT ▽ TO ENTER AND GO TO NEXT ▲ TO ENTER AND GO TO PREVIOUS CLEAR TO CLEAR THE PREVIOUSLY ENTERED DATA OR TO SWITCH BETWEEN OPTIONS. 0/- TO 9 & . TO ENTER NUMERICAL DATA </p>	
2	uPdt. OFF	uPdt. on		
3	ConstAnt	Si nGLE		
4	Ph. 0			
5	d.oP.SPEED	d.oP.rAt, o		d.oP.PhASE
6	r.P. 60			
7	rEF. ~ ~ ~	rEF. Si nE		
8	F.P. 60			
9	F.b. ~ ~ ~	F.b. Si nE		
10	ACCEL 10			
11	DECEL 10			
12	dP.no. 0			
13	UG. 100			
14	out.unid.	out.bi dir.		
15	inc. 10			
16	bAnd on	bAnd OFF		
17	PL. 500			
18	P.dEL on	P.dEL OFF		
19	P.rEC. 2			
20	GRin 5			
21	intG. 150			
22	rAtE 7			
23	bRud.4800			
24	id.no. 1			
25	Loc. 0			
26	HL. 2000			
27	F.F.rE. 30			

SPEED CONTROLLER MODE

INTRODUCTION

The speed controller mode will control a precision speed of one motor by constantly monitoring speed from either an incremental encoder (single or dual channel), magnetic pickup, zero speed pickup or even an ac tachometer. The feedback frequency received from the motor is compared with the commanded set point to develop an error. The resultant error is then passed through programmable error limits and then the enhanced digital (PID) loop. The output from the PID loop is then summed with the feed forward, converted to an analog signal and passed through the ground isolation circuitry. This analog signal will then be suitable for every dc or ac adjustable speed drive without the need for further isolation. Bidirectional speed control is achieved by selecting the direction input prior to the RUN command. The SPEED command can be programmed through the front panel or through the serial port if the (LOC) security is not activated. Eight preprogrammed set points can be recalled via discrete inputs.

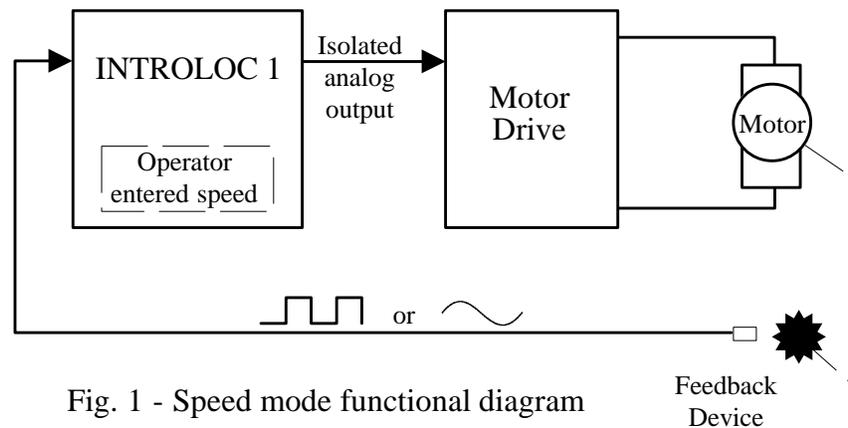


Fig. 1 - Speed mode functional diagram

SETUP

1. **CTR.**

Control. This step selects mode of operation. Select speed then press **ENTER** .

<Steps 2-7 are omitted in speed mode>

8. **F.P.**

Feedback Pulses. F.P. is the number of encoder pulses that would be generated by the feedback device in one minute when "1" is programmed as the set point (speed command). For example if the feedback device is mounted on the motor, to program set points in rpm, F.P. is equal to the encoder resolution. Programmable 6 decade with decimal point.

Example: a 60 tooth magnetic pickup is mounted at the motor shaft operating a pump. The pump makes 30.98 revolutions per one gallon output, to program in gallons/minute
 $F.P. = 60 * 30.98 = 1858.8$

The display will automatically calibrate to read in gallons/minute or any other unit relating to F.P.

SETUP (continued)9. **F.B**

Feedback Device Type. This parameter is used to select the type of feedback device. For squarewave encoders and zero speed pickups select . Select **sine** for magnetic pickups, ac tachometers and zero crossing devices.

10. **ACCEL**

Acceleration Time. 0 to 600 seconds in 0.1 increments. This is the time it will take to increase speed to programmed maximum speed at line 26 (H.L.).

11. **DECEL**

Deceleration Time. 0 to 600 seconds in 0.1 increments. This is the time it will take to reduce speed to zero from the programmed maximum speed at line 26 (H.L.).

12. **DP.NO.**

Decimal Point. This is the number of decimal places on the display for speed readout.

13. **JG.**

Jog speed. Programmable 0.000001 to 999999. Programmed in the unit that F.P was calculated.

14. **OUT.**

Output. Analog reference output to the drive, bidirectional or unidirectional.

Bidirectional - 0 to ± 10 vdc for servos and reversible drives. When bidirectional is selected, the feedback encoder must be a dual channel quadrature type.

Unidirectional - 0 to + 10 vdc or 0 to - 10 vdc based on which output terminal is used (see connection diagrams). When unidirectional is selected, the analog output will not cross zero. This option is usually used with single channel encoders and magnetic

15. **INC.**

Increase/Decrease. The rate at which the increase/decrease speed inputs will operate is set by this step. The number programmed at this step is usually set by trial and error. Higher value entry results in faster change in speed for a given time. Programmable 0 to 9999. If the rate of change becomes greater than accel/decel rate the accel/decel dictates the rate of change in speed. The speed will change as long as the corresponding input remains activated.

The following instructions are for those who would like to correlate the rate of change to the pulse width or the time that the increase/decrease inputs are active.

Example 1: The relationship between increase/decrease input to speed change is best described by the equation shown on the next page.

SETUP (continued)

15. (cont) Change speed per second = $\frac{1500 (\text{constant \#}) * \# \text{ programmed in line 15}}{\text{F.P. (feedback pulses)}}$

In most cases we know how much change in speed we would like, therefore, the above equation can be written differently to calculate what number should be programmed in step 15 to give the desired change.

$$\text{Value to be programmed} = \frac{\text{Speed change per second} * \text{F.P. (feedback pulses)}}{1500}$$

<For most applications, steps 16, 17, and 18 are not used.>

16. **BAND.**

Digital Band. When this step is set to ON it will work in conjunction with steps 17 and 18. It enables the INTROLOC 1 to process only the programmed \pm error pulses in step 17 and either remember the excess error or dispose of the error based on the state of step 18 (pulse delete ON/OFF).

Generally with very slow unidirectional drives and or the high inertia of a load, when the controller is started or stopped with a faster accel/decel rate than the drive and load can handle, usually a large following error will develop. This error can be controlled and minimized by setting steps 16 and 18 to ON and programming the \pm number of pulses that should be recovered in step 17.

- The motor could overshoot its set point, run at maximum speed, go to zero speed then back up depending on the severity of the accumulated error without the use of this step for the condition described above.

17. **P.L.**

Error pulse limit. The number of error pulses (in feedback pulses) that should be allowed to influence the PID loop and affect the analog output. Programmable from 0 to 999999.

18. **P.DEL.**

Pulse delete. When the pulse limit is reached and this step is set to on, the error pulses over and beyond the specified amount in step 17 (P.L.) will be disposed.

19. **P.REC.**

Pulse (Error) Recovery. Not used in this mode. Set to zero.

20. **GAIN**

Proportional Gain. The scaled master reference pulses are subtracted from the feedback pulses every 10 milliseconds to calculate the error. The calculated error is multiplied by the entry at this step and then divided by the scaling constant to drive the proportional term of the PID loop. Programmable 0 to 200.

SETUP (continued)21. **INTG.**

Integral Gain. The scaled master reference pulses are subtracted from the feedback pulses every 10 milliseconds to calculate the error. The calculated error is then summed with the previous errors. This is the total running accumulated error. This total error is then multiplied by the entry at this step then divided by the scaling constant to drive the integral term of the PID loop. Programmable 0 to 9999.

22. **RATE.**

Differential Gain. The scaled master reference pulses are subtracted from the feedback pulses every 10 milliseconds to calculate the error. The present error is subtracted from the previous sample to calculate the rate of change. The rate of change is then multiplied by the entry at this step then divided by the scaling constant to drive the differential term of the PID loop. Programmable 0 to 200.

23. **BAUD.**

Baud Rate. Serial port (RS 422) baud rate. Programmable 300, 600, 1200, 2400, 4800. 8 data bits, one start and one stop bit, no parity.

24. **ID.NO.**

Device ID Number (address). Each INTROLOC 1 can be assigned an ID number and addressed on a multidrop RS 422 line.

25. **LOC**

Software Switch. Program 1 to ignore jog through the front panel. Program 2 to ignore programming set point through the front panel keypad. Program 3 to ignore programming set point and jog through the front panel keypad.

26. **H.L.**

High Limit. Maximum operating speed in the unit that line 8 (F.P.) was calculated and programmed in (rpm, fpm, gpm, rps, fps etc.). This step is necessary for the INTROLOC 1 to calculate accel/decel rate and the scaling constant for feed forward.

27. **F.F.r.t.**

Feed Forward Rate of Change. This parameter is fixed in many controllers. Making this a programmable parameter it is possible to set the response of the feed forward loop to provide the best possible response to interface with a variety of drives and load conditions. Programmable 0 to 200. When this step is set to zero the feed forward portion of the control loop is turned off and the analog output is only provided by the PID loop (100% trim). A Larger entry will quicken the follower response to master speed changes and reduce the instantaneous phase shift (following error).

TUNING PROCEDURE

The following instructions provide the necessary steps to tune the velocity and position loop of the INTROLOC 1 to achieve stability and response. Tuning the controller with the motor connected to the actual load (gear box, conveyor etc.) is recommended.

WARNING: Stay clear of all moving parts. Do not attempt to make any mechanical adjustments while the power is on.

Do not run production or product while tuning the controller.

After the tuning procedure is complete, make a note of all the INTROLOC 1 setup parameters.

- A. Set step 16 (BAND) to off.
- B. Program zero for steps 20 (GAIN), 21 (INTG.) and 22 (RATE).
- C. Program the maximum operating speed in step 26 (H.L.).
- D. Program 30 for step 27 (F.F.r.t.). 30 will provide a moderate response for most of the drives used. This number is not critical in this mode.
- E. Press PHASE. The display should read a previously programmed speed.
- F. Press CLEAR. Program a speed set point then press ENTER.
- G. Initiate run. The display should read SP. and the actual speed calibrated in your unit of measure. This number may not necessarily be at what it was commanded to run.

The INTROLOC 1 at this point is operating in an open loop mode. The feedback pulses are used for display purposes only.

- H. Adjust the maximum speed adjustment of the drive (or tach) so that the display of the INTROLOC 1 reads the same speed as was programmed in step F.

CAUTION: The display of the INTROLOC 1 should display a positive number. If you are using a dual channel encoder as a feedback and the display is showing a negative number, channel A and B of the feedback encoders are reversed. Turn the power off and correct before proceeding.

- I. Press MENU. "CODE" will be displayed. Program "8788" then press ENTER to access setup parameters.
- J. Press ENTER until GAIN is displayed. (Step 20).
- K. Press CLEAR. Increase the value by programming a new number then press ENTER. Press Δ to return to this step. Repeat this step until system becomes unstable or erratic. Once the unstable condition has been reached, reduce the GAIN until stable and smooth operation is achieved.

For servo and high bandwidth drives with velocity feedback loop, GAIN can be set to zero.

TUNING PROCEDURE (continued)

- L. Tune the integral gain (step 21). Increase the value by 10's or 20's until overshoot occurs. Changing speed set points and/or stopping/starting will aid in observing this overshoot. (Overshoot will occur when the motor shoots over the command set point before settling). Once overshoot has occurred, reduce integral gain to achieve stability.
- M. Differential gain (RATE step 22), is only needed if a sluggish response is experienced during speed changes and/or load shift. Increase RATE until it becomes erratic then reduce for smooth operation. Remember to change speed and/or start/stop while adjusting parameters.

For servo and high bandwidth drives with velocity feedback no RATE is required and could be set to zero.

OPERATION

This section describes the operation of the INTROLOC 1 and will provide the necessary instructions to enter a speed set point and how to access the 8 programmable set points.

At this point it is assumed that all of the setup parameters have been programmed and the controller has been properly connected and tuned.

When the power is turned on the INTROLOC 1 will default to stop regardless of the run input status. The previously entered speed is displayed at this time.

The INTROLOC 1 can be started externally via activation of the run input. If the run input is active and the power is turned on the INTROLOC 1 will not run. To initiate a run the run input must be deactivated then reactivated or press ENTER on the front panel keypad while the run input is active or jumpered.

To enter a new speed set point while the previous is being displayed, press CLEAR , enter the desired speed in your unit of measure, then press ENTER. Every time a new number is programmed the INTROLOC 1 clears the previously programmed number and stores the new number in nonvolatile memory. While the run input is active (ON), a new entry will cause the INTROLOC 1 to accelerate or decelerate to the new commanded speed. After the run is initiated, to enter a new set point simply program the desired speed, press ENTER. Every time a new speed has been entered the INTROLOC 1 will display - - - - - for one second, then will return to display the actual speed.

The INTROLOC 1 is programmable on the fly. All of the parameters can be accessed through the front panel or the serial port without disturbing the operation of the controller.

While in motion, to verify the entered speed setpoint press PHASE. The programmed speed will be displayed.

Press MENU to access the setup parameters or the 8 preset speeds. "CODE" will be displayed. To access the setup parameters program "8788", press ENTER. To access the preset speeds program "6645", and press ENTER.

OPERATION (continued)

The 8 preset speeds are selected and recalled through external inputs. These presets are provided in addition to the on demand single preset described earlier for optional use.

During the programming of the setup parameters or preset speeds, depression of the PHASE will exit that mode and will return to the display mode. While programming the 8 external preset speeds, the two left hand digits will prompt the current preset numbers 0P through 7P (preset 0 through 7).

The INTROLOC 1 can be jogged through the front panel, serial port or external inputs. INTROLOC 1 must be at stop to jog (the run input must be deactivated).

Jog through front panel. Press the JOG key on the front panel. The display will read JG. followed by the direction and the actual speed. Press Δ or ∇ to jog forward or reverse.

Bidirectional operation is only possible if a reversible drive with a dual channel encoder feedback is used. The INTROLOC 1 should be configured for bidirectional mode at setup.

Keeping the Δ or the ∇ key depressed, the motor will run at the preprogrammed jog speed until the key is released then will decelerate to stop. Press the CLEAR key to exit the jog mode.

Jog through external input. Activate the Fwd/Rev and the jog input for reverse direction. Activate the jog input only for forward direction (+ analog reference to the drive).

The Hold Update input is used in applications where the accel/decel ramps need to be modified via external inputs. During acceleration or deceleration, if the Hold Update is activated, the INTROLOC 1 will maintain the analog output at the level at which the input was activated. While the input is maintained the INTROLOC 1 will operate in a semi open loop mode. Once the input is deactivated the INTROLOC 1 will continue with the ramp from where it was left off.

The Hold Update input could be used in applications where the follower drive has been disabled after stop and the motor is rotated manually. Activation of the Hold Update input will cause the encoder pulses from the manual rotation to be ignored thus not affecting the analog output to the drive.

For additional inputs and their functions please refer to page 34 of the input section.

FOLLOWER (RATIO) MODE

INTRODUCTION

In the follower (ratio) mode the INTROLOC 1 will accept a pulse train generated by an encoder or a similar device providing the speed and the traveled distance of the lead motor or the line. These pulses are referred to as the "master reference pulses". As the pulses are received, the INTROLOC 1 calculates the velocity at which the follower (slave) drive should be operating. The result of the velocity calculation is called the "feed forward". Using only the feed forward portion of the controller (with PID parameters set to zero), it will run in an open loop mode, also known as a tach follower. After the feed forward calculations the INTROLOC 1 calculates the expected feedback pulses by taking into account the received master pulses, programmed ratio and the pulse ratio (internally calculated based on setup parameter 6 and 8). The INTROLOC 1 compares the scaled master reference pulses with the feedback pulses received from the follower drive then calculates the error. The calculated error then passes through the programmable limits and PID filters. The outcome of the PID filters is summed with the feed forward, converted to an analog signal then isolated to provide a reference to the follower (slave) drive. The INTROLOC 1 is capable of following the generated master reference pulses in both directions with zero following and accumulative error. There are two ways that the follower can reverse its direction, one is to reverse the master reference direction, the other is to activate or deactivate the direction input of the INTROLOC 1.

For bidirectional control a dual channel quadrature type encoder must be used so the INTROLOC 1 can sense the direction change as well as speed.

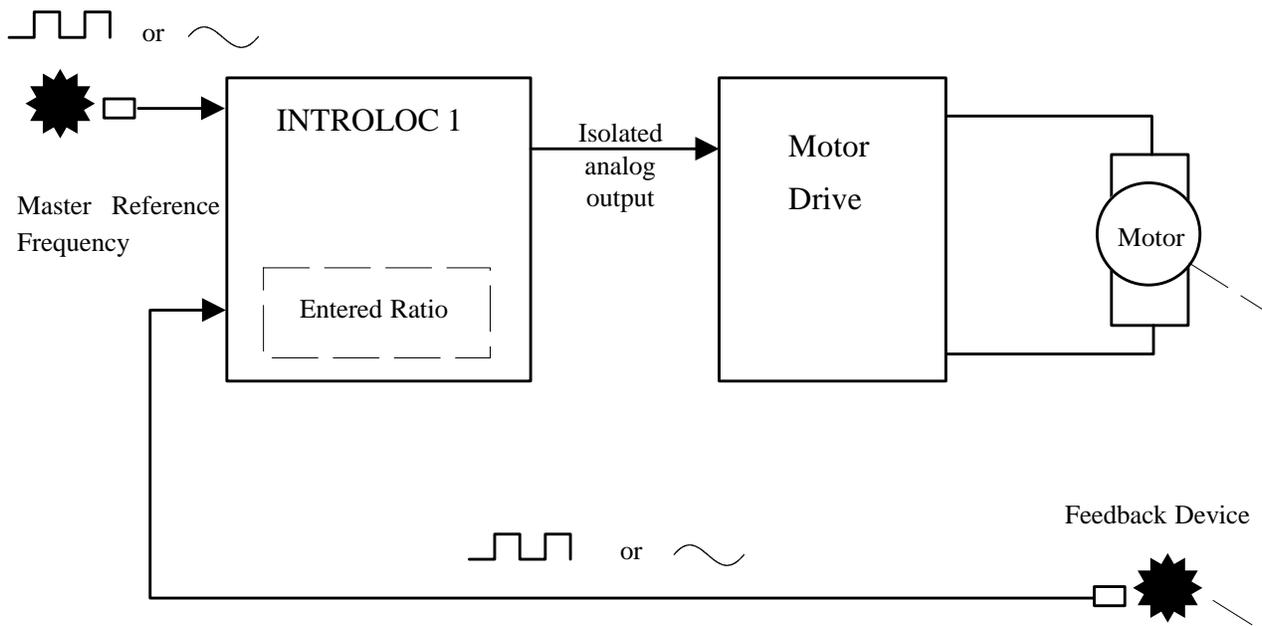


Fig. 2 - Follower mode functional diagram

SETUP1. **CTR.**

Control. This step selects the mode of operation. Select ratio and press ENTER.

2. **UPDT.**

Update is set to off for this mode. Press ENTER.

<Step 3 is omitted in follower mode.>

4. **PH.**

Phase shift is set to zero for follower mode. Press ENTER.

5. **D.OP.**

Display option. This step sets priority to display speed, ratio, or phase after each power up.

6. **R.P.**

Reference (master) pulses. This is the number of master pulses per one part or unit. See line #8, F.P., for description. (# of pulses per revolution, per foot, per cycle, etc.)

7. **REF.**

Reference Device Type. This is used to select the type of reference (master) speed sensing device. Select  for squarewave encoders and zero speed pickups. Select **sine** for magnetic pickups, AC tachometers and all zero crossing type devices.

8. **F.P.**

Feedback Pulses. F.P is equal to the number of feedback pulses that allows the follower (slave) to be at a 1:1 ratio with the lead drive (master reference).

Example: The master motor has a 200 ppr encoder mounted on the shaft and makes 1.75 revolutions per product. The follower (slave) motor has a 60 ppr encoder and makes 8.5 revolutions per product. Program the following parameters for a 1:1 ratio. $R.P. = 200 * 1.75 = 350$, $F.P. = 60 * 8.5 = 510$. The speed display will calibrate to read in product per minute.

9. **F.B.**

Feedback Device Type. This parameter is used to select the type of feedback speed sensing device. For squarewave encoders and zero speed pickups select . Select **sine** for magnetic pickups, AC tachometers and zero crossing devices.

10. **ACCEL**

Acceleration time. 0 to 600 seconds. This is the time that will take to increase speed from zero to programmed maximum speed at line 26 (H.L.).

SETUP**11. DECEL**

Deceleration time. 0 to 600 seconds. This is the time it will take to reduce speed to zero from the programmed maximum speed at line 26 (H.L.).

12. DP.N.O.

Decimal Point. This is the number of decimal places on the display when only the speed is displayed.

When displaying the ratio, the decimal point will default to 2 places if the entered ratio contains 2 or less D.P. If the set point includes more than 2 decimal places, the display resolution will change to match the entered resolution.

13. JG.

Jog speed. Programmable 0.000001 to 999999. Program in using the unit in which F.P. was calculated.

14. OUT

Output. Analog reference output to the drive, bidirectional or unidirectional.

Bidirectional - 0 to ± 10 vdc for servos and reversible drives. When bidirectional is selected, the feedback encoder must be a dual channel quadrature type.

Unidirectional - 0 to +10 vdc or 0 to -10 vdc based on which output terminal is used (see connection diagrams). When unidirectional is selected, the analog output will not cross zero. This option is usually used with single channel encoders and magnetic pickups.

15. INC.

Increase/Decrease. The rate at which the increment/decrement ratio input will operate is set by this step. The number programmed at this step is usually set by trial and error. Higher value entry results in faster change in ratio for a given time. Programmable 0 to 9999.

The following instructions are for those who would like to correlate the rate of change to the pulse width or the time that the increment/decrement inputs are activated.

Example: The relationship between increment/decrement input to ratio change is described by the following equation.

First calculate the pulse ratio of the master to the follower (slave). Use the example below for clarification since some of the rules may be confusing because of the microprocessor's internal arithmetic.

Let us assume that R.P. (reference pulse) = 512, F.P. (feedback pulses) = 1000, and 20 is programmed into INC.

$$\text{P.R. (pulse ratio)} = \frac{\text{F.P.}}{\text{R.P.}} \qquad \text{P.R.} = \frac{1000}{512} = 1.95312$$

<continued>

SETUP

15. Move the decimal point in front of the most significant digit making it less than 1.
(cont) P.R.1 = 0.195312.

$$\% \text{ ratio change per second} = \frac{0.01 * \text{programmed number in line \#15}}{0.195312}$$

$$\% \text{ ratio change per second} = \frac{0.01 * 20}{0.195312} = 1.024$$

In most cases we know how much change in ratio we would like to have, therefore the above equation can be written differently to calculate what numbers should be programmed at step #15 to give the desired change per second.

Value to be programmed in line 15 = 100 * % desired ratio change per second * P.R.1

<For most applications, steps 16, 17, and 18 are not used.>

16. BAND.

Digital Band. When this step is set to ON it will work in conjunction with steps 17 and 18. It enables the INTROLOC 1 to process only the programmed \pm error pulses in step #17 and either remember the excess error or dispose of the error based on the state of step 18 (pulse delete on/off). In some applications where the follower (slave) drive is started/stopped while the lead (master) motor is operating at line speed, the follower in accelerating to synch speed accumulates a significant amount of following error which can only be corrected by having the follower operate in speeds in excess of the desired ratio. This unwanted behavior can be controlled by setting line 16 (BAND) to ON and programming the number of error pulses that should influence the output in line 17. Providing the positional relationship is not a concern, step 18 is most commonly set to ON

A. Step 18 (pulse delete) ON. When step 18 is set to ON the INTROLOC 1 will only remember the error up to the programmed amount in line 17, any excess will be disposed of.

B. Step 18 (pulse delete) off. If step 18 is set to off, the INTROLOC 1 will remember the error pulses up to \pm 8,300,000 and will only allow the programmed amount of them in line #17 to influence the output at one time until the error is minimized.

17. P.L.

Error Pulse Limit. The number of error pulses (in feedback pulses) that should be allowed to influence the PID loop and effect the analog output. Programmable from 0 to 999999.

18. P.DEL.

Pulse Delete. When the pulse limit is reached and this step is set to ON, the error pulses over and beyond the specified amount in step 17 (P.L.) will be disposed of.

SETUP

19. **P.REC.**

Pulse (Error) Recovery. The Introloc 1 with the aid of this step can compensate for follower drive nonlinearity, drift and change in gain to maintain an absolute zero position error through the speed and load changes.

Non servo drives (drives without a velocity (tach) feedback) usually have a non linear behavior associated with them. When using these types of drives with a digital controller, it is the controllers responsibility to compensate for changes in velocity. The INTROLOC 1 produces an analog signal proportional to the scaled velocity of the lead motor (master), this is called feed forward. When the load increases, the velocity of the follower will tend to decrease if the follower is a non servo type. The INTROLOC 1 through it's PID loop detects this change and compensates for this change. However, in order for the PID loop to produce a signal it has to have accumulated some error pulses which relates to position. This is not a concern in most speed follower applications, however in some cases any positional shift could be a concern. The INTROLOC 1 contains an auxiliary error processing loop which is implemented as a pure integrator. Every 10 milliseconds it checks the positional error, divides the error by a scaling constant, multiplies it by the entry in step 19 (P.REC.) and accumulates (integrates). The output of this operation is then summed with the feed forward and the PID loop to provide a reference to the follower drive. This step is programmable 0 to 200. The larger the number the quicker the response, too large of a number will cause instability and oscillation. Programming zero will disable this step.

20. **GAIN**

Proportional Gain. The scaled master reference pulses are subtracted from the feedback pulses every 10 milliseconds to calculate the error. The calculated error is multiplied by the entry at this step and then divided by the scaling constant to drive the proportional term of the PID loop. Programmable from 0 to 200.

21. **INTG.**

Integral Gain. The scaled master reference pulses are subtracted from the feedback pulses every 10 milliseconds to calculate the error. The calculated error is then summed with the previous errors. This is the total running accumulated error. The total error is multiplied by the entry at this step, then divided by the scaling constant to drive the integral term of the PID loop. Programmable from 0 to 9999.

22. **RATE.**

Differential Gain. The scaled master reference pulses are subtracted from the feedback pulses every 10 milliseconds to calculate the error. The present error is subtracted from the previous sample to calculate the rate of change. The rate of change is multiplied by the entry at this step, then divided by the scaling constant to drive the differential term of the PID loop. Programmable from 0 to 200.

SETUP

23. BAUD.

Baud Rate. Serial port (RS 422) baud rate. Programmable 300, 600, 1200, 2400, 4800. 8 data bits, one start and one stop bit, no parity.

24. ID.NO.

Device ID Number (address). Each INTROLOC 1 can be assigned an ID number and addressed on a multidrop RS 422 line.

25. LOC.

Software Switch. This step is provided as a software switch to enable some of the special features incorporated into the software. Program 1 to lock jogging and phase shift through the front panel keypad. Program 2 to lock any numeric entry through the front panel keypad. Program 4 to enable the inverse ratio calculations. When this is enabled the INTROLOC 1 will calculate the reciprocal of the ratio entered and will use the calculated number as the scaling factor. This feature is useful in applications such as wire winding and braiding where material lay programming is desired. For example programming a ratio of 2 will cause the slave to run at $\frac{1}{2}$ the speed of the master rather than twice the speed. The ratio displayed will be calibrated to read the same as the programmed ratio.

To enable more than one option, simply add the values and program in that value.

26. H.L.

High Limit. Maximum operating speed in the unit that step 8 (F.P.) was calculated and programmed in (rpm, fpm, gpm, rps, fps etc.). This step is necessary for the INTROLOC 1 to calculate accel/decel rate and the scaling constant for feed forward.

27. F.F.r.t.

Feed Forward Rate of Change. This parameter is fixed in many controllers. Making this a programmable parameter it is possible to set the response of the feed forward loop to provide the best possible response to interface with a variety of drives and load conditions. Programmable 0 to 200. When this step is set to zero the feed forward portion of the control loop is turned off and the analog output is only provided by the PID loop (100% trim). Larger entry will quicken the follower response to master speed changes and reduce the instantaneous phase shift (following error).

TUNING PROCEDURE

The following instructions provide the necessary steps to tune the velocity and position loop of the INTROLOC 1 to achieve stability and response. It is recommended to tune the controller with the motor connected to the actual load (gear box, conveyor etc.).

WARNING: *Stay clear of all moving parts. Do not attempt to make any mechanical adjustments while the power is on.*

Do not run production or product while tuning the controller.

After the tuning procedure is complete, make a note of all the INTROLOC 1 set-up parameters.

TUNING PROCEDURE (cont.)

- A. Set step 16 (BAND) and step 18 (P.DEL.) to on. Program in 500 at step 17 (P.L.).
- B. Program zero for steps 19 (P.REC.), 20 (GAIN), 21 (INTG.), and 22 (RATE).
- C. Program the maximum operating speed of the follower in step 26 (H.L.).
- D. Program 30 for step 27 (F.F.r.t.). 30 will provide a moderate response for most all drives. This number is not critical providing the lead (master) is not changing speed rapidly. This number will be tuned in later steps.
- E. Press PHASE . The display should now read a previously programmed ratio.
- F. Press CLEAR. Program a ratio set point followed by ENTER.

Program a ratio that will cause the follower motor to operate at maximum operating speed when in operation.

- G. Initiate run. The display of the INTROLOC 1 should become active displaying SP., ra. or ph. Press MENU until ra. is displayed.
- H. Start the lead (master) drive and run at a low speed. While "ra." is displayed adjust the maximum speed adjustment of the follower drive (or tach) so that the display of the INTROLOC 1 reads the same ratio as was programmed in step F. Increase the speed of the line to the normal operating speed and readjust as needed to maintain the approximate same reading.

The INTROLOC 1 at this point is operating in open loop mode (tach follower). Feedback pulses are used for display purposes only. The analog output to the follower drive should be a positive voltage. If using a dual channel master reference encoder and a zero or negative voltage reading is observed, stop and reverse channels A and B of the master encoder.

If you are using a dual channel feedback encoder, depress MENU until "SP" is displayed. This is the speed of the follower. If a positive reference is applied to the follower drive, the speed read out should be positive (not -). If (-) is displayed, stop and reverse channels A and B of the feedback encoder.

- I. Press MENU until "CODE" is displayed. Program "8788", then press ENTER. Press Δ until F.F.r.t. is displayed.
- J. Next tune step 27 (F.F.r.t.). This step provides a multiplier for the rate at which the feed forward is adjusted to provide the slave drive with the master velocity information. Step 27 is programmable from 0 to 200. A larger number represents a faster response to master speed changes. With the master operating at line speed, start/stop the INTROLOC 1 to see the follower drive's behavior. Increase or decrease the value programmed at this step accordingly to achieve the desired response.

The INTROLOC 1 is programmable on the fly, therefore it is not necessary to leave the set-up to start or stop.

TUNING PROCEDURE

- K. Press ∇ until GAIN is displayed (step 20). Increase the value by pressing CLEAR and programming a new number. Press ENTER. To return to this step press Δ . Increase the value until the system becomes unstable or erratic. Once the unstable condition has been reached, reduce the GAIN until stable and smooth operation is achieved.

For servo and high bandwidth drives with velocity feedback loop, GAIN can be set to zero.

- L. Tune the Integral Gain (step 21). Increase the value by 10's or 20's until overshoot occurs. Changing ratio set points and/or starting/stopping will aid in observing this overshoot. (Overshoot will occur when the motor shoots over the commanded set point before settling). Once the overshoot has occurred, reduce integral gain to achieve stability.

- M. Differential Gain (RATE step 22), is only needed if a sluggish response is experienced during speed changes and/or load shift. Increase RATE until it becomes erratic then reduce for smooth operation. Remember to change speed and/or start/stop while adjusting parameters.

For servo and high bandwidth drives with velocity feedback no RATE is required and could be set to zero.

- N. At step A of this section it was instructed to set steps 16 and 18 to ON and to program 500 for step 17. This was done so that during start/stop while tuning the controller it does not accumulate more than 500 error pulses. Based on the nature of the application this number can be increased to aid in faster start up or decreased for smoother and slower start up. For the majority of applications, these steps are not used. Steps 16, 17, and 18 find their use in applications where the follower (slave) must be stopped and restarted with the master already operating at line speed.

OPERATION

This section describes the operation of the INTROLOC 1 and will provide the necessary instructions to enter a ratio set point and how to access the 8 programmable set points.

At this point it is assumed that all of the setup parameters have been programmed and the controller has been properly connected and tuned.

When the power is turned on the INTROLOC 1 will default to stop regardless of the run input status. The previously entered ratio is displayed at this time.

The INTROLOC 1 can be started externally via activation of the run input. If the run input is active and the power is turned ON the INTROLOC 1 will not run. To initiate a run the run input must be deactivated then reactivated or press enter on the front panel keypad.

To enter a new ratio set point while the previous is being displayed, press CLEAR then enter the desired ratio. Press ENTER. Every time a new ratio is programmed the INTROLOC 1 clears the previously programmed number and stores the new number in nonvolatile memory. While the run input is active (ON), a new entry will cause the INTROLOC 1 to command the follower motor to operate at commanded ratio. After the run is initiated, to enter a new set

OPERATION (continued)

point simply program the desired ratio then press enter. Every time a new ratio has been entered the INTROLOC 1 will display - - - - - for one second then will return to display the actual speed or ratio. While in operation to verify the programmed ratio press PHASE. The programmed ratio will be displayed. To exit press PHASE or ENTER.

The INTROLOC 1 is programmable on the fly. All of the parameters can be accessed through the front panel or the serial port without disturbing the operation of the controller.

Press MENU to access the setup parameters or the 8 preset ratios, continue pressing MENU until "CODE" is displayed. To access the setup parameters program "8788" then press ENTER. To access the preset ratios program "6645" then press ENTER.

The 8 preset ratios are selected and recalled through external inputs. These presets are provided in addition to the on demand single preset described earlier for optional use.

During the programming of the setup parameters or preset ratios, depression of the PHASE will exit that mode and will return to the display mode. While programming the 8 preset ratios, the two left hand digits will prompt the current preset numbers 0P through 7P (preset 0 through 7).

The INTROLOC 1 can be jogged through the front panel, serial port or external inputs. INTROLOC 1 must be at stop to jog (the run input must be deactivated).

Jog through front panel. Press the jog key on the front panel. The display will read JG. followed by the direction and the actual speed. Press Δ or ∇ to jog forward or reverse.

Bidirectional operation is only possible if a reversible drive with a dual channel encoder feedback is used. The INTROLOC 1 should be configured for bidirectional mode at setup.

Keeping the Δ or the ∇ key depressed, the motor will run at the preprogrammed jog speed until the key is released then will decelerate to stop. Press the CLEAR key to exit the jog mode.

Jog through external input. Activate the FWD/REV and the jog input for reverse direction. Activate the jog input only for forward direction (+ analog reference to the drive).

The Hold Update input is used in applications where the master motor is stopped, but the slave motor must maintain the last synch speed. Activating the Hold Update before stopping the master motor will cause the INTROLOC 1 to stop updating its analog output and maintain the last output level. Normal operation can be resumed when the Hold Update input is deactivated in which the slave motor will follow the master speed.

The Hold Update input could be used in applications where the follower drive has been disabled after stop and the motor is rotated manually. Activation of the Hold Update input will cause the encoder pulses from the manual rotation to be ignored thus not affecting the analog output to the slave drive.

The direction input is functional at all times making it useful for traverse type applications. The INTROLOC 1 is a bidirectional controller and will accept a dual channel encoder from both the master and slave. This is extremely important for traverse winders. This feature allows the controller to wind and unwind without the need for additional electronics and reversing contactors.

Additional input functions and operations are provided in the input section page 34.

POSITION SYNCHRONIZER MODE

INTRODUCTION

In the position synchronizer mode the INTROLOC 1 will accept a pulse train generated by an encoder or a similar device providing the speed and the traveled distance of the lead motor or the line. These pulses are referred to as the "master reference pulses". As the pulses are received, the INTROLOC 1 calculates the velocity at which the follower (slave) drive should be operating. The result of the velocity calculation is called the "feed forward". Using only the feed forward portion of the controller (with PID parameters set to zero), it will run in an open loop mode, also known as a tach follower. After the feed forward calculations the INTROLOC 1 calculates the expected feedback pulses by taking into account the received master pulses, programmed ratio and the pulse ratio (internally calculated based on setup parameter #6 and 8). The INTROLOC 1 compares the scaled master reference pulses with the feedback pulses received from the follower drive, calculating an error. Additionally, the INTROLOC 1 will receive signals from both the master and slave position detection devices. After the reception of these two signals the INTROLOC 1 will measure the difference and sum it with the error. The calculated error passes through the programmable limits and PID filters. The outcome of the PID filters is summed with the feed forward, converted to an analog signal then isolated to provide a reference to the follower (slave) drive.

For bidirectional control a dual channel quadrature type encoder must be used so the INTROLOC 1 can sense the direction change as well as speed.

The INTROLOC 1 will allow phase shift (trim) to offset (advance or retard) the slave position relative to the master. There are several ways to phase shift.

- A. Directly programming the plus or minus amount of shift.
- B. Through the front panel depressing the PHASE key then Δ or ∇ .
- C. External inputs phase and Fwd./Rev.
- D. Serial port.

The INTROLOC 1 will maintain absolute relative position through the speed range in either direction. The INTROLOC 1 can be setup in a constant update mode to monitor position on a continuous basis in applications where the position needs to be monitored constantly because of product inconsistency. In other applications where the follower drive is stopped occasionally with the master running at operating speed, the INTROLOC 1 provides a programmable error limit to minimize the amount of correction or the over speed. These features allow for a smooth start-up avoiding product spills and shock to the mechanics of the machine.

<see diagram next page>

SYNCHRONIZER MODE

INTRODUCTION

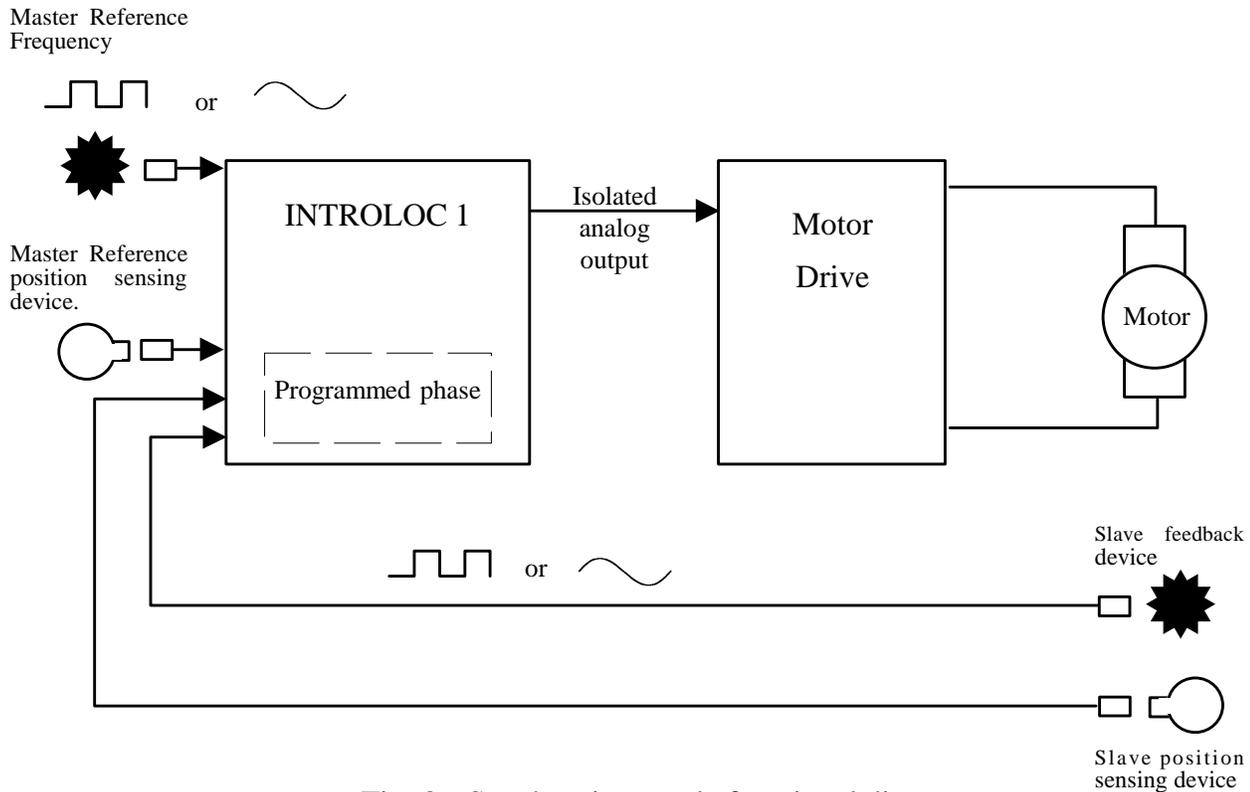


Fig. 3 - Synchronizer mode functional diagram.

SET-UP

1. **CTR.**

Control. This step selects the mode of operation. Select ratio and press ENTER.

2. **UPDT.**

Update. Set to ON for position synchronization. This will enable (turn on) the master and slave position sensor to allow keyway to keyway or product position lock.

3. **CONSTANT / SINGLE**

Single update - After start, the controller will respond to the first positional signal received and will ignore thereafter.

Constant update - After start, the controller will respond and correct every time the positional signals are received.

SETUP (continued)4. **PH.**

Phase Shift. The relative position of the slave to master can be programmed at this step. This step is programmable in \pm slave pulse count. The sensing devices are moved electronically rather than mechanically for initial alignment. Programmable from 0 to \pm 999999 feedback pulses.

5. **D.OP.**

Display Option. This step sets priority to display speed, ratio or phase shift after each power up.

6. **R.P.**

Reference (Master) Pulses. This is the number of master pulses per one part or unit. See line #8, F.P. for description.

7. **REF.**

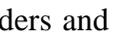
Reference Device Type. This is used to select the type of reference (master) speed sensing device. Select  for squarewave encoders and zero speed pickups. Select **sine** for magnetic pickups, ac tachometers and all zero crossing type devices.

8. **F.P.**

Feedback Pulses. F.P. equals the number of feedback pulses that allows the follower (slave) to be at a 1:1 ratio with the lead drive (master reference).

Example: The master motor has a 200 ppr encoder mounted on the shaft and makes 1.75 revolutions per product. The slave (follower) motor has a 60 ppr encoder and makes 8.5 revolutions per product. Program in the following parameters for a 1:1 ratio. $R.P. = 200 * 1.75 = 350$, $F.P. = 60 * 8.5 = 510$. The speed display will calibrate to read in product per minute.

9. **F.B.**

Feedback Device Type. This parameter is used to select the type of feedback speed sensing device. For squarewave encoders and zero speed pickups select . Select **sine** for magnetic pickups, ac tachometers and zero crossing devices.

10. **ACCEL**

Acceleration Time. 0 to 600 seconds. This is the time it will take to increase speed from zero to programmed maximum speed at line 26 (H.L.).

11. **DECEL**

Deceleration Time. 0 to 600 seconds. This is the time it will take to reduce speed to zero from the programmed maximum speed at line 26 (H.L.).

SETUP

12. **DP.NO.**

Decimal Point. This is the number of decimal places on the display when only the speed is displayed.

When displaying the ratio, the decimal point will default to 2 places if the entered ratio contains 2 or less D.P. If the set point includes more than 2 decimal places, the display resolution will change to match the entered resolution.

13. **J.G.**

Jog speed. Programmable 0.000001 to 999999. Programmed in the unit that F.P. was calculated.

14. **OUT.**

Output. Analog reference output to the drive, bidirectional or unidirectional.

Bidirectional - 0 to ± 10 vdc for servos and reversible drives. When bidirectional is selected, the feedback encoder must be a dual channel quadrature type.

Unidirectional - 0 to +10 vdc or 0 to -10 vdc based on which output terminal is used (see connection diagrams). When unidirectional is selected, the analog output will not cross zero. This option is usually used with single channel encoders or magnetic pickups.

15. **INC.**

Increase/Decrease. Not used in this mode. Program zero.

<For most applications, steps 16, 17, and 18 are not used. These steps are provided for delicate control of the follower line.>

16. **BAND.**

Digital Band. When this step is set to ON it will work in conjunction with steps 17 and 18. It enables the INTROLOC 1 to process only the programmed \pm error pulses in step 17 and either remember the excess or dispose of them based on the state of step 18 (pulse delete ON/off). The master and slave encoders determine the position error as well as the position synch signals for alignment purposes.

A. Step 18 (pulse delete) off. After reception of the position synch signals the INTROLOC 1 calculates the position error (difference between synch signals). The calculated error is then compared with the allowable error limit at step #17. If the error is less than the programmed limit, normal action will be taken to reduce position error to zero by causing the follower drive to run faster or slower based on if the follower was leading or lagging. If the error was greater than the programmed limit in step 17, only the programmed limit amount would be used to influence the output. The follower drive will run faster or slower, then synch speed proportional to the limit until all positional error pulses are compensated for.

B. Step 18 (pulse delete) ON. The INTROLOC 1 under this condition will react similar to step A except when the position error is greater than programmed limit (step 17), only the programmed limit amount would be compensated. The follower drive may have to sense several position signals before the perfect alignment is reached.

SETUP (continued)17. **P.L.**

Error Pulse Limit. The number of error pulses (in feedback pulses) that should be allowed to influence the PID loop and effect the analog output. Programmable 0 to 999999.

18. **P.DEL.**

Pulse Delete. When the pulse limit is reached and this step is set to ON, the error pulses over and beyond the specified amount in step 17 (P.L.) will be disposed of.

19. **P.REC.**

Pulse (Error) Recover. The INTROLOC 1 with the aid of this step can compensate for follower drive nonlinearity, drift and change in gain to maintain an absolute zero position error through the speed and load changes.

Non servo drives (drives without a velocity (tach) feedback) usually have a non linear behavior associated with them. When using these types of drives with a digital controller, it is the controllers responsibility to compensate for changes in velocity. The INTROLOC 1 produces an analog signal proportional to the scaled velocity of the lead motor (master), this is called "feed forward". When the load increases the velocity of the follower will tend to decrease if the follower is a non servo type. The INTROLOC 1 through its PID loop detects this change and compensates for it. However, in order for the PID loop to produce a signal it has to have accumulated some error pulses which relates to position. This is not a concern in most speed follower applications, however in some cases any positional shift could be a concern. The INTROLOC 1 contains an auxiliary error processing loop which is implemented as a pure integrator. Every 10 milliseconds it checks the positional error, divides the error by a scaling constant, multiplies it by the entry in step 19 (P.REC.) and accumulates (integrates). The output of this operation is then summed with the feed forward and the PID loop to provide a reference to the follower drive. This step is programmable from 0 to 200. The larger the number the quicker the response, too large of a number will cause instability and oscillation. Programming zero will disable this step.

20. **GAIN**

Proportional Gain. The scaled master reference pulses are subtracted from the feedback pulses every 10 milliseconds to calculate the error. The calculated error is multiplied by the entry at this step and then divided by the scaling constant to drive the proportional term of the PID loop. Programmable from 0 to 200.

21. **INTG.**

Integral Gain. The scaled master reference pulses are subtracted from the feedback pulses every 10 milliseconds to calculate the error. The calculated error is summed with the previous errors. This is the total running accumulated error. This total error is multiplied by the entry at this step then divided by the scaling constant to drive the integral term of the PID loop. Programmable from 0 to 9999.

SETUP (continued)22. **RATE.**

Differential Gain. The scaled master reference pulses are subtracted from the feedback pulses every 10 milliseconds to calculate the error. The present error is subtracted from the previous sample to calculate the rate of change. The rate of change is multiplied by the entry at this step, then divided by the scaling constant to drive the differential term of the PID loop. Programmable from 0 to 200.

23. **BAUD.**

Baud Rate. Serial port (RS 422) baud rate. Programmable 300, 600, 1200, 2400, 4800. 8 data bits, one start and one stop bit, no parity.

24. **ID.NO.**

Device ID number (address). Each INTROLOC 1 can be assigned an ID number and addressed on a multidrop RS 422 line.

25. **LOC.**

Software Switch. This step is provided as a software switch to enable some of the special features incorporated into the software. Program in 1 to lock jogging and phase shift through the front panel keypad. Program in 2 to lock any numeric entry through the front panel keypad. Program in 4 to enable the inverse ratio calculations. When this is enabled the INTROLOC 1 will calculate the reciprocal of the ratio entered and will use the calculated number as the scaling factor. This feature is useful in applications such as wire winding and braiding where the material lay programming is desired. For example programming a ratio of 2 will cause the slave to run at $\frac{1}{2}$ the speed of the master rather than twice the speed. The ratio displayed will calibrate itself to read in the same format as the programmed preset.

To enable more than one option, simply add the values and program that value.

26. **H.L.**

High Limit. Maximum operating speed in the unit that line 8 (F.P.) was calculated and programmed in (rpm, fpm, gpm, rps, fps etc.). This step is necessary for the INTROLOC 1 to calculate accel/decel rate and the scaling constant for feed forward.

27. **F.F.r.t.**

Feed Forward Rate of Change. This parameter is fixed in many controllers. Making this a programmable parameter it is possible to set the response of the feed forward loop to provide the best possible response to interface with a variety of drives and load conditions. Programmable from 0 to 200. When this step is set to zero the feed forward portion of the control loop is turned off and the analog output is only provided by the PID loop (100% trim). Larger entry will quicken the follower response to master speed changes and reduce the instantaneous phase shift (following error).

TUNING PROCEDURE

The following instructions provide the necessary steps to tune the velocity and position loop of the INTROLOC 1 to achieve stability and response. Tuning the controller with the motor connected to the actual load (gear box, conveyor etc.) is recommended.

WARNING: Stay clear of all moving parts. Do not attempt to make any mechanical adjustments while the power is on.

Do not run production or product while tuning the controller.

After the tuning procedure is complete, make a note of all the INTROLOC 1 setup parameters.

You must use a solid state device for both the master and the slave position sensors. Avoid using contacts or any "bouncy" devices.

- A. Set step 16 (BAND) and step 18 (P.DEL.) to ON. Program in 500 at step 17 (P.L.). Set (UPDATE) (step 2) to off. This will disable position sensor inputs so they will not interfere with the tuning procedure.
- B. Program zero for steps 19 (P.REC.), 20 (GAIN), 21 (INTG.), and 22 (RATE).
- C. Program the maximum operating speed of the follower in step 26 (H.L.).
- D. Program 30 for step 27 (F.F.r.t.). 30 will provide a moderate response for most all drives. This number is not critical providing the lead (master) is not changing speed rapidly. This number will be tuned in later steps.
- E. Press PHASE. The display should now read a previously programmed ratio.
- F. Press CLEAR. Program a ratio set point followed by ENTER. ***The ratio programmed must be for product 1:1 relationship.***
- G. Initiate run. The display of the INTROLOC 1 should become active displaying SP., ra. or ph. Press MENU until ra. is displayed.
- H. Start the lead (master) drive and run at a low speed. While "ra." is displayed adjust the maximum speed adjustment of the follower drive (or tach) so that the display of the INTROLOC 1 reads the same ratio as was programmed in step F. Increase the speed of the line to the normal operating speed and readjust as needed to maintain the approximate same reading.

The INTROLOC 1 at this point is operating in open loop mode (tach follower). Feedback pulses are used for display purposes only. The analog output to the follower drive should be a positive voltage. If using a dual channel master reference encoder and a zero or negative voltage reading is observed, stop and reverse channels A and B of the master encoder.

If you are using a dual channel feedback encoder, depress MENU until "SP" is displayed. This is the speed of the follower. If a positive reference is applied to the follower drive, the speed read out should be positive (not -). If (-) is displayed, stop and reverse channels A and B of the feedback encoder.

TUNING PROCEDURE (continued)

- I. Press MENU until "CODE" is displayed. Program "8788", press ENTER. Press Δ until F.F.r.t. is displayed.
- J. Next is to tune step 27 (F.F.r.t.). This step provides a multiplier for the rate at which the feed forward is adjusted to provide the slave drive with the master velocity information. Step 27 is programmable from 0 to 200. A larger number represents a faster response to master speed changes. With the master operating at line speed, start/stop the INTROLOC 1 to see the follower drives behavior. Increase or decrease the value programmed at this step accordingly to achieve the desired response.

The INTROLOC 1 is programmable on the fly, therefore it is not necessary to leave the setup to start or stop.

- K. Press ∇ until GAIN is displayed (step 20). Increase the value by pressing CLEAR and programming a new number. Press ENTER. To return to this step press Δ . Increase the value until the system becomes unstable or erratic. Once the unstable condition has been reached, reduce the GAIN until stable and smooth operation is achieved.

For servo and high bandwidth drives with velocity feedback loop GAIN can be set to zero.

- L. Tune the integral gain (step 21). Increase the value by 10's or 20's until overshoot occurs. Changing speed set points and/or starting/stopping will aid in observing this overshoot. (Overshoot will occur when the motor shoots over the commanded set point before settling). Once the overshoot has occurred, reduce integral gain to achieve stability.
- M. Differential gain (RATE step 22), is only needed if a sluggish response is experienced during speed changes and/or load shift. Increase RATE until it becomes erratic then reduce for smooth operation. Remember to change speed and/or start/stop while adjusting parameters.

For servo and high bandwidth drives with velocity feedback no RATE is required and could be set to zero.

- N. At step A of this section it was instructed to set steps 16 and 18 to ON and program 500 for step 17. This was done so that during start/stop while tuning the controller it does not accumulate more than 500 error pulses. Based on the nature of the application this number can be increased to aid in faster start up or decreased for smoother and slower start up. Set step 2 (UPDATE) to ON to start position synchronization. For the majority of applications steps 16, 17, and 18 are not used. These steps are used in applications where the follower (slave) must be stopped and restarted while the master continues at line speed.

OPERATION

This section provides the necessary instructions to properly operate the INTROLOC 1 and to describe the different ways to establish perfect alignments.

At this point it is assumed that all of the setup parameters have been programmed and the controller has been properly connected and tuned.

OPERATION (continued)

When the power is turned on the INTROLOC 1 will default to stop regardless of the run input status. The previously entered ratio is displayed at this time. The ratio is almost always set to 1 for product synchronization except in special applications dealing with plastic or rubber products, which may be slightly higher or lower.

The INTROLOC 1 can be started externally via activation of the run input. If the run input is active and the power is turned on the INTROLOC 1 will not run. To initiate a run the run input must be deactivated then reactivated or press ENTER on the front panel keypad.

The 1:1 ratio that was mentioned earlier does not necessarily mean that the master and slave encoder shafts would be operating at the same speed. To enter a new ratio set point while the previous is being displayed, press CLEAR then enter the desired ratio. Press ENTER. Every time a new ratio is programmed, the INTROLOC 1 clears the previously programmed number, and stores the new number in nonvolatile memory. While the run input is active (ON), a new entry will cause the INTROLOC 1 to command the follower motor to operate at the commanded ratio. After the run is initiated, to enter a new set point simply program the desired ratio then press enter. Every time a new ratio has been entered the INTROLOC 1 will display - - - - - for one second then will return to display the actual speed or ratio.

The INTROLOC 1 is programmable on the fly. All of the parameters can be accessed through the front panel or the serial port without disturbing the operation of the controller.

Press MENU to access the setup parameters continue pressing MENU until "CODE" is displayed. To access the setup parameters program "8788" then press ENTER.

During the programming of the setup parameters depression of the PHASE will exit that mode and will return to the display mode.

When the INTROLOC 1 is started, via reception of master reference pulses it calculates the expected slave feedback pulses and starts generating an analog signal proportional to the velocity of the master and velocity error. As the motion begins, the slave and master position sensing devices provide position alignment information. After initial start if the master position sensor information is received before the slave position sensor information, the INTROLOC 1 will force the slave to run faster in order to catch up to the master. However, if the slave position sensor information is received first the slave speed would be reduced so the master can catch up to the slave. Realignment smoothness can be controlled by setup

1. Permanent phase shift by programming the amount of offset (phase shift) in + or - slave count pulses. [See setup parameter 4, (P.H.)]. This method is used for initial alignment during machine setup. Every time INTROLOC 1 is powered up and started it will use the programmed phase shift for proper alignment.
2. Permanent phase shift by mechanically altering the position of the master or slave position sensing devices.

OPERATION (continued)

3. Temporary phase shift. Position of the slave relative to the master can also be altered through external inputs or through the front panel if the run input is active.
 - A. Phase shift through external inputs. Activate phase input, use direction input to advance or retard. While the phase input is active the INTROLOC 1 will alter position at a rate of 25 pulses per second.
 - B. Phase shift through the front panel. Press the PHASE key. The display will read Ph. followed by the actual phase shift in slave pulse units. Press ∇ or Δ to phase advance or retard. The INTROLOC 1 will alter position at a rate of 25 pulses per second. Press CLEAR to exit the phase shift mode.

The INTROLOC 1 will remember the current phase even if it is stopped and restarted. The temporary phase shift will be cleared once the power is turned off. After modifying the phase, if it is desired to use this as the permanent phase, access the setup parameters and program the number with the direction in step 4.

While in operation, the display mode can be altered by pressing the MENU key. Each time the MENU key is pressed the display will change to read actual speed, ratio, phase or "CODE" (for access to the setup parameters). Ratio entry can be made when SP, ra or Ph is displayed.

The INTROLOC 1 can be jogged through the front panel, serial port or through external inputs. INTROLOC 1 must be at stop to jog (the run input must be deactivated).

Jog through front panel. Press the jog key on the front panel. The display will read JG. followed by the direction and the actual speed. Press Δ or ∇ to jog forward or reverse.

Bidirectional operation is only possible if a reversible drive with a dual channel encoder feedback is used. The INTROLOC 1 should be configured for bidirectional mode at setup.

Keeping the Δ or the ∇ key depressed, the motor will run at the preprogrammed jog speed until the key is released then will decelerate to stop. Press the CLEAR key to exit the jog mode.

Jog through external input. Activate the Fwd/Rev and the jog input for reverse direction. Activate the jog input only for forward direction (+ analog reference to the drive).

The Hold Update input is used in applications where the master motor is stopped, but the slave motor must maintain the last synch speed. Activating the Hold Update before stopping the master motor will cause the INTROLOC 1 to stop updating its analog output and maintain the last output level. Normal operation can be resumed when the Hold Update input is deactivated. The slave motor will follow the master speed.

The Hold Update input could be used in applications where the follower drive has been disabled after stop and the motor is rotated manually. Activation of the Hold Update input will cause the encoder pulses from the manual rotation to be ignored thus not affecting the analog output to the slave drive.

Additional input functions and operations are provided in the input section page 34.

INPUTS

This section provides input descriptions and their functions in various modes. To achieve higher noise immunity the inputs are divided into two groups.

1. **High Speed Inputs.** Reference (master) pulse input and feedback (slave) pulse input.
2. **Control Inputs.** Run/stop, jog, master/slave position, hold update and increment/decrement, direction and memory select.

1. High Speed Inputs

These inputs are designed for harsh, electrically noisy environments. The INTROLOC 1 will pass encoder signals through comparator type inputs with some filtering to reject some of the high frequency noise that normally exists (especially when a big noise generator like an AC inverter is used in the system). After the comparator section, the signals are fed through a digital filter to remove any lower frequency oscillation, bounce and stubborn noise that may have passed through the first stage. Finally these noise free pulses are used by the controller as a reference and feedback. The comparator section will also take care of the type of input used, squarewave encoder or sinewave magnetic pickup. Even though the input comparators are powered by a 5 vdc on board, they can handle signals up to ± 50 vdc in amplitude for ease of interfacing with existing equipment. Fig 4 shows a typical one channel encoder input.

Please note when using an encoder or zero speed pick up with NPN or sinking output, it must contain a pull up resistor internal to the device or an external pull up must be installed. If the output is sourcing PNP, it should include a pull down resistor.

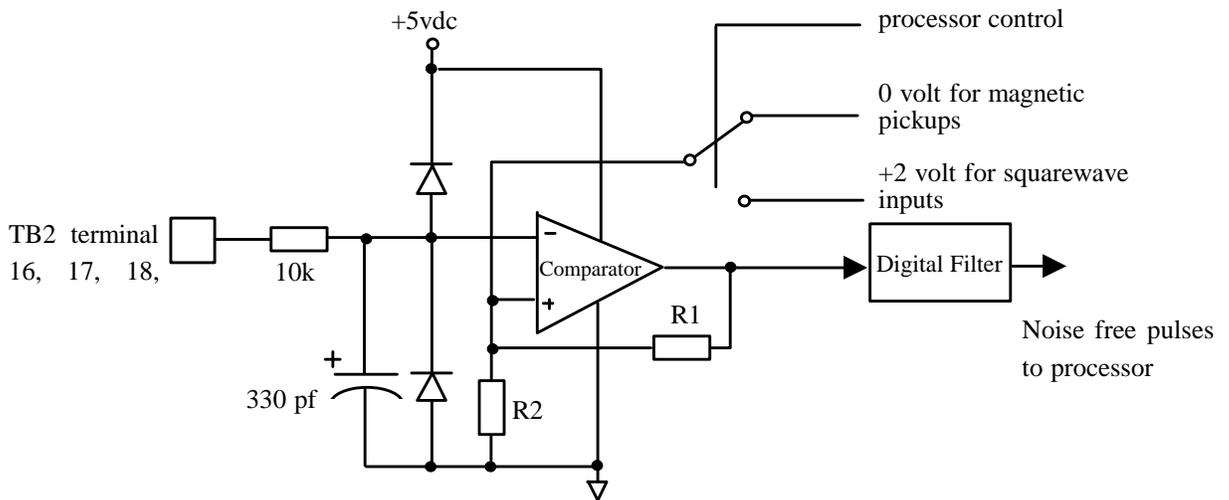


Fig. 4 Typical high speed input used to filter channels A and B of the reference and feedback.

INPUTS (continued)**2. Control Inputs**

The control inputs of the INTROLOC 1 are optically isolated for increased noise immunity and ease of interface. Some of these inputs will have different functions based on the operating mode (master (speed) mode, follower (ratio) mode or position synchronization mode). All of the input optoisolators are powered from a common point, TB2 terminal 8 which will connect to a dc power supply. Each input can then be activated by connecting the appropriate input to (-) or common of the dc power supply. Fig. 5 illustrates the INTROLOC 1 inputs powered by an external power supply.

If input isolation is not required the on board + 12 vdc or + 5 vdc can be used.

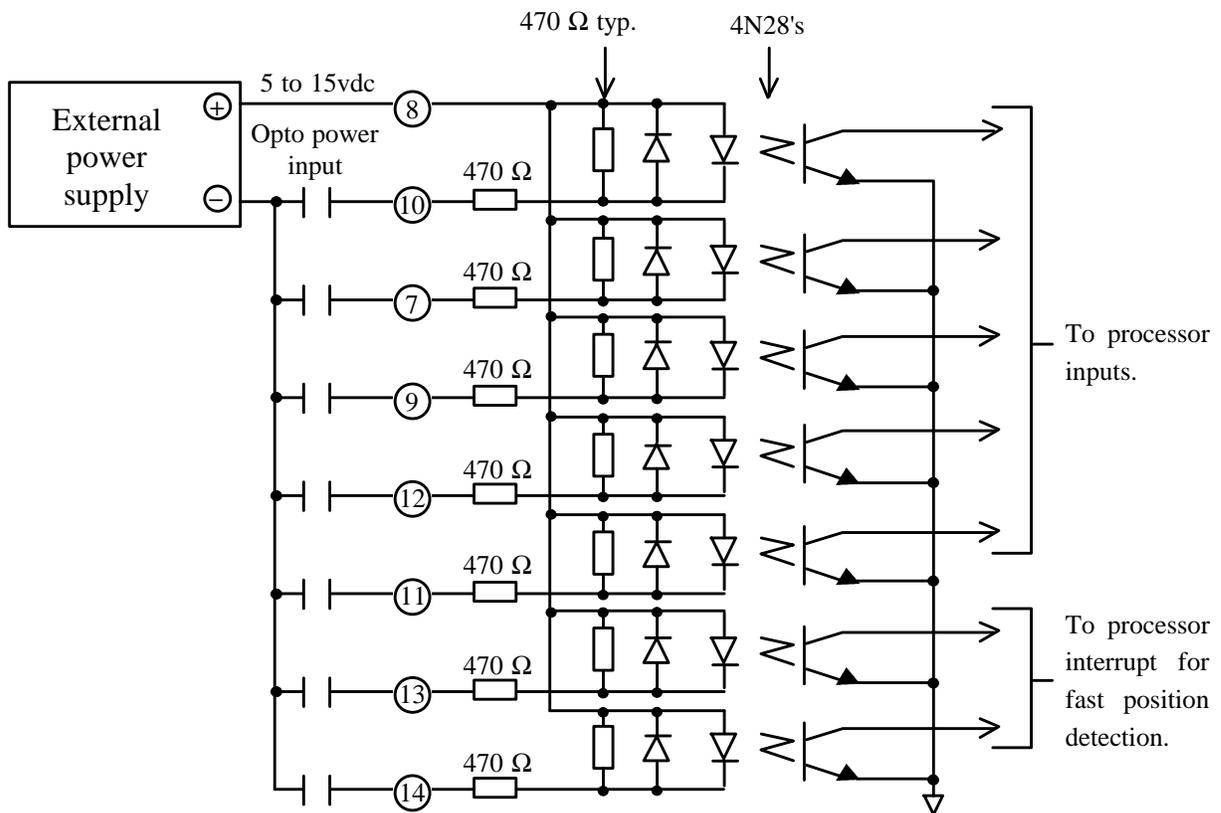


Fig. 5 Control inputs logic diagram, with external power supply connection.

As is illustrated in Fig. 5, the inputs of the INTROLOC 1 contain anti-parallel diodes to prevent damage to the logic if and when the input level becomes greater than the supplied opto power. This scheme will also allow the position input signals (proximities) in the synchronizer mode to operate with different power levels than the other inputs. The opto inputs can be powered by the INTROLOC's on board + 12 vdc or by the + 5 vdc. When using a device to switch the input of the INTROLOC 1 its rating will depend on the power supply voltage connected at the opto power input. To determine rating use the following procedures.

INPUTS (continued)

- A. The voltage rating of the output device at off state must be equal to or greater than the power supply voltage connected at the opto power input.
- B. The current rating of the output device at ON state must be greater than the minimum current rating.

$$\text{Minimum current rating} = \frac{\text{Opto power voltage} - 1.4 \text{ volt}}{470 \text{ ohms}}$$

For example, using the on board +12 vdc power to power, the device that will be used to activate any of the inputs should have a rating of:

- a. 12 vdc minimum.
- b. $\frac{12 - 1.4}{470} = 0.022 \text{ Amp}$, 22 mA minimum or 22 mA @ 12 vdc.

In the following illustrations the run/stop is functional regardless of the mode of operation. Jogging is only possible when the run input is not active (at stop). The direction input must be selected on or before the jog input is activated. Direction change during jogging will be ignored to allow two switch jog inputs for bidirectional operation. During run, direction input is functional in master (speed) mode and follower (ratio) mode, ignored in position synchronizer mode.

The bidirectional run and jog are only possible when the INTROLOC 1 is configured as a bidirectional controller during setup at step 14 (OUT) and a dual channel encoder is used.

Master (speed) and follower (ratio mode).

The control input configuration is as follows.

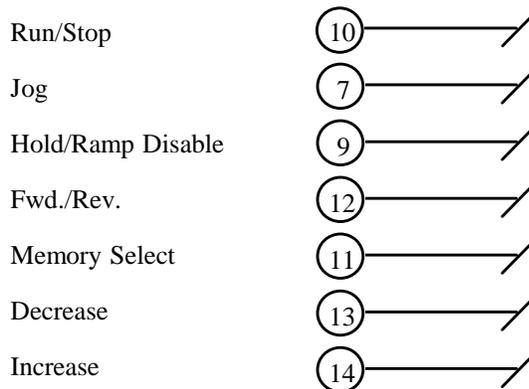


Fig. 6 Input functions, master & follower modes.

INPUTS (continued)

When the memory select input is activated, the inputs will be configured as follows.

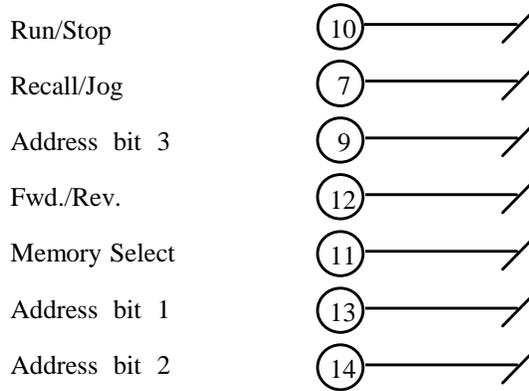


Fig. 7 Auxiliary input functions.

When the memory select input is activated, eight different preprogrammed presets can be recalled and processed by binary selection of the address bit 1, 2, 3. The presets verses address select inputs are as follows.

Input Preset	Memory select	Address bit 3	Address bit 2	Address bit 1	Preset selected
OP	1	0	0	0	1st preset
1P	1	0	0	1	2nd preset
2P	1	0	1	0	3rd preset
3P	1	0	1	1	4th preset
4P	1	1	0	0	5th preset
5P	1	1	0	1	6th preset
6P	1	1	1	0	7th preset
7P	1	1	1	1	8th preset

1 = Active level (input on)

0 = Not active (input off)

Fig. 8 Memory select with preset recall.

When the memory operation is selected in run mode, the jog input will serve as a recall and enter. The other way to enter the selected memory preset is by momentarily deactivating and reactivating the run input. The jog input will be used as jog when the run input is not active.

INPUTS (continued)

Synchronizer Mode

In this mode the inputs will be configured by the INTROLOC 1 to satisfy the requirements as illustrated by fig 9.

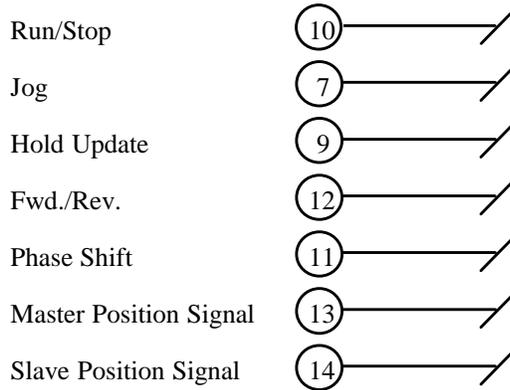


Fig. 9 Synchronizer mode input functions.

Bidirectional phase shift (moving slave position relative to master) is accomplished by phase shift input and Fwd./Rev. input as shown in figure 11. In the synchronizer mode the Fwd./Rev. input is only functional with the jog and phase inputs. Bidirectional operation of the slave motor will depend on the direction of the master motor.

For bidirectional operation it is necessary to use dual channel encoders for master and slave.

The INTROLOC 1 internally provides the necessary timing for the use of multi switches to distinguish jog fwd. or jog rev., phase shift + or phase shift -. Following are a few examples of how jog Fwd./Rev. and phase Fwd./Rev. can be connected.

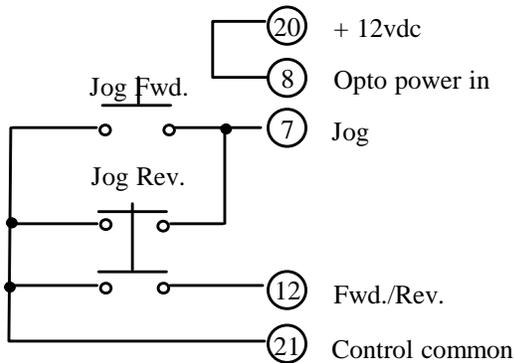


Fig. 10 Jog Fwd./Rev. connection.

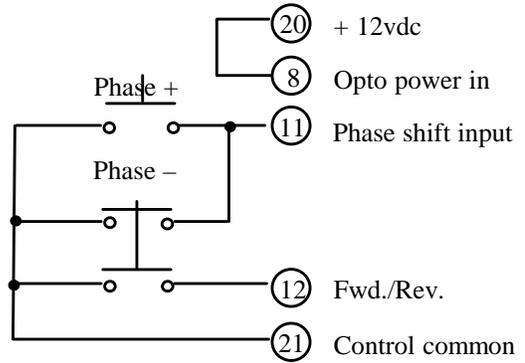
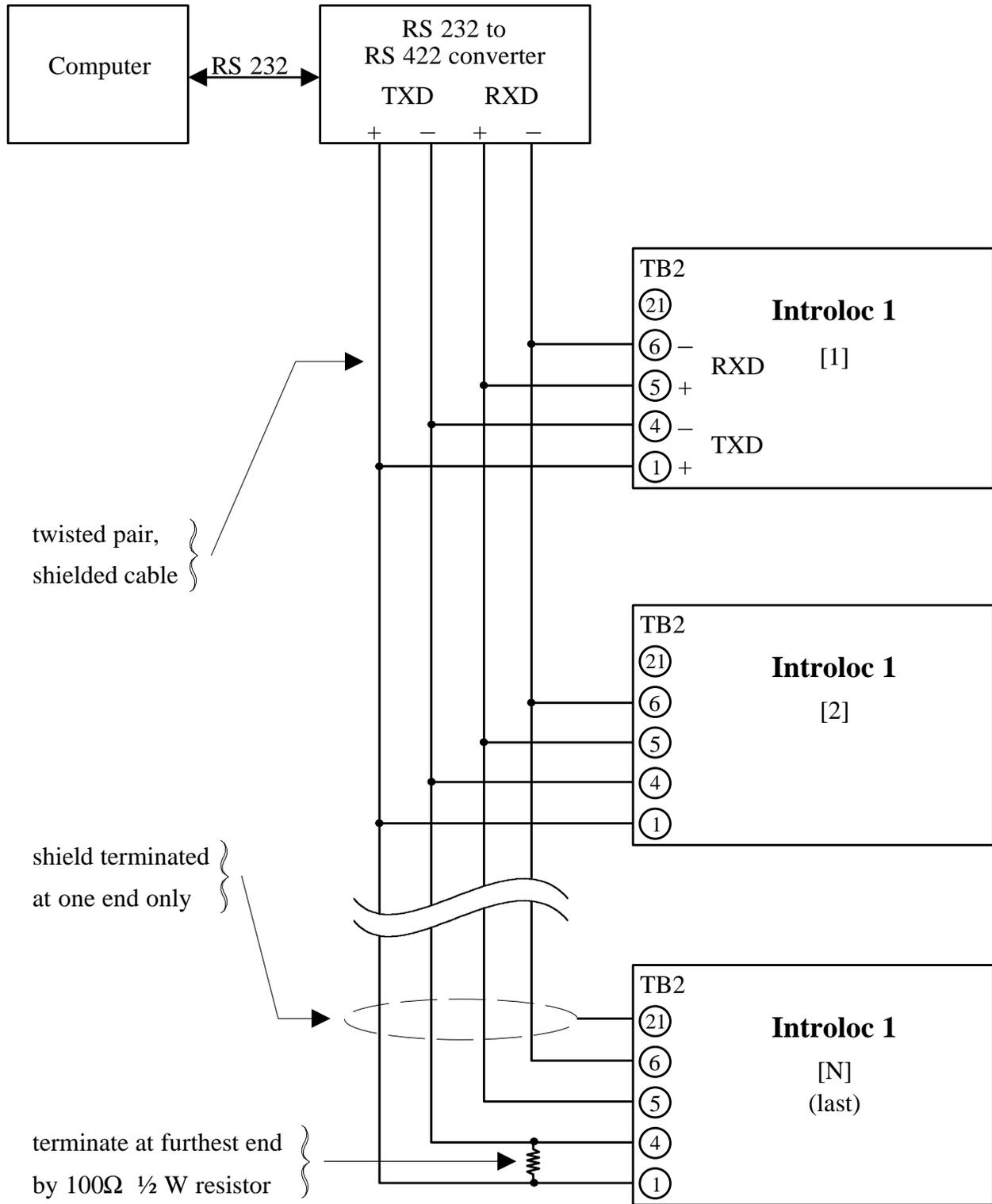


Fig. 11 Use of two pushbutton switches to phase shift +/-.

RECOMMENDED SERIAL COMMUNICATION CONNECTION



INTROLOC 1 SERIAL COMMUNICATION

The Introloc 1 is equipped with RS 422 serial interface and uses the American Standard Code for Information Interchange (ASCII). All parameters accessed through the front panel keypad are also accessible through the serial port. To simplify and reduce the software overheads of the controller which is communicating with the Introloc 1, the control commands are divided into two groups.

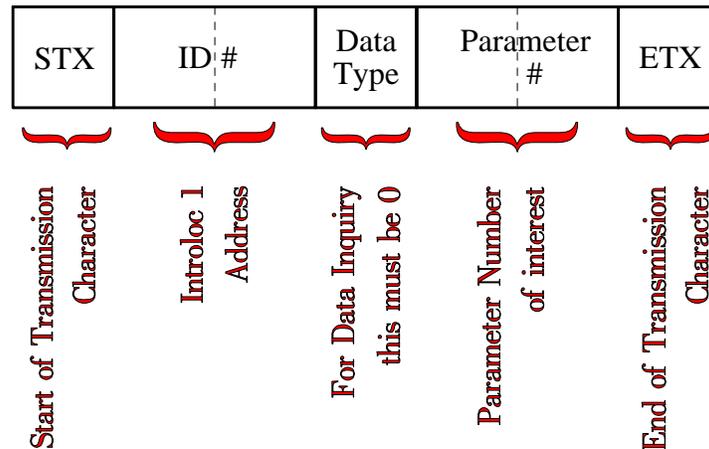
- 1 - Data (Parameter) Inquiry
- 2 - Data (Parameter) Entry

All parameters received and transmitted should be at the selected baud rate (300 to 4800) with 8 data bits, one start bit, and one stop bit.

1. Data (Parameter) Inquiry

This function allows the controlling device to retrieve data from the specific step number (parameter #). All of the parameters which are accessible are listed on pages 44 and 45, including their designating parameter #. The current display data (speed or ratio read out, depending on the current display function) is also assigned a parameter # for external use.

To inquire about previously entered data, (current speed, ratio, phase shift, and selected modes), the requesting controller must follow the sequence given here.



STX This is the start transmission character. All Introloc 1's will listen to the characters following this one.

ID # These are the two characters which contain the address of the Introloc 1 to which the following characters are directed. An ID # of 99 is a universal number where all Introloc 1's will respond.

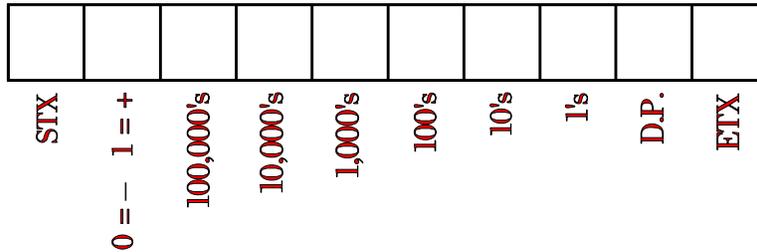
Data Inquiry

Data Type This character determines the data type. 0 = Data Inquiry
1 = Data Entry

Parameter # These two characters select the parameter to read out or write into.

ETX This is the end transmission character. It will also signal the selected Introloc 1 to process the received command or data.

The Introloc 1 will transmit data only if no error was detected and it was properly addressed. The data transmitted from the Introloc 1 will always have the following format, regardless of the number of digits in a particular step # (parameter #).



Example : To read out the acceleration currently stored in an Introloc 1 with an ID # of 4, the following character sequence should be received by the Introloc 1.

STX	ID #		Data Type	Parameter #		ETX
02	30	34	30	31	30	03

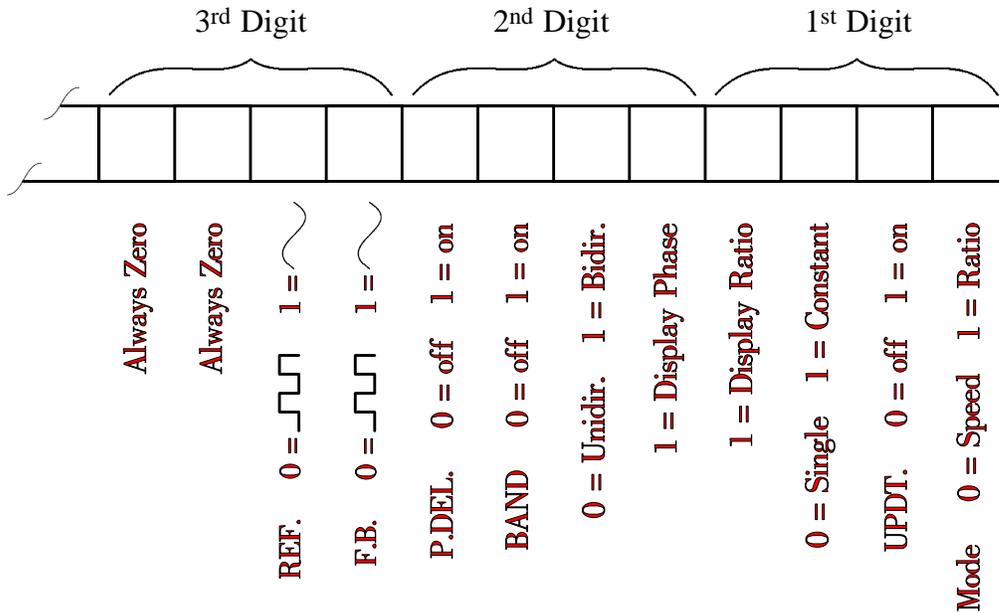
The Introloc 1 with an ID # of 4 will transmit the acceleration in the following format.

STX	+	MSD	5th	4th	3rd	2nd	LSD	D.P.	ETX
02	31	30	30	30	30	31	32	31	03

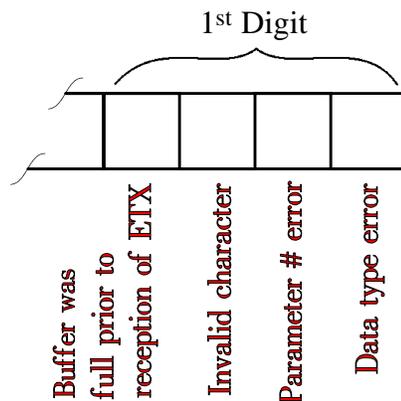
The received data translates to 1.2 seconds acceleration time.

Data Inquiry

All the steps that are selectable functions through the front panel keypad (mode speed/ratio, update on/off, etc.) can be read out or written into by addressing parameter #1. When parameter #1 is transmitted out of the Introloc 1 it carries information about the modes of operation presently selected. The three least significant digits can be numbers from 0 to 9, or A, B, C, D, E, or F since they contain binary bit patterns. Following is the description of each bit of the three least significant digits.

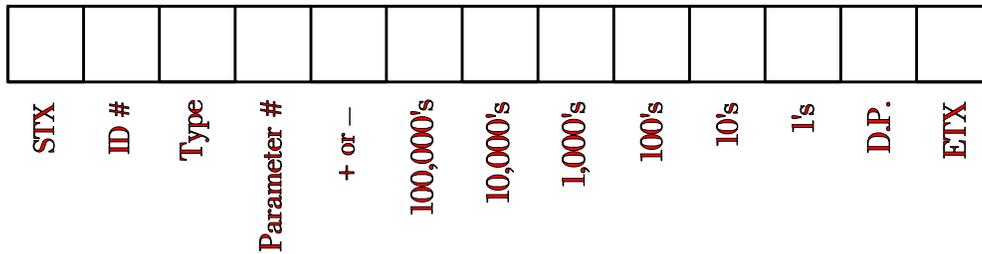


During data reception, the Introloc 1 will check that the received data is correct, and sets internal bits accordingly for various error detection. If and when an error is detected, the Introloc 1 sets the appropriate flag bit and exits the reception without further processing the data. It is the external controllers responsibility to interrogate the addressed Introloc 1 to ensure error free reception. The serial communication error bits are read only and can be accessed by reading parameter #2. The least significant digit will contain the error information. The error status bits will reset once they are accessed and outputted, or if the next reception does not contain any errors. The error status bits are as follows :



2. Data (Parameter) Entry

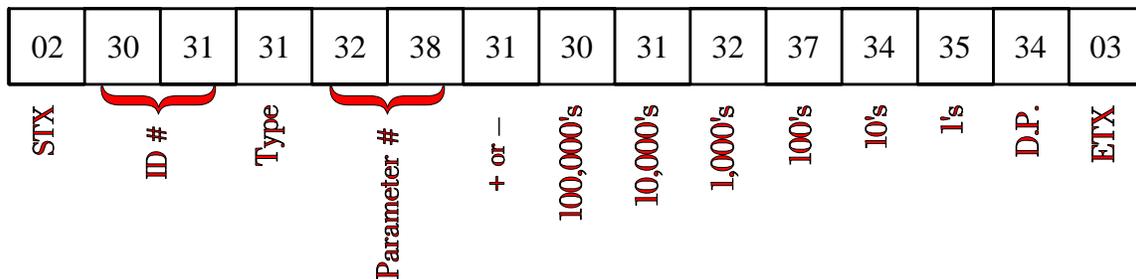
All data received by the Introloc 1 must be in the following format :



All parameters received by the Introloc 1 will be stored in nonvolatile memory without affecting normal operation. The entered parameters will take effect once the preset speed/ratio is entered by addressing parameter #28. Any time the speed/ratio is entered, the Introloc 1 will display - - - - - on the front panel display and process all the entered parameters.

The external inputs are functional at all times. When a speed/ratio is entered through the serial port and the memory operation is selected via external inputs, the memory preset selected will have priority over the entered speed/ratio. Under the described condition, the entered speed/ratio will be stored in the memory as the on demand preset.

Example : The Introloc 1 with an ID # of 1 is operating in follower mode with a ratio of 1.275. The process controller needs to change the ratio to 1.2745. The process controller must transmit :



Parameter Numbers Available to Read from Serial Port

Parameter # 00 *	Actual running speed/ratio based on the current display status.
Parameter # 01	All bit addressable steps, on/off, and other selectable steps. See page 42 for description.
Parameter # 02 *	All serial communication error occurrence bits. See page 42 for description.
Parameter # 04	Phase shift programmed
Parameter # 06	R.P.
Parameter # 08	F.P.
Parameter # 10	Acceleration time
Parameter # 11	Deceleration time
Parameter # 12	DP.NO. Speed display resolution
Parameter # 13	JG. Jog speed
Parameter # 15	INC. Increase/decrease rate
Parameter # 17	P.L. Pulse lead/lag limit
Parameter # 19	P.REC. Error pulse recovery multiplier
Parameter # 20	GAIN Proportional gain
Parameter # 21	INTG. Integral gain
Parameter # 22	RATE Differential gain
Parameter # 23	Baud rate
Parameter # 24	Device ID number
Parameter # 25	LOC.
Parameter # 26	H.L. Maximum speed

Parameter Numbers (Cont.)

Parameter # 27	F.F.r.t. Feed forward rate of change
Parameter # 28	Manual preset
Parameter # 29	Not used (future use)
Parameter # 30	Memory preset 0
Parameter # 31	Memory preset 1
Parameter # 32	Memory preset 2
Parameter # 33	Memory preset 3
Parameter # 34	Memory preset 4
Parameter # 35	Memory preset 5
Parameter # 36	Memory preset 6
Parameter # 37	Memory preset 7
Parameter # 38 *	Actual phase shift or following error in feedback pulse unit.

* Read only parameters

TROUBLESHOOTING

1. Display blank (no display).
 - A. No power applied.
 - B. Internal fuse blown.
 - C. Check for shorts on +5vdc or +12vdc.
 - D. Depress **•** and power up. When "DEFAULT" is displayed, press ENTER then reprogram the setup parameters.
2. Slave motor runs away when the INTROLOC 1 is started.
 - A. No feedback (check feedback encoder).
 - B. Wrong mode has been selected (bidirectional with unidirectional encoder).
 - C. Incorrect calibrator values for R.P or F.P. See setup.
 - D. Incorrect feedback device is selected. See line 19.
 - E. Feedback encoder channel A and B are reversed, if dual channel encoder is used.
3. Unit runs at incorrect speed or ratio.
 - A. Incorrect setpoint entered.
 - B. Incorrect setup parameters 6 and 8.
 - C. Faulty feedback device (encoder).
 - D. Faulty master reference encoder.
 - E. Noisy encoder signals.
4. Unit runs ok at low speed but can not get max speed.
 - A. Not tuned properly.
 - B. Slave drive not setup correctly.
 - C. Incorrect parameters at setup, if step 16 is set to ON, then step 17 should not be set to zero.
 - D. If in follower mode check master reference encoder.
5. The display shows - - - - - for more than 1 second.
 - A. Noisy run input.
 - B. Poor grounding.
 - C. Faulty controller.
6. Display number changes by a large amount, but runs ok.
 - A. If displaying speed, too large of a resolution is selected in step 12 of the setup.
 - B. If displaying ratio, enter ratio with fewer D.P.

TROUBLESHOOTING (continued)

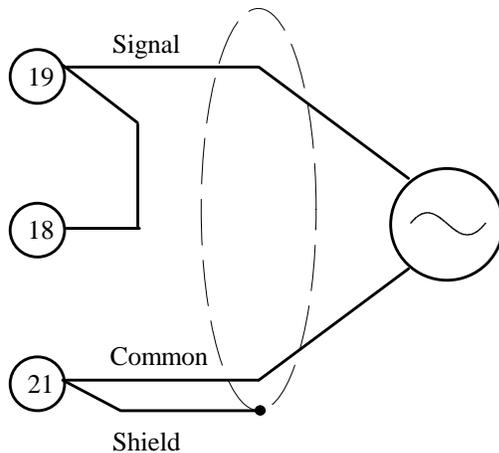
7. Drive runs rough at all speeds.
 - A. Check drive with speed potentiometer input.
 - B. PID not tuned properly.
8. Can not enter data or jog through front panel.
 - A. Keypad lock is activated, setup 25.
 - B. Chassis not grounded.
 - C. Control common not grounded.
9. Motor rocks back and forth when at stop.
 - A. Drive response too sluggish.
 - B. Drive accel/decel is active.
 - C. INTROLOC 1 setup parameter 19 needs to be adjusted.
10. In position synchronizer mode the slave makes an abrupt correction each time the position signals are received.
 - A. Incorrect ratio. Check entered ratio and setup parameters #6 and #8 for accuracy.
 - B. Faulty encoder signals.
 - C. Multiple position signal input (bounce, noise, oscillation).
 - D. Inconsistent position signals. (Not repeatable).
11. As the speed increases the follower position shifts relative to the master.
 - A. INTROLOC 1 not tuned properly.
 - B. Position signals are delayed. (Do not run position signals through a PLC or relay logic).
 - C. INTROLOC 1 step #19 is not active.

After you have read this manual and followed the instructions, if it becomes necessary to call for assistance, please have the following information ready.

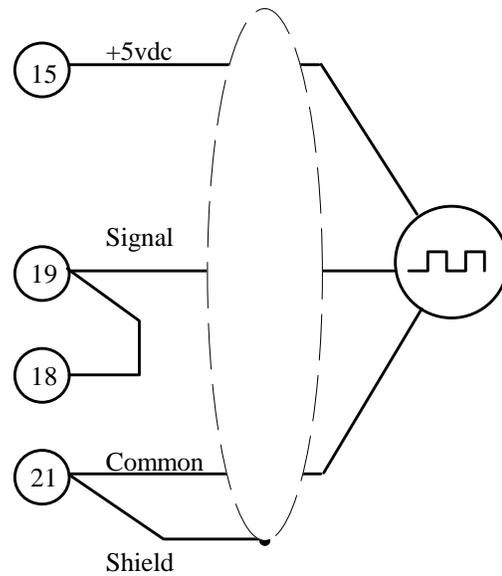
1. Know your application.
2. Know your gear ratios, number of teeth on sprocket, roll diameters or any other mechanically geared equipment that relates to the control of the device.
3. Know the resolution of the encoders or magnetic pickups and their types.
4. Verify the programmed parameters and keep notes of them if possible.

HINTS

The following connection diagrams illustrate the connection of a dual and single channel encoder to the INTROLOC 1. To use a single channel encoder or a magnetic pickup, connect a single wire to both channel A and B of the corresponding input of the INTROLOC 1.



Magnetic pickup connection.



Single channel encoder or zero speed pickup connection.

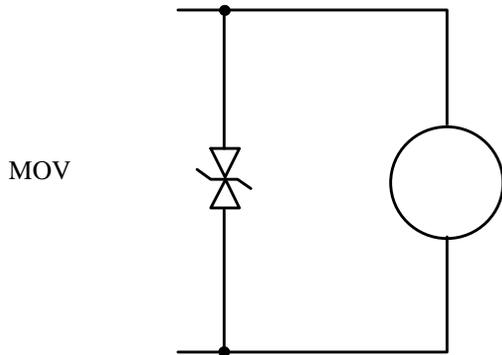
Use shielded cable as shown and terminate shield at one end only (on INTROLOC 1 side for all inputs). Connect any unused conductor of the shielded cable to where the shield is terminated.

Each shielded cable should carry signals for one device only. DO NOT USE MIXED SIGNALS WITHIN THE SAME SHIELDED CABLE.

Note: Do not use the same shielded cable to carry the master and slave encoder signals. Use a separate cable for each one.

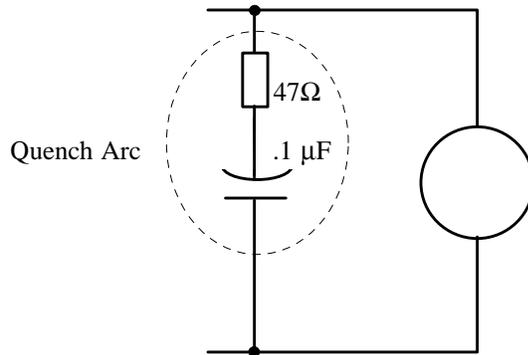
HINTS (continued)

All AC/DC relays, solenoids and motor starters must be suppressed to insure trouble free operation. Following are a few examples of AC/DC inductive device suppression methods.



AC relay/solenoid suppression (snubber) using a metal oxide varistor (MOV)

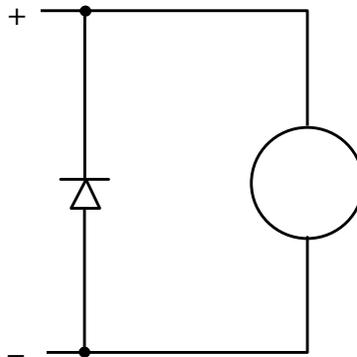
"Good"



AC relay/solenoid suppression (snubber) using resistor/capacitor combination. (Quench arc).

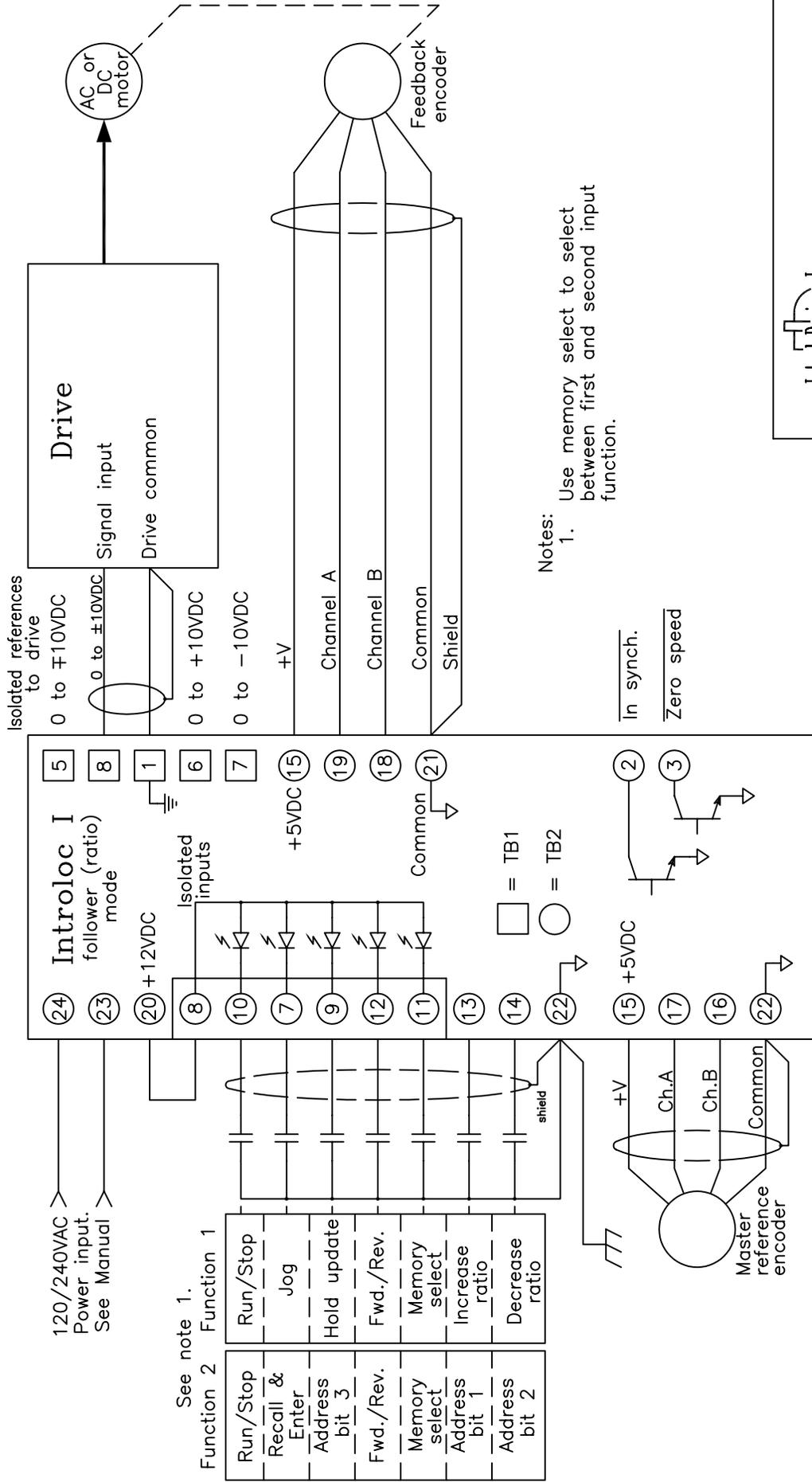
"Better"

A combination of both methods is best.



DC relay/solenoid suppression using a rectifier diode.

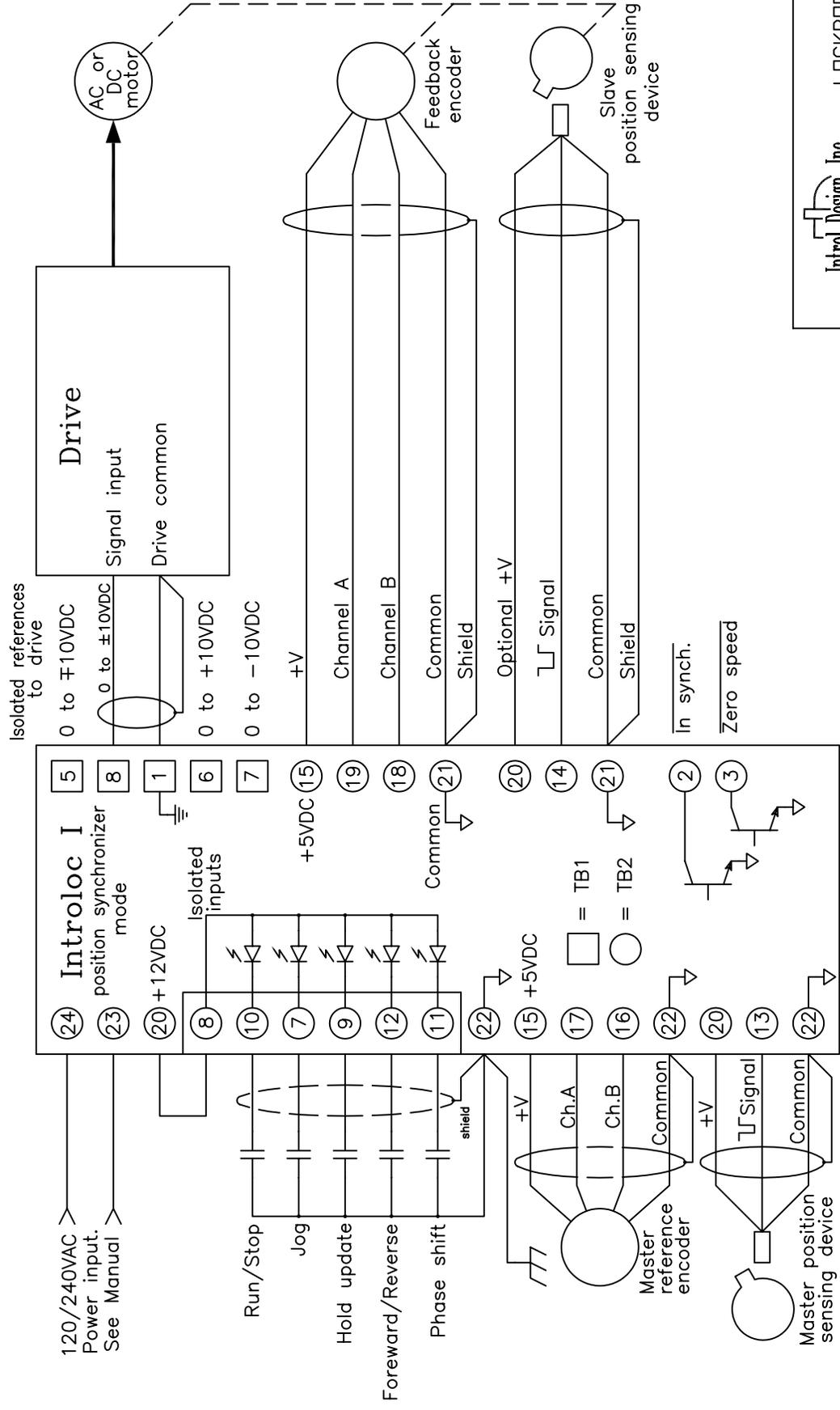
All suppressors must be installed as close as possible to the coil in order to be effective.



Introloc Design, Inc. LOCKPORT, NY.	
NO.	601CC-FM
TITLE	Follower mode (ratio) connection diagram
TRB DRAWN	10/29/92 DATE
CHKD.	APPVD.

A Added isolated reference TRB 10/5/93

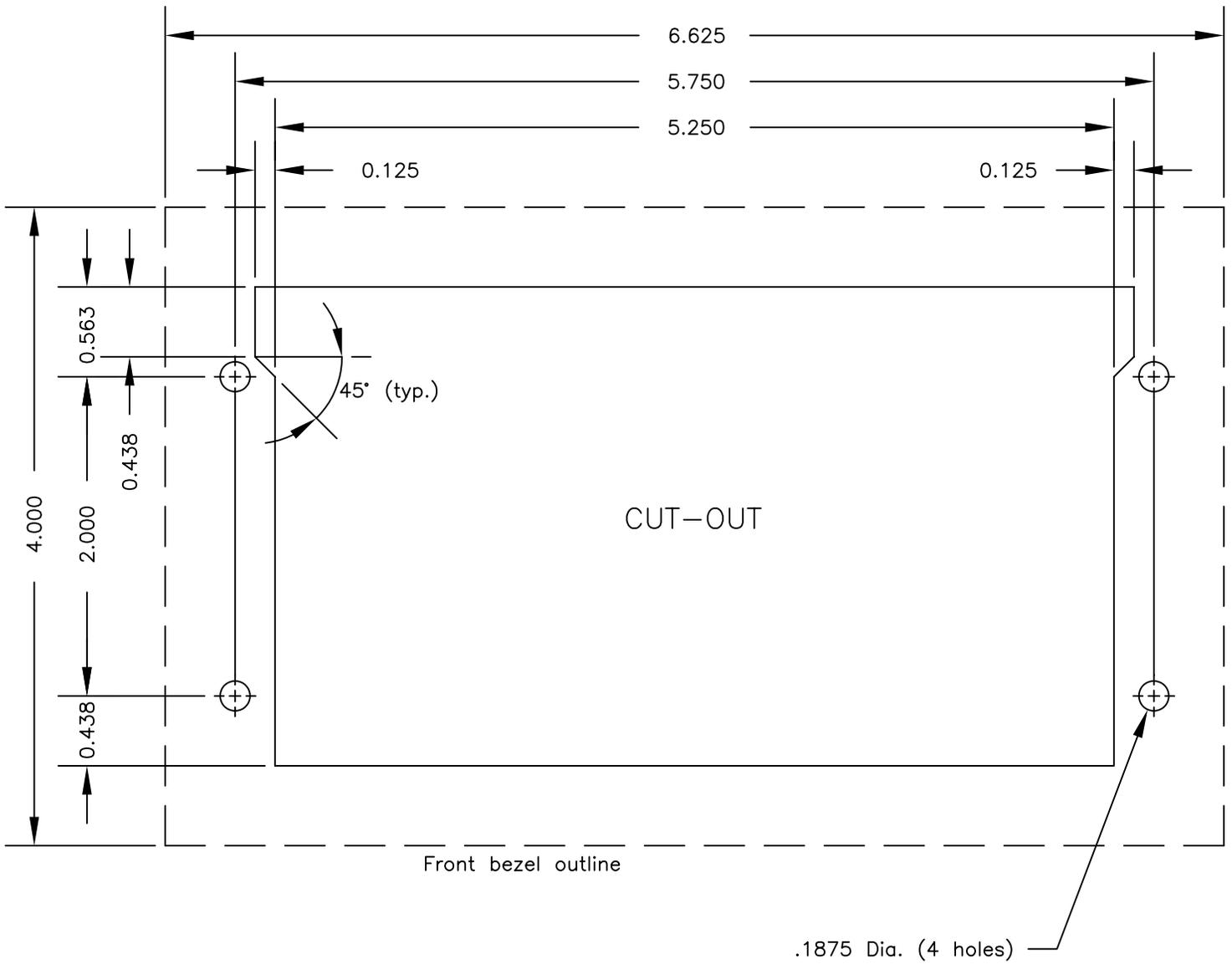
DESCRIPTION	DATE	APPVD.
REVISIONS		



Introloc Design, Inc. LOCKPORT, NY.	
NO.	601CC-PS
TITLE	Position Synchronization Follower Mode
TRB DRAWN	10/29/92 DATE
CHKD.	APPV.D.

A Added isolated references TRB 10/5/93

DESCRIPTION	DATE	APPV.D.
REVISIONS		



Notes:

1. All dimensions are in inches and are ± 0.010 unless noted otherwise.
2. Dotted line represents outside edge of front bezel.

		 LOCKPORT, NY.	
		NO. 601-02 Panel cut-out dimension drawing for INTROLOC I	
A	Redrawn	TRB	10-19-93
	DESCRIPTION	DATE	APPVD.
REVISIONS		DRAWN	DATE
		CHKD.	APPVD.

WARRANTY POLICY

Introl Design, Inc. guarantees its products against defects in workmanship and materials for a period of twelve (12) months from date of purchase, not to exceed twenty-four (24) months from date of manufacture. Final determination of whether a device is defective rests with Introl Design. Introl Design must be notified about any alleged defects, and will provide the customer with shipping instructions. If inspection reveals defects caused by faulty materials or workmanship, Introl reserves the right either to rebuild the device using new or refurbished and warranted parts or to replace the device with a new device, returning to the buyer a device meeting full factory standards for new performance. Any repairs necessary due to customer modification will be considered non-warranty and billed by the factory at current rates. Buyer will bear costs of transportation to and from the factory, risk of loss for goods not at the factory, and costs required to remove or prepare for shipment and to reinstall equipment after repair. Introl Design, Inc. assumes no responsibility for injuries or damages to persons or property arising out of improper use of this device, and Introl Design's liability arising out of the device or its use, whether on warranty or otherwise, shall not exceed the cost of correcting defects. There are no expressed or implied warranties of merchantability or fitness for a particular purpose that apply to this device. Introl Design, Inc. reserves the right to make changes or improvements in its products without incurring any obligation to make such changes or improvements in the similar products previously purchased.

Introl Design, Inc.

**4883 IDA Park Drive
Lockport, NY 14094**

Phone (716) 434-6919

Fax (716) 434-1911

www.introldesign.com

introl@introldesign.com