

The Application Note is pertinent to the Unidrive Family

Shaft Orientation

Scope – This Application Note discusses the issues to be dealt with when attempting to use the built-in orientation-upon stop feature of the Unidrive with a gear-in present between the motor and the shaft to be positioned. A solution for a range of “exact integer” gear-in(s) is provided for the case of a single orientation position and a limited range of “orientation position programmability” near that position.

Background

The Unidrive, operating in either the Closed Loop Vector or Servo Mode, includes a “Stop with Positioning” feature that can be used to position the motor shaft anywhere within one revolution when a stop is commanded. This mode requires an encoder with an Index Marker channel(Z) as well as the normal A and B quadrature channels.

If the motor to machine gear-in is 1:1, the application is quite straight forward. Any gear-in greater than 1:1 will divide the output shaft into a series of sectors representing motor revolutions. If the ratio is an exact integer ratio that divides 360 degrees without remainder, the output shaft beginning, middle and end points for these “sectors” will remain in fixed positions relative to the output shaft.

Stopping and orientating to a particular fixed position with a gear-in under these conditions becomes a matter of slowing down to the orientating speed, detecting the desired sector, then initiating a stop with “stop with position” (orientation) configuration. Consider the illustration below for an example of what the motor shaft does with a 4:1 gear-in. There will be 4 sectors where orientation can occur. With respect to the output shaft of the machine, we may want it to stop every time some specific spot within Sector 2. A limit or proximity switch can be used to provide sector information so that orientation can occur within that specific sector.

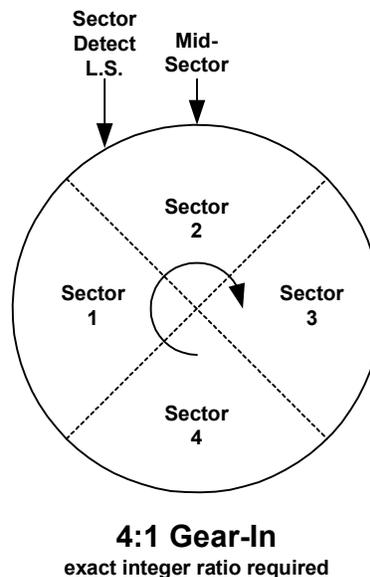


Figure 1 Output Shaft with 4:1 Gear In Illustrated

Practically speaking, not all integer reduction(s) can work for this application, nor can all types of reducer(s) exactly attain one of the ratios that will work.

Gear-in Sectors	Sector Degrees	Usable?
2:1	180	Yes
3:1	120	Yes
4:1	90	Yes
5:1	72	Yes
6:1	60	Yes
7:1	51.42857	No
8:1	45	Yes
9:1	40	Yes
10:1	36	Yes
11:1	32.72727	No
12:1	30	yes

Gear types that can achieve one of these exact reduction(s) include spur, helical, herringbone, bevel, and planetary designs. Timing Belts or Chains with Sprockets can also attain these exact ratios. Worm gears will probably not do the job (common practices with worm designs preclude exact ratios)

There are some dynamic issues to address to insure that the stop is completed within the desired sector and not over-travel to the next sector. A related issue is the range of programmability of the final position within a single, selected sector.

A reduction of 12:1 is judged as the upper limit of this approach, as it limits the target sector to only 30 degrees. It is probably not practical to place a single sensor (such as limit switch or proximity detector) at the beginning of a smaller arc on the output shaft and stop with position within that same arc, without overshoot and backup.

Implementation

Besides having a built-in Position Orientation feature, the Unidrive also has some miscellaneous logic functions (AND, OR gates and Timers) that can help us with a solution.

Basically, when an Orientation Stop is requested, we will not halt motion right then but rather go to a low adjustable speed while looking for the desired sector location- (look for the limit switch or proximity sensor). When that sensor is detected, we now can invoke the normal Stop that will position the motor shaft at the desired set position within that particular sector.

The logic we need to implement looks like:

(ORIENT SELECTED * AT SEEK SPEED) * 0.1 sec = SEEKING SECTOR

SEEKING SECTOR * SECTOR LIMIT SWITCH DETECTED = STOP & ORIENT

This works out great, because there are 2 free sets of logic gates with time delays. One delay is required because the actual “orient stop” halts motion once, then positions at the final orientation position.

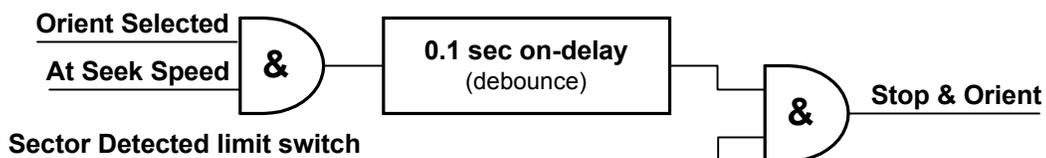


Figure 2 Logic Overview

Timing Diagram of Events

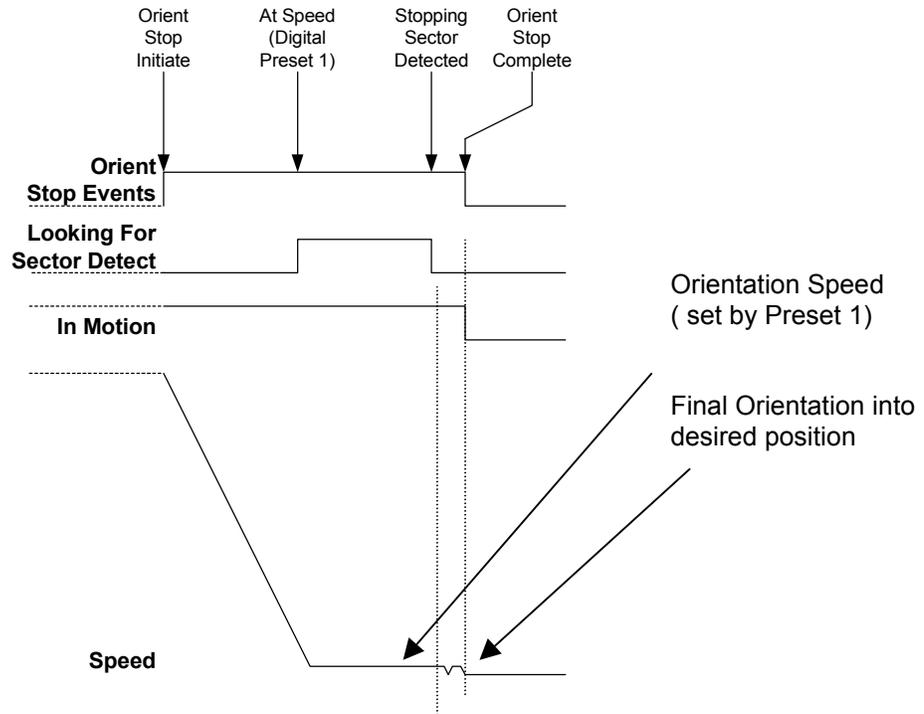


Figure 3 Orient Stop with Gear-in Timing Diagram

Unidrive Configuration and Resources Required for this Application

1. Dedicated use of Menu 9 for the required logic
 - Both Programmable Logic Functions needed
2. Dedicated use of the Unidrive's Relay Output for the "Orient Sector Detected". Is illustrated
 - Note that this is usually used for the "Drive OK" output.
 - Use of the last free I/O point as an active output for "Orient Sector Detected" implies that the "enable" input serve as the only "STOP". This Application note illustrates a normally closed "halt at any sector" input that was used for testing.
3. Dedicated use of a Digital Preset, digital preset #1 used for app note.
4. Five (5) of the available six (6) local I/O Points configured in Menu 8 are required
 - One Output needed
 - Four Inputs needed
 - Last (optional) Input is used as Reverse/Forward Selection in Application note (for testing)
5. Dedicated use of a Digital Preset
 - Digital Preset #1 used for Application note.
 - Switching between the normal Analog Speed Input and Digital Preset 1 is illustrated in Application note.
 - Use of a different Speed Reference configuration will require revision of the "Slowdown to Orient Speed" logic.
6. Sequencing "Mode 0" (# 6.04 =0) must be selected for the Application
 - "Stop and Orient to Position" must be a "momentary" event
7. "Hold Zero Speed" (# 6.08 =1) must be selected for the Application
 - Output # 8.01 on pin 24 will not drop out at the end of the sequence if "hold zero speed" is not selected.
8. In addition to the Unidrive resources, a single 24 VDC Relay, with two "form C" contact blocks, is required.
 - This is used to insure that the Unidrive uses to a copy of the "orientation speed" held in Digital preset #1 for its speed target while looking for the sector detect limit switch.
 - A optional "1N4006 style" silicon diode is illustrated as a "flyback diode" (desirable, but not mandatory).

24VDC
Relay
2-pole
w/ back
diode

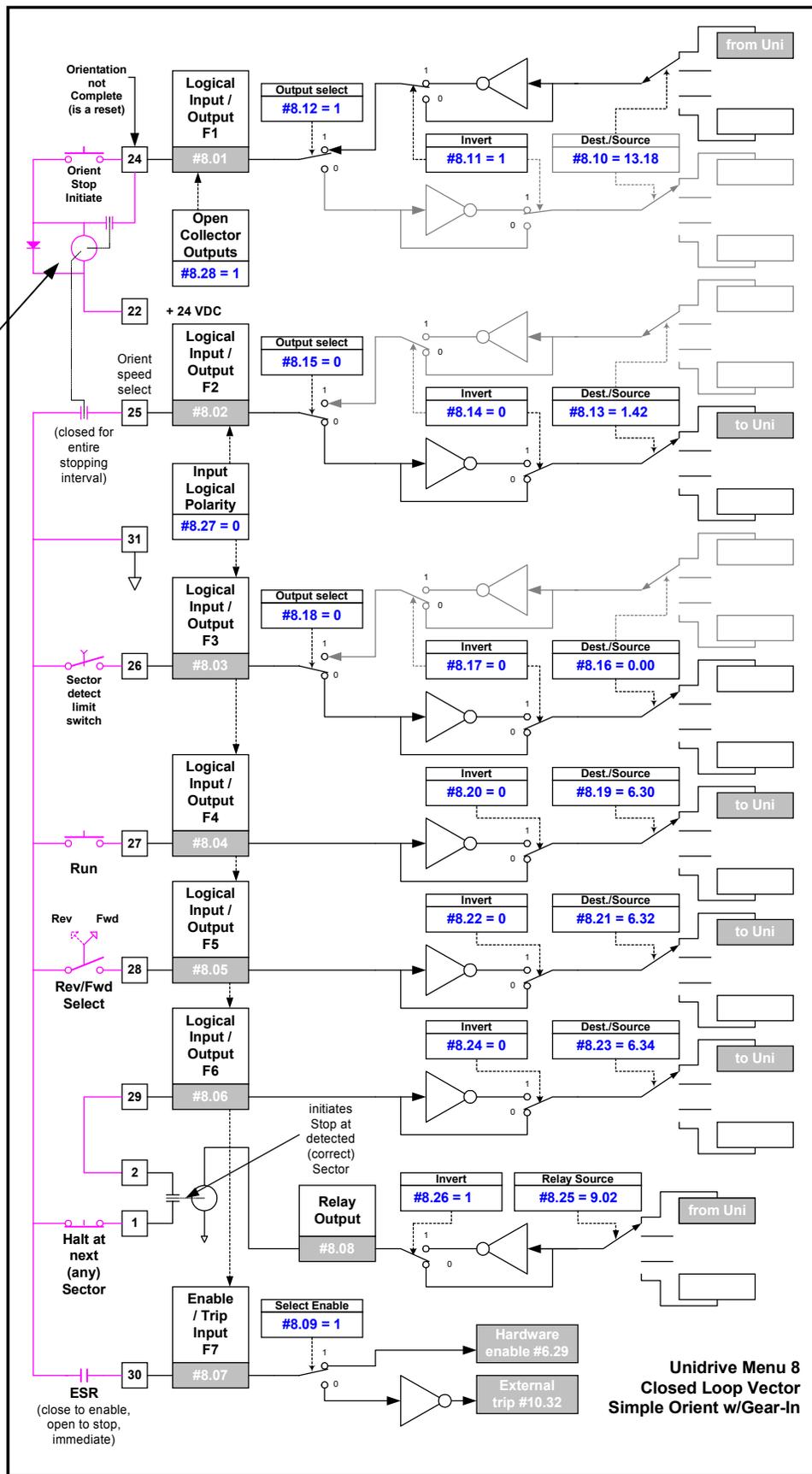


Figure 4 Shaft Orient with Gear-in Connections and Menu 8 Input / Output Details

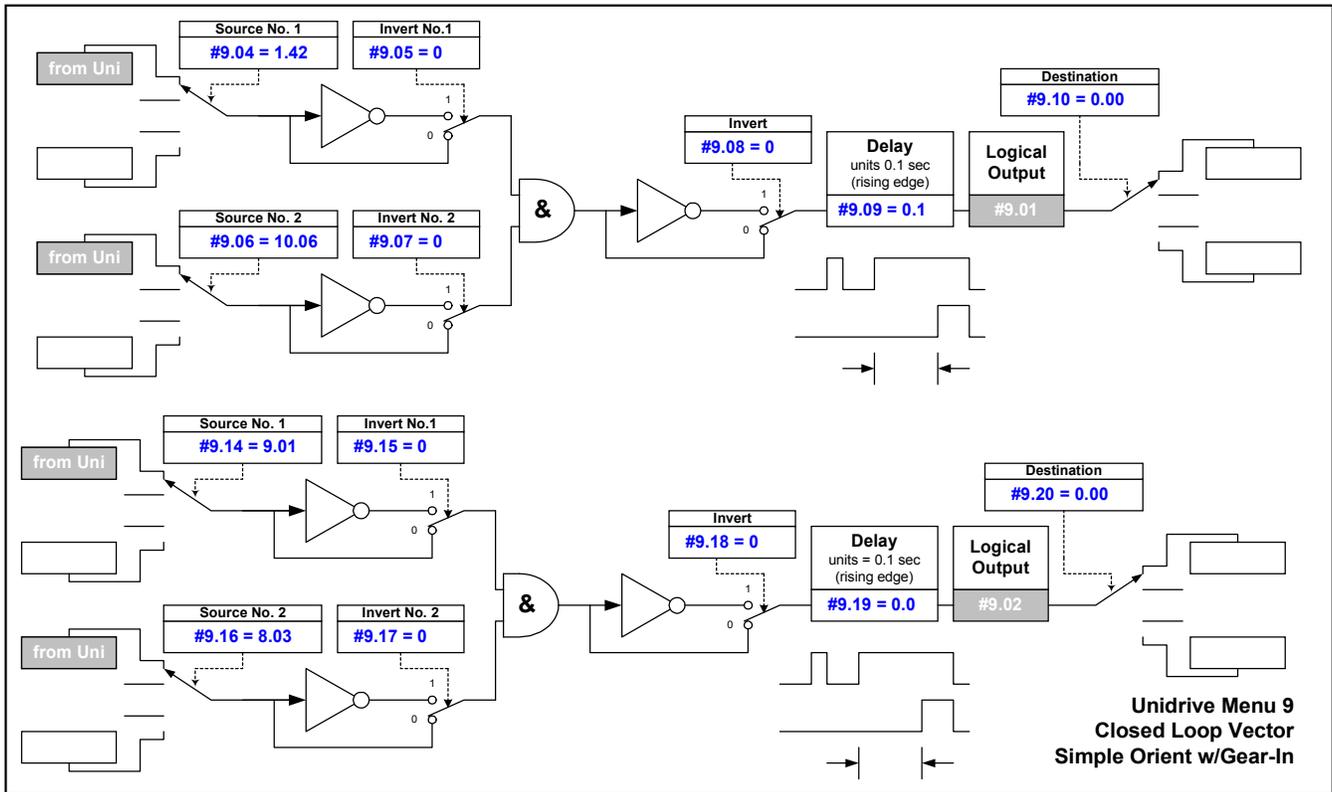


Figure 5 Orient Stop with Gear-in Menu 9 Threshold Compare Details

Shaft Orient with Gear-in – critical, non-default parameters		
# 1.14 =	0	Set for terminal control of reference
# 1.21 =	100	Set to same value as # 13.10 (100rpm Seeking Sector speed)
# 3.20 =	1	Needed for positioning to be effective
# 6.01 =	rP-POS	Basic requirement for application
# 6.04 =	0	Needed for momentary contact control
# 6.08 =	1	Hold zero speed required for proper control out # 8.01
# 13.08 =	5	5 prevents picking present sector at “enable”, requires full sequence
# 13.09 =	0.020	Positioning Gain (default value of 0.100 may be too high)
# 13.10 =	100	Set to same value as # 1.21 (100rpm Seeking Sector speed)
# 13.11 =	2048	This value selects middle of sector detected by sensor

Shaft Orient with Gear-in – critical, non-default parameters (continued)		
# 8.09 =	1	See Figure 4 for explanation
# 8.10 =	13.18	
# 8.11 =	1	
# 8.12 =	1	
# 8.13 =	1.42	
# 8.14 =	0	
# 8.15 =	0	
# 8.16 =	0.00	
# 8.17 =	0	
# 8.18 =	0	
# 8.19 =	6.30	
# 8.20 =	0	
# 8.21 =	6.32	
# 8.22 =	0	
# 8.23 =	6.34	
# 8.24 =	0	
# 8.25 =	9.02	
# 8.26 =	1	
# 8.27 =	0	
# 8.28 =	1	

# 9.04 =	1.42	See Figure 4 for explanation
# 9.05 =	0	
# 9.06 =	10.06	
# 9.07 =	0	
# 9.08 =	0	
# 9.09 =	0.1	
# 9.10 =	0.00	
# 9.14 =	9.01	
# 9.15 =	0	
# 9.16 =	8.03	
# 9.17 =	0	
# 9.18 =	0	
# 9.19 =	0.0	
# 9.20 =	0.00	

Setup and Troubleshooting

1. Get the Unidrive and the motor running together first in open loop to check and confirm the feedback from the encoder and forward direction. This application requires the index marker (**Z**) as well as the two quadrature channels (**A** and **B**). Remember that the default value for # 3.22 is a value of “1” in open loop, and that # 3.22 needs to be a value of “0” to evaluate the encoder feedback. The Speed Feedback in # 3.26 needs to be positive in a forward direction. Reverse A and “not A” channel to correct a negative speed indication in forward.
2. Once in closed loop vector mode, enter the application parameters as documented. The index target value of “2048” for parameter # 13.11 places the position target in mid-sector. Varying this value from “0001” to “4095” while holding position after a stop will allow observing the beginning and end of the selected sector.

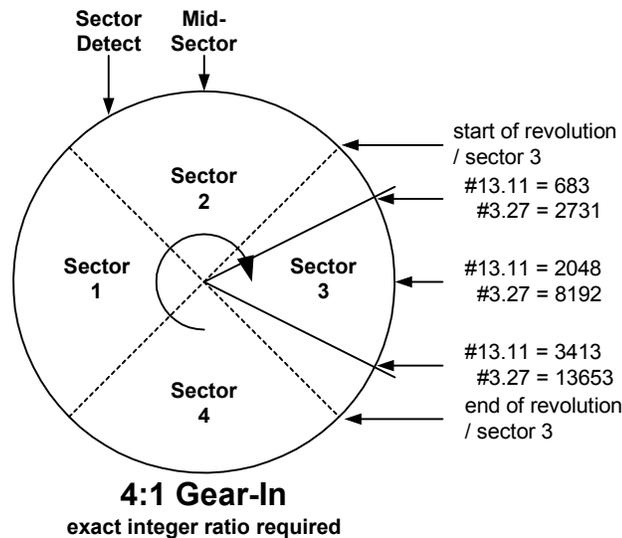


Figure 6 Illustrating a practical range of positioning within 60 degree arc for 4:1 Gear-in

3. Precise positioning requires good position information from the encoder. If trouble is encountered, mark the motor shaft and insure repeatable positioning in the motor and pulse frame of reference. Look to the encoder cabling first if trouble is encountered.
4. For the “orientation complete” output at pin 24 (# 8.01) to properly drop out at the completion of orientation sequence, parameter # 6.08 *must* be at a value of “1”.
5. If the final position “moves” after a series of stops and the motor position before the gearbox is okay back in “Step 3, you have used a reduction (or gear-box) that is not exactly one of the ratios cited. This was observed during the drafting of this application note on a worm gearbox that was nominally “10:1”, hence the warning earlier about suitable reduction approaches that may be compatible with this application.

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