690Like Phase Locking Application

HA503284U007 Issue 2

690Like Phase Locking Application Manual

Description

Phase Control or Phase Lock, sometimes referred to as electronic gearbox, is a position trim of a slave drive to a speed to maintain the relative position between a master and a slave shaft or a precision ratio between the two shafts. The slave speed demand is composed of the master speed demand and a position trim from a counter of the accumulated differences between the Master and Slave Encoders

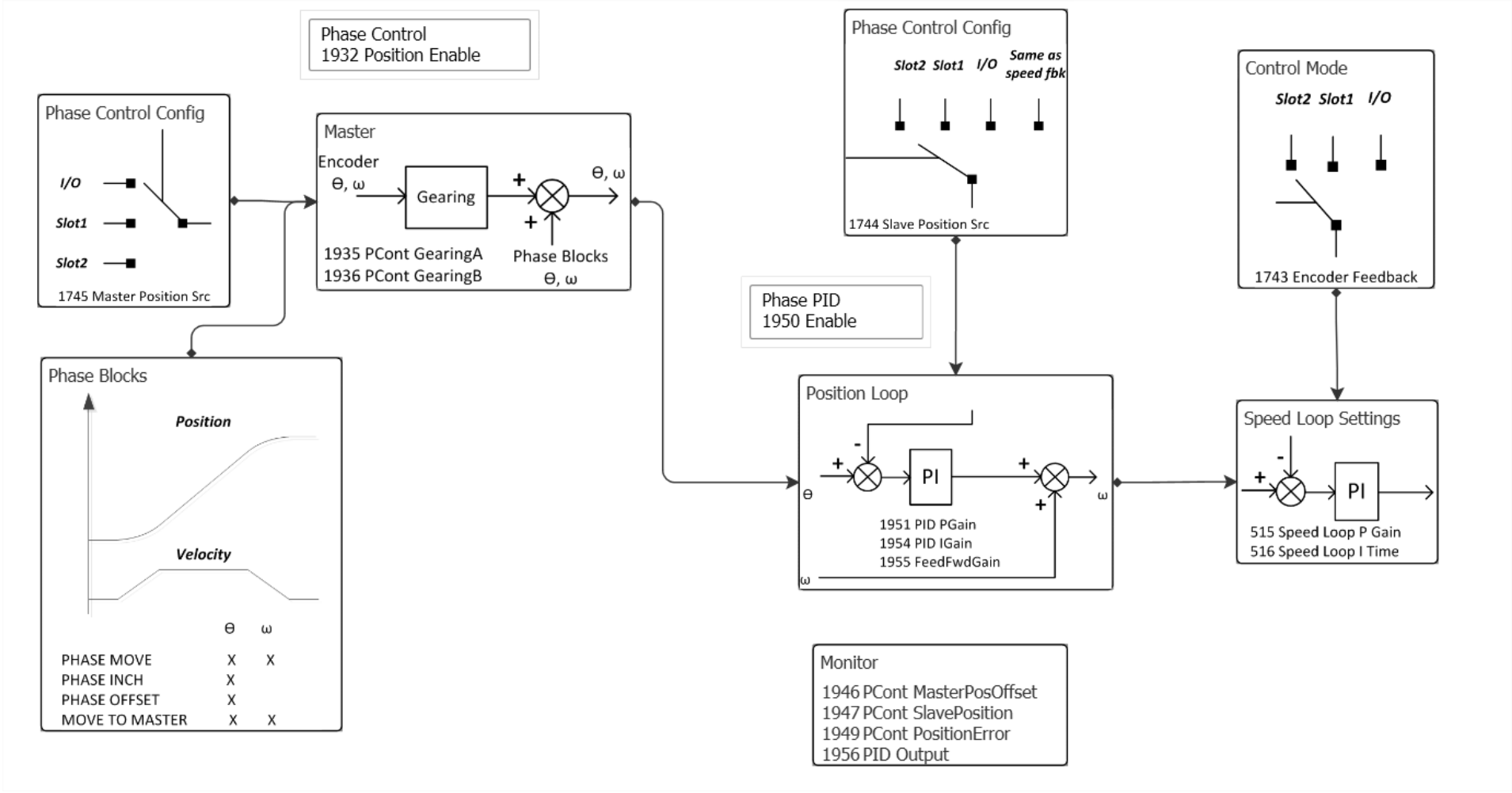
Features

- 690Like Phase Control application specific menus and parameters with Master Slave Encoder Inputs
- Retransmit Output which is a duplicated output of one of the encoder input or a synthetic encoder output from a speed setpoint
- Phase Control or position loop

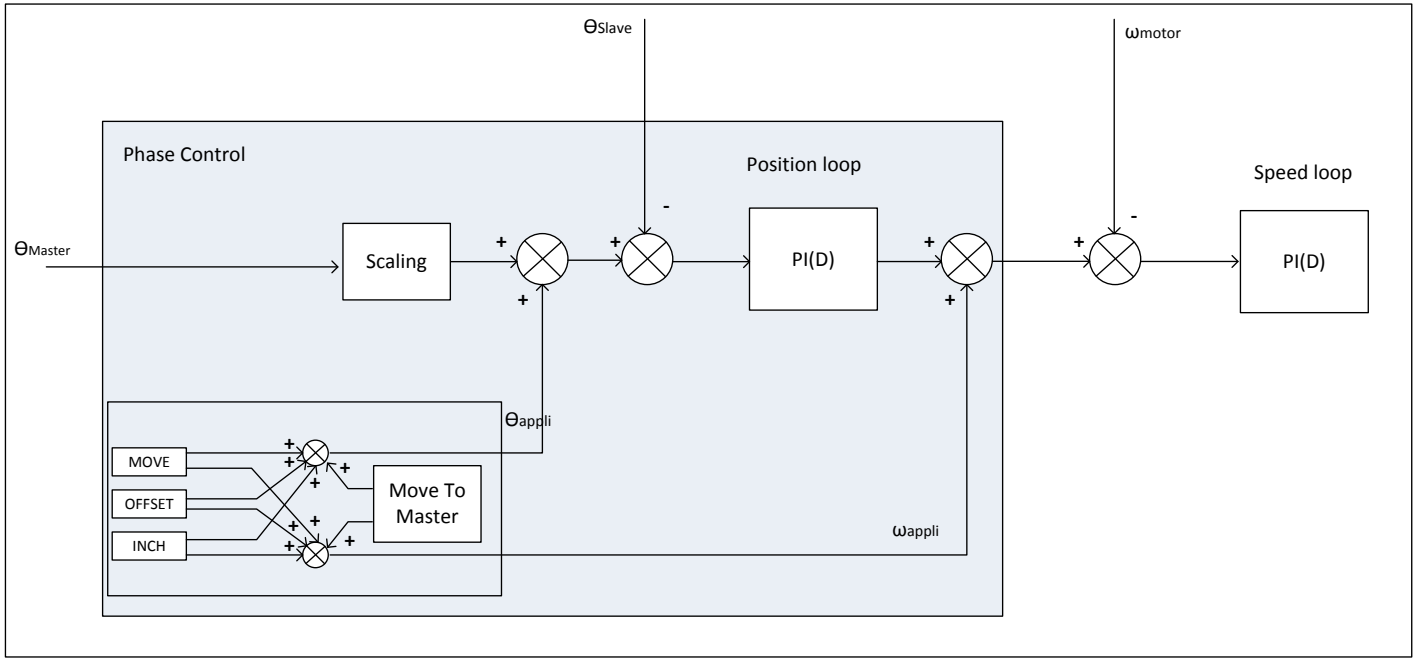
Requirements

To use the AC30P/D for phase control as described in this manual, the application RA503284U007 must be loaded into an AC30P/D series drive with firmware 2.13 or newer.

690Like Phase Locking - PDQ



Principle



Type of Applications

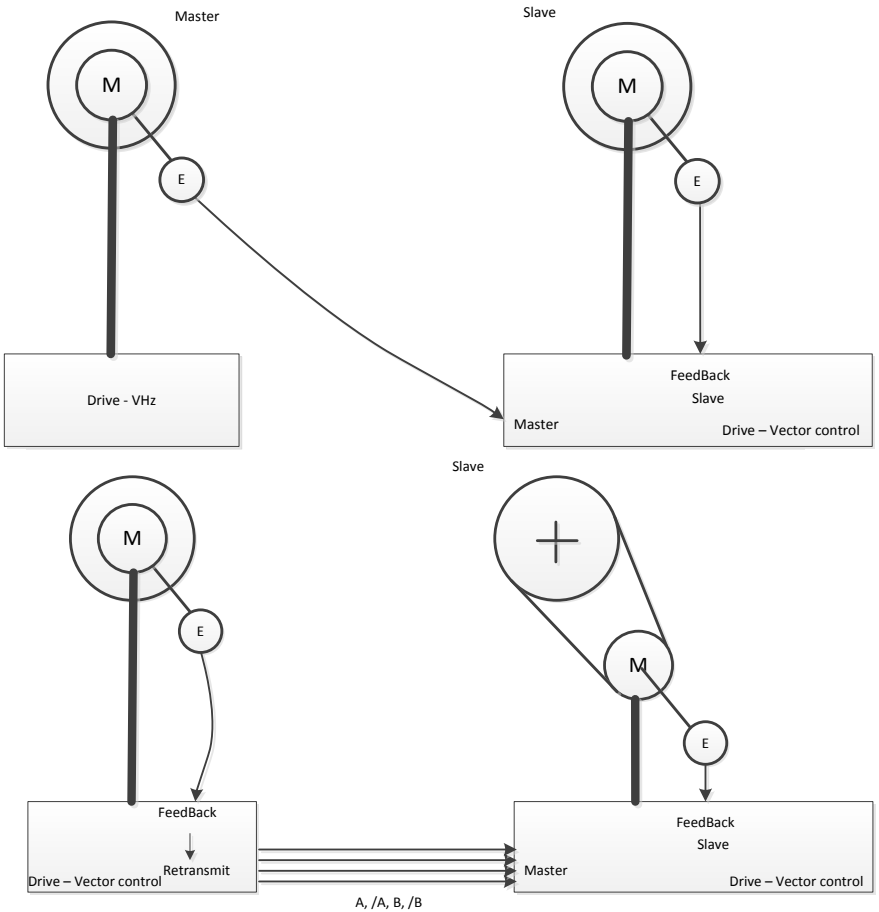
The slave drive is to follow a master drive.

Phase control adds a position loop over the speed control to synchronize in position master and slave drives. Adding a factor between Master and Slave allows to synchronize drives in various situation.

PHASE CONTROL WITH FIXED 1:1 RATIO

The simpliest phase control configuration is described below.

The first drive controls a motor in VHz mode. An encoder attached to the motor is then connected to a second drive and is configured to be the Master input. The second drive (the Slave) will follow the Master.



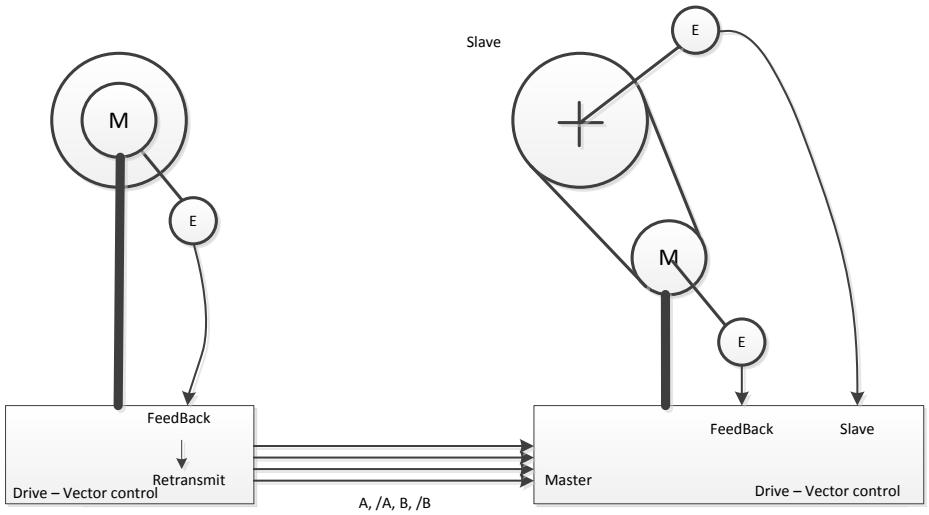
The same configuration could also be done by using the first drive in Vector control mode by using the first encoder as the speed feedback encoder and retransmit the encoder to the second drive.

PHASE CONTROL WITH FIXED RATIO

The first drive is run in Vector control mode by using the first encoder as the speed feedback encoder and retransmit the encoder to the second drive.

The second drive controls a motor with a pulley ratio to the load. The Slave encoder is connected to the load.

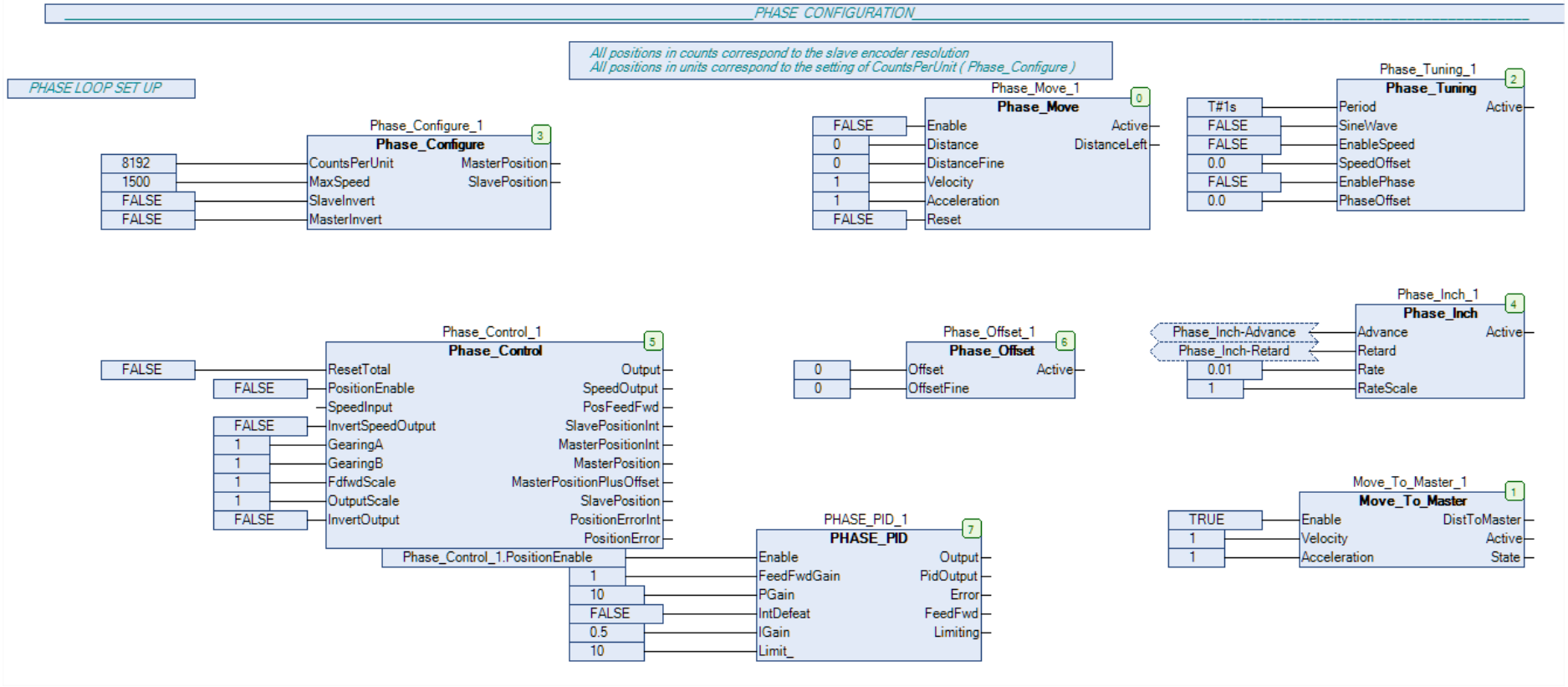
If the load must turn in phase with the Master, then a Gearing factor is used to compensate for the pulley ratio.


Slave
E
M
E
M
E
FeedBack
Retransmit
Drive – Vector control
A, /A, B, /B
FeedBack
Slave
Master
Drive – Vector control

Inputs and Outputs

Main Block Diagram

In default application, all Blocks inputs are initialized with safe values.

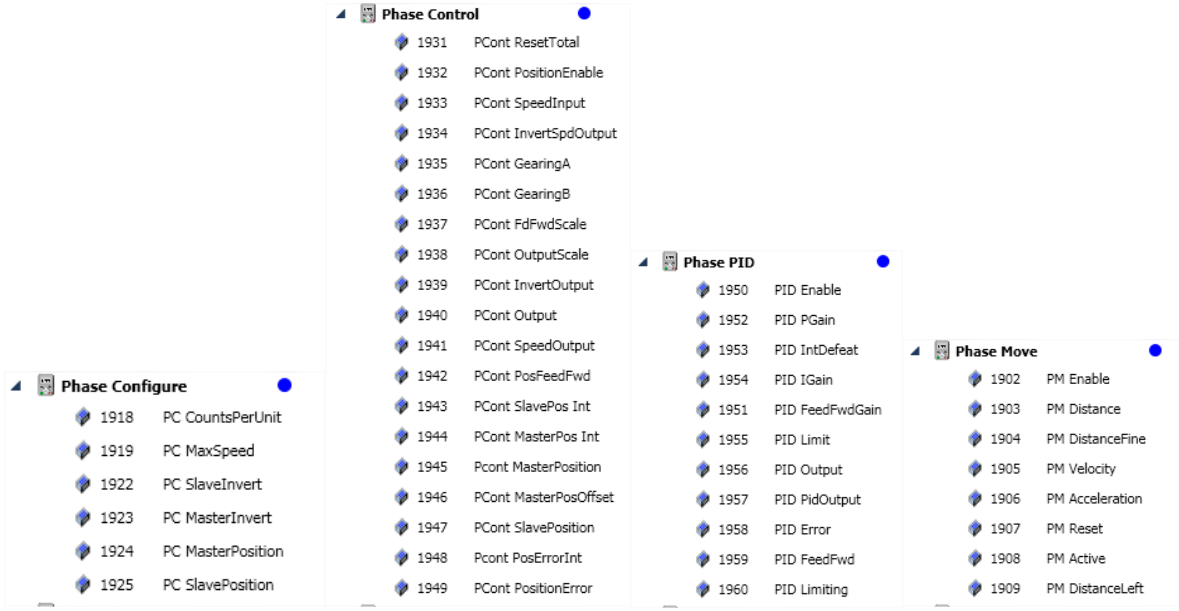


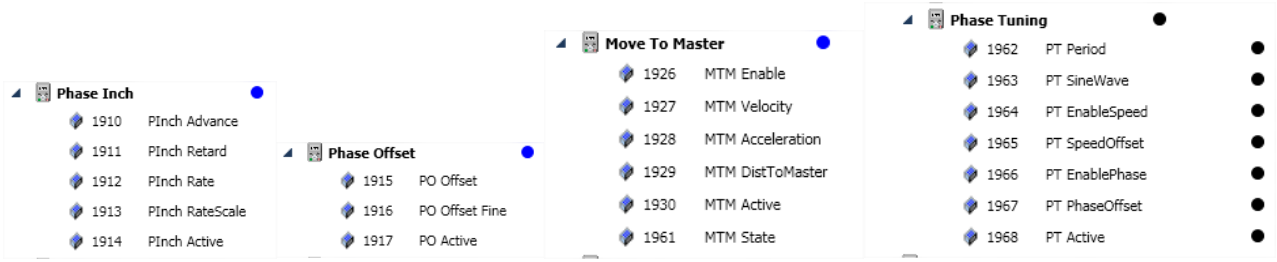
Phase_Configure, **Phase_Control** and **Phase_PID** need to operate together. They are internally linked and cannot be used separately.

Graphical Keypad (GKP) Application Customisation

The application ***AC30P_690Like_Phase_Locking*** adds menus and parameters to the GKP. It also modifies the behaviour of the Control Screen and set-up wizard.

Below is the list of added parameters :





Function Blocks

An user unit used in the Phase Control, Phase Move, Phase Inch , Phase Offset block can be defined by setting up 2 parameters of the Phase Configure Block :

- ***CountsPerUnit*** : is used to define the number of counts from the slave encoder which will represent 1 unit.
- ***MaxSpeed*** : is also used to scale the feedforward term of the position loop and should represents the maxpseed of the Slave in unit per minute.

Exemple :

Slave encoder is a 2048 lines.

That gives 8192 counts per revolution.

The Maxspeed of the slave (corresponding to 100% setpoint) is 1500RPM.

1st case :

1 slave revolution corresponds to 2mm. So 1mm is 8192/2 = 4096.

By entering ***CountsPerUnits*** = 4096 and ***MaxSpeed*** = 1500*2 = 3000, than the positions are in mm and the speed in mm/s.

2nd Case :

1 slave revolution corresponds to 5 mm. So 1 mm is 8192/5 = 1638.4.

As the value is not an integer, using 1638 would give an error. Better would be to work in cm : 1 slave revolution corresponds to 0.5cm, which gives 8192/0.5 = 16384.

By entering ***CountsPerUnits*** = 16384 and ***MaxSpeed*** = 1500*0.5 = 750, than the positions are in cm and the speed in cm/s.

Nota :

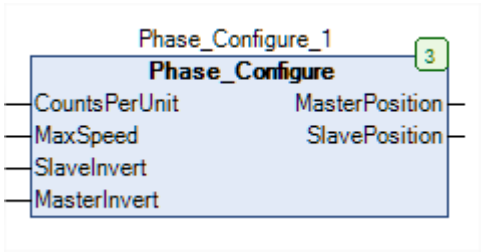
(*) : unit : 1.0 represents 1 unit define using ***CountsPerUnit*** and ***Maxspeed***

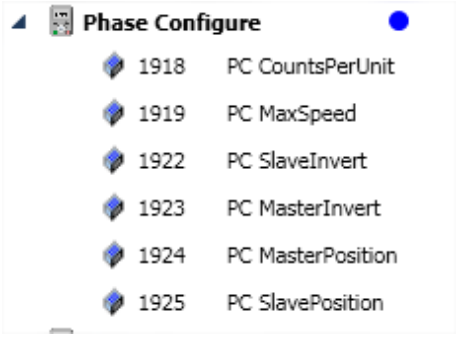
(**) : unit/s : 1.0 represents a speed of 1unit/s

(***) : unit/s² : 1.0 represents an acceleration/deceleration of 1 unit/s per second.

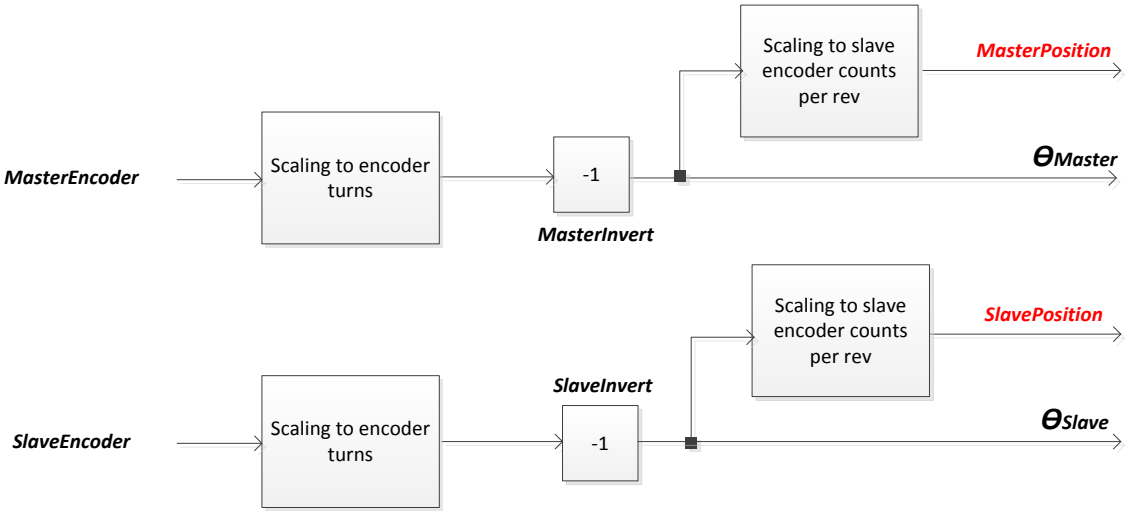
PHASE CONFIGURE

Application::Phase Configure





Configuration of the phase control inputs in term of user units and possible inversion of master and slave position inputs.



Parameter Name	No.	WEB/GKP	Default	Range	Units	Writable
CountsPerUnit	1918	Application::Phase Configure::PC CountsPerUnit	4096	1 to 1000000000		

Allows to define a specific unit as input to the phase Blocks.
For example :
If you want to work in mm, and 1 mm corresponds to 5000 counts of the Slave encoder, then enter 5000 In this parameter
If you want to work in slave encoder revolutions, and the encoder is a 2048 lines (2048*4 = 8192 counts) then enter 8192 in this parameter

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MaxSpeed	1919	Application::Phase Configure::PC MaxSpeed	1500	0 to 100	RPM	

Used to Scale the Feed Forward term of the position loop.
It should correspond to the full speed of the drive
For example :
If you want to work in mm/s, then you have to convert the full speed of the drive from rpm to mm per minute. As described in the ***CountsPerUnit***, if your slave encoder is a 2048 lines and 1mm corresponds to 5000, then you will enter :

[100% Speed in RPM(0464)]* [2048*4] / 5000

SlaveInvert	1922	Application::Phase Configure::PC SlaveInvert	FALSE			

Inverts the sign of the Slave encoder input when set to TRUE

MasterInvert	1923	Application::Phase Configure::PC MasterInvert	FALSE			

Inverts the sign of the Master encoder input when set to TRUE

MasterPosition	1924	Application::Phase Configure::PC MasterPosition	10	0 to 100	counts	NEVER

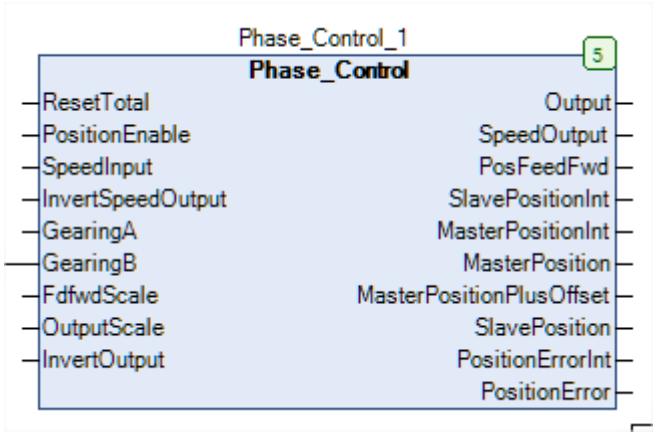
Master position scaled in slave encoder counts

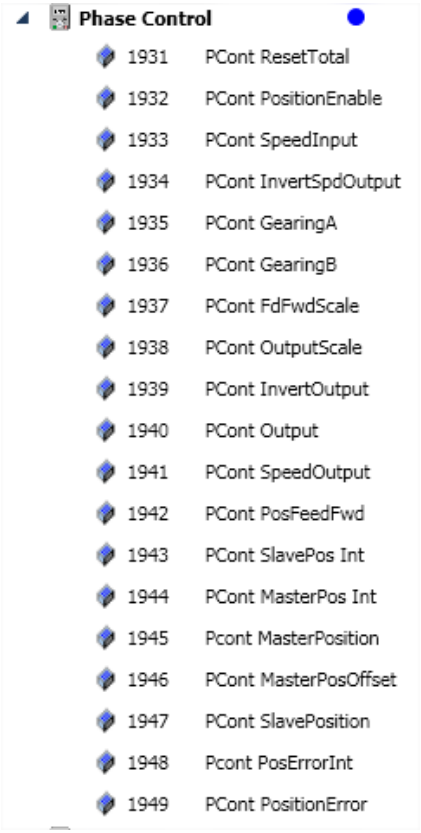
SlavePosition	1925	Application::Phase Configure::PC SlavePosition	10	0 to 100	counts	NEVER

Slave position in encoder counts

PHASE CONTROL

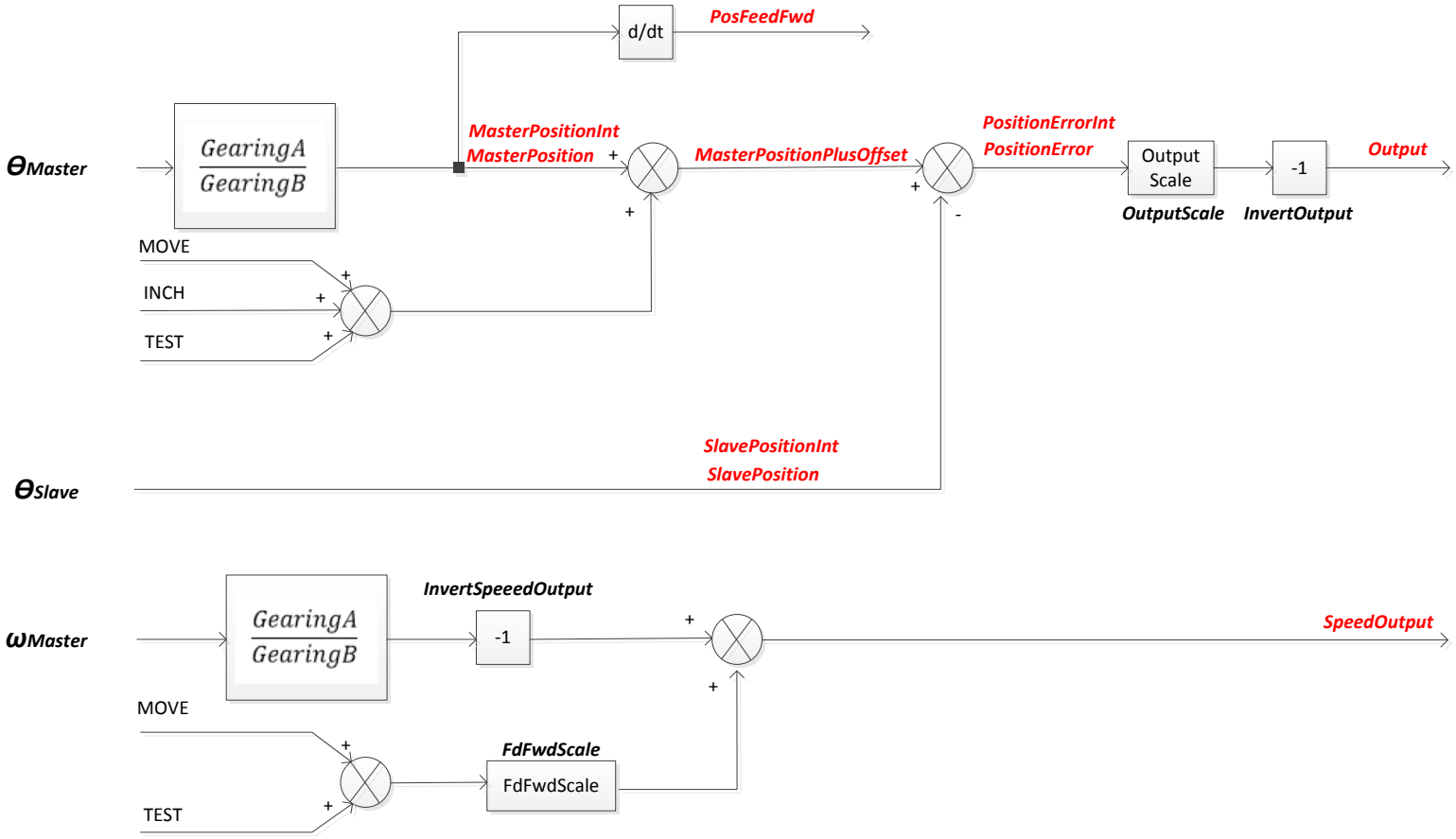
Application::Phase Control





Settings of the phase control.

This is the main control block to control error generation and feed forward terms.



ΘMaster : master position, before gearing

ωMaster : master speed, before gearing

Parameter Name	No.	WEB/GKP	Default	Range	Units	Writable
ResetTotal	1931	Application::Phase Control::PCont ResetTotal	FALSE			

Input used to Reset all positions Ouptuts at Zero
When set to TRUE, positions feeding the position loop are reset to Zero. Positions remains at Zero as long as this input is TRUE.

PositionEnable	1932	Application::Phase Control::PCont PositionEnable	FALSE			

Input to Enable the phase control in term of speed and position.
Allows to feed speed and position informations to the speed loop.
Outputs are internally connected to the inputs of the position loop.

SpeedInput	1933	Application::Phase Control::PCont SpeedInput	0.0	-300.0 to 300.0	unit/s	

Input to the speed feed forward term of the position loop.
When the position loop is enabled (***Phase PID::Enable*** = TRUE), this input is not used. The speed of the reference/master is directly/ internally connected to this input.
When the position loop is disabled (***Phase PID::Enable*** = FALSE) and when ***PositionEnable*** = TRUE, this input is used. The speed output connected to the position loop is derived from this value. The value is in unit/s

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InvertSpeedOutput	1934	Application::Phase Control::PCont InvertSpdOutput	FALSE			

Used to Invert ***SpeedOutput*** information

GearingA	1935	Application::Phase Control::PCont GearingA	1.0	-30000.0 to 30000.0		

To allow the slave to run as a Gearing (ratio) of the Master speed and position
Slave position = Master position x ***GearingA*** / ***GearingB***

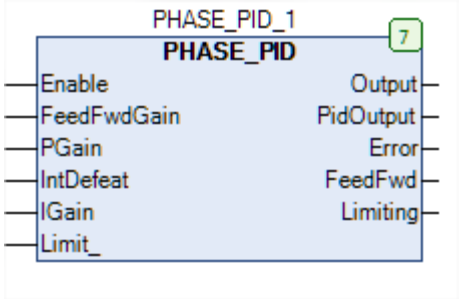
Parameter Name	No.	WEB/GKP	Default	Range	Units	Writable
GearingB	1936	Application::Phase Control::PCont GearingB	1.0	-30000.0 to 30000.0		
To allow the slave to run as a Gearing (ratio) of the Master speed and position Slave position = Master position x ***GearingA*** / ***GearingB***						
FdFwdScale	1937	Application::Phase Control::PCont FdFwdScale	1.0	-300.0 to 300.0		
To scale the Feed Forward terms added to the speed input						
OutputScale	1938	Application::Phase Control::PCont OutputScale	1.0	0.0 to 300.0		
To scale ***PositionError***.						
InvertOutput	1939	Application::Phase Control::PCont InvertOutput	FALSE			
To invert the scaled error which feed the position demand of the speed loop						
Output	1940	Application::Phase Control::PCont Output			unit	NEVER
Output term feeding the position loop in unit Internally connected to the position loop						
SpeedOutput	1941	Application::Phase Control::PCont SpeedOutput			unit/s	NEVER
Speed output term feeding the feed forward term of the position loop in unit/s. Internally connected to the position loop.						

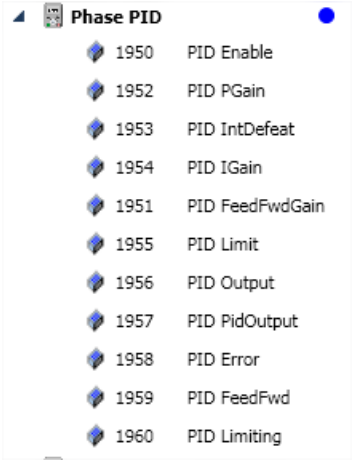
Parameter Name	No.	WEB/GKP	Default	Range	Units	Writable
PosFeedFwd	1942	Application::Phase Control::PCont PosFeedFwd			unit/s	NEVER
Feed Forward term of the position loop in unit/s.						
SlavePositionInt	1943	Application::Phase Control::PCont SlavePositionInt			counts	NEVER
Slave position in counts.						
MasterPositionInt	1944	Application::Phase Control::PCont MasterPositionInt			counts	NEVER
Master position with the Gearing in counts .						
MasterPosition	1945	Application::Phase Control::PCont MasterPosition			unit	NEVER
Master position with the Gearing in unit						
MasterPositionPlusOffset	1946	Application::Phase Control::PCont MasterPosOffset			unit	NEVER
MasterPositionPlusOffset = ***MasterPosition*** + all offsets related to phase blocks in unit						
SlavePosition	1947	Application::Phase Control::PCont SlavePositon			unit	NEVER
Slave position in unit.						
PositionErrorInt	1948	Application::Phase Control::PCont PositionErrorInt			counts	NEVER
Error of position in counts.						

Parameter Name	No.	WEB/GKP	Default	Range	Units	Writable
PositionError Error of position in unit.	1949	Application::Phase Control::PCont PositionError			unit	NEVER

PHASE PID

Application::Phase PID



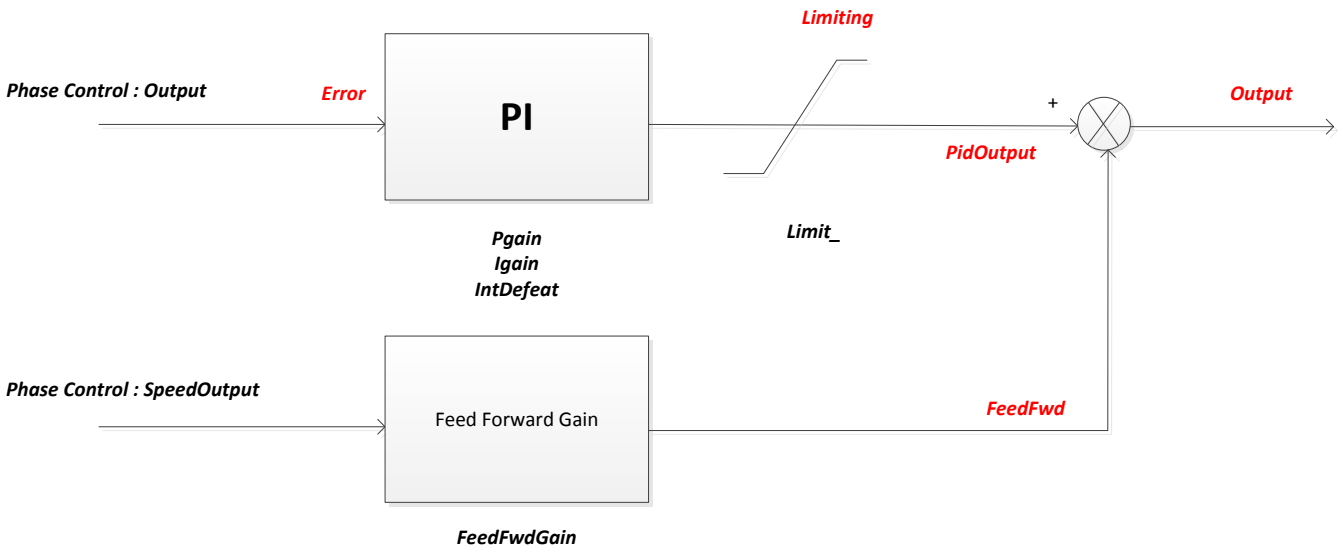


Configuration of the position loop of the phase control.

This block controls the position of the motor. It compares a reference position to a feedback position, and generates a speed demand dependent of the difference.

The Position Loop works on a multi turn position. The error between the Master and the slave can be a multi turn error.

Please Note that all the Phase blocks (including the Move To Master) will not work if this block has not been enabled by ***Enable*** = TRUE



Parameter Name	No.	WEB/GKP	Default	Range	Units	Writable
Enable Input to enable the position loop	1950	Application::Phase PID::PID Enable	FALSE			
FeedFwdGain To add a scaling to the feed forward term of the position loop	1951	Application::Phase PID::PID FeedFwdGain	1.0	-300.0 to 300.0		
PGain Proportional Gain of the speed loop.	1952	Application::Phase PID::PID PGain	10.0	0.0 to 3000.0		
IntDefeat When TRUE disables the operation of the integral term of the position loop	1953	Application::Phase PID::PID IntDefeat	FALSE			
IGain	1954	Application::Phase PID::PID IGain	1	0.0 to 300		

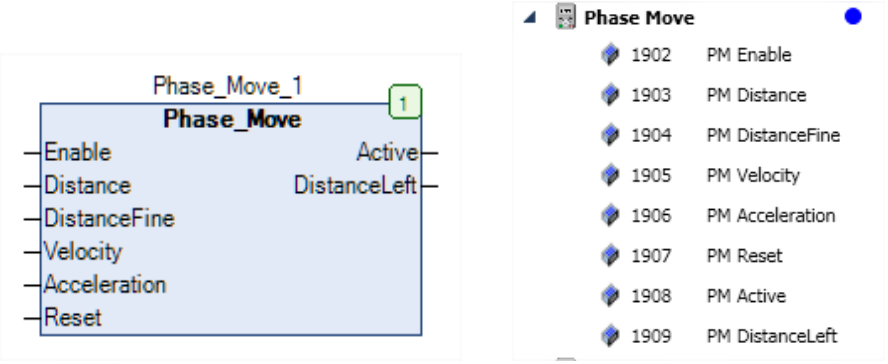
Parameter Name	No.	WEB/GKP	Default	Range	Units	Writable
Integral Gain of the speed loop.						
Limit_	1955	Application::Phase PID::PID Limit	10.0	0 to 300	%	
Sets a symmetric clamp as a percentage of the maxspeed, to limit the maximum position loop output *(PidOutput)*						
Output	1956	Application::Phase PID::PID Output			%	NEVER
Shows the total output of the position loop (***PidOutput*** + ***FeedFwrd***) in %. This output is internally connected to the speed loop of the drive. It represents the speed setpoint.						
PidOutput	1957	Application::Phase PID::PID PidOutput			%	NEVER
Shows the output of the position loop only in %.						
Error	1958	Application::Phase PID::PID Error				NEVER
Show the instantaneous position error in slave revolution						
FeedFwd	1959	Application::Phase PID::PID FeedFwd			%	NEVER
Shows the speed feed forward term from the master speed + other speeds from phase blocks in %.						
Limiting	1960	Application::Phase PID::PID Limitng	FALSE			NEVER
TRUE when the ***PidOutput*** has reached the ***Limit***_ value.						

PHASE MOVE

Application::Phase Move

This block moves the motor a set distance. The distance is in slave encoder revolutions and is added to movement of other phase blocks and the position demand.

This is a simple trapezoidal speed shape, which acts on each rising edge of the Enable Input.



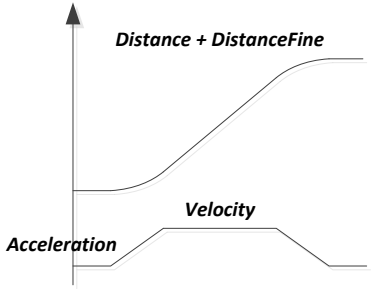
A move must be complete before a new move will be run.

The move operation is aborted by the Reset Input.

The Total Distance is the sum of ***Distance*** and ***DistanceFine***. The direction of the move is given by the sign of the Total Distance.

DistanceLeft Output provides an information of remaining distance to be done while the move is active.

Active Output is TRUE while the move is active.



Parameter Name	No.	WEB/GKP	Default	Range	Units	Writable
Enable	1902	Application::Phase Move::PM Enable	FALSE			
Enable starts the Move operation when going from FALSE TO TRUE (if block is not already ***Active***) Setting ***Enable*** to FALSE will not abort the operation while the Move is ***Active***						
Distance	1903	Application:: Phase Move::PM Distance	1.0	-3000.0 to 3000.0	unit	
The distance that the Move command will add to the Master position in unit. Total Distance = ***Distance*** + ***DistanceFine***						
DistanceFine	1904	Application:: Phase Move::PM DistanceFine	1.0	-1.0 to 1.0	unit	
The distance that the Move command will add to the Master position in unit. Total Distance = ***Distance*** + ***DistanceFine***						
Velocity	1905	Application:: Phase Move::PM Velocity	1.0	0.1 to 300.0	unit/s	
Maximum speed in unit/s at which the distance will be added to the position loop						
Acceleration	1906	Application:: Phase Move::PM Acceleration	1.0	0.1 to 3000.0	unit/s²	
Acceleration in unit/s² at which the distance will be added to the position loop						
Reset	1907	Application: Phase Move::PM Reset	FALSE			
When TRUE stops the actual Move operation with a controlled deceleration						
Active	1908	Application:: Phase Move::PM Active	1.0			NEVER

Parameter Name	No.	WEB/GKP	Default	Range	Units	Writable
TRUE when a Move command is on going						
DistanceLeft	1909	Application:: Phase Move::PM DistanceLeft	1.0		Unit	NEVER
Remaining distance in unit of the Move when active. 0 when move is inactive						

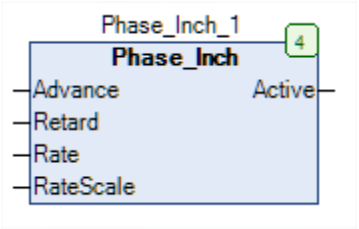
PHASE INCH

Application::Phase Inch

The block may be used to advance or retard the relative position on the slave relative to the master.

This is achieved by feeding extra counts into the position loop at a rate given by the combination of Rate and RateScale. The actual Rate is the product of Rate and RateScale and is in slave encoder turn per second.

The Active output is active while Advance or Retard are set to TRUE.



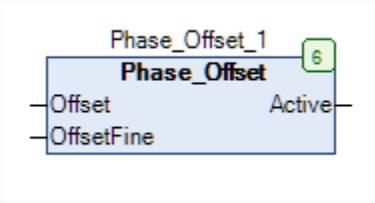
Parameter Name	No.	WEB/GKP	Default	Range	Units	Writable
Advance	1910	Application::Phase Inch:PInch Advance	FALSE			
While is TRUE, counts are added to the Master position at a rate given by ***Rate*** If Both ***Advance*** and ***Retard*** are TRUE, then no action is taken.						
Retard	1911	Application::Phase Inch:: PInch Retard	FALSE			
While is TRUE, counts are substracted to the Master position at a rate given by ***Rate*** If Both ***Advance*** and ***Retard*** are TRUE, then no action is taken						
Rate	1912	Application::Phase Inch:: PInch Rate	0.01	0.0001 to 30	unit/s	
The rate at which the counts are added/substracted to the Master position. A rate of 1.0 would cause the Slave to move at a rate of 1 unit per second						
RateScale	1913	Application::Phase Inch:: PInch RasteScale	1.0	0.0001 to 30		
Allows fine control of actual rate = ***Rate*** * ***RateScale***						
Active	1914	Application::Phase Inch:: PInch Active				NEVER
TRUE when ***Advance*** or ***Retard*** actions are active						

PHASE OFFSET

Application::Phase Offset

The block adds an offset to the master position

This is an unramped position Offset.



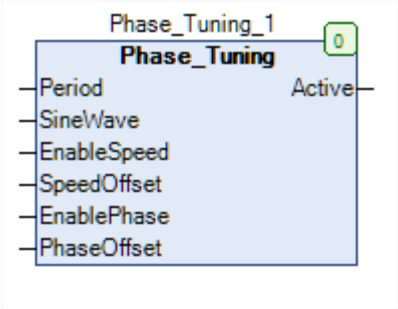
Parameter Name	*No.*	*WEB/GKP*	*Default*	*Range*	*Units*	*Writable*
Offset	1915	Application::Phase Offset:PO Offset	0	-3000.0 to 3000.0	unit	
Positon added to the Master position in unit. Will cause the Slave to move to the new Master position with an unramped motion						
OffsetFine	1916	Application::Phase Offset::PO OffsetFine	FALSE	-1.0 to 1.0	unit	
Additional position added to the Master position in unit. Will cause the Slave to move to the new Master position with an unramped motion.						
Active	1917	Application::Phase Offset::PO Active				NEVER
TRUE when ***Offset*** and ***OffsetFine*** are applied						

PHASE TUNING

Application::Phase Tuning

The block adds either a periodic speed signal or an offset of position.

This is mainly used to set up loops of the system and must not be used as position/speed setpoint generator in the application.



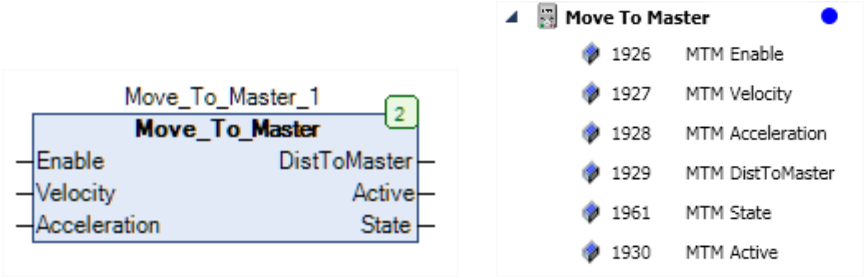
Parameter Name	*No.*	*WEB/GKP*	*Default*	*Range*	*Units*	*Writable*
Period Define the period in s of the stimulus	1962	Application::Phase Tuning::PT Period	T#5s	T#0.1S to T#30s		
SineWave TRUE will generate a sinusoidal stimulus FALSE will generate a square stimulus.	1963	Application:: Phase Tuning::PT SineWave	FALSE			
EnableSpeed Enable speed offset to be added to the speed feed forward term	1964	Application:: Phase Tuning::PT EnableSpeed	0.0	-300 to 300		
SpeedOffset Speed offset value	1965	Application:: Phase Tuning::PT SpeedOffset	FALSE			

Parameter Name	No.	WEB/GKP	Default	Range	Units	Writable
EnablePhase	1966	Application:: Phase Tuning::PT EnablePhase	FALSE			
Enable position offset to be added .						
PhaseOffset	1967	Application:: Phase Tuning::PT PhaseOffset	0.0	-300 to 300	unit	
Position offset value						
Active	1968	Application:: Phase Tuning::PT Active				NEVER
When either ***EnableSpeed*** or ***EnablePhase*** are active						

MOVE TO MASTER

Application::Move To Master

This block allows to align the position demand from the Master + offsets from phase blocks to the Slave position in a controlled manner. A trapezoidal move is added to align the Master+offsets to the Slave by using ***Velocity*** and ***Acceleration***.



When ***Enable***, if an offset exists when the Slave drive is enabled, the Slave will move to the Master position in a controlled movement.

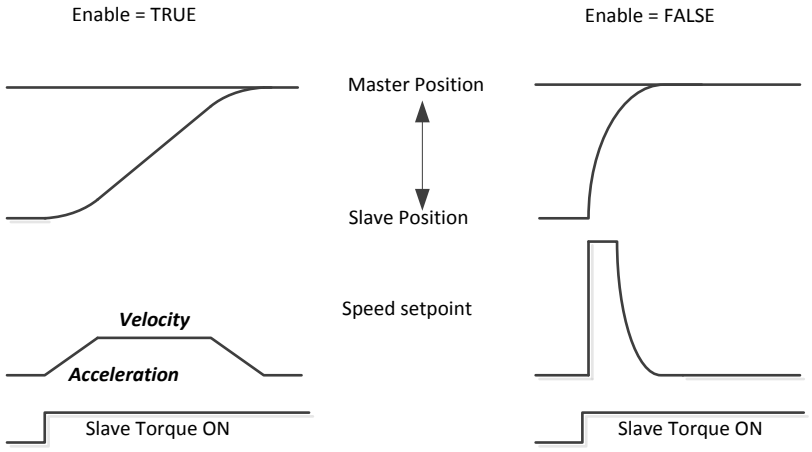
If disabled, in the same condition, the system moves to the Master position with a crude movement.

Velocity and Acceleration define the shape of the motion.

DistToMaster output is the remaining distance to be done while the ***Move to Master*** is ***Active***

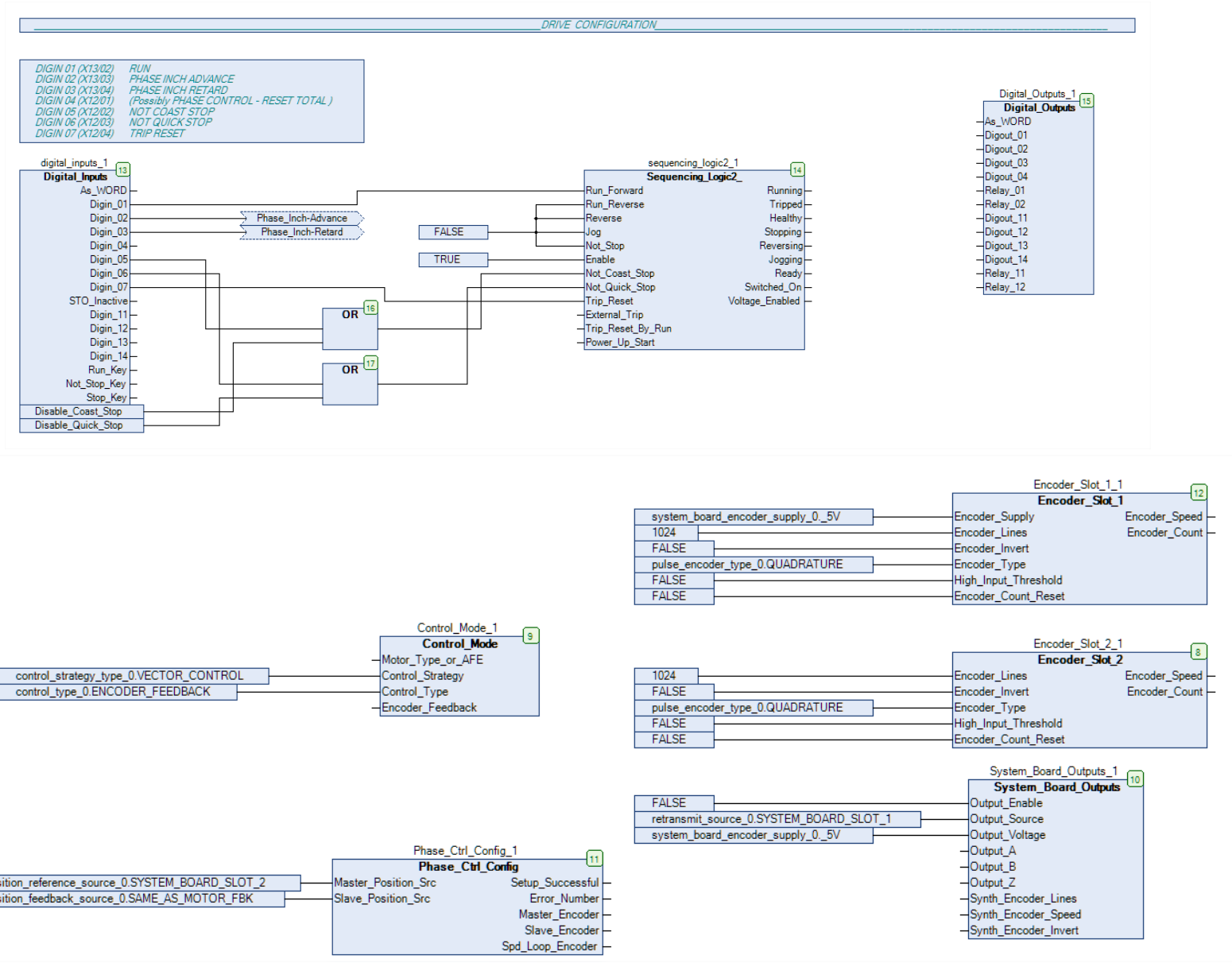
Active is TRUE is the ***Move to Master*** is in action.

State gives the state of the actual ***Move To Master*** block



Parameter Name	No.	WEB/GKP	Default	Range	Units	Writable
Enable	1926	Application::Move To Master::MTM Enable	FALSE			
To validate any controlled alignment of the Master and Slave due to offsets						
Velocity	1927	Application:: Move To Master::MTM Velocity	1.0	0.1 to 300	unit/s	
Maximum velocity of the Move, set in unit/s.						
Acceleration	1928	Application:: Move To Master::MTM Acceleration	1.0	0.1 to 3000	unit/s²	
Acceleration/deceleration of the Move in unit/s²						
DistToMaster	1929	Application:: Move To Master::MTM DistToMaster			unit	NEVER
Remaining distance between the Master and the Slave in unit. 0 when ***Move To Master*** inactive						
Active	1930	Application:: Move To Master::MTM Active				NEVER
TRUE to indicate that the ***Move To Master*** is Active						
State	1961	Application:: Move To Master::MTM State		0 : RESET 1 : POS AQUIRE 2 : ALIGN 3 : DONE		NEVER
Gives the state of the actual Move To Master : RESET : When ***Enable*** is FALSE POS_AQUIRE : While the Slave is OFF and ***Enable*** is TRUE. ALIGN : When a Move To Master is in progress to align a Slave to Master DONE : When Move To Master is completed						

Drive Configuration Block Diagram



Functional Description

Disable Coast Stop:
This feature disables the use of the COAST STOP input.

Caution The Drive will not stop when the coast stop input is disconnected.

Power Up Start:
This feature removes the requirement of a transition from FALSE to TRUE on the run command. This allows an immediate start of the motor when power is applied to the Drive.

Caution The Drive may run without warning.

Control mode to select the encoder used as the speed feedback

Phase_Ctrl_Config to select the slave encoder connected. If the slave and the speed feedback encoder are the same, then setup Slave_Position_Src to SAME_AS_MOTOR_FBK

Phase _Ctrl_Config to select the master encoder

Encoder_Slot_1 and/or **Encoder_Slot_2** to set up encoder connected to system board Slot1 and/or Slot2

System_Board_Outputs to set up Retransmit configuration (if used)

Basic Steps for a simple 690Like Configuration