Chapter 5

Function Blocks

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Chapter 5 Function Blocks

SETUP PARAMETERS

Introduction

This section provides reference information for the more advanced programming capabilities of the 620 Vector series controllers.

Each section describes a particular functional area and the associated menu options which are used to alter the parameters. Where appropriate, a functional block diagram illustrates the how the function operates. Reference to the Functional Description and Microprocessor Block Diagram in Chapter 2 may be of assistance in understanding the relationship between these functional diagrams.

Each of the menu options (refer to Figure 5.1) has an associated 'Tag' number associated with it, which provides a unique identification. These tag numbers are shown within this section and also within Chapter 9, which holds a complete list of all tags with there ranges and defaults.

Menu Title

Text as it appears on MMI

Tag Number

```
......RAMPS
........RAMP ACCEL TIME  [54 ] =      10.0 SECS
........RAMP DECEL TIME  [55 ] =      10.0 SECS
f.......RAMP QUENCH      [56 ] = FALSE
h.......SPECIAL          [XXX] = FALSE
```

Default Value

(Italic) f.... Tag is only visible if FULL MENUS = TRUE

(Italic) h.... Tag is only visible with special PASSWORD..

Figure 5.1 Set-up Parameter entry.

These tag numbers may be used to reconfigure the block diagram if the default configuration (shown in figure 2.5) does not provide the functionality required.

Reconfiguring is done using:

source tags

destination tags

internal links.

Analogue and digital inputs have destination tags. See section 'Configure I/O' on page 5-35. An analogue or digital input may be connected to a function block input by setting its destination tag equal to the tag number of the block input as required.

Analogue and digital outputs have source tags. See section 'Configure I/O' on page 5-35. A function block output may be connected to an analogue or digital output by setting the analogue or digital output source tag equal to the tag number of the block output as required.

Function blocks have destination tags. A function block output may be connected to the input of another function block by setting its destination tag equal to the tag number of the block input or analogue/digital output, as required. Function blocks do not have source tags. A function block output may therefore be routed to any variable, but only parameters which have a destination tag can be connected to its inputs.

Internal links are used to route variables which do not have source tags or destination tags associated with them.

Source and destination tags are found in the menu 'Configure I/O' under 'System'. See 'Menu Structure' in chapter 4. This menu contains sub menus 'Analogue Inputs', 'Digital Inputs', 'Analogue Outputs', 'Digital Outputs', 'Block Diagram', and 'Internal Links'. Destination tags for analogue and digital inputs may be found under 'Analogue Inputs' and 'Digital Inputs'. Source tags for analogue and digital outputs may be found under 'Analogue Outputs' and 'Digital Outputs'. Destination tags for function blocks may be found in 'Block Diagram'. A full description of the source and destination tags available is given in section 'Configure I/O' on page 5-35.

The menu also contains the flag 'Configure Enable' which must be set to true before any re-configuring can be done. See section 'Configure I/O' on page 5-35.

Example 1

Re-route digital input 1 (terminal E2) to the 'System Ramp' 'External Reset' (It is normally connected to 'ramp hold' by default). See 'System Ramp' diagram on page 5-3. This will cause the system ramp output to return to its reset value whenever a '1' is applied to digital input 1.

1. Go into 'System' menu, then into 'Configure I/O'.
2. Select 'Configure Enable' and set this flag to true.
3. Find 'Digital Inputs' menu and select 'DIGIN 1 (E2)'.
4. Go into this menu and find 'Destination Tag'. Set this to the 'External Reset' tag number 62, which may be found in section 'System Ramp' or in the tag number list in the appendix, chapter 9.
5. Return to 'Configure Enable' flag and set this to false.

Example 2

Bring Current Feedback to analogue output 2 (torque demand is normally connected to this output by default).

1. Go into 'System' menu, then into 'Configure I/O'.
2. Select 'Configure Enable' and set this flag to true.
3. Find 'Digital Inputs' menu and select 'ANOUT 2 (F5)'.
4. Go into this menu and find 'Source Tag'. Set this to the 'Current Feedback' tag number 78, which may be found in the MMI list in the appendix, chapter 9, under diagnostics.
5. Return to 'Configure Enable' flag and set this to false.

Example 3

Connect Speed Feedback to System Ramp Reset Value. This would allow the drive to start a spinning motor in a smooth manner. System Ramp Reset Value is a parameter which does not have a source tag associated with it, as it is normally a fixed value set via the MMI. Speed Feedback does not have a destination tag. So the only way to do this is via an internal link.

1. Go into 'System' menu, then into 'Configure I/O'.
2. Select 'Configure Enable' and set this flag to true.
3. Set Link 1 Source to 11 (i.e. tag number of speed feedback).
4. Set Link 1 Destination to 63 (i.e. tag number of Reset Value).
5. Return to 'Configure Enable' flag and set this to false.

Ramps

MMI Entries

```
......RAMPS
........RAMP ACCEL TIME   [54 ] =      10.0 SECS
........RAMP DECEL TIME   [55 ] =      10.0 SECS
f.......RAMP QUENCH       [56 ] = FALSE
........RAMP HOLD         [57 ] = FALSE
........RAMP INPUT        [58 ] =      0.00 %
........% S-RAMP          [59 ] =      0.00 %
........RAMPING THRESH.   [60 ] =      1.00 %
........AUTO RESET        [61 ] = TRUE
........EXTERNAL RESET    [62 ] = FALSE
........RESET VALUE       [63 ] =      0.00 %
```

Block Diagram

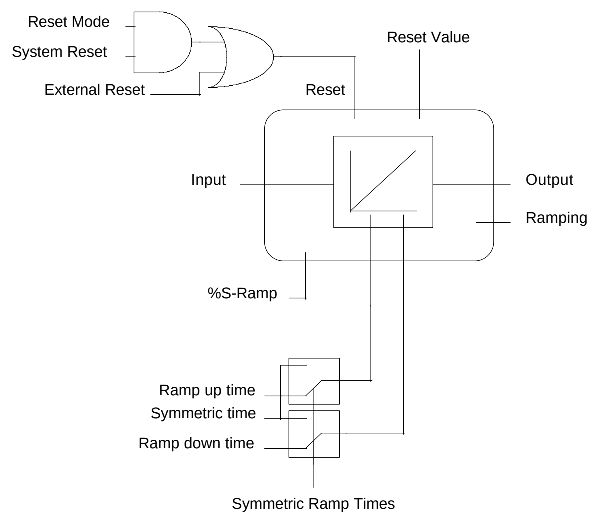


Figure 5.2 System Ramp

Parameters

RAMP ACCEL / DECEL TIME Acceleration / Deceleration time. The times are for an output change from 0 to 100%.

Example:

A change of Ramp Input from 20% to 50% with an acceleration time of 60 Seconds will take. $\frac{50\% - 10\%}{100\%} \times 60\,Secs$

Effect of %S on Ramp times.

$$Actual\ Ramp\ Time\ =\ Ramp\ Time\ \text{x}\left[\frac{3.5}{100}\ \text{x}\ (\%S - Ramp) + 1\right]$$

Zero ramp times are a special case where the ramp can be effectively by-passed.

RAMP QUENCH While **TRUE** the ramp input is held at zero. NOTE: This parameter is automatically set TRUE during a normal stop if USE SYSTEM RAMP is TRUE.

RAMP HOLD While **TRUE** the ramp output is held at its last value. This is overridden by External Reset.

RAMP INPUT

Ramp Input TAG.

% S-RAMP

Percentage of ramp with S-shaped rate of change. A value of zero is equivalent to a linear ramp. Changing this value affects the ramp times. See **RAMP ACCEL/DECEL TIME** equation.

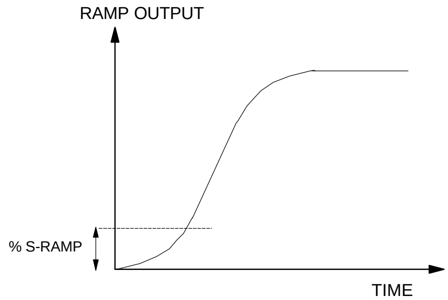


Figure 5.3 S-Ramp

RAMPING THRESH.

Ramping flag threshold level. The threshold is used to detect whether the ramp is active, shown by the ramping TAG.

```
if( |RAMP OUTPUT - RAMP INPUT| > RAMPING THRESH)
      RAMPING := TRUE
else
      RAMPING := FALSE
endif
```

AUTO RESET

If **AUTO RESET** is **TRUE** then the ramp is reset whenever **SYSTEM RESET** is **TRUE**, that is each time the Speed / Current loop is unquenched. If the drive is restarted befor the stop sequence has reached stop zero speed the System Ramp will not be reset.

If **FALSE** then the ramp is only reset by **EXTERNAL RESET**.

System Reset is an internal flag that is set **TRUE** for one cycle after the Speed / Current loop is enabled i.e. every time the drive is started.

EXTERNAL RESET

If **EXTERNAL RESET** is **TRUE** then the ramp is held in reset. **EXTERNAL RESET** does not depend on **AUTO RESET** for its operation.

Ramp Reset Definition:

Ramp Reset = (**SYSTEM RESET** AND **AUTO RESET**) OR **EXTERNAL RESET**.

RESET VALUE

This value is pre-loaded directly into the output while Ramp Reset is **TRUE** or at power-up. In order to catch a spinning load smoothly ("bumpless transfer" or "Fly Catching") connect speed feedback TAG 7 (Source) to this reset value TAG 63 (Destination) using an internal link.

__Note:__ The System ramp may also be used for stopping the drive if **STOP RATES::USE SYSTEM RAMP** is **TRUE**, **AUTO RESET** is **TRUE** and **EXTERNAL RESET** is **FALSE**, in this case the Sequencer will set **RAMP QUENCH** to be **TRUE**. This will force the ramp input to zero, and only when the ramp output is zero will the stop ramp be invoked. **RAMP QUENCH** is not normally shown on the MMI.

Op-station

MMI Entries

```
......OP-STATION
........START UP VALUES
..........SETPOINT         [503] =       0.0 %
..........REV DIRECTION    [504] = FALSE
f.........PROGRAM          [505] = FALSE
..........LOCAL            [506] = FALSE
........LOCAL RAMP
..........RAMP ACCEL TIME  [511] =      10.0 SECS
..........RAMP DECEL TIME  [512] =      10.0 SECS
h.........RAMP QUENCH      [513] = FALSE
h.........RAMP HOLD        [514] = FALSE
h.........RAMP INPUT       [515] =      0.00 %
..........% S-RAMP         [516] =      0.00 %
h.........RAMPING THRESH.  [517] =      1.00 %
h.........AUTO RESET       [518] = TRUE
h.........EXTERNAL RESET   [519] = FALSE
h.........RESET VALUE      [520] =      0.00 %
h.........RAMP OUTPUT      [509] =      0.00 %
```

Parameters

START UP VALUES

SETPOINT	Default Value of local setpoint on power up.
REV DIRECTION	Default Value of Direction.
LOCAL	Default mode of op-station **local** key on power up.
LOCAL RAMP	See Ramps.

Note: See Jog for parameters effecting the local jog.

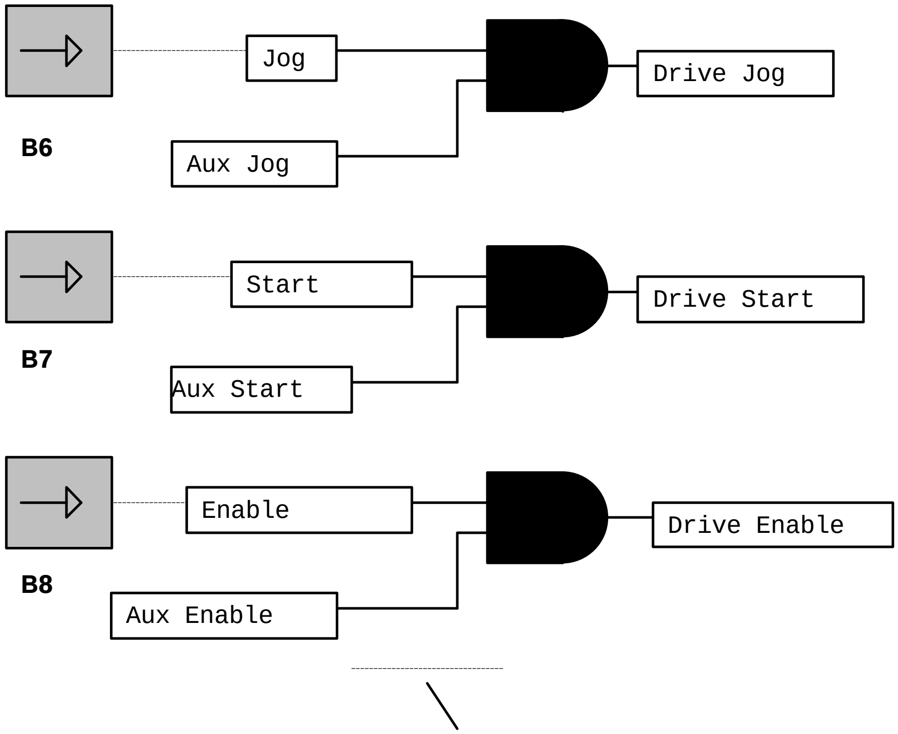
Aux. I/O

MMI Entries

```
......AUX I/O
........AUX START        [66 ] = TRUE
........START            [70 ] = FALSE
........AUX JOG          [67 ] = TRUE
........JOG INPUT        [71 ] = FALSE
........AUX ENABLE       [68 ] = TRUE
........ENABLE           [72 ] = FALSE
```

Parameters

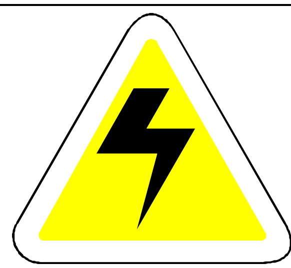
Aux. Start, Aux. Jog, and **Aux. Enable,** Allow the drive to be started and stopped by software, only applicable to the 620 Link.



Dotted lines denote default connections.

Figure 5.4 Aux. I/O

`Start, Jog,` and **`Enable,`** Also allow the drive to be started and stopped by software alone. These parameters are by default connected to there respective terminals.



WARNING!

CARE MUST BE TAKEN IN RECONFIGURING THE START, JOG AND ENABLE INPUTS AS THESE TAGS MAY DIRECTLY ENABLE THE DRIVE.

IF THERE ARE TO BE RECONFIGURED THEN COAST STOP INPUT SHOULD UNDER OPERATOR CONTROL. THIS WILL ALLOW THE ENABLE COMMANDS TO BE OVERRIDDEN.

Jog

MMI Entries

```
........JOG SPEED 1      [75 ] =     10.00 %
........JOG SPEED 2      [76 ] =    -10.00 %
........MODE             [80 ] = FALSE
........JOG ACCEL RATE   [113] =      10.0 SECS
........JOG DECEL RATE   [114] =      10.0 SECS
```

Parameters

JOG SPEED 1	Drive setpoint during Jog if Mode = FALSE
JOG SPEED 2	Drive setpoint during Jog if Mode = TRUE

MODE	Selects Jog Speed to be used.
JOG ACCEL RATE	Acceleration rate used by Jog
JOG DECEL RATE	Deceleration rate used by Jog
NOTE:	The ACCEL / DECEL rates and the setpoints apply to both local and normal operating modes.

Raise Lower Ramp

MMI Entries

```
......RAISE/LOWER
........RESET VALUE       [82 ] =       0.00 %
........RAMP RATE         [83 ] =       60.0 SECS
........RAISE INPUT       [85 ] = FALSE
........LOWER INPUT       [86 ] = FALSE
........MIN VALUE         [87 ] =    -100.00 %
........MAX VALUE         [88 ] =     100.00 %
........EXTERNAL RESET    [89 ] = FALSE
```

Block Diagram

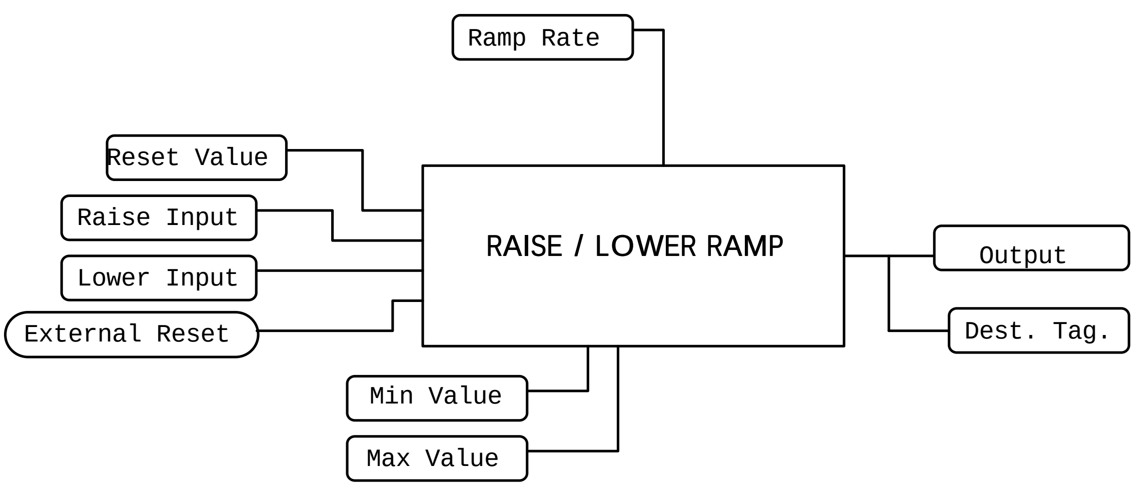


Figure 5.5 Raise Lower Ramp

Parameters

RESET VALUE	This reset value is pre-loaded directly into the output when **EXTERNAL RESET** is **TRUE** or at power-up. It is clamped by **MIN** and **MAX. VALUE**s.
RAMP RATE	This is the rate of change of output value. The raise and lower rates are always equal.
RAISE INPUT	
LOWER INPUT	Command to raise / lower output. These are normally connected to digital inputs in order to be useful.
MAX VALUE	
MIN VALUE	Maximum / minimum ramp output clamp. This is a plain clamp, not a ramped "**MIN SPEED**" setting.

EXTERNAL RESET	If **EXTERNAL RESET** is **TRUE** the output of the raise / lower block is set to the reset value. If an auto-reset feature is required then the System Reset TAG can be linked to the external reset.

Inverse Time

MMI Entries

```
h.....INVERSE TIME
h.......AIMING POINT     [116] =    105.00 %
h.......DELAY            [117] =      60.0 SECS
h.......DOWN RATE        [118] =      10.0 SECS
h.......UP RATE          [148] =     120.0 SECS
```

The inverse time function carries out two separate functions, a) Protects the stack against over heating by winding back the current after a defined period. b) clamps the torque demand in the field weakening region to ensure that it does not exceed the motor current limit.

At speeds greater than base speed the output of the inverse time will normally be less that 150 % due to the Magnetisation. Current element of Motor Current.

NOTE: The inverse time function is the only limit that works in motor current, all others work in Torque limit. Torque limit takes no account the Magnetisation. Current.

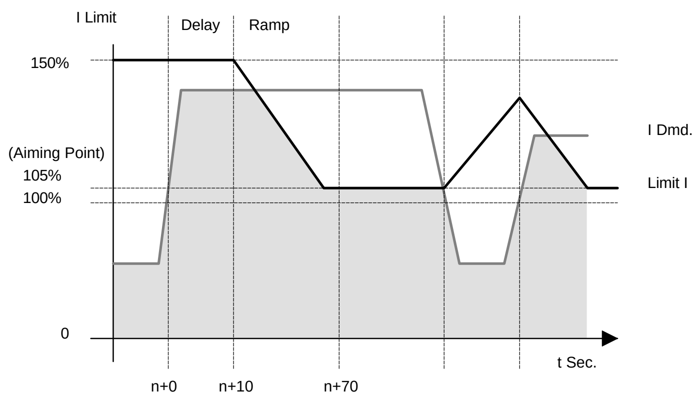


Figure 5.6 Inverse Time

Parameters

AIMING POINT	The level to which the inverse time function will wind back the current limit.
DELAY	The delay before the inverse time starts to operate.
DOWN RATE	The Rate at which the current is wound back
UP RATE	The rate at which the inverse time function recovers.

Stop Rates

MMI Entries

```
......STOP RATES
........RUN STOP TIME    [120] =      10.0 SECS
........RUN STOP LIMIT   [121] =      60.0 SECS
........FAST STOP TIME   [123] =       1.0 SECS
........FAST STOP LIMIT  [124] =      60.0 SECS
........USE SYSTEM RAMP  [125] = TRUE
f.......PRE-START DELAY  [122] =     0.500 SECS
f.......READY DELAY      [352] =     0.000 SECS
........CONTACTOR DELAY  [112] =       0.5 SECS
```

```
........STOP ZERO SPEED  [126] =      1.00 %
........PROG STOP I-LIM  [622] =    150.00 %
```

Stop Hierarchy

Coast Stop

- Disables the drive and opens the output contactor via the pilot output.

Enable

- Suspends And Resets The Control Loops

Fast Stop

- Independent Ramp Time
- Timer
- Independent Zero Speed.

Normal Run / Stop

- Independent Ramp Time

Parameters

RUN STOP TIME	Sets deceleration rate for the Stop ramp operation.
RUN STOP LIMIT	Sets the maximum time the drive will allow the Stop function to operate, if the drive has not reached zero speed in this period the drive will coast to a stop. If USE SYSTEM RAMP = TRUE then timer is started once the o/p of the system ramp of local ramp reaches zero.
FAST STOP TIME	Sets deceleration rate for the Fast Stop ramp operation.
FAST STOP LIMIT	Sets the maximum time the drive will allow the Fast Stop function to operate, if the drive has not reached zero speed in this period the drive will coast to a stop.
USE SYSTEM RAMP	Forces the drive to quench the input to the system ramp / local ramp and wait for the ramp output to reach zero before doing a normal stop. Not applicable for Fast Stop.
PRE-START DELAY	Delays the enabling of the drive to allow time for an o/p contactor to close before current is passed.
READY DELAY	See below for a more detailed description.
CONTACTOR DELAY	Sets the time during which the drive will maintain zero speed after the motor has stopped. NOTE: This does not effect the operation of the pilot output. The term contactor delay comes from the 590 DC drive.
STOP ZERO SPEED	Sets the threshold at which the contactor delay timer is started.
PROG STOP I-LIM	Sets the current limit used during a program stop. This will not override the inverse time output.

NOTES: **USE SYSTEM RAMP**.

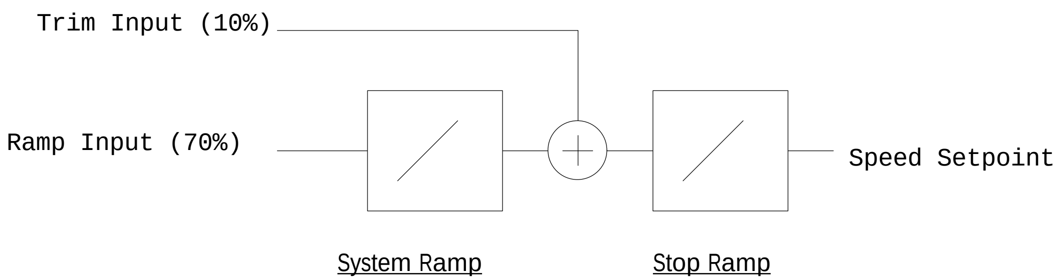


Figure 5.7 Example

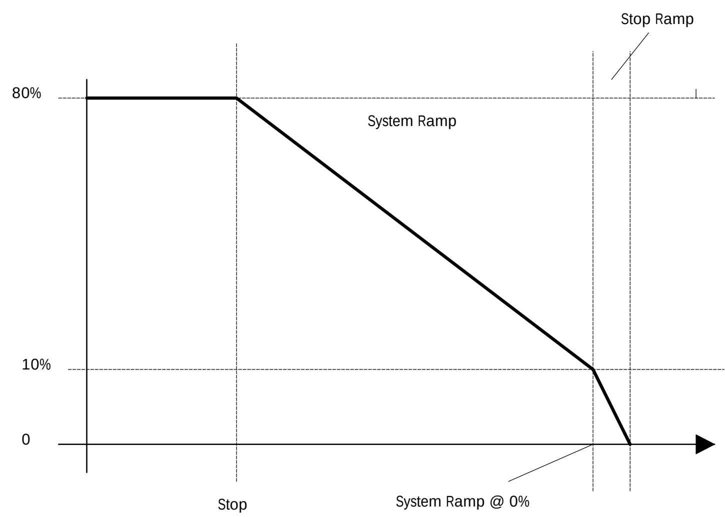


Figure 5.8 Use System Ramp

NOTES: Ready Output

The Ready output will go high "ready delay" seconds after the drive has been stated and is ready to make current.

The ready output remains high until the drive is stopped, then if "ready delay" > 0 then it goes low as soon as the drive reaches "stop zero speed" else as the drive is quenched.

In case of a fault / trip the ready line will also go low.

MODE 1 Ready Delay = 0

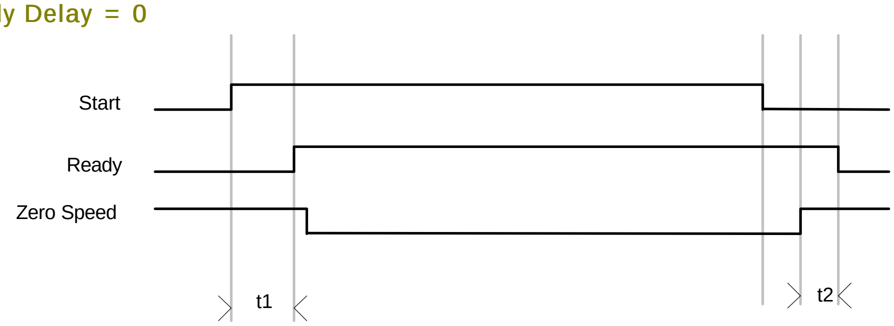


Figure 5.9 Ready Timing Ready delay = 0

t1 Pre-Start Checks

t2 Contactor Delay

Setting Ready delay to 0 (default) causes ready to be set once the drive has be initialised and is healthy. Ready is held high until the drive is quenched by /Start, Program stop, Coast Stop or the drive becoming unhealthy.

NOTE:

- Ready is independent of Enable.

- In this mode Start and Jog are synonymous.

MODE 2 Ready Delay ≠ 0

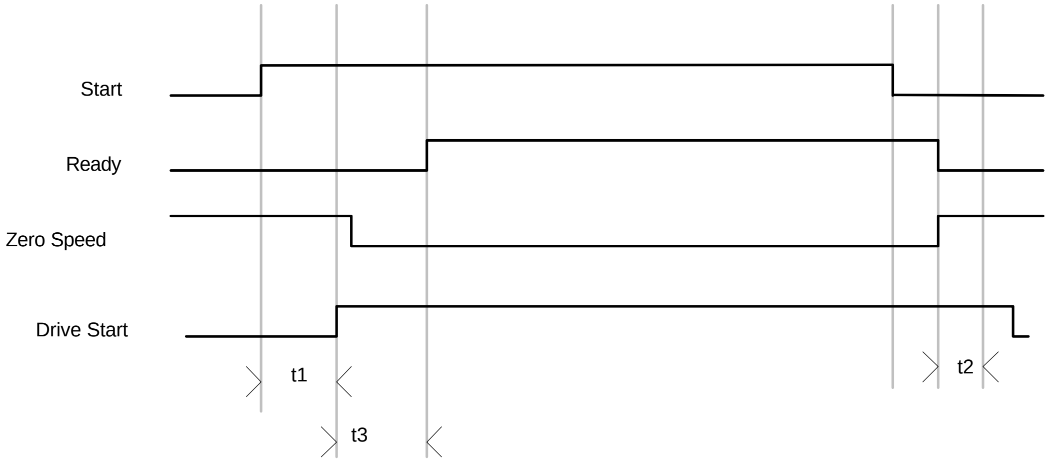


Figure 5.10 Ready Timing Ready delay ≠ 0

t1 Pre-Start Checks

t2 Contactor Delay

t3 Ready Delay

Setting Ready delay to none 0 causes ready to be set a fixed delay after the drive becoming ready. Ready is held high until the drive is stooped by /Start, Program stop, Coast Stop or the drive becoming unhealthy. In the case of a /Start command Ready will be low during the contactor delay period.

More Notes:

- Ready is independent of Enable.
- The delay is only inserted for Start and not for JOG

Alarms

MMI Entries

```
......ALARMS
........EXTERNAL TRIP    [144] = FALSE
h.......MOTOR TEMP       [141] =     26.88 %
h.......MOTOR TMP.TRIP   [128] =     75.00 %
h.......MOTOR TMP.RST.   [309] =     50.00 %
........MOTR.TMP.INHIBIT [146] = FALSE
h.......HEATSINK LEVEL   [129] =     17.00 %
h.......ACK ALARM        [166] = TRUE
........STALL INHIBIT    [143] = FALSE
........STALL TORQUE     [136] =    100.00 %
........STALL SPEED      [138] =    100.00 %
........STALL DELAY      [137] =    100.00
........OVER SPD INHIBIT [145] = FALSE
........OVER SPEED LEVEL [139] =    150.00 %
........5703 RCV.INHIBIT [142] = FALSE
```

EXTERNAL TRIP If set generates a user alarm / trip.

MOTOR TEMP Reserved.

MOTOR TMP.TRIP Reserved.

MOTOR TMP.RST. Reserved.

MOTOR.TMP.INHIBIT Disables operation of the Motor thermistor alarm

HEATSINK LEVEL	Reserved.
ACK ALARM	Reserved.

Stall

STALL INHIBIT	Disables the stall alarm.
STALL TORQUE	The threshold at which torque must reach to be deemed as stalled.
STALL SPEED	The threshold for speed feedback below which the stall condition is looked for. Note the speed demand must also be above this threshold.
STALL DELAY	Time stall has to be present before if generates an alarm.

Algorithm

IF ((|**SPEED_DEMAND|** > **STALL_SPEED**) AND (|**SPEED_FEEDBACK**| < **STALL_SPEED**) AND |**TORQUE_DEMAND**| > **STALL_TORQUE**)) THEN Start Stall Timer

OVER SPD INHIBIT	Disables the overspeed alarm.
OVER SPEED LEVEL	Threshold above which the over speed an alarm is generated.
5703 RCV.INHIBIT	Disables the 5703 alarm. This only applies for 5703 slaves, if enabled the drive will trip if it stops receiving valid 5703 messages from its master.

Calibration

MMI Entries

```
......CALIBRATION
........ENCODER LINES     [131] =      2048
........MAX SPEED RPM     [130] =      1500 RPM
........BASE FREQUENCY    [448] =      50.0 Hz
........MOTOR VOLTS       [486] =       415 VOLTS
........MOTOR RATING RMS  [134] =       1.0 AMPS
........NO.OF POLES       [399] =         4
........NAMEPLATE RPM     [135] =      1440 RPM
```

Parameters

ENCODER LINES	The exact number of lines on the encoder.
MAX SPEED RPM	Motor top speed setting, equates to 100% setpoint. This may be adjusted to suit your process.
BASE FREQUENCY	Base speed of the motor usually 50 or 60Hz.
MOTOR VOLTS	Actual motor volts from motor nameplate, or motor data sheet.
MOTOR RATING RMS	The motor rating current in amps from the motor nameplate. For the best performance this value should be at least 50% of the drive rating. If you are derating your motor for “inverter” use then you should use the non derated value of current.
NO OF POLES	Number of poles in the motor; must be divisible by 2, e.g. 2,4,6,8.
NAMEPLATE RPM	Motor speed, taking slip into account. Obtained from motor nameplate.

Torque Loop

Background

The current in an induction motor may be split into a torque producing component (iq) and a magnetising component (id). The vector drive will attempt to control both these components. The magnetising current controls the flux in the motor. When the motor turns, this flux produces a back emf, which is proportional to flux and rotor speed. The voltage at the motor terminals will be approximately equal to this back emf, plus a small stator voltage drop.

At light load, i.e. when the motor is rotating with bare shaft only, there is no torque component and the current flowing is entirely magnetising current. If the motor flux is correct, then the terminal volts at base speed should be approximately equal to the rated motor voltage. This enables the magnetising current to be set up. In practice the terminal volts should be about 95% of rated volts, to allow for the extra stator voltage drop under load.

At light load, the applied magnetising current will rotate synchronously with the motor shaft. As the load increases, the vector controller will cause the applied current to rotate slowly with respect to the motor shaft. This is called 'slip'. This slip frequency will increase linearly as load is applied to the motor, and may be typically of the order of 1Hz at rated load. That is, if the motor shaft is rotating at 50Hz, then the motor current will be rotating at 51Hz. This slip frequency is necessary to split the motor current into a magnetising component and a torque component.

The slip frequency is given by the value of the rotor time constant. It is important to get it correct in order to ensure the correct split of the motor current into the torque component and the magnetising component. If the slip frequency is zero, then 100% of the motor current goes to magnetise the rotor, and none produces torque. As the slip frequency is increased, the proportion of magnetising current decreases. Slip frequency is inversely proportional to rotor time constant.

The aim is to maintain constant magnetising current for all load conditions by linearly increasing the slip frequency as load increases. If the slip frequency is increased too much as load is applied, the magnetising current will be too small, and the terminal voltage will drop. If the slip frequency is increased by too little, the magnetising current will be too large, and the terminal voltage will increase. This enables the rotor time constant to be set up. After setting up the magnetising current as above, with no load on the motor, the motor is then fully loaded, and the value of rotor time constant is adjusted to give the correct slip frequency to give the correct motor terminal volts. Alternatively it is possible to calculate the value of rotor time constant which will give the slip frequency written on the motor nameplate. This is less accurate but it doesn't require a load rig.

Increasing rotor time constant	Decreases slip frequency	Increases motor terminal volts
Decreasing rotor time constant	Increases slip frequency	Decreases motor terminal volts

Mag. Current Caculation

If an Autotune can not be performed then an approximation of Mag current can be found from either the motors “no load current” ((No Load Current/Motor Rating RMS) * 100%) or using the motors power factor cos.φ and the table below.

cos φ	MAG CURRENT %
.60	72%
.65	70%
.70	60%
.75	55%
.80	49%
.85	38%
.90	26%
.92	25%

Figure 5.11

MMI Entries

```
......TORQUE LOOP
........MAG CURRENT %    [453] =     30.00 %
........ROTOR TIME CONST [458] =     100.0 mSECS
........1 / GAIN         [149] =        70
........POS TORQUE LIMIT [157] =    150.00 %
........NEG TORQUE LIMIT [158] =   -150.00 %
........MAIN TORQUE LIM. [159] =    100.00 %
........SYMETRIC TQ.LIM. [153] = TRUE
........AUX TORQUE DMD   [599] =      0.00 %
........TORQ.DMD.ISOLATE [596] = FALSE
........CURRENT LIMIT    [585] =    150.00 %
```

Parameters

ROTOR TIME CONST [458]	set by Autotune
MAG CURRENT % [453]	set by Autotune
1 / GAIN [149]	Current loop gain is not a critical parameter and it should not normally be necessary to change it from the factory default value provided the motor is a standard type whose rating is reasonably close to the rating of the drive. See Appendix A, "Current Loop Gain".

Torque Limits

These limits the torque to the motor, not the current. The Current to the motor is made up of two component a Torque producing component, Iq and a "Field" producing component. The vector sum of these to is motor current.

The torque limits are limited to 0 to 150% and 0 to -150% and there can not be used to generate torque demand.

POS TORQUE LIMIT	Positive Torque Limit see below.
NEG TORQUE LIMIT	Negative Torque Limit see below.
MAIN TORQUE LIMIT	Main Torque Limit see below.
SYMMETRIC TQ.LIMIT	Selects whether the negative limit is used or not.

Symmetric Limits

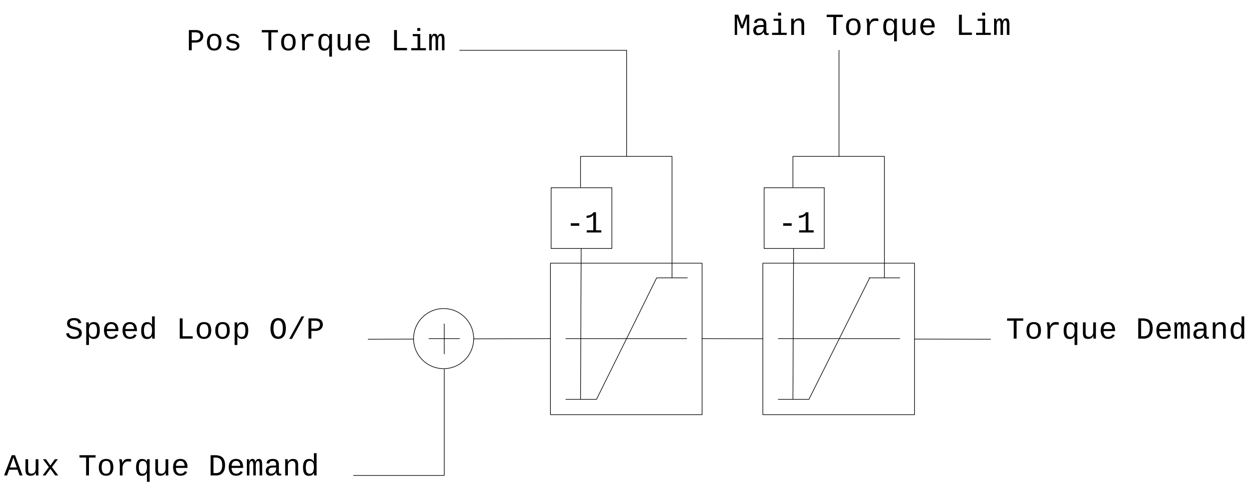


Figure 5.12 Symmetric Limits

Asymmetric Limits

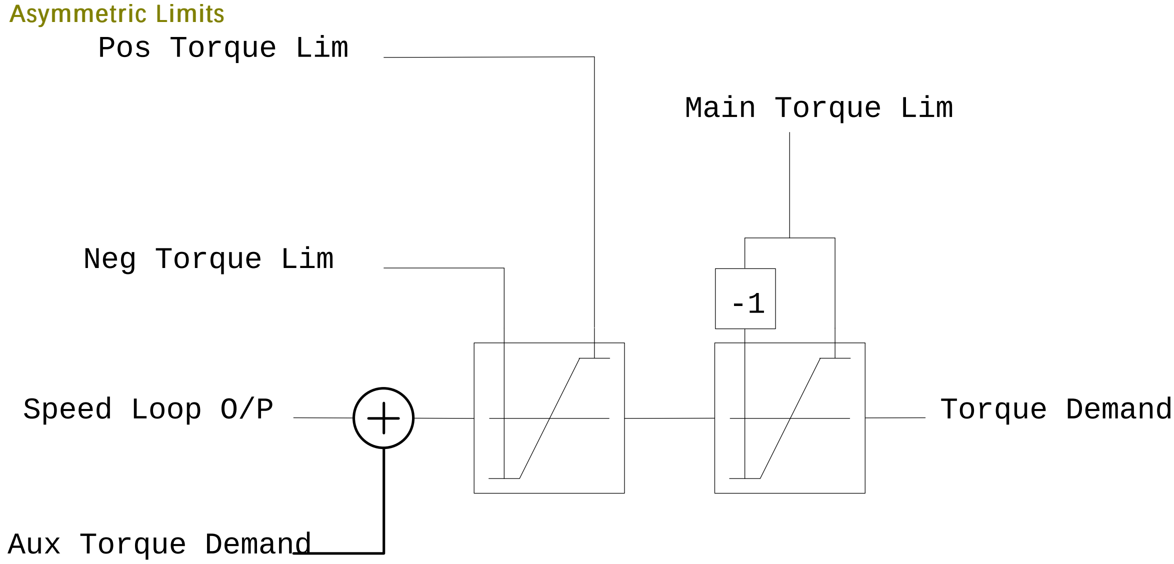


Figure 5.13 Asymmetric Limits

Algorithm

```
/* Clamp POS Limit  > NEG Limit */
if (NEG > POS)
        if (POS >= 0)
                /* POS clamp is positive so clamp NEG clamp to POS */
                 NEG := POS;
        else if (NEG <= 0)
                 /* NEG clamp is negative so clamp POS clamp to NEG */
                POS := NEG;
        else
                 /* Clamps have crossed over so set to zero */
                 NEG := POS = 0;
        endif
endif
```

Direct Torque Control

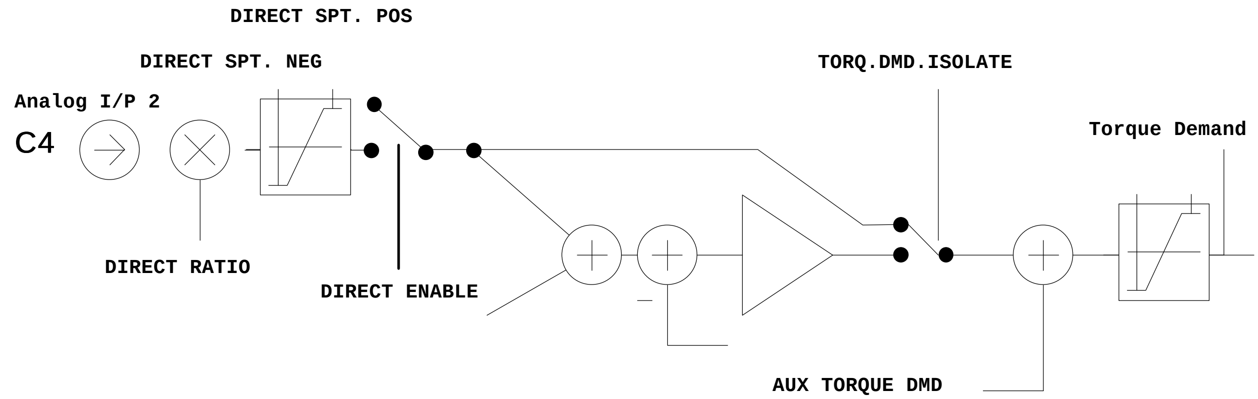


Figure 5.14 Speed Loop

AUX TORQUE DMD	Additional torque demand.
TORQ.DMD.ISOLATE	Bypasses the speed loop.
CURRENT LIMIT	Current Limit in “Motor Amps” taking into account both the magnetisation and torque components iq and id.

Speed Loop

MMI Entries

```
......SPEED LOOP
........SPD. PROP. GAIN  [161] =     10.00
........SPD. INT. TIME   [162] =       100 mSECS
f.......INT. DEFEAT      [163] = FALSE
........ENCODER SIGN     [164] = NEG
........SPEED FBK FILTER [165] = TRUE
........SPEED SETPOINTS
..........DIRECT SPT1      [171] =      0.00 %
..........DIRECT RATIO     [172] =    0.1000
..........DIRECT SPT. MAX  [173] =    100.00 %
..........DIRECT SPT. MIN  [174] =   -100.00 %
..........DIRECT ENABLE    [175] = FALSE
..........MAIN SPD.SPT.    [176] =     0.00 %
..........MAX SPEED        [177] =    100.00 %
..........MIN SPEED        [178] =   -100.00 %
..........ZERO SPD HYST    [132] =      0.10 %
..........ZERO SPEED LEVEL [252] =      0.50 %
```

Speed Loop Tuning

PROP GAIN	Speed loop PI proportional gain adjustment. A gain value of 1.00 is unity.
INT. TIME CONST.	Speed loop PI integral gain adjustment.
INT. DEFEAT	Turn speed loop in to a P only controller.

The PI is designed as a saturating loop, i.e. it is normal for the output to reach saturation. In order to prevent integral wind up during saturation the integral term is held constant while the output is saturated.

Saturation is deemed to be when the output is ≥ to the prevailing torque limit.

Speed Feedback

The 620 requires an encoder feedback device tightly coupled to the motor shaft to achieve its high level of performance. This is because accurate real time measurement of shaft position is used in the vector calculations. The number of encoder lines is also important to achieve high performance, the higher the number of lines the greater the speed loop gain. Also as a result of more lines the high frequency ripple in the torque is also reduced, reducing audible noise.

The number of lines on the encoder is set in the **SETUP PARAMETERS::CALIBRATION** menu. An incorrect number of lines will prevent the drive from operating smoothly and in some circumstances may cause the drive to operate in an uncontrolled manner.

ENCODER SIGN	If the Encoder sign is incorrect the motor will not operate smoothly. The sign of the encoder can be changed either in hardware by swapping the A and B channels or by toggling this parameter. A third way of matching encoder sign to motor direction is to swap any two motor output phases.
SPEED FBK FILTER	Enables a simple filter function applied to speed feedback to reduce ripple caused by low line count encoders.

Speed Setpoints

The Speed setpoint can come from one of two sources (Local or Remote). In Local mode the setpoint is derived directly from the Op-Station value and the reset of the drives block diagram is running but not used in the calculation of the setpoint.

The Speed Demand has a 10% over-range, although input 0 only has the range ± 105.00%. This allows take up slack to operate over the whole speed range.

DIRECT SPT1	This setpoint processing is synchronous with the speed loop (every 1.1 ms) and can be used by an external trim loop (positioning systems etc.). When not in use this should be disabled.
DIRECT SPT. MAX	
DIRECT SPT. MIN	Limits the range of the scaled Direct input.
DIRECT ENABLE	Disables the processing of analogue input C4, this must be enabled to make use of this feature. The Direct setpoint is automatically disabled while the stop ramps are active and in Local mode.
MAIN SPD.SPT.	This is the main setpoint from the block diagram.
MAX SPEED	
MIN SPEED	These are intended to prevent the speed setpoint from going negative and not to create an offset. Offsets may be generated elsewhere, probably before the system ramp.
ZERO SPD HYST	Hysterises level for zero speed detection.
ZERO SPEED LEVEL	Zero speed threshold.

Autotune

MMI Entries

```
......AUTOTUNE
........AUTOTUNE FLAG    [482] = FALSE
```

```
........MAG I AUTOTUNE   [483] = TRUE
........SET Tr < RTD SPD [484] = TRUE
........AUTOCAL MAX RPM  [629] = 30000 RPM
```

Parameters

AUTOTUNE FLAG — If set the drive will begin its Autotune routine next time the drive is started.

MAG I AUTOTUNE — Enables the tuning of the Magnetisation Current phase of the Autotune, this requires the motor to rotate at base speed.

SET TR < RTD SPD — Enables the Rotor Time Constant calculation phase of Autotune.

AUTOCAL MAX RPM — The speed in rpm at which the last successful mag current autotune was carried out. If at any later date the user increases MAX SPEED RPM to more than 30% above this value, an error will be flagged. This parameter is set to a high default value so that the drive may run before any autocal has been carried out.

Setpoint Sum 1- 3

MMI Entries

```
......SETPOINT SUM 1
........RATIO 0          [189] =    1.0000
........RATIO 1          [190] =    1.0000
........SIGN 0           [191] = POS
........SIGN 1           [192] = POS
........DIVIDER 0        [193] =    1.0000
........DIVIDER 1        [194] =    1.0000
........LIMIT            [195] =    100.00 %
........INPUT 0          [196] =     74.61 %     *
........INPUT 1          [197] =      0.02 %     *
........INPUT 2          [198] =      0.00 %
......SETPOINT SUM 2
........RATIO 1          [365] =    1.0000
........RATIO 0          [364] =    1.0000
........SIGN 1           [367] = POS
........SIGN 0           [366] = POS
........DIVIDER 1        [369] =    1.0000
........DIVIDER 0        [368] =    1.0000
........LIMIT            [370] =    100.00 %
........INPUT 0          [371] =      0.00 %
........INPUT 1          [372] =     74.68 %     *
........INPUT 2          [373] =      0.00 %
......SETPOINT SUM 3
........RATIO 1          [376] =    1.0000
........RATIO 0          [375] =    1.0000
........SIGN 1           [378] = POS
........SIGN 0           [377] = POS
........DIVIDER 1        [380] =    1.0000
........DIVIDER 0        [379] =    1.0000
........LIMIT            [381] =    100.00 %
........INPUT 0          [382] =      0.00 %
........INPUT 1          [383] =      0.00 %
........INPUT 2          [384] =      0.00 %
```

Block Diagram

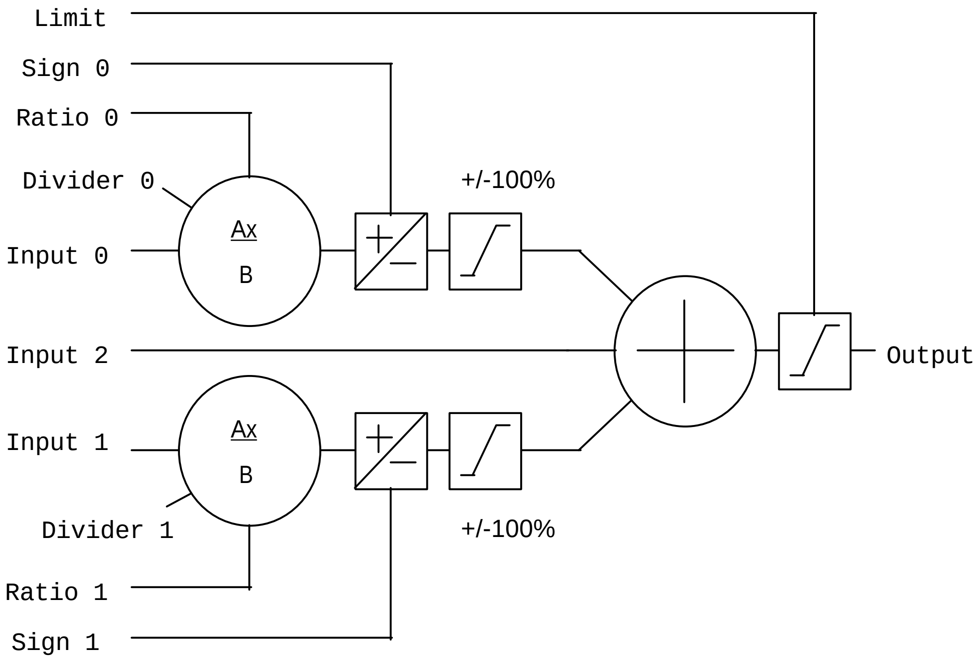


Figure 5.15 Setpoint Sum

Algorithm

$$Output = \left(\left(\left(\frac{Input0_n \times Ratio0_n + Input0_{n-1} \% Ratio0_{n-1}}{Divider0} \right)_{-limit}^{limit} \times sign0_{-1}^{+1} \right) + \left(\left(\frac{Input1_n \times Ratio1_n + Input1_{n-1} \% Ratio1_{n-1}}{100\%} \right)_{-limit}^{limit} \times sign1_{-1}^{+1} \right) + Input2_n \right)_{-limit}^{limit}$$

Equation 5.1 Setpoint Sum

RATIO 0/RATIO 1 — Input scaling, a signed quantity +/- 3.0000. Resolution is maintained by re-addition of all remainders, ensuring no information is lost.

SIGN 0/SIGN 1 — Input 1 polarity. The sign is displayed as **NEG** or **POS** with 0 being negative and 1 being positive .

DIVIDER 0/DIVIDER 1 — Input scaling. Divisions by zero are trapped and the result is set to zero.

LIMIT — The Setpoint Sum programmable limit is symmetrical and has the range 0.00% to 300.00%. The limit is applied both to the intermediate results of the RATIO calculation and the total output.

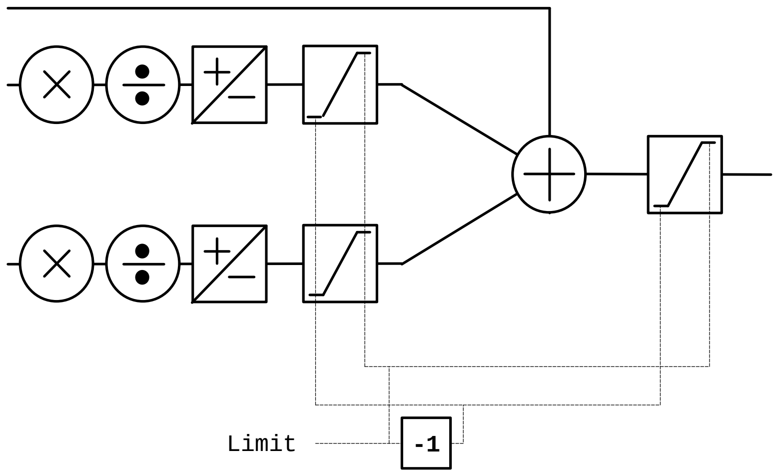


Figure 5.16 Setpoint Sum

INPUT 0/INPUT 1/INPUT 2 Input values.

Reference Encoder

MMI Entries

```
f..... REF ENCODER
f.......SPEED
f.........REFSPEED         [357] =      0.00 %
f.........MAX SPEED RPM    [353] =      1500 RPM
f.........ENCODER LINES    [356] =      2048
f.......PHASE
f.........OFFSET           [447] =         0
f.........OFFSET SCALE     [609] =         1
f.........RESET            [600] = FALSE
f.........POS CALC ENABLE  [337] = FALSE
f.........POSITION ERROR   [338] =         0
f.........MAX POSITION ERR [342] =    100.00
f.........REF SCALE A      [343] =       100
f.........REF SCALE B      [344] =       100
f.........REF ENCODER I/P  [359] =         0
f.........SATURATED        [610] = FALSE
f.........OVERFLOW         [611] = FALSE
f.......INCH
f.........INCH ADVANCE     [604] = FALSE
f.........INCH RETARD      [605] = FALSE
f.........INCH RATE        [606] =      10.0
```

Block Diagram

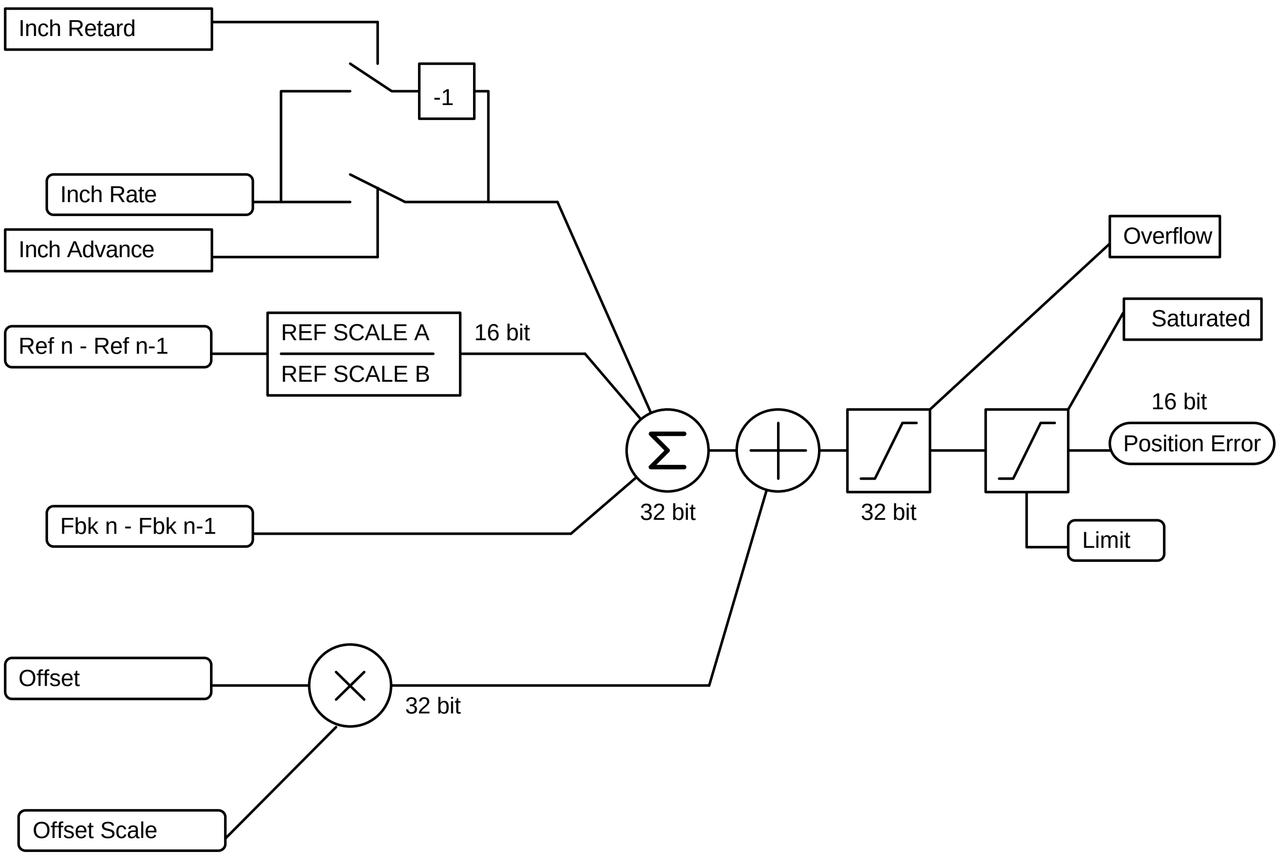


Figure 5.17 Phase Loop

Speed

Only available on the 620L

REFSPEED	Speed diagnostic calculated from Reference encoder.
MAX SPEED RPM	100% for reference encoder.
ENCODER LINES	Number of lines on the reference encoder used for the calculation of reference speed.

Phase

OFFSET	Fixed offset into error calculator in encoder counts[1].
OFFSET SCALE	Scalar for offset to allow greater range.
RESET	Set and hold the Error to zero.
POS CALC ENABLE	Enable the computation of position error, disabling this also zeros the position error.
POSITION ERROR	Clamped Error output.

[1] Note: Encoder counts are equale to four times the number of lines on the encoder per revolution.

MAX POSITION ERR	Limit clamp for position error**.**
REF SCALE A	Multiplicand for reference encoder.
REF SCALE B	Divisor for reference encoder. Example: Reference encoder has 1000 line and Master has 2048 lines then for 1:1 phase locking Ref. Scale A and B should be set to 2048 and 1000 respectively.
REF ENCODER I/P	Diagnostic for incoming encoder counter (unscaled).
SATURATED	Position Error output has been clamped.
OVERFLOW	Position Error has overflowed and phase information has been lost. This is because the error has exceeded +/- 1,000,000,000 counts, about 120,000 revolutions with a 2048 line encloder.

Inch

INCH ADVANCE	Boolean flag that when TRUE will trickle `INCH RATE` counts into the position Error each millisecond. This can be used to align the master motor to the reference motor.
INCH RETARD	As above in the other sense.
INCH RATE	The number of counts to be trickled into the Position error accumulator every millisecond.

PID

The PID Block allows the drive to be used in applications where a trim is required from an external loop. The PID input can be load cell tension, dancer position or any other transducer feedback such as pressure, flow etc.

The most commonly encountered applications in web transfer and winding are:

Section Control with PID trim on speed demand. The PID input is either load cell tension or dancer position feedback.

Features

1. Independent adjustment of gain and time constants.
2. Additional first-order filter (F).
3. Functions P, PI, PD, PID with/without F individually selected.
4. Ratio and divider for scaling each input.
5. Independent positive and negative limits.
6. Output scalar (Trim).