

# 590 DRV Digital DC Drive

## Product Manual Addendum

### Version 4 Software

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**NOTICE**

This addendum contains instruction on how to use the new features of the 590 DC Digital DC Drive firmware, version 4. It also lists the version 4 corrections to version 3 firmware bugs.

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# 590 Digital DC Drive Version 4 Firmware

## MAJOR BLOCK DIAGRAM ENHANCEMENTS

### Two Additional Internal Links with Increased Functionality

Version 4 firmware has increased the number of internal links from 10 to 12. These new links can perform the following seven functions, depending on the values of the MODE and ADVANCED parameters:

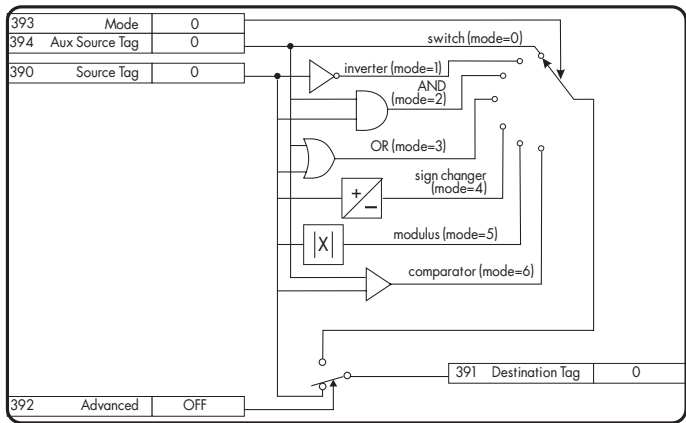
- switch— switches the signal source between the auxiliary and the source analog or logic tags.
- logic AND— gives AND-ed result of source logic signal and an auxiliary source logic signal.
- boolean OR— gives OR-ed result of source logic signal and an auxiliary source logic signal.
- logic inverter— inverts source logic signal.
- sign changer— reverses the sign of source analog signal.
- modulus— produces the modulus of the source analog signal.
- comparator— changes destination logic signal to TRUE when source analog signal is greater than auxiliary analog signal.

In addition to the standard source and destination parameter tags which are common to Links 1 through 10, Links 11 and 12 have three additional parameters that give them added functionality:

1. ADVANCED: When OFF, the link operates as a standard link. When ON, the link’s functionality changes depending on the MODE parameter setting.
2. AUX SOURCE: Provides the second input for the two-input functions.
3. MODE: Determines which function the link performs on the source tag signals.

The following diagrams and table summarize the capability of Links 11 and 12.

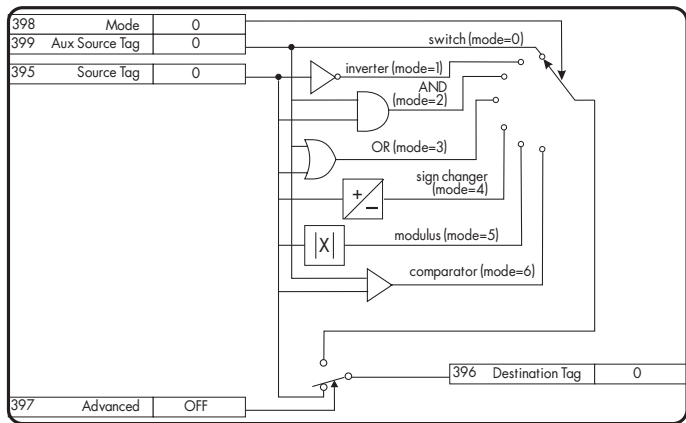
SYSTEM:  
CONFIGURE I/O:  
INTERNAL LINKS:  
LINK 11



KEY

→	Non-configurable	*	Filtered Tag
- ->	Configurable	D.nn	Diagnostics #

SYSTEM:  
CONFIGURE I/O:  
INTERNAL LINKS:  
LINK 12



KEY

→	Non-configurable	*	Filtered Tag
- ->	Configurable	D.nn	Diagnostics #

Figure 1 - Block Diagram of Advanced Links 11 & 12

MODE	ADVANCED	OUTPUT SIGNAL
switch (0)	Off	Source
	On	Auxiliary Source
inverter (1)	Off	Source
	On	LOGIC INVERSION of Source
AND (2)	Off	Source
	On	LOGIC AND of Source & Auxiliary Source
OR (3)	Off	Source
	On	LOGIC OR of Source & Auxiliary Source
sign changer (4)	Off	Source
	On	sign polarity change of Source
modulus (5)	Off	Source
	On	MODULUS (magnitude) of Source
comparator (6)	Off	Source
	On	if Source < Auxiliary Source, then destination is false (0) if Source > or = to Auxiliary Source, then destination is true (1)

Figure 2 - Mode Selection Table for Links 11 &amp; 12

The tag number ranges and default settings for the parameters of both links are:

**LINK 11**

Tag	Parameter	Description	Range	Default
390	SOURCE	Tag for the source input value.	0 to 499	0
391	DESTINATION	Tag for the destination output value.	0 to 499	0
392	ADVANCED	Determines whether link acts as a simple link or has advanced functionality.	ON/OFF	OFF
393	MODE	Determines the advanced function. Active only when ADVANCED is ON.	0 to 6 (see table above)	0 (switch)
394	AUX SOURCE	Tag for the auxiliary source value.	0 to 499	0

**LINK 12**

Tag	Parameter	Description	Range	Default
395	SOURCE	Tag for the source input value.	0 to 499	0
396	DESTINATION	Tag for the destination output value.	0 to 499	0
397	ADVANCED	Determines whether link acts as a simple link or has advanced functionality.	ON/OFF	OFF
398	MODE	Determines the advanced function. Active only when ADVANCED is ON.	0 to 6 (see table above)	0 (switch)
399	AUX SOURCE	Tag for the auxiliary source input value.	0 to 499	0

## Torque Compensations Calculator Block

The TENS + COMP CALC block is located in the SPECIAL BLOCKS menu. It provides additional torque to compensate for frictional and inertia losses. Add these losses to the diameter-scaled tension demand to produce a compensated torque demand for open loop winder applications.

The internal block diagram is shown below:

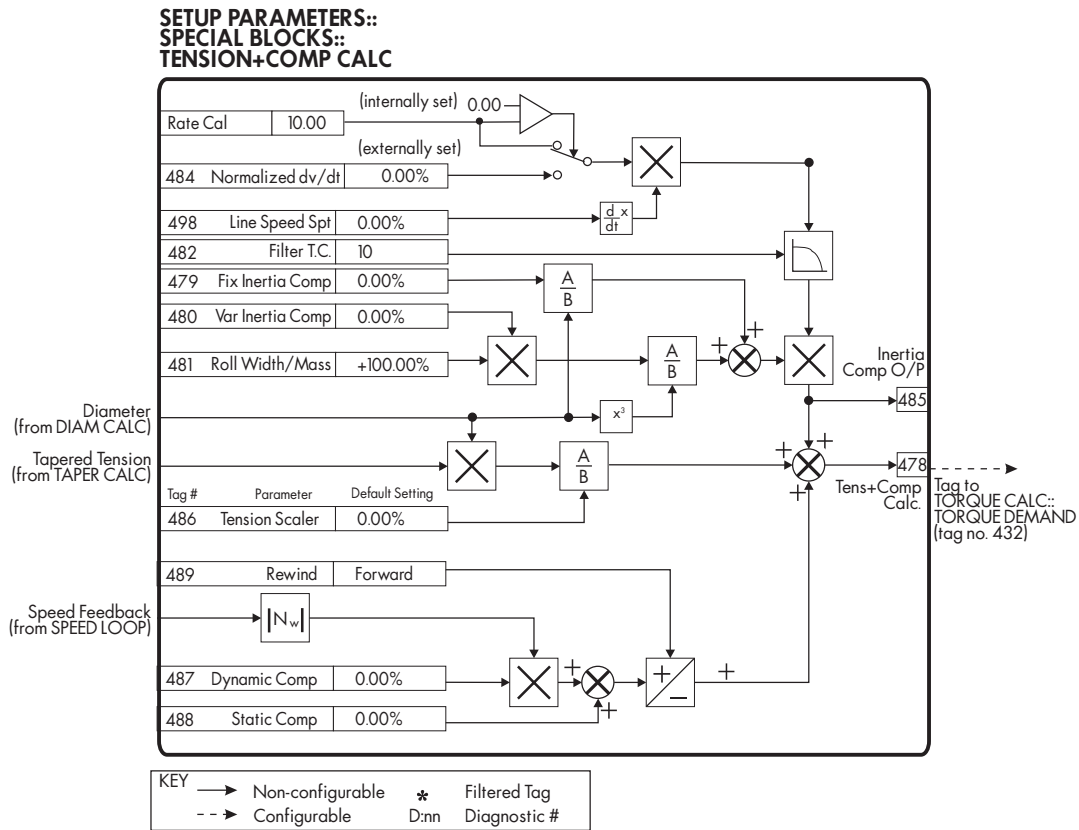


Figure 3 - Tension + Comp Calc. Block Diagram

## Static and Dynamic Frictional Losses

Static and dynamic friction are due to gearbox resistance and mechanical binding in the winder spindle and motor bearings. Both absorb motor output torque and require compensation to maintain accurate winder tension control.

Static friction, or “stiction”, is a constant offset most noticeable at or near zero speed. The compensation torque required to overcome static friction is fixed over the entire operating speed range. You can ignore “stiction” for winders which do not normally operate at zero speeds.

Dynamic friction results from friction losses within the drive train, which includes gearboxes and chain and belting linkages. The oil viscosity in gearboxes and windage losses in the motor armature fans also contribute to dynamic frictional losses.

The effects of static and dynamic friction are shown in Figure 4.

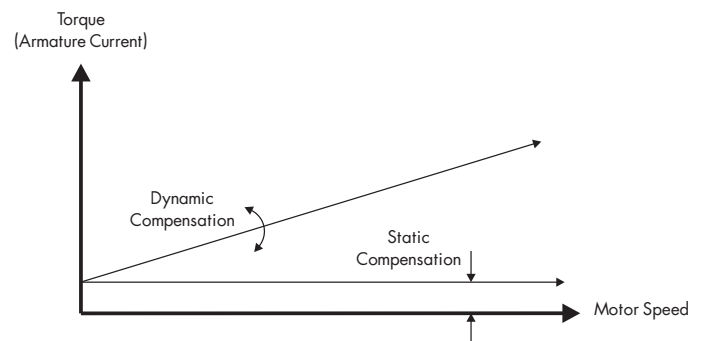


Figure 4 - Effect of Static & Dynamic Friction on Motor Torque

## Inertia Compensation

Many winders need inertia compensation to add or subtract torque during acceleration and deceleration to maintain constant tension, especially at large roll diameters. Without compensation, the tension holding capability of open loop winders diminishes during speed changes causing tension sag.

The inertia compensation characteristic is shown in Figure 5.

For winder applications, inertia compensation is split into two components:

1. Fixed inertia compensation for the fixed motor, transmission and load components.
2. Variable inertia compensation for the changing roll inertia. This is especially necessary for high diameter build unwinds and winders.

The parameters for the TENS+COMP CALC block are listed below:

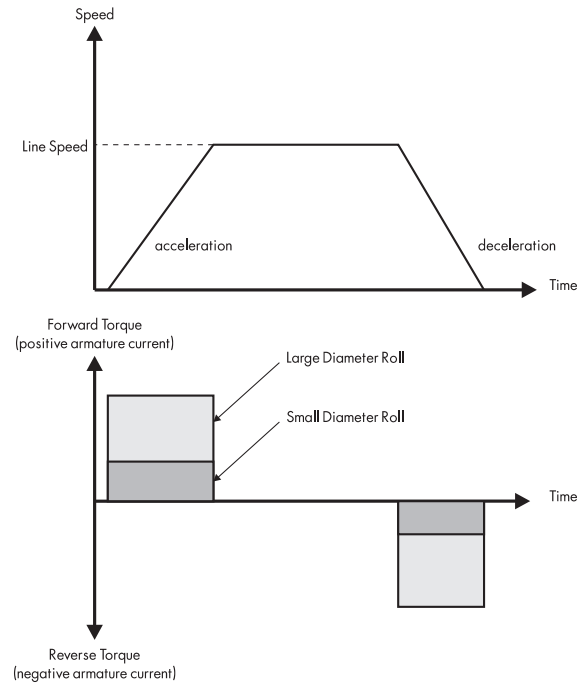


Figure 5 - Effect of Inertia on Motor Torque

### TENS+COMP CALC BLOCK

Tag	Parameter	Description	Range	Default
479	FIX INERTIA COMP	Fixed inertia compensation setup parameter.	±300.00%	0.00%
480	VAR INERTIA COMP	Variable inertia compensation setup parameter.	±300.00%	0.00%
481	ROLL WIDTH/MASS	Scales fixed and variable inertia compensations based on roll width. 100% = maximum roll width.	0 to +100.00%	100.00%
482	FILTER TC	The line speed acceleration rate value, which is calculated from the line speed input, may have a large ripple component that can disturb motor torque. A filter smoothes this signal to diminish the ripple. This parameter sets the time constant of this filter.	0 to 20000	10
483	RATE CAL	Scales the inertia compensation acceleration/ deceleration rate to 100% of the maximum line ramp rate. Set this parameter to the maximum time required to ramp from zero to full speed in seconds. [NOTE. Inertia compensation works best for line ramp rates below 100 seconds and is therefore limited to 100 seconds.] If RATE CAL = 0.00, then this parameter is set externally through NORMALIZED dv/dt. Otherwise, RATE CAL sets the inertia compensation acceleration/ deceleration rate.	0 to 100.00	10.00
484	NORMALIZED dv/dt	Tag an external signal to NORMALIZED dv/dt to set the inertia compensation acceleration/ deceleration rate externally from the drive. Useful for ramp rates exceeding 100 seconds. The external signal must be normalized to 100% = the maximum line ramp rate. Active <i>only</i> when RATE CAL = 0.00.	±300.00%	0.00%

**TENS+COMP CALC BLOCK (CONTINUED)**

<b>Tag</b>	<b>Parameter</b>	<b>Description</b>	<b>Range</b>	<b>Default</b>
485	INERTIA COMP O/P	Monitors the sum of all inertia compensations.	±200.00%	---
486	TENSION SCALER	Scales the TENSION DEMAND, which directly connected from the TAPER CALC block.	±3.0000	1.0000
487	STATIC COMP	Static friction compensation setup parameter.	±300.00%	0.00%
488	DYNAMIC COMP	Dynamic friction compensation setup parameter.	±300.00%	0.00%
489	REWIND	Switches polarity of friction compensations when motor direction changes. Set to DISABLED only when winder reverses.	ENABLED/DISABLED	ENABLED (forward)
498	LINE SPEED SPT	Used to calculate the line speed acceleration rate value for the fixed and variable inertia compensations.	±105.00%	0.00%
478	TENS+COMP CALC	The sum of the diameter-scaled TENSION DEMAND after the TENSION SCALER scaling and the compensation losses. For open loop winder applications, connect this output to the TORQUE DEMAND input (tag no. 432) to the TORQUE CALC block. (This output is located in the SYSTEM:: CONFIGURE I/O:: BLOCK DIAGRAM menu.)	---	---

## MINOR BLOCK DIAGRAM ENHANCEMENTS

### RAMP O/P range extension from 100.00 to 105.00%

Ramp output range extended from 100.00 to 105.00%. This allows the speed loop to be saturated in open loop winder applications.

### New tags for individual inputs in SETPOINT SUM 2 block

SETPOINT SUM 2 block inputs INPUT 0 and INPUT 1 now have the source tags 491 and 492, respectively. These tags appear after the respective scaling parameters RATIO 0, DIVIDER 0 and RATIO 1 and DIVIDER 1.

NOTE. You can connect these inputs to other destination tags within the drive software using the software package ConfigEd Lite, or with the INTERNAL LINKS in the SYSTEM:: CONFIGURE I/O menu through the MMI. These tags are unallocated and therefore do not appear in the MMI menu.

### New tag for non-configurable scaled analog input 2 (terminal A3)

Tag 493 allows you to use the signal at analog input 2 (terminal A3) after the CALIBRATION, MIN and MAX VALUE operations. The signal is still hardwired to SETPOINT 2 in the SPEED LOOP and remains non-configurable to other drive software parameters. To avoid interfering with other drive functions, set the I DEMAND ISOLATE switch in CURRENT LOOP to SPEED LOOP and scale RATIO 2 in SPEED LOOP to 0.00%.

NOTE. You can connect this input to other destination tags within the drive software using the software package ConfigEd Lite (version 2.0), or with the INTERNAL LINKS in the SYSTEM:: CONFIGURE I/O menu through the MMI. This tag is unallocated and therefore does not appear in the MMI menu.

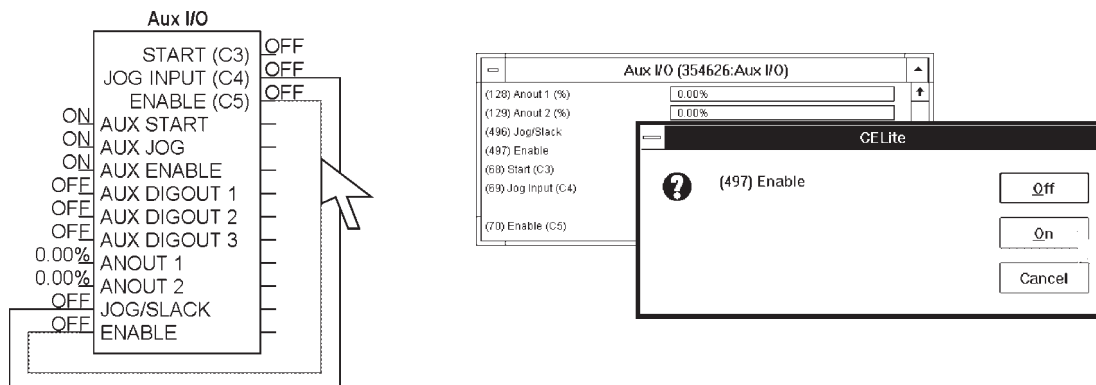
### Configurability of Digital Inputs C4 (Jog) and C5 (Enable)

You can now use digital input terminals C4 (Jog) and C5 (Enable) when you do not need the external jog or current loop enable functions. This adds two additional digital inputs thereby increasing the number of I/O and expanding functionality.

NOTE. Unlike the DIGIN 1, 2 and 3 (terminals C6, C7 and C8), C4 and C5 do not have VALUE FOR TRUE and VALUE FOR FALSE parameters and therefore cannot switch analog values. You can only configure the destination tag for these inputs. These inputs transmit a TRUE value (1) when the voltage at the terminal is at +24VDC and a FALSE value (0) when the voltage is at 0 VDC to their destination tags.

The default settings for these tags are 496 (JOG/SLACK enable) for terminal C4 and 497 (ENABLE) for terminal C5.

To use terminal C5 as a digital input, use ConfigEd Lite to delete the connection between output ENABLE (C5) and the input ENABLE in the AUX I/O block, then open the AUX I/O block and set the ENABLE parameter to ON. Or, set the ENABLE parameter in SETUP PARAMETERS:: AUX I/O in the MMI to ON. Other than a normal, program stop, coast stop or drive fault override, this permanently enables the drive. You can then tag the output ENABLE (C5) to a digital parameter within the 590 software. The destination tag for DIGITAL INPUT C5 is located in the SYSTEM:: CONFIGURE I/O:: DIGITAL INPUTS menu in the MMI.

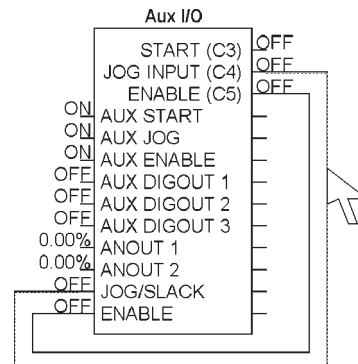


### Caution

If you are isolating power on the drive output using a DC contactor, you must use an auxiliary, normally-open contact connected to terminal C5 to immediately disable the drive's current loop when the contactor coil deenergizes. You should free up terminal C5 for other uses only when isolating main power on the input side of the drive using an AC contactor.

NOTE. Since all 590 DRV models isolate power on the 590 drive output using a DC contactor, you cannot use terminal C5 as an additional digital input.

To use terminal C4 as a digital input, delete the connection between output JOG INPUT(C4) and the input JOG/SLACK in the AUX I/O block using ConfigEd Lite. You can then tag the block output JOG INPUT(C4) to a digital parameter within the 590 software. Or, you may re-tag the parameter using the MMI. The destination tag for DIGITAL INPUT C4 is located in the SYSTEM:: CONFIGURE I/O:: DIGITAL INPUTS menu in the MMI.



### MIN SPEED DEMAND limits extended to positive quadrant

In firmware version 3, the MIN SPD DEMAND parameter was limited to -105.00 to 0.00%. The limits are now  $\pm 105.00\%$ , which allows you to set a positive minimum speed demand. The MAX SPD DEMAND limits remain at 0 to +105.00%.

### Tags for encoder pulse counting

Version 4 firmware includes an encoder position counter (tag 267) and divider (tag 275). This permits you to calculate distance or measure processed material using a line speed encoder. To do this, you need a programmable logic controller (PLC) to accumulate the position counter counts through the drive's optional RS422/485 communications port (P1) and a speed feedback encoder mounted to the motor shaft.

#### Position Counter

The position counter counts pulses in hexadecimal format with a range of 0000 to FFFF (65,534 counts).

It begins incrementing from 0000 when you start the drive in the forward direction, then rolls over to 0000 on the count after FFFF. If you start and run the drive in reverse, the counter begins at 0000, rolls over to FFFF, then counts down to 0000. On reaching 0000, the counter rolls over to FFFF on the next count. After the drive is stopped, the counter retains its count when the shaft reaches standstill. The counter resets when you restart the drive.

NOTE. You cannot monitor the POSITION COUNT value through the MMI. Use EI Bisync to gain access to the parameter through the serial port (P1).

#### Divider

The divider, which provides scaling capability, is in decimal format. Its range is 1 to 3000. The divider scales the encoder signal before the pulses reach the position counter. A separate register accumulates the remainders.

#### Using a PLC

To read the position count using a PLC, connect the POSITION COUNT output in the CALIBRATION block to a free serial PNO slot (PNO 112 through 120) using ConfigEd Lite or the MMI. The PNO parameters are located in the SERIAL LINKS:: PNO CONFIG menu.

NOTE. CONFIGURE ENABLE under the SYSTEM:: CONFIGURE I/O menu must be enabled to re-tag PNO slots.

**Encoder RPM tag reads in % of full speed when not used for speed feedback.**

The 590 Digital DC Drive can now generate an analog speed signal proportional the encoder pulses it receives through an encoder option board, regardless of the type of speed feedback the drive actually uses. This feature is useful for sending a  $\pm 10$  VDC analog speed reference to analog drives or other equipment which are part of the same control system.

By using a resistor caliabration card and terminal B2, you can use an analog tachometer generator as speed feedback for the master drive or simply use armature volt feedback control. This eliminates the need for a switchable tachometer generator calibration card. You can then mount an encoder option board and connect a line shaft mounted encoder to the master drive. Use the ENCODER RPM line speed signal from this (master) drive as a normalized (%) line encoder reference to other (slave) drives .

## **PERFORMANCE ENHANCEMENTS**

### **Extended main power-loss ride through capability**

In version 3, the drive was allowed to restart automatically after mains failure lasting up to two seconds if you inhibited the 3-PHASE FAIL alarm in the RESERVED menu. Version 4 now allows power loss ride through without the need to inhibit the 3-PHASE FAIL alarm. (See *Section 5* of this addendum.)

### **Fixed firing circuit**

A more deterministic circuit provides maximum converter volts nearer to a pure “diode rectification” limit.

### **CONFIGURE ENABLE state no longer saved in EEPROM**

Version 3 software saved the current state of the CONFIGURE ENABLE MMI parameter when you executed a PARAMETER SAVE. If you saved this parameter in the active (enabled) state and initiated a START with serial port P2 active (communicating), the MMI would malfunction. Version 4 avoids this anomaly by not saving this parameter to EEPROM on a PARAMETER SAVE.

### **Bumpless speed transition in run to normal or programmed stop**

The two “ramp-to-zero” ramps in the STOP RATES software block — one for normal and one for program stop— ramp the drive SPEED DEMAND to zero speed at the instant a normal or program stop is initiated. In open loop winder applications, the motor speed demand is set higher in magnitude than the speed feedback in order to saturate the speed loop and run the drive in current limit. In these situations, program or normal stopping switches the drive out of current limit and causes the actual motor speed to quickly rise to the new, higher speed demand as the speed loop becomes unsaturated. This causes a noticeable “speed bump”. Version 4 alleviates the problem by using the instantaneous drive speed feedback as the starting reference to both “ramp-to-zero” ramps.

### **Reduced micro reset delay at power-up**

Version 4 firmware has eliminated the need for extending the power-up delay while the firmware resets the drive’s microprocessor on power-up. This has cut the power-up time from three seconds to around one second thus allowing the microprocessor to initialize quicker.

## **SOFTWARE BUG FIXES**

### **Corrected field latch-up problem**

If the ENABLE (C5) input was toggled during a regenerative stop, the field control software block would occasionally “latch up” and clamp the field supply output to zero. The latch up problem could only be cleared by cycling the control power. This was due to a software interrupt race condition. Version 4 corrects this problem.

### **Corrected field fail alarm problem**

When you are using an AC contactor and are supplying a blower motor from the drive side of the contactor, the drive occasionally faulted on a FIELD FAIL alarm during start up. Version 4 corrects this problem by triggering the field delay timer when the phase lock loop locks on to the supply mains frequency, rather than when the START input (C3) goes high.

### **Corrected INVERSE TIME block failure with bipolar current clamp crossover problem**

In version 3, the INVERSE TIME software block occasionally functioned improperly when the POS I CLAMP was set to a negative value greater in magnitude than 100.00%. The block could also fail whenever NEG I CLAMP was set to a positive value larger in magnitude than 100.00%. The problem occurred due to math sign faults. Version 4 corrects this problem.

### **Critical error & auxiliary supply failure now resets HEALTHY output and contactor supply**

When a CRITICAL ERROR occurs (the MMI annunciates the HEALTH STORE hex word 0xFFFF), the HEALTH OUTPUT now immediately disables and the contactor start power (terminals D5 and D6) immediately switches off. This also occurs if the drive loses its auxiliary supply without completely losing its supply rails. This is particularly critical for crane applications where these signals are used for brake switching.

## POWER LOSS RIDE THROUGH

During a power outage, the 590 Digital DC Drive cannot supply power to the motor. However, motor inertia will keep the machine turning for a short period. If the drive can recover and not fault on a power loss alarm, the drive can maintain motor control for a short period until power is restored.

You must consider separately the two main supplies to the drive—the control and three-phase power—when adjusting the drive to withstand a short term power loss.

### Three-phase supply

The 590 Digital DC Drive has a three-phase supply tolerance range of 198 to 550 VAC. Consequently, a drive operating on 460 VAC (the standard three-phase power supply rating for most US industrial facilities) can continue to function with a supply reduced to less than 50% of nominal line voltage, assuming that the control supply is maintained. Although the drive remains functional (it does not fault out), it cannot produce full output voltage for the motor armature or field.

The drive normally faults out on a 3-PHASE FAIL alarm if the three phase drops below tolerance. Version 4 firmware delays triggering a 3-PHASE FAIL alarm for two seconds when the mains supply dips below 198 VAC. During that two second period, the drive disables the current loop and allows the motor to coast on its own inertial load. The firmware triggers a 3-PHASE FAIL and faults out the drive if the power mains do not rise above 198 VAC after two seconds. Otherwise, the current loop is re-enabled, and the drive continues to produce armature and field volts to control the motor as before.

NOTE. If you require a fault delay *greater* than two seconds, contact Eurotherm Drives Customer Service for assistance.

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### WARNING!

If these alarms are inhibited, the current loop disables when power drops below 198 VAC, but automatically re-enables if the power recovers and the drive is not shut off. To avoid a shock hazard and unexpected mechanical motion, you *must* use an external, hardwired independent timer circuit to prevent the drive from restarting. The time-out period setting depends upon the inertia of the load and running conditions—factors which determine how LONG the system can maintain itself and still fully recover.

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If power has still not recovered, the drive will still register the alarm when it is started, even if you have overridden 3-PHASE and PHASE LOCK FAIL alarms. This alarm is symbolic alarm message 0xF003, indicating that the drive cannot lock on to the supply.

### Control Supply

The drive must have a constant control supply to avoid shutting down during a momentary mains supply loss. The 590 Digital DC Drive accepts minimum control supply of 99 VAC and can recover from a dip below that level for 100 ms. Therefore, unlike the drive's main supply circuit, the drive's control circuit operating on a 115 VAC supply (the nominal control supply rating in the U.S.) *cannot* tolerate a 50% sag. Further, the control power to the drive very often feeds the drive power isolation contactor and other system control devices which may be unaffected by a mains supply loss, but will drop out after 10 or 20 ms for a control power drop.

This means that you must power the drive's control circuitry, contactor and external control device with a reliable, constant supply—such as from a constant voltage transformer, or an uninterruptable power supply (UPS)—if you wish the drive to automatically recover from intermittent main power loss. Both devices ensure that the drive, main contactor and other system control devices can maintain drive logic signals to resume control when power restores.

NOTE. Because a UPS or constant voltage transformer supplies control power to the drives as well as control process equipment or most drive systems, it is recommended to use a time-out circuit to initiate a normal stop of the drive and all control processes. Set the time-out period for no longer than the time the process can self-maintain

## Inversion Fault

A power outage prevents a drive from producing current while it is motoring and usually causes no damage to a drive. If a drive is regenerating, the drive relies on an AC line voltage *higher* than the DC armature voltage to commutate, or turn off the thyristors. During an outage, a regenerating motor cannot fully dissipate the motor armature current, since the armature voltage *exceeds* the line voltage. The reverse current through the thyristor therefore rapidly increases, which can blow thyristor fuses or damage a thyristor. This scenario, common to all DC thyristor drives, is known as an inversion fault.

The likelihood of an inversion fault occurring depends on the armature voltage, or motor speed, and the amount of voltage sag. It can cause fast stopping at low speeds and an overcurrent trip or a semiconductor to rupture at high speeds.

## Power Loss Ride Through Procedure

Follow the procedures below when setting up a 590 DRV Digital DC drive to maintain motor control during a mains power loss:

1. Use a constant voltage transformer to supply control power to the 590 DRV and all control circuitry related to the drive system control, including a programmable logic controller (PLC), if used. Rewire the 590 DRV, as shown in the figure below, to bypass its on-board control transformer.
- NOTE. When supplying a control supply through DRV terminals L and N, the control supply is limited to 110 VAC.
2. If you wish to extend the drive's power-loss alarm delay time beyond two seconds, contact Eurotherm Drives Customer Service for assistance. Add an independent time-out circuit to the drive's start-stop circuitry, as shown in Figure 6. Set the timer for no longer than the amount of time the system can maintain adequate control during a power loss.
  3. Add an independent time-out circuit to initiate a normal stop to *all* system processes. (You may do this using a contactor or relay whose coil is rated for the main voltage voltage. Refer to Figure 6.) Set the timer for no longer than the amount of time the system can maintain adequate control during a power loss.

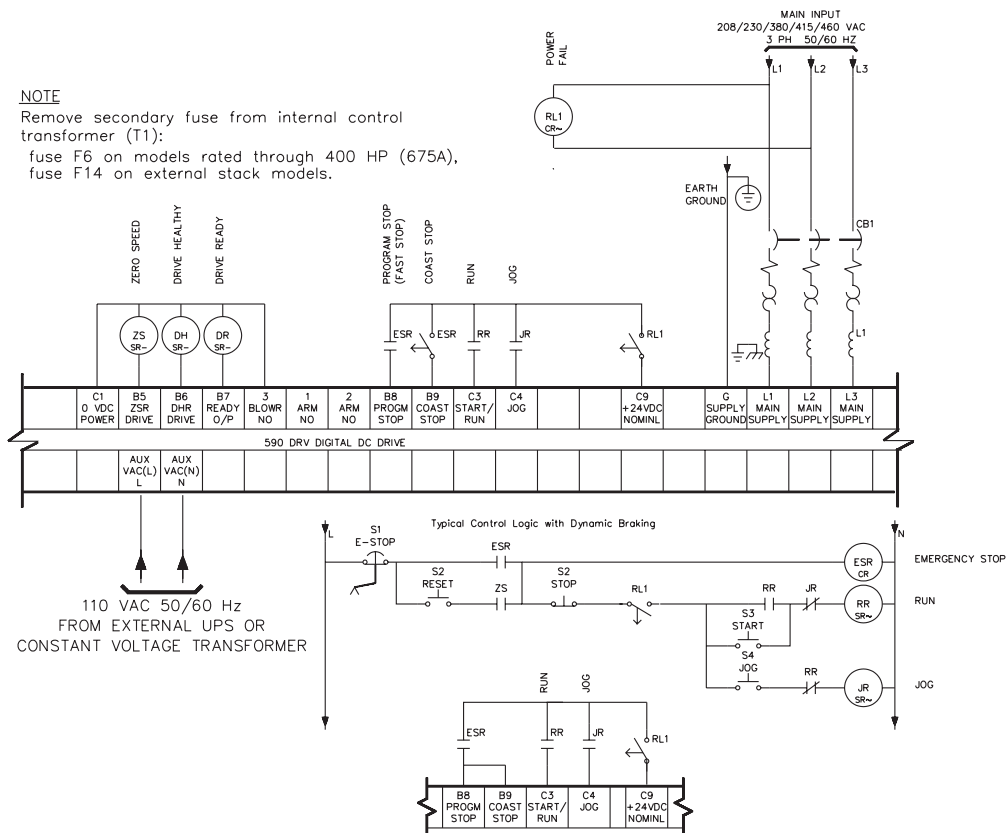


Figure 6 - Supplying Control Power to a 590 DRV for Power Loss Ride Through