Technical Note 205

Adaptive and supply voltage on 580 series

Parameters 95.01 - 95.03 impact on drive limits

The 580 series drive (ACH, ACS, and ACQ), being a global product, can be connected to different supply line voltages from 208 to 600 V. For ease of commissioning, regardless of where in the world the drive will be installed, the drive is setup to automatically detect the input line voltage. Two adjustable parameters that impact functionality are 95.01 *Supply voltage* and 95.02 *Adaptive voltage limits*. Most of the time adjustments of parameters 95.01 and 95.02 are unnecessary: however there are situations where adjustment of the parameters may be necessary. This technical note will discuss how both parameters 95.01 and 95.02 work for 6-pulse drives and Ultra-low harmonic (ULH) drives. Also, for 6-pulse drives, example situations are provided for when parameter 95.02 may need to be adjusted.

The 580 series drive estimates the phase-to-phase AC line voltage from the measured DC bus voltage. The DC bus voltage measurement is taken during initialization of the drive on power-up. The estimated AC line voltage value then can be seen in read-only parameter 95.03 *Estimated AC supply voltage*. In the case of 6-pulse drives, this 95.03 setting impacts the undervoltage, overvoltage, and control limits of the drive if 95.02 *Adaptive voltage limits = Enable*. The ULH drive does not use the 95.03 value for determining limits.

Parameter 95.02 *Adaptive voltage limits = Enable* by default for 6-pulse and ULH drives. The default setting of parameter 95.01 *Supply voltage* is different depending on the drive type being 6-pulse versus ULH, and the voltage class of the drive (-2, -4, -6).

6-pulse drive overview of 95.01 settings

Table 1 provides the default setting of parameter 95.01 for 6-pulse drives based on the drive's voltage class.

Table 1

Voltage class	95.01 default setting	Value
-2	[1] 208…240 V	Leave as a setting of [1], as the [0] Automatic has no impact on -2 drives
-4	[0] Automatic / not selected	Settings of [2] 380…415 V or [3] 440…480 V are also possible
-6	[5] 525…600 V	Leave as a setting of [5], as the [0] Automatic has no impact on -6 drives

6-pulse -4 drives (380…480 VAC)

When parameter 95.02 *Adaptive voltage limits = Enable* (default), the drive will use the estimated AC supply voltage measured at power up to calculate undervoltage and overvoltage control limits along with internal brake chopper trigger levels. Appendix A shows how the calculated values will be different based on parameter 95.03 *Estimated AC supply voltage*. For example, if 95.03 is 480 VAC, the limits will be different than if 95.03 was 485 VAC.

If parameter 95.02 *Adaptive voltage limits = Disable*, then the undervoltage and overvoltage limits along with internal brake chopper triggers are fixed values. The exact value is based on the setting of parameter 95.01 (380…415 or 440…480 VAC). Appendix B details the fixed values.

6-pulse -2 (208…240 VAC) and -6 (525…600 VAC)

Parameter 95.01 has no impact on the limits and triggers of -2 and -6 voltage class drives. The setting of parameter 95.02 = *Enable* results in voltage limits and triggers based on Appendix A. The setting of parameter 95.02 = *Disable* results in voltage limits and triggers based on Appendix B. Reference the specific columns for 208…240 VAC and 525…600 VAC supplies in Appendixes A and B.

Using 95.02 as a troubleshooting aid for 6-pulse drives

While commissioning a drive under certain circumstances it may be necessary to adjust parameter 95.02 = *Disable* to resolve drive motor control problems. The following are three example situations and troubleshooting techniques to determine when parameter 95.02 should be adjusted.

Generator supply

Drives powered from a generator may experience an initial input voltage spike. With 95.02 = *Enable,* the drive calculates the AC RMS line voltage (95.03) from this initial high DC bus value and will use limits based on Appendix A. After the voltage spike, the line voltage and DC bus voltage will settle out to their nominal values. However, the calculated value of 95.03 will remain abnormally high and the drive's undervoltage limits will be higher than typically expected for the nominal voltage. As a result, the drive may show an undervoltage alarm even though the DC bus voltage in parameter *01.11* shows a correct value when compared to a measured phase-to-phase input voltage (AC RMS x $\sqrt{2}$ = Voltage DC) with the drive not running the motor. To diagnose the problem, view the value of parameter 95.03. If the estimated supply voltage reads a value that is much higher than the measured AC input phase-to-phase voltage, then change parameter 95.02 *to "Disable"* and 95.01 to the specific input voltage range if not already set. Make sure to power cycle the drive after making these parameter adjustments.

Passive harmonic filter

Another scenario where parameter 95.02 may need to be disabled is an initial input voltage spike condition from an input passive harmonic filter that has capacitors engaged on powerup. Some brands of passive filters do not come with a disconnecting contactor to remove the capacitors at low load or when the drive is not running the motor. As in the previous generator supply example, a high voltage spike may occur during power up which causes the drive to calculate an incorrect AC supply voltage (95.03). To resolve this incorrect AC supply voltage calculation, set parameter 95.02 to *"Disable",* parameter 95.01 to the specific input voltage range, and power cycle the drive.

Single-phase input

In rare situations, a 200 volt class drive that has single-phase input voltage applied to it requires parameter 95.02 = *Disable* to get the motor up to full speed. It may be observed that the drive will stop accelerating the motor even though the motor speed is below the reference setpoint. If the drive is updated with the latest firmware, a warning should appear on the control panel screen indicating the cause of the problem. If the firmware is an older revision, manually checking limit status word parameters 30.01 and 30.02 will be necessary. Parameter 30.01 bit 0 will be "1" indicating a torque limit event, and 30.02 bit 0 will be "1" indicating the torque is being limited due to an undervoltage condition. In some cases, these bits may cycle between "0" and "1" values.

In this scenario, the input line voltage is the correct 240 VAC and the value of 95.03 matches the measured input line voltage. When a drive has single-phase input voltage applied, it has more DC bus ripple when under load compared to a drive with three-phase input voltage, even though the drive is oversized correctly per the hardware manual. In these situations with 95.02 = *Enable* the undervoltage warning and control limits are calculated to be higher values compared to when 95.02 = *Disable*. The lower peak in the DC bus ripple is bumping into the undervoltage warning limit.

Here is an example of the calculated undervoltage warning limit for a -2 (208…240 VAC) class drive for parameter 95.02 = *Enable* and parameter 95.02 = *Disable* from the charts in the firmware manual. Parameter 95.03 = *240 VAC* for both situations below.

95.02 = *Enable*

0.85 x 1.41 x 240 AC = 270.72 VDC undervoltage warning limit (Appendix A)

95.02 = *Disable*

239 VDC undervoltage warning limit is a fixed value (Appendix B)

By disabling parameter 95.02 a lower DC bus voltage is allowed before an undervoltage warning will be declared.

ULH drives

ULH drives have a slightly elevated DC bus voltage compared to a 6-pulse drives. As a result, they have different limits compared to 6-pulse drives. Regardless of the setting of parameter 95.02 *Adaptive voltage limits,* the undervoltage and overvoltage limits are fixed values based on the setting of parameter 95.01 *Supply voltage*. Appendix C details these voltage levels.

Summary

Most of the time adjustments to parameters 95.01 *Supply voltage* and 95.02 *Adaptive voltage limits* are not necessary. There are times however where 95.02 may need to be disabled to overcome site-specific voltage conditions such as when single-phase input voltage is applied, or a generator is used. Please reach out to your local ABB representative for more information.

Appendix A Adaptive voltage limits 95.02 = Enable

DC voltage level [V] See *95.01 Supply voltage*.	95.01 Supply voltage				
	AC supply voltage range [V] 208…240	**AC supply voltage range [V] 380…415**	**AC supply voltage range [V] 440…480**	**AC supply voltage range [V] 525…600**	**Automatic / Not selected**
Overvoltage fault limit	421	842	842	1053	842
Overvoltage control limit	389	779	779	974	779
Internal brake chopper start limit	389	779	779	974	779
Internal brake chopper stop limit	379	759	759	949	759
Overvoltage warning limit	372	745	745	931	745
Undervoltage warning limit	0.85 x 1.41 x par *95.03* value	0.85 × 1.41 × par *95.03* value	0.85 × 1.41 × par *95.03* value	0.85 × 1.41 × par *95.03* value	0.85 × 1.41 × par *95.03* value
Undervoltage control limit	0.78 x 1.41 x par *95.03* value	0.78 × 1.41 × par *95.03* value	0.78 × 1.41 × par *95.03* value	0.78 × 1.41 × par *95.03* value	0.78 × 1.41 × par *95.03* value
Charging relay closing limit / charging deactivation	0.78 x 1.41 x par *95.03* value	0.78 × 1.41 × par *95.03* value	0.78 × 1.41 × par *95.03* value	0.78 × 1.41 × par *95.03* value	0.78 × 1.41 × par *95.03* value
Charging relay opening limit / charging activation	0.73 x 1.41 x par *95.03* value	0.73 × 1.41 × par *95.03* value	0.73 × 1.41 × par *95.03* value	0.73 × 1.41 × par *95.03* value	0.73 × 1.41 × par *95.03* value
DC voltage at upper bound of supply voltage range (U_{DCmax})	324	560	648	810	(variable)
DC voltage at lower bound of supply voltage range (U_{DCmin})	281	513	594	709	(variable)
Standby limit [3)]	0.73 x 1.41 x par *95.03* value	0.73 × 1.41 × par *95.03* value	0.73 × 1.41 × par *95.03* value	0.73 × 1.41 × par *95.03* value	0.73 × 1.41 × par *95.03* value
Charging relay opening limit / charging activation	0.73 x 1.41 x par *95.03* value	0.73 × 1.41 × par *95.03* value	0.73 × 1.41 × par *95.03* value	0.73 × 1.41 × par *95.03* value	0.73 × 1.41 × par *95.03* value

Appendix B Adaptive voltage limits 95.02 = Disable

DC voltage level [V] See *95.01 Supply voltage*.	95.01 Supply Voltage					
	AC supply voltage range [V] 208…240	AC supply voltage range [V] 380…415	AC supply voltage range [V] 440…480	AC supply voltage range [V] 525…600	Automatic / Not selected	
					if *95.03* < 456 V AC	if *95.03* > 456 V AC
Overvoltage fault limit	421	842	842	1053	842	842
Overvoltage control limit	389	779	779	974	779	779
Internal brake chopper start limit	389	779	779	974	779	779
Internal brake chopper stop limit	379	759	759	949	759	759
Overvoltage warning limit	372	745	745	931	745	745
Undervoltage warning limit	0.85 x 1.35 x 208 = 239	0.85 × 1.35 × 380 = 436	0.85 × 1.35 × 440 = 504	0.85 x 1.35 x 525 = 602	0.85 × 1.35 × 380 = 436	0.85 × 1.35 × 440 = 505
Undervoltage control limit	0.78 x 1.35 x 208 = 219	0.78 × 1.35 × 380 = 400	0.78 × 1.35 × 440 = 463	0.78 x 1.35 x 525 = 553	0.78 × 1.35 × 380 = 400	0.78 × 1.35 × 440 = 463
Charging relay closing limit / charging deactivation	0.78 x 1.35 x 208 = 219	0.78 × 1.35 × 380 = 400	0.78 × 1.35 × 440 = 463	0.78 x 1.35 x 525 = 553	0.78 × 1.35 × 380 = 400	0.78 × 1.35 × 440 = 463
Charging relay opening limit / charging activation	0.73 x 1.35 x 208 = 205	0.73 × 1.35 x 380 = 374	0.73 × 1.35 x 440 = 433	0.73 x 1.35 x 525 = 517	0.73 × 1.35 x 380 = 374	0.73 × 1.35 x 440 = 433
DC voltage at upper bound of supply voltage range (U_{DCmax})	324	560	648	810	(variable)	(variable)
DC voltage at lower bound of supply voltage range (U_{DCmin})	281	513	594	709	(variable)	(variable)
Standby limit	0.73 x 1.35 x 208 = 205	0.73 × 1.35 × 380 = 374	0.73 × 1.35 × 440 = 433	0.73 x 1.35 x 525 = 517	0.73 × 1.35 × 380 = 374	0.73 × 1.35 × 440 = 433
Undervoltage fault limit [1)]	0.73 x 1.35 x 208 = 205	0.73 × 1.35 × 380 = 374	0.73×1.35×440 = 433	0.73 x 1.35 x 525 = 517	0.73 × 1.35 × 380 = 374	0.73 × 1.35 × 440 = 433

Appendix C ULH Voltage limits based on 95.01 setting with 95.02 = 'enable' or 'disable'

The following table shows the values of selected DC voltage levels in volts and in percent of U_{DCmax} (the DC voltage at the upper bound of the supply voltage range).

Level [V DC (% of U_{DCmax})]	**Supply voltage range [V AC]** (see *95.01 Supply voltage*)					
	208…240	**380…415**	**440…480**	**500**	**525…600**	**660…690**
Overvoltage fault limit	489/440*	800	878	880	1113	1218
Overvoltage control limit	405 (125)	700 (125)	810 (125)	810 (120)	1013 (125)	1167 (125)
Internal brake chopper at 100% pulse width	403 (124)	697 (124)	806 (124)	806 (119)	1008 (124)	1159 (124)
Internal brake chopper at 0% pulse width	375 (116)	648 (116)	749 (116)	780 (116)	936 (116)	1077 (116)
Overvoltage warning limit	373 (115)	644 (115)	745 (115)	776 (115)	932 (115)	1071 (115)
U_{DCmax} = DC voltage at upper bound of supply voltage range	324 (100)	560 (100)	648 (100)	675 (100)	810 (100)	932 (100)
DC voltage at lower bound of supply voltage range	281	513	594	675	709	891
Undervoltage control and warning limit	239 (85)	436 (85)	505 (85)	574 (85)	602 (85)	757 (85)
Charging activation/standby limit	225 (80)	410 (80)	475 (80)	540 (80)	567 (80)	713 (80)
Undervoltage fault limit	168 (60)	308 (60)	356 (60)	405 (60)	425 (60)	535 (60)