Technical Note

87 Hz Technique

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History

Rev.	Comments	Date
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V1.1	Table 3.1 corrected	21st June 2022

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1 Introduction

Three-phase motors provide constant torque up to their nominal speed. The area above nominal speed is the field weakening area, where the motor should operate at constant power, i.e. for each doubling of speed you can only use half the torque.

The 87 Hz technique provides a means to extend the constant torque range. That allows increasing the nominal motor speed and its power by a factor of around 1.73.

Be aware that this document addresses qualified persons, and it cannot replace profound technical education and training.

2 Requirements

- 400 V mains voltage
- A drive with current capacity of 1.73 times the motor's nominal current or higher
- A motor, suitable for Wye and Delta connection
- A motor with an insulation that withstands the increased voltage in Delta connection
- The higher motor speed may reduce the lifetime of its bearings and insulation. Therefore, it is necessary to check the suitability of the 87 Hz technique against the machine's lifetime specifications
- The motor should not operate at 87 Hz continuously, because the iron losses increase disproportionately above 50 Hz. That carries the risk of overheating. For motors with shaft-driven fan, the situation is even more critical, because the fan's efficiency decreases above and below 50 Hz.
  By all means, use motors with built-in thermal sensors or thermal contacts and connect them to the drive to provide overheat protection

3 Technical Background

The 87 Hz technique relies on keeping the ratio of voltage and frequency V/f constant. That is e.g. the case with the following values: 230 V / 50 Hz = 400 V / 87 Hz.

A motor connected in Wye to 400 V will enter its field weakening area at 50 Hz. The same motor connected in Delta to 230 V will do the same. However, that same motor connected in Delta to 400 V will enter the field weakening area at 87 Hz.

That means, the same motor will be able to run 1.73 times faster with constant torque. With the same nominal current and 1.73 times higher voltage, the motor provides 1.73 times as much power.

4 The 87 Hz Technique

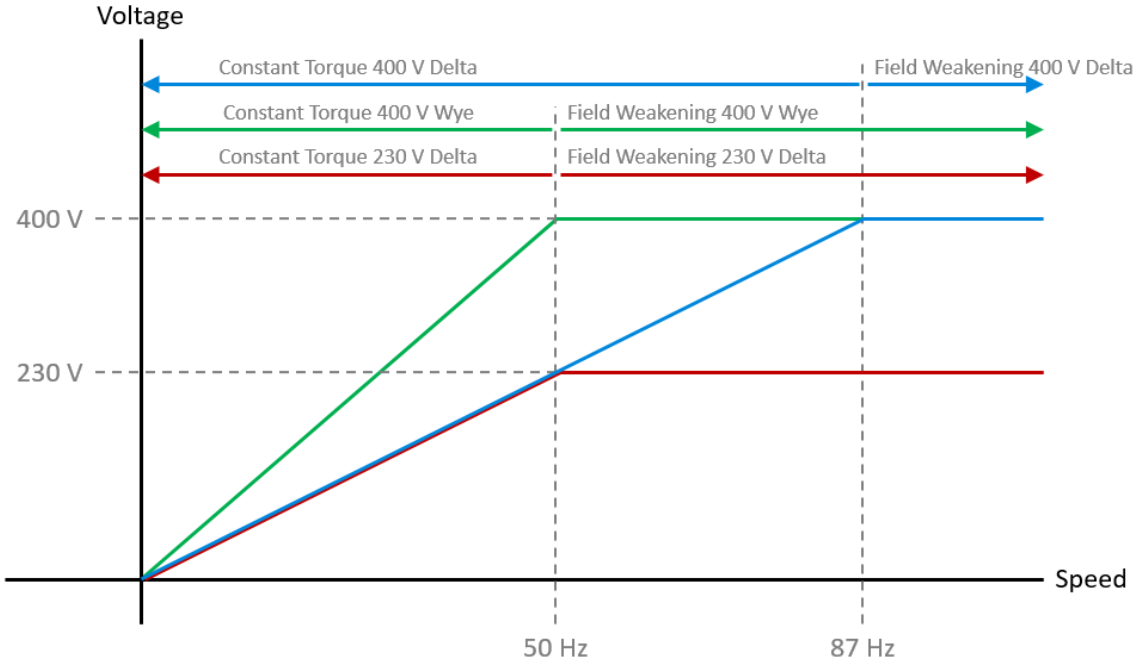

Figure 3.1 Comparison 50 Hz to 87 Operation (Simplified)

Table 3.1 shows how to connect the motor and which values to set in the drive parameters.

Table 3.1 Comparison 50 Hz to 87 Hz Operation

	Standard 230 V	**Standard 400 V**	**87 Hz Technique**
Motor connection	Delta	Wye	Delta
Motor voltage	230 V	400 V	400 V
Motor frequency	50 Hz	50 Hz	87 Hz
Motor current	1.9 A	1.1 A	1.9 A
Motor power	0.37 kW	0.37 kW	0.64 kW
Motor speed	1360 rpm	1360 rpm	2460 rpm

The same setup is possible for 60 Hz motors. In that case, the frequency will rise to 104 Hz instead of 87 Hz. The name “87 Hz Technique” stuck, because this technique is mostly popular in Europe where the mains frequency is 50 Hz.

It also works for different voltages as long as the ratio remains constant, e.g. 400 V / 50 Hz = 690 V / 87 Hz.

5 The 29 Hz Technique

The principle can be inverted, e.g. if due to derating a motor must be significantly larger than the required power. In that case, it becomes the 29 Hz technique, because 690 V / 50 Hz = 400 V / 29 Hz. The drive needs to be rated for the required current instead of the much higher nominal motor current.

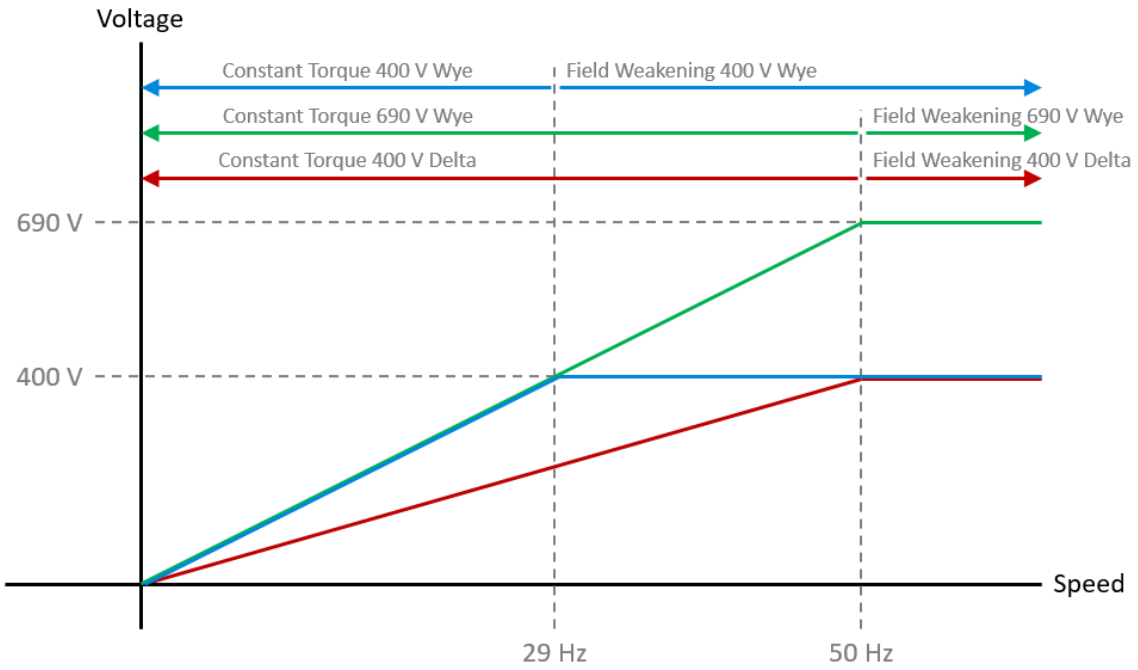

Figure 3.2 Comparison 50 Hz to 29 Operation (Simplified)

According to table 3.2, a 55 kW drive would suffice to control a 110 kW motor that moves a load that is smaller than or equal to 64 kW.

Table 3.2 Comparison 50 Hz to 29 Hz Operation

	Standard 230 V	**Standard 400 V**	**29 Hz Technique**
Motor connection	Delta	Wye	Wye
Motor voltage	400 V	690 V	400 V
Motor frequency	50 Hz	50 Hz	29 Hz
Motor current	183 A	106 A	106 A
Motor power	110 kW	110 kW	64 kW
Motor speed	2970 rpm	2970 rpm	1700 rpm

Using this technique with 60 Hz rated motors, increases the frequency from 29 Hz to 35 Hz.