VFD Output: Speed, Voltage and Torque at a Frequency

Motor synchronous speed and V/f voltage at a variable frequency drive setting, with the torque and power available below and above base speed.

Method: N_s = 120 f / p; constant V/f control (textbook)

Input parameters

Unit system: SI

Parameter	Value	Unit
Rated frequency of the motor	50.000	Hz
Rated voltage of the motor	415.00	V
Number of poles	4.0000	
Drive output frequency	35.000	Hz

Calculated results

Parameter	Value	Unit
Synchronous speed at that frequency	1,050.0	rpm
Output voltage (constant V/f up to rated)	290.50	V
Volts per hertz	8.3000	
Torque available	100.00	%
Power available	70.000	%

Notes for this case

- Below base speed: constant torque, power falls with speed. Self-cooled motors need derating at low speed.

Formula and method

$$N_s = \frac{2f}{p}\ [\text{rev/s}] = \frac{120f}{p}\ [\text{rpm}], \quad V = V_r \min\left(1, \frac{f}{f_r}\right), \quad \frac{V}{f} = \frac{V_r}{f_r}$$

$$\frac{T}{T_r} = 1\ (f \le f_r),\ \frac{f_r}{f}\ (f > f_r), \qquad \frac{P}{P_r} = \min\left(1, \frac{f}{f_r}\right)$$

Variables

f_r	Rated frequency of the motor	1/s
V_r	Rated voltage of the motor	V
p	Number of poles	-
f	Drive output frequency	1/s
N_s	Synchronous speed at that frequency	1/s
V	Output voltage (constant V/f up to rated)	V
V/f	Volts per hertz	-
T/T_r	Torque available	-
P/P_r	Power available	-

Method and standards

Synchronous speed and constant flux control.

Assumptions and limits

- Constant torque (T/T_r = 1) below base frequency assumes the motor is cooled independently of speed. A self-cooled (shaft-fan) motor must be derated at low speed per its maker's curve; that derating is not applied. Above base frequency the voltage stays at V_r and the motor runs at constant power.

- Linear V/f, no boost.

References

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Report details

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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/electrical/motors/vfd-speed-voltage

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Reopens the calculator with the inputs of this report.