

Three-Phase-Induction Motor with Squirrel Cage Rotor

Operating and Installation Data:

| | | | | | |
|--------------|-----------------|------------------|-----------------------------|---|-------------------|
| Rated- | | | | | |
| -power | P_N : | 1180 kW | Connection | : | Y |
| -voltage | U_N : | 6600 V +10%/-10% | Class of rating | : | S1 |
| -frequency | f_N : | 50 Hz +5%/-5% | Absolute altitude | : | <1000 m ab.s.l. |
| -current | I_N : | 122 A | Coolant temperature | : | 40 °C |
| -speed | n_N : | 995 1/min | Therm. class (design/util.) | : | 155 (F) / 130 (B) |
| -torque | M_N : | 11326 Nm | | | |
| Power factor | $\cos\varphi$: | 0.88 | | | |

Standard: IEC/EN 60034-1
Tolerances: IEC/EN 60034-1

Calculated Start-Up Data:

| | | | | | |
|-------------------------------------------------|-----------|------|------|--|--|
| Motor voltage | U/U_N | 1.00 | 0.80 | | |
| Locked-rotor torque | M_A/M_N | 0.80 | 0.50 | | |
| Pull-up torque | M_S/M_N | 0.80 | 0.50 | | |
| Breakdown torque | M_K/M_N | 2.50 | 1.55 | | |
| Locked-rotor current | I_A/I_N | 7.00 | 5.52 | | |
| (values for current without positive tolerance) | | | | | |

Calculated Partial Load Data:

| | | | | | |
|---------------|------|------|------|------|--|
| P/P_N | 1.25 | 1.00 | 0.75 | 0.50 | |
| $\cos\varphi$ | 0.88 | 0.88 | 0.87 | 0.82 | |
| η [%] | 96.4 | 96.7 | 96.8 | 96.5 | |

Additional Technical Ratings and Information:

Rotor material: E-CU

Measuring surface sound pressure level (no-load): 77 dB(A), tol.: +3 dB(A)

Level and duration of voltage and frequency variations during operation according to IEC/EN 60034-1 (chapter 7.3)

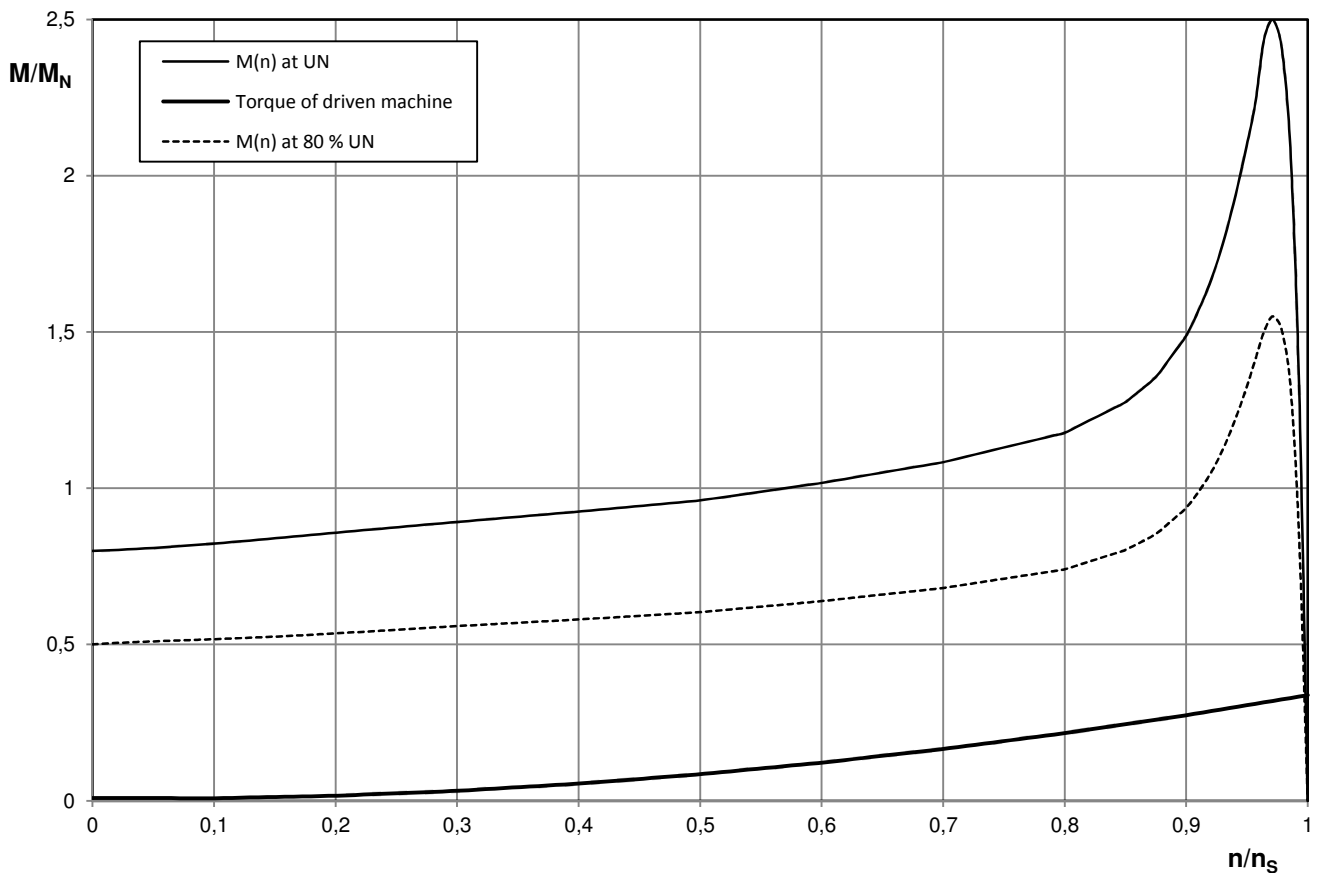
| | | | | | | | |
|------|------|------|------|---------------------|------------|--------------------------------|--|
| | | | | Date | 09.02.2015 | Electrical Data Sheet | |
| | | | | Name | PANGERL | | |
| | | | | Exam. | ANKOWSKI | | |
| | | | | Std. | | | |
| | | | | PD LD P MF-NMA EN M | | Type 1LA4 504-6CN70-Z | |
| | | | | SIEMENS AG | | Order No. 1448200 / 010 - E001 | |
| IND. | Text | Date | Name | BG147200 | | | |

Three-Phase-Induction Motor with Squirrel Cage Rotor

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Standard: IEC/EN 60034-1
Tolerances: IEC/EN 60034-1



| | | | |
|---------------------------|---|-----------------------------------------|---------------------------|
| Torque of driven machine: | : | $M \sim n^2$ (... 37% $M_{required}$) | (referred to motor speed) |
| Driven machine | : | Fan | |
| Required power | : | 1053 kW | |
| Moment of inertia (load) | : | 1590 kgm^2 | (referred to motor speed) |
| Starting time | : | 17 s | at $U/U_N = 1.00$ |
| | | 29 s | at $U/U_N = 0.80$ |
| Perm. number of starts | : | 3 cold, 2 warm | at $U/U_N = 1.00$ |
| | | 3 cold, 2 warm | at $U/U_N = 0.80$ |
| | | | 1000 per year |

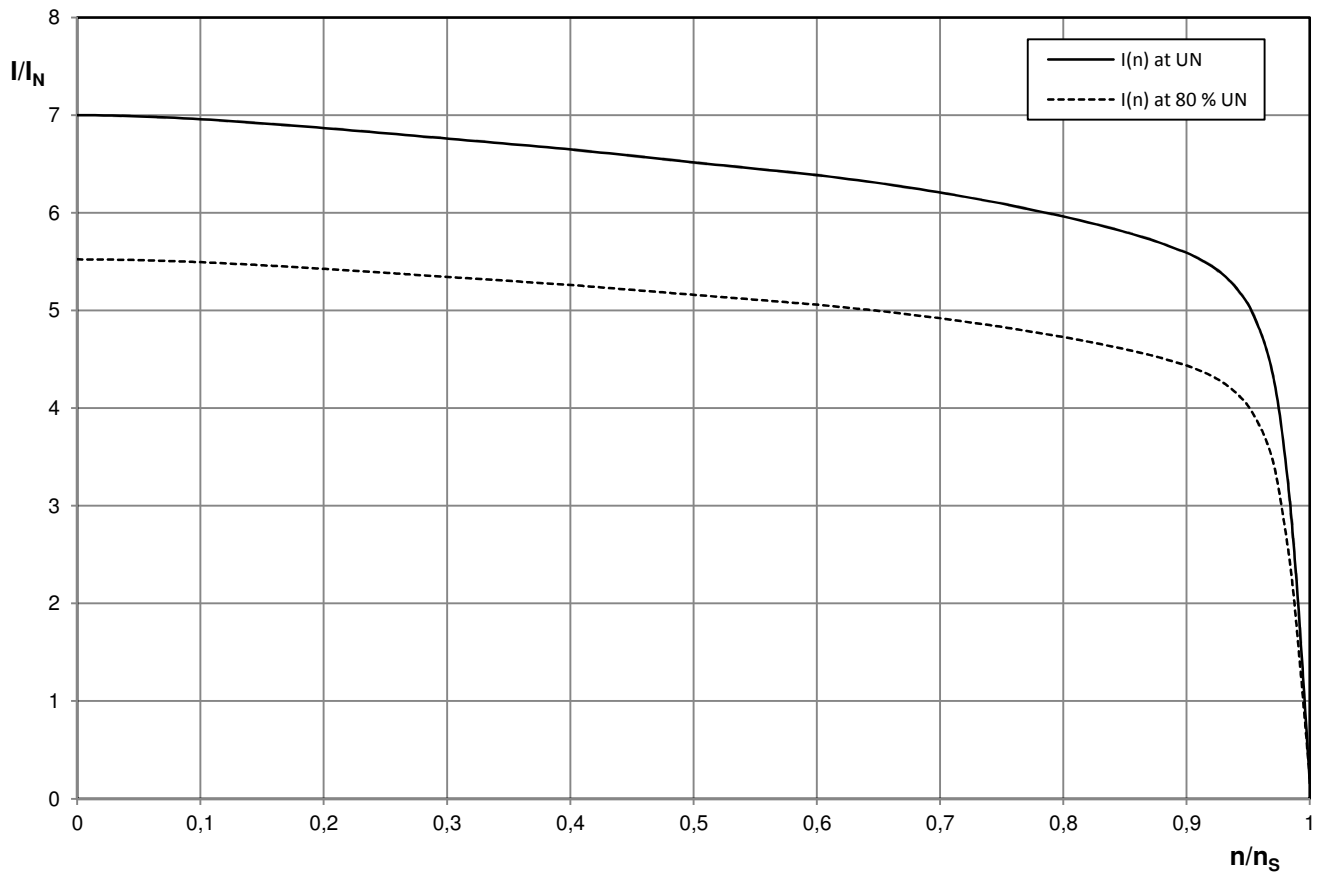
| | | | | | | | |
|------|------|------|------|---------------------|------------|--------------------------------|--|
| | | | | Date | 09.02.2015 | Starting Data M=f(n) | |
| | | | | Name | PANGERL | | |
| | | | | Exam. | ANKOWSKI | | |
| | | | | Std. | | | |
| | | | | PD LD P MF-NMA EN M | | Type 1LA4 504-6CN70-Z | |
| | | | | SIEMENS AG | | Order No. 1448200 / 010 - E002 | |
| IND. | Text | Date | Name | BG147200 | | | |

Three-Phase-Induction Motor with Squirrel Cage Rotor

Operating and Installation Data:

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Standard: IEC/EN 60034-1
Tolerances: IEC/EN 60034-1



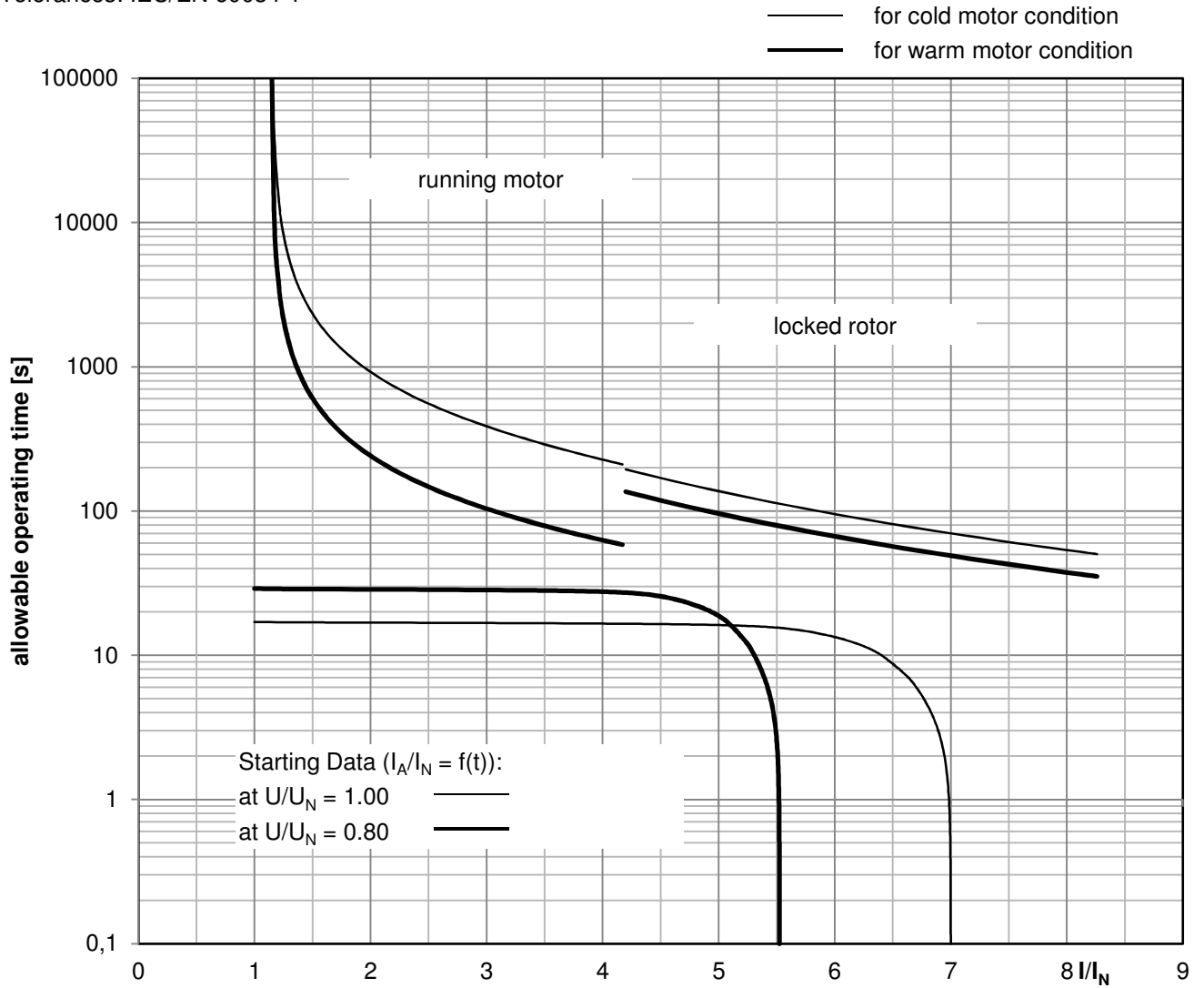
| | | | | | | | |
|------|------|------|------|---------------------|------------|--------------------------------|--|
| | | | | Date | 09.02.2015 | Starting Data I=f(n) | |
| | | | | Name | PANGERL | | |
| | | | | Exam. | ANKOWSKI | | |
| | | | | Stnd. | | | |
| | | | | PD LD P MF-NMA EN M | | Type 1LA4 504-6CN70-Z | |
| | | | | SIEMENS AG | | Order No. 1448200 / 010 - E003 | |
| IND. | Text | Date | Name | BG147200 | | | |

Three-Phase-Induction Motor with Squirrel Cage Rotor

Operating and Installation Data:

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| Rated- | | | | | |
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Standard: IEC/EN 60034-1
Tolerances: IEC/EN 60034-1



| | |
|-----------------------------------------------------------|---------|
| Thermal copper time constant (short-term load variation): | 27 min |
| Thermal time constant (long-term load variation): | 85 min |
| Thermal time constant for cooling down (standstill): | 340 min |

| | | | | | | | |
|------|------|------|------|---------------------|------------|--------------------------------|--|
| | | | | Date | 09.02.2015 | Thermal Limit Curve | |
| | | | | Name | PANGERL | | |
| | | | | Exam. | ANKOWSKI | | |
| | | | | Stnd. | | | |
| | | | | PD LD P MF-NMA EN M | | Type 1LA4 504-6CN70-Z | |
| | | | | SIEMENS AG | | Order No. 1448200 / 010 - E004 | |
| IND. | Text | Date | Name | BG147200 | | | |

Three-Phase-Induction Motor with Squirrel Cage Rotor

Operating and Installation Data:

| | | | | |
|--------------|-----------------|---------------------------------|-----------------------------|---------------------|
| Rated- | | | | |
| -power | P_N : | 1180 kW | Connection | : Y |
| -voltage | U_N : | 6600 V <small>+10%/-10%</small> | Class of rating | : S1 |
| -frequency | f_N : | 50 Hz <small>+5%/-5%</small> | Absolute altitude | : <1000 m ab.s.l. |
| -current | I_N : | 122 A | Coolant temperature | : 40 °C |
| -speed | n_N : | 995 1/min | Therm. class (design/util.) | : 155 (F) / 130 (B) |
| -torque | M_N : | 11326 Nm | | |
| Power factor | $\cos\varphi$: | 0.88 | | |

Standard: IEC/EN 60034-1
Tolerances: IEC/EN 60034-1

| |
|--------------------------------------------------------------------------------------------------------------------------|
| Trans. Torque in Air Gap: $M(t)/M_N = \Sigma (M/M_N \times e^{(t^*\tau)} \times \sin(2\pi \times f \times t + \varphi))$ |
|--------------------------------------------------------------------------------------------------------------------------|

Starting with locked rotor and $U_{Line} = 100\%$

| M/M _N | τ/s^{-1} | f/Hz | $\varphi/degree$ |
|------------------|---------------|-------|------------------|
| 0.80 | 0.00 | 0.00 | 90.00 |
| 0.80 | -48.22 | 0.00 | 90.00 |
| 5.34 | -0.39 | 50.00 | -171.42 |
| 5.34 | -47.82 | 50.00 | -8.58 |

$M_{max}/M_N = 5.89$ at $t = 94.6ms$

System transfer at 100% residual field, $U_{Line} = 100\%$, $\theta = 240^\circ$, Slip = 0.0050

| M/M _N | τ/s^{-1} | f/Hz | $\varphi/degree$ |
|------------------|---------------|-------|------------------|
| 1.01 | 0.00 | 0.00 | 90.00 |
| -0.81 | -72.27 | 0.00 | 90.00 |
| -2.52 | -24.17 | 0.00 | 90.00 |
| 11.97 | -12.08 | 49.78 | 26.37 |
| 12.26 | -36.13 | 1.06 | -137.13 |
| -21.66 | -48.22 | 48.73 | -17.05 |

$M_{max}/M_N = 18.50$ at $t = 8ms$

3-pole terminal short circuit

| M/M _N | τ/s^{-1} | f/Hz | $\varphi/degree$ |
|------------------|---------------|-------|------------------|
| -0.84 | -24.17 | 0.00 | 90.00 |
| -0.27 | -72.27 | 0.00 | 90.00 |
| 7.22 | -48.22 | 48.73 | 162.98 |

$M_{max}/M_N = 6.36$ at $t = 5.6ms$

2-pole terminal short circuit

| M/M _N | τ/s^{-1} | f/Hz | $\varphi/degree$ |
|------------------|---------------|--------|------------------|
| 0.15 | 0.00 | 0.00 | 90.00 |
| -0.83 | -24.17 | 0.00 | 90.00 |
| -0.07 | -72.27 | 0.00 | 90.00 |
| 3.44 | -12.08 | 49.78 | 178.57 |
| 1.79 | -36.13 | 1.06 | 16.12 |
| 3.62 | -48.22 | 48.73 | 161.89 |
| 1.73 | 0.00 | 100.00 | -2.68 |
| 0.62 | -12.08 | 50.22 | 90.30 |
| 1.80 | -36.13 | 98.94 | -15.92 |

$M_{max}/M_N = 8.34$ at $t = 7ms$

The value of the mechanical torque of the whole shafting can only be determined by using the above transient torques in a torsional analysis calculation. The plant manufacturer is responsible for the torsional vibrations analysis.

| | | | | | | | |
|------|------|------|------|---------------------|-----------------------|--------------------------------|--|
| | | | | Date | 09.02.2015 | Transient Torques | |
| | | | | Name | PANGERL | | |
| | | | | Exam. | ANKOWSKI | | |
| | | | | Stnd. | | | |
| | | | | PD LD P MF-NMA EN M | Type 1LA4 504-6CN70-Z | | |
| | | | | SIEMENS AG | | Order No. 1448200 / 010 - E005 | |
| IND. | Text | Date | Name | BG147200 | | | |

Three-Phase-Induction Motor with Squirrel Cage Rotor

Operating and Installation Data:

| | | | | | |
|--------------|-----------------|------------------|-----------------------------|---|-------------------|
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| -frequency | f_N : | 50 Hz +5%/-5% | Absolute altitude | : | <1000 m ab.s.l. |
| -current | I_N : | 122 A | Coolant temperature | : | 40 °C |
| -speed | n_N : | 995 1/min | Therm. class (design/util.) | : | 155 (F) / 130 (B) |
| -torque | M_N : | 11326 Nm | | | |
| Power factor | $\cos\varphi$: | 0.88 | | | |

Standard: IEC/EN 60034-1
Tolerances: IEC/EN 60034-1

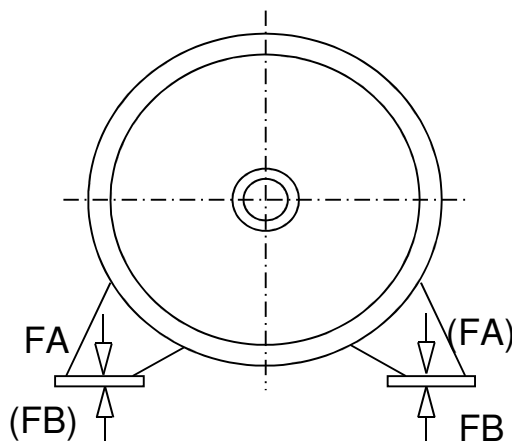
Foundation Load

The listed foundation loads are derived from a stress analysis for a rigid foundation, caused by the maximum dynamic torque and the machine weight. The forces occur alternately on each side of the machine, irrespective of the direction of rotation.

Transfer of vibrations from the surrounding has to be avoided by appropriate layout of foundation. On the basis of DIN 4024 Part 1 the natural frequencies f_n of the system - machine on foundation - must differ as follows from the operating frequencies f_m (for mains-fed operation: Rotating frequency, double rotating frequency, line frequency and double line frequency, for converter-fed operation: Rotating frequency, double rotating frequency, supply frequency and double supply frequency):

- 1. Natural frequency of system: $f_1 \geq 1.25 f_m$ or $f_1 \leq 0.8 f_m$
- Higher natural frequencies: $f_n \geq 1.1 f_m$ or $f_n \leq 0.9 f_m$

→ The plant manufacturer is responsible for the design of the foundations!



2-pole terminal short circuit

compressive force FA = 135 kN
tensile force FB = 62 kN

System transfer at 100% residual field, ULine = 100%

compressive force FA = 256 kN
tensile force FB = 183 kN

(forces on one side of the machine)

| | | | | | | | |
|------|------|------|------|---------------------|-----------------------|--------------------------------|--|
| | | | | Date | 09.02.2015 | Foundation Load | |
| | | | | Name | PANGERL | | |
| | | | | Exam. | ANKOWSKI | | |
| | | | | Stnd. | | | |
| | | | | PD LD P MF-NMA EN M | Type 1LA4 504-6CN70-Z | | |
| | | | | SIEMENS AG | | Order No. 1448200 / 010 - E006 | |
| IND. | Text | Date | Name | BG147200 | | | |

Three-Phase-Induction Motor with Squirrel Cage Rotor

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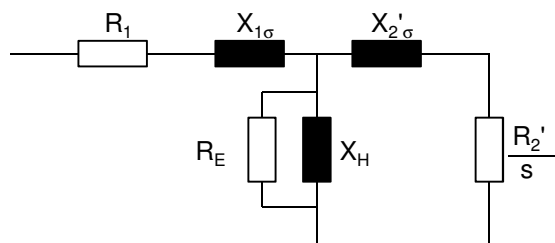
Resistances, Reactances (Calculated Values per Phase)

Values (p.u.) referred to Z_N

$$Z_N = U_{PH} / I_{PH} : 31.234 \Omega$$

| | | | | |
|--------------------------|------------------------|---|--------------|---------|
| at slip | | : | $s = 0.0050$ | $s = 1$ |
| Stator-resistance | R_1 / Z_N : | | 0.00599 | 0.00599 |
| Stator-leakage reactance | $X_{1\sigma} / Z_N$: | | 0.15629 | 0.10804 |
| Rotor-resistance | R_2' / Z_N : | | 0.00470 | 0.01789 |
| Rotor-leakage reactance | $X_{2\sigma}' / Z_N$: | | 0.08207 | 0.05108 |
| Magnetizing-reactance | X_H / Z_N : | | 3.557 | 3.593 |
| Ironloss-resistance | R_E / Z_N : | | 143.04 | 143.04 |

The resistances apply to the warm machine.
The rotor-resistances / -reactances refer to the stator.



Time Constants, Currents

| | | |
|-----------------------------|---|---------|
| Magn. no load time constant | : | 2.47 s |
| No load-/rated current | : | 0.27 |
| Power factor (s=1) | : | 0.14 |
| Starting time constant | : | 13.16 s |



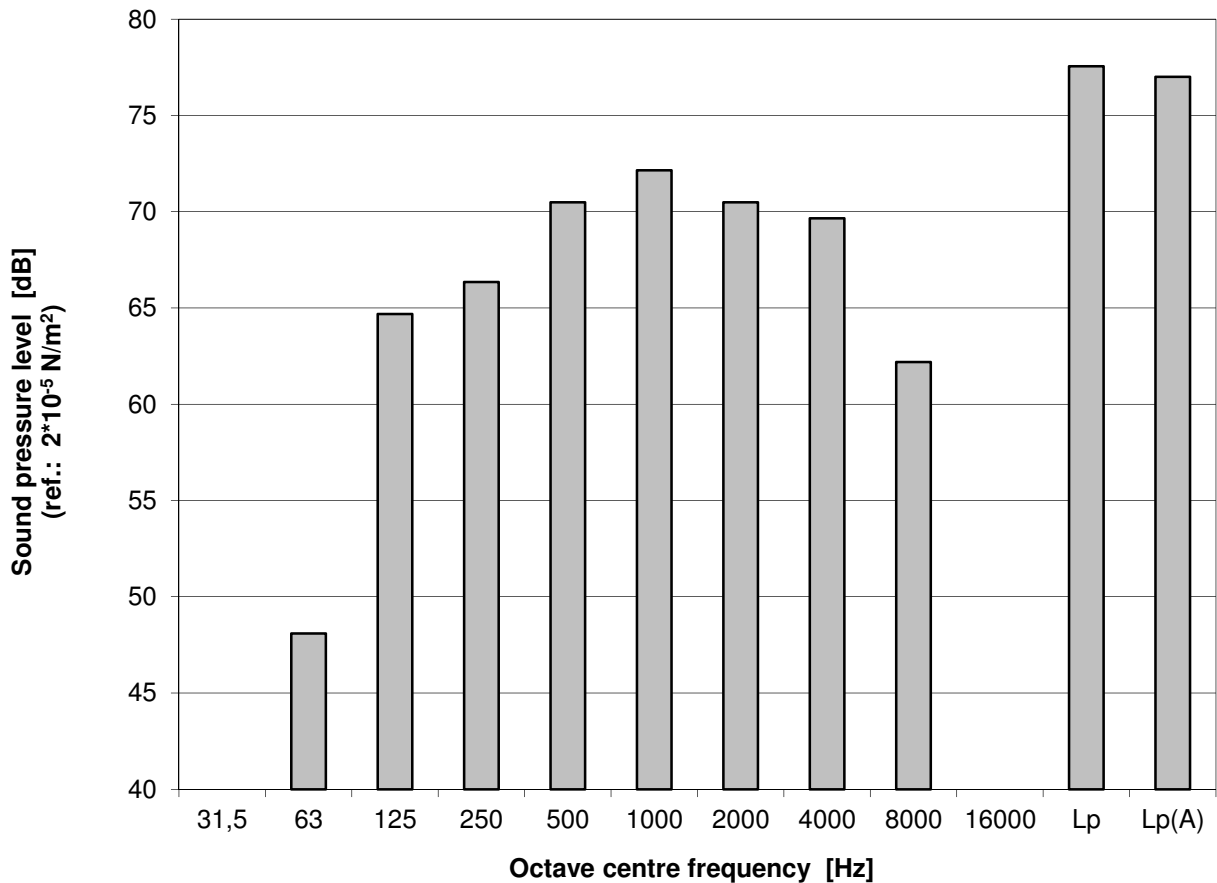
| | | | | | | | |
|------|------|------|------|---------------------|------------|-----------------------------------|--|
| | | | | Date | 09.02.2015 | Equivalent-Circuit Diagram | |
| | | | | Name | PANGERL | | |
| | | | | Exam. | ANKOWSKI | | |
| | | | | Std. | | | |
| | | | | PD LD P MF-NMA EN M | | Type 1LA4 504-6CN70-Z | |
| | | | | SIEMENS AG | | Order No. 1448200 / 010 - E007 | |
| IND. | Text | Date | Name | BG147200 | | | |

Three-Phase-Induction Motor with Squirrel Cage Rotor

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Tolerances: IEC/EN 60034-1



Measuring surface sound pressure level (no-load): 77 dB(A), tol.: +3 dB(A)

| | | | | | | | |
|------|------|------|------|---------------------|------------|--------------------------------------------------|--|
| | | | | Date | 09.02.2015 | Calculated Octave Spectrum (unvalued) | |
| | | | | Name | PANGERL | | |
| | | | | Exam. | ANKOWSKI | | |
| | | | | Stnd. | | | |
| | | | | PD LD P MF-NMA EN M | | Type 1LA4 504-6CN70-Z | |
| | | | | SIEMENS AG | | Order No. 1448200 / 010 - E008 | |
| IND. | Text | Date | Name | BG147200 | | | |