

Information on characteristic diagram calculation FSE motor typ A2370DD

There are 3 different diagrams available. Because the magnet properties and losses of the motor change depending on the motor temperature.

Base: 80° motor temperature

Excel-File: A2370DD_T80C.xlsx

Matlab-File: A2370DD_T80C.mat

Base: 100° motor temperature

Excel-File: A2370DD_T100C.xlsx

Matlab-File: A2370DD_T100C.mat

Base: 120° motor temperature

Excel-File: A2370DD_T120C.xlsx

Matlab-File: A2370DD_T120C.mat

Base values for calculation:

- The diagram is based on a DC bus voltage of 600 VDC.
- The diagram is calculated from 0 rpm to 20.000 rpm in 100 rpm steps (see worksheet <Speed>).
- For each speed, the motor current is varied from 0 A to 105 A in 20 steps (each 5.25 A). The variation of the motor current, suitable for the speeds, can be seen in the worksheet <Stator_Current_Line_RMS>.

In all other worksheets you can see the result of the calculation with the respective motor current and speed.

The following applies to these worksheets:

- Columns A - U correspond to the current variation from 0 A - 105 A in 5.25 A steps.
- Lines 1 - 201 correspond to the speed variation from 0 rpm – 20.000 rpm in 100 rpm steps.

Example:

What torque is set at 900 rpm and 47.25 A?

The value in J10 (12.045 Nm) in the worksheet <Shaft_Torque> is the torque that occurs at 900 rpm (worksheet <Speed> line 10) and 47.25A (worksheet <Stator_Current_Line_RMS> column J).

J10 : f_x 12,0451036370466

		0,00 A	5,25 A	10,5 A	15,75 A	21,00 A	26,25 A	31,50 A	36,75 A	42,00 A	47,25 A	52,50 A	57,75 A
		A	B	C	D	E	F	G	H	I	J	K	L
0 rpm	1	0	1,4974235	2,99644502	4,47889175	5,92935328	7,33505861	8,68575318	9,97357583	11,1929358	12,3405008	13,4179345	14,4337598
100 rpm	2	-0,17053581	1,32462369	2,81899105	4,29468774	5,73659771	7,13224427	8,47166717	9,74729957	10,9538451	12,0888833	13,1562165	14,1644452
200 rpm	3	-0,17394646	1,32116039	2,81541987	4,29095799	5,73266322	7,12806342	8,46720287	9,74251926	10,9487207	12,0834058	13,1504232	14,1583706
300 rpm	4	-0,177357	1,31769727	2,81184895	4,28722863	5,72872929	7,12388336	8,46273964	9,73774039	10,9435983	12,0779307	13,1446331	14,1523
400 rpm	5	-0,18076747	1,31423425	2,80827821	4,28349951	5,72479572	7,1197038	8,45827711	9,73296245	10,938477	12,0724572	13,138845	14,146232
500 rpm	6	-0,1841779	1,31077132	2,80470759	4,27977059	5,72086242	7,11552461	8,45381509	9,7281852	10,9333567	12,0669849	13,1330585	14,1401659
600 rpm	7	-0,18758829	1,30730845	2,80113707	4,2760418	5,71692933	7,11134572	8,44935347	9,72340849	10,9282371	12,0615136	13,1272731	14,1341014
700 rpm	8	-0,19099864	1,30384564	2,79756663	4,27231315	5,71299641	7,10716708	8,44489219	9,71863223	10,9231181	12,056043	13,1214888	14,1280381
800 rpm	9	-0,19440897	1,30038287	2,79399626	4,26858459	5,70906365	7,10298864	8,4404312	9,71385635	10,9179996	12,050573	13,1157052	14,1219759
900 rpm	10	-0,19781927	1,29692014	2,79042596	4,26485612	5,70513101	7,09881039	8,43597045	9,70908081	10,9128815	12,0451036	13,1099225	14,1159146
1000 rpm	11	-0,20122956	1,29345745	2,7868557	4,26112774	5,70119849	7,09463229	8,43150993	9,70430557	10,9077638	12,0396348	13,1041403	14,1098541
1100 rpm	12	-0,20463982	1,28999478	2,7832855	4,25739943	5,69726607	7,09045435	8,42704961	9,6995306	10,9026465	12,0341664	13,0983588	14,1037944
1200 rpm	13	-0,20805007	1,28653215	2,77971534	4,25367118	5,69333374	7,08627653	8,42258946	9,69475586	10,8975295	12,0286984	13,0925778	14,0977354
1300 rpm	14	-0,2114603	1,28306955	2,77614523	4,24994299	5,6894015	7,08209883	8,41812948	9,68998135	10,8924128	12,0232307	13,0867972	14,0916769

Variable DC bus voltage

The diagram is based on a DC bus voltage of 600 VDC.

If a lower DC bus voltage is available, not all calculated operating points can be approached.

Which working points can still be reached, can be seen in the worksheets with the voltage that is set depending on the current and the speed.

Example:

With a DC bus voltage of 500 VDC ($500 \text{ VDC} / \sqrt{2}$), a maximum of 354 VAC motor voltage is available. Accordingly, the maximum torque generating motor current up to 13,000 rpm is available (example a). At a maximum speed of 20,000 rpm, the torque generating motor current is reduced to 10.5 A (example b).

Example a:

<Voltage_Phase_RMS> (line 137) 13.000 rpm at (column U) 105 A.

U137 : f_x

	A	B	C	S	T	105 A U
133	226,477811	229,683721	234,245	28,689755	336,736046	344,997004
134	228,193552	231,418502	236,005	31,125208	339,231538	347,554322
135	229,909293	233,153286	237,770	33,560712	341,727081	350,111692
136	231,625034	234,888075	239,536	35,996267	344,222676	352,669115
13.000 rpm 137	233,340775	236,622868	241,301	38,431872	346,718322	355,226589
138	235,056516	238,357665	243,066	40,867527	349,214019	357,784115

Example b:

<Voltage_Phase_RMS> (line 201) 20.000 rpm but only (column C) 10.5 A.

C201 :    35

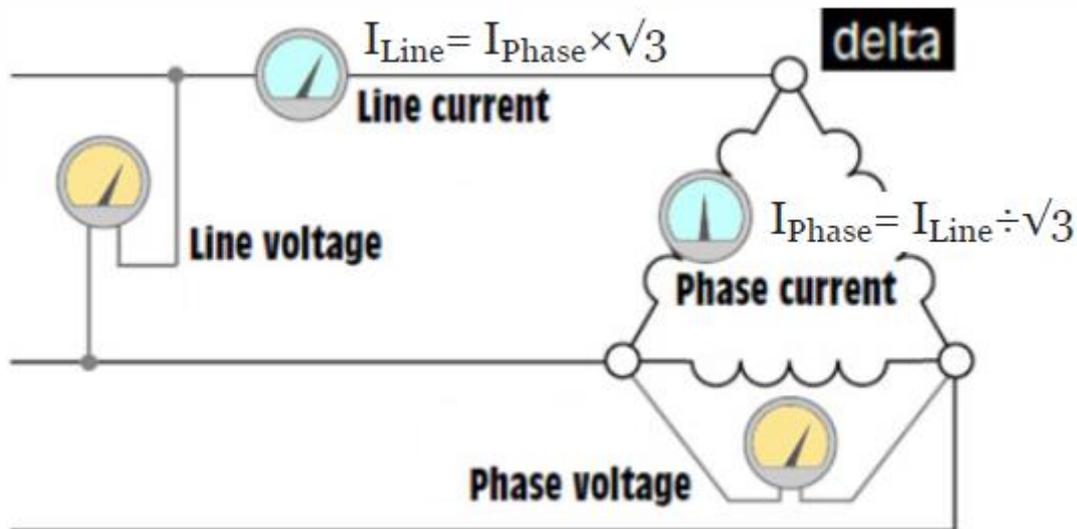
10.5 A

	A	B	C	
181	308,833379	312,95776	318,943071	
182	310,54912	314,692735	320,707876	
183	312,264861	316,427714	322,472691	
184	313,980602	318,162697	324,237516	
185	315,696343	319,897684	326,00235	
186	317,412084	321,632675	327,767194	
187	319,127825	323,367671	329,532047	
188	320,843566	325,10267	331,29691	
189	322,559307	326,837673	333,061782	
190	324,275048	328,572681	334,826664	
191	325,990789	330,307692	336,591556	
192	327,70653	332,042708	338,356457	
193	329,422271	333,777727	340,121368	
194	331,138012	335,512751	341,886288	
195	332,853753	337,247779	343,651218	
196	334,569494	338,98281	345,416157	
197	336,285235	340,717846	347,181106	
198	338,000976	342,452886	348,946064	
199	339,716717	344,18793	350,711032	
200	341,432458	345,922978	352,47601	
20.000 rpm	201	343,148199	347,65803	354,240997
202				

Available values

Worksheet	Description	Unit
<Speed>	Speed	rpm
<Shaft_Torque>	Torque on the shaft	Nm
<Stator_Current_Phase_Peak>	Amplitude phase current	Ampere
<Stator_Current_Phase_RMS>	RMS value phase current	Ampere
<Stator_Current_Line_Peak>	Amplitude line current	Ampere
<Stator_Current_Line_RMS>	RMS value line current	Ampere
<Voltage_Phase_Peak>	= Voltage_Line_Peak	Volt
<Voltage_Phase_RMS>	= Voltage_Line_RMS	Volt

<Voltage_Line_Peak>	= Voltage_Line_RMS	Volt
<Voltage_Line_RMS>	= Voltage_Line_Peak	Volt
<Id_Peak>	Amplitude field weakening current	Ampere
<Id_RMS>	RMS field weakening current	Ampere
<Iq_Peak>	Amplitude of torque generating current	Ampere
<Iq_RMS>	RMS value torque generating current	Ampere
<Vd_Peak>	Amplitude field weakening voltage	Volt
<Vd_RMS>	RMS field weakening voltage	Volt
<Vq_Peak>	Amplitude of torque generating voltage	Volt
<Vq_RMS>	RMS torque generating voltage	Volt
<Frequency>	Frequency	Hz
<Total_Loss>	Sum of: Stator_Copper_Loss Iron_Loss Magnet_Loss Mechanical_Loss	Watt
<Stator_Copper_Loss>	Copper losses in the stator	Watt
<Iron_Loss>	Iron losses	Watt
<Magnet_Loss>	Magnetic losses	Watt
<Mechanical_Loss>	Mechanical losses	Watt
<Power_Factor>	Power factor	
<Electromagnetic_Torque>	Electromagnetic torque is the internal torque of the motor, which results from the simulation. From this the iron losses, magnet losses and mechanical losses are subtracted in order to obtain the mechanical torque on the shaft.	Nm



Term	Description
Line voltage / Phase voltage	In the case of a delta connection, the line voltage and the phase voltage are the voltages measured between any two conductors.
Line current	The line current, is the current flowing through any line between the inverter and the motor connection.
Phase current	The phase current, is the current that flows through the motor winding.
RMS	RMS value Root Mean Square The effective value for sine waves is: RMS value = amplitude / $\sqrt{2}$
Peak	Peak value or amplitude (not peak / peak)