Motor Parameter Estimation

Induction Motor Dynamic Modelling (Where Optimization is seen to be required):

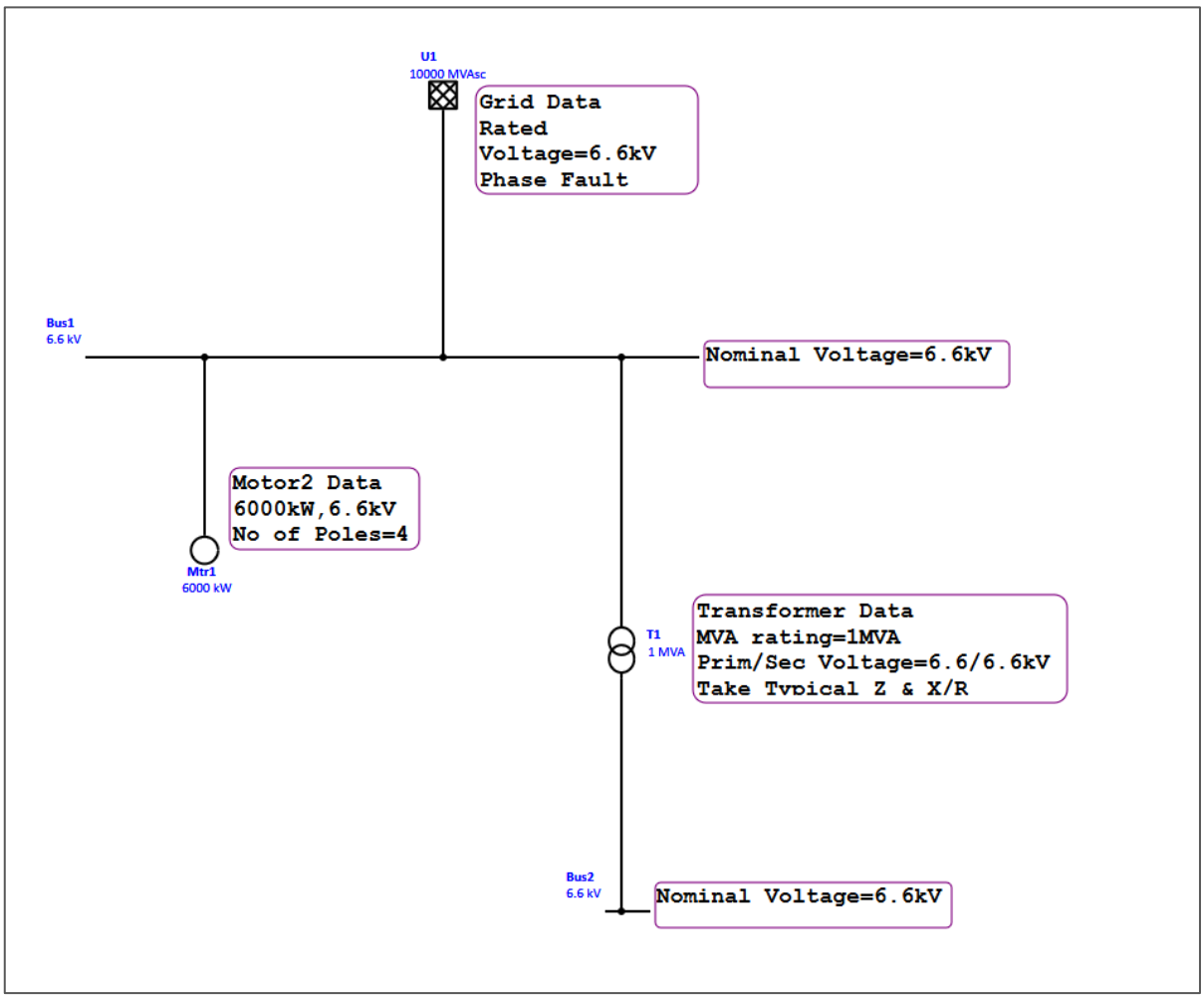
Using optimization technique for arriving of rotor (non-linear) impedance variation with slip. Optimization required where large difference exists in ETAP calculated (using linear impedance technique) values of torque-slip as compare to vendor declared values.

This exercise involves creating the below shown SLD and entering the corresponding data. The detail modelling of the SLD is shown in the subsequent pages.

Procedure:

Step1: Modelling of equivalent circuit model with few inputs such as Peak torque, LR torque, LR power factor, LR Current, FL power factor, FL efficiency & slip as specified in attached vendor datasheet.

1. As per given datasheet, model the motor connected to grid in ETAP.



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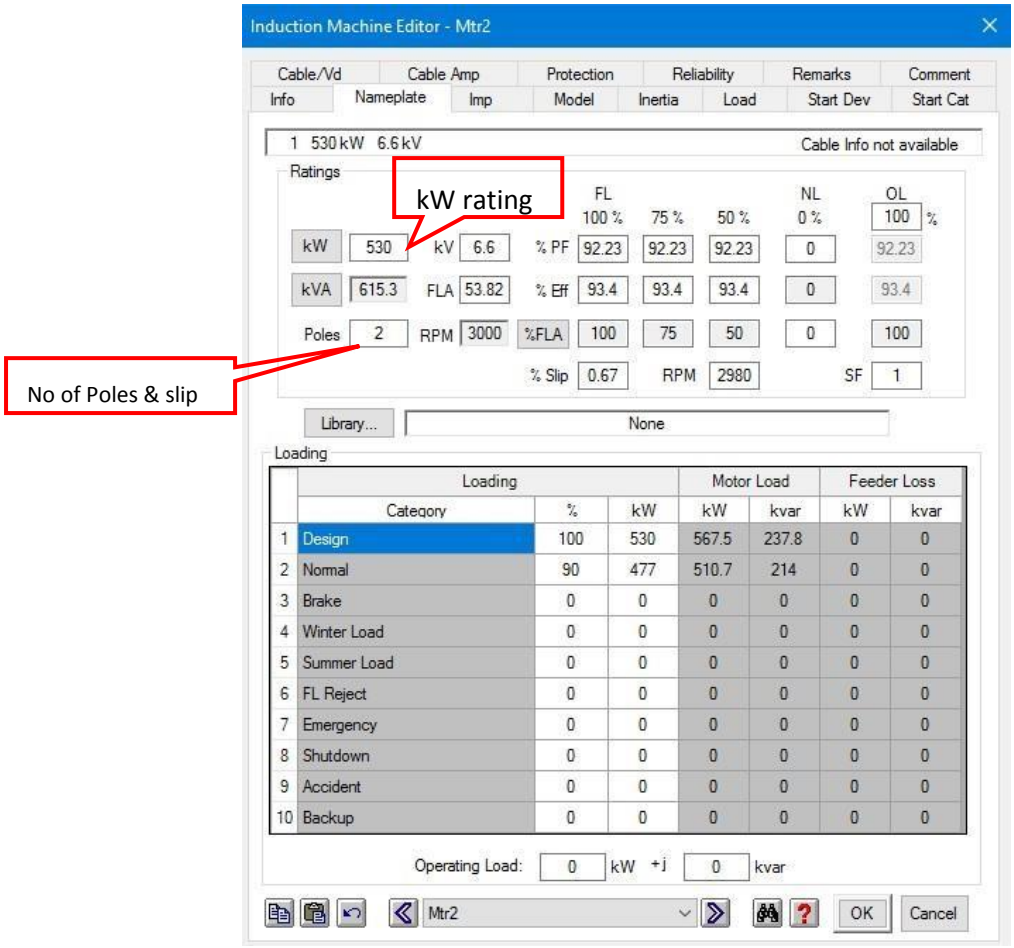
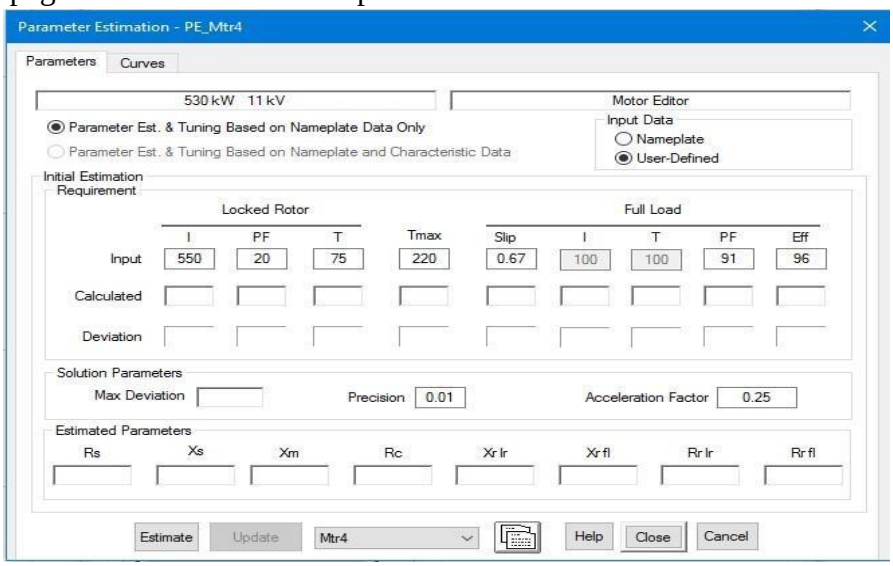


2. Go to model page & estimate the motor parameters.



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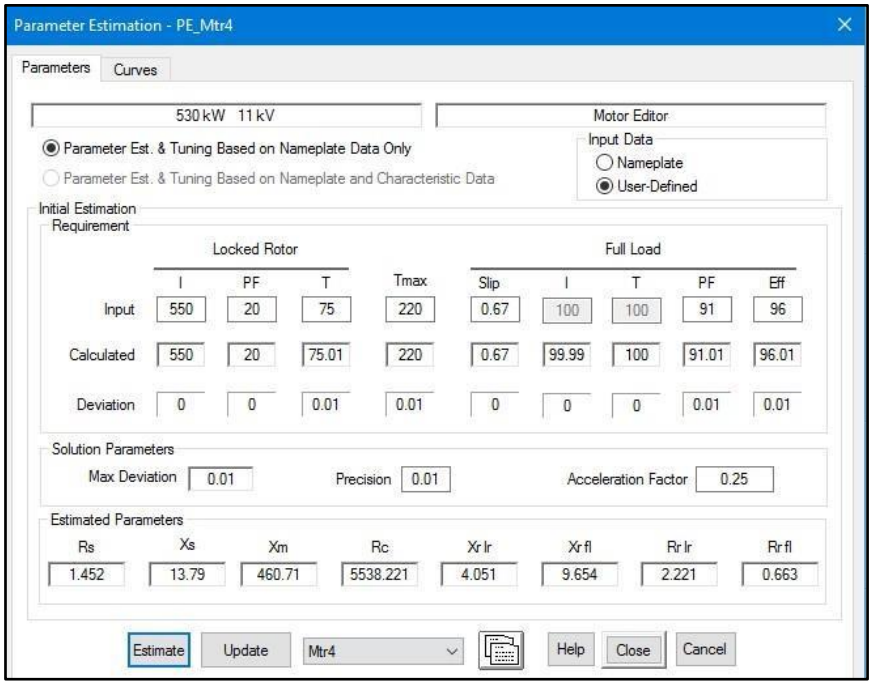
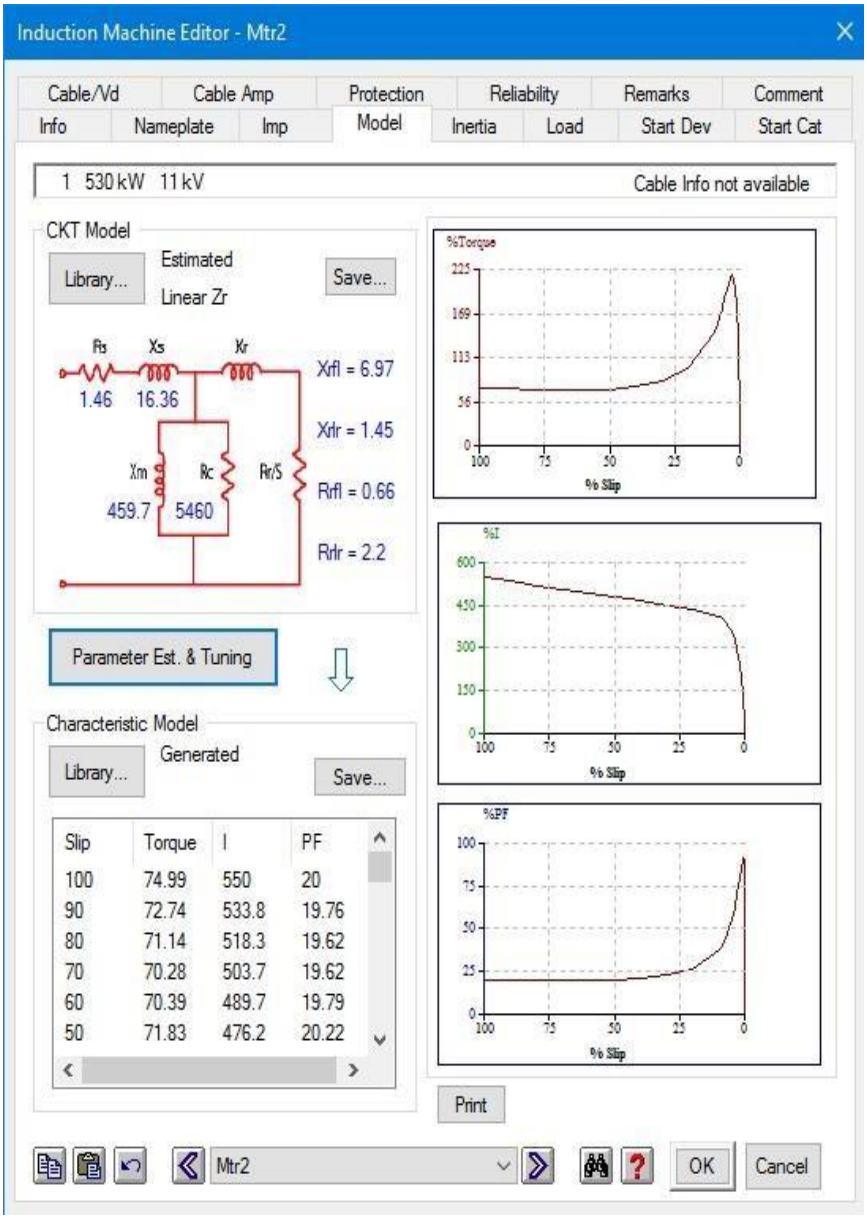
Note: Locked rotor power factor is assumed to be 20%.



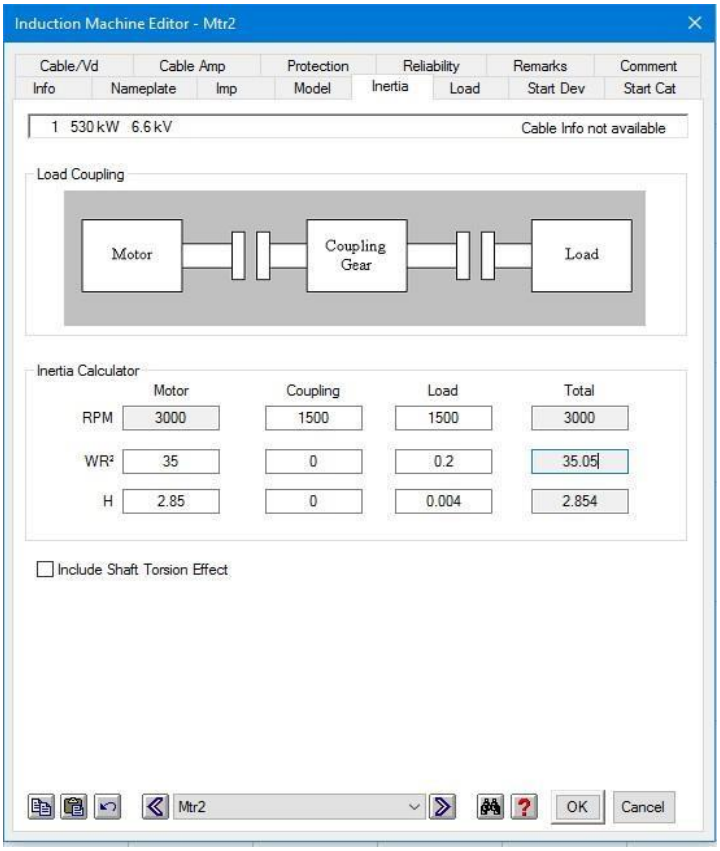
3. Update the estimated values in motor. The ETAP estimated curves will appear as shown below.

Motor Parameter Estimation



4. Go to Inertia page, enter inertia data for motor & load model from motor data sheet.

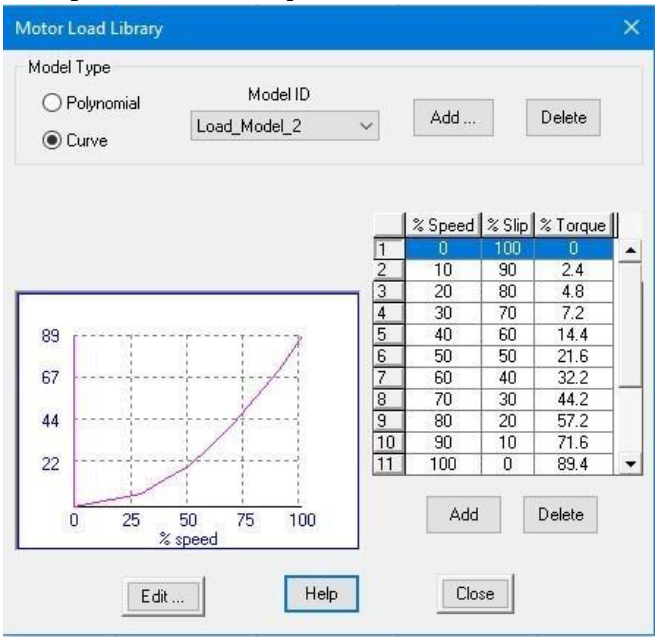
Motor Parameter Estimation



5. Enter load curve points in ETAP library as shown below.

   Go to library => Motor load model=> Add a new 'curve type' model with ID 'Load_Model_2'.

   Enter the data of % Speed V/S % Torque for load curve as available in data sheet.



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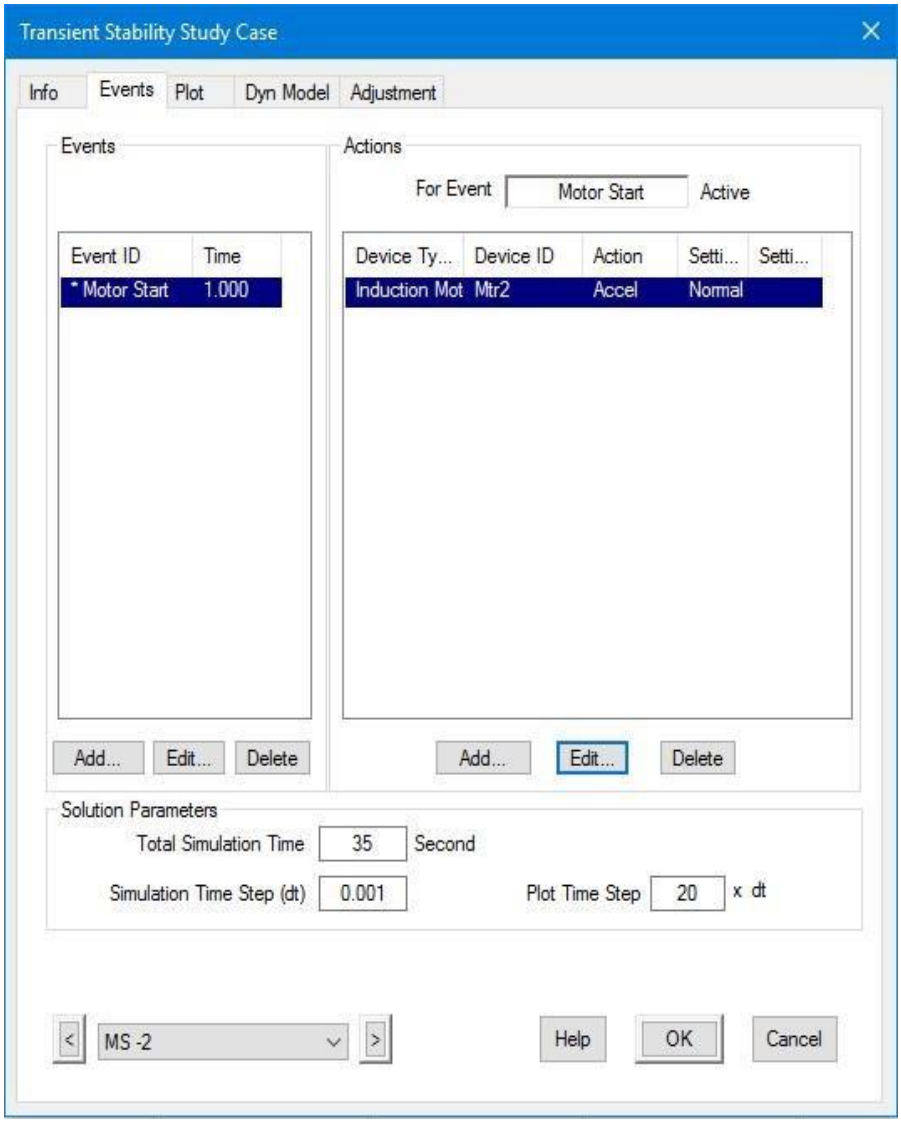
6. Go to Induction motor => Load page & select above load model.
7. Now, go to transient stability module, make a new study as 'MS-2' and give the event to accelerate the motor 2.



8. Plot bus and motor2.
9. Run the case & check the starting time of motor-2 by using plot option.

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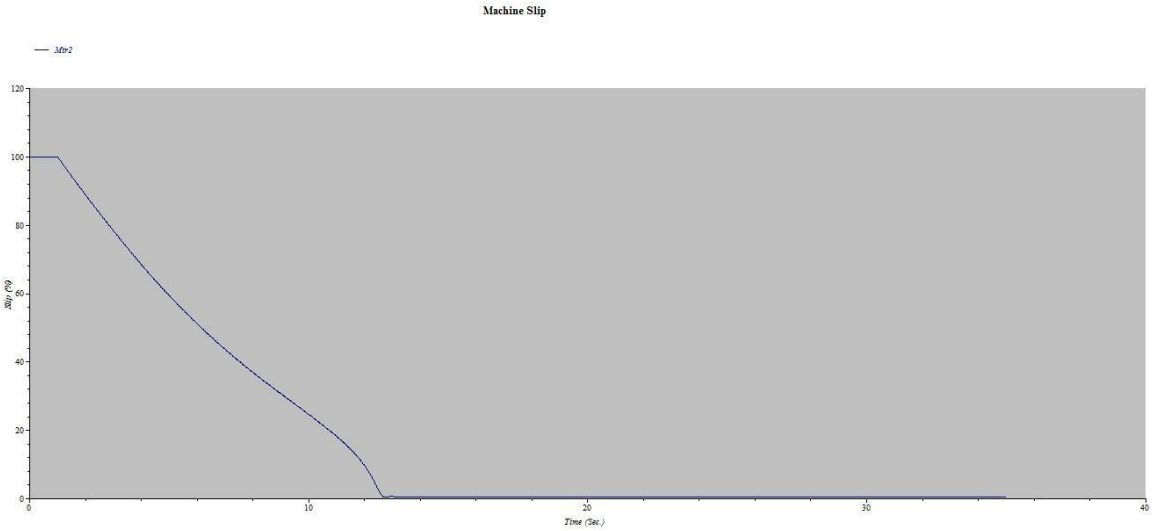
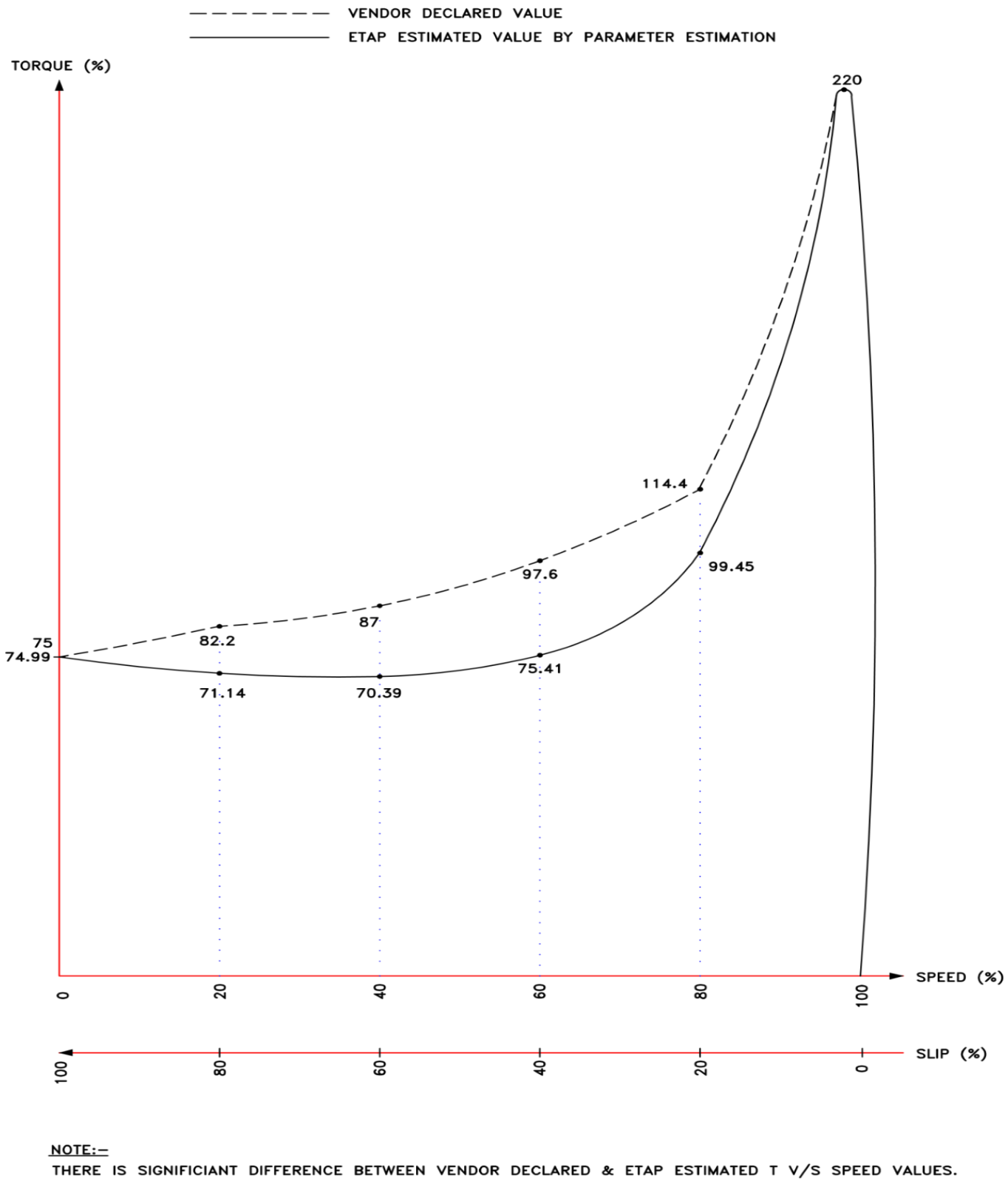


10. **Starting time of motor as per vendor datasheet: 8.5sec at 100% voltage**
    & calculated Starting time of motor in ETAP is = 11.6 sec, which is not matching with starting time mentioned in vendor datasheet.
11. Now, compare the vendor declared Torque v/s Speed curve data with ETAP estimated data.

Speed (%)	Torque as per vendor datasheet (%)	Torque as per ETAP estimation (%)
0	75	74.99
20	82.2	71.14
40	87	70.39
60	97.6	75.41
80	114.4	99.45
Tmax	220	220

Note: There is significant difference between vendor declared & ETAP parameter estimated values of Torque v/s Speed.
This is because ETAP parameter estimation is based on few data points such as Locked rotor torque, Locked rotor current, Locked rotor power factor, Peak torque, Full load efficiency, Full load slip & Full load power factor, where ETAP uses linear rotor impedance (Z) variation with slip.
A more elaborate model estimates, when more data points are taken from Torque v/s Slip, Pf v/s Slip & Current v/s Slip curve for motor characteristics model library, which is first created and then used as input to parameter estimation.
In next points parameter estimation by characteristics model is explained

Motor Parameter Estimation

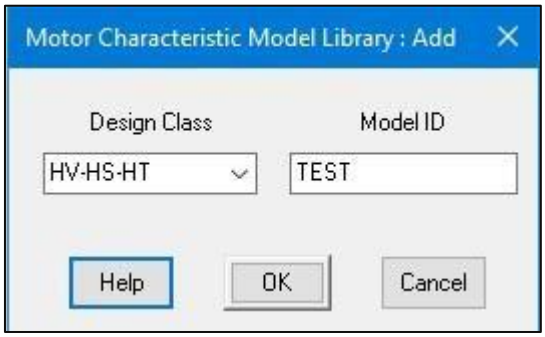


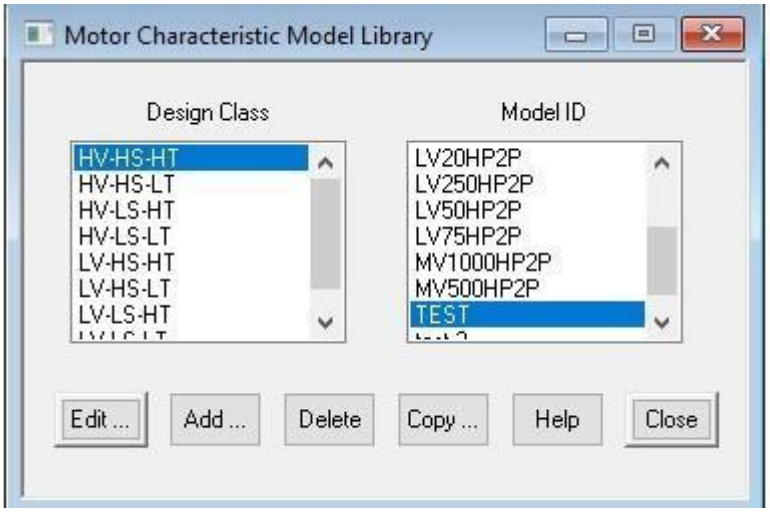
NOTE:–
THERE IS SIGNIFICIANT DIFFERENCE BETWEEN VENDOR DECLARED & ETAP ESTIMATED T V/S SPEED VALUES.

Motor Parameter Estimation

Step 2: To perform optimization more torque, current & pf V/s slip points are need to be consider.

12. Go to library – "Motor characteristic Model", then add new motor characteristics model named as 'TEST' as shown below.





13. Add the following points in the TEST model:

Slip	Torque	Current	Pf
%	%	%	%
100	74.8	549.3	20.02
90	77.9	543.7	19.78
80	80.7	540.5	19.64
70	83.5	533.2	19.63
60	87.3	525.2	19.8
50	92.9	516.3	20.23
40	97.6	502.6	21.1
30	103.8	485.7	22.81

Slip	Torque	Current	Pf
%	%	%	%
6	181.6	397	49.88
5	192.87	383.31	55.07
4	209.2	357.15	61.66
3	220.24	318.73	70.01
2	215.2	274	79.98
1.5	212.6	216.6	85.1
1	165.7	159.35	89.45
0.8	138.5	118.35	90.6

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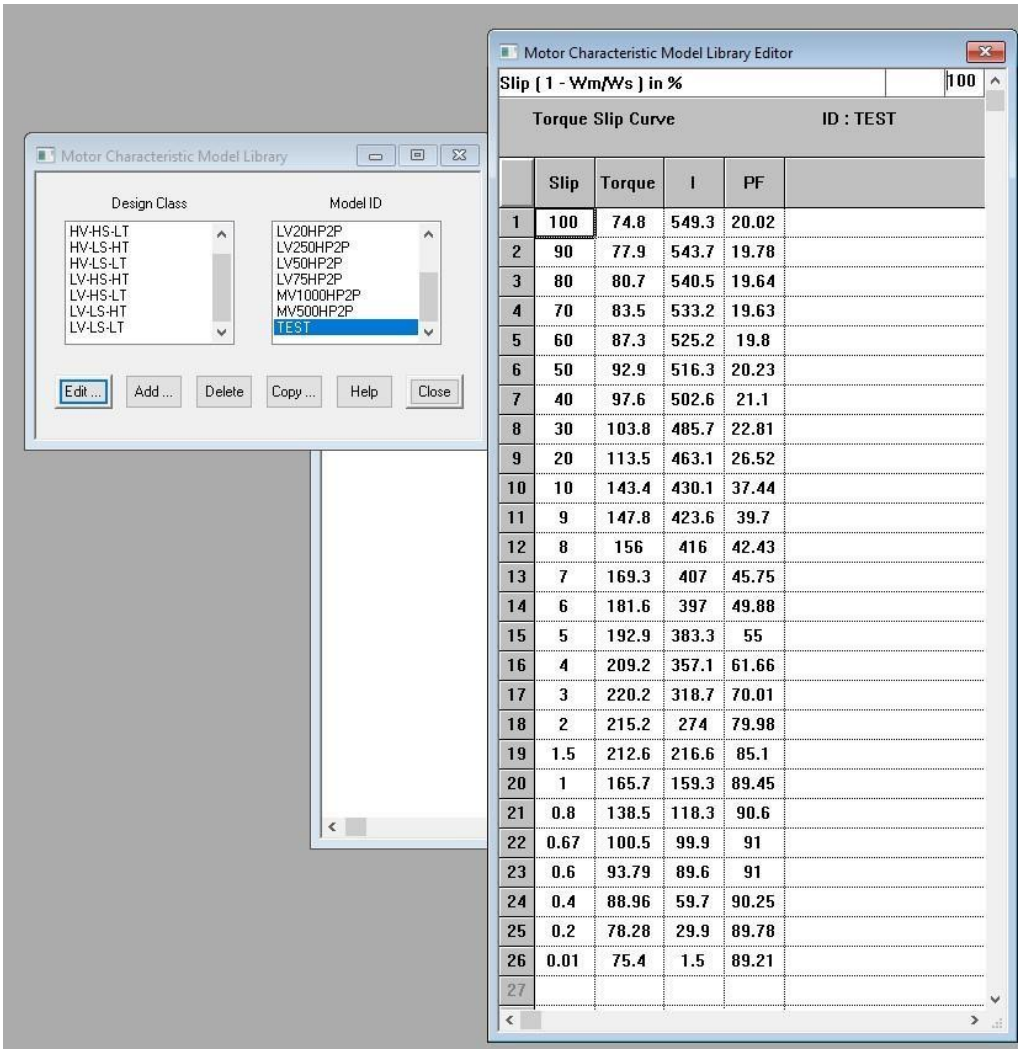
20	113.5	463.1	26.52
10	143.4	430.1	37.44
9	147.84	423.6	39.7
8	156.04	416	42.43
7	169.29	407	45.75

0.67	101.5	99.91	91
0.6	93.79	89.55	91
0.4	88.96	59.70	90.25
0.2	78.28	29.85	89.78
0.01	75.4	1.49	89.21

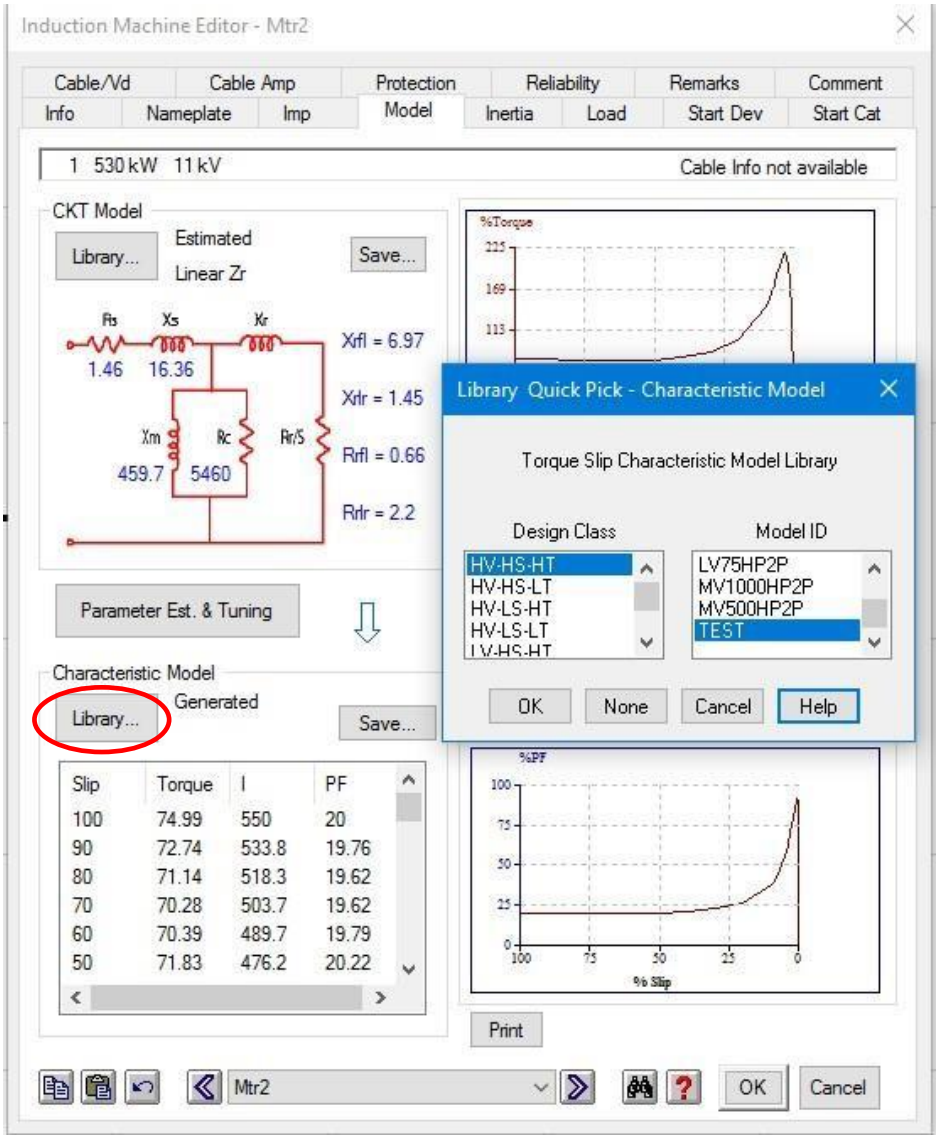


	Slip	Torque	I	PF
1	100	74.8	549.3	20.02
2	90	77.9	543.7	19.78
3	80	80.7	540.5	19.64
4	70	83.5	533.2	19.63
5	60	87.3	525.2	19.8
6	50	92.9	516.3	20.23
7	40	97.6	502.6	21.1
8	30	103.8	485.7	22.81
9	20	113.5	463.1	26.52
10	10	143.4	430.1	37.44
11	9	147.8	423.6	39.7
12	8	156	416	42.43
13	7	169.3	407	45.75
14	6	181.6	397	49.88
15	5	192.9	383.3	55
16	4	209.2	357.1	61.66
17	3	220.2	318.7	70.01
18	2	215.2	274	79.98
19	1.5	212.6	216.6	85.1
20	1	165.7	159.3	89.45
21	0.8	138.5	118.3	90.6
22	0.67	100.5	99.9	91
23	0.6	93.79	89.6	91
24	0.4	88.96	59.7	90.25
25	0.2	78.28	29.9	89.78
26	0.01	75.4	1.5	89.21
27				

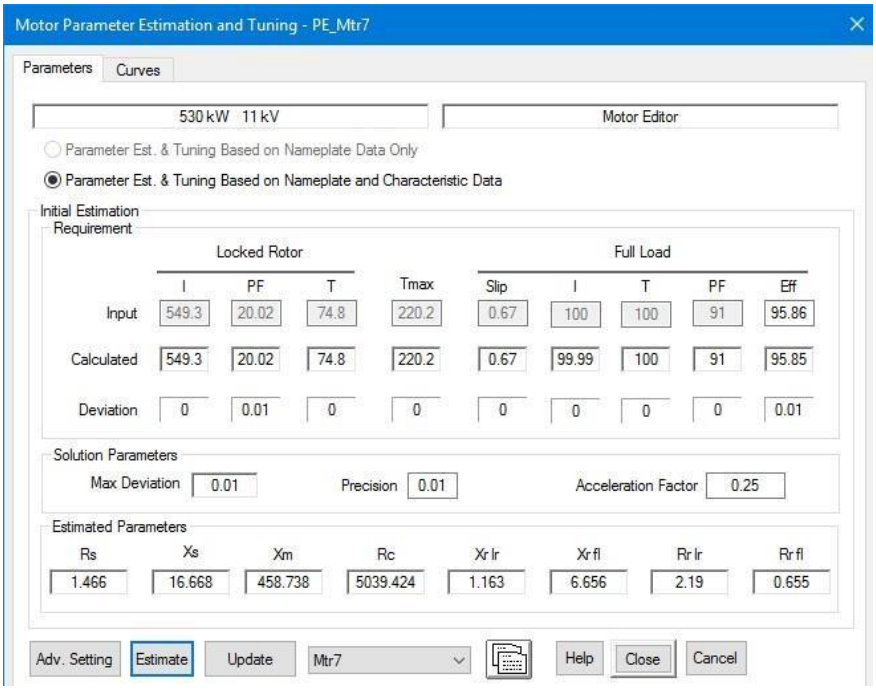
Note: The points can be traced using Didger software as well for accurate results.

14. Now, go to Model page of motor & select the saved characteristic Model from library as shown below:

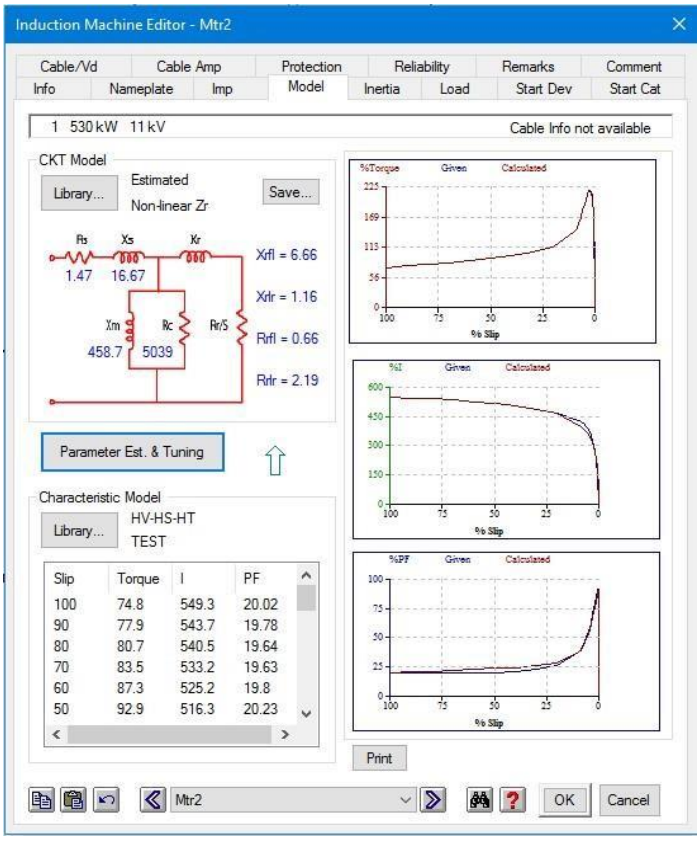
Motor Parameter Estimation



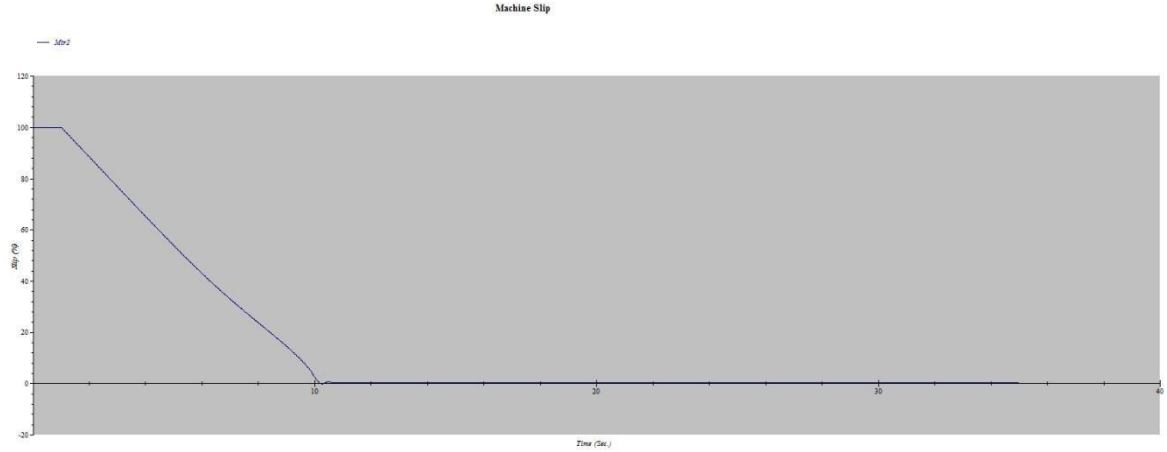
15. Again estimate and update the motor parameters with TEST characteristics model.



16. The deviation in the manufacturer curves (entered in library) and ETAP estimated curves are shown below.



17. The difference between two curves can be reduced by changing weighting factor specified in Advance settings.
18. Now, go to transient stability module and run the same case to accelerate motor 2.
19. Check motor starting time by using plot options.



Starting time of motor is reduced from 11.6 sec to 9.2 sec.

