

HYPERSTUDY: MULTIDISCIPLINARY DESIGN OPTIMIZATION INITIATION

ALTAIR MULTIDISCIPLINARY DESIGN OPTIMIZATION PLATFORM
FOR ELECTRIC MOTORS

October 2021, Altair Flux / FluxMotor Valorization and Support Team

OUTLINE

Overview of the MDO process and solver setting in Altair HyperStudy

FluxMotor model and Flux model import

Solving for magnetic problems and thermal problem

HyperMesh and OptiStruct models and scripts import

Mechanical problem solving

Input files

- **FluxMotor / HyperStudy connector:**
Connector_FM_Hst.fm2hst
- **Flux / HyperStudy connector**
Connector_Fx_Hst_BasePoint.F2HST
- **Flux / HyperStudy connector:**
Connector_Fx_Hst_OperatingPoint.F2HST
- **Flux / HyperStudy connector**
Connector_Fx_Hst_Thermal.F2HST
- **HyperMesh / OptiStruct project and script**
 - reference1.hm
 - Update_motor.tcl

Software

- Altair HyperStudy 2019.1 (or later versions)

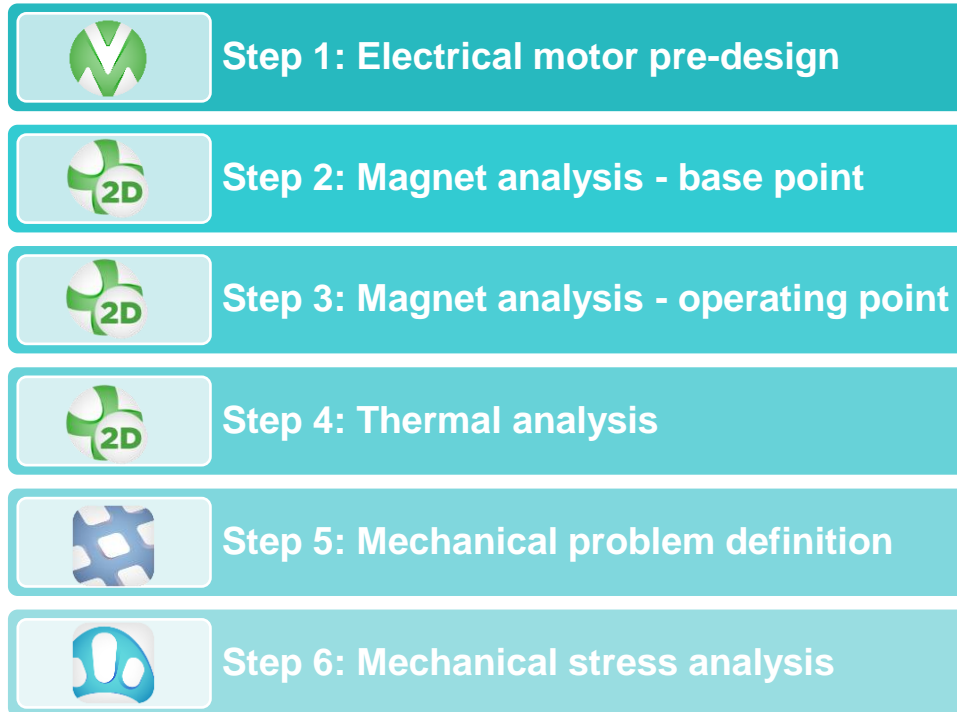
Output file

- **HyperStudy project**
MDO_EMOTOR_STUDY.hstudy

OVERVIEW OF THE MDO PROCESS AND THE SOLVER SETTING IN HYPERSTUDY

OVERVIEW OF THE E-MOTOR MDO PROCESS IN HYPERSTUDY

- Multidisciplinary design optimization (MDO) process with Altair HyperWorks for electrical machines



1) The MDO process is built and run with Altair HyperStudy.



2) All the five phases are represented by “Connector” between software.

3) Solvers required for HyperStudy:

- Flux
- FluxMotor
- HM Batch (HyperMesh)
- OptiStruct

SOLVER SETTING IN HYPERSTUDY

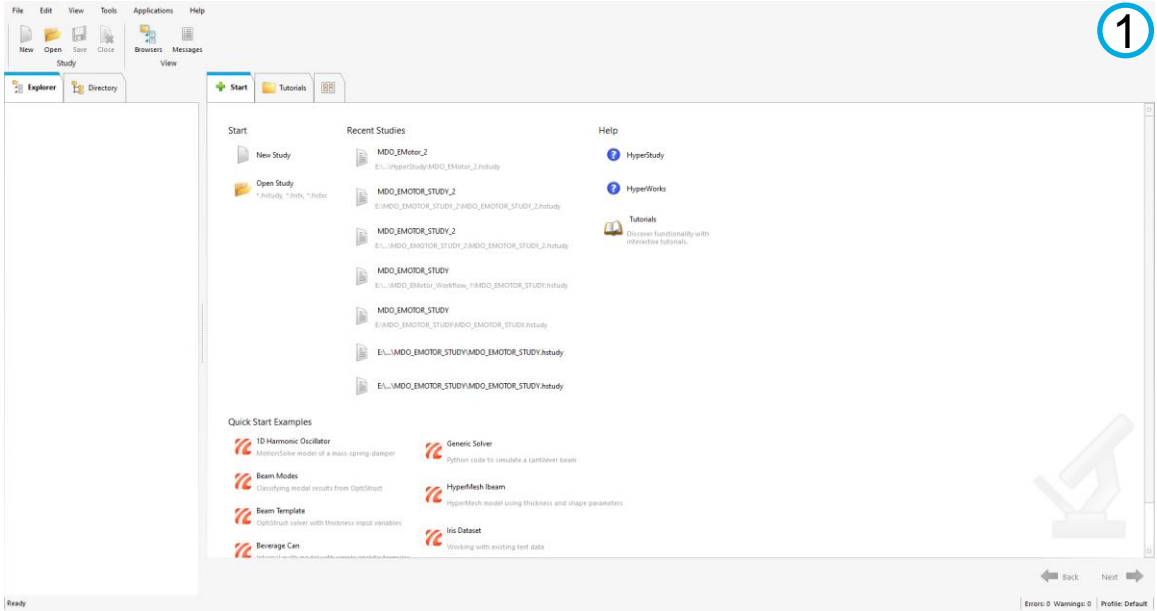
- Prepare the MDO E-Motor project with HyperStudy

Step	Action
1	Open Altair HyperStudy

Project folder structure

- ✓ MDO_EMOTOR_Case2
 - ✓ HyperStudy
 - > 1_FluxMotor
 - > 2_MagBasePoint
 - > 3_MagOperatingPoint
 - > 4_Thermal
 - 5_Structural

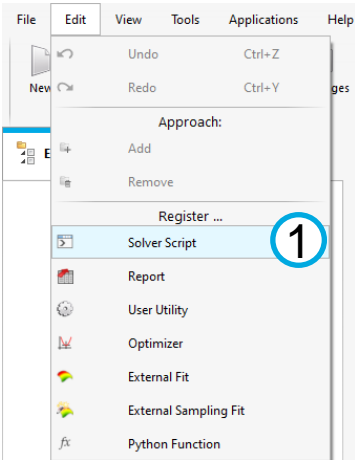
1



SOLVER SETTING IN HYPERSTUDY

- Verify the solver script registration in HyperStudy

Step	Action
1	Click on [Edit] – [Register Solver Script]
2	Verify if the “Flux”, “FluxMotor” and “OptiStruct” solvers are already correctly loaded



Register Solver Script - Altair HyperStudy™ (28.2120949)

+ Add Solver Script Remove Solver Script Export

	Label	Varname	Type	Preference	Path	
1	RADIOSS	radioss	RADIOSS	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/./hwsolvers/scripts/radioss.bat	
2	OptiStruct	os	OptiStruct	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/./hwsolvers/scripts/optistruct.svb	
3	MotionSolve	ms	MotionSolve	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/./hwsolvers/scripts/motionsolve.bat	
4	Python	py	Python	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/./common/python/python3.5/win64/python.exe	
5	Tcl	tcl	Other Application	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/hw/tcl/tcl8.5.9/win64/bin/tclsh85.exe	
6	Templex	templex	Other Application	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/hw/bin/win64/templex.exe	
7	HyperXtrude	hx	Other Application	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/./hwsolvers/scripts/hx.bat	
8	HM Batch	hmbatch	Other Application	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/hm/bin/win64/hmbatch.exe	
9	HM BatchMesher	hmbatchmesher	Other Application	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/hm/batchmesh/hw_batchmesh.bat	-nocmd_win
10	MDL Batch	mdl_batch	Other Application	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/io/translators/bin/win64/mdl_batch.bat	
11	HyperStudy Batch	hstbatch	Other Application	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/hst/bin/win64/hstbatch.exe	
12	HyperWorks	hw_exe	Other Application	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/hw/bin/win64/hw.exe	
13	HyperView	hv	HyperView	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/hw/bin/win64/hv.exe	-b -tcl "D:\Program
14	HV Trans	hvtrans	Other Application	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/io/result_readers/bin/win64/hvtrans.exe	
15	FEKO	feko	HyperWorks	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/./feko/bin/runfeko.exe	
16	FLUX	flux	Flux	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/./flux/Flux/Bin/prg/win64/flux.exe	-executeBatchSpy
17	None	hst_none	None	Internal	D:/Program Files/Altair/2021.1/hwdesktop/hst/bin/win64/hstsolver_none.bat	

② Attention: the solver FluxMotor are NOT preloaded in HyperStudy.

OK

SOLVER SETTING IN HYPERSTUDY

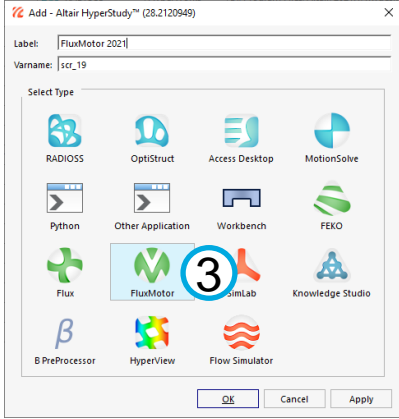
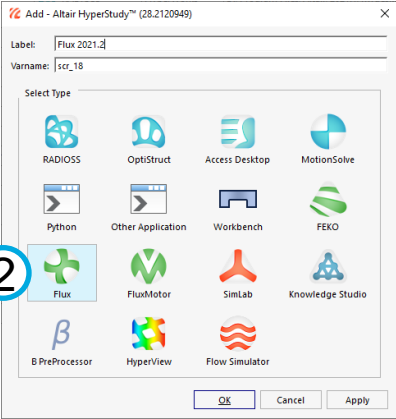
- Register solver scripts for the solvers “Flux” and “FluxMotor”

Step	Action
1	Click on [Add Solver Script] to add new solvers
2	Add the first solver “Flux”
3	Add the second solver “FluxMotor”

Register Solver Script - Altair HyperStudy™ (28.2120949)

+ Add Solver Script 1 Remove Solver Script Export

Label	Varname	TYPE	Preference	Path
1 RADIOSS	radioss	RADIOSS	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/./hwsolvers/scripts/radioss.bat
2 OptiStruct	os	OptiStruct	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/./hwsolvers/scripts/optistruct.bat
3 MotionSolve	ms	MotionSolve	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/./hwsolvers/scripts/motionsolve.bat
4 Python	py	Python	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/./common/python/python3.5/win64/pyth
5 Tcl	tcl	Other Application	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/hw/tcl/tcl8.5.9/win64/bin/tclsh85.exe
6 Templex	templex	Other Application	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/hw/bin/win64/templex.exe
7 HyperXtrude	hx	Other Application	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/./hwsolvers/scripts/hx.bat
8 HM Batch	hmbatch	Other Application	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/hm/bin/win64/hmbatch.exe
9 HM BatchMesher	hmbatchmesher	Other Application	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/hm/batchmesh/hw_batchmesh.bat
10 MDL Batch	mdl_batch	Other Application	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/io/translators/bin/win64/mdl_batch.bat
11 HyperStudy Batch	hstbatch	Other Application	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/hst/bin/win64/hstbatch.exe
12 HyperWorks	hw_exe	Other Application	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/hw/bin/win64/hw.exe
13 HyperView	hv	HyperWorks	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/hw/bin/win64/hv.exe
14 HV Trans	hvtrans	Other Application	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/io/result_readers/bin/win64/hvtrans.exe
15 FEKO	feko	FEKO	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/./feko/bin/runfeko.exe
16 FLUX	flux	Flux	HyperWorks	D:/Program Files/Altair/2021.1/hwdesktop/./flux/Flux/Bin/prg/win64/flux.exe
17 None	hst_none	None	Internal	D:/Program Files/Altair/2021.1/hwdesktop/hst/bin/win64/hstsolver_none.bat

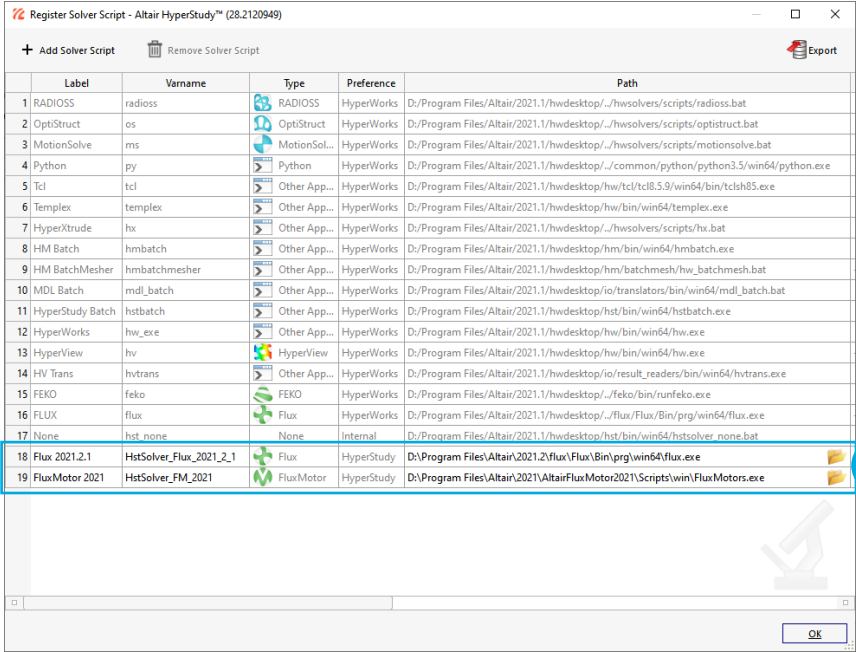


SOLVER SETTING IN HYPERSTUDY

- Modify the solver settings

Step	Action
1	Modify the solver settings (Label, Varname, and Path) for the two solvers “Flux” and “FluxMotor”

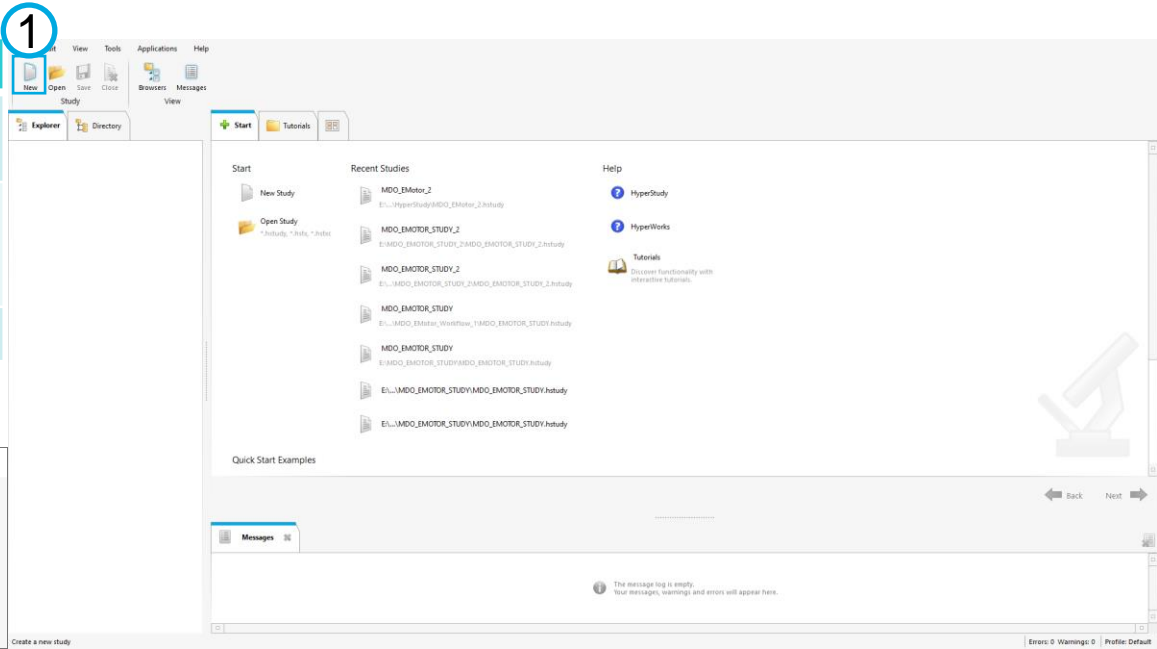
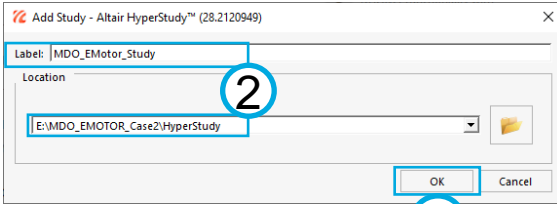
Label	Varname	Path
Flux 2021.2.1	HstSolver_Flux_2021_2_1	<Flux installation directory> /flux/Flux/Bin/prg/win64/Flux.exe
FluxMotor 2021	HstSolver_FM_2021	<FluxMotor installation directory> /Scripts/win/FluxMotor.exe



OPTIMIZATION INITIALIZATION

- Create a new **HyperStudy** project

Step	Action
1	Click on the icon [New] to start a new HyperStudy project
2	Define the project name “MDO_EMotor_Study”, and select the saving location
3	Click on [OK]



FLUXMOTOR MODEL AND FLUX MODEL IMPORT

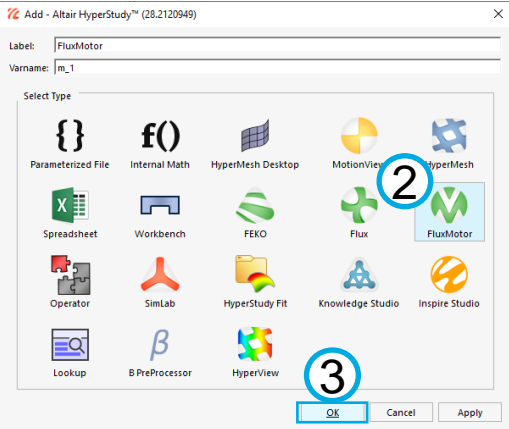
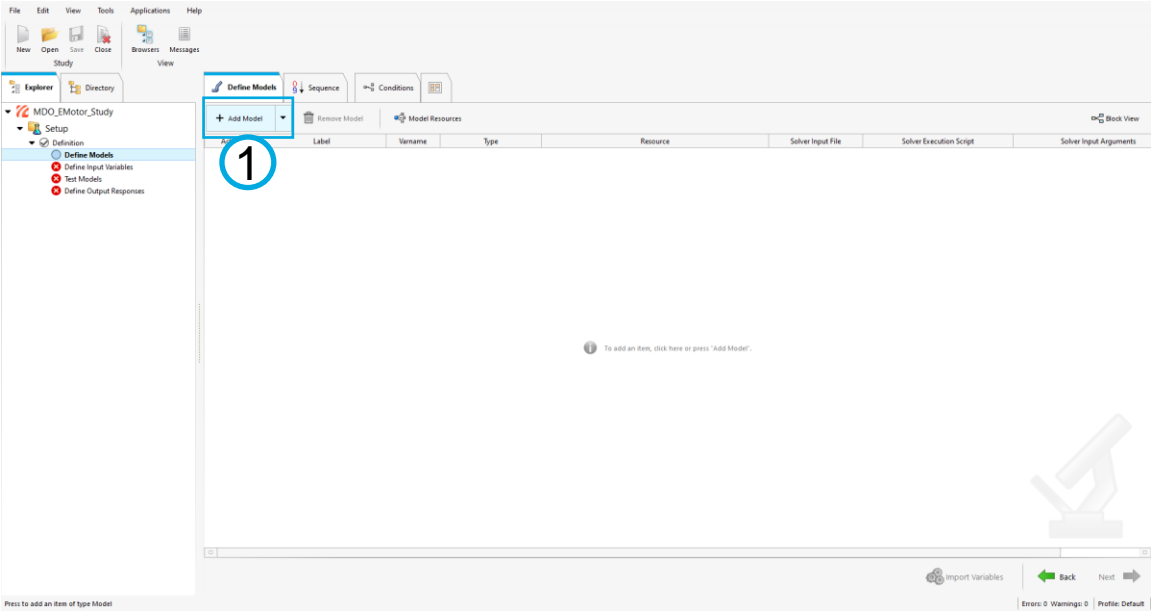
ADD FLUXMOTOR AND FLUX MODELS



FluxMotor model import

- Create a new **FluxMotor** model

Step	Action
1	Click on [Add Model] to create the model "FluxMotor"
2	Select the type "FluxMotor"
3	Click on [OK]




ADD FLUXMOTOR AND FLUX MODELS



FluxMotor model import

- Link the model to the **FluxMotor / Hyperstudy** connector

Step	Action
1	Click on the icon  to define the resource connector path
2	Select the connector "Connector_FM_Hst.fm2hst" in 1_FluxMotor
3	Click on [Open]

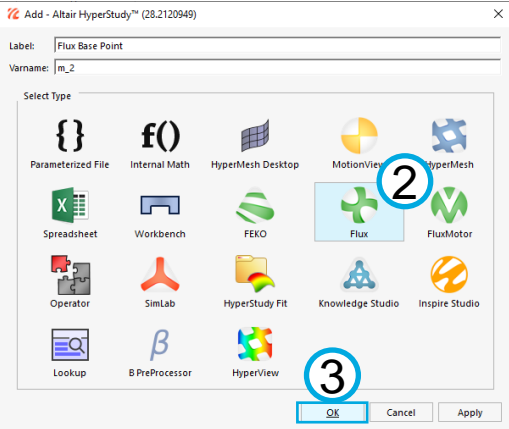
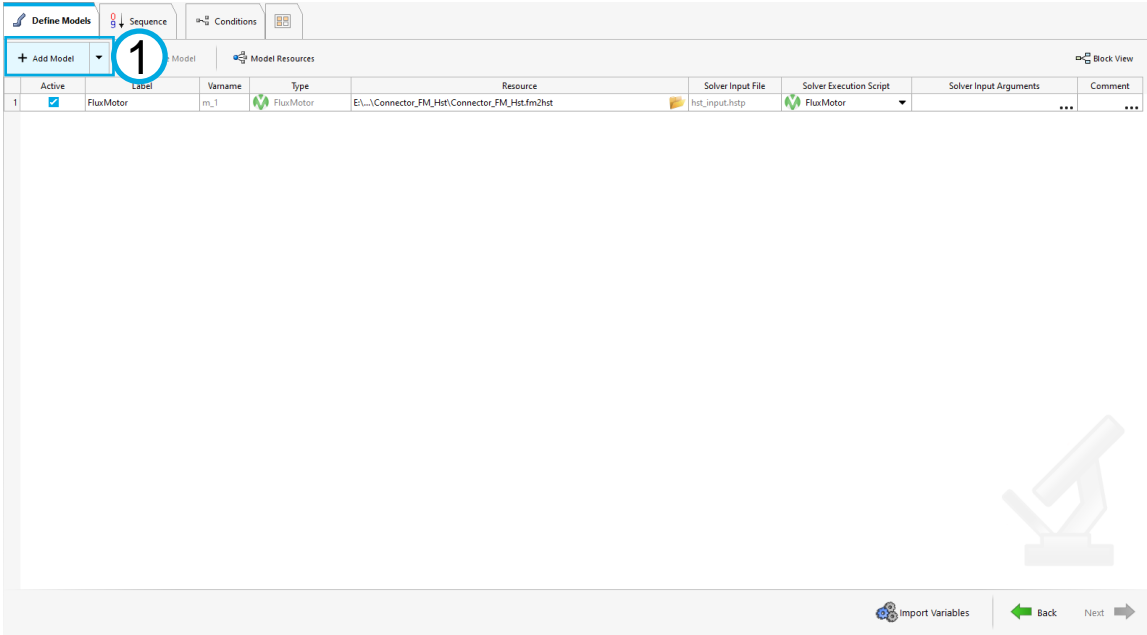
ADD FLUXMOTOR AND FLUX MODELS



Flux model import: magnetic analysis at base speed point

- Create a new **Flux** model

Step	Action
1	Click on [Add Model] to create the model “Flux Base Point”
2	Select the type “Flux”
3	Click on [OK]




ADD FLUXMOTOR AND FLUX MODELS



Flux model import: magnetic analysis at base speed point

- Link the model to the Flux / Hyperstudy connector

Step	Action
1	Click on the icon  to define the resource connector path
2	Select the Flux connector "Connector_Fx_Hst_BasePoint.F2HST" in 2_MagBasePoint
3	Click on [Open]

Active	Label	Vname	Type	Resource	Solver Input File	Solver Execution Script	Solver Input Arguments	Comment
<input checked="" type="checkbox"/>	FluxMotor	m_1	FluxMotor	E:\...\Connector_FM_Hst\Connector_FM_Hst.fm2hst	hst_input.htsp	FluxMotor	...	...
<input checked="" type="checkbox"/>	Flux Base Point	m_2	Flux	hst_input.htsp	FLUX	-batch	...	...

HyperStudy - Load model resource

Storage (E:) > MDO_EMOTOR_Case2 > HyperStudy > 2_MagBasePoint

Name	Date modified	Type	Size
Connector_Fx_Hst_BasePoint.F2HST.FLU	10-22 12:19	File folder	
Connector_Fx_Hst_BasePoint.F2HST	11-09 11:09	F2HST File	21 KB

File name: Connector_Fx_Hst_BasePoint.F2HST

Flux (*.F2HST)

Open Cancel

ADD FLUXMOTOR AND FLUX MODELS



Flux model import: magnetic analysis at specific operating point

- Create a new **Flux** model

Step	Action
1	Click on [Add Model] to create the model "Flux Operating Point"
2	Select the type "Flux"
3	Click on [OK]

Active	Label	Varname	Type	Resource	Solver Input File	Solver Execution Script	Solver Input Arguments	Comment
<input checked="" type="checkbox"/>	FluxMotor	m_1	FluxMotor	E:_A_Connector_FM_Hst\Connector_FM_Hst.fm2hst	hst_input.htsp	FluxMotor	...	...
<input checked="" type="checkbox"/>	Flux Base Point	m_2	Flux	E:_A2_MagBasePoint\Connector_Fx_Hst_BasePoint.F2HST	hst_input.htsp	FLUX	-batch	...

Label: Flux Operating Point
 Varname: m_3

Select Type

Parameterized File Internal Math HyperMesh Desktop MotionView HyperMesh
 Spreadsheet Workbench FEKO Flux FluxMotor
 Operator SimLab HyperStudy Fit Knowledge Studio Inspire Studio
 Lookup B PreProcessor HyperView


OK Cancel Apply

ADD FLUXMOTOR AND FLUX MODELS



Flux model import: magnetic analysis at specific operating point

- Link the model to the **Flux / Hyperstudy** connector

Step	Action
1	Click on the icon  to define the resource connector path
2	Select the Flux connector "Connector_Fx_Hst_Operating Point.F2HST" in 3_MagOperatingPoint
3	Click on [Open]

Active	Label	Vname	Type	Resource	Solver Input File	Solver Execution Script	Solver Input Arguments	Comment
<input checked="" type="checkbox"/>	FluxMotor	m_1	FluxMotor	E:\...\Connector_FM_Hst\Connector_FM_Hst.fm2hst	ht_input.htsp	FluxMotor	...	...
<input checked="" type="checkbox"/>	Flux Base Point	m_2	Flux	E:\...\MagBasePoint\Connector_Fx_Hst_BasePoint.F2HST	ht_input.htsp	FLUX	-batch	...
<input checked="" type="checkbox"/>	Flux Operating Point	m_3	Flux		ht_input.htsp	FLUX	-batch	...

ADD FLUXMOTOR AND FLUX MODELS



Flux model import: thermal analysis

- Create a new Flux model

Step	Action
1	Click on [Add Model] to create the model "Flux Thermal"
2	Select the type "Flux"
3	Click on [OK]


Active	Label	Vname	Type	Resource	Solver Input File	Solver Execution Script	Solver Input Arguments	Comment
<input checked="" type="checkbox"/>	FluxMotor	m_1	FluxMotor	E:\...\Connector_FM_Hst\Connector_FM_Hst.fm2hst	hst_input.hstp	FluxMotor	...	...
<input checked="" type="checkbox"/>	Flux Base Point	m_2	Flux	E:\...\MagBasePoint\Connector_Fx_Hst_BasePoint.F2HST	hst_input.hstp	FLUX	-batch	...
<input checked="" type="checkbox"/>	Flux Operating Point	m_3	Flux	E:\...\MagOperatingPoint\Connector_Fx_Hst_OperatingPoint.F2HST	hst_input.hstp	FLUX	-batch	...

ADD FLUXMOTOR AND FLUX MODELS



Flux model import: thermal analysis

- Link the model to the **Flux / Hyperstudy** connector

Step	Action
1	Click on the icon  to define the Flux connector path
2	Select the Flux connector "Connector_Fx_Hst_Thermal.F2HST" in 4_Thermal
3	Click on [Open]

Active	Label	Vaname	Type	Resource	Solver Input File	Solver Execution Script	Solver Input Arguments	Comment
<input checked="" type="checkbox"/>	FluxMotor	m_1	FluxMotor	E:\...\Connector_FM_Hst\Connector_FM_Hst.fm2hst	hst_input.hstp	FluxMotor	...	...
<input checked="" type="checkbox"/>	Flux Base Point	m_2	Flux	E:\...\MagBasePoint\Connector_Fx_Hst_BasePoint.F2HST	hst_input.hstp	FLUX	-batch	...
<input checked="" type="checkbox"/>	Flux Operating Point	m_3	Flux	E:\...\MagOperatingPoint\Connector_Fx_Hst_OperatingPoint.F2HST	hst_input.hstp	FLUX	-batch	...
<input checked="" type="checkbox"/>	Flux Thermal	m_4	Flux	...	hst_input.hstp	FLUX	-batch	...

HyperStudy - Load model resource

This PC > Storage (E:) > MDO_EMOTOR_Case2 > HyperStudy > 4_Thermal

Name	Date modified	Type	Size
Connector_Fx_Hst_Thermal.F2HST.FLU	22 12:19	File folder	
Connector_Fx_Hst_Thermal.F2HST	29 10:14	F2HST File	46 KB

File name: Connector_Fx_Hst_Thermal.F2HST

Flux (*.F2HST)


Open Cancel

ADD FLUXMOTOR AND FLUX MODELS











Update solvers (Flux and FluxMotor)

- Update the solver as defined in page 8

Step	Action
1	Click on the flash  to select the solver
2	Select the created solvers

Active	Label	Varname	Type	Resource	Solver Input	Solver Execution Script	Solver Input Arguments	Comment
<input checked="" type="checkbox"/>	FluxMotor	m_1	FluxMotor	E:\...\Connector_FM_Hst\Connector_FM_Hst.fm2hst	hst_input.hstp	FluxMotor		...
<input checked="" type="checkbox"/>	Flux Base Point	m_2	Flux	E:\...\2_MagBasePoint\Connector_Fx_Hst_BasePoint.F2HST	hst_input.hstp	FLUX	/batch	...
<input checked="" type="checkbox"/>	Flux Operating Point	m_3	Flux	E:\...\3_MagOperatingPoint\Connector_Fx_Hst_OperatingPoint.F2HST	hst_input.hstp	FLUX	/batch	...
<input checked="" type="checkbox"/>	Flux Thermal	m_4	Flux	E:\...\4_Thermal\Connector_Fx_Hst_Thermal.F2HST	hst_input.hstp	FLUX	/batch	...

	Active	Label	Varname	Type	Resource	Solver Input File	Solver Execution Script
1	<input checked="" type="checkbox"/>	FluxMotor	m_1	 FluxMotor	E:\...\Connector_FM_Hst\Connector_FM_Hst.fm2hst	hst_input.hstp	 FluxMotor 2021
2	<input checked="" type="checkbox"/>	Flux Mag Base Speed	m_2	 Flux	E:\...\2_MagBasePoint\Connector_Fx_Hst_BasePoint.F2HST	hst_input.hstp	 Flux 2021.2.1
3	<input checked="" type="checkbox"/>	Flux Mag Operating Point	m_3	 Flux	E:\...\3_MagOperatingPoint\Connector_Fx_Hst_OperatingPoint.F2HST	hst_input.hstp	 Flux 2021.2.1
4	<input checked="" type="checkbox"/>	Flux Thermal	m_4	 Flux	E:\...\4_Thermal\Connector_Fx_Hst_Thermal.F2HST	hst_input.hstp	 Flux 2021.2.1

SOLVING FOR MAGNETIC PROBLEMS AND THERMAL PROBLEM

SOLVING FOR MAGNETIC PROBLEMS AND THERMAL PROBLEM

Model variable import

Step	Action
1	Click on the icon [Import Variables]
2	Click on [Define Input Variables] to verify all the imported variables

Explorer Directory

- MDO_EMotor_Study
 - Setup
 - Definition
 - Define Models
 - Define Input Variables** 2
 - Test Models
 - Define Output Responses

Define Models Sequence Conditions

+ Add Model Remove Model Model Resources Block View

Active	Label	Vaname	Type	Resource	Solver Input File	Solver Execution Script	Solver Input Arguments	Comment
<input checked="" type="checkbox"/>	FluxMotor	m_1	FluxMotor	E:_1_Connector_FM_Hst\Connector_FM_Hst_fm2hst	hst_input.hstip	FluxMotor 2021	...	...
<input checked="" type="checkbox"/>	Flux Base Point	m_2	Flux	E:_12_MagBasePoint\Connector_Fx_Hst_BasePoint.F2HST	hst_input.hstip	Flux 2021.2	-batch	...
<input checked="" type="checkbox"/>	Flux Operating Point	m_3	Flux	E:_13_MagOperatingPoint\Connector_Fx_Hst_OperatingPoint.F2HST	hst_input.hstip	Flux 2021.2	-batch	...
<input checked="" type="checkbox"/>	Flux Thermal	m_4	Flux	E:_14_Thermal\Connector_Fx_Hst_Thermal.F2HST	hst_input.hstip	Flux 2021.2	-batch	...

Import Variables 1 Back Next

SOLVING FOR MAGNETIC PROBLEMS AND THERMAL PROBLEM

Model variable import

- Define parameter links

Active	Label	Vname	Lower Bound	Nominal	Upper Bound	Comment
<input checked="" type="checkbox"/>	Magnet:TM1A (mm)	var_1	2.700000	3.000000	3.300000	***
<input checked="" type="checkbox"/>	Magnet:TM2A (mm)	var_2	2.700000	3.000000	3.300000	***
<input checked="" type="checkbox"/>	Magnet:TA (mm)	var_3	1.350000	1.500000	1.650000	***
<input checked="" type="checkbox"/>	Magnet:T3A (mm)	var_4	1.350000	1.500000	1.650000	***
<input checked="" type="checkbox"/>	Magnet:HM1A (mm)	var_5	12.150000	13.500000	14.850000	***
<input checked="" type="checkbox"/>	Magnet:HM2A (mm)	var_6	9.000000	10.000000	11.000000	***
<input checked="" type="checkbox"/>	Magnet:WA (mm)	var_7	0.450000	0.500000	0.550000	***
<input checked="" type="checkbox"/>	Magnet:TM1B (mm)	var_8	2.700000	3.000000	3.300000	***
<input checked="" type="checkbox"/>	Magnet:TM2B (mm)	var_9	2.700000	3.000000	3.300000	***
<input checked="" type="checkbox"/>	Magnet:T2B (mm)	var_10	1.350000	1.500000	1.650000	***
<input checked="" type="checkbox"/>	Magnet:T3B (mm)	var_11	1.350000	1.500000	1.650000	***
<input checked="" type="checkbox"/>	Magnet:HM1B (mm)	var_12	9.450000	10.500000	11.550000	***
<input checked="" type="checkbox"/>	Magnet:HM2B (mm)	var_13	6.300000	7.000000	7.700000	***
<input checked="" type="checkbox"/>	Magnet:WB (mm)	var_14	0.450000	0.500000	0.550000	***
<input checked="" type="checkbox"/>	Magnet:TM1C (mm)	var_15	3.600000	4.000000	4.400000	***
<input checked="" type="checkbox"/>	Magnet:TM2C (mm)	var_16	3.600000	4.000000	4.400000	***
<input checked="" type="checkbox"/>	Magnet:T2C (mm)	var_17	1.350000	1.500000	1.650000	***
<input checked="" type="checkbox"/>	Magnet:T3C (mm)	var_18	1.350000	1.500000	1.650000	***
<input checked="" type="checkbox"/>	Magnet:HM1C (mm)	var_19	5.400000	6.000000	6.600000	***
<input checked="" type="checkbox"/>	Magnet:HM2C (mm)	var_20	2.700000	3.000000	3.300000	***
<input checked="" type="checkbox"/>	Magnet:WVC (mm)	var_21	0.450000	0.500000	0.550000	***
<input checked="" type="checkbox"/>	Magnet:R_hole (mm)	var_22	2.430000	2.700000	2.970000	***
<input checked="" type="checkbox"/>	CTRL_ANGLE	var_23	44.915400	49.909000	54.896600	PHYS ***
<input checked="" type="checkbox"/>	L_RMS	var_24	252.000000	280.000000	308.000000	PHYS ***
<input checked="" type="checkbox"/>	SPEED	var_25	6480.000000	7200.000000	7920.000000	PHYS ***
<input checked="" type="checkbox"/>	IM_R_HOLE	var_26	2.430000	2.700000	2.970000	GEOM ***
<input checked="" type="checkbox"/>	IM_T2A	var_27	1.350000	1.500000	1.650000	GEOM ***
<input checked="" type="checkbox"/>	IM_T2B	var_28	1.350000	1.500000	1.650000	GEOM ***
<input checked="" type="checkbox"/>

Variable number	Total number	Description	Original model	Action in HyperStudy
1-22	22	Meta geometric parameters	FluxMotor	Modify upper and lower bounds
23-25	3	Linked electrical parameters	Flux Mag Base Point	Link to model output responses
26-47	22	Linked geometric parameters	Flux Mag Base Point	Link to variable 1-22
48-49	2	Linked electrical parameters	Flux Mag Operating Point	Link to model output responses
50	1	Fixed operating speed (7200 RPM)	Flux Mag Operating Point	To be deleted !! Because the operating speed is a constant
51-72	22	Linked geometric parameters	Flux Mag Operating Point	Link to variable 1-22
73-94	22	Linked geometric parameters	Flux Thermal	Link to variable 1-22
95-109	15	Linked electrical parameters	Flux Thermal	Link to model output responses

MDO_EMotor_Study / Setup (Nominal Run, ...) / Definition / Define Input Variables

Errors: 0 Warnings: 15 | Profile: Default

22 **Note: all the modification for variable information in HyperStudy can be copied and pasted from the file "ParameterTableInHS.xlsx"**



SOLVING FOR MAGNETIC PROBLEMS AND THERMAL PROBLEM

Model variable import

- Define parameter variation intervals for geometric parameters from the FluxMotor model

Step	Action
1	Click on [Bounds]
2	Define lower bounds and upper bounds for the meta motor geometric parameters (variable 1-22)

The screenshot shows the 'Bounds' tab in the software interface. A table lists 22 variables with their lower and upper bounds highlighted in red. A circled '1' points to the 'Bounds' button in the top toolbar.

	Label	Vname	Lower Bound	Nominal	Upper Bound	Comment
1	Magnet:TM1A (mm)	var_1	2.700000	3.000000	3.300000	...
2	Magnet:TM2A (mm)	var_2	2.700000	3.000000	3.300000	...
3	Magnet:T2A (mm)	var_3	1.350000	1.500000	1.650000	...
4	Magnet:T3A (mm)	var_4	1.350000	1.500000	1.650000	...
5	Magnet:WM1A (mm)	var_5	12.150000	13.500000	14.850000	...
6	Magnet:WM2A (mm)	var_6	9.000000	10.000000	11.000000	...
7	Magnet:WA (mm)	var_7	0.450000	0.500000	0.550000	...
8	Magnet:TM1B (mm)	var_8	2.700000	3.000000	3.300000	...
9	Magnet:TM2B (mm)	var_9	2.700000	3.000000	3.300000	...
10	Magnet:T2B (mm)	var_10	1.350000	1.500000	1.650000	...
11	Magnet:T3B (mm)	var_11	1.350000	1.500000	1.650000	...
12	Magnet:WM1B (mm)	var_12	9.450000	10.500000	11.550000	...
13	Magnet:WM2B (mm)	var_13	6.300000	7.000000	7.700000	...
14	Magnet:WB (mm)	var_14	0.450000	0.500000	0.550000	...
15	Magnet:TM1C (mm)	var_15	3.600000	4.000000	4.400000	...
16	Magnet:TM2C (mm)	var_16	3.600000	4.000000	4.400000	...
17	Magnet:T2C (mm)	var_17	1.350000	1.500000	1.650000	...
18	Magnet:T3C (mm)	var_18	1.350000	1.500000	1.650000	...
19	Magnet:WM1C (mm)	var_19	5.400000	6.000000	6.600000	...
20	Magnet:WM2C (mm)	var_20	2.700000	3.000000	3.300000	...
21	Magnet:WC (mm)	var_21	0.450000	0.500000	0.550000	...
22	Magnet:R_hole (mm)	var_22	2.430000	2.700000	2.970000	...
23	CTRL_ANGLE	var_23	44.915400	49.906000	54.896600	PHYS
24	I_RMS	var_24	252.000000	280.000000	308.000000	PHYS
25	SPEED	var_25	6480.000000	7200.000000	7920.000000	PHYS
26	IM_R_HOLE	var_26	2.430000	2.700000	2.970000	GEOM
27	IM_T2A	var_27	1.350000	1.500000	1.650000	GEOM
28	IM_T2B	var_28	1.350000	1.500000	1.650000	GEOM

Note: the bound values can be copied and pasted from the file "ParameterTableInHS.xlsx"

SOLVING FOR MAGNETIC PROBLEMS AND THERMAL PROBLEM

Model variable import

- Delete the input variable “SPEED” from operating point model

Step	Action
1	Select the No.50 variable “SPEED”
2	Right click and click on [Remove Input Variables]
3	Verify the total input variable number is 108

The screenshot displays the software interface with three numbered callouts: 1 points to the 'SPEED' variable (var_50) in the 'Active' table; 2 points to the 'Remove Input Variable' option in the context menu; 3 points to the 'Remove Input Variable' button in the top toolbar. The 'Active' table lists variables with columns for 'Active', 'Label', and 'Varname'. The 'Remove Input Variable' table lists variables with columns for 'Bound', 'Active', 'Label', 'Varname', 'Lower Bound', 'Nominal', 'Upper Bound', and 'Comment'.

Active	Label	Varname
<input checked="" type="checkbox"/>	SPEED	var_25
<input checked="" type="checkbox"/>	IM_R_HOLE	var_26
<input checked="" type="checkbox"/>	IM_T2A	var_27
<input checked="" type="checkbox"/>	IM_T2B	var_28
<input checked="" type="checkbox"/>	IM_T2C	var_29
<input checked="" type="checkbox"/>	IM_T3A	var_30
<input checked="" type="checkbox"/>	IM_T3B	var_31
<input checked="" type="checkbox"/>	IM_T3C	var_32
<input checked="" type="checkbox"/>	IM_TM1A	var_33
<input checked="" type="checkbox"/>	IM_TM1B	var_34
<input checked="" type="checkbox"/>	IM_TM1C	var_35
<input checked="" type="checkbox"/>	IM_TM2A	var_36
<input checked="" type="checkbox"/>	IM_TM2B	var_37
<input checked="" type="checkbox"/>	IM_TM2C	var_38
<input checked="" type="checkbox"/>	IM_WA	var_39
<input checked="" type="checkbox"/>	IM_WB	var_40
<input checked="" type="checkbox"/>	IM_WC	var_41
<input checked="" type="checkbox"/>	IM_WM1A	var_42
<input checked="" type="checkbox"/>	IM_WM1B	var_43
<input checked="" type="checkbox"/>	IM_WM1C	var_44
<input checked="" type="checkbox"/>	IM_WM2A	var_45
<input checked="" type="checkbox"/>	IM_WM2B	var_46
<input checked="" type="checkbox"/>	IM_WM2C	var_47
<input checked="" type="checkbox"/>	CTRL_ANGLE	var_48
<input checked="" type="checkbox"/>	I_RMS	var_49
<input checked="" type="checkbox"/>	SPEED	var_50
<input checked="" type="checkbox"/>	IM_R_HOLE	var_51
<input checked="" type="checkbox"/>	IM_T2A	var_52
<input checked="" type="checkbox"/>	IM_T2B	var_53

Bound	Active	Label	Varname	Lower Bound	Nominal	Upper Bound	Comment
100	<input checked="" type="checkbox"/>	IM_TM1C	var_82	3.6000000	4.0000000	4.4000000	GEOM
100	<input checked="" type="checkbox"/>	IM_TM2A	var_83	2.7000000	3.0000000	3.3000000	GEOM
100	<input checked="" type="checkbox"/>	IM_TM2B	var_84	2.7000000	3.0000000	3.3000000	GEOM
100	<input checked="" type="checkbox"/>	IM_TM2C	var_85	3.6000000	4.0000000	4.4000000	GEOM
100	<input checked="" type="checkbox"/>	IM_WA	var_86	0.4500000	0.5000000	0.5500000	GEOM
100	<input checked="" type="checkbox"/>	IM_WB	var_87	0.4500000	0.5000000	0.5500000	GEOM
100	<input checked="" type="checkbox"/>	IM_WC	var_88	0.4500000	0.5000000	0.5500000	GEOM
100	<input checked="" type="checkbox"/>	IM_WM1A	var_89	12.1500000	13.5000000	14.8500000	GEOM
100	<input checked="" type="checkbox"/>	IM_WM1B	var_90	9.4500000	10.5000000	11.5500000	GEOM
100	<input checked="" type="checkbox"/>	IM_WM1C	var_91	5.4000000	6.0000000	6.6000000	GEOM
100	<input checked="" type="checkbox"/>	IM_WM2A	var_92	9.0000000	10.0000000	11.0000000	GEOM
100	<input checked="" type="checkbox"/>	IM_WM2B	var_93	6.3000000	7.0000000	7.7000000	GEOM
100	<input checked="" type="checkbox"/>	IM_WM2C	var_94	2.7000000	3.0000000	3.3000000	GEOM
100	<input checked="" type="checkbox"/>	IRON_LOSS_ROTOR	var_95	12.1500000	13.5000000	14.8500000	PHYS
100	<input checked="" type="checkbox"/>	IRON_LOSS_STATOR	var_96	112.89600	125.44000	137.98400	PHYS
100	<input checked="" type="checkbox"/>	JOULE_LOSS_STATOR	var_97	251.37000	279.30000	307.23000	PHYS
100	<input checked="" type="checkbox"/>	LOSS_IM_MAGNET1A	var_98	0.9000000	1.0000000	1.1000000	PHYS
100	<input checked="" type="checkbox"/>	LOSS_IM_MAGNET1A_SYM	var_99	0.9000000	1.0000000	1.1000000	PHYS
100	<input checked="" type="checkbox"/>	LOSS_IM_MAGNET1B	var_100	0.9000000	1.0000000	1.1000000	PHYS
100	<input checked="" type="checkbox"/>	LOSS_IM_MAGNET1B_SYM	var_101	0.9000000	1.0000000	1.1000000	PHYS
100	<input checked="" type="checkbox"/>	LOSS_IM_MAGNET1C	var_102	0.9000000	1.0000000	1.1000000	PHYS
100	<input checked="" type="checkbox"/>	LOSS_IM_MAGNET1C_SYM	var_103	0.9000000	1.0000000	1.1000000	PHYS
100	<input checked="" type="checkbox"/>	LOSS_IM_MAGNET2A	var_104	0.9000000	1.0000000	1.1000000	PHYS
100	<input checked="" type="checkbox"/>	LOSS_IM_MAGNET2A_SYM	var_105	0.9000000	1.0000000	1.1000000	PHYS
100	<input checked="" type="checkbox"/>	LOSS_IM_MAGNET2B	var_106	0.9000000	1.0000000	1.1000000	PHYS
100	<input checked="" type="checkbox"/>	LOSS_IM_MAGNET2B_SYM	var_107	0.9000000	1.0000000	1.1000000	PHYS
100	<input checked="" type="checkbox"/>	LOSS_IM_MAGNET2C	var_108	0.9000000	1.0000000	1.1000000	PHYS
100	<input checked="" type="checkbox"/>	LOSS_IM_MAGNET2C_SYM	var_109	0.9000000	1.0000000	1.1000000	PHYS

SOLVING FOR MAGNETIC PROBLEMS AND THERMAL PROBLEM

Model variable import

- Define parameter links for geometric parameters between models

Step	Action
1	Click on [Links]
2	Link all the geometric parameters from Flux models (26-47, 51-72, 73-94) to the meta geometric parameters form FluxMotor model (1-22).
2.a	Example: for the variable 26: IM_R_HOLE - Click on [...] - Select [Input Variables], - Select the target variable 22 - Click on [Insert Varname] - Click on [OK]

The screenshot shows the Altair HyperStudy interface. The main window displays a table of variables with columns for Active, Label, Varname, Data Type, and Expression. A red circle highlights the 'Links' button in the top toolbar. A second window, 'Expression Builder: IM_R_HOLE (var_26)', shows the 'Input Variables' section with a list of variables. Variable 22, 'Magnet:R_hole (mm)', is selected. A red box highlights the 'Insert Varname' button, and another red box highlights the 'OK' button. Arrows indicate the flow of the process from the main table to the expression builder and then to the 'OK' button.

SOLVING FOR MAGNETIC PROBLEMS AND THERMAL PROBLEM

Model variable import

- Define parameter links between electrical parameters and output responses

Step	Action
1	Click on [Links]
2	Link all the electrical parameters (23-25, 48-50, 95-109) to output responses
2.a	<p>Example: for the variable 23:</p> <ul style="list-style-type: none"> Click on [...] Select [Output Responses], Select the target response 8 Click on [Insert Varname] Click on [OK]

The screenshot shows the 'Links' tab in Altair HyperStudy. A table lists variables and their data types. Variable 23, CTRL_ANGLE, is highlighted. The 'Output Responses' dialog is open, showing a list of responses, with response 8, Base speed:Control angle (deg), selected. The 'Insert Varname' button is highlighted, and the 'OK' button is also highlighted.


Active	Label	Varname	Data Type	Expression
19	Magnet:WM1C (mm)	var_19	Real	...
20	Magnet:WM2C (mm)	var_20	Real	...
21	Magnet:WC (mm)	var_21	Real	...
22	Magnet:R_hole (mm)	var_22	Real	...
23	CTRL_ANGLE	var_23	Real	r_8
24	I_RMS	var_24	Real	r_9
25	SPEED	var_25	Real	r_5
26	IM_R_HOLE	var_26	Real	var_22
27	IM_T2A	var_27	Real	var_3
28	IM_T2B	var_28	Real	var_10
29	IM_T2C	var_29	Real	var_17
30	IM_T3A	var_30	Real	var_4
31	IM_T3B	var_31	Real	var_11
32	IM_T3C	var_32	Real	var_18
33	IM_TM1A	var_33	Real	var_1
34	IM_TM1B	var_34	Real	var_8
35	IM_TM1C	var_35	Real	var_15
36	IM_TM2A	var_36	Real	var_2
37	IM_TM2B	var_37	Real	var_9
38	IM_TM2C	var_38	Real	var_16
39	IM_WA	var_39	Real	var_7
40	IM_WB	var_40	Real	var_14
41	IM_WC	var_41	Real	var_21
42	IM_WM1A	var_42	Real	var_5
43	IM_WM1B	var_43	Real	var_12
44	IM_WM1C	var_44	Real	var_19
45	IM_WM2A	var_45	Real	var_6
46	IM_WM2B	var_46	Real	var_13
47	IM_WM2C	var_47	Real	var_20

Label	Varname	Comment
1	Masses:Rotor (kg)	r_1
2	Masses:Rotor:Magnets (kg)	r_2
3	Masses:Rotor:Magnetic circuit (kg)	r_3
4	Base speed:Mechanical torque (N.m)	r_4
5	Base speed:Speed (rpm)	r_5
6	Base speed:Mechanical power (W)	r_6
7	Base speed:Machine efficiency (%)	r_7
8	Base speed:Control angle (deg)	r_8
9	Base speed:Line current, rms (A)	r_9
10	Maximum speeds:Mechanical torque (N.m)	r_10
11	Maximum speeds:Mechanical power (W)	r_11
12	Maximum speeds:Machine efficiency (%)	r_12
13	Maximum speeds:Control angle (deg)	r_13
14	Maximum speeds:Line current, rms (A)	r_14
15	User work_pt.:Mechanical power (W)	r_15
16	User work_pt.:Machine efficiency (%)	r_16

SOLVING FOR MAGNETIC PROBLEMS AND THERMAL PROBLEM

Model variable import

- Define parameter constraints

Step	Action
1	Click on [Constraints]
2	Click on [Add Constraints]
3	Add the following 6 constraints
4	Click on the icon 

Active	Label	Varname	Left Expression	Comparison	Right Expression	Comment
<input checked="" type="checkbox"/>	Constraint 1	con_1	var_2+var_5 ...	\leq ▼	17.5 ...	...
<input checked="" type="checkbox"/>	Constraint 2	con_2	var_9+var_12 ...	\leq ▼	14 ...	...
<input checked="" type="checkbox"/>	Constraint 3	con_3	var_16+var_19 ...	\leq ▼	10.5 ...	...
<input checked="" type="checkbox"/>	Constraint 4	con_4	var_3+var_7+var_6 ...	\leq ▼	13 ...	...
<input checked="" type="checkbox"/>	Constraint 5	con_5	var_10+var_14+var_13 ...	\leq ▼	9.5 ...	...
<input checked="" type="checkbox"/>	Constraint 6	con_6	var_17+var_21+var_20 ...	\leq ▼	5.5 ...	...


Notes:

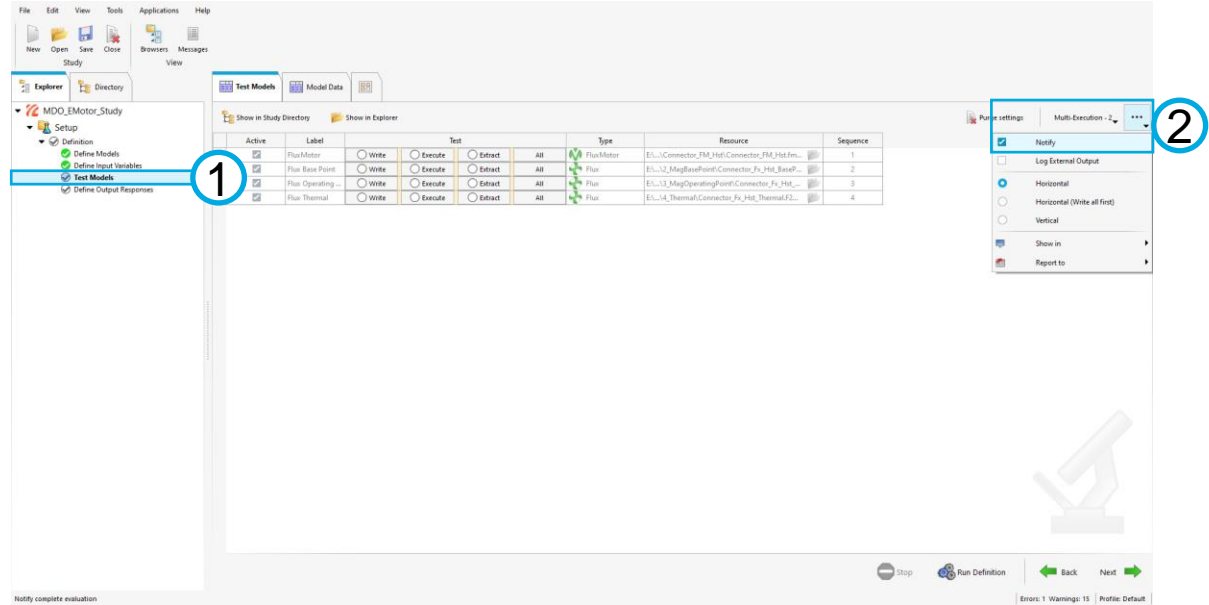
- The geometric constraints should be respected for generating correct motor geometri
- The constraint definition can be copied and pasted from the file "ParameterTableInHS.xlsx"

SOLVING FOR MAGNETIC PROBLEMS AND THERMAL PROBLEM

Model solving

- Test model definition

Step	Action
1	Click on [Test Models]
2	Click on the icon  , Click on [Notify]



The screenshot shows the HyperMesh software interface. The 'Test Models' table is visible, listing various models and their configurations. A blue circle with the number '1' highlights the 'Test Models' icon in the left-hand 'Explorer' pane. Another blue circle with the number '2' highlights the 'Notify' option in a context menu that is open over the 'Test Models' table.

Active	Label	Write	Execute	Extract	All	Type	Resource	Sequence
<input checked="" type="checkbox"/>	Flux Motor	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Flux Motor	ES...Connector_PM_Hat_Connector_PM_Hat...	1
<input checked="" type="checkbox"/>	Flux Base Point	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Flux	ES...MagBasePoint_Connector_Fx_Hat_BaseP...	2
<input checked="" type="checkbox"/>	Flux Operating ...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Flux	ES...MagOperatingPoint_Connector_Fx_Hat_...	3
<input checked="" type="checkbox"/>	Flux Thermal	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Flux	ES...Thermal_Connector_Fx_Hat_Thermal.F2...	4

SOLVING FOR MAGNETIC PROBLEMS AND THERMAL PROBLEM

Model solving

- Test model definition

Step	Action
1	Click on the icon [Run Definition]

Active	Label	Test	Type	Resource	Sequence
<input checked="" type="checkbox"/>	FluxMotor	<input checked="" type="checkbox"/> Write <input checked="" type="checkbox"/> Execute <input checked="" type="checkbox"/> Extract	All	FluxMotor	1
<input checked="" type="checkbox"/>	Flux Base Point	<input checked="" type="checkbox"/> Write <input checked="" type="checkbox"/> Execute <input checked="" type="checkbox"/> Extract	All	Flux	2
<input checked="" type="checkbox"/>	Flux Operating ...	<input checked="" type="checkbox"/> Write <input checked="" type="checkbox"/> Execute <input checked="" type="checkbox"/> Extract	All	Flux	3
<input checked="" type="checkbox"/>	Flux Thermal	<input checked="" type="checkbox"/> Write <input checked="" type="checkbox"/> Execute <input checked="" type="checkbox"/> Extract	All	Flux	4

1

Altair HyperStudy™

Evaluation complete

Elapsed time (414.67125 seconds)

Don't show again

SOLVING FOR MAGNETIC PROBLEMS AND THERMAL PROBLEM

Model output responses

- Create a new output response for the magnetic torque ripple value

Step	Action
1	Click on [Define Output Response]
2	Click on [Add output Response]
3	Define the “Label” and “Expression”
4	Click on [Evaluate]

Label	TORQUE_BASE_SPEED_RIPPLE
Expression	Expression in HS: r_21-r_22 TORQUE_BASE_SPEED_MAX – TORQUE_BASE_SPEED_MIN

Active	Label	Varname	Expression	Value	Goals	Output Type	Comment
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_1A_MEAN	r_26	m_3MAGNET_LOSSES_OPERATING_POINT_1A_MEAN	0.0209141		+ Real	PHYS ...
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_1A_SYM	r_27	m_3MAGNET_LOSSES_OPERATING_POINT_1A_SYM_MEAN	0.0489919		+ Real	PHYS ...
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_1B_MEAN	r_28	m_3MAGNET_LOSSES_OPERATING_POINT_1B_MEAN	0.0117487		+ Real	PHYS ...
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_1B_SYM	r_29	m_3MAGNET_LOSSES_OPERATING_POINT_1B_SYM_MEAN	0.0146036		+ Real	PHYS ...
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_1C_MEAN	r_30	m_3MAGNET_LOSSES_OPERATING_POINT_1C_MEAN	0.0160296		+ Real	PHYS ...
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_1C_SYM	r_31	m_3MAGNET_LOSSES_OPERATING_POINT_1C_SYM_MEAN	0.0081741		+ Real	PHYS ...
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_2A_MEAN	r_32	m_3MAGNET_LOSSES_OPERATING_POINT_2A_MEAN	0.0360188		+ Real	PHYS ...
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_2A_SYM	r_33	m_3MAGNET_LOSSES_OPERATING_POINT_2A_SYM_MEAN	0.0495267		+ Real	PHYS ...
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_2B_MEAN	r_34	m_3MAGNET_LOSSES_OPERATING_POINT_2B_MEAN	0.0305470		+ Real	PHYS ...
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_2B_SYM	r_35	m_3MAGNET_LOSSES_OPERATING_POINT_2B_SYM_MEAN	0.106975		+ Real	PHYS ...
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_2C_MEAN	r_36	m_3MAGNET_LOSSES_OPERATING_POINT_2C_MEAN	0.0506685		+ Real	PHYS ...
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_2C_SYM	r_37	m_3MAGNET_LOSSES_OPERATING_POINT_2C_SYM_MEAN	0.0037846		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_COIL	r_38	m_4T_COIL	151.03880		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_1A	r_39	m_4T_MAG_1A	45.513891		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_1A_SYM	r_40	m_4T_MAG_1A_SYM	45.508708		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_1B	r_41	m_4T_MAG_1B	46.004194		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_1B_SYM	r_42	m_4T_MAG_1B_SYM	46.003212		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_1C	r_43	m_4T_MAG_1C	46.781349		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_1C_SYM	r_44	m_4T_MAG_1C_SYM	46.802594		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_2A	r_45	m_4T_MAG_2A	46.281304		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_2A_SYM	r_46	m_4T_MAG_2A_SYM	46.287982		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_2B	r_47	m_4T_MAG_2B	48.479626		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_2B_SYM	r_48	m_4T_MAG_2B_SYM	48.479580		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_2C	r_49	m_4T_MAG_2C	46.877281		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_2C_SYM	r_50	m_4T_MAG_2C_SYM	46.889757		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_ROTOR_YOKE	r_51	m_4T_ROTOR_YOKE	46.548458		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_STATOR_YOKE	r_52	m_4T_STATOR_YOKE	88.104190		+ Real	PHYS ...
<input checked="" type="checkbox"/>	TORQUE_BASE_SPEED_RIPPLE	r_53	r_21-r_22	43.161852		+ Real	PHYS ...

SOLVING FOR MAGNETIC PROBLEMS AND THERMAL PROBLEM

Model output responses

- Create a new output response for the maximum magnet temperature value

Step	Action
1	Click on [Define Output Response]
2	Click on [Add output Response]
3	Define the “Label” and “Expression”
4	Click on [Evaluate]

Label	MAX_MAGNET_TEMPERATURE
Expression	$\max(\{r_39, r_40, r_41, r_42, r_43, r_44, r_45, r_46, r_47, r_48, r_49, r_50\})$

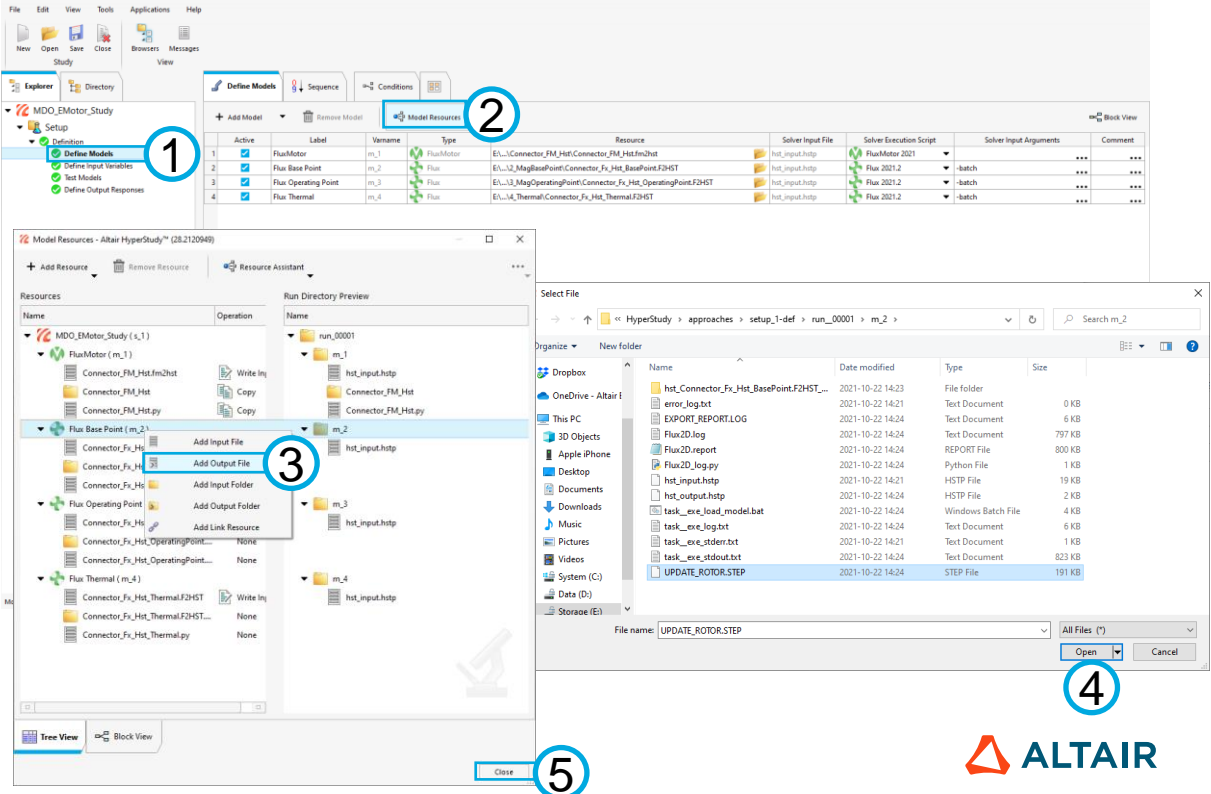
The screenshot shows the 'Define Output Responses' dialog in Altair HyperMesh. The 'Add Output Response' section is active, displaying a table of existing responses. The response 'MAX_MAGNET_TEMPERATURE' is highlighted in blue at the bottom of the list. The dialog includes buttons for 'Add Output Response', 'Remove Output Response', and 'Evaluate'. The 'Evaluate' button is circled in blue with the number 4. The 'Define Output Responses' button in the left sidebar is circled in blue with the number 1. The 'Add Output Response' button in the dialog is circled in blue with the number 2. The 'MAX_MAGNET_TEMPERATURE' entry in the table is circled in blue with the number 3.

Active	Label	Variable Name	Expression	Value	Goals	Output Type	Comment
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_1A_SYM	r_27	m_3_MAGNET_LOSSES_OPERATING_POINT_1A_SYM.ME...	0.0499519		Real	PHYS
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_1B_MEAN	r_28	m_3_MAGNET_LOSSES_OPERATING_POINT_1B_MEAN	0.0111697		Real	PHYS
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_1B_SYM	r_29	m_3_MAGNET_LOSSES_OPERATING_POINT_1B_SYM.ME...	0.0164056		Real	PHYS
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_1C_MEAN	r_30	m_3_MAGNET_LOSSES_OPERATING_POINT_1C_MEAN	0.0160296		Real	PHYS
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_1C_SYM	r_31	m_3_MAGNET_LOSSES_OPERATING_POINT_1C_SYM.ME...	0.0081741		Real	PHYS
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_2A_MEAN	r_32	m_3_MAGNET_LOSSES_OPERATING_POINT_2A_MEAN	0.0492687		Real	PHYS
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_2A_SYM	r_33	m_3_MAGNET_LOSSES_OPERATING_POINT_2A_SYM.ME...	0.0492687		Real	PHYS
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_2B_MEAN	r_34	m_3_MAGNET_LOSSES_OPERATING_POINT_2B_MEAN	0.0030470		Real	PHYS
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_2B_SYM	r_35	m_3_MAGNET_LOSSES_OPERATING_POINT_2B_SYM.ME...	0.0069875		Real	PHYS
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_2C_MEAN	r_36	m_3_MAGNET_LOSSES_OPERATING_POINT_2C_MEAN	0.0056665		Real	PHYS
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_2C_SYM	r_37	m_3_MAGNET_LOSSES_OPERATING_POINT_2C_SYM.ME...	0.0037846		Real	PHYS
<input checked="" type="checkbox"/>	T_COIL	r_38	m_4_T_COIL	151.03690		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_1A	r_39	m_4_T_MAG_1A	45.513691		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_1A_SYM	r_40	m_4_T_MAG_1A_SYM	45.508708		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_1B	r_41	m_4_T_MAG_1B	46.004194		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_1B_SYM	r_42	m_4_T_MAG_1B_SYM	46.003212		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_1C	r_43	m_4_T_MAG_1C	46.783349		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_1C_SYM	r_44	m_4_T_MAG_1C_SYM	46.805504		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_2A	r_45	m_4_T_MAG_2A	46.283304		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_2A_SYM	r_46	m_4_T_MAG_2A_SYM	46.287002		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_2B	r_47	m_4_T_MAG_2B	46.476926		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_2B_SYM	r_48	m_4_T_MAG_2B_SYM	46.477848		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_2C	r_49	m_4_T_MAG_2C	46.877281		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_2C_SYM	r_50	m_4_T_MAG_2C_SYM	46.889157		Real	PHYS
<input checked="" type="checkbox"/>	T_STATOR_YOKE	r_51	m_5_T_STATOR_YOKE	46.548436		Real	PHYS
<input checked="" type="checkbox"/>	T_STATOR_YOKE	r_52	m_5_T_STATOR_YOKE	85.104190		Real	PHYS
<input checked="" type="checkbox"/>	TORQUE_BASE_SPEED_RIPPLE	r_53	r_21-r_22	43.161952		Real	PHYS
<input checked="" type="checkbox"/>	MAX_MAGNET_TEMPERATURE	r_54	max(r_39, r_40, r_41, r_42, r_43, r_44, r_45, r_46, r_47, r_48, r_49, r_50)	46.889157		Real	PHYS

SOLVING FOR MAGNETIC PROBLEMS AND THERMAL PROBLEM

Define the output motor geometry file (.STEP) for structural analysis

Step	Action
1	Click on [Define Models]
2	Click on [Model Resources]
3	Right click on the model [Flux Base Speed], click on [Add Output File]
4	Select on the output file [UPDATE_ROTOR.STEP], click on [Open]
5	Click on [Close]



HYPERMESH AND OPTISTRUCT MODELS AND SCRIPTS IMPORT

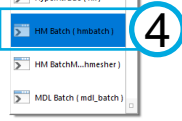
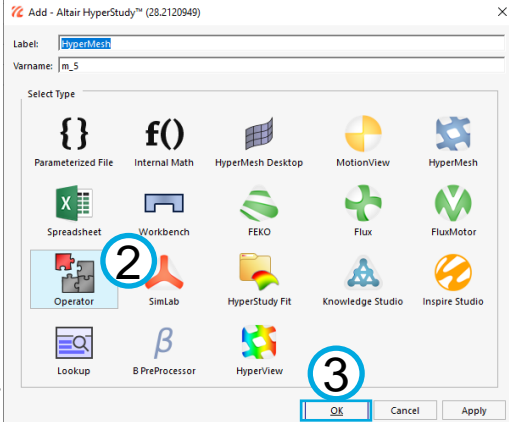
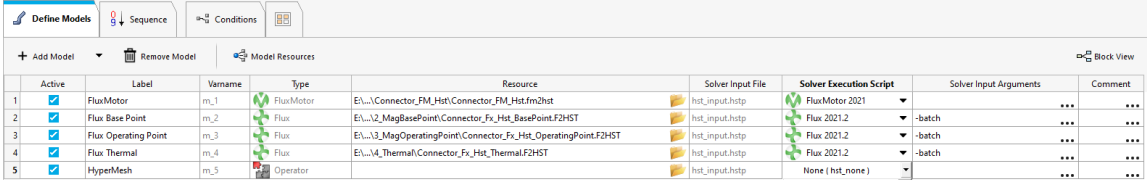
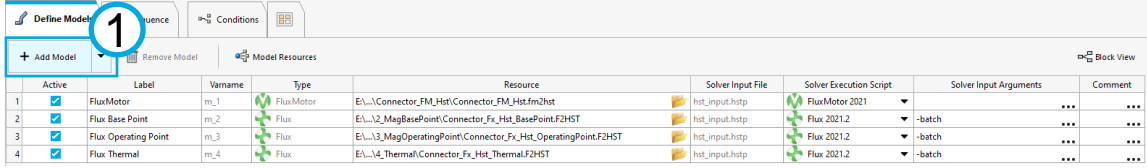
ADD HYPERMESH AND OPTISTRUCT MODELS



HyperMesh model import

- Create a new **Operator**

Step	Action
1	Click on [Add Model] to create the model “HyperMesh”
2	Select the type “Operator”
3	Click on [OK]
4	Select the solver “HM Batch”



ADD HYPERMESH AND OPTISTRUCT MODELS

HyperMesh

OptiStruct

HyperMesh model import

- Add input files

Step	Action
1	Click on [Model Resource]
2	Right click on the model "HyperMesh"
3	Click on [Add Input File]
4	Add the two files: - reference1.hm - update_motor.tcl in the folder "5_Structural"

The image shows three screenshots from the Altair HyperMesh software interface illustrating the steps to add input files to a HyperMesh model.

Step 1: The "Model Resources" table is shown. A blue circle with the number "1" highlights the "Model Resources" button in the top toolbar. The table lists various models and their associated resources.

Active	Label	Vname	Type	Resource	Solver Input File	Solver Execution Script	Solver Input Arguments	Comment
1	FluxMotor	m_1	FluxMotor	E:\...\Connector_FM_Hst\Connector_FM_Hst.fm2hst	hst_input.htsp	FluxMotor 2021	...	...
2	Flux Base Point	m_2	Flux	E:\...\MagBasePoint\Connector_Fx_Hst_BasePoint.F2HST	hst_input.htsp	Flux 2021.2	-batch	...
3	Flux Operating Point	m_3	Flux	E:\...\MagOperatingPoint\Connector_Fx_Hst_OperatingPoint.F2HST	hst_input.htsp	Flux 2021.2	-batch	...
4	Flux Thermal	m_4	Flux	E:\...\Thermal\Connector_Fx_Hst_Thermal.F2HST	hst_input.htsp	Flux 2021.2	-batch	...
5	HyperMesh	m_5	Operator		hst_input.htsp	HM Batch		...

Step 2: The "Model Resources" dialog is shown. A blue circle with the number "2" highlights the "HyperMesh (m_5)" model in the "Resources" list. A blue circle with the number "3" highlights the "Add Input File" option in the context menu.

Step 3: The "Select File" dialog is shown. A blue circle with the number "4" highlights the "reference1.hm" and "update_motor.tcl" files in the "5_Structural" folder.

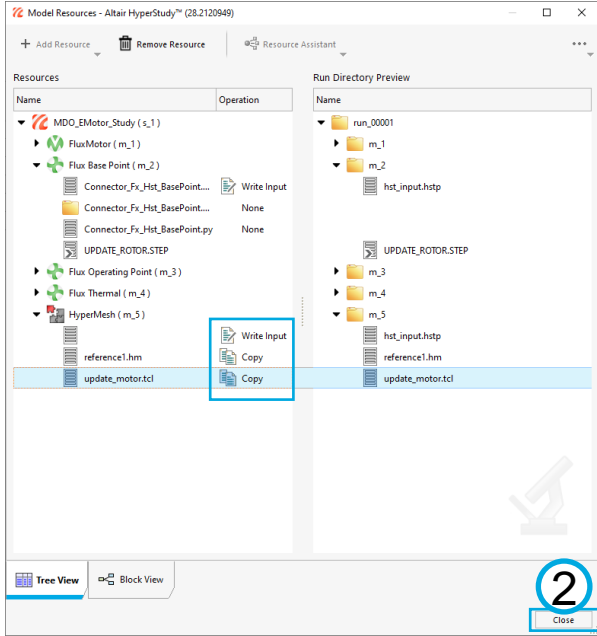
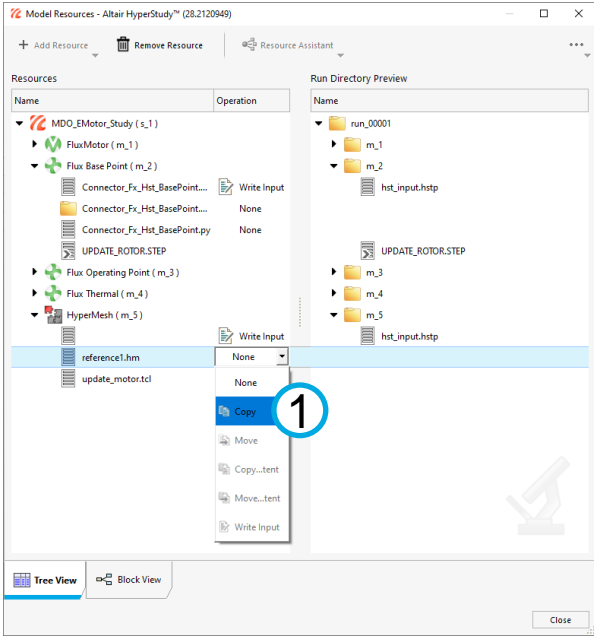
ADD HYPERMESH AND OPTISTRUCT MODELS



HyperMesh model import

- Add input files

Step	Action
1	Modify the Operation of the two files: - reference1.hm - update_motor.tcl as type "Copy"
2	Click on [Close]



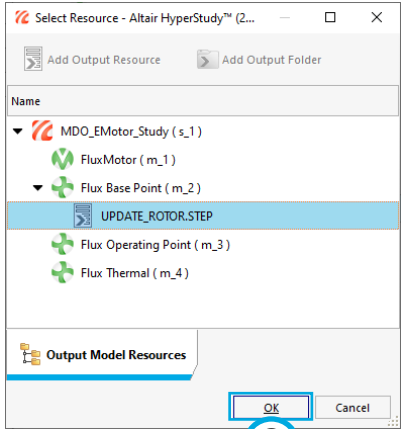
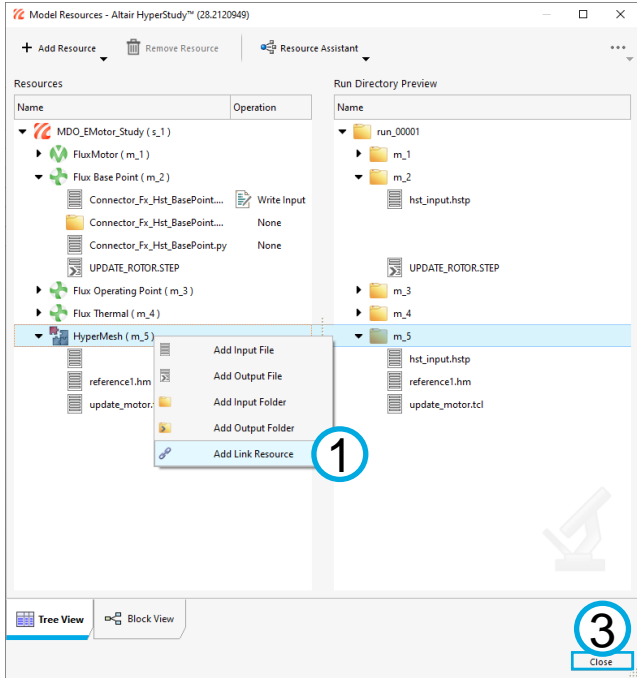
ADD HYPERMESH AND OPTISTRUCT MODELS



HyperMesh model import

- Add linked file

Step	Action
1	Right click on the model “HyperMesh (m_5)”, click on [Add Link Resource]
2	Select the file “UPDATE_ROTOR.STEP” from the “Flux Base Speed” model, click on [OK]
3	Click on [Close]



ADD HYPERMESH AND OPTISTRUCT MODELS



HyperMesh model import

- Define solver input arguments

Step	Action
1	In the [Solver Input Arguments], input -tcl update_motor.tcl reference1.hm

Active	Label	Vaname	Type	Resource	Solver Input File	Solver Execution Script	Solver Input Arguments	Comment
<input checked="" type="checkbox"/>	FluxMotor	m_1	FluxMotor	E:\...Connector_FM_HstConnector_FM_Hst.fm2hst	hst_input.hstip	FluxMotor 2021	...	...
<input checked="" type="checkbox"/>	Flux Base Point	m_2	Flux	E:\...MagBasePointConnector_Fx_Hst_BasePoint.F2HST	hst_input.hstip	Flux 2021.2	-batch	...
<input checked="" type="checkbox"/>	Flux Operating Point	m_3	Flux	E:\...MagOperatingPointConnector_Fx_Hst_OperatingPoint.F2HST	hst_input.hstip	Flux 2021.2	-batch	...
<input checked="" type="checkbox"/>	Flux Thermal	m_4	Flux	E:\...ThermalConnector_Fx_Hst_Thermal.F2HST	hst_input.hstip	Flux 2021.2	-batch	...
<input checked="" type="checkbox"/>	HyperMesh	m_5	Operator		hst_input.hstip	HM Batch	-tcl update_motor.tcl reference1.hm	...

ADD HYPERMESH AND OPTISTRUCT MODELS



HyperMesh model import

- Pre-processing for the HyperMesh model

Step	Action
1	Click on [Test Models]
2	Click successively on [Write] – [Execute] – [Extract] for the model HyperMesh

The screenshot shows the Altair HyperMesh software interface. The 'Test Models' table is visible, listing various models and their associated actions. A blue circle with the number '1' highlights the 'Test Models' option in the left-hand 'Setup' menu. Another blue circle with the number '2' highlights the 'Write', 'Execute', and 'Extract' buttons for the 'HyperMesh' model in the table.

Active	Label	Write	Execute	Extract	Type	Resource	Sequence
<input checked="" type="checkbox"/>	FluxMotor	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	FluxMotor	ES...Connector_FM_HatConnector_FM_HatIn...	1
<input checked="" type="checkbox"/>	Flux Base Point	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Flux	ES...MagBasePointConnector_Fx_Hat_BaseP...	2
<input checked="" type="checkbox"/>	Flux Operating...	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Flux	ES...MagOperatingPointConnector_Fx_Hat_...	3
<input checked="" type="checkbox"/>	Flux Thermal	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Flux	ES...ThermalConnector_Fx_Hat_ThermalF2...	4
<input checked="" type="checkbox"/>	HyperMesh	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Operator		Skip - No Outp...

ADD HYPERMESH AND OPTISTRUCT MODELS

HyperMesh

OptiStruct

HyperMesh model import

- Define output file

Step	Action
1	Click on [Define Models]
2	Click on [Model Resources]
3	Right click on the model "HyperMesh (m_5)", click on [Add Output File]
4	Select on the file "update_Rotor.fem" in the output folder, click on [OK]
5	Click on [Close]

The screenshot illustrates the steps for adding an output file to a HyperMesh model in Altair HyperStudy. The interface is divided into several panels:

- Define Models Table:** A table with columns for Active, Label, Varname, Type, Resource, Solver Input File, Solver Execution Script, and Solver Input Arguments. The 'HyperMesh' model (m_5) is highlighted.
- Model Resources Panel:** A tree view showing the model structure. The 'HyperMesh (m_5)' model is selected, and a context menu is open with 'Add Output File' highlighted.
- Select File Dialog:** A dialog box showing the file selection process. The file 'update_Rotor.fem' is selected in the 'Downloads' folder.

Numbered callouts (1-5) indicate the sequence of actions: 1. Click on [Define Models], 2. Click on [Model Resources], 3. Right click on the model "HyperMesh (m_5)", click on [Add Output File], 4. Select on the file "update_Rotor.fem" in the output folder, click on [OK], 5. Click on [Close].

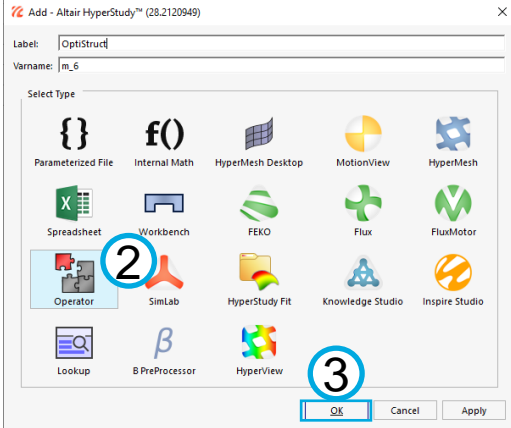
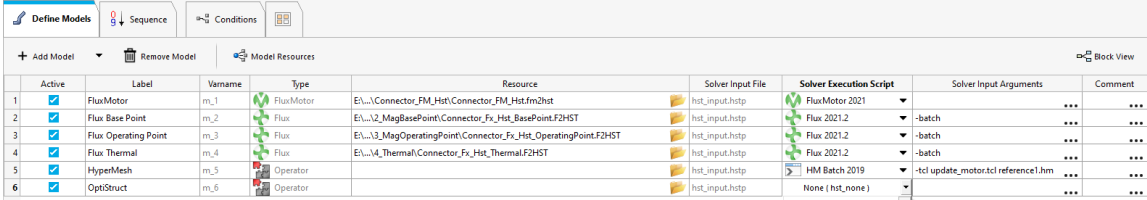
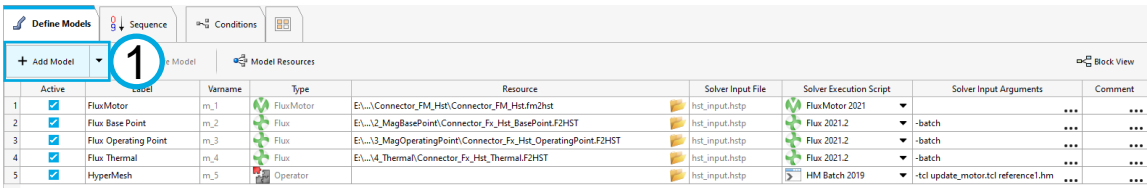
ADD HYPERMESH AND OPTISTRUCT MODELS



OptiStruct model import

- Create a new **Operator**

Step	Action
1	Click on [Add Model] to create the model "OptiStruct"
2	Select the type "Operator"
3	Click on [OK]
4	Select the solver "OptiStruct"



ADD HYPERMESH AND OPTISTRUCT MODELS



OptiStruct model import

- Add input file (link resources)

Step	Action
1	Click on [Model Resource]
2	Right click on the model "OptiStruct", click on [Add Link Resource]
3	Select the file "update_Rotor.fem" from the HyperMesh model, click on [OK]
4	Click on [Close]

Active	Label	Vname	Type	Resource	Solver Input File	Solver Execution Script	Solver Input Arguments	Comment
<input checked="" type="checkbox"/>	FluxMotor	m_1	FluxMotor	E:\...\Connector_FM_Hst_Connector_FM_Hst.fem2ht	ht_input.htsp	FluxMotor 2021	...	...
<input checked="" type="checkbox"/>	Flux Base Point	m_2	Flux	E:\...\MagBasePoint_Connector_Fx_Hst_BasePoint.F2HST	ht_input.htsp	Flux 2021.2	-batch	...
<input checked="" type="checkbox"/>	Flux Operating Point	m_3	Flux	E:\...\MagOperatingPoint_Connector_Fx_Hst_OperatingPoint.F2HST	ht_input.htsp	Flux 2021.2	-batch	...
<input checked="" type="checkbox"/>	Flux Thermal	m_4	Flux	E:\...\Thermal_Connector_Fx_Hst_Thermal.F2HST	ht_input.htsp	Flux 2021.2	-batch	...
<input checked="" type="checkbox"/>	HyperMesh	m_5	Operator		ht_input.htsp	HM Batch 2019	-tcl update_motor.tcl	reference1.hm
<input checked="" type="checkbox"/>	OptiStruct	m_6	Operator		ht_input.htsp	OptiStruct		...

Model Resources - Altair HyperStudy™ (28.2120949)

Resources

- MDO_EMotor_Study (s_1)
 - FluxMotor (m_1)
 - Flux Base Point (m_2)
 - Connector_Fx_Hst_BasePoint... Write Input
 - Connector_Fx_Hst_BasePoint... None
 - Connector_Fx_Hst_BasePoint.py None
 - UPDATE_ROTOR.STEP
 - Flux Operating Point (m_3)
 - Flux Thermal (m_4)
 - HyperMesh (m_5)
 - reference1.hm Write Input
 - update_motor.tcl Copy
 - UPDATE_ROTOR.STEP Copy
 - update_Rotor.fem Copy
 - OptiStruct (m_6)
 - Add Input File
 - Add Output File
 - Add Input Folder
 - Add Output Folder
 - Add Link Resource

Run Directory Preview

- run_00001
 - m_1
 - m_2
 - hst_input.htsp
 - UPDATE_ROTOR.STEP
 - m_3
 - m_4
 - m_5
 - hst_input.htsp
 - reference1.hm
 - update_motor.tcl
 - UPDATE_ROTOR.STEP
 - update_Rotor.fem
 - m_6

Select Resource - Altair HyperStudy™ (2...

Add Output Resource Add Output Folder

Name

- FluxMotor (m_1)
- Flux Base Point (m_2)
 - UPDATE_ROTOR.STEP
- Flux Operating Point (m_3)
- Flux Thermal (m_4)
- HyperMesh (m_5)
 - update_Rotor.fem

Output Model Resources

OK Cancel

ADD HYPERMESH AND OPTISTRUCT MODELS



OptiStruct model import

- Define input arguments

Step	Action
1	In the [Solver Input Arguments], input the command <code>update_rotor.fem -nt 4 -optskip -len 15000</code>

Active	Label	Vname	Type	Resource	Solver Input File	Solver Execution Script	Solver Input Arguments	Comment
<input checked="" type="checkbox"/>	FluxMotor	m_1	FluxMotor	E:_1_Connector_FM_Hst\Connector_FM_Hst.fem2hst	hst_input.hstip	FluxMotor 2021	...	...
<input checked="" type="checkbox"/>	Flux Base Point	m_2	Flux	E:_12_MagBasePoint\Connector_Fx_Hst_BasePoint.F2HST	hst_input.hstip	Flux 2021.2	-batch	...
<input checked="" type="checkbox"/>	Flux Operating Point	m_3	Flux	E:_13_MagOperatingPoint\Connector_Fx_Hst_OperatingPoint.F2HST	hst_input.hstip	Flux 2021.2	-batch	...
<input checked="" type="checkbox"/>	Flux Thermal	m_4	Flux	E:_14_Thermal\Connector_Fx_Hst_Thermal.F2HST	hst_input.hstip	Flux 2021.2	-batch	...
<input checked="" type="checkbox"/>	HyperMesh	m_5	Operator		hst_input.hstip	HM Batch 2019	-tcl update_motor.tcl reference.lhm	...
<input checked="" type="checkbox"/>	OptiStruct	m_6	Operator		hst_input.hstip	OptiStruct	update_rotor.fem -nt 4 -optskip -len 15000	...

Notes:

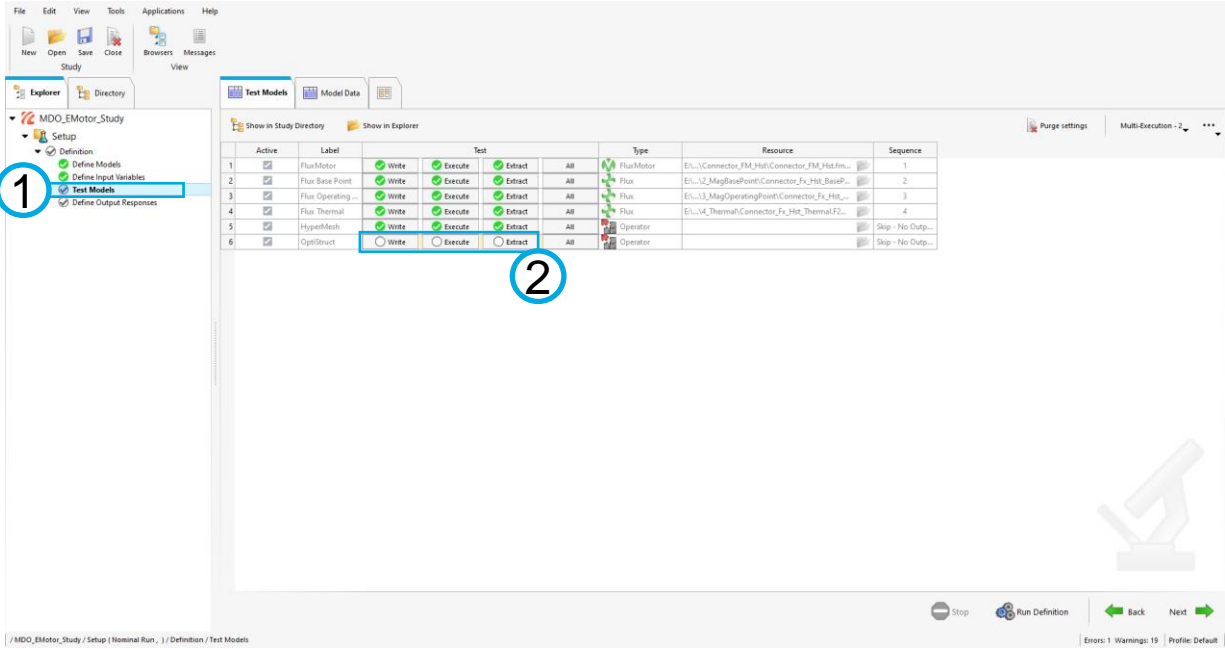
- 1) -nt 4 means 4 cores in parallel are used;
- 2) -len 15000 means 15 Gb of RAM are reserved for the OptiStruct process.

MECHANICAL PROBLEM SOLVING

MECHANICAL PROBLEM SOLVING

OptiStruct model solving

Step	Action
1	Click on [Test Models]
2	Click successively on [Write] – [Execute] – [Extract] for the model HyperMesh



MECHANICAL PROBLEM SOLVING

OptiStruct model post-processing

- Visualize the mechanical analysis result

Step	Action
1	Click on [Show in Explorer]
2	Open the file "update_rotor.mvw" in the project output folder ~\HyperStudy\approaches\setup_1-defrun__00001\m_6

Active	Label	Write	Execute	Extract	Type	Resource	Sequence
<input checked="" type="checkbox"/>	Flux/Motor	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Flux/Motor	E:\...Connector_FM_Hst\Connector_FM_Hst.fm...	1
<input checked="" type="checkbox"/>	Flux Base Point	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Flux	E:\..._V2_MagBasePoint\Connector_Fx_Hst_BaseP...	2
<input checked="" type="checkbox"/>	Flux Operating ...	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Flux	E:\..._V3_MagOperatingPoint\Connector_Fx_Hst_...	3
<input checked="" type="checkbox"/>	Flux Thermal	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Flux	E:\..._V4_Thermal\Connector_Fx_Hst_Thermal.F2...	4
<input checked="" type="checkbox"/>	HyperMesh	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Operator		Skip - No Outp...
<input checked="" type="checkbox"/>	OptiStruct	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Operator		Skip - No Outp...

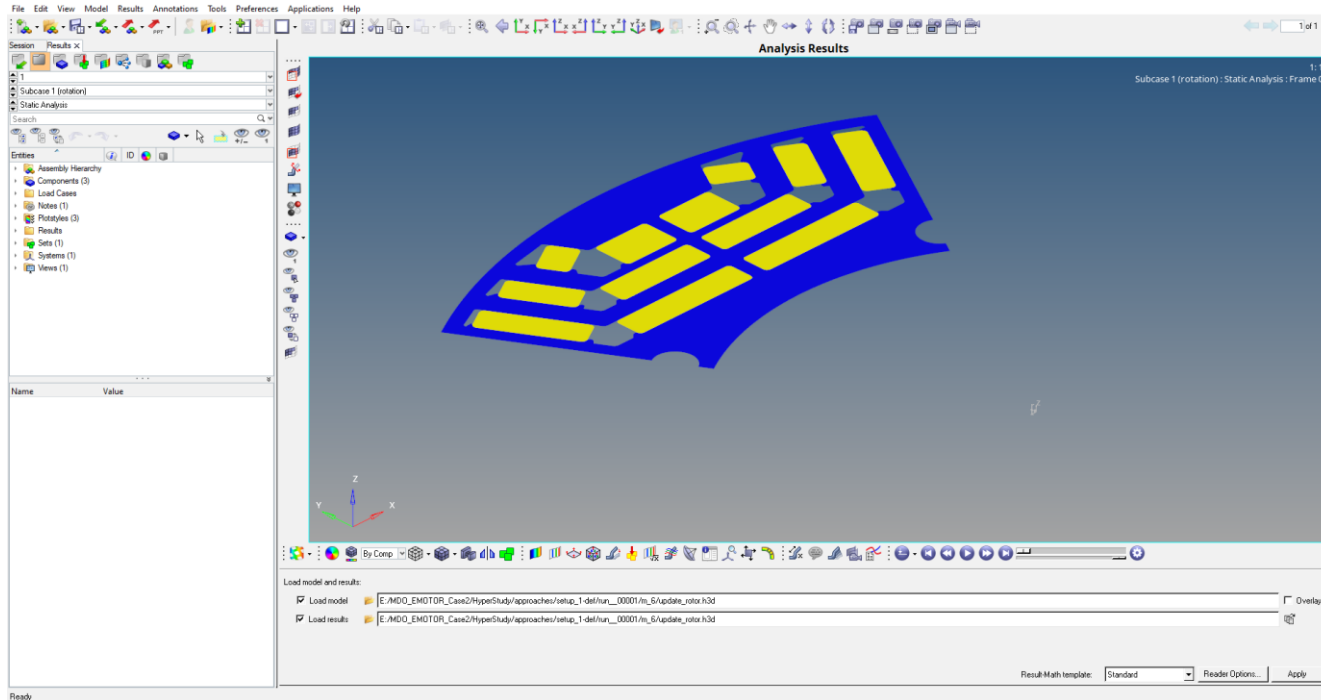
File Explorer window showing the file 'update_rotor.mvw' selected in the folder path: MDO_EMOTOR_Case2 > HyperStudy > approaches > setup_1-def > run__00001 > m_6.

Software interface showing a 'Run Definition' button and navigation arrows (Back, Next).

MECHANICAL PROBLEM SOLVING

OptiStruct model post-processing



- Visualize the mechanical analysis result

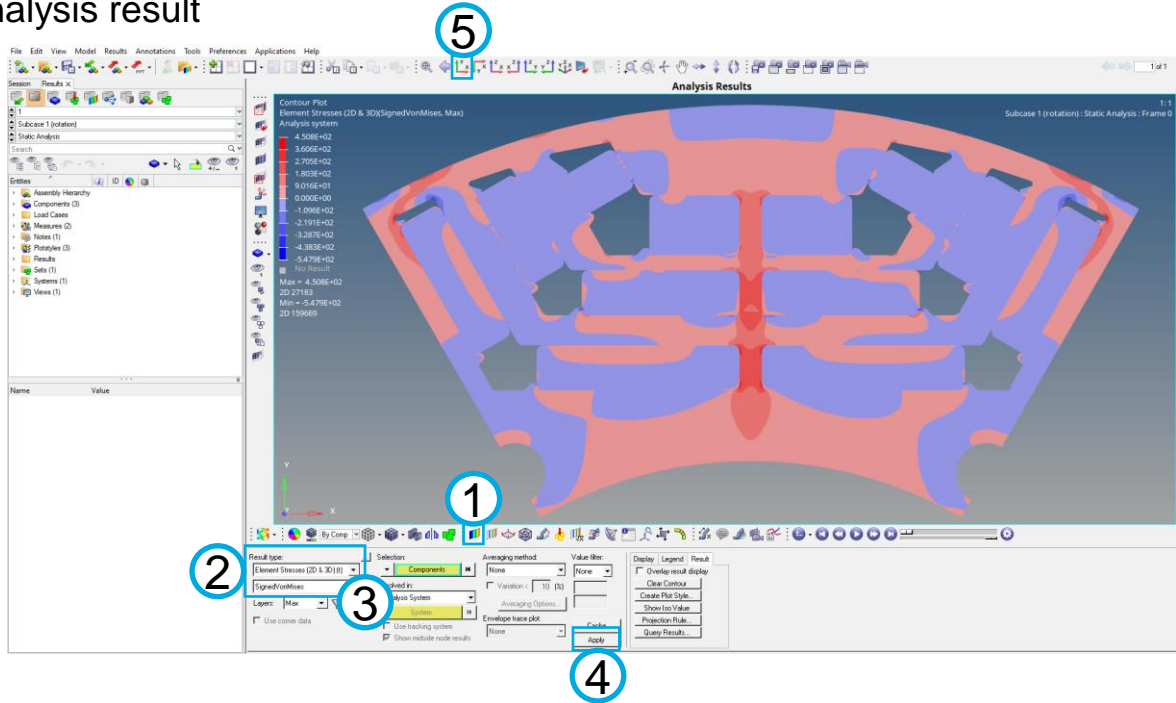


MECHANICAL PROBLEM SOLVING

OptiStruct model post-processing

- Visualize the mechanical analysis result

Step	Action
1	Click on the icon 
2	Select [Element Stress (2D&3D)]
3	Select [SignedVonMises]
4	Click on [Apply]
5	Click on the icon  to adjust the view



MECHANICAL PROBLEM SOLVING

HyperMesh and OptiStruct model post-processing

- Define output response (**HyperMesh** model)

Step	Action
1	Click on [Define Output Response]
2	Click on [Add output Response]
3	Define the new output response label as "OUTPUT_HYPERMESH_MODEL"
4	Click on [...]

The screenshot shows the 'Define Output Responses' dialog in HyperMesh. The table below represents the data visible in the dialog:

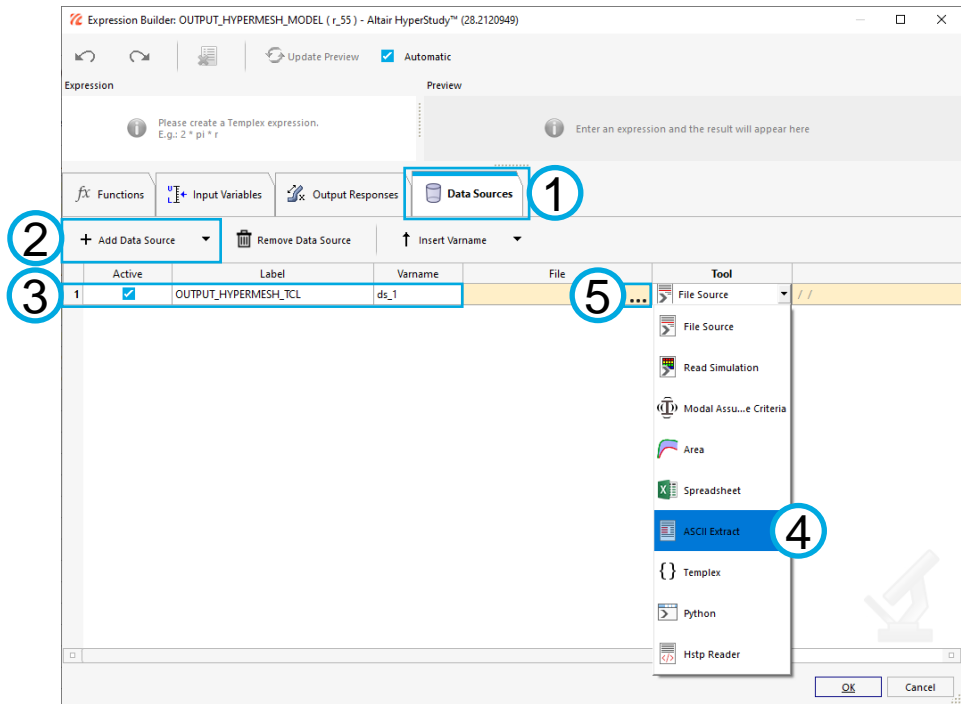
Active	Label	Variable	Expression	Value	Goals	Output Type	Comment
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_1B_ME...	r_28	m_3_MAGNET_LOSSES_OPERATING_POINT_1B_MEAN	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_1C_ME...	r_29	m_3_MAGNET_LOSSES_OPERATING_POINT_1C_MEAN	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_1C_ME...	r_30	m_3_MAGNET_LOSSES_OPERATING_POINT_1C_MEAN	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_1C_ME...	r_31	m_3_MAGNET_LOSSES_OPERATING_POINT_1C_MEAN	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_1A_ME...	r_32	m_3_MAGNET_LOSSES_OPERATING_POINT_1A_MEAN	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_2A_ME...	r_33	m_3_MAGNET_LOSSES_OPERATING_POINT_2A_MEAN	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_2B_ME...	r_34	m_3_MAGNET_LOSSES_OPERATING_POINT_2B_MEAN	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_2B_ME...	r_35	m_3_MAGNET_LOSSES_OPERATING_POINT_2B_MEAN	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_2C_ME...	r_36	m_3_MAGNET_LOSSES_OPERATING_POINT_2C_MEAN	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_2C_ME...	r_37	m_3_MAGNET_LOSSES_OPERATING_POINT_2C_MEAN	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_COIL	r_38	m_4_T_COIL	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_1B	r_39	m_4_T_MAG_1B	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_1B_SYMM	r_40	m_4_T_MAG_1B_SYMM	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_1B	r_41	m_4_T_MAG_1B	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_1B_SYMM	r_42	m_4_T_MAG_1B_SYMM	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_1C	r_43	m_4_T_MAG_1C	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_1C_SYMM	r_44	m_4_T_MAG_1C_SYMM	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_2A	r_45	m_4_T_MAG_2A	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_2A_SYMM	r_46	m_4_T_MAG_2A_SYMM	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_2B	r_47	m_4_T_MAG_2B	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_2B_SYMM	r_48	m_4_T_MAG_2B_SYMM	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_2C	r_49	m_4_T_MAG_2C	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_MAG_2C_SYMM	r_50	m_4_T_MAG_2C_SYMM	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_ROTOR_YOKE	r_51	m_4_T_ROTOR_YOKE	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	T_STATOR_YOKE	r_52	m_4_T_STATOR_YOKE	Not Extracted		+ Real	PHYS ...
<input checked="" type="checkbox"/>	TORQUE_BASE_SPEED_BURPLE	r_53	r_21-r_22	...		+ Real	...
<input checked="" type="checkbox"/>	MAX_MAGNET_TEMPERATURE	r_54	max(r_38, r_40, r_41, r_42, r_43, r_44, r_45, r_46, r_47, r_48, r_49, r_50, r_51, r_52)	...		+ Real	...
<input checked="" type="checkbox"/>	OUTPUT_HYPERMESH_MODEL	r_55	...	Not Extracted		+ Real	...

MECHANICAL PROBLEM SOLVING

HyperMesh and OptiStruct model post-processing

- Define output response (**HyperMesh** model)


Step	Action
1	Click on [Data Sources]
2	Click on [Add Data Source]
3	Define the new data source label as "OUTPUT_HYPERMESH_TCL"
4	Select the type as "ASCII Extract"
5	Click on [...]

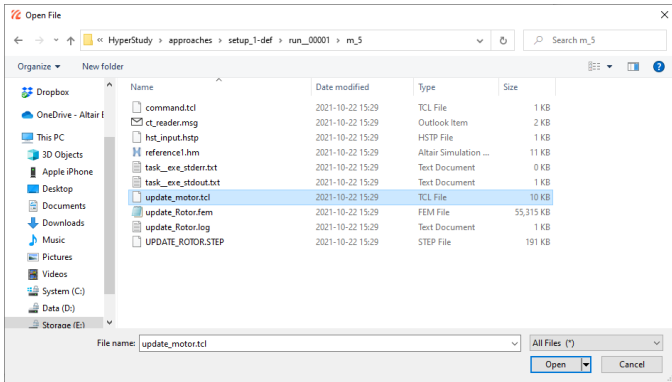
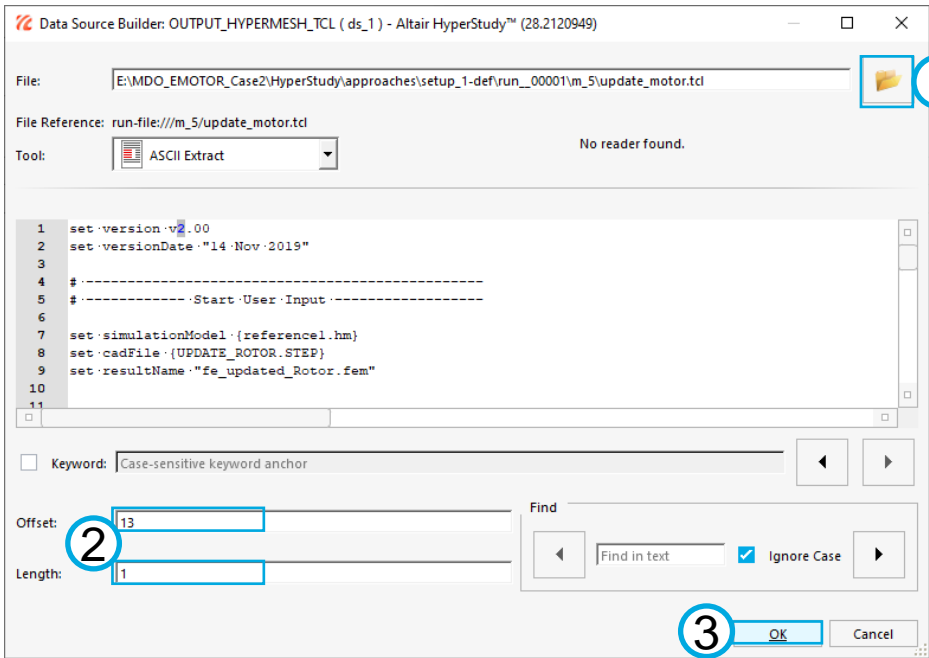


MECHANICAL PROBLEM SOLVING

HyperMesh and OptiStruct model post-processing

- Define output response (**HyperMesh** model)

Step	Action
1	Click on the icon  to locate the file "update_motor.tcl" in the folder "run_00001/m_5"
2	Define the Offset as 13, and Length as 1
3	Click on [OK]

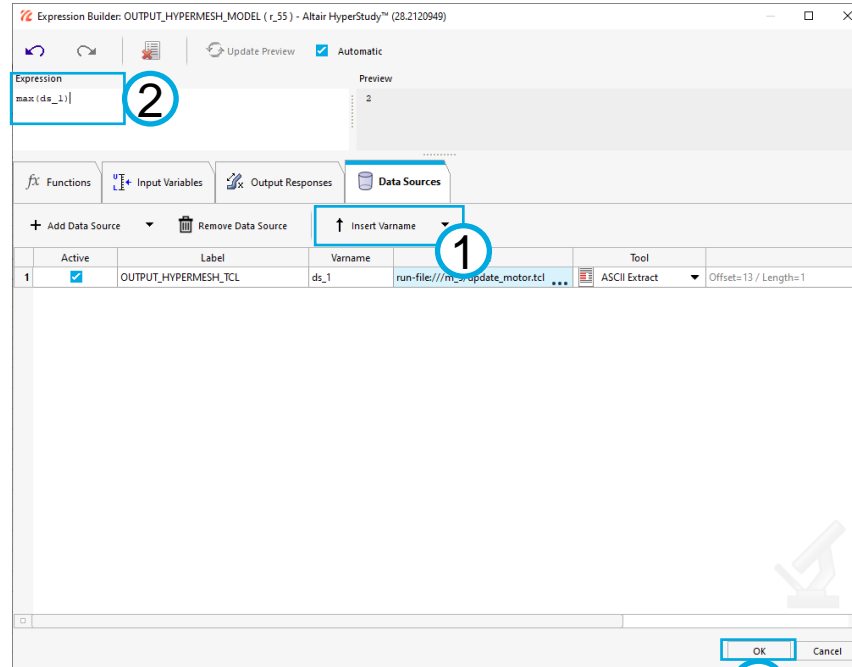


MECHANICAL PROBLEM SOLVING PROBLEM SOLVING

HyperMesh and OptiStruct model post-processing

- Define output response (**HyperMesh** model)

Step	Action
1	Click on [Insert Varname]
2	Verify if the expression is “max(ds_1)”
3	Click on [OK]



MECHANICAL PROBLEM SOLVING

HyperMesh and OptiStruct model post-processing

- Define output response (**OptiStruct** model)

Step	Action
1	Click on [Add output Response]
2	Define the new output response label as "MECHANICAL_STRESS_MAX"
4	Click on [...]

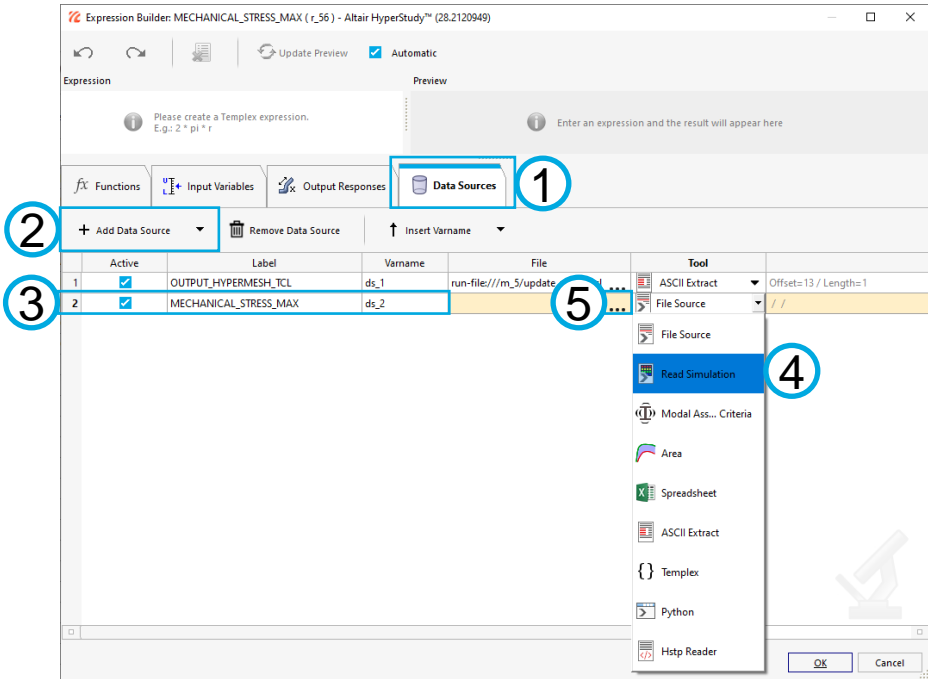
Active	Label	Varname	Expression	Value	Goals	Output Type	Comment
29	MAGNET_LOSSES_OPERATING_POINT_1B_SY...	r_29	m_3.MAGNET_LOSSES_OPERATING_POINT_1B_SYM_ME...	Not Extracted		+ Real	PHYS ...
30	MAGNET_LOSSES_OPERATING_POINT_1C_ME...	r_30	m_3.MAGNET_LOSSES_OPERATING_POINT_1C_MEAN	Not Extracted		+ Real	PHYS ...
31	MAGNET_LOSSES_OPERATING_POINT_1C_SY...	r_31	m_3.MAGNET_LOSSES_OPERATING_POINT_1C_SYM_ME...	Not Extracted		+ Real	PHYS ...
32	MAGNET_LOSSES_OPERATING_POINT_2A_ME...	r_32	m_3.MAGNET_LOSSES_OPERATING_POINT_2A_MEAN	Not Extracted		+ Real	PHYS ...
33	MAGNET_LOSSES_OPERATING_POINT_2A_SY...	r_33	m_3.MAGNET_LOSSES_OPERATING_POINT_2A_SYM_ME...	Not Extracted		+ Real	PHYS ...
34	MAGNET_LOSSES_OPERATING_POINT_2B_ME...	r_34	m_3.MAGNET_LOSSES_OPERATING_POINT_2B_MEAN	Not Extracted		+ Real	PHYS ...
35	MAGNET_LOSSES_OPERATING_POINT_2B_SY...	r_35	m_3.MAGNET_LOSSES_OPERATING_POINT_2B_SYM_ME...	Not Extracted		+ Real	PHYS ...
36	MAGNET_LOSSES_OPERATING_POINT_2C_ME...	r_36	m_3.MAGNET_LOSSES_OPERATING_POINT_2C_MEAN	Not Extracted		+ Real	PHYS ...
37	MAGNET_LOSSES_OPERATING_POINT_2C_SY...	r_37	m_3.MAGNET_LOSSES_OPERATING_POINT_2C_SYM_ME...	Not Extracted		+ Real	PHYS ...
38	T_COIL	r_38	m_4.T_COIL	Not Extracted		+ Real	PHYS ...
39	T_MAG_1A	r_39	m_4.T_MAG_1A	Not Extracted		+ Real	PHYS ...
40	T_MAG_1A_SYM	r_40	m_4.T_MAG_1A_SYM	Not Extracted		+ Real	PHYS ...
41	T_MAG_1B	r_41	m_4.T_MAG_1B	Not Extracted		+ Real	PHYS ...
42	T_MAG_1B_SYM	r_42	m_4.T_MAG_1B_SYM	Not Extracted		+ Real	PHYS ...
43	T_MAG_1C	r_43	m_4.T_MAG_1C	Not Extracted		+ Real	PHYS ...
44	T_MAG_1C_SYM	r_44	m_4.T_MAG_1C_SYM	Not Extracted		+ Real	PHYS ...
45	T_MAG_2A	r_45	m_4.T_MAG_2A	Not Extracted		+ Real	PHYS ...
46	T_MAG_2A_SYM	r_46	m_4.T_MAG_2A_SYM	Not Extracted		+ Real	PHYS ...
47	T_MAG_2B	r_47	m_4.T_MAG_2B	Not Extracted		+ Real	PHYS ...
48	T_MAG_2B_SYM	r_48	m_4.T_MAG_2B_SYM	Not Extracted		+ Real	PHYS ...
49	T_MAG_2C	r_49	m_4.T_MAG_2C	Not Extracted		+ Real	PHYS ...
50	T_MAG_2C_SYM	r_50	m_4.T_MAG_2C_SYM	Not Extracted		+ Real	PHYS ...
51	T_ROTOR YOKE	r_51	m_4.T_ROTOR YOKE	Not Extracted		+ Real	PHYS ...
52	T_STATOR YOKE	r_52	m_4.T_STATOR YOKE	Not Extracted		+ Real	PHYS ...
53	TORQUE_BASE_SPEED_RIPPLE	r_53	r_21-r_22	...		+ Real	...
54	MAX_MAGNET_TEMPERATURE	r_54	max(r_39, r_40, r_41, r_42, r_43, r_44, r_45, r_46, r_47, r_4...	Not Extracted		+ Real	...
55	OUTPUT_HYPERMESH_MODEL	r_55	max(ds_1)	Not Extracted		+ Real	...
56	MECHANICAL_STRESS_MAX	r_56	...	Not Extracted		+ Real	...

MECHANICAL PROBLEM SOLVING

HyperMesh and OptiStruct model post-processing

- Define output response (**OptiStruct** model)


Step	Action
1	Click on [Data Sources]
2	Click on [Add Data Source]
3	Define the new data source label as "MECHANICAL_STRESS_MAX"
4	Select the type as "Read Simulation"
5	Click on [...]

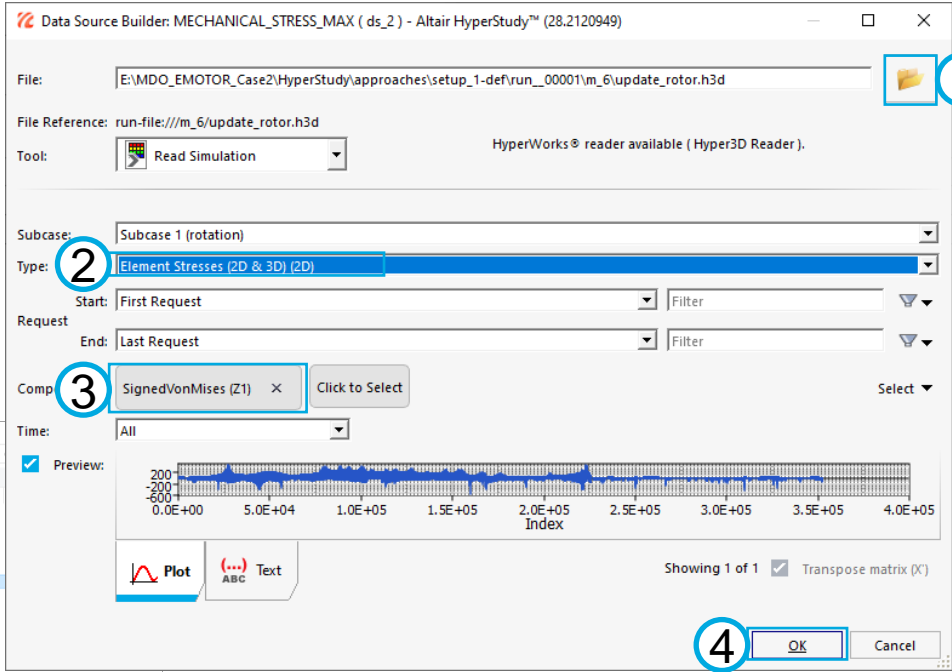
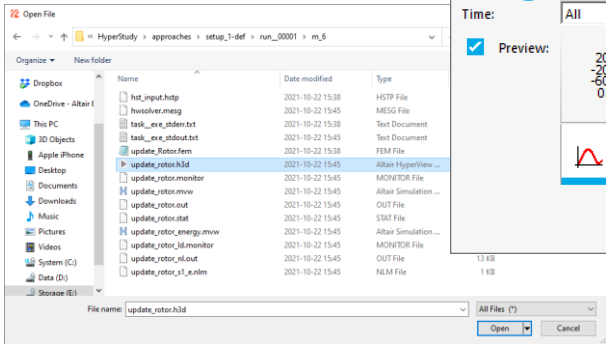


MECHANICAL PROBLEM SOLVING

HyperMesh and OptiStruct model post-processing

- Define output response (**OptiStruct** model)

Step	Action
1	Click on the icon  to locate the file "update_rotor.h3d" in the folder "run_00001/m_6"
2	Select the type as "Element Stresses"
3	Change the component to "SignedVonMises (Mid)"
4	Click on [OK]

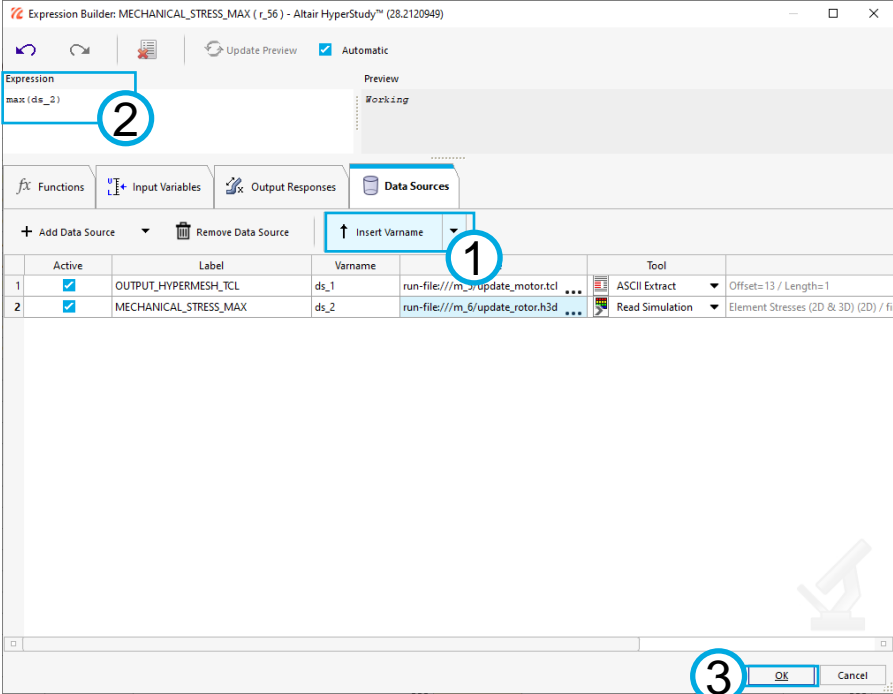


MECHANICAL PROBLEM SOLVING

HyperMesh and OptiStruct model post-processing

- Define output response (**OptiStruct** model)

Step	Action
1	Click on [Insert Varname]
2	Verify if the expression is “max(ds_2)”
3	Click on [OK]



MECHANICAL PROBLEM SOLVING

HyperMesh and OptiStruct model post-processing

- Evaluate new responses

Step	Action
1	Click on [Evaluate]

	Original value¹
Mechanical power at base point / W	137076.74
Rotor mass / kg	4.96
Mechanical torque at base point / N*m	183.15
Mechanical torque ripple at base point / N*m	43.16
Winding temperature / °C	151.04
Magnet temperature / °C	46.89
Mechanical stress / MPa	431.22

Active	Label	Varname	Expression	Value	Goals	Output Type	Comment
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_1B_SY...	r_29	m_3.MAGNET_LOSSES_OPERATING_POINT_1B_SYM_ME...	0.2931794		Real	PHYS
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_1C_ME...	r_30	m_3.MAGNET_LOSSES_OPERATING_POINT_1C_MEAN	0.1139576		Real	PHYS
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_1C_SY...	r_31	m_3.MAGNET_LOSSES_OPERATING_POINT_1C_SYM_ME...	0.0785157		Real	PHYS
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_2A_ME...	r_32	m_3.MAGNET_LOSSES_OPERATING_POINT_2A_MEAN	0.1344764		Real	PHYS
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_2A_SY...	r_33	m_3.MAGNET_LOSSES_OPERATING_POINT_2A_SYM_ME...	0.2093189		Real	PHYS
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_2B_ME...	r_34	m_3.MAGNET_LOSSES_OPERATING_POINT_2B_MEAN	0.0375729		Real	PHYS
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_2B_SY...	r_35	m_3.MAGNET_LOSSES_OPERATING_POINT_2B_SYM_ME...	0.4709016		Real	PHYS
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_2C_ME...	r_36	m_3.MAGNET_LOSSES_OPERATING_POINT_2C_MEAN	0.0551524		Real	PHYS
<input checked="" type="checkbox"/>	MAGNET_LOSSES_OPERATING_POINT_2C_SY...	r_37	m_3.MAGNET_LOSSES_OPERATING_POINT_2C_SYM_ME...	0.0753843		Real	PHYS
<input checked="" type="checkbox"/>	T_COIL	r_38	m_4.T_COIL	650.25072		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_1A	r_39	m_4.T_MAG_1A	85.317991		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_1A_SYM	r_40	m_4.T_MAG_1A_SYM	85.334434		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_1B	r_41	m_4.T_MAG_1B	86.755749		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_1B_SYM	r_42	m_4.T_MAG_1B_SYM	86.792418		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_1C	r_43	m_4.T_MAG_1C	88.995925		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_1C_SYM	r_44	m_4.T_MAG_1C_SYM	89.081314		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_2A	r_45	m_4.T_MAG_2A	87.589319		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_2A_SYM	r_46	m_4.T_MAG_2A_SYM	87.628837		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_2B	r_47	m_4.T_MAG_2B	88.152213		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_2B_SYM	r_48	m_4.T_MAG_2B_SYM	88.220820		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_2C	r_49	m_4.T_MAG_2C	89.314793		Real	PHYS
<input checked="" type="checkbox"/>	T_MAG_2C_SYM	r_50	m_4.T_MAG_2C_SYM	89.397699		Real	PHYS
<input checked="" type="checkbox"/>	T_ROTOR_YOKE	r_51	m_4.T_ROTOR_YOKE	88.356123		Real	PHYS
<input checked="" type="checkbox"/>	T_STATOR_YOKE	r_52	m_4.T_STATOR_YOKE	180.38080		Real	PHYS
<input checked="" type="checkbox"/>	TORQUE_BASE_SPEED_RIPPLE	r_53	r_21-r_22	101.55945		Real	PHYS
<input checked="" type="checkbox"/>	MAX_MAGNET_TEMPERATURE	r_54	max(r_39, r_40, r_41, r_42, r_43, r_44, r_45, r_46, r_47, r_4...	89.397699		Real	PHYS
<input checked="" type="checkbox"/>	OUTPUT_HYPERMESH_MODEL	r_55	max(dr_53)	2.0000000		Real	PHYS
<input checked="" type="checkbox"/>	MECHANICAL_STRESS_MAX	r_56	max(dr_54)	431.21609		Real	PHYS

¹Different software versions may cause slight changes in result values.



THANK YOU

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