Motor-CAD Software

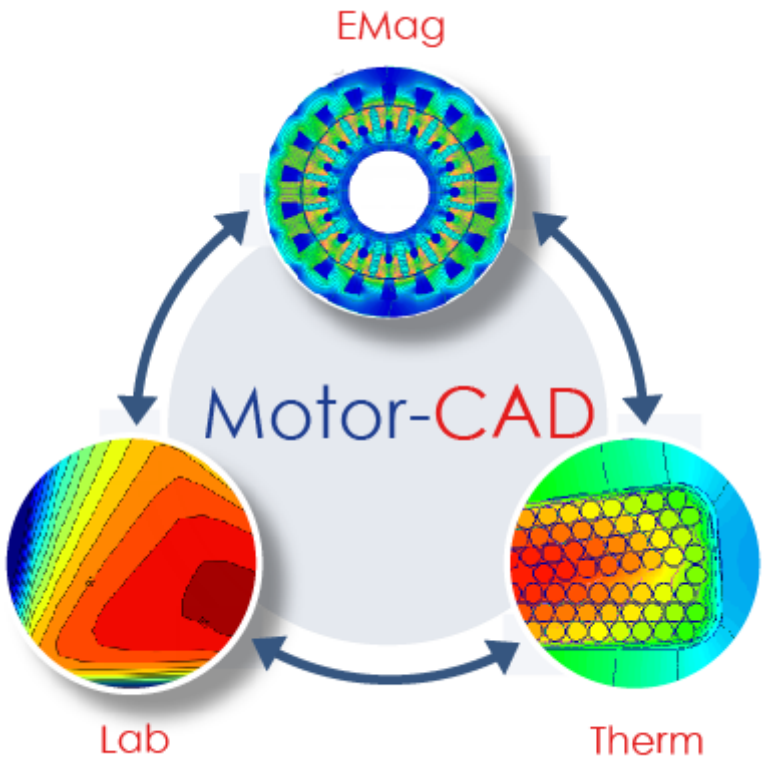
We develop Motor-CAD, the most complete and integrated electrical and thermal motor design software.

Motor-CAD is recognized worldwide as class-leading motor design software, providing integrated and highly accurate electrical, thermal and performance predictions for all your motor design needs.

EMag - An ultra fast 2D finite element module for accurate electromagnetic and electrical performance predictions.

Therm - Combines a lumped circuit and finite element thermal calculation for optimising the cooling system of a machine.

Lab - Works together with EMag and Therm to help develop new design concepts. Provides efficiency mapping and duty cycle / drive cycle transient outputs within a few minutes.



Motor-CAD Scripting Control for Duty Cycle analysis

(August 2015)

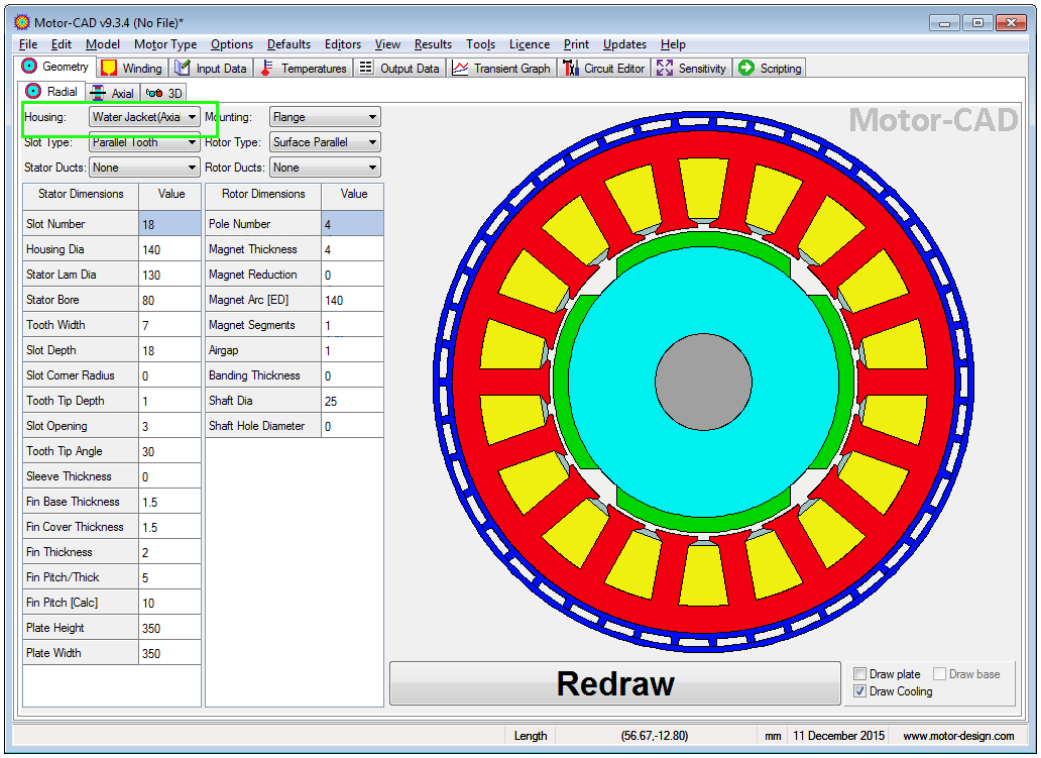
Description

This document gives a brief description of how the internal Motor-CAD scripting can be used to vary parameters during a duty cycle analysis. This can be useful for example for varying losses, for varying imposed temperatures, varying thermal paths or modifying flow rates using user specified functions.

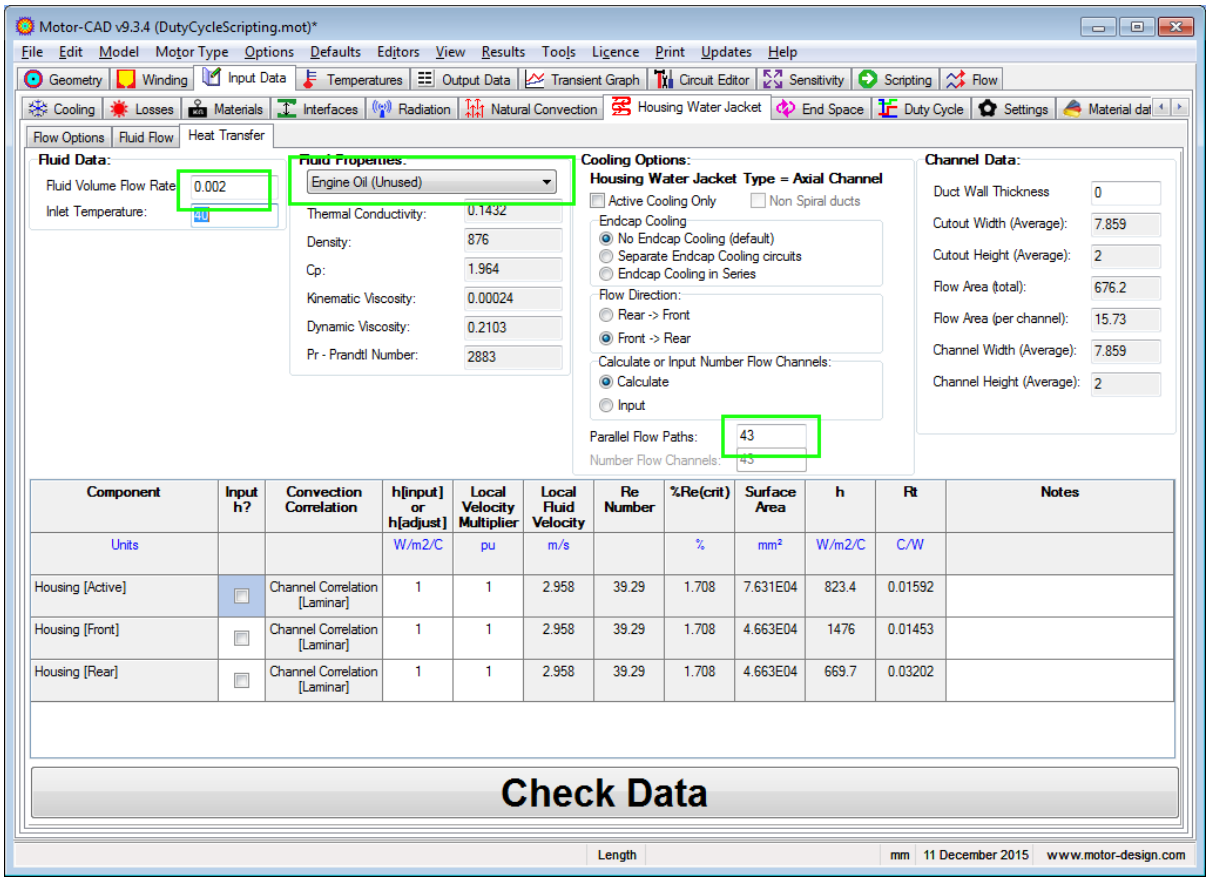
This tutorial will show an example of the scripting being used to vary the housing water jacket flow rate during a duty cycle.

Model Definition

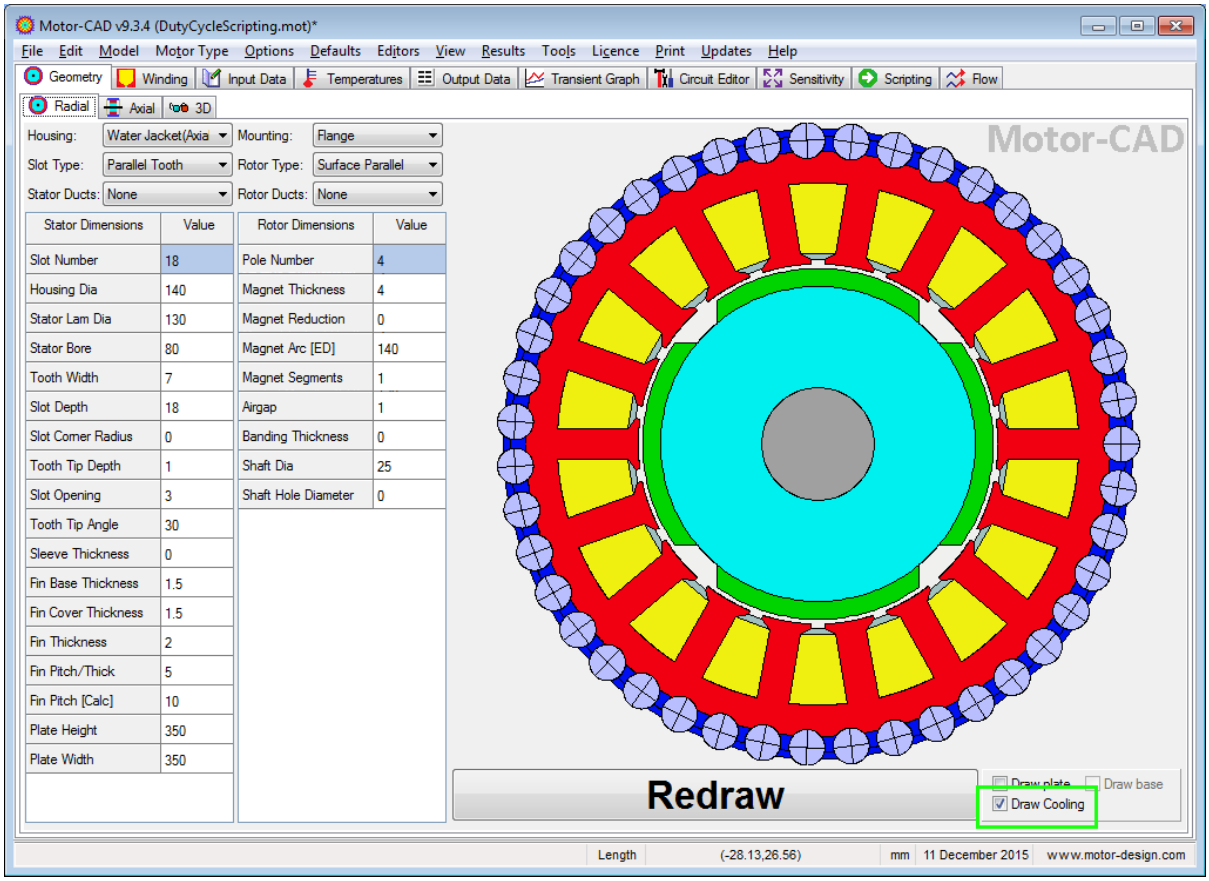
For this example a default machine geometry will be used. The housing is set to have axial water jacket channels as shown below:

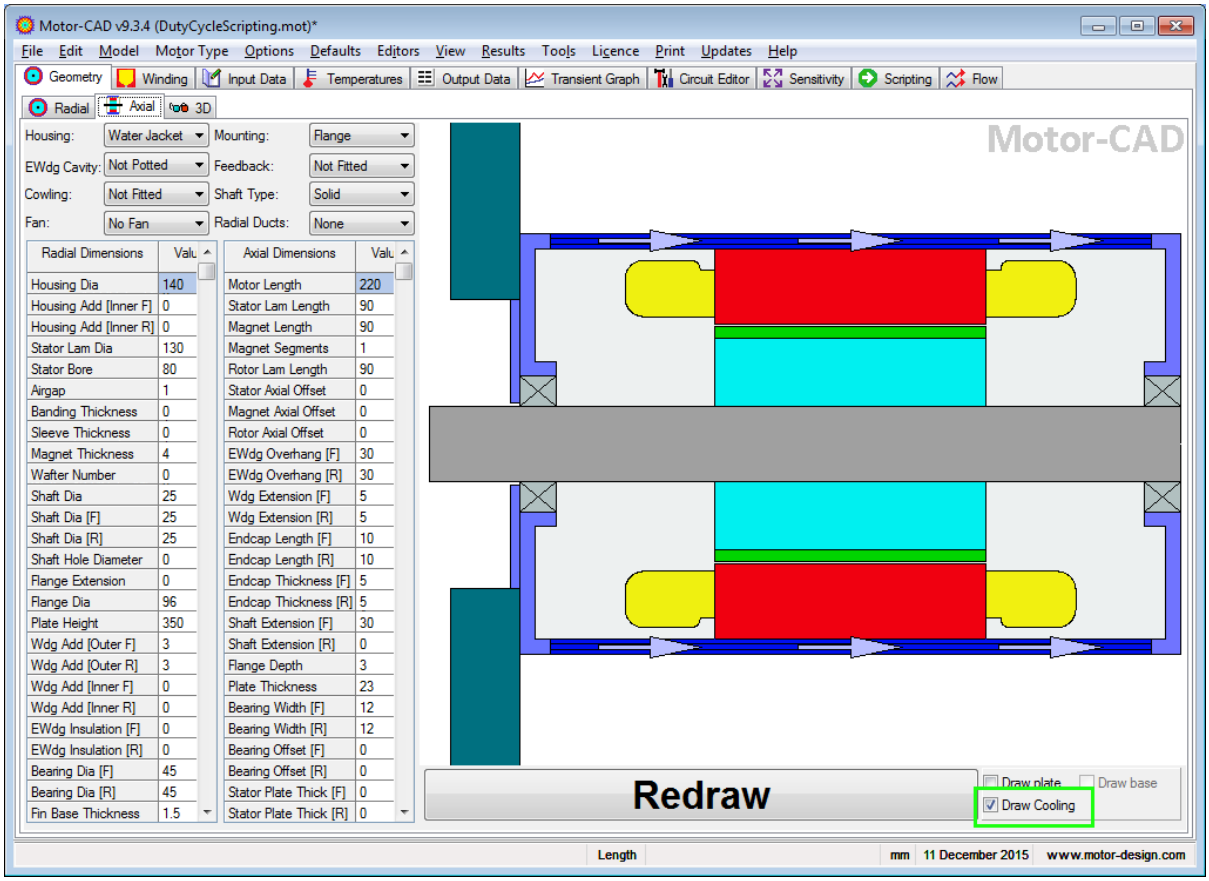


The default housing water jacket settings are used as shown below. For this example have set a flow rate of 0.002m3/s with a coolant of engine oil and the flow passing through all 43 ducts in parallel from front to rear of machine.

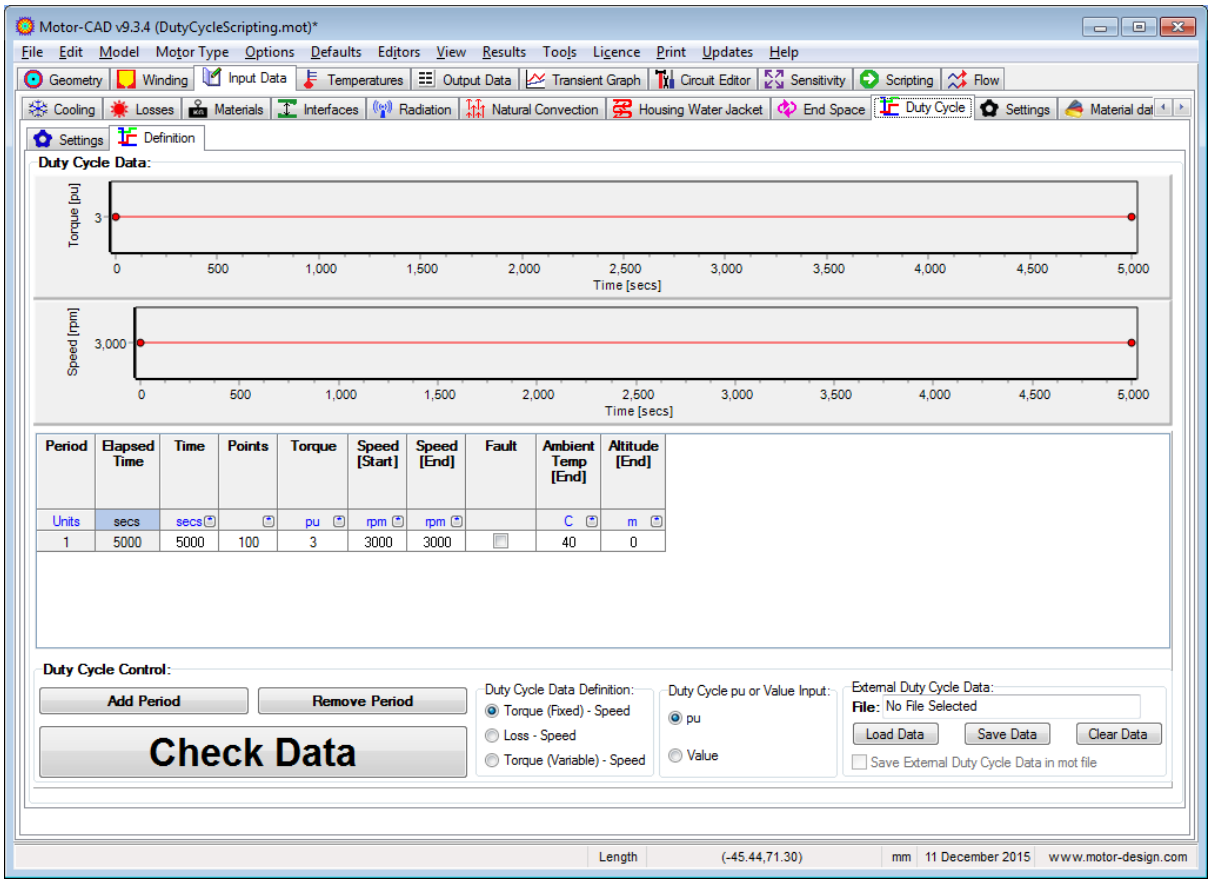


This flow is shown in the machine cross sections as shown below:

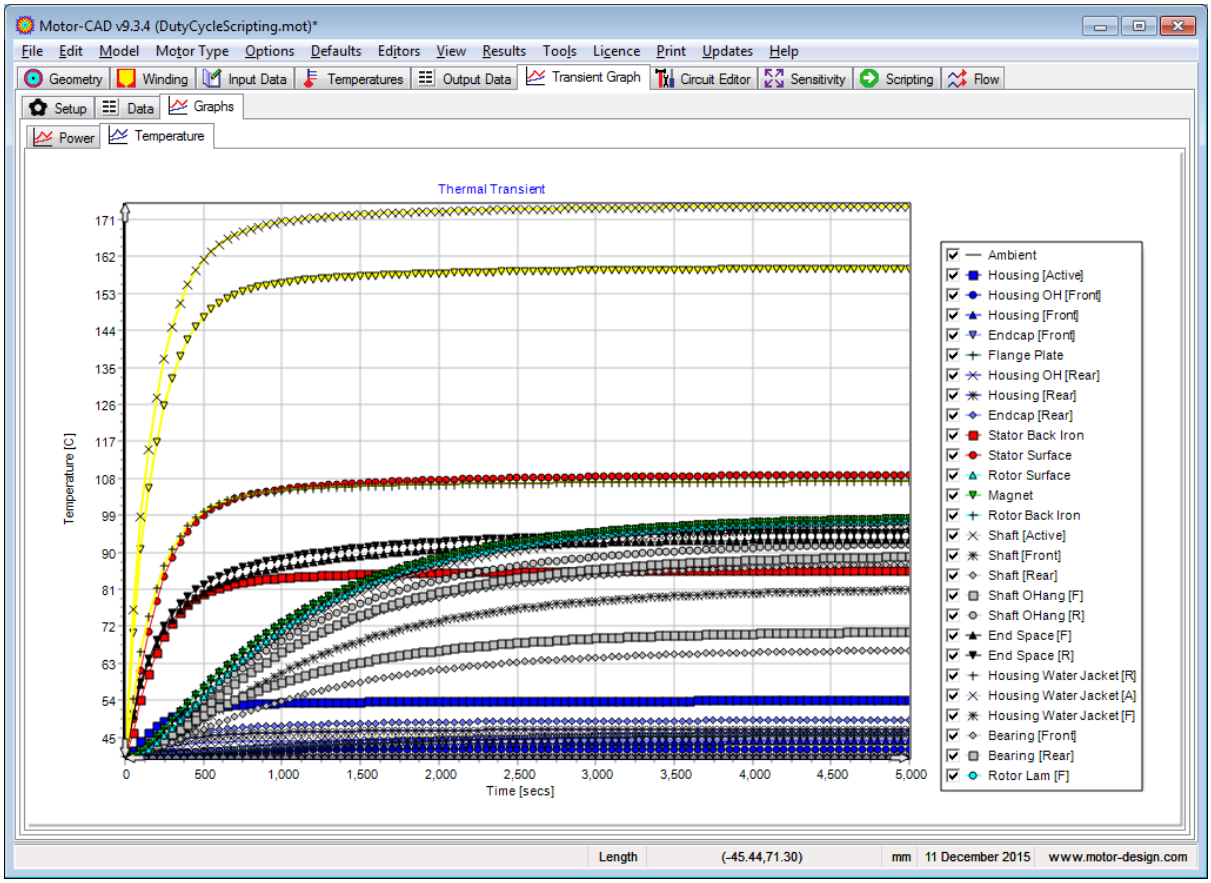




Have setup a simple duty cycle with a period of 5000 seconds where the machine is operating a 3 times per unit torque as shown below:



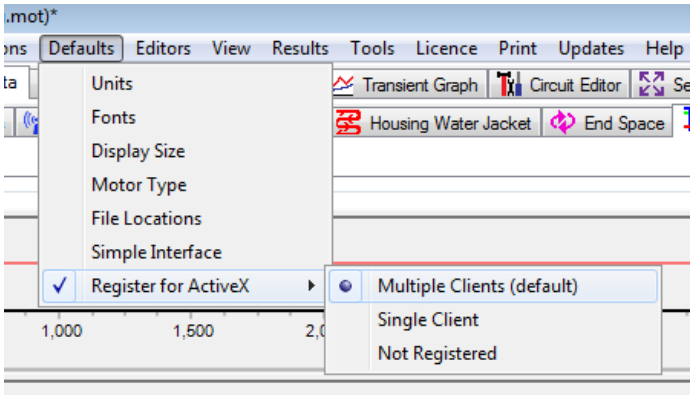
Run the transient analysis by clicking on the transient graph tab. The transient temperatures are shown below. It can be seen that the machine reaches a steady state operating point with the winding hotspot at 174C.



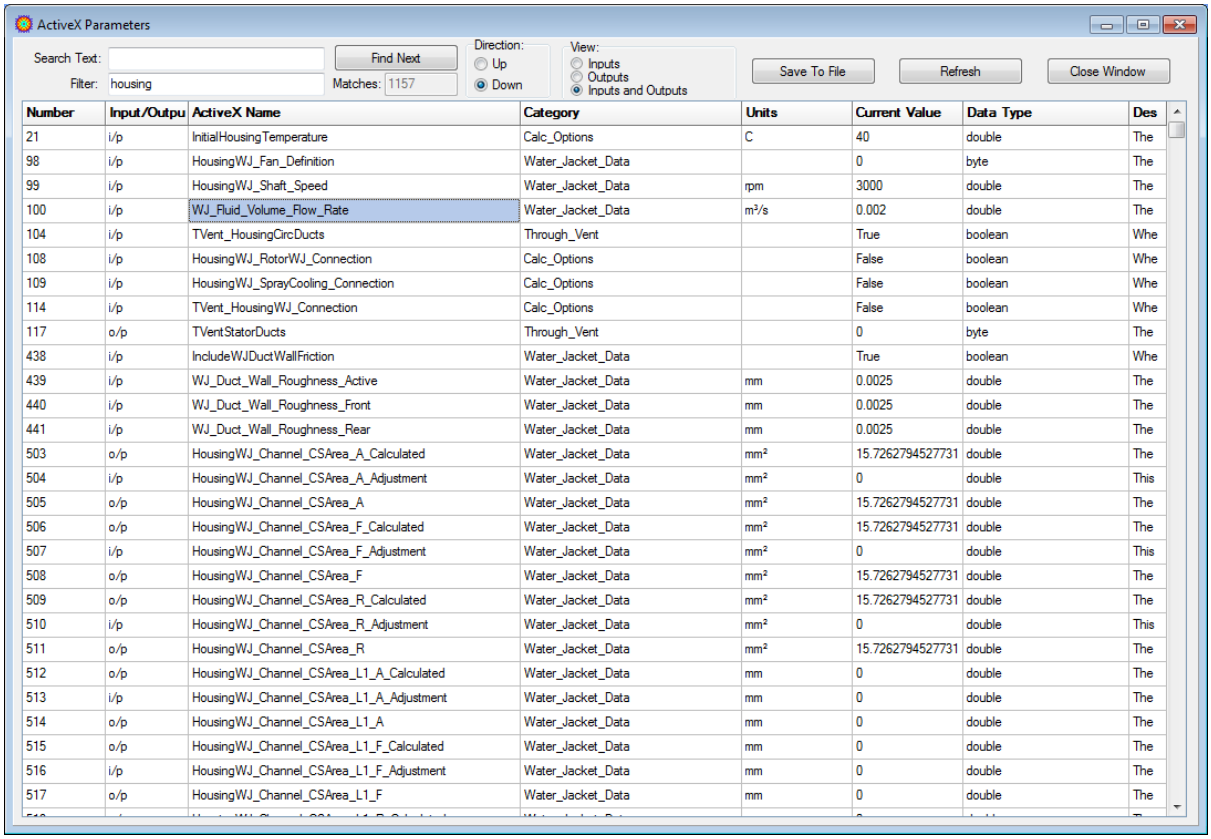
Adding water jacket flow control using scripting

The water jacket pump in this application is to be switched off 2500 seconds into the duty cycle. This pump control can be added using the internal scripting.

The internal scripting engine uses ActiveX to communicate with Motor-CAD. It is important that ActiveX has been enabled. This is done from the menu->Defaults->Register for ActiveX->Multiple Clients:

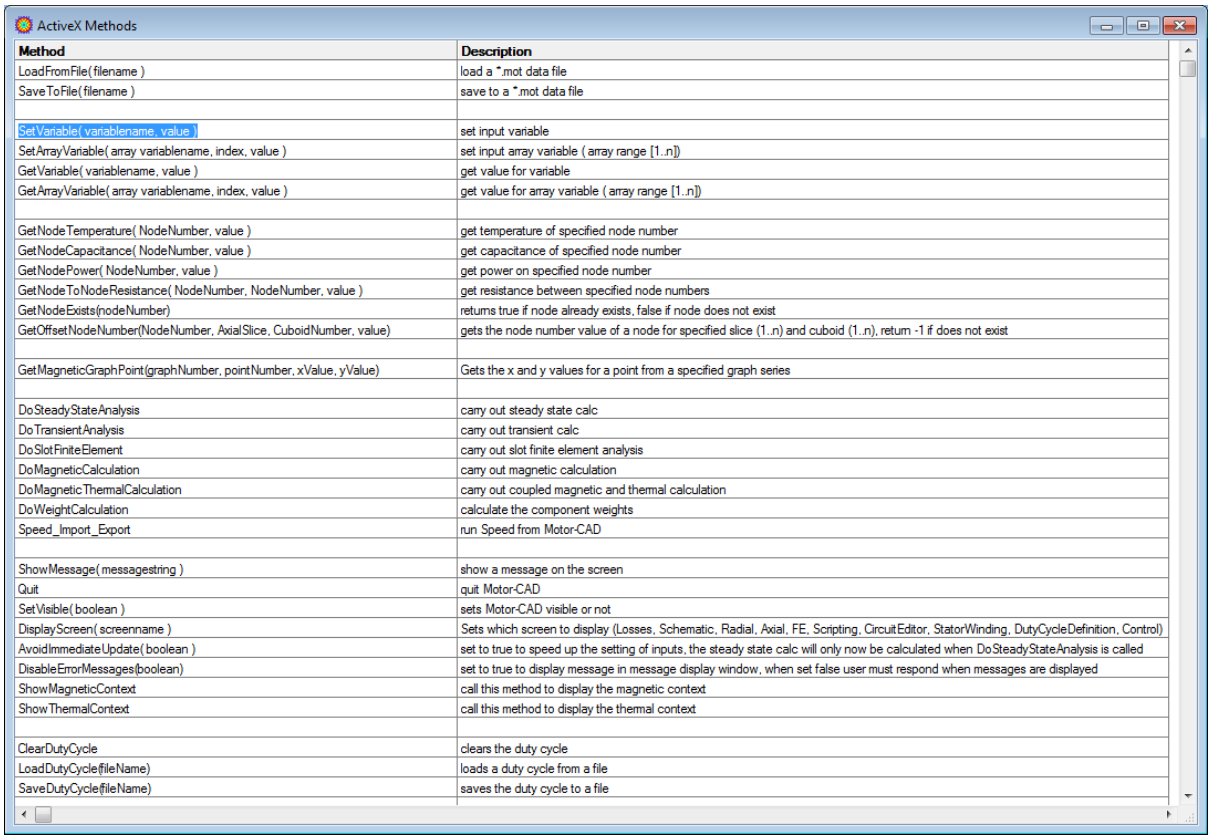


The ActiveX parameter names can be obtained from menu->Help->ActiveX parameter names. The list can be searched and filtered to find the required parameter names as shown below:



Number	Input/Outpu	ActiveX Name	Category	Units	Current Value	Data Type	Des
21	i/p	InitialHousingTemperature	Calc_Options	C	40	double	The
98	i/p	HousingWJ_Fan_Definition	Water_Jacket_Data		0	byte	The
99	i/p	HousingWJ_Shaft_Speed	Water_Jacket_Data	rpm	3000	double	The
100	i/p	WJ_Fluid_Volume_Flow_Rate	Water_Jacket_Data	m³/s	0.002	double	The
104	i/p	TVent_HousingCircDucts	Through_Vent		True	boolean	Whe
108	i/p	HousingWJ_RotorWJ_Connection	Calc_Options		False	boolean	Whe
109	i/p	HousingWJ_SprayCooling_Connection	Calc_Options		False	boolean	Whe
114	i/p	TVent_HousingWJ_Connection	Calc_Options		False	boolean	Whe
117	o/p	TVentStatorDucts	Through_Vent		0	byte	The
438	i/p	IncludeWJDuctWallFriction	Water_Jacket_Data		True	boolean	Whe
439	i/p	WJ_Duct_Wall_Roughness_Active	Water_Jacket_Data	mm	0.0025	double	The
440	i/p	WJ_Duct_Wall_Roughness_Front	Water_Jacket_Data	mm	0.0025	double	The
441	i/p	WJ_Duct_Wall_Roughness_Rear	Water_Jacket_Data	mm	0.0025	double	The
503	o/p	HousingWJ_Channel_CSArea_A_Calculated	Water_Jacket_Data	mm²	15.7262794527731	double	The
504	i/p	HousingWJ_Channel_CSArea_A_Adjustment	Water_Jacket_Data	mm²	0	double	This
505	o/p	HousingWJ_Channel_CSArea_A	Water_Jacket_Data	mm²	15.7262794527731	double	The
506	o/p	HousingWJ_Channel_CSArea_F_Calculated	Water_Jacket_Data	mm²	15.7262794527731	double	The
507	i/p	HousingWJ_Channel_CSArea_F_Adjustment	Water_Jacket_Data	mm²	0	double	This
508	o/p	HousingWJ_Channel_CSArea_F	Water_Jacket_Data	mm²	15.7262794527731	double	The
509	o/p	HousingWJ_Channel_CSArea_R_Calculated	Water_Jacket_Data	mm²	15.7262794527731	double	The
510	i/p	HousingWJ_Channel_CSArea_R_Adjustment	Water_Jacket_Data	mm²	0	double	This
511	o/p	HousingWJ_Channel_CSArea_R	Water_Jacket_Data	mm²	15.7262794527731	double	The
512	o/p	HousingWJ_Channel_CSArea_L1_A_Calculated	Water_Jacket_Data	mm	0	double	The
513	i/p	HousingWJ_Channel_CSArea_L1_A_Adjustment	Water_Jacket_Data	mm	0	double	The
514	o/p	HousingWJ_Channel_CSArea_L1_A	Water_Jacket_Data	mm	0	double	The
515	o/p	HousingWJ_Channel_CSArea_L1_F_Calculated	Water_Jacket_Data	mm	0	double	The
516	i/p	HousingWJ_Channel_CSArea_L1_F_Adjustment	Water_Jacket_Data	mm	0	double	The
517	o/p	HousingWJ_Channel_CSArea_L1_F	Water_Jacket_Data	mm	0	double	The

Similarly the ActiveX commands are also available from menu->Help->ActiveX commands:



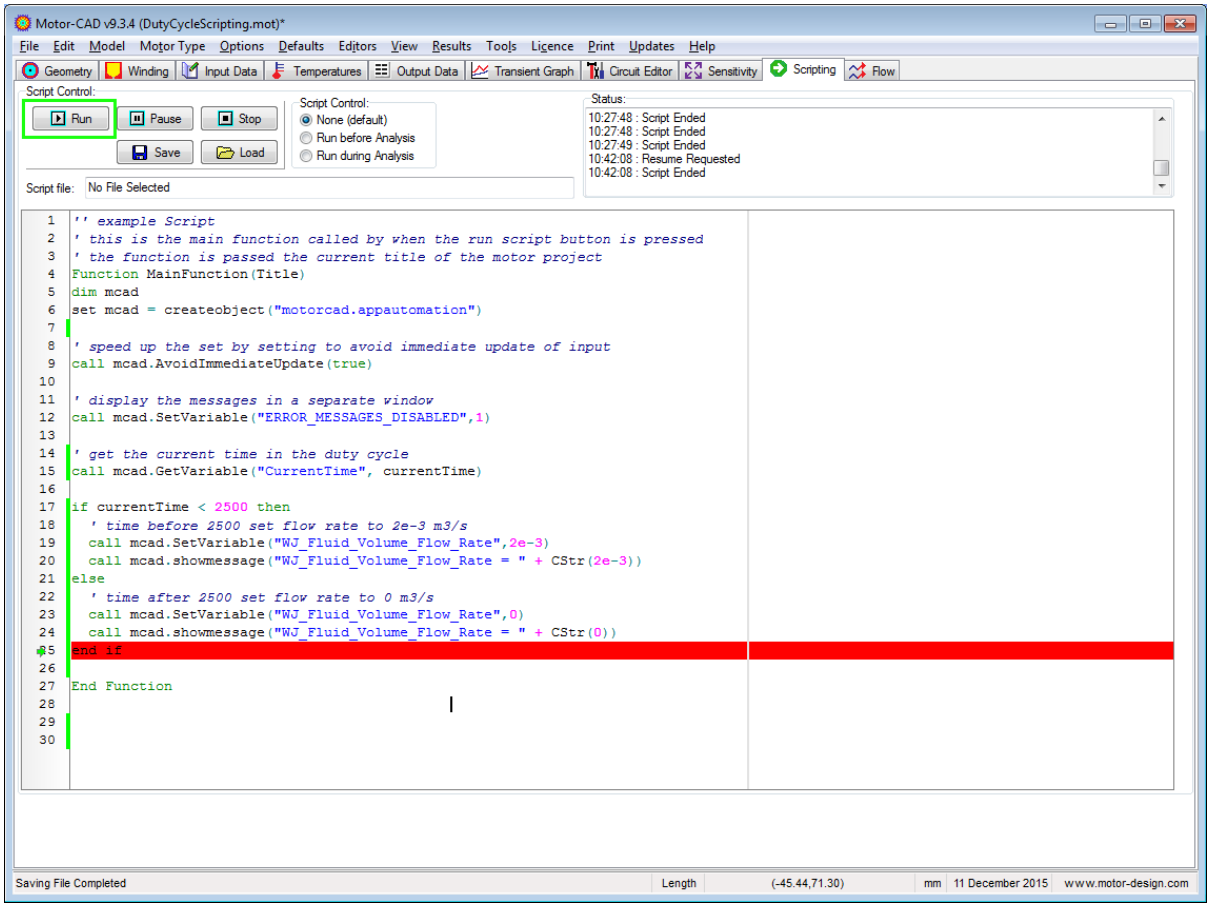
Method	Description
LoadFromFile(filename)	load a *.mot data file
SaveToFile(filename)	save to a *.mot data file
SetVariable(variablename, value)	set input variable
SetArrayVariable(array variablename, index, value)	set input array variable (array range [1..n])
GetVariable(variablename, value)	get value for variable
GetArrayVariable(array variablename, index, value)	get value for array variable (array range [1..n])
GetNodeTemperature(NodeNumber, value)	get temperature of specified node number
GetNodeCapacitance(NodeNumber, value)	get capacitance of specified node number
GetNodePower(NodeNumber, value)	get power on specified node number
GetNodeToNodeResistance(NodeNumber, NodeNumber, value)	get resistance between specified node numbers
GetNodeExists(nodeNumber)	returns true if node already exists, false if node does not exist
GetOffsetNodeNumber(NodeNumber, AxialSlice, CuboidNumber, value)	gets the node number value of a node for specified slice (1..n) and cuboid (1..n), return -1 if does not exist
GetMagneticGraphPoint(graphNumber, pointNumber, xValue, yValue)	Gets the x and y values for a point from a specified graph series
DoSteadyStateAnalysis	carry out steady state calc
DoTransientAnalysis	carry out transient calc
DoSlotFiniteElement	carry out slot finite element analysis
DoMagneticCalculation	carry out magnetic calculation
DoMagneticThermalCalculation	carry out coupled magnetic and thermal calculation
DoWeightCalculation	calculate the component weights
Speed_Import_Export	run Speed from Motor-CAD
ShowMessage(messagestring)	show a message on the screen
Quit	quit Motor-CAD
SetVisible(boolean)	sets Motor-CAD visible or not
DisplayScreen(screenname)	Sets which screen to display (Losses, Schematic, Radial, Axial, FE, Scripting, CircuitEditor, StatorWinding, DutyCycleDefinition, Control)
AvoidImmediateUpdate(boolean)	set to true to speed up the setting of inputs, the steady state calc will only now be calculated when DoSteadyStateAnalysis is called
DisableErrorMessages(boolean)	set to true to display message in message display window, when set false user must respond when messages are displayed
ShowMagneticContext	call this method to display the magnetic context
ShowThermalContext	call this method to display the thermal context
ClearDutyCycle	clears the duty cycle
LoadDutyCycle(fileName)	loads a duty cycle from a file
SaveDutyCycle(fileName)	saves the duty cycle to a file

To control the housing water jacket flow have written the script shown below.

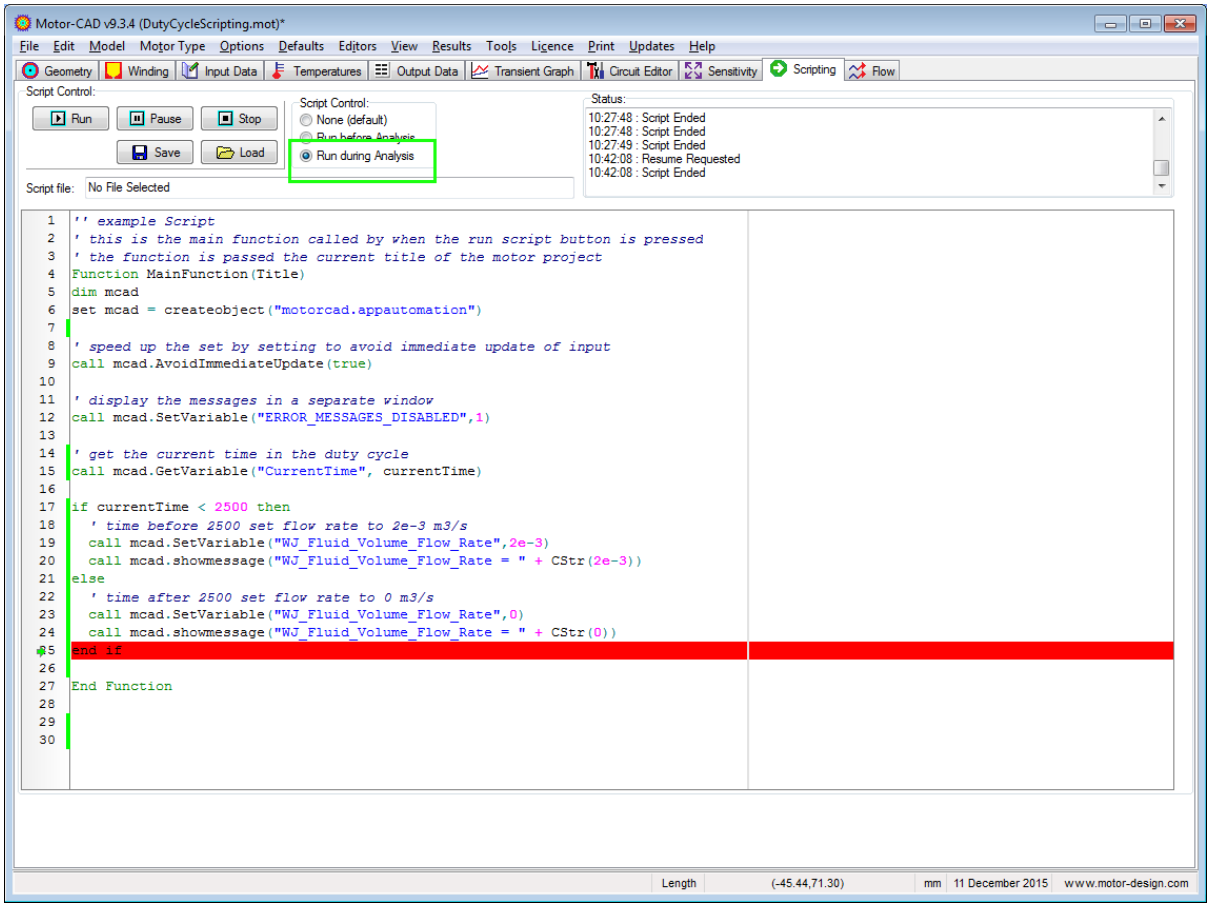
The **CurrentTime** parameter gets the current time in the duty cycle. The water jacket flow rate is set using the **WJ_Fluid_Volume_Flow_Rate** parameter.

Note: all parameters used in ActiveX are in SI units.

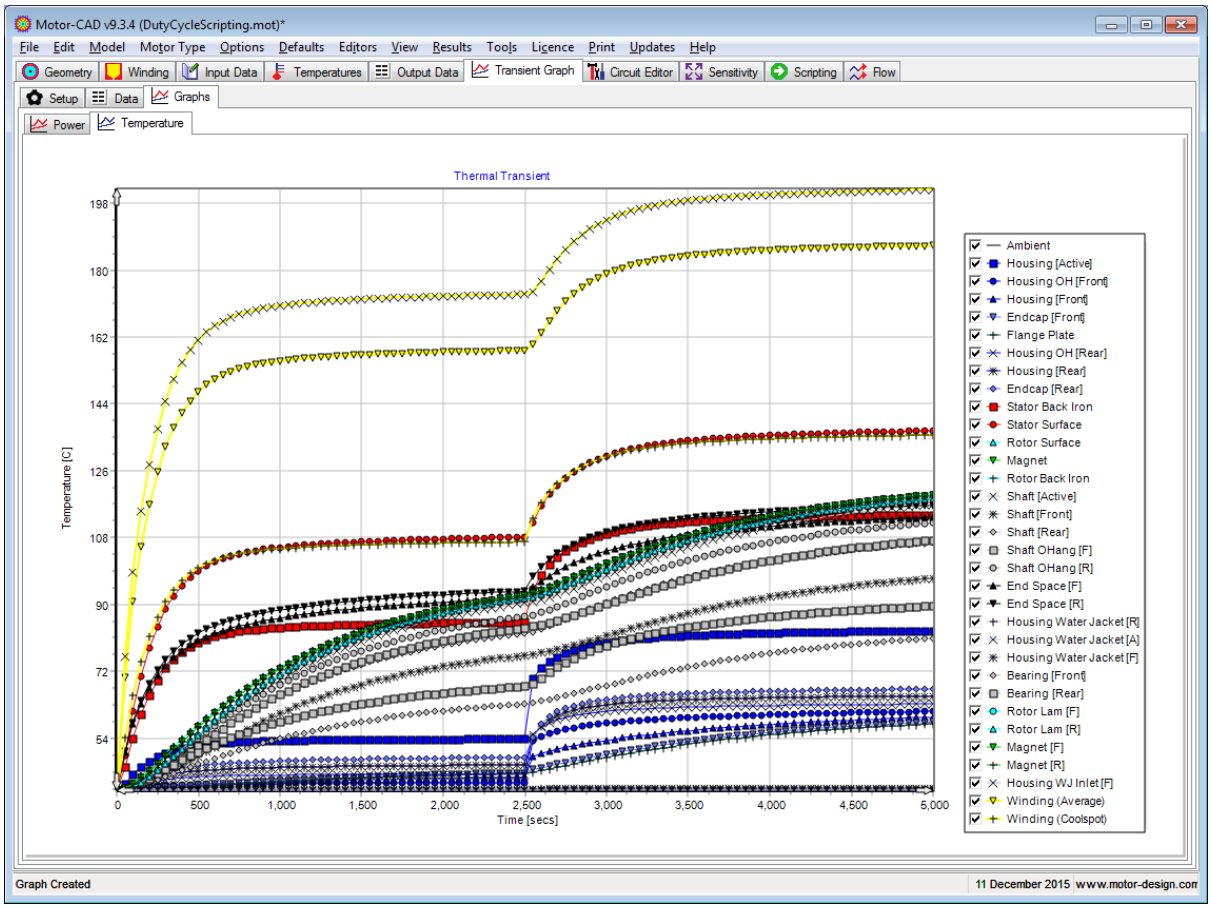
Before running the script in the duty cycle it is best to test the script itself by running using the Run button shown below:



If the script has run successfully it can then be added to the duty cycle calculation. This is done by selecting the **Run during Analysis** option shown below:



Now when the transient analysis is run the script will be run for each step of the transient analysis. Can see the increase in the machine temperatures after 2500 seconds when the housing water jacket flow is stopped:



Conclusion

This example shows how the internal scripting inside Motor-CAD can be used to vary the housing water jacket flow rate. The internal scripting in Motor-CAD provides a great degree of flexibility for customising transient duty cycles.

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