Transformer Saturation Curve Matching in PSCAD™/EMTDC™
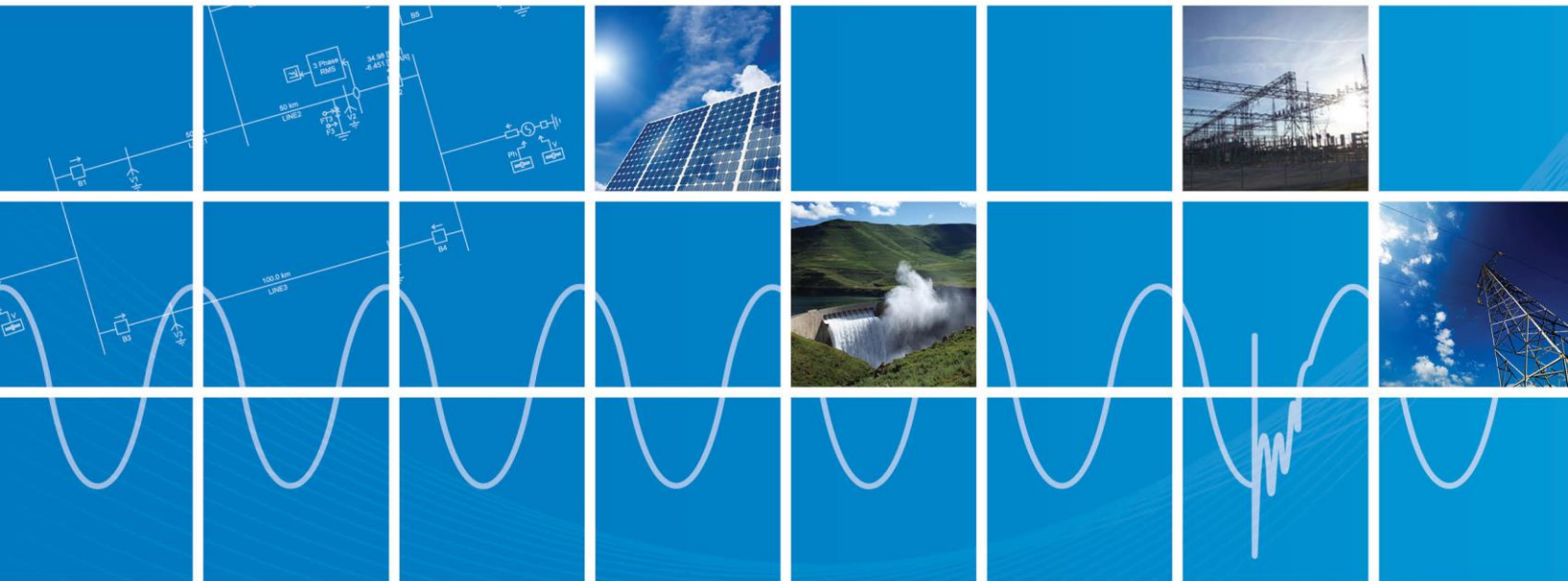
Written for PSCAD version 4.6.3

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Revision 1

CONTENTS

1. Introduction

In some studies, it may be required to match the measured saturation curve (V-I data points) when using the transformer model. In such cases, the MatchSat workspace can be used to find the matching *magnetizing current* and *knee voltage* for the given V-I data points. The MatchSat workspace and other relevant files are accessible in a zip file where the most updated version of this PDF document is also available:

https://hvdc.ca/knowledge-base/read,article/561/transformer-saturation-curve-matching-in-pscad-emtdc/v:

1.1 Running the Simulation

After launching PSCAD, as shown in Figure 1 and Figure 2, open MatchSat workspace.
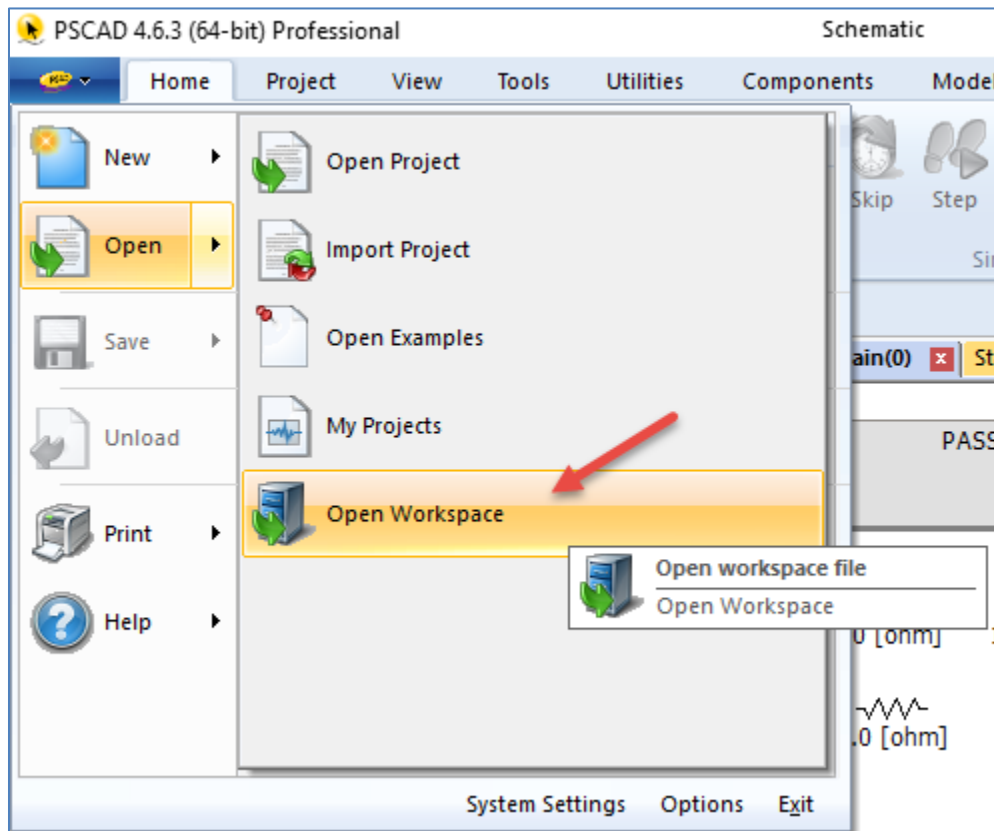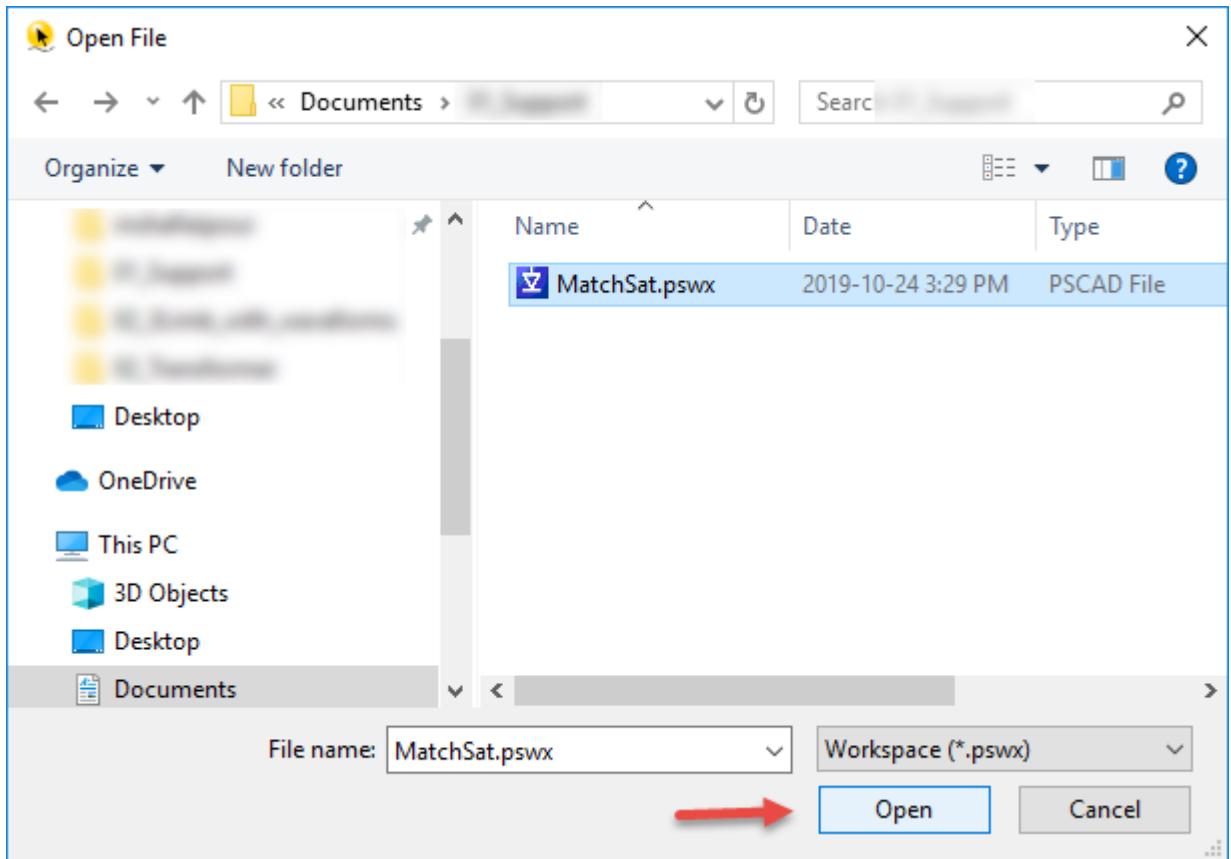

Figure 1: Opening a Workspace

Figure 2: Opening MatchSat Workspace

Subsequently, The set can be run by right-clicking on "MatchSatSet" and selecting "Run Set" as shown in Figure 3.
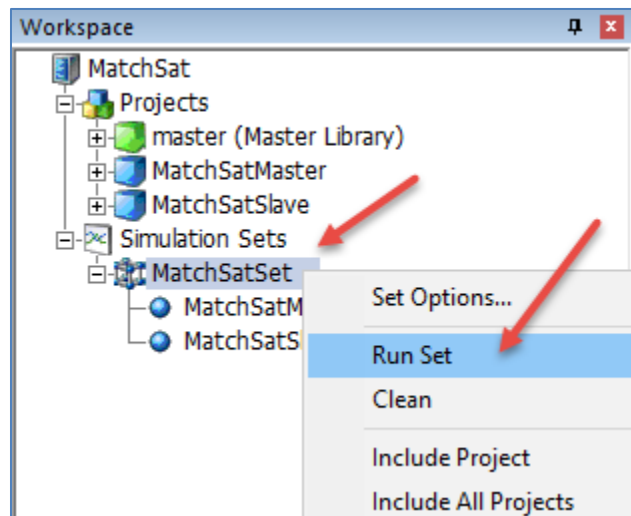

Figure 3: Running the MatchSatSet simulation set

2. Using the Simulation Set for the Transformer under the Study

Procedure for using the simulation set for a given transformer and desired V-I curve is summarized as below

1. Place the transformer model with the known parameters in "MatchSatSlave" as in Figure 4. The sought after *magnetizing current* and *knee voltage* are entered as variables "Im" and "Vknee", respectively (Figure 5).

2. Modify the input parameters in "MatchSatMaster" for the desired parameters (Figure 6).

3. Run the set (Figure 3).

4. Once simulation is complete, use the recommended magnetizing current and knee voltage (Figure 7) in the model.
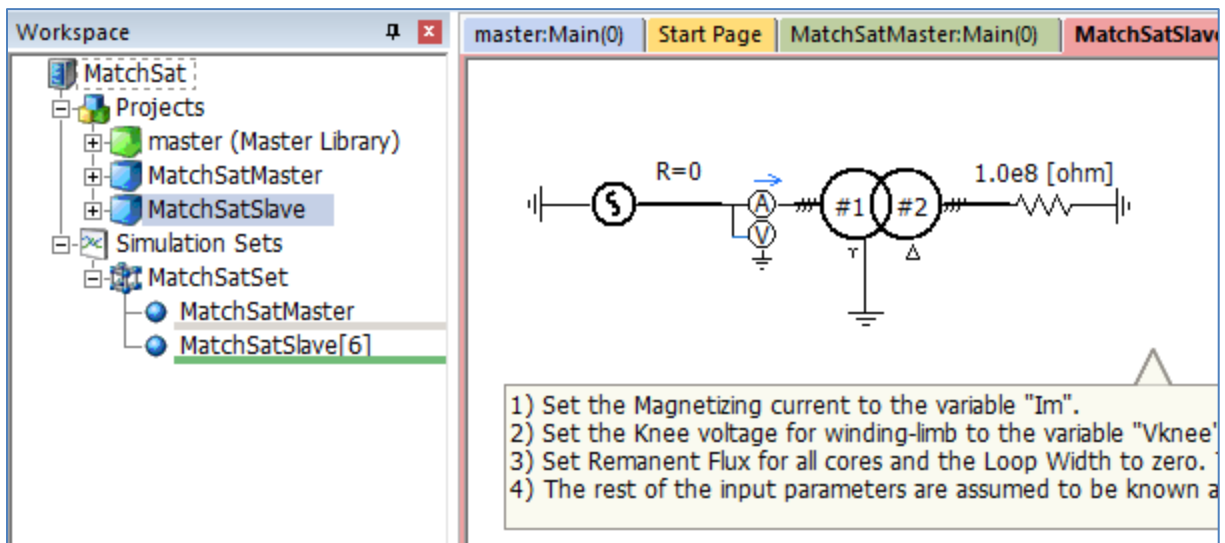

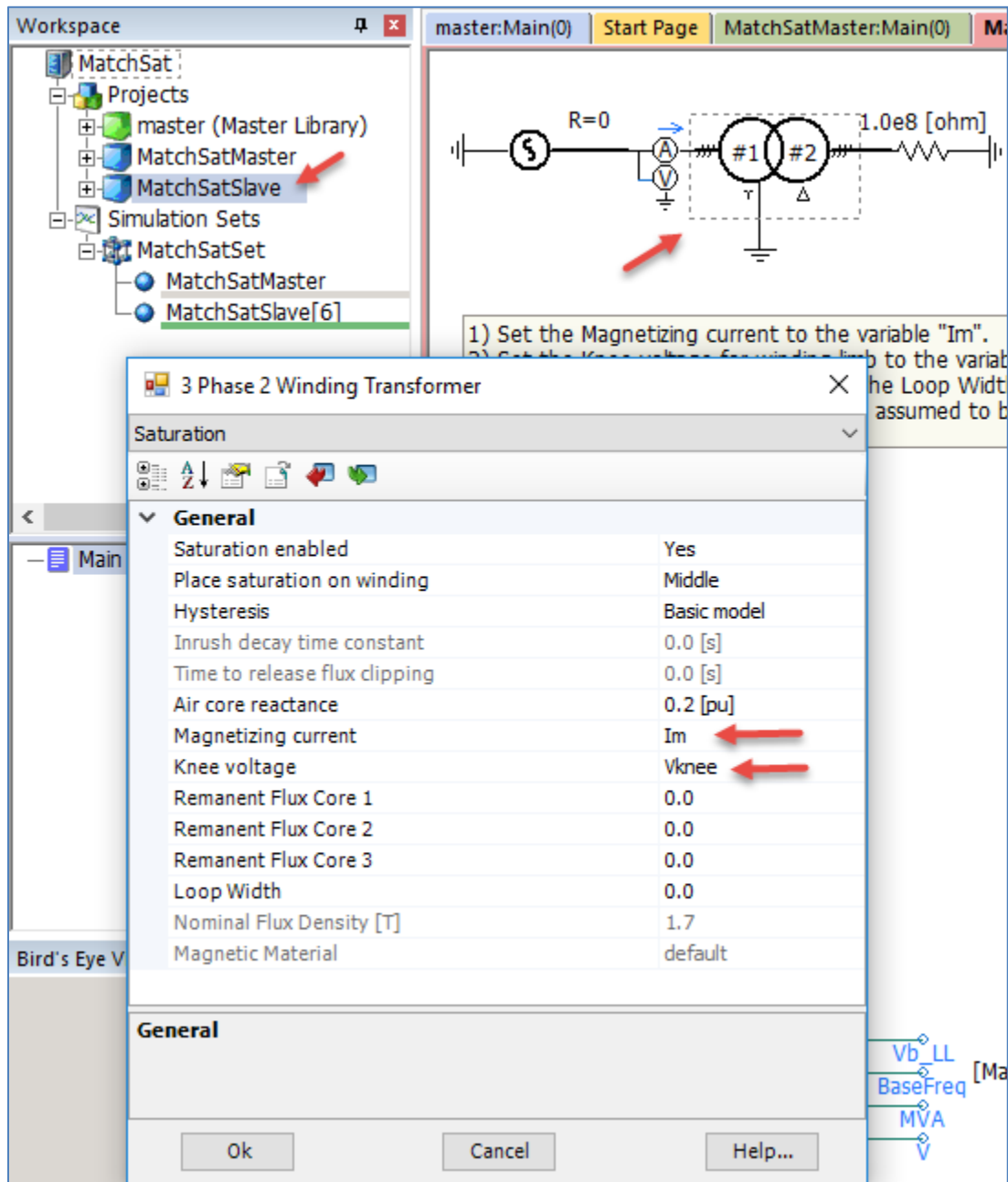*Figure 4: The transformer under the study placed in MatchSatSlave*

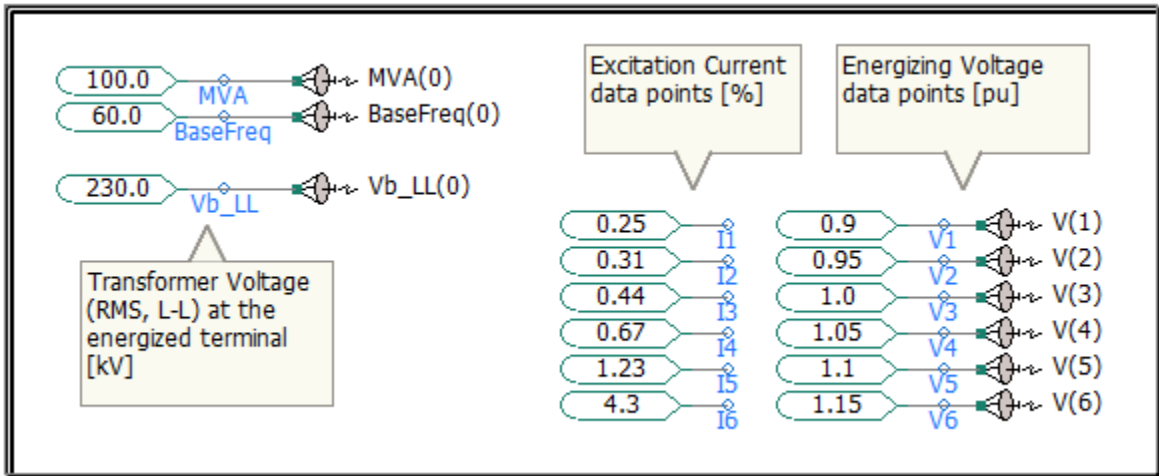*Figure 5: The knee voltage and magnetizing current as the variables "Vknee" and "Im" in "MatchSatSlave"*
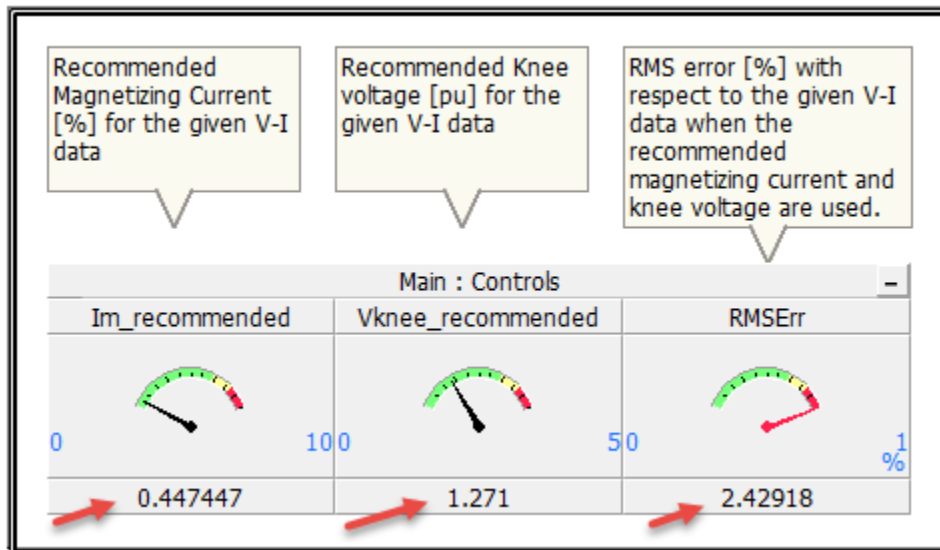
Figure 6: Input parameters in "MatchSatMaster"

Figure 7: The recommended Excitation Current and Knee Voltage for the given V-I data points
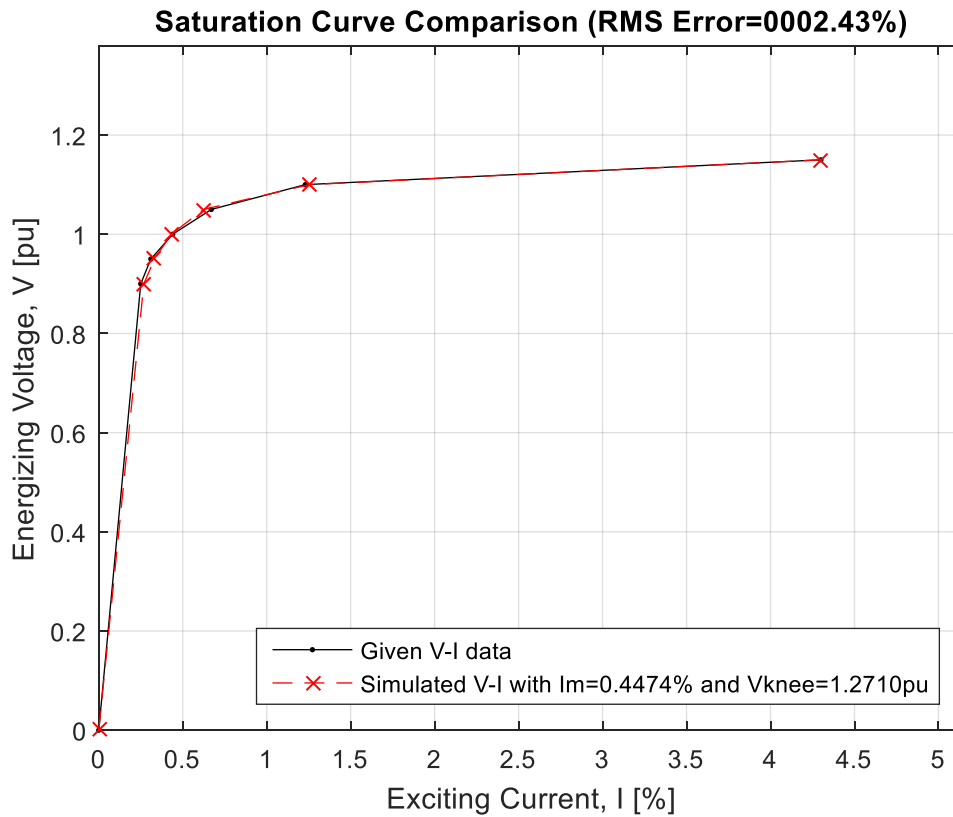
Figure 8: Comparing the desired and produced V-I curves

Figure 8 compares the given V-I data of Figure 6, with that of the resulting V-I when the recommended parameters (Im=0.4474%, Vknee=1.271pu) are used in the model. The match is satisfacory consistent with the root-mean-square error (RMSErr≃2.43%) reported in Figure 7.

It is important to note that the MatchSat simulation set is created for 6 V-I data points. If fewer or more data points are desired, the simulation set should be modified. Alternatively, if more data points are available, some intermediate points may be removed, or if fewer data points are available, extra points may be introduced by interpolation between available points.

3. Enabling MATLAB Plotting

The plot depicted in Figure 8 is automatically generated by SatCurvePlot in MatchSatMaster. In order to enable such plotting, MATLAB and Intel Fortran Compiler are required. They both need to be either 32 bit or 64 bit. In addition, only MATLAB versions from 2015 to 2017 are tested and newer versions of MATLAB are not currently supported.

Figure 9 and Figure 10 show how this feature can be enabled. Once enabled, by running the MatchSat set (Figure 3), the saturation curve plot appears as the simulations progresses. This is shown in Figure 11 to Figure 14. As seen in these figures, the optimization algorithm does not have a good fit at the beginning of the simulation (Figure 11), but as the simulation proceeds, the match improves and finally stops as in Figure 14. This is the same plot shown in Figure 8.
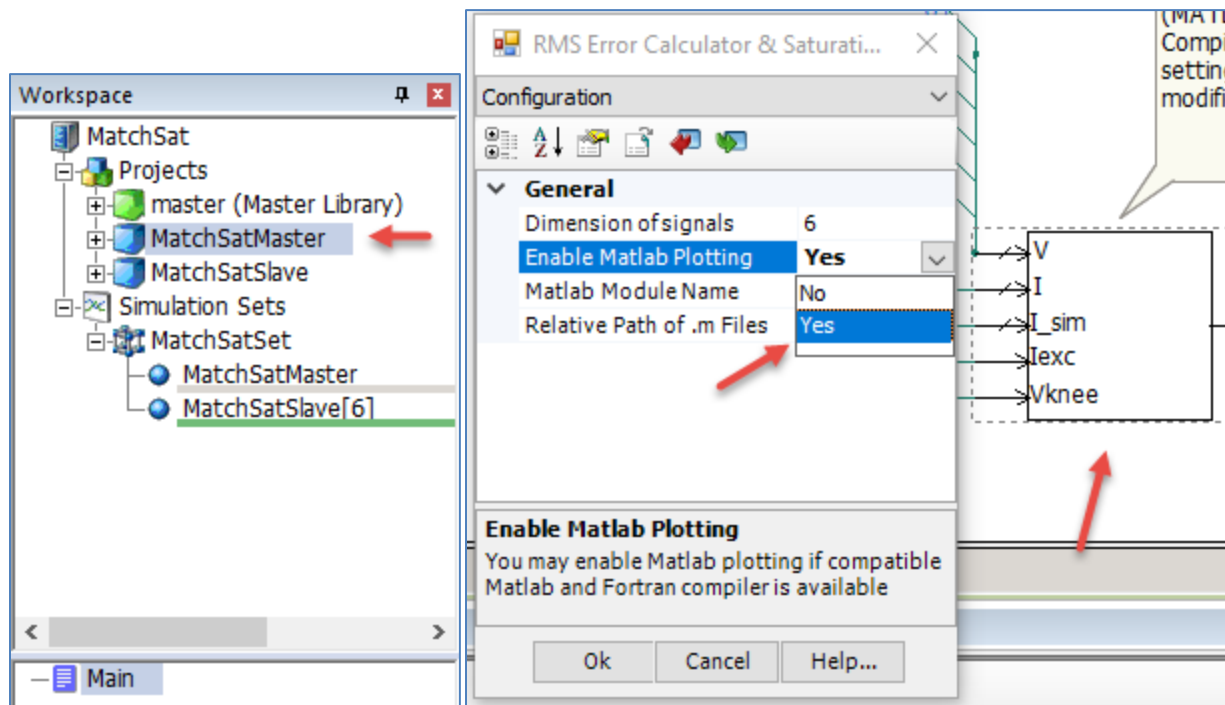

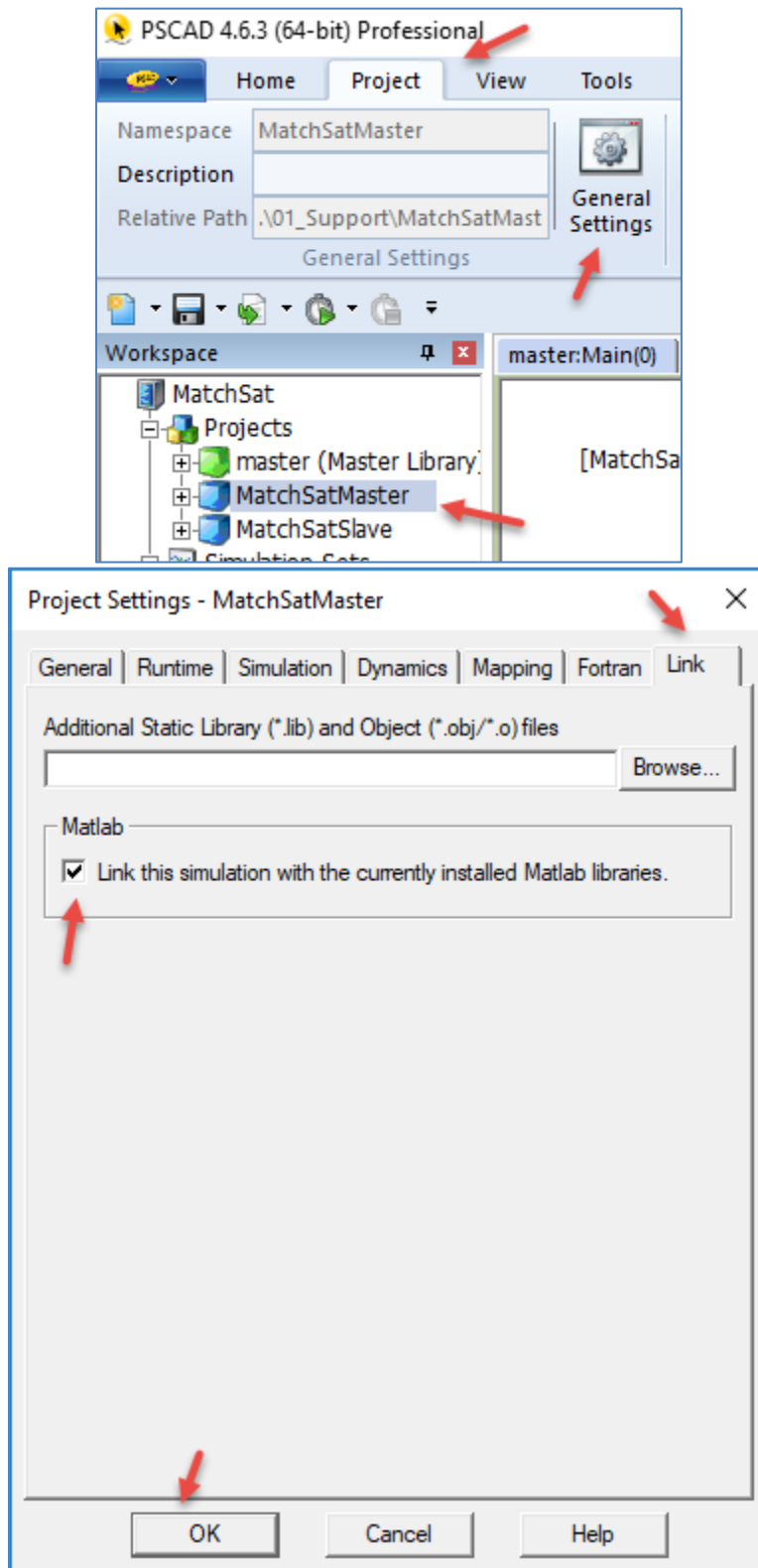*Figure 9: Enabling MATLAB Plotting (Part 1 of 2)*
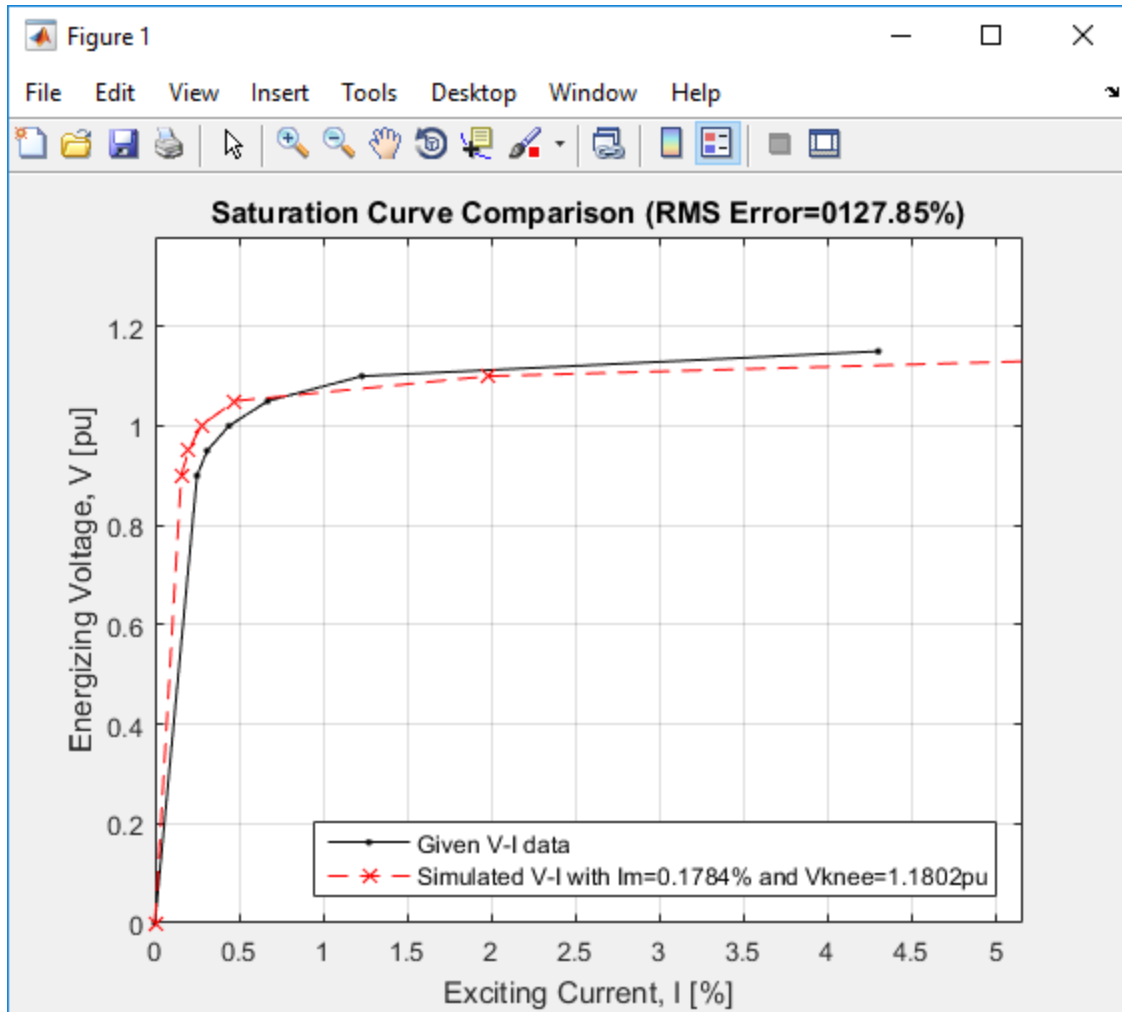
Figure 10: Enabling MATLAB Plotting (Part 2 of 2)

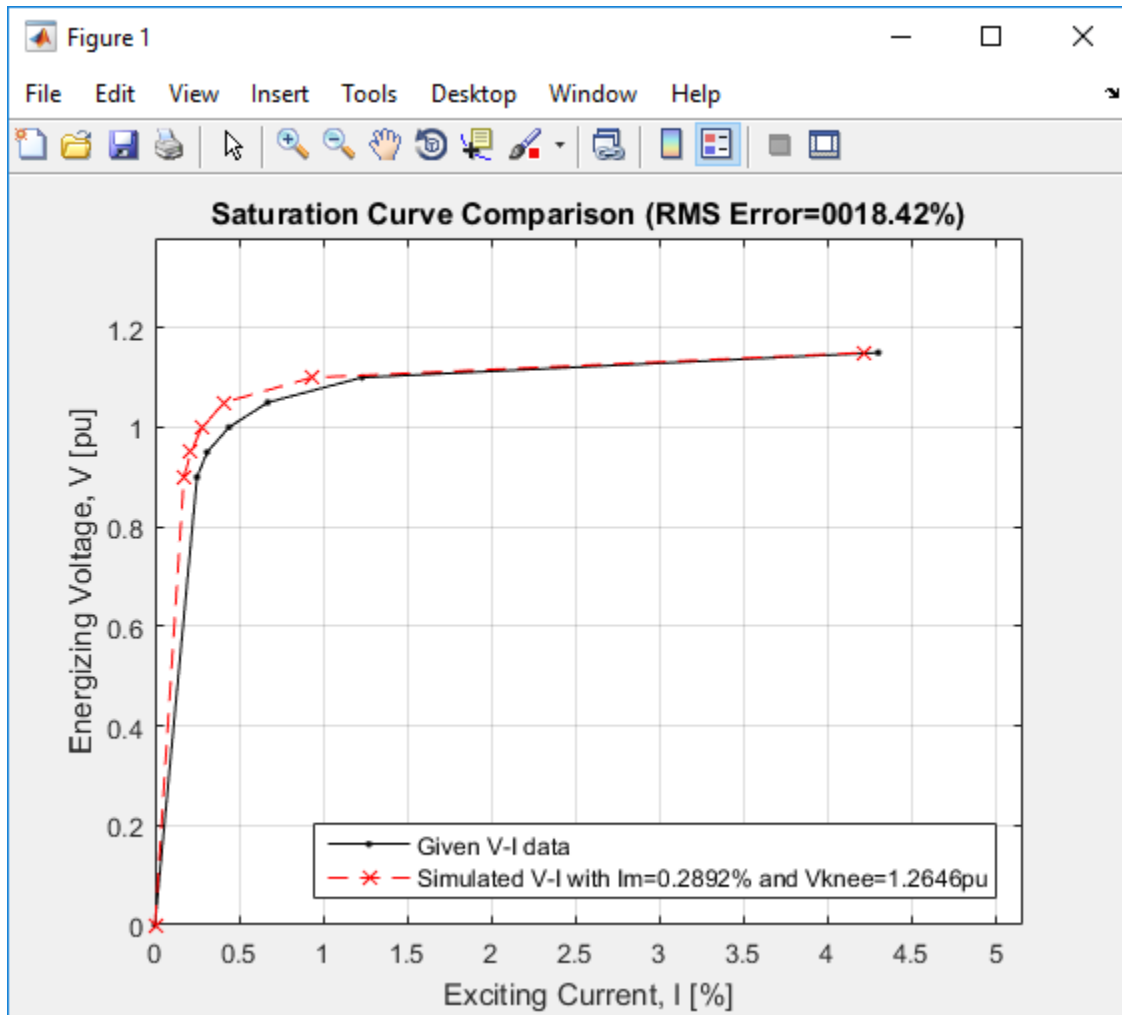*Figure 11: Plotting of Saturation Curve using MATLAB (1 of 4)*

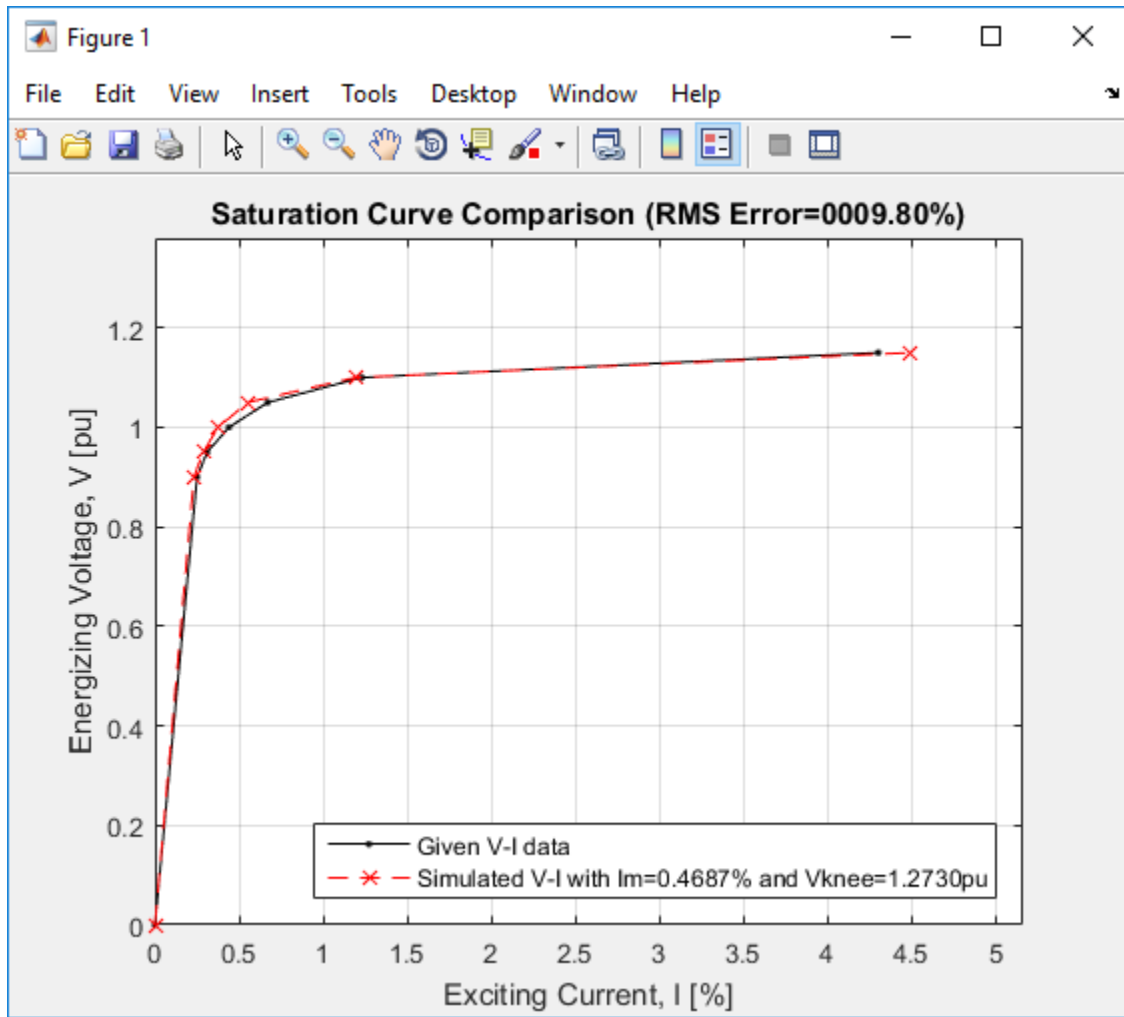*Figure 12: Plotting of Saturation Curve using MATLAB (2 of 4)*

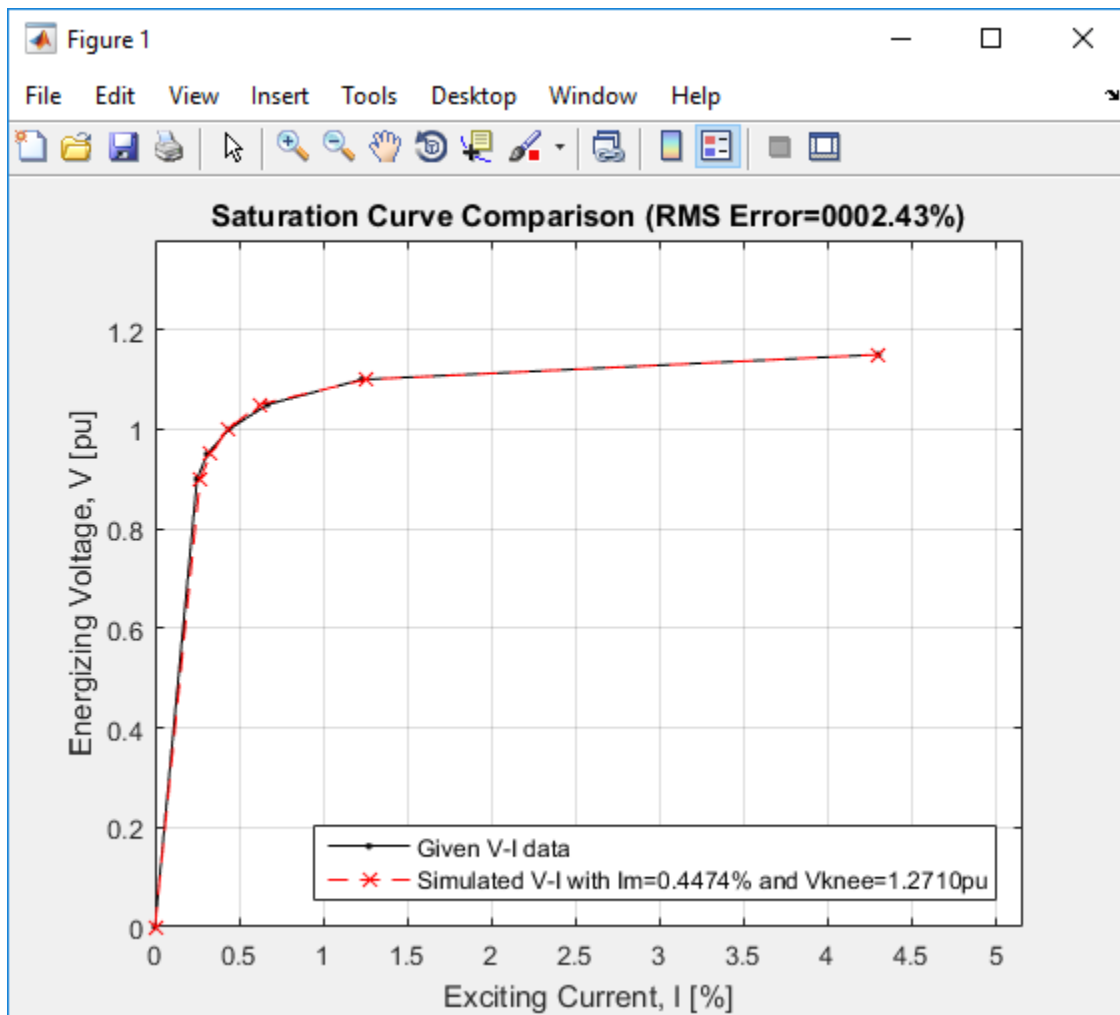*Figure 13: Plotting of Saturation Curve using MATLAB (3 of 4)*

Figure 14: Plotting of Saturation Curve using MATLAB (4 of 4)

A video snapshot from the progress is available here:

https://hvdc.ca/knowledge-base/read,article/561/transformer-saturation-curve-matching-in-pscad-emtdc/v:

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