Grid Example: Rotor Angle Stability with HVDC Light Link

The following pages shows how the rotor angle stability of a small network connected through an ABB HVDC Light link. Three different control strategies for the HVDC-link are implemented in this small NEPLAN example.

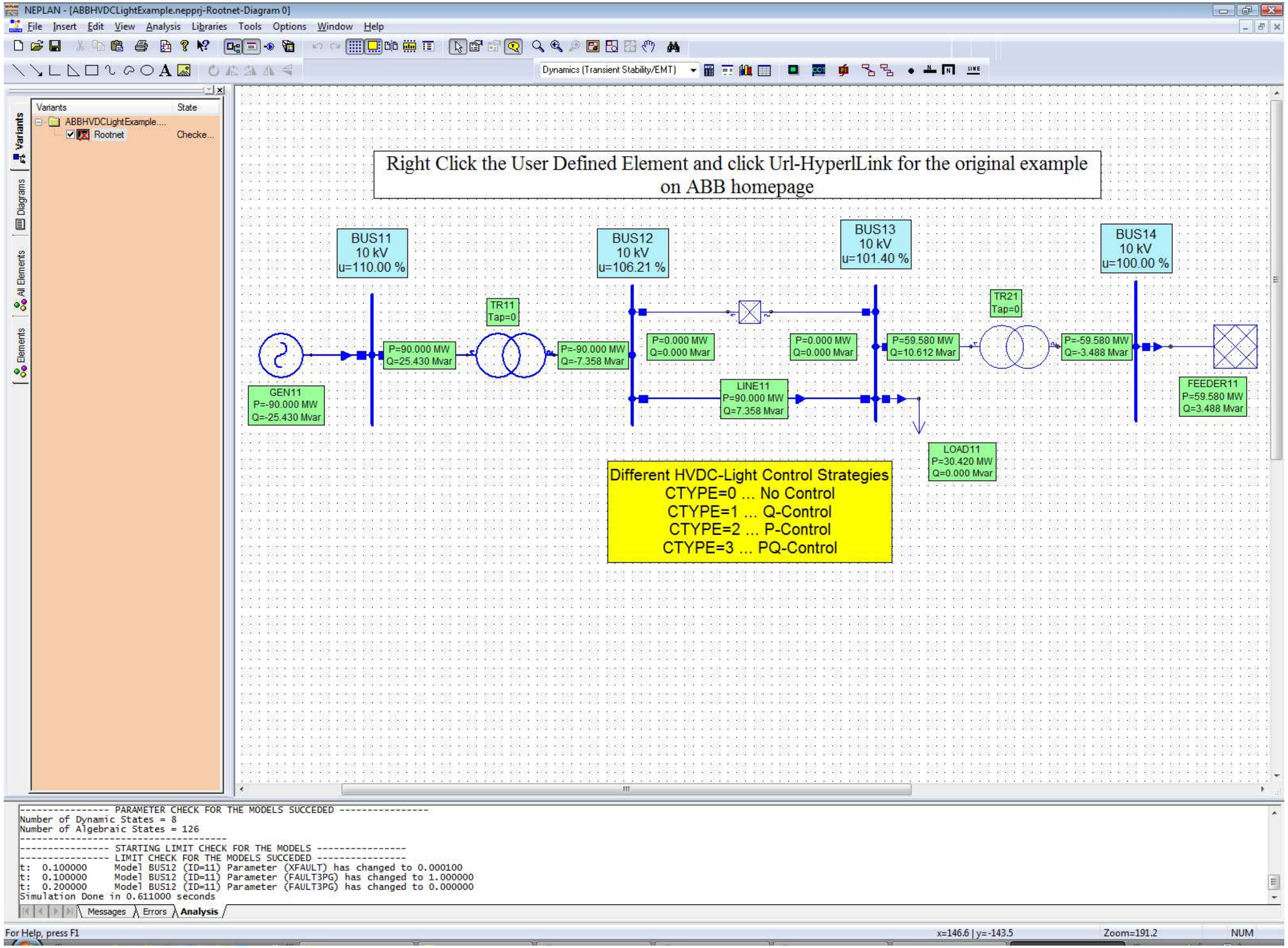
The small ABB HVDC Light model may be found at the ABB site:
http://www.abb.com/cawp/GAD02181/C1256D71001E0037C1256D2600278534.aspx

It shows the also the efficiency of the NEPLAN Dynamic Simulator and how fast an easy user defined models may be developed.

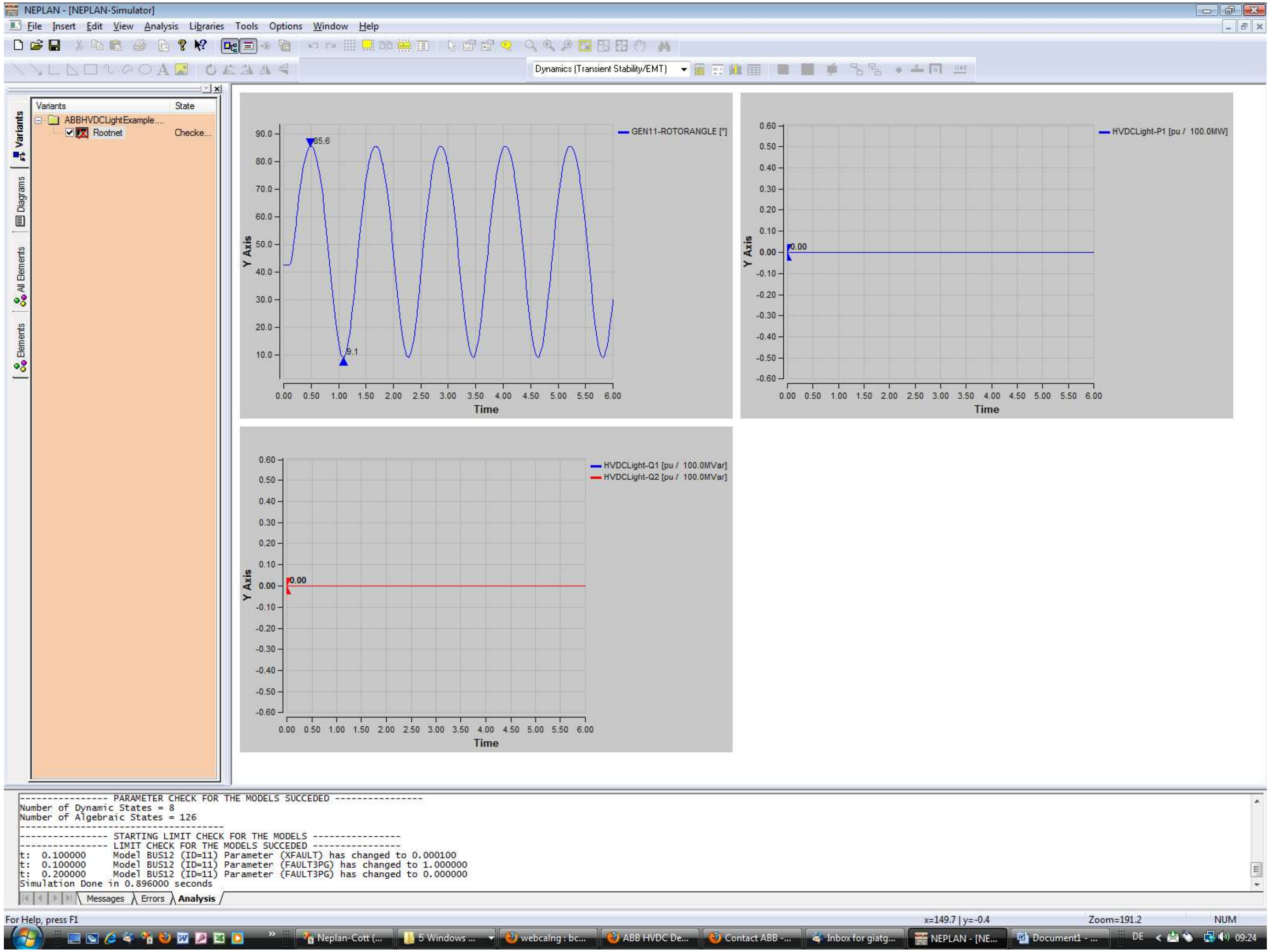
See:
www.neplan.ch
http://www.neplan.ch/pdf/english/modules/NEPLAN_B08_Simulator_engl.pdf

This is a standard example in NEPLAN, which will be available in Version 5.4.2. It may be changed and adapted also in the demo version and might be shown to potential HVDC clients.

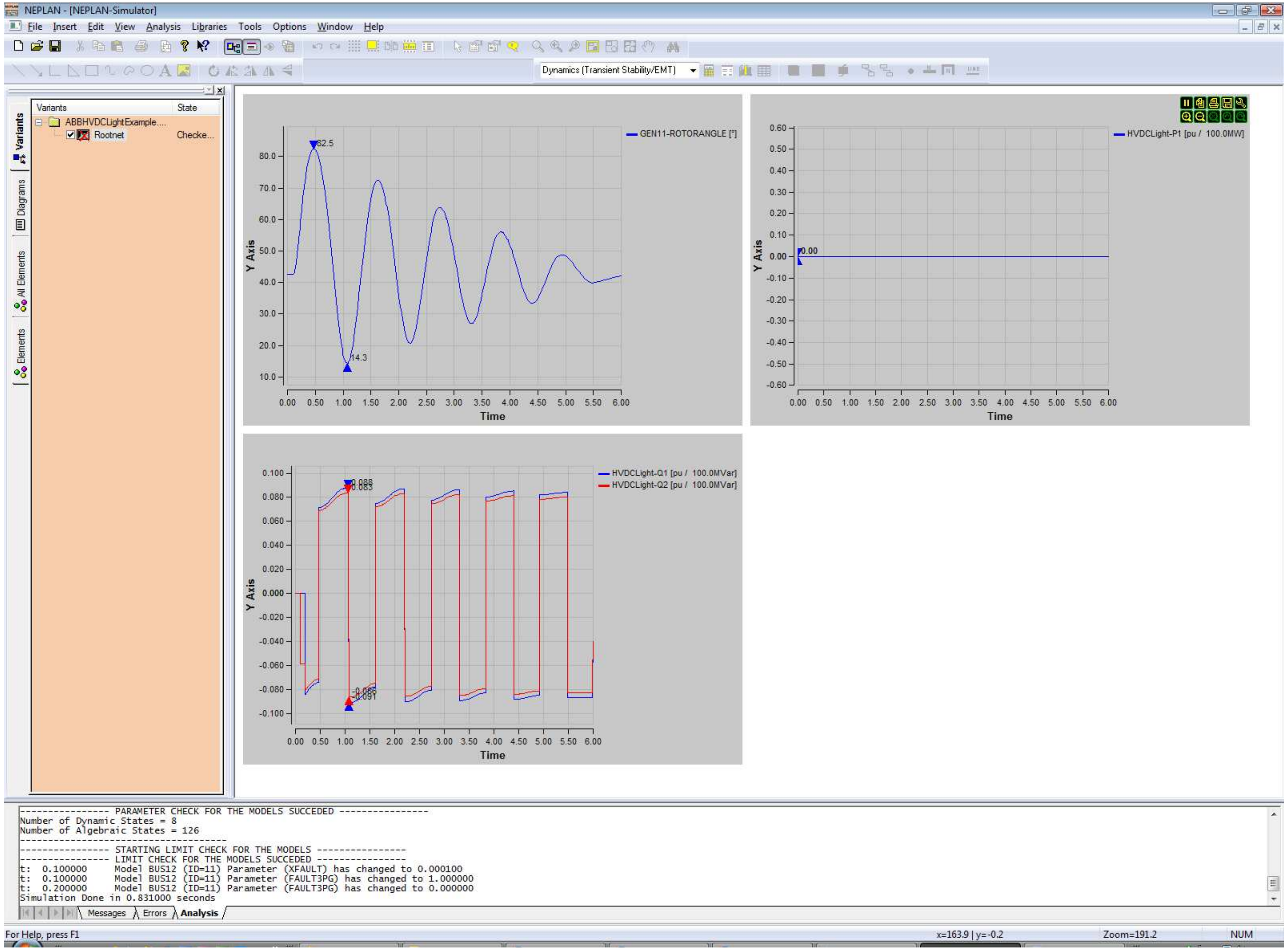
The NEPLAN Demo may be downloaded at:
http://www.neplan.ch/support_area/index.php?action=REQUEST&interest=Demo



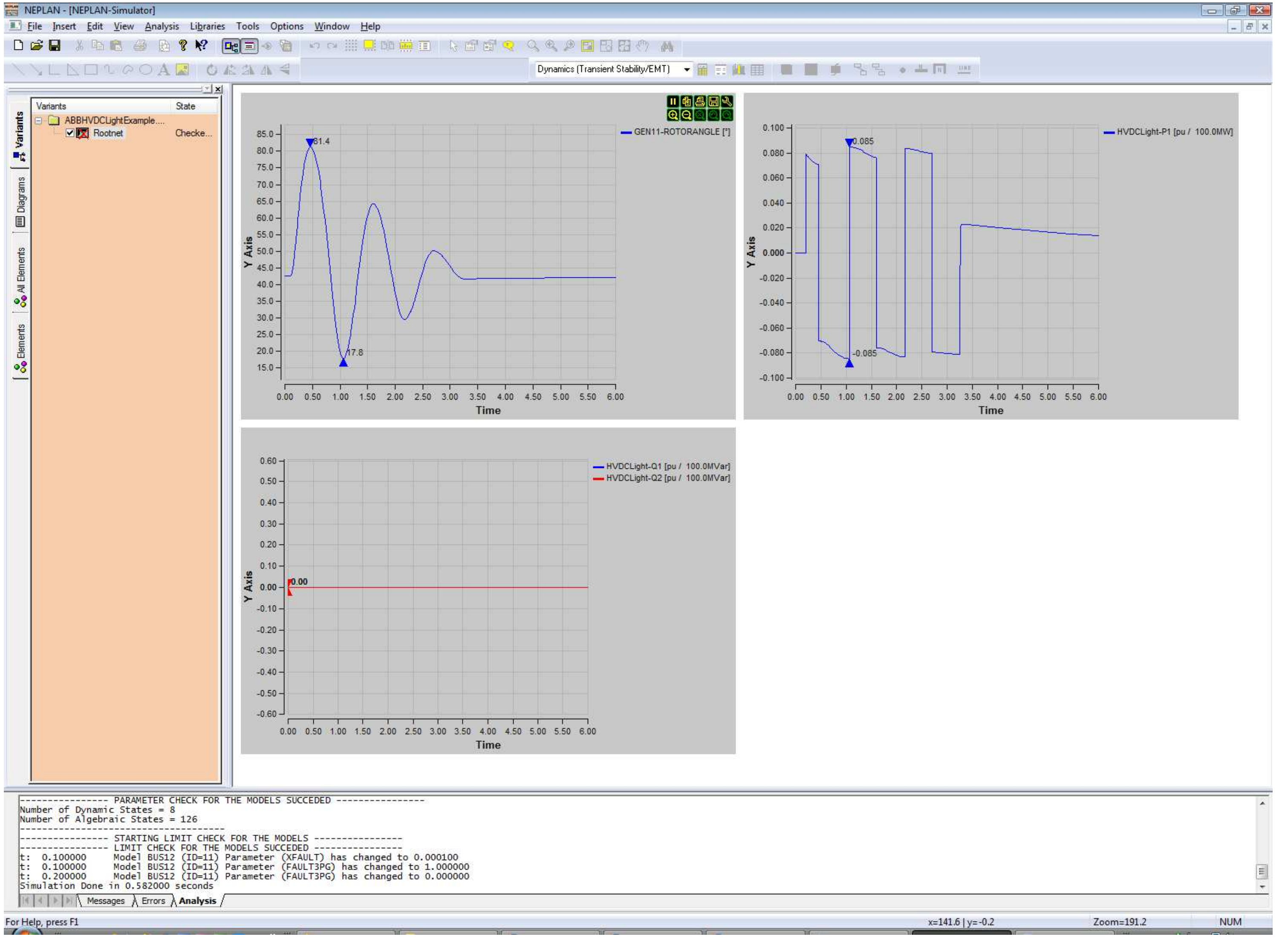
NEPLAN Network with a user defined model of the HVDC Link



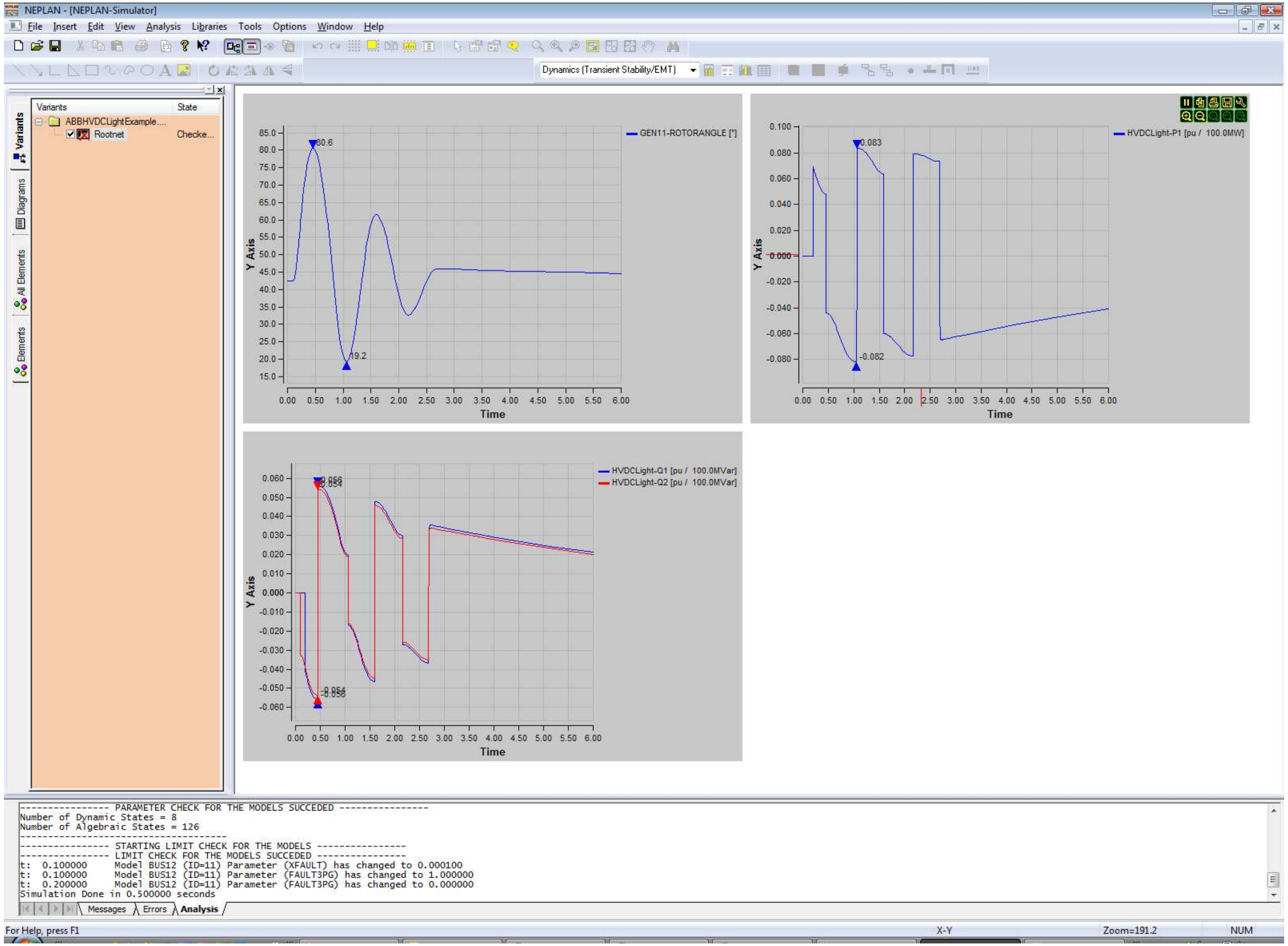
Results of the simulation with NO Control



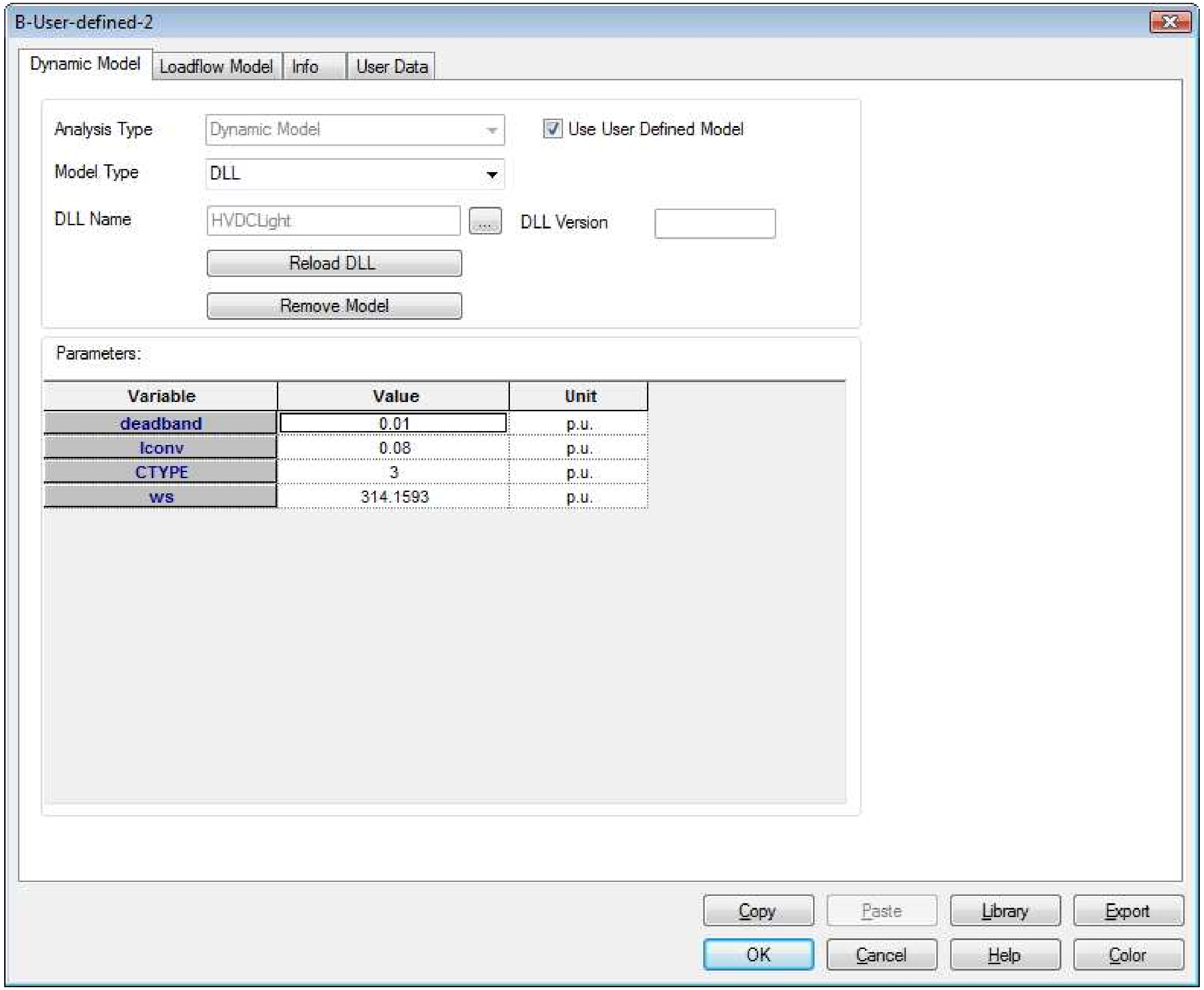
Results of the simulation with Q Control



Results of the simulation with P Control



Results of the simulation with PQ Control



Dialog of the User Defined HVDC Light model.
The model is hidden in a binary DLL file. The user does not see the implementation of the model
The user may only change the input parameters.

Below is the HVDC Light Model defined in a symdef file. This file will be compiled from Matlab to a DLL

```
%-----------------------
definitions:
%-----------------------
inputs VD1=1 VQ1 VD2=1 VQ2 W
external_states ID1 IQ1 ID2 IQ2 P1 P2 Q1 Q2
internal_states VMAG1=1 VMAG2=1 VMIN COSDELTA=1 SINDELTA
events !ev_W1 !ev_W2
parameters Iconv=0.08 deadband=0.01 ws=3.141592653589793e+002 CTYPE
%-----------------------
initializations:
%-----------------------

%-----------------------
f_equations:
%-----------------------

%-----------------------
g_equations:
%-----------------------
g01 = P1 - (VD1*ID1 + VQ1*IQ1)
g02 = Q1 - (VQ1*ID1 - VD1*IQ1)
g03 = P2 - (VD2*ID2 + VQ2*IQ2)
g04 = Q2 - (VQ2*ID2 - VD2*IQ2)
g05 = P1 + P2
g09 = VMAG1 - magnitude(VD1,VQ1,1.0)
g10 = VMAG2 - magnitude(VD2,VQ2,1.0)
g11 = VMIN - min(VMAG1,VMAG2)
g12 = ev_W1 - (W - ( 1.0 + deadband/ws ))
g13 = ev_W2 - (W - ( 1.0 - deadband/ws ))
if t < 0
   g06 = P1
   g07 = Q1
   g08 = Q2
else
   if CTYPE == 0
```

```
    g06 = P1
    g07 = Q1
    g08 = Q2
else
    if CTYPE == 1
        if ev_W1 > 0
            g06 = P1
            g07 = Q1 + VMAG1*Iconv
            g08 = Q2 + VMAG2*Iconv
        else
            if ev_W2 < 0
                g06 = P1
                g07 = Q1 - VMAG1*Iconv
                g08 = Q2 - VMAG2*Iconv
            else
                g06 = P1
                g07 = Q1 + VMAG1*Iconv*ws*(W-1.0)/(deadband)
                g08 = Q2 + VMAG2*Iconv*ws*(W-1.0)/(deadband)
            end
        end
    else
        if CTYPE == 2
            if ev_W1 > 0
                g06 = P1 - Iconv*VMIN
                g07 = Q1
                g08 = Q2
            else
                if ev_W2 < 0
                    g06 = P1 + Iconv*VMIN
                    g07 = Q1
                    g08 = Q2
                else
                    g06 = P1 - VMIN*Iconv*ws*(W-1.0)/deadband
                    g07 = Q1
                    g08 = Q2
                end
            end
        else
            if CTYPE == 3
```

```
                if ev_W1 > 0
                    g06 = P1 - COSDELTA*Iconv*VMIN
                    g07 = Q1 + SINDELTA*VMAG1*Iconv
                    g08 = Q2 + SINDELTA*VMAG2*Iconv
                else
                    if ev_W2 < 0
                        g06 = P1 + COSDELTA*Iconv*VMIN
                        g07 = Q1 - SINDELTA*VMAG1*Iconv
                        g08 = Q2 - SINDELTA*VMAG2*Iconv
                    else
                        g06 = P1 - COSDELTA*VMIN*Iconv*ws*(W-1.0)/deadband
                        g07 = Q1 + SINDELTA*VMAG1*Iconv*ws*(W-1.0)/deadband
                        g08 = Q2 + SINDELTA*VMAG2*Iconv*ws*(W-1.0)/deadband
                    end
                end
            end
        end
    end
  end
end
g21 = COSDELTA - ((VD1/VMAG1)*(VD2/VMAG2)+(VQ1/VMAG1)*(VQ2/VMAG2))
g22 = SINDELTA - ((VQ1/VMAG1)*(VD2/VMAG2)-(VD1/VMAG1)*(VQ2/VMAG2))
%----------------------
h_equations:
%----------------------

%----------------------
measurements:
%----------------------


%-----------------------------------------------------------------------
checkparameters:
%-----------------------------------------------------------------------
```