We verified the DNA A/D converter in “Dry experiment” with simulations. To verify the functionality of A/D converter, we formalized a model with ordinary differential equation (ODE) based on chemical kinetics. The numerical simulation was carried by MATLAB.

We could achieve success of this simulation with 207 the reaction rate equations and 467 differential equations. Please see Source code and all reaction rate equations and differential equations below.

Reaction rate equations

Common variables of each gate

G_out_	’gate : output’ of each gate
G_in_	‘gate : input’ of each gate
G_fuel_	‘gate : fuel’ of each gate
th_	‘threshold’ of each gate
fuel_	‘fuel’ of each gate

＊ Valiable name of each gate is written in the back of ‘_’.

Variables of Threshold gates and NOT gates

out i	・The output generated by program of TEAM Sendai. ・input of Threshold gate.
out_Th Ai	・The output generated by Threshold gate had ‘out i’ as input. ・input of NOT gate and reacts ‘Inverter i’.
out_NOT i	・The output generated by NOT gate had ‘Inverter i’ as input. ・input of AND gate.
out_Th Bi	・The output generated by Threshold gate had ‘out_ThAi’ as input. ・input of AND gat.

＊ The value of i is from 1 to 7.

ThresholdgateA-1

v1 = ks * (out1 * G_out_ThA1 - out_ThA1 * G_in_ThA1);

v2 = ks * (fuel_ThA1 * G_in_ThA1 - out1 * G_fuel_ThA1);

v3 = kf * out1 * th_ThA1;

NOTgate-1

v4 = km * (Inverter1 * out_ThA1);

v5 = ks * (Inverter1 * G_out_NOT1 - out_NOT1 * G_in_NOT1);

v6 = kf * (Inverter1 * th_NOT1);

v7 = ks * (Inverter1 * G_fuel_NOT1 - fuel_NOT1 * G_in_NOT1);

ThresholdgateB-1

v8 = ks * (out_ThA1 * G_out_ThB1 - out_ThB1 * G_in_ThB1);

v9 = ks * (fuel_ThB1 * G_in_ThB1 - out_ThA1 * G_fuel_ThB1);

v10 = kf * out_ThA1 * th_ThB1;

ThresholdgateA-2

v11 = ks * (out2 * G_out_ThA2 - out_ThA2 * G_in_ThA2);

v12 = ks * (fuel_ThA2 * G_in_ThA2 - out2 * G_fuel_ThA2);

v13 = kf * out2 * th_ThA2;

NOTgate-2

v14 = km * (Inverter2 * out_ThA2);

v15 = ks * (Inverter2 * G_out_NOT2 - out_NOT2 * G_in_NOT2);

v16 = kf * (Inverter2 * th_NOT2);

v17 = ks * (Inverter2 * G_fuel_NOT2 - fuel_NOT2 * G_in_NOT2);

ThresholdgateB-2

v18 = ks * (out_ThA2 * G_out_ThB2 - out_ThB2 * G_in_ThB2);

v19 = ks * (fuel_ThB2 * G_in_ThB2 - out_ThA2 * G_fuel_ThB2);

v20 = kf * out_ThA2 * th_ThB2;

ThresholdgateA-3

v21 = ks * (out3 * G_out_ThA3 - out_ThA3 * G_in_ThA3);

v22 = ks * (fuel_ThA3 * G_in_ThA3 - out3 * G_fuel_ThA3);

v23 = kf * out3 * th_ThA3;

NOTgate-3

v24 = km * (Inverter3 * out_ThA3);

v25 = ks * (Inverter3 * G_out_NOT3 - out_NOT3 * G_in_NOT3);

v26 = kf * (Inverter3 * th_NOT3);

v27 = ks * (Inverter3 * G_fuel_NOT3 - fuel_NOT3 * G_in_NOT3);

ThresholdgateB-3

v28 = ks * (out_ThA3* G_out_ThB3 - out_ThB3 * G_in_ThB3);

v29 = ks * (fuel_ThB3 * G_in_ThB3 - out_ThA3 * G_fuel_ThB3);

v30 = kf * out_ThA3 * th_ThB3;

ThresholdgateA-4

v31 = ks * (out4 * G_out_ThA4 - out_ThA4 * G_in_ThA4);

v32 = ks * (fuel_ThA4 * G_in_ThA4 - out4 * G_fuel_ThA4);

v33 = kf * out4 * th_ThA4;

NOTgate-4

v34 = km * (Inverter4 * out_ThA4);

v35 = ks * (Inverter4 * G_out_NOT4 - out_NOT4 * G_in_NOT4);

v36 = kf * (Inverter4 * th_NOT4);

v37 = ks * (Inverter4 * G_fuel_NOT4 - fuel_NOT4 * G_in_NOT4);

ThresholdgateB-4

v38 = ks * (out_ThA4 * G_out_ThB4 - out_ThB4 * G_in_ThB4);

v39 = ks * (fuel_ThB4 * G_in_ThB4 - out_ThA4 * G_fuel_ThB4);

v40 = kf * out_ThA4 * th_ThB4;

ThresholdgateA-5

v41 = ks * (out5 * G_out_ThA5 - out_ThA5 * G_in_ThA5);

v42 = ks * (fuel_ThA5 * G_in_ThA5 - out5 * G_fuel_ThA5);

v43 = kf * out5 * th_ThA5;

NOTgate-5

v44 = km * (Inverter5 * out_ThA5);

v45 = ks * (Inverter5 * G_out_NOT5 - out_NOT5 * G_in_NOT5);

v46 = kf * (Inverter5 * th_NOT5);

v47 = ks * (Inverter5 * G_fuel_NOT5 - fuel_NOT5 * G_in_NOT5);

ThresholdgateB-5

v48 = ks * (out_ThA5 * G_out_ThB5 - out_ThB5 * G_in_ThB5);

v49 = ks * (fuel_ThB5 * G_in_ThB5 - out_ThA5 * G_fuel_ThB5);

v50 = kf * out_ThA5 * th_ThB5;

ThresholdgateA-6

v51 = ks * (out6 * G_out_ThA6 - out_ThA6 * G_in_ThA6);

v52 = ks * (fuel_ThA6 * G_in_ThA6 - out6 * G_fuel_ThA6);

v53 = kf * out6 * th_ThA6;

NOTgate-6

v54 = km * (Inverter6 * out_ThA6);

v55 = ks * (Inverter6 * G_out_NOT6 - out_NOT6 * G_in_NOT6);

v56 = kf * (Inverter6 * th_NOT6);

v57 = ks * (Inverter6 * G_fuel_NOT6 - fuel_NOT6 * G_in_NOT6);

ThresholdgateB-6

v58 = ks * (out_ThA6 * G_out_ThB6 - out_ThB6 * G_in_ThB6);

v59 = ks * (fuel_ThB6 * G_in_ThB6 - out_ThA6 * G_fuel_ThB6);

v60 = kf * out_ThA6 * th_ThB6;

ThresholdgateA-7

v61 = ks * (out7 * G_out_ThA7 - out_ThA7 * G_in_ThA7);

v62 = ks * (fuel_ThA7 * G_in_ThA7 - out7 * G_fuel_ThA7);

v63 = kf * out7 * th_ThA7;

NOTgate-7

v64 = km * (Inverter7 * out_ThA7);

v65 = ks * (Inverter7 * G_out_NOT7 - out_NOT7 * G_in_NOT7);

v66 = kf * (Inverter7 * th_NOT7);

v67 = ks * (Inverter7 * G_fuel_NOT7 - fuel_NOT7 * G_in_NOT7);

ThresholdgateB-7

v68 = ks * (out_ThA7 * G_out_ThB7 - out_ThB7 * G_in_ThB7);

v69 = ks * (fuel_ThB7 * G_in_ThB7 - out_ThA7 * G_fuel_ThB7);

v70 = kf * out_ThA7 * th_ThB7;

ThresholdgateA-8

v71 = ks * (input2 * G_out_ThA8 - out_ThA8 * G_in_ThA8);

v72 = ks * (fuel_ThA8 * G_in_ThA8 - input2 * G_fuel_ThA8);

v73 = kf * input2 * th_ThA8;

NOTgate-8

v74 = km * (Inverter8 * out_ThA8);

v75 = ks * (Inverter8 * G_out_NOT8 - out_NOT8 * G_in_NOT8);

v76 = kf * (Inverter8 * th_NOT8);

v77 = ks * (Inverter8 * G_fuel_NOT8 - fuel_NOT8 * G_in_NOT8);

Variables of AND gates

in	Optional input.
out_g j_AND j	The output generated by each gate in AND gate.
waste_AND j	The output generated by ‘gate3’ in AND gate.
out_AND k	・The final output generated by AND gate. ・input of OR gate.

＊ The value of j is from 1 to 4.

＊ The value of k is from 1 to 8.

ANDgate-1

v78 = ks * (in * G1_out_AND1 - out_g1_AND1 * G1_in1_AND1);

v79 = ks * (out_g3_AND1 * G1_in1_AND1 - in * G1_in2_AND1);

v80 = kf * in * th1_g1_AND1;

v81 = kf * out_g1_AND1 * th_g4_AND1;

v82 = kf * out_g3_AND1 * th2_g1_AND1;

v83 = ks * (out_NOT1 * G2_out_AND1 - out_g2_AND1 * G2_in_AND1);

v84 = ks * (fuel_g2_AND1 * G2_in_AND1 - out_NOT1 * G2_fuel_AND1);

v85 = kf * out_NOT1 * th_g2_AND1;

v86 = kf * out_g2_AND1 * th_g3_AND1;

v87 = ks * (out_g3_AND1 * G3_waste_AND1 - waste_AND1 * G3_out_AND1);

v88 = ks * (out_g2_AND1 * G3_waste_AND1 - waste_AND1 * G3_in_AND1);

v89 = ks * (out_g1_AND1 * G4_out_AND1 - out_AND1 * G4_in_AND1);

v90 = ks * (fuel_g4_AND1 * G4_in_AND1 - out_g1_AND1 * G4_fuel_AND1);

ANDgate-2

v91 = ks * (out_ThB1 * G1_out_AND2 - out_g1_AND2 * G1_in1_AND2);
v92 = ks * (out_g3_AND2 * G1_in1_AND2 - out_ThB1 * G1_in2_AND2);
v93 = kf * out_ThB1 * th1_g1_AND2;
v94 = kf * out_g1_AND2 * th_g4_AND2;
v95 = kf * out_g3_AND2 * th2_g1_AND2;

v96 = ks * (out_NOT2 * G2_out_AND2 - out_g2_AND2 * G2_in_AND2);
v97 = ks * (fuel_g2_AND2 * G2_in_AND2 - out_NOT2 * G2_fuel_AND2);
v98 = kf * out_NOT2 * th_g2_AND2;
v99 = kf * out_g2_AND2 * th_g3_AND2;

v100 = ks * (out_g3_AND2 * G3_waste_AND2 - waste_AND2 * G3_out_AND2);
v101 = ks * (out_g2_AND2 * G3_waste_AND2 - waste_AND2 * G3_in_AND2);

v102 = ks * (out_g1_AND2 * G4_out_AND2 - out_AND2 * G4_in_AND2);
v103 = ks * (fuel_g4_AND2 * G4_in_AND2 - out_g1_AND2 * G4_fuel_AND2);

ANDgate-3

v104 = ks * (out_ThB2 * G1_out_AND3 - out_g1_AND3 * G1_in1_AND3);
v105 = ks * (out_g3_AND3 * G1_in1_AND3 - out_ThB2 * G1_in2_AND3);
v106 = kf * out_ThB2 * th1_g1_AND3;
v107 = kf * out_g1_AND3 * th_g4_AND3;
v108 = kf * out_g3_AND3 * th2_g1_AND3;

v109 = ks * (out_NOT3 * G2_out_AND3- out_g2_AND3 * G2_in_AND3);
v110 = ks * (fuel_g2_AND3 * G2_in_AND3 - out_NOT3 * G2_fuel_AND3);
v111 = kf * out_NOT3 * th_g2_AND3;
v112 = kf * out_g2_AND3 * th_g3_AND3;

v113 = ks * (out_g3_AND3 * G3_waste_AND3 - waste_AND3 * G3_out_AND3);
v114 = ks * (out_g2_AND3 * G3_waste_AND3 - waste_AND3 * G3_in_AND3);

v115 = ks * (out_g1_AND3 * G4_out_AND3 - out_AND3 * G4_in_AND3);
v116 = ks * (fuel_g4_AND3 * G4_in_AND3 - out_g1_AND3 * G4_fuel_AND3);

ANDgate-4

v117 = ks * (out_ThB3 * G1_out_AND4 - out_g1_AND4 * G1_in1_AND4);
v118 = ks * (out_g3_AND4* G1_in1_AND4 - out_ThB3 * G1_in2_AND4);
v119 = kf * out_ThB3 * th1_g1_AND4;
v120 = kf * out_g1_AND4 * th_g4_AND4;
v121 = kf * out_g3_AND4* th2_g1_AND4;

v122 = ks * (out_NOT4 * G2_out_AND4 - out_g2_AND4 * G2_in_AND4);
v123 = ks * (fuel_g2_AND4 * G2_in_AND4 - out_NOT4 * G2_fuel_AND4);
v124 = kf * out_NOT4 * th_g2_AND4;
v125 = kf * out_g2_AND4 * th_g3_AND4;

v126 = ks * (out_g3_AND4* G3_waste_AND4 - waste_AND4 * G3_out_AND4);
v127 = ks * (out_g2_AND4 * G3_waste_AND4 - waste_AND4 * G3_in_AND4);

v128 = ks * (out_g1_AND4 * G4_out_AND4 - out_AND4 * G4_in_AND4);
v129 = ks * (fuel_g4_AND4 * G4_in_AND4 - out_g1_AND4 * G4_fuel_AND4);

ANDgate-5

v130 = ks * (out_ThB4 * G1_out_AND5 - out_g1_AND5 * G1_in1_AND5);
v131 = ks * (out_g3_AND5 * G1_in1_AND5 - out_ThB4 * G1_in2_AND5);
v132 = kf * out_ThB4 * th1_g1_AND5;
v133 = kf * out_g1_AND5 * th_g4_AND5;
v134 = kf * out_g3_AND5 * th2_g1_AND5;

v135 = ks * (out_NOT5 * G2_out_AND5 - out_g2_AND5 * G2_in_AND5);
v136 = ks * (fuel_g2_AND5 * G2_in_AND5 - out_NOT5 * G2_fuel_AND5);

v137 = kf * out_NOT5 * th_g2_AND5;
v138 = kf * out_g2_AND5 * th_g3_AND5;

v139 = ks * (out_g3_AND5 * G3_waste_AND5 - waste_AND5 * G3_out_AND5);
v140 = ks * (out_g2_AND5 * G3_waste_AND5 - waste_AND5 * G3_in_AND5);

v141 = ks * (out_g1_AND5 * G4_out_AND5 - out_AND5 * G4_in_AND5);
v142 = ks * (fuel_g4_AND5 * G4_in_AND5 - out_g1_AND5 * G4_fuel_AND5);

ANDgate-6

v143 = ks * (out_ThB5 * G1_out_AND6 - out_g1_AND6 * G1_in1_AND6);
v144 = ks * (out_g3_AND6 * G1_in1_AND6 - out_ThB5 * G1_in2_AND6);
v145 = kf * out_ThB5 * th1_g1_AND6;
v146 = kf * out_g1_AND6 * th_g4_AND6;
v147 = kf * out_g3_AND6 * th2_g1_AND6;

v148 = ks * (out_NOT6 * G2_out_AND6 - out_g2_AND6 * G2_in_AND6);
v149 = ks * (fuel_g2_AND6 * G2_in_AND6 - out_NOT6 * G2_fuel_AND6);
v150 = kf * out_NOT6 * th_g2_AND6;
v151 = kf * out_g2_AND6 * th_g3_AND6;

v152 = ks * (out_g3_AND6 * G3_waste_AND6 - waste_AND6 * G3_out_AND6);
v153 = ks * (out_g2_AND6 * G3_waste_AND6 - waste_AND6 * G3_in_AND6);

v154 = ks * (out_g1_AND6 * G4_out_AND6 - out_AND6 * G4_in_AND6);
v155 = ks * (fuel_g4_AND6 * G4_in_AND6 - out_g1_AND6 * G4_fuel_AND6);

ANDgate7

v156 = ks * (out_ThB6 * G1_out_AND7 - out_g1_AND7 * G1_in1_AND7);
v157 = ks * (out_g3_AND7 * G1_in1_AND7 - out_ThB6 * G1_in2_AND7);
v158 = kf * out_ThB6 * th1_g1_AND7;

v159 = kf * out_g1_AND7 * th_g4_AND7;
v160 = kf * out_g3_AND7 * th2_g1_AND7;

v161 = ks * (out_NOT7 * G2_out_AND7 - out_g2_AND7 * G2_in_AND7);
v162 = ks * (fuel_g2_AND7 * G2_in_AND7 - out_NOT7 * G2_fuel_AND7);
v163 = kf * out_NOT7 * th_g2_AND7;
v164 = kf * out_g2_AND7 * th_g3_AND7;

v165 = ks * (out_g3_AND7 * G3_waste_AND7 - waste_AND7 * G3_out_AND7);
v166 = ks * (out_g2_AND7 * G3_waste_AND7 - waste_AND7 * G3_in_AND7);

v167 = ks * (out_g1_AND7 * G4_out_AND7 - out_AND7 * G4_in_AND7);
v168 = ks * (fuel_g4_AND7 * G4_in_AND7 - out_g1_AND7 * G4_fuel_AND7);

ANDgate-8

v169 = ks * (out_ThB7 * G1_out_AND8 - out_g1_AND8 * G1_in1_AND8);
v170 = ks * (out_g3_AND8 * G1_in1_AND8 - out_ThB7 * G1_in2_AND8);
v171 = kf * out_ThB7 * th1_g1_AND8;
v172 = kf * out_g1_AND8 * th_g4_AND8;
v173 = kf * out_g3_AND8 * th2_g1_AND8;

v174 = ks * (out_NOT8 * G2_out_AND8 - out_g2_AND8 * G2_in_AND8);
v175 = ks * (fuel_g2_AND8 * G2_in_AND8 - out_NOT8 * G2_fuel_AND8);
v176 = kf * out_NOT8 * th_g2_AND8;
v177 = kf * out_g2_AND8 * th_g3_AND8;

v178 = ks * (out_g3_AND8 * G3_waste_AND8 - waste_AND8 * G3_out_AND8);
v179 = ks * (out_g2_AND8 * G3_waste_AND8 - waste_AND8 * G3_in_AND8);

v180 = ks * (out_g1_AND8 * G4_out_AND8 - out_AND8 * G4_in_AND8);
v181 = ks * (fuel_g4_AND8 * G4_in_AND8 - out_g1_AND8 * G4_fuel_AND8);

Variable of OR gates

g_out i	'gate : output' of OR gate
g_in i	'gate : input' of OR gate
X n	The output generated from OR gate

＊ The value of n is 1 from 3.

＊ The value of i is 1 from 7.

OR gate

v182 = ks * (out_AND1 * g_out2 - X2 * g_in7);
v183 = ks * (out_AND1 * g_out1 - X1 * g_in7);
v184 = ks * (out_AND1 * g_out0 - X0 * g_in7);
v185 = ks * (fuel * g_in7 - out_AND1 * g_fuel);
v186 = kf * out_AND1 * th07;

v187 = ks * (out_AND2 * g_out2 - X2 * g_in6);
v188 = ks * (out_AND2 * g_out1 - X1 * g_in6);
v189 = ks * (fuel * g_in6 - out_AND2 * g_fuel);
v190 = kf * out_AND2 * th06;

v191 = ks * (out_AND3 * g_out2 - X2 * g_in5);
v192 = ks * (out_AND3 * g_out0 - X0 * g_in5);
v193 = ks * (fuel * g_in5 - out_AND3 * g_fuel);
v194 = kf * out_AND3 * th05;

v195 = ks * (out_AND4 * g_out2 - X2 * g_in4);
v196 = ks * (fuel * g_in4 - out_AND4 * g_fuel);
v197 = kf * out_AND4 * th04;

v198 = ks * (out_AND5 * g_out1 - X1 * g_in3);
v199 = ks * (out_AND5 * g_out0 - X0 * g_in3);

```
v200   =   ks * ( fuel * g_in3 - out_AND5 * g_fuel );
v201   =   kf * out_AND5 * th03;

v202   =   ks * ( out_AND6 * g_out1 - X1 * g_in2 );
v203   =   ks * (fuel * g_in2 - out_AND6 * g_fuel );
v204   =   kf * out_AND6 * th02;

v205   =   ks * ( out_AND7 * g_out0 - X0 * g_in1 );
v206   =   ks * (fuel * g_in1 - out_AND7 * g_fuel );
v207   =   kf * out_AND7 * th01;
```

Differential equations

TEAM Sendai

dx1/dt = -ks*in1*tri1 + ks*in1_tri1*sig1;

dx2/dt = -ks*in1*tri1 + ks*in1_tri1*sig1;

dx3/dt = ks*in1*tri1 - ks*in1_tri1*sig1 - kf*in1_tri1*fuel1 + krf*w_1_7 - ks*in1_tri1*in_tri1 + ks*w_1_8*sig2;

dx4/dt = ks*in1*tri1-ks*in1_tri1*sig1-kf*sig1*trans1-ks*sig1*gate1 + ks*n_tri1*sig1_gate1 + ks*sig1_gate1*fuel1-ks*sig1*w_1_1 - kf*sig1*sig1_gate1 + krf*w_1_6;

dx5/dt = -kf*sig1*trans1;

dx6/dt = kf*sig1*trans1;

dx7/dt = kf*sig1*trans1-v1 + v2-v3;

dx8/dt = -ks*sig1*gate1 + ks*n_tri1*sig1_gate1 - kf*gate1*n_tri1 + krf*w_1_2 - kf*gate1*fuel1 + krf*w_1_5;

dx9/dt = ks*sig1*gate1 - ks*n_tri1*sig1_gate1 - kf*gate1*n_tri1 + krf*w_1_2 - kf*n_tri1*w_1_1 + krf*w_1_4 - ks*in1_tri1*n_tri1 + ks*w_1_8*sig2;

dx10/dt = ks*sig1*gate1 - ks*n_tri1*sig1_gate1 - ks*sig1_gate1*fuel1 + ks*sig1*w_1_1 - kf*sig1*sig1_gate1 + krf*w_1_6;

dx11/dt = -ks*sig1_gate1*fuel1 + ks*sig1*w_1_1 - kf*fuel1*w_1_1 + krf*w_1_3 - kf*gate1*fuel1 + krf*w_1_5 - kf*in1_tri1*fuel1 + krf*w_1_7;

dx12/dt = -ks*sig1*w_1_1 + ks*sig1_gate1*fuel1 - kf*fuel1*w_1_1 + krf*w_1_3 - kf*n_tri1*w_1_1 + krf*w_1_4;

dx13/dt = kf*gate1*n_tri1 - krf*w_1_2;

dx14/dt = kf*fuel1*w_1_1 - krf*w_1_3;

dx15/dt = kf*n_tri1*w_1_1 - krf*w_1_4;

dx16/dt = kf*gate1*fuel1 - krf*w_1_5;

dx17/dt = kf*sig1*sig1_gate1 - krf*w_1_6;

dx18/dt = kf*in1_tri1*fuel1 - krf*w_1_7;

dx19/dt = ks*in1_tri1*n_tri1 - ks*w_1_8*sig2 - kf*w_1_8*fuel2 + krf*w_2_7 - ks*w_1_8*n_tri2 + ks*w_2_8*sig3;

dx20/dt = ks*in1_tri1*n_tri1 - ks*w_1_8*sig2 – kf*sig2*trans2 - ks*sig2*gate2 + ks*n_tri2*sig2_gate2 + ks*sig2_gate2*fuel2 - ks*sig2*w_2_1 – kf*sig2*sig2_gate2+krf*w_2_6;

dx21/dt = -kf*sig2*trans2;

dx22/dt = kf*sig2*trans2;

dx23/dt = kf*sig2*trans2 - v11 + v12 - v13;

dx24/dt = -ks*sig2*gate2 + ks*n_tri2*sig2_gate2 - kf*gate2*n_tri2 + krf*w_2_2 – kf*gate2*fuel2 + krf*w_2_5;

dx25/dt = ks*sig2*gate2 - ks*n_tri2*sig2_gate2 - kf*gate2*n_tri2 + krf*w_2_2 - kf*n_tri2*w_2_1 + krf*w_2_4 - ks*w_1_8*n_tri2 + ks*w_2_8*sig3;

dx26/dt = ks*sig2*gate2 - ks*n_tri2*sig2_gate2 - ks*sig2_gate2*fuel2 + ks*sig2*w_2_1 - kf*sig2*sig2_gate2 + krf*w_2_6;

dx27/dt = -ks*sig2_gate2*fuel2 + ks*sig2*w_2_1 - kf*fuel2*w_2_1 + krf*w_2_3 – kf*gate2*fuel2 + krf*w_2_5 - kf*w_1_8*fuel2 + krf*w_2_7;

dx28/dt = -ks*sig2*w_2_1 + ks*sig2_gate2*fuel2 - kf*fuel2*w_2_1 + krf*w_2_3 – kf*n_tri2*w_2_1 + krf*w_2_4;

dx29/dt = kf*gate2*n_tri2 - krf*w_2_2;

dx30/dt = kf*fuel2*w_2_1 - krf*w_2_3;

dx31/dt = kf*n_tri2*w_2_1 - krf*w_2_4;

dx32/dt = kf*gate2*fuel2 - krf*w_2_5;

dx33/dt = kf*sig2*sig2_gate2 - krf*w_2_6;

dx34/dt = kf*w_1_8*fuel2 - krf*w_2_7;

dx35/dt = ks*w_1_8*n_tri2 - ks*w_2_8*sig3 - kf*w_2_8*fuel3 + krf*w_3_7;

dx36/dt = ks*w_1_8*n_tri2-ks*w_2_8*sig3 - kf*sig3*trans3 - ks*sig3*gate3 + ks*n_tri3*sig3_gate3 + ks*sig3_gate3*fuel3 - ks*sig3*w_3_1 – kf*sig3*sig3_gate3+krf*w_3_6;

dx37/dt = -kf*sig3*trans3;

dx38/dt = kf*sig3*trans3;

dx39/dt = kf*sig3*trans3 - v21 + v22 - v23;

dx40/dt = -ks*sig3*gate3 + ks*n_tri3*sig3_gate3 - kf*gate3*n_tri3 + krf*w_3_2 – kf*gate3*fuel3 + krf*w_3_5;

dx41/dt = ks*sig3*gate3 - ks*n_tri3*sig3_gate3 - kf*gate3*n_tri3 + krf*w_3_2 – kf*n_tri3*w_3_1 + krf*w_3_4;

dx42/dt = ks*sig3*gate3 - ks*n_tri3*sig3_gate3 - ks*sig3_gate3*fuel3 + ks*sig3*w_3_1 - kf*sig3*sig3_gate3 + krf*w_3_6;

dx43/dt = -ks*sig3_gate3*fuel3 + ks*sig3*w_3_1 - kf*fuel3*w_3_1 + krf*w_3_3 – kf*gate3*fuel3 +krf*w_3_5 - kf*w_2_8*fuel3 + krf*w_3_7;

dx44/dt = -ks*sig3*w_3_1 + ks*sig3_gate3*fuel3 - kf*fuel3*w_3_1 + krf*w_3_3 – kf*n_tri3*w_3_1 + krf*w_3_4;

dx45/dt = kf*gate3*n_tri3 - krf*w_3_2;

dx46/dt = kf*fuel3*w_3_1 - krf*w_3_3;

dx47/dt = kf*n_tri3*w_3_1 - krf*w_3_4;

dx48/dt = kf*gate3*fuel3 - krf*w_3_5;

dx49/dt = kf*sig3*sig3_gate3 - krf*w_3_6;

dx50/dt = kf*w_2_8*fuel3 - krf*w_3_7;

dx51/dt = ks*w_2_8*n_tri3-ks*w_3_8*sig4 - kf*w_3_8*fuel4 + krf*w_4_7;

dx52/dt = ks*w_2_8*n_tri3-ks*w_3_8*sig4 - kf*sig4*trans4 - ks*sig4*gate4 + ks*n_tri4*sig4_gate4 + ks*sig4_gate4*fuel4-ks*sig4*w_4_1- kf*sig4*sig4_gate4 + krf*w_4_6;

dx53/dt = -kf*sig4*trans4;

dx54/dt = kf*sig4*trans4;

dx55/dt = kf*sig4*trans4 - v31 + v32 - v33;

dx56/dt = -ks*sig4*gate4 + ks*n_tri4*sig4_gate4 - kf*gate4*n_tri4 + krf*w_4_2 - kf*gate4*fuel4 + krf*w_4_5;

dx57/dt = ks*sig4*gate4 - ks*n_tri4*sig4_gate4 - kf*gate4*n_tri4 + krf*w_4_2 – kf*n_tri4*w_4_1 + krf*w_4_4;

dx58/dt = ks*sig4*gate4 - ks*n_tri4*sig4_gate4 - ks*sig4_gate4*fuel4 + ks*sig4*w_4_1 - kf*sig4*sig4_gate4 + krf*w_4_6;

dx59/dt = -ks*sig4_gate4*fuel4 + ks*sig4*w_4_1 - kf*fuel4*w_4_1 + krf*w_4_3 – kf*gate4*fuel4 + krf*w_4_5 - kf*w_3_8*fuel4 + krf*w_4_7;

dx60/dt = -ks*sig4*w_4_1 + ks*sig4_gate4*fuel4 - kf*fuel4*w_4_1 + krf*w_4_3 – kf*n_tri4*w_4_1 + krf*w_4_4;

dx61/dt = kf*gate4*n_tri4 - krf*w_4_2;

dx62/dt = kf*fuel4*w_4_1 - krf*w_4_3;

```
dx63/dt  =  kf*n_tri4*w_4_1 - krf*w_4_4;
dx64/dt  =  kf*gate4*fuel4 - krf*w_4_5;
dx65/dt  =  kf*sig4*sig4_gate4 - rf*w_4_6;
dx66/dt  =  kf*w_3_8*fuel4 - krf*w_4_7;
dx67/dt  =  ks*w_3_8*n_tri4 - ks*w_4_8*sig5 - kf*w_4_8*fuel5 + krf*w_5_7 –
            ks*w_4_8*n_tri5 + ks*w_5_8*sig6;
dx68/dt  =  ks*w_3_8*n_tri4 - ks*w_4_8*sig5 – kf*sig5*trans5 - ks*sig5*gate5 +
            ks*n_tri5*sig5_gate5 + ks*sig5_gate5*fuel5-ks*sig5*w_5_1 –
            kf*sig5*sig5_gate5 + krf*w_5_6;
dx69/dt  =  -kf*sig5*trans5;
dx70/dt  =  kf*sig5*trans5;
dx71/dt  =  kf*sig5*trans5 - v41 + v42 - v43;
dx72/dt  =  -ks*sig5*gate5 + ks*n_tri5*sig5_gate5 - kf*gate5*n_tri5 + krf*w_5_2 –
            kf*gate5*fuel5 + krf*w_5_5;
dx73/dt  =  ks*sig5*gate5 - ks*n_tri5*sig5_gate5 - kf*gate5*n_tri5 + krf*w_5_2 –
            kf*n_tri5*w_5_1 + krf*w_5_4 - ks*w_4_8*n_tri5 + ks*w_5_8*sig6;
dx74/dt  =  ks*sig5*gate5 - ks*n_tri5*sig5_gate5 - ks*sig5_gate5*fuel5 +
            ks*sig5*w_5_1 - kf*sig5*sig5_gate5 + krf*w_5_6;
dx75/dt  =  -ks*sig5_gate5*fuel5 + ks*sig5*w_5_1 - kf*fuel5*w_5_1 + rf*w_5_3 –
            kf*gate5*fuel5 + krf*w_5_5 - kf*w_4_8*fuel5 + krf*w_5_7;
dx76/dt  =  -ks*sig5*w_5_1 + ks*sig5_gate5*fuel5 - kf*fuel5*w_5_1 + krf*w_5_3 –
            kf*n_tri5*w_5_1 + krf*w_5_4;
dx77/dt  =  kf*gate5*n_tri5 - krf*w_5_2;
dx78/dt  =  kf*fuel5*w_5_1 - krf*w_5_3;
dx79/dt  =  kf*n_tri5*w_5_1 - krf*w_5_4;
dx80/dt  =  kf*gate5*fuel5 - krf*w_5_5;
dx81/dt  =  kf*sig5*sig5_gate5 - krf*w_5_6;
dx82/dt  =  kf*w_4_8*fuel5 - krf*w_5_7;
dx83/dt  =  ks*w_4_8*n_tri5 - ks*w_5_8*sig6 - kf*w_5_8*fuel6 + krf*w_6_7 –
            ks*w_5_8*n_tri6 + ks*w_6_8*sig7;
dx84/dt  =  ks*w_4_8*n_tri5 - ks*w_5_8*sig6 - kf*sig6*trans6 - ks*sig6*gate6 +
            ks*n_tri6*sig6_gate6 + ks*sig6_gate6*fuel6 - ks*sig6*w_6_1 –
            kf*sig6*sig6_gate6 + krf*w_6_6;
```

dx85/dt = -kf*sig6*trans6;
dx86/dt = kf*sig6*trans6;
dx87/dt = kf*sig6*trans6 - v51 + v52 - v53;
dx88/dt = -ks*sig6*gate6 + ks*n_tri6*sig6_gate6 - kf*gate6*n_tri6 + krf*w_6_2 – kf*gate6*fuel6 + krf*w_6_5;
dx89/dt = ks*sig6*gate6 - ks*n_tri6*sig6_gate6 - kf*gate6*n_tri6 + krf*w_6_2 – kf*n_tri6*w_6_1 + krf*w_6_4 - ks*w_5_8*n_tri6 + ks*w_6_8*sig7;
dx90/dt = ks*sig6*gate6 - ks*n_tri6*sig6_gate6 - ks*sig6_gate6*fuel6 + ks*sig6*w_6_1 - kf*sig6*sig6_gate6 + krf*w_6_6;
dx91/dt = -ks*sig6_gate6*fuel6 + ks*sig6*w_6_1 - kf*fuel6*w_6_1 + krf*w_6_3 – kf*gate6*fuel6 + krf*w_6_5 - kf*w_5_8*fuel6 + krf*w_6_7;
dx92/dt = -ks*sig6*w_6_1 + ks*sig6_gate6*fuel6 - kf*fuel6*w_6_1 + krf*w_6_3 - kf*n_tri6*w_6_1 + krf*w_6_4;
dx93/dt = kf*gate6*n_tri6 - krf*w_6_2;
dx94/dt = kf*fuel6*w_6_1 - krf*w_6_3;
dx95/dt = kf*n_tri6*w_6_1 - krf*w_6_4;
dx96/dt = kf*gate6*fuel6 - krf*w_6_5;
dx97/dt = kf*sig6*sig6_gate6 - krf*w_6_6;
dx98/dt = kf*w_5_8*fuel6 - krf*w_6_7;
dx99/dt = ks*w_5_8*n_tri6 - ks*w_6_8*sig7 - kf*w_6_8*fuel7 + krf*w_7_7;
dx100/dt = ks*w_5_8*n_tri6 - ks*w_6_8*sig7 - kf*sig7*trans7 - ks*sig7*gate7 + ks*n_tri7*sig7_gate7 + ks*sig7_gate7*fuel7 - ks*sig7*w_7_1 – kf*sig7*sig7_gate7 + krf*w_7_6;
dx101/dt = -kf*sig7*trans7;
dx102/dt = kf*sig7*trans7;
dx103/dt = kf*sig7*trans7 - v61 + v62 - v63;
dx104/dt = -ks*sig7*gate7 + ks*n_tri7*sig7_gate7 - kf*gate7*n_tri7 + krf*w_7_2 – kf*gate7*fuel7 + krf*w_7_5;
dx105/dt = ks*sig7*gate7 - ks*n_tri7*sig7_gate7 - kf*gate7*n_tri7 + krf*w_7_2 – kf*n_tri7*w_7_1 + krf*w_7_4;
dx106/dt = ks*sig7*gate7 - ks*n_tri7*sig7_gate7 - ks*sig7_gate7*fuel7 + ks*sig7*w_7_1 - kf*sig7*sig7_gate7 + krf*w_7_6;
dx107/dt = -ks*sig7_gate7*fuel7 + ks*sig7*w_7_1 - kf*fuel7*w_7_1 + krf*w_7_3 –

kf*gate7*fuel7 + krf*w_7_5 - kf*w_6_8*fuel7 + krf*w_7_7;

dx108/dt = -ks*sig7*w_7_1 + ks*sig7_gate7*fuel7 - kf*fuel7*w_7_1 + krf*w_7_3 – kf*n_tri7*w_7_1 + krf*w_7_4;

dx109/dt = kf*gate7*n_tri7 - krf*w_7_2;

dx110/dt = kf*fuel7*w_7_1 - krf*w_7_3;

dx111/dt = kf*n_tri7*w_7_1 - krf*w_7_4;

dx112/dt = kf*gate7*fuel7 - krf*w_7_5;

dx113/dt = kf*sig7*sig7_gate7 - krf*w_7_6;

dx114/dt = kf*w_6_8*fuel7 - krf*w_7_7;

Optional input-2

dx115/dt = -v78 + v79 - v80;

ThresholdgateA-1

dx116/dt = v1 - v4 - v8 + v9 - v10;

dx117/dt = -v2;

dx118/dt = v1 - v2;

dx119/dt = -v1;

dx120/dt = v2;

dx121/dt = -v3;

NOTgate-1

dx122/dt = -v4 - v5 - v6 - v7;

dx123/dt = -v5;

dx124/dt = v5 + v7;

dx125/dt = v5 - v83 + v84 - v85;

dx126/dt = -v6;

dx127/dt = -v7;

dx128/dt = v7;

ThresholdgateB-1

dx129/dt = v8 - v91 + v92 - v93;

dx130/dt = -v9;

dx131/dt = v8 - v9;
dx132/dt = -v8;
dx133/dt = v9;
dx134/dt = -v10;

ThresholdgateA-2

dx135/dt = v11 - v14 - v18 + v19 - v20;
dx136/dt = -v12;
dx137/dt = v11 - v12;
dx138/dt = -v11;
dx139/dt = v12;
dx140/dt = -v13;

NOTgate-2

dx141/dt = -v14 - v15 - v16 - v17;
dx142/dt = -v15;
dx143/dt = v15 + v17;
dx144/dt = v15 - v96 + v97 - v98;
dx145/dt = -v16;
dx146/dt = -v17;
dx147/dt = v17;

ThresholdgateB-2

dx148/dt = v18 - v104 + v105 - v106;
dx149/dt = -v19;
dx150/dt = v18 - v19;
dx151/dt = -v18;
dx152/dt = v19;
dx153/dt = -v20;

ThresholdgateA-3

dx154/dt = v21 - v24 - v28 + v29 - v30;
dx155/dt = -v22;

dx156/dt = v21 - v22;
dx157/dt = -v21;
dx158/dt = v22;
dx159/dt = -v23;

NOTgate-3

dx160/dt = -v24 - v25 - v26 - v27;
dx161/dt = -v25;
dx162/dt = v25 + v27;
dx163/dt = v25 - v109 + v110 - v111;
dx164/dt = -v26;
dx165/dt = -v27;
dx166/dt = v27;

ThresholdgateB-3

dx167/dt = v28 - v117 + v118 - v119;
dx168/dt = -v29;
dx169/dt = v28 - v29;
dx170/dt = -v28;
dx171/dt = v29;
dx172/dt = -v30;

ThresholdgateA-4

dx173/dt = v31 - v34 - v38 + v39 - v40;
dx174/dt = -v32;
dx175/dt = v31 - v32;
dx176/dt = -v31;
dx177/dt = v32;
dx178/dt = -v33;

NOTgate-4

dx179/dt = -v34 - v35 - v36 - v37;
dx180/dt = -v35;
dx181/dt = v35 + v37;

dx182/dt = v35 - v122 + v123 - v124;

dx183/dt = -v36;

dx184/dt = -v37;

dx185/dt = v37;

ThresholdgateB-4

dx186/dt = v38 - v130 + v131 - v132;

dx187/dt = -v39;

dx188/dt = v38 - v39;

dx189/dt = -v38;

dx190/dt = v39;

dx191/dt = -v40;

ThresholdgateA-5

dx192/dt = v41 - v44 - v48 + v49 - v50;

dx193/dt = -v42;

dx194/dt = v41 - v42;

dx195/dt = -v41;

dx196/dt = v42;

dx197/dt = -v43;

NOTgate-5

dx198/dt = -v44 - v45 - v46 - v47;

dx199/dt = -v45;

dx200/dt = v45 + v47;

dx201/dt = v45 - v135 + v136 - v137;

dx202/dt = -v46;

dx203/dt = -v47;

dx204/dt = v47;

ThresholdgateB-5

dx205/dt = v48 - v143 + v144 - v145;

dx206/dt = -v49;

dx207/dt = v48 - v49;

dx208/dt = -v48;

dx209/dt = v49;

dx210/dt = -v50;

ThresholdgateA-6

dx211/dt = v51 - v54 - v58 + v59 - v60;

dx212/dt = -v52;

dx213/dt = v51 - v52;

dx214/dt = -v51;

dx215/dt = v52;

dx216/dt = -v53;

NOTgate-6

dx217/dt = -v54 - v55 - v56 - v57;

dx218/dt = -v55;

dx219/dt = v55 + v57;

dx220/dt = v55 - v148 + v149 - v150;

dx221/dt = -v56;

dx222/dt = -v57;

dx223/dt = v57;

ThresholdgateB-6

dx224/dt = v58 - v156 + v157- v158;

dx225/dt = -v59;

dx226/dt = v58 - v59;

dx227/dt = -v58;

dx228/dt = v59;

dx229/dt = -v60;

ThresholdgateA-7

dx230/dt = v61 - v64 - v68 + v69 - v70;

dx231/dt = -v62;

dx232/dt = v61 - v62;

dx233/dt = -v61;

dx234/dt = v62;

dx235/dt = -v63;

NOTgate-7

dx236/dt = -v64 - v65 - v66 - v67;

dx237/dt = -v65;

dx238/dt = v65 + v67;

dx239/dt = v65 - v161 + v162 - v163;

dx240/dt = -v66;

dx241/dt = -v67;

dx242/dt = v67;

ThresholdgateB-7

dx243/dt = v68 - v169 + v170 - v171;

dx244/dt = -v69;

dx245/dt = v68 - v69;

dx246/dt = -v68;

dx247/dt = v69;

dx248/dt = -v70;

NOTgate-8

dx249/dt = v71-v74;

dx250/dt = -v72;

dx251/dt = v71 - v72;

dx252)/dt = -v71;

dx253/dt = v72;

dx254/dt = -v73;

ThresholdgateB-8

dx255/dt = -v74 - v75 - v76 - v77;

dx256/dt = -v75;

dx257/dt = v75 + v77;

dx258/dt = v75 - v174 + v175 - v176;
dx259/dt = -v76;
dx260/dt = -v77;
dx261/dt = v77;

ANDgate-1

dx262/dt = v78 - v81 - v89 + v90;
dx263/dt = -v79 - v82 - v87;
dx264/dt = v78 - v79;
dx265/dt = -v78;
dx266/dt = +v79;
dx267/dt = -v80;
dx268/dt = -v81;
dx269/dt = -v82;

dx270/dt = v83 - v86 - v88;
dx271/dt = -v84;
dx272/dt = v83 - v84;
dx273/dt = -v83;
dx274/dt = v84;
dx275/dt = -v85;
dx276/dt = -v86;

dx277/dt = v87 + v88;
dx278/dt = v87;
dx279/dt = v88;
dx280/dt = -v87 - v88;

dx281/dt = v89 - v182 - v183 - v184 + v185 - v186;
dx282/dt = -v90;
dx283/dt = v89 - v90;
dx284/dt = -v89;
dx285/dt = v90;

ANDgate-2

dx286/dt = v91 - v94 - v102 + v103;
dx287/dt = -v92 - v95 - v100;
dx288/dt = v91 - v92;
dx289/dt = -v91;
dx290/dt = v92;
dx291/dt = -v93;
dx292/dt = -v94;
dx293/dt = -v95;

dx294/dt = v96 - v99 - v101;
dx295/dt = -v97;
dx296/dt = v96 - v97;
dx297/dt = -v96;
dx298/dt = v97;
dx299/dt = -v98;
dx300/dt = -v99;

dx301/dt = v100 + v101;
dx302/dt = v100;
dx303/dt = v101;
dx304/dt = -v100 - v101;

dx305/dt = v102 - v187 - v188 + v189 - v190;
dx306/dt = -v103;
dx307/dt = v102 - v103;
dx308/dt = -v102;
dx309/dt = v103;

ANDgate-3

dx310/dt = v104 - v107 - v115 + v116;
dx311/dt = -v105 - v108 - v113;

dx312/dt = v104 - v105;
dx313/dt = -v104;
dx314/dt = +v105;
dx315/dt = -v106;
dx316/dt = -v107;
dx317/dt = -v108;

dx318/dt = v109 - v112 - v114;
dx319/dt = -v110;
dx320/dt = v109 - v110;
dx321/dt = -v109;
dx322/dt = v110;
dx323/dt = -v111;
dx324/dt = -v112;

dx325/dt = v113 + v114;
dx326/dt = v113;
dx327/dt = v114;
dx328/dt = -v113 - v114;

dx329/dt = v115 - v191 - v192 + v193 - v194;
dx330/dt = -v116;
dx331/dt = v115 - v116;
dx332/dt = -v115;
dx333/dt = v116;

ANDgate-4

dx334/dt = v117 - v120 - v128 + v129;
dx335/dt = -v118 -v121 -v126;
dx336/dt = v117 - v118;
dx337/dt = -v117;
dx338/dt = +v118;
dx339/dt = -v119;

dx340/dt = -v120;
dx341/dt = -v121;

dx342/dt = v122 - v125 - v127;
dx343/dt = -v123;
dx344/dt = v122 - v123;
dx345/dt = -v122;
dx346/dt = v123;
dx347/dt = -v124;
dx348/dt = -v125;

dx349/dt = v126 + v127;
dx350/dt = v126;
dx351/dt = v127;
dx352/dt = -v126 - v127;

dx353/dt = v128 - v195 + v196 - v197;
dx354/dt = -v129;
dx355/dt = v128 -v129;
dx356/dt = -v128;
dx357/dt = v129;

ANDgate-5

dx358/dt = v130 - v133 - v141 + v142;
dx359/dt = -v131 - v134 - v139;
dx360/dt = v130 - v131;
dx361/dt = -v130;
dx362/dt = +v131;
dx363/dt = -v132;
dx364/dt = -v133;
dx365/dt = -v134;

dx366/dt = v135 - v138 - v140;

dx367/dt = -v136;
dx368/dt = v135 - v136;
dx369/dt = -v135;
dx370/dt = v136;
dx371/dt = -v137;
dx372/dt = -v138;

dx373/dt = v139 + v140;
dx374/dt = v139;
dx375/dt = v140;
dx376/dt = -v139 - v140;

dx377/dt = v141 - v198 - v199 + v200 - v201;
dx378/dt = -v142;
dx379/dt = v141 - v142;
dx380/dt = -v141;
dx381/dt = v142;

ANDgate-6

dx382/dt = v143 - v146 - v154 + v155;
dx383/dt = -v144 - v147 - v152;
dx384/dt = v143 - v144;
dx385/dt = -v143;
dx386/dt = +v144;
dx387/dt = -v145;
dx388/dt = -v146;
dx389/dt = -v147;

dx390/dt = v148 - v151 - v153;
dx391/dt = -v149;
dx392/dt = v148 - v149;
dx393/dt = -v148;
dx394/dt = v149;

dx395/dt = -v150;
dx396/dt = -v151;

dx397/dt = v152 + v153;
dx398/dt = v152;
dx399/dt = v153;
dx400/dt = -v152 - v153;

dx401/dt = v154 - v202 + v203 - v204;
dx402/dt = -v155;
dx403/dt = v154 - v155;
dx404/dt = -v154;
dx405/dt = v155;

ANDgate-7

dx406/dt = v156 - v159 - v167 + v168;
dx407/dt = -v157 - v160 - v165;
dx408/dt = v156 - v157;
dx409/dt = -v156;
dx410/dt = +v157;
dx411/dt = -v158;
dx412/dt = -v159;
dx413/dt = -v160;

dx414/dt = v161 - v164 - v166;
dx415/dt = -v162;
dx416/dt = v161 - v162;
dx417/dt = -v161;
dx418/dt = v162;
dx419/dt = -v163;
dx420/dt = -v164;

dx421/dt = v165 + v166;

dx422/dt = v165;
dx423/dt = v166;
dx424/dt = -v165 - v166;

dx425/dt = v167- v205 + v206 - v207;
dx426/dt = -v168;
dx427/dt = v167 - v168;
dx428/dt = -v167;
dx429/dt = v168;

ANDgate-8

dx430/dt = v169 – v172 – v180 + v181;
dx431/dt = - v170 - v173 - v178;
dx432/dt = v169 - v170;
dx433/dt = -v169;
dx434/dt = +v170;
dx435/dt = -v171;
dx436/dt = -v172;
dx437/dt = -v173;

dx438/dt = v174 - v177 - v179;
dx439/dt = -v175;
dx440/dt = v174 - v175;
dx441/dt = -v174;
dx442/dt = v175;
dx443/dt = -v176;
dx444/dt = -v177;

dx445/dt = v178 + v179;
dx446/dt = v178;
dx447/dt = v179;
dx448/dt = -v178 - v179;

dx449/dt = v180; %-v102+v103-v104;
dx450/dt = -v181;
dx451/dt = v180 - v181;
dx452/dt = -v180;
dx453/dt = v181;

OR gate

dx454/dt = v182 + v187 + v191 + v195;
dx455/dt = v183 + v188 + v198 + v202;
dx456/dt = v184 + v192 + v199 + v205;

dx457/dt = -v185 - v189 - v193 - v196 - v200 - v203 - v206;

dx458/dt = v182 + v183 + v184 - v185;
dx459/dt = v187 + v188 - v189;
dx460/dt = v191 + v192 - v193;
dx461/dt = v195 - v196;
dx462/dt = v198 + v199 - v200;
dx463/dt = v202 - v203;
dx464/dt = v205 - v206;

dx465/dt = -v182 - v187 - v191 - v195;
dx466/dt = -v183 – v188 - v198 - v202;
dx467/dt = -v184 - v192 - v199 - v205;
dx468/dt = v185 + v189 + v193 + v196 + v200 + v203 + v206;
dx469/dt = -v186;
dx470/dt = -v190;
dx471/dt = -v194;
dx472/dt = -v197;
dx473/dt = -v201;
dx474/dt = -v204;
dx475/dt = -v207;

Optional input-2

dx476/dt = -v71 + v72 - v73;