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ภาคผนวก

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ภาคผนวก ก.

ลักษณะโปรแกรมในการอินเตอร์เฟซการ์ด PCL-818 กับชุดทดลองโดยใช้ภาษาซี

โปรแกรมคำสั่งในการแปลงสัญญาณอะนาล็อกเป็นสัญญาณดิจิทัล

```

extern pcl818(int, unsigned int *);
unsigned int param[60];
unsigned int data[100];
unsigned int far * dat;
main()
{
float DataBuf;
int j;
clrscr();
dat = data;
param[0] = 0;          /* Board number          */
param[1] = 0x300;     /* Base I/O address      */
param[5] = 100;       /* Pacer rate            */
Param[6] = 1000;
Param[7] = 0;         /* Trigger mode          */
Param[10] = FP_OFF(dat); /* Offset of A/D data    */
Param[11] = FP_SEG(dat); /* Segment of A/D data   */
Param[12] = 0;        /* Data buffer B         */
Param[13] = 0;        /* used, must set to 0.  */
Param[14] = 2;        /* A/D conversion number */
Param[15] = 0;        /* A/D conversion start channel */
Param[16] = 1;        /* A/D conversion stop channel */
Param[17] = 5;        /* Overall gain code     */


```

```
pc1818(3, param);          /* Func 3 : Hardware initialization */
if (param[45] != 0)
{
    clrscr( );
    printf("DRIVER INITIALIZATION FAILED! %d",param[45]);
    exit(1);
}

pc1818(4,param);          /* Func 4 : A/D initialization */
if (param[45] != 0)
{
    printf("A/D INITIALIZATION FAILED! %d",param[45]);
    exit(1);
}

pc1818(5,param);
if (param[45] != 0)
{
    printf("A/D DATA TRANSFER FAILED! %d",param[45]);
    exit(1);
}

for(i=0 ; i<param[14] ; ++i)
    DataBuf = data[i] & 0xFF;
}
```



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โปรแกรมคำสั่งในการแปลงสัญญาณดิจิทัลเป็นสัญญาณอะนาล็อก

```

void DAOUT_CHO(void)
{
param[0] = 0;           /* Board number          */
param[1] = 0x300;      /* Base I/O address     */
param[20] = FP_OFF(dat); /* Offset of D/A output daa buffer A */
Param[21] = FP_SEG(dat); /* Segment of D/A output daa buffer A */
Param[22] = 0;         /* Output data buffer B address, if not */
Param[23] = 0;         /* used,must set to 0.   */
Param[24] = 1;         /* D/A conversion number */
Param[25] = 0;         /* D/A conversion start channel */
Param[26] = 0;         /* D/A conversion stop channel */

pc1818(12, param);    /* Func 12 : D/A initialization */
if (param[45] != 0)
{
clrscr( );
printf("D/A INITIALIZATION FAILED ! %d",param[45]);
exit(1);
}

CO_MV(loop,mode, alg);
data[0] = CO;

pc1818(13,param);
if (param[45] != 0)
{
clrscr();
printf("D/A OUTPUT FAILED! %d",param[45]);
exit(1);
}
}

```

ภาคผนวก ข.

ตารางแสดงค่าสัมประสิทธิ์จากการทดสอบการตอบสนองต่อสเต็ม
สำหรับคาบการเก็บตัวอย่าง 10 วินาที

คาบ	เวลา(วินาที)	ค่าสัมประสิทธิ์การตอบสนองต่อสเต็ม			
		น้ำเย็นต่อระดับ	น้ำเย็นต่ออุณหภูมิ	น้ำร้อนต่อระดับ	น้ำร้อนต่ออุณหภูมิ
0	0	0.000	0.000	0.000	0.000
1	10	0.439	0.000	1.074	0.000
2	20	0.875	0.000	2.137	0.000
3	30	1.307	0.000	3.189	0.000
4	40	1.735	-0.011	4.231	0.000
5	50	2.160	-0.036	5.262	0.000
6	60	2.581	-0.061	6.283	0.048
7	70	2.999	-0.086	7.293	0.163
8	80	3.413	-0.109	8.293	0.272
9	90	3.823	-0.132	9.283	0.376
10	100	4.231	-0.154	10.264	0.475
11	110	4.635	-0.176	11.234	0.570
12	120	5.035	-0.197	12.194	0.660
13	130	5.432	-0.217	13.145	0.745
14	140	5.826	-0.236	14.087	0.827
15	150	6.217	-0.255	15.018	0.905
16	160	6.604	-0.274	15.941	0.978
17	170	6.988	-0.292	16.854	1.049
18	180	7.369	-0.309	17.758	1.116
19	190	7.746	-0.326	18.652	1.180
20	200	8.121	-0.342	19.538	1.240
21	210	8.492	-0.358	20.415	1.298
22	220	8.860	-0.374	21.283	1.353
23	230	9.226	-0.388	22.142	1.406
24	240	9.588	-0.403	22.993	1.456
25	250	9.947	-0.417	23.835	1.503
26	260	10.303	-0.431	24.668	1.548
27	270	10.656	-0.444	25.493	1.591
28	280	11.006	-0.457	26.310	1.632
29	290	11.353	-0.469	27.118	1.671
30	300	11.698	-0.481	27.919	1.709
31	310	12.039	-0.493	28.711	1.744
32	320	12.378	-0.504	29.495	1.778
33	330	12.714	-0.515	30.272	1.810
34	340	13.047	-0.526	31.040	1.840
35	350	13.377	-0.536	31.801	1.870
36	360	13.704	-0.546	32.554	1.897
37	370	14.029	-0.556	33.300	1.924
38	380	14.351	-0.565	34.038	1.949
39	390	14.670	-0.574	34.769	1.973



คาบ	เวลา(วินาที)	ค่าสัมประสิทธิ์การตอบสนองต่อสเตรท			
		น้ำเย็นต่อระดับ	น้ำเย็นต่ออุณหภูมิ	น้ำร้อนต่อระดับ	น้ำร้อนต่ออุณหภูมิ
40	400	14.987	-0.583	35.492	1.995
41	410	15.301	-0.592	36.208	2.017
42	420	15.612	-0.600	36.917	2.038
43	430	15.921	-0.608	37.618	2.057
44	440	16.227	-0.616	38.313	2.076
45	450	16.531	-0.624	39.000	2.094
46	460	16.832	-0.631	39.681	2.111
47	470	17.130	-0.638	40.354	2.127
48	480	17.426	-0.645	41.021	2.142
49	490	17.720	-0.652	41.682	2.157
50	500	18.011	-0.659	42.335	2.171
51	510	18.300	-0.665	42.982	2.184
52	520	18.586	-0.671	43.622	2.197
53	530	18.870	-0.677	44.256	2.209
54	540	19.151	-0.683	44.884	2.220
55	550	19.430	-0.688	45.505	2.231
56	560	19.707	-0.694	46.120	2.242
57	570	19.982	-0.699	46.729	2.251
58	580	20.254	-0.704	47.332	2.261
59	590	20.524	-0.709	47.928	2.270
60	600	20.792	-0.714	48.519	2.278
61	610	21.057	-0.719	49.103	2.286
62	620	21.320	-0.723	49.682	2.294
63	630	21.581	-0.728	50.255	2.302
64	640	21.840	-0.732	50.822	2.309
65	650	22.097	-0.736	51.383	2.315
66	660	22.351	-0.740	51.939	2.322
67	670	22.604	-0.744	52.489	2.328
68	680	22.854	-0.748	53.034	2.333
69	690	23.102	-0.752	53.573	2.339
70	700	23.348	-0.755	54.107	2.344
71	710	23.593	-0.759	54.635	2.349
72	720	23.835	-0.762	55.158	2.354
73	730	24.075	-0.765	55.675	2.358
74	740	24.313	-0.768	56.188	2.363
75	750	24.549	-0.771	56.695	2.367
76	760	24.783	-0.774	57.197	2.371
77	770	25.015	-0.777	57.694	2.374
78	780	25.245	-0.780	58.186	2.378
79	790	25.473	-0.783	58.674	2.381
80	800	25.699	-0.785	59.156	2.384
81	810	25.924	-0.788	59.633	2.387
82	820	26.146	-0.790	60.106	2.390
83	830	26.367	-0.793	60.573	2.393
84	840	26.586	-0.795	61.037	2.396
85	850	26.803	-0.797	61.495	2.398
86	860	27.018	-0.799	61.949	2.401

คาบ	เวลา(วินาที)	ค่าสัมประสิทธิ์การตอบสนองต่อสเปค			
		น้ำเย็นต่อระดับ	น้ำเย็นต่ออุณหภูมิ	น้ำร้อนต่อระดับ	น้ำร้อนต่ออุณหภูมิ
87	870	27.232	-0.802	62.398	2.403
88	880	27.443	-0.804	62.843	2.405
89	890	27.653	-0.806	63.283	2.407
90	900	27.861	-0.808	63.718	2.409
91	910	28.068	-0.809	64.150	2.411
92	920	28.272	-0.811	64.577	2.413
93	930	28.475	-0.813	65.000	2.414
94	940	28.676	-0.815	65.418	2.416
95	950	28.876	-0.816	65.832	2.418
96	960	29.074	-0.818	66.242	2.419
97	970	29.270	-0.820	66.648	2.420
98	980	29.465	-0.821	67.050	2.422
99	990	29.657	-0.823	67.448	2.423
100	1000	29.849	-0.824	67.841	2.424
101	1010	30.039	-0.825	68.231	2.425
102	1020	30.227	-0.827	68.617	2.426
103	1030	30.413	-0.828	68.999	2.427
104	1040	30.598	-0.829	69.377	2.428
105	1050	30.782	-0.830	69.751	2.429
106	1060	30.964	-0.832	70.122	2.430
107	1070	31.144	-0.833	70.489	2.431
108	1080	31.323	-0.834	70.852	2.432
109	1090	31.501	-0.835	71.211	2.433
110	1100	31.676	-0.836	71.567	2.433
111	1110	31.851	-0.837	71.919	2.434
112	1120	32.024	-0.838	72.268	2.435
113	1130	32.196	-0.839	72.613	2.435
114	1140	32.366	-0.840	72.955	2.436
115	1150	32.534	-0.841	73.293	2.437
116	1160	32.702	-0.842	73.628	2.437
117	1170	32.868	-0.843	73.959	2.438
118	1180	33.032	-0.843	74.287	2.438
119	1190	33.195	-0.844	74.612	2.439
120	1200	33.357	-0.845	74.934	2.439
121	1210	33.517	-0.846	75.252	2.439
122	1220	33.676	-0.846	75.567	2.440
123	1230	33.834	-0.847	75.879	2.440
124	1240	33.991	-0.848	76.188	2.441
125	1250	34.146	-0.849	76.493	2.441
126	1260	34.300	-0.849	76.796	2.441
127	1270	34.452	-0.850	77.095	2.442
128	1280	34.603	-0.850	77.392	2.442
129	1290	34.753	-0.851	77.685	2.442
130	1300	34.902	-0.852	77.976	2.443
131	1310	35.050	-0.852	78.263	2.443
132	1320	35.196	-0.853	78.548	2.443
133	1330	35.341	-0.853	78.830	2.443

คาบ	เวลา(วินาที)	ค่าสัมประสิทธิ์การตอบสนองต่อสเค็ด			
		น้ำเย็นต่อระดับ	น้ำเย็นต่ออุณหภูมิ	น้ำร้อนต่อระดับ	น้ำร้อนต่ออุณหภูมิ
134	1340	35.485	-0.854	79.109	2.444
135	1350	35.627	-0.854	79.385	2.444
136	1360	35.769	-0.855	79.658	2.444
137	1370	35.909	-0.855	79.929	2.444
138	1380	36.048	-0.856	80.197	2.444
139	1390	36.186	-0.856	80.462	2.444
140	1400	36.323	-0.856	80.725	2.445
141	1410	36.459	-0.857	80.985	2.445
142	1420	36.593	-0.857	81.242	2.445
143	1430	36.726	-0.858	81.496	2.445
144	1440	36.859	-0.858	81.749	2.445
145	1450	36.990	-0.858	81.998	2.445
146	1460	37.120	-0.859	82.245	2.446
147	1470	37.249	-0.859	82.490	2.446
148	1480	37.377	-0.859	82.732	2.446
149	1490	37.504	-0.860	82.971	2.446
150	1500	37.629	-0.860	83.209	2.446
151	1510	37.754	-0.860	83.444	2.446
152	1520	37.878	-0.861	83.676	2.446
153	1530	38.000	-0.861	83.906	2.446
154	1540	38.122	-0.861	84.134	2.446
155	1550	38.243	-0.861	84.359	2.446
156	1560	38.362	-0.862	84.583	2.446
157	1570	38.481	-0.862	84.804	2.447
158	1580	38.598	-0.862	85.022	2.447
159	1590	38.715	-0.862	85.239	2.447
160	1600	38.831	-0.863	85.453	2.447
161	1610	38.945	-0.863	85.666	2.447
162	1620	39.059	-0.863	85.876	2.447
163	1630	39.172	-0.863	86.084	2.447
164	1640	39.284	-0.863	86.289	2.447
165	1650	39.395	-0.864	86.493	2.447
166	1660	39.504	-0.864	86.695	2.447
167	1670	39.613	-0.864	86.895	2.447
168	1680	39.722	-0.864	87.092	2.447
169	1690	39.829	-0.864	87.288	2.447
170	1700	39.935	-0.865	87.482	2.447
171	1710	40.041	-0.865	87.673	2.447
172	1720	40.145	-0.865	87.863	2.447
173	1730	40.249	-0.865	88.051	2.447
174	1740	40.352	-0.865	88.237	2.447
175	1750	40.454	-0.865	88.421	2.447
176	1760	40.555	-0.865	88.604	2.447
177	1770	40.655	-0.866	88.784	2.447
178	1780	40.754	-0.866	88.963	2.447
179	1790	40.853	-0.866	89.139	2.448
180	1800	40.951	-0.866	89.314	2.448

คาบ	เวลา(วินาที)	ค่าสัมประสิทธิ์การตอบสนองต่อสแต็ป			
		น้ำขึ้นต่อระดับ	น้ำขึ้นต่ออุณหภูมิ	น้ำร้อนต่อระดับ	น้ำร้อนต่ออุณหภูมิ
181	1810	41.048	-0.866	89.488	2.448
182	1820	41.144	-0.866	89.659	2.448
183	1830	41.239	-0.866	89.829	2.448
184	1840	41.334	-0.866	89.997	2.448
185	1850	41.428	-0.867	90.164	2.448
186	1860	41.520	-0.867	90.328	2.448
187	1870	41.613	-0.867	90.491	2.448
188	1880	41.704	-0.867	90.653	2.448
189	1890	41.795	-0.867	90.813	2.448
190	1900	41.885	-0.867	90.971	2.448
191	1910	41.974	-0.867	91.127	2.448
192	1920	42.062	-0.867	91.282	2.448
193	1930	42.150	-0.867	91.436	2.448
194	1940	42.237	-0.867	91.588	2.448
195	1950	42.323	-0.867	91.738	2.448
196	1960	42.408	-0.868	91.887	2.448
197	1970	42.493	-0.868	92.034	2.448
198	1980	42.577	-0.868	92.180	2.448
199	1990	42.661	-0.868	92.324	2.448
200	2000	42.743	-0.868	92.467	2.448
201	2010	42.825	-0.868	92.609	2.448
202	2020	42.907	-0.868	92.749	2.448
203	2030	42.987	-0.868	92.887	2.448
204	2040	43.067	-0.868	93.025	2.448
205	2050	43.146	-0.868	93.161	2.448
206	2060	43.225	-0.868	93.295	2.448
207	2070	43.303	-0.868	93.428	2.448
208	2080	43.380	-0.868	93.560	2.448
209	2090	43.457	-0.868	93.690	2.448
210	2100	43.533	-0.868	93.820	2.448
211	2110	43.608	-0.868	93.947	2.448
212	2120	43.683	-0.868	94.074	2.448
213	2130	43.757	-0.869	94.199	2.448
214	2140	43.831	-0.869	94.323	2.448
215	2150	43.903	-0.869	94.446	2.448
216	2160	43.976	-0.869	94.568	2.448
217	2170	44.047	-0.869	94.688	2.448
218	2180	44.118	-0.869	94.807	2.448
219	2190	44.189	-0.869	94.925	2.448
220	2200	44.259	-0.869	95.042	2.448
221	2210	44.328	-0.869	95.157	2.448
222	2220	44.397	-0.869	95.272	2.448
223	2230	44.465	-0.869	95.385	2.448
224	2240	44.533	-0.869	95.497	2.448
225	2250	44.600	-0.869	95.608	2.448
226	2260	44.666	-0.869	95.718	2.448
227	2270	44.732	-0.869	95.826	2.448

คาบ	เวลา(วินาที)	ค่าสัมประสิทธิ์การตอบสนองต่อสเต็ป			
		น้ำเย็นต่อระดับ	น้ำเย็นต่ออุณหภูมิ	น้ำร้อนต่อระดับ	น้ำร้อนต่ออุณหภูมิ
228	2280	44.797	-0.869	95.934	2.448
229	2290	44.862	-0.869	96.040	2.448
230	2300	44.926	-0.869	96.146	2.448
231	2310	44.990	-0.869	96.250	2.448
232	2320	45.053	-0.869	96.354	2.448
233	2330	45.116	-0.869	96.456	2.448
234	2340	45.178	-0.869	96.557	2.448
235	2350	45.240	-0.869	96.657	2.448
236	2360	45.301	-0.869	96.757	2.448
237	2370	45.361	-0.869	96.855	2.448
238	2380	45.421	-0.869	96.952	2.448
239	2390	45.481	-0.869	97.048	2.448
240	2400	45.540	-0.869	97.144	2.448
241	2410	45.599	-0.869	97.238	2.448
242	2420	45.657	-0.869	97.332	2.448
243	2430	45.714	-0.869	97.424	2.448
244	2440	45.772	-0.869	97.515	2.448
245	2450	45.828	-0.869	97.606	2.448
246	2460	45.884	-0.869	97.696	2.448
247	2470	45.940	-0.869	97.784	2.448
248	2480	45.995	-0.869	97.872	2.448
249	2490	46.050	-0.870	97.959	2.448
250	2500	46.104	-0.870	98.045	2.448
251	2510	46.158	-0.870	98.131	2.448
252	2520	46.212	-0.870	98.215	2.448
253	2530	46.265	-0.870	98.299	2.448
254	2540	46.317	-0.870	98.381	2.448
255	2550	46.369	-0.870	98.463	2.448
256	2560	46.421	-0.870	98.544	2.448
257	2570	46.472	-0.870	98.624	2.448
258	2580	46.523	-0.870	98.704	2.448
259	2590	46.573	-0.870	98.782	2.448
260	2600	46.623	-0.870	98.860	2.448
261	2610	46.673	-0.870	98.937	2.448
262	2620	46.722	-0.870	99.014	2.448
263	2630	46.771	-0.870	99.089	2.448
264	2640	46.819	-0.870	99.164	2.448
265	2650	46.867	-0.870	99.238	2.448
266	2660	46.914	-0.870	99.311	2.448
267	2670	46.962	-0.870	99.383	2.448
268	2680	47.008	-0.870	99.455	2.448
269	2690	47.055	-0.870	99.526	2.448
270	2700	47.101	-0.870	99.597	2.448
271	2710	47.146	-0.870	99.666	2.448
272	2720	47.191	-0.870	99.735	2.448
273	2730	47.236	-0.870	99.803	2.448
274	2740	47.280	-0.870	99.871	2.448

คาบ	เวลา(วินาที)	ค่าสัมประสิทธิ์การตอบสนองต่อสเค็ด			
		น้ำเย็นต่อระดับ	น้ำเย็นต่ออุณหภูมิ	น้ำร้อนต่อระดับ	น้ำร้อนต่ออุณหภูมิ
275	2750	47.324	-0.870	99.938	2.448
276	2760	47.368	-0.870	100.004	2.448
277	2770	47.411	-0.870	100.069	2.448
278	2780	47.454	-0.870	100.134	2.448
279	2790	47.497	-0.870	100.198	2.448
280	2800	47.539	-0.870	100.262	2.448
281	2810	47.581	-0.870	100.325	2.448
282	2820	47.623	-0.870	100.387	2.448
283	2830	47.664	-0.870	100.449	2.448
284	2840	47.705	-0.870	100.510	2.448
285	2850	47.745	-0.870	100.570	2.448
286	2860	47.785	-0.870	100.630	2.448
287	2870	47.825	-0.870	100.689	2.448
288	2880	47.865	-0.870	100.748	2.448
289	2890	47.904	-0.870	100.806	2.448
290	2900	47.943	-0.870	100.863	2.448
291	2910	47.981	-0.870	100.920	2.448
292	2920	48.019	-0.870	100.976	2.448
293	2930	48.057	-0.870	101.032	2.448
294	2940	48.095	-0.870	101.087	2.448
295	2950	48.132	-0.870	101.141	2.448
296	2960	48.169	-0.870	101.196	2.448
297	2970	48.206	-0.870	101.249	2.448
298	2980	48.242	-0.870	101.302	2.448
299	2990	48.278	-0.870	101.354	2.448
300	3000	48.314	-0.870	101.406	2.448
301	3010	48.349	-0.870	101.458	2.448
302	3020	48.384	-0.870	101.508	2.448
303	3030	48.419	-0.870	101.559	2.448
304	3040	48.453	-0.870	101.609	2.448
305	3050	48.488	-0.870	101.658	2.448
306	3060	48.522	-0.870	101.707	2.448
307	3070	48.555	-0.870	101.755	2.448
308	3080	48.589	-0.870	101.803	2.448
309	3090	48.622	-0.870	101.850	2.448
310	3100	48.655	-0.870	101.897	2.448
311	3110	48.687	-0.870	101.944	2.448
312	3120	48.719	-0.870	101.989	2.448
313	3130	48.752	-0.870	102.035	2.448
314	3140	48.783	-0.870	102.080	2.448
315	3150	48.815	-0.870	102.125	2.448
316	3160	48.846	-0.870	102.169	2.448
317	3170	48.877	-0.870	102.212	2.448
318	3180	48.908	-0.870	102.256	2.448
319	3190	48.938	-0.870	102.298	2.448
320	3200	48.968	-0.870	102.341	2.448
321	3210	48.998	-0.870	102.383	2.448

คาบ	เวลา(วินาที)	ค่าสัมประสิทธิ์การตอบสนองต่อสเค็ด			
		น้ำเย็นต่อระดับ	น้ำเย็นต่ออุณหภูมิ	น้ำร้อนต่อระดับ	น้ำร้อนต่ออุณหภูมิ
322	3220	49.028	-0.870	102.424	2.448
323	3230	49.057	-0.870	102.465	2.448
324	3240	49.087	-0.870	102.506	2.448
325	3250	49.115	-0.870	102.546	2.448
326	3260	49.144	-0.870	102.586	2.448
327	3270	49.173	-0.870	102.626	2.448
328	3280	49.201	-0.870	102.665	2.448
329	3290	49.229	-0.870	102.703	2.448
330	3300	49.257	-0.870	102.742	2.448
331	3310	49.284	-0.870	102.779	2.448
332	3320	49.311	-0.870	102.817	2.448
333	3330	49.339	-0.870	102.854	2.448
334	3340	49.365	-0.870	102.891	2.448
335	3350	49.392	-0.870	102.927	2.448
336	3360	49.418	-0.870	102.963	2.448
337	3370	49.445	-0.870	102.999	2.448
338	3380	49.471	-0.870	103.034	2.448
339	3390	49.496	-0.870	103.069	2.448
340	3400	49.522	-0.870	103.104	2.448
341	3410	49.547	-0.870	103.138	2.448
342	3420	49.572	-0.870	103.172	2.448
343	3430	49.597	-0.870	103.205	2.448
344	3440	49.622	-0.870	103.239	2.448
345	3450	49.646	-0.870	103.272	2.448
346	3460	49.670	-0.870	103.304	2.448
347	3470	49.695	-0.870	103.336	2.448
348	3480	49.718	-0.870	103.368	2.448
349	3490	49.742	-0.870	103.400	2.448
350	3500	49.766	-0.870	103.431	2.448
351	3510	49.789	-0.870	103.462	2.448
352	3520	49.812	-0.870	103.493	2.448
353	3530	49.835	-0.870	103.523	2.448
354	3540	49.857	-0.870	103.553	2.448
355	3550	49.880	-0.870	103.583	2.448
356	3560	49.902	-0.870	103.612	2.448
357	3570	49.924	-0.870	103.641	2.448
358	3580	49.946	-0.870	103.670	2.448
359	3590	49.968	-0.870	103.699	2.448
360	3600	49.990	-0.870	103.727	2.448
361	3610	50.011	-0.870	103.755	2.448
362	3620	50.032	-0.870	103.782	2.448
363	3630	50.053	-0.870	103.810	2.448
364	3640	50.074	-0.870	103.837	2.448
365	3650	50.095	-0.870	103.864	2.448
366	3660	50.115	-0.870	103.890	2.448
367	3670	50.136	-0.870	103.917	2.448
368	3680	50.156	-0.870	103.943	2.448

คาบ	เวลา(วินาที)	ค่าสัมประสิทธิ์การคอบสมองต่อสเปค			
		น้ำเย็นต่อระดับ	น้ำเย็นต่ออุณหภูมิ	น้ำร้อนต่อระดับ	น้ำร้อนต่ออุณหภูมิ
369	3690	50.176	-0.870	103.969	2.448
370	3700	50.196	-0.870	103.994	2.448
371	3710	50.216	-0.870	104.019	2.448
372	3720	50.235	-0.870	104.044	2.448
373	3730	50.254	-0.870	104.069	2.448
374	3740	50.274	-0.870	104.094	2.448
375	3750	50.293	-0.870	104.118	2.448
376	3760	50.311	-0.870	104.142	2.448
377	3770	50.330	-0.870	104.166	2.448
378	3780	50.349	-0.870	104.189	2.448
379	3790	50.367	-0.870	104.213	2.448
380	3800	50.385	-0.870	104.236	2.448
381	3810	50.403	-0.870	104.258	2.448
382	3820	50.421	-0.870	104.281	2.448
383	3830	50.439	-0.870	104.303	2.448
384	3840	50.457	-0.870	104.326	2.448
385	3850	50.474	-0.870	104.347	2.448
386	3860	50.492	-0.870	104.369	2.448
387	3870	50.509	-0.870	104.391	2.448
388	3880	50.526	-0.870	104.412	2.448
389	3890	50.543	-0.870	104.433	2.448
390	3900	50.560	-0.870	104.454	2.448
391	3910	50.576	-0.870	104.474	2.448
392	3920	50.593	-0.870	104.495	2.448
393	3930	50.609	-0.870	104.515	2.448
394	3940	50.625	-0.870	104.535	2.448
395	3950	50.641	-0.870	104.555	2.448
396	3960	50.657	-0.870	104.575	2.448
397	3970	50.673	-0.870	104.594	2.448
398	3980	50.689	-0.870	104.613	2.448
399	3990	50.704	-0.870	104.632	2.448
400	4000	50.720	-0.870	104.651	2.448
401	4010	50.735	-0.870	104.670	2.448
402	4020	50.750	-0.870	104.688	2.448
403	4030	50.765	-0.870	104.706	2.448
404	4040	50.780	-0.870	104.724	2.448
405	4050	50.795	-0.870	104.742	2.448
406	4060	50.810	-0.870	104.760	2.448
407	4070	50.824	-0.870	104.778	2.448
408	4080	50.839	-0.870	104.795	2.448
409	4090	50.853	-0.870	104.812	2.448
410	4100	50.867	-0.870	104.829	2.448
411	4110	50.881	-0.870	104.846	2.448
412	4120	50.895	-0.870	104.863	2.448
413	4130	50.909	-0.870	104.879	2.448
414	4140	50.923	-0.870	104.896	2.448
415	4150	50.936	-0.870	104.912	2.448

คาบ	เวลา(วินาที)	ค่าสัมประสิทธิ์การตอบสนองต่อสเทีย			
		น้ำเย็นต่อระดับ	น้ำเย็นต่ออุณหภูมิ	น้ำร้อนต่อระดับ	น้ำร้อนต่ออุณหภูมิ
416	4160	50.950	-0.870	104.928	2.448
417	4170	50.963	-0.870	104.944	2.448
418	4180	50.977	-0.870	104.959	2.448
419	4190	50.990	-0.870	104.975	2.448
420	4200	51.003	-0.870	104.990	2.448
421	4210	51.016	-0.870	105.005	2.448
422	4220	51.028	-0.870	105.021	2.448
423	4230	51.041	-0.870	105.035	2.448
424	4240	51.054	-0.870	105.050	2.448
425	4250	51.066	-0.870	105.065	2.448
426	4260	51.079	-0.870	105.079	2.448
427	4270	51.091	-0.870	105.094	2.448
428	4280	51.103	-0.870	105.108	2.448
429	4290	51.115	-0.870	105.122	2.448
430	4300	51.127	-0.870	105.136	2.448
431	4310	51.139	-0.870	105.149	2.448
432	4320	51.151	-0.870	105.163	2.448
433	4330	51.163	-0.870	105.177	2.448
434	4340	51.174	-0.870	105.190	2.448
435	4350	51.186	-0.870	105.203	2.448
436	4360	51.197	-0.870	105.216	2.448
437	4370	51.208	-0.870	105.229	2.448
438	4380	51.220	-0.870	105.242	2.448
439	4390	51.231	-0.870	105.255	2.448
440	4400	51.242	-0.870	105.267	2.448
441	4410	51.253	-0.870	105.280	2.448
442	4420	51.264	-0.870	105.292	2.448
443	4430	51.274	-0.870	105.304	2.448
444	4440	51.285	-0.870	105.316	2.448
445	4450	51.296	-0.870	105.328	2.448
446	4460	51.306	-0.870	105.340	2.448
447	4470	51.316	-0.870	105.352	2.448
448	4480	51.327	-0.870	105.363	2.448
449	4490	51.337	-0.870	105.375	2.448
450	4500	51.347	-0.870	105.386	2.448
451	4510	51.357	-0.870	105.397	2.448
452	4520	51.367	-0.870	105.408	2.448
453	4530	51.377	-0.870	105.419	2.448
454	4540	51.387	-0.870	105.430	2.448
455	4550	51.397	-0.870	105.441	2.448
456	4560	51.406	-0.870	105.452	2.448
457	4570	51.416	-0.870	105.462	2.448
458	4580	51.425	-0.870	105.473	2.448
459	4590	51.435	-0.870	105.483	2.448
460	4600	51.444	-0.870	105.493	2.448
461	4610	51.453	-0.870	105.504	2.448
462	4620	51.462	-0.870	105.514	2.448

คาบ	เวลา(วินาที)	ค่าสัมประสิทธิ์การตอบสนองต่อสแต็ป			
		น้ำขึ้นต่อระดับ	น้ำขึ้นต่ออุณหภูมิ	น้ำร้อนต่อระดับ	น้ำร้อนต่ออุณหภูมิ
463	4630	51.471	-0.870	105.524	2.448
464	4640	51.481	-0.870	105.533	2.448
465	4650	51.489	-0.870	105.543	2.448
466	4660	51.498	-0.870	105.553	2.448
467	4670	51.507	-0.870	105.562	2.448
468	4680	51.516	-0.870	105.572	2.448
469	4690	51.524	-0.870	105.581	2.448
470	4700	51.533	-0.870	105.590	2.448
471	4710	51.542	-0.870	105.600	2.448
472	4720	51.550	-0.870	105.609	2.448
473	4730	51.558	-0.870	105.618	2.448
474	4740	51.567	-0.870	105.627	2.448
475	4750	51.575	-0.870	105.635	2.448
476	4760	51.583	-0.870	105.644	2.448
477	4770	51.591	-0.870	105.653	2.448
478	4780	51.599	-0.870	105.661	2.448
479	4790	51.607	-0.870	105.670	2.448
480	4800	51.615	-0.870	105.678	2.448
481	4810	51.623	-0.870	105.686	2.448
482	4820	51.630	-0.870	105.695	2.448
483	4830	51.638	-0.870	105.703	2.448
484	4840	51.646	-0.870	105.711	2.448
485	4850	51.653	-0.870	105.719	2.448
486	4860	51.661	-0.870	105.727	2.448
487	4870	51.668	-0.870	105.734	2.448
488	4880	51.676	-0.870	105.742	2.448
489	4890	51.683	-0.870	105.750	2.448
490	4900	51.690	-0.870	105.757	2.448
491	4910	51.697	-0.870	105.765	2.448
492	4920	51.705	-0.870	105.772	2.448
493	4930	51.712	-0.870	105.779	2.448
494	4940	51.719	-0.870	105.787	2.448
495	4950	51.726	-0.870	105.794	2.448
496	4960	51.732	-0.870	105.801	2.448
497	4970	51.739	-0.870	105.808	2.448
498	4980	51.746	-0.870	105.815	2.448
499	4990	51.753	-0.870	105.822	2.448
500	5000	51.759	-0.870	105.829	2.448

ภาคผนวก ค.

ส่วนสำคัญของโปรแกรมการควบคุมแบบพีไอดี

```

float CO_MV(int loop,char mode[2],char alg)
{
float PREV_PV[2],PREV_ERR[2],PPREV_ERR[2],PREV_CO[2];
float CO_DIF;
float ERR;
switch(loop)
{
case 0:
switch(mode[0])
{
case 'M':
CO = CO_PERCENT[0];
break;
case 'A':
if(RESET[0] == 1)
{
PREV_PV[loop] = 0;
PREV_ERR[loop] = 0;
PPREV_ERR[loop] = 0;
PREV_SUM[loop] = 0;
PREV_CO[loop] = 0;
}
ERR = SP[0]-PV[0];
switch(alg)
{
case '1':
CO = (Kc[0]*(ERR+((Ts/Ti[0])*(PREV_SUM[0]+ERR))+((Td[0]/Ts)*(ERR-PREV_ERR[0])))+
BIAS[0];
PREV_ERR[0] = ERR;
PREV_SUM[0] = PREV_SUM[0]+ERR;
break;

```

/*Engineering Unit*/

```

case '2':
CO_DIF = Kc[0]*((ERR*(1+(Ts/Ti[0])+(Td[0]/Ts)))-((1+(2*Td[0]/Ts))*PREV_ERR[0])+((Td[0]/
Ts)*PPREV_ERR[0]));
CO = PREV_CO[0]+CO_DIF;
if(CO > 100) CO = 100;
if(CO < 0 ) CO = 0;
PPREV_ERR[0] = PREV_ERR[0];
PREV_ERR[0] = ERR;
PREV_CO[0] = CO;
break;
}
break;
}
break;
case 1:
switch(mode[1])
{
case 'M':
CO = CO_PERCENT[1];
break;
case 'A':
if(RESET[1] == 1)
{
PREV_PV[loop] = 0;
PREV_ERR[loop] = 0;
PPREV_ERR[loop] = 0;
PREV_SUM[loop] = 0;
PREV_CO[loop] = 0;
}
}

ERR = SP[1]-PV[1];
switch(alg)
{
case '1':
CO = (Kc[1]*(ERR+((Ts/Ti[1])*(PREV_SUM[1]+ERR))+((Td[1]/Ts)*(ERR-PREV_ERR[1]))))+
BIAS[1];
PREV_ERR[1] = ERR;
PREV_SUM[1] = PREV_SUM[1]+ERR;
break;
}

```

/*Engineering Unit*/

```

case '2':
CO_DIF = Kc[1]*((ERR*(1+(Ts/Ti[1])+(Td[1]/Ts)))-((1+(2*Td[1]/Ts))*PREV_ERR[1])+(Td[1]/
Ts)*PPREV_ERR[1]));
CO = PREV_CO[1]+CO_DIF;
if(CO > 100) CO = 100;
if(CO < 0 ) CO = 0;
PPREV_ERR[1] = PREV_ERR[1];
PREV_ERR[1] = ERR;
PREV_CO[1] = CO;
break;
}
break;
}
break;
}
return CO;
}

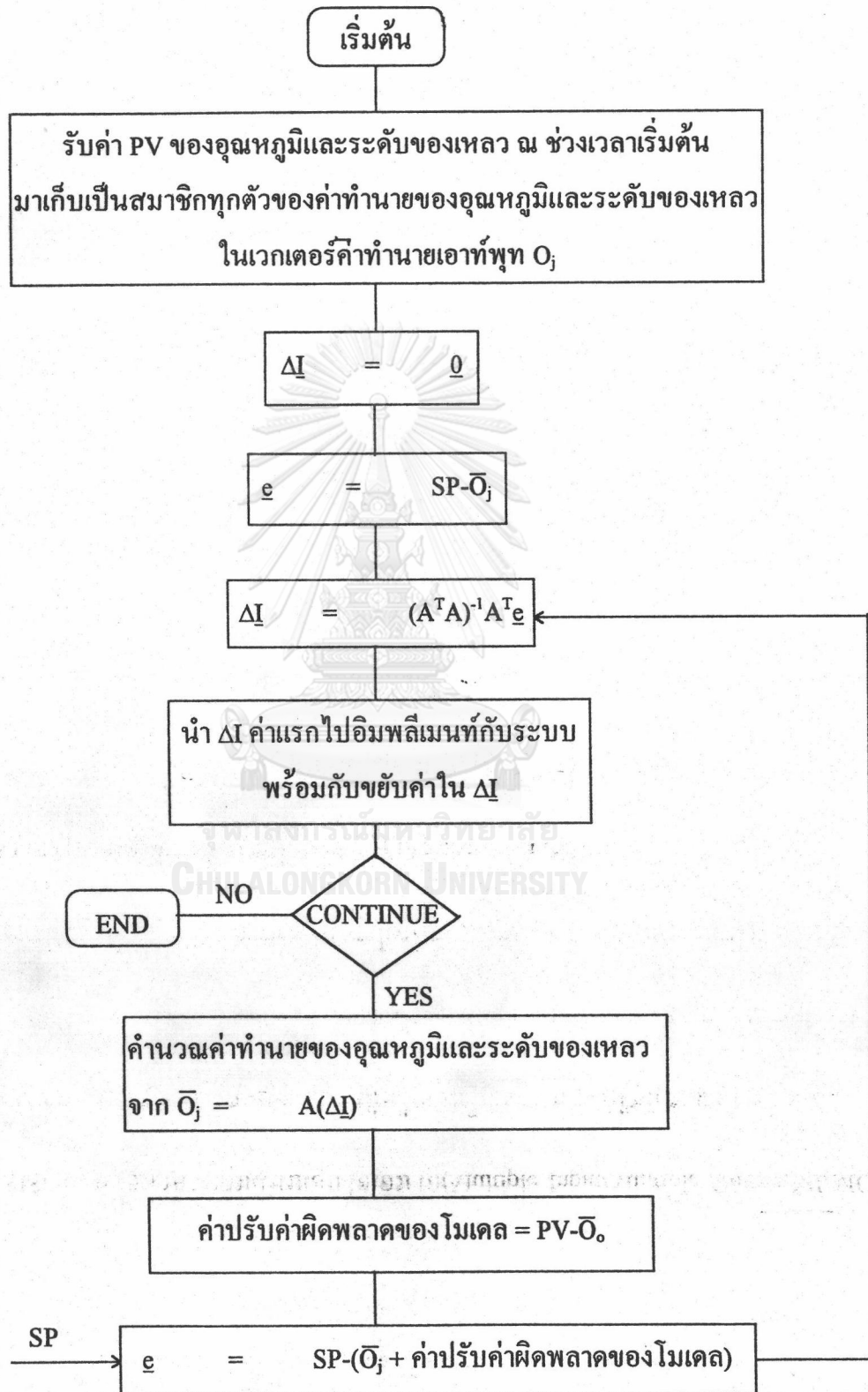
```



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CHULALONGKORN UNIVERSITY

ภาคผนวก ง.

อัลกอริทึมของโปรแกรมการควบคุมแบบดีเอ็มซี



ภาคผนวก จ.

ส่วนสำคัญของโปรแกรมการควบคุมแบบดีเอ็มซี

```

void DMC_CO (void)
{
int p,q;
float A[120][30] = {
    {6.217, 5.826, 5.432, 5.035, 4.635, 4.231, 3.823, 3.413, 2.999, 2.581, 2.160, 1.735, 1.307, 0.875, 0.439,
    15.018, 14.087, 13.145, 12.194, 11.234, 10.264, 9.283, 8.293, 7.293, 6.283, 5.262, 4.231, 3.189, 2.137,1.047},
    {6.604, 6.217, 5.826, 5.432, 5.035, 4.635, 4.231, 3.823, 3.413, 2.999, 2.581, 2.160, 1.735, 1.307, 0.875,
    15.941, 15.018, 14.087, 13.145, 12.194, 11.234, 10.264, 9.283, 8.293, 7.293, 6.283, 5.262, 4.231, 3.189, 2.137},
    {6.988, 6.604, 6.217, 5.826, 5.432, 5.035, 4.635, 4.231, 3.823, 3.413, 2.999, 2.581, 2.160, 1.735, 1.307,
    16.854, 15.941, 15.018, 14.087, 13.145, 12.194, 11.234, 10.264, 9.283, 8.293, 7.293, 6.283, 5.262, 4.231, 3.189},
    {7.369, 6.988, 6.604, 6.217, 5.826, 5.432, 5.035, 4.635, 4.231, 3.823, 3.413, 2.999, 2.581, 2.160, 1.735,
    17.758, 16.854, 15.941, 15.018, 14.087, 13.145, 12.194, 11.234, 10.264, 9.283, 8.293, 7.293, 6.283, 5.262, 4.231},
    {7.746, 7.369, 6.988, 6.604, 6.217, 5.826, 5.432, 5.035, 4.635, 4.231, 3.823, 3.413, 2.999, 2.581, 2.160,
    18.652, 17.758, 16.854, 15.941, 15.018, 14.087, 13.145, 12.194, 11.234, 10.264, 9.283, 8.293, 7.293, 6.283, 5.262},
    {
    -0.714,-0.709,-0.704,-0.699,-0.694,-0.688,-0.683,-0.677,-0.671,-0.665,-0.659,-0.652,-0.645,-0.638,-0.631,
    2.278,2.270,2.261,2.251,2.242,2.231,2.220,2.209,2.197,2.184,2.171,2.157,2.142,2.127,2.111},
    -0.714,-0.709,-0.704,-0.699,-0.694,-0.688,-0.683,-0.677,-0.671,-0.665,-0.659,-0.652,-0.645,-0.638,-0.631,
    2.278,2.270,2.261,2.251,2.242,2.231,2.220,2.209,2.197,2.184,2.171,2.157,2.142,2.127,2.111},
    -0.714,-0.709,-0.704,-0.699,-0.694,-0.688,-0.683,-0.677,-0.671,-0.665,-0.659,-0.652,-0.645,-0.638,-0.631,
    2.278,2.270,2.261,2.251,2.242,2.231,2.220,2.209,2.197,2.184,2.171,2.157,2.142,2.127,2.111},
    -0.714,-0.709,-0.704,-0.699,-0.694,-0.688,-0.683,-0.677,-0.671,-0.665,-0.659,-0.652,-0.645,-0.638,-0.631,
    2.278,2.270,2.261,2.251,2.242,2.231,2.220,2.209,2.197,2.184,2.171,2.157,2.142,2.127,2.111},
    -0.714,-0.709,-0.704,-0.699,-0.694,-0.688,-0.683,-0.677,-0.671,-0.665,-0.659,-0.652,-0.645,-0.638,-0.631,
    2.278,2.270,2.261,2.251,2.242,2.231,2.220,2.209,2.197,2.184,2.171,2.157,2.142,2.127,2.111},
    };
float Ac[120] = {
    0.4410, 0.2629, 0.0081,-0.0994,-0.0590, 0.0154, 0.0043, 0.0094, 0.0021,-0.0040, 0.0039, 0.0039,
    -0.0047,-0.0054, 0.1188,-0.0973,-0.0250, 0.0229, -0.0383, 0.0643,-0.0618,-0.0319, 0.1438,-0.0675,
    -0.0474, 0.0144,-0.0033,-0.0230, 0.0166, 0.0669, -0.0579, 0.0552,-0.0223, 0.0104,-4.9760, 7.1392,
    0.3389,-1.7196,-1.1583,-0.2160, 0.3639, 0.2750, 0.0489,-0.0445,-0.0410,-0.0744,-0.0618, 0.1286,
    -0.0229, 0.0198, 0.0237,-0.0455,-0.0064,-0.0897, 0.0312, 0.0668, 0.0554,-0.0879, 0.0125, 0.0069,
    0.0000, 0.0000, 0.0000,-1.3549,-2.4584,-3.3659, -4.5128,-1.0148, 0.8269, 0.9175, 0.1788,-0.1885,
    -0.1099, 0.0129,-0.0241,-0.0094,-0.0292, 0.0629, -0.0516, 0.0847,-0.0586,-0.0974, 0.1236,-0.0547,
    0.0429,-0.0270, 0.0353,-0.0183, 0.0565,-0.0514, -0.0253, 0.0458, 0.0100,-0.0255,-0.0029, 0.0414,
    -0.0741, 0.0700, 0.0134,-0.0026,-0.0914, 0.0370, 0.0671,-0.0485,-0.0711, 0.0752, 0.0415,-0.0101,
    -0.0837,-0.0532, 0.1092, 0.0203,-0.0232,-0.0208, 0.0646,-0.1272, 0.0925,-0.0097,-0.0215, 0.0010 };

```

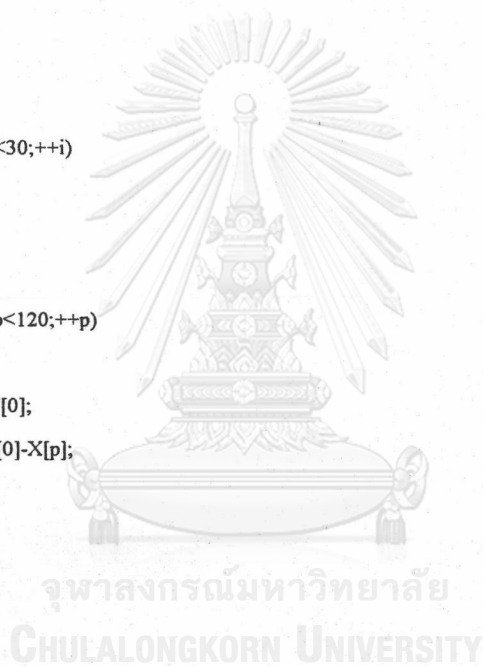
```
float Ah[120] = {
    0.7477,-0.1074,-0.0017, 0.0410, 0.0238,-0.0066, -0.0018,-0.0038,-0.0008, 0.0017,-0.0016,-0.0016,
    0.0019, 0.0026,-0.0495, 0.0410, 0.0096,-0.0092, 0.0148,-0.0252, 0.0252, 0.0128,-0.0586, 0.0282,
    0.0189,-0.0064, 0.0016, 0.0096,-0.0074,-0.0261, 0.0228,-0.0224, 0.0099,-0.0052, 2.0180,-2.9058,
    -0.1282, 0.7061, 0.4701, 0.0819,-0.1511,-0.1118, -0.0186, 0.0189, 0.0164, 0.0301, 0.0248,-0.0522,
    0.0100,-0.0091,-0.0090, 0.0181, 0.0029, 0.0366, -0.0135,-0.0269,-0.0221, 0.0360,-0.0059,-0.0020,
    0.0000, 0.0000, 0.0000, 0.5493, 0.9937, 1.3986, 1.8763, 0.3918,-0.3473,-0.3744,-0.0689, 0.0786,
    0.0444,-0.0048, 0.0095, 0.0025, 0.0131,-0.0264, 0.0213,-0.0351, 0.0247, 0.0392,-0.0499, 0.0218,
    -0.0179, 0.0112,-0.0142, 0.0075,-0.0229, 0.0217, 0.0092,-0.0181,-0.0043, 0.0089, 0.0024,-0.0182,
    0.0313,-0.0291,-0.0052, 0.0004, 0.0380,-0.0151, -0.0281, 0.0207, 0.0288,-0.0308,-0.0169, 0.0041,
    0.0347, 0.0211,-0.0448,-0.0075, 0.0093, 0.0081, -0.0258, 0.0521,-0.0390, 0.0053, 0.0083,-0.0009 };
```

```
if(RESET[0] == 1)
{
    {
        for(i=15;i<30;++i)
            dl[i] = 0;
    }

    for(p=60;p<120;++p)
    {
        X[p] = PV[0];
        E[p] = SP[0]-X[p];
    }
}
```

```
if(RESET[1] == 1)
{
    {
        for(i=0;i<15;++i)
            dl[i] = 0;
    }

    for(p=0;p<60;++p)
    {
        X[p] = PV[1];
        E[p] = SP[1]-X[p];
    }
}
```



```

if(RESET[0] == 0)
{
for(p=60;p<120;++p)      /* error vector calculation */
{
X[p] = 0;
for(q=0;q<30;++q)
{
P = A[p][q]*dI[q];
X[p] = X[p]+P;
}
E[p] = SP[0]-(X[p]+(PV[0]-X[60]));
}
}

```

```

if(RESET[1] == 0)
{
for(p=0;p<60;++p)      /* error vector calculation */
{
X[p] = 0;
for(q=0;q<30;++q)
{
P = A[p][q]*dI[q];
X[p] = X[p]+P;
}
E[p] = SP[1]-(X[p]+(PV[1]-X[0]));
}
}

```

```
DEL_MV[0] = 0;
```

```
DEL_MV[1] = 0;
```

```
for(p=0;p<120;++p)
```

```

{
DI = E[p]*Ah[p];
DEL_MV[0] = DEL_MV[0]+DI;
}

```

```
for(p=0;p<120;++p)
```

```

{
DI = E[p]*Ac[p];
DEL_MV[1] = DEL_MV[1]+DI;
}

```



```
for(i=0;i<1;++i)
{
    if(DEL_MV[i] > 100)
        DEL_MV[i] = 100;
    if(DEL_MV[i] < -100)
        DEL_MV[i] = -100;

    DEL_CO[i] = DEL_MV[i];
}

dI[0] = dI[1];
dI[1] = dI[2];
dI[2] = dI[3];
dI[3] = dI[4];
dI[4] = dI[5];
dI[5] = dI[6];
dI[6] = dI[7];
dI[7] = dI[8];
dI[8] = dI[9];
dI[9] = dI[10];
dI[10] = dI[11];
dI[11] = dI[12];
dI[12] = dI[13];
dI[13] = dI[14];
dI[14] = DEL_CO[1];
dI[15] = dI[16];
dI[16] = dI[17];
dI[17] = dI[18];
dI[18] = dI[19];
dI[19] = dI[20];
dI[20] = dI[21];
dI[21] = dI[22];
dI[22] = dI[23];
dI[23] = dI[24];
dI[24] = dI[25];
dI[25] = dI[26];
dI[26] = dI[27];
dI[27] = dI[28];
dI[28] = dI[29];
dI[29] = DEL_CO[0];
}
```





ประวัติผู้เขียน

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สำเร็จการศึกษาปริญญาตรีวิทยาศาสตร์บัณฑิต สาขาเคมีอุตสาหกรรม คณะวิทยาศาสตร์
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ในหลักสูตรวิศวกรรมศาสตรมหาบัณฑิต สาขาวิศวกรรมเคมี เมื่อ พ.ศ. 2533



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