

REFERENCES

- [1] OMRON. (2001). *Beginner's Guide to PLC*. Singapore
- [2] Morina Abdullah and Kamaruddin Tawi. (1999). *Elektronik Perindustrian*. 1st Edition, Universiti Teknologi Malaysia.
- [3] Zainal Abidin Bin Daud. (2000). *Auto-adjustable Traffic Light Control System*. Degree Thesis, Universiti Putra Malaysia, Malaysia
- [4] Parr, E.A. (1999). *Programmable Controllers an Engineer's Guide*, Newnes, USA.
- [5] Crispin, A.J. (1990). *Programmable Logic Controllers and Engineering Applications*, McGraw-Hill, USA.
- [6] OMRON. (2004). Sysmac, Programmable Controllers, Programming Manual. 21 - http://www.omronap.com/admin/access_download_plc.asp, 12 January 2007.
- [7] Terry Bartelt. (2001). *Industrial Control Electronics, Devices, Systems and Applications* 2nd Edition, Delmar Publishing, Clifton Park, NY.
- [8] <http://www.mrollins.com/irled.html>
- [9] <http://www.ideafinder.com/history/inventions/trafficlight.htm>

APPENDIX A

APPENDIX B

Rung	Step	Instruction	Operand	Value	Comment
0	0	LD	0.00		system on
	1	OR	11.15		
	2	ANDNOT	0.01		system off
	3	OUT	11.15		
1	4	LD	11.15		
	5	L(02)			
2	6	LDNOT	TIM012		
	7	ANDNOT	10.10		
	8	ANDNOT	11.14		
	9	TIM	001		
			#10		
3	10	LD	TIM001		
	11	ANDNOT	10.10		
	12	ANDNOT	11.11		
	13	TIM	002		
			#40		
4	14	LD	TIM002		
	15	ANDNOT	10.10		
	16	TIM	003		
			#15		
5	17	LD	TIM003		
	18	ANDNOT	10.10		
	19	TIM	004		
			#10		
6	20	LD	TIM004		
	21	ANDNOT	10.10		
	22	ANDNOT	11.12		
	23	TIM	005		
			#40		
7	24	LD	TIM005		
	25	ANDNOT	10.10		
	26	TIM	006		
			#15		
8	27	LD	TIM006		
	28	ANDNOT	10.10		
9	30	LD	TIM007		
	31	ANDNOT	10.10		
	32	ANDNOT	11.13		
	33	TIM	008		
			#40		
10	34	LD	TIM008		
	35	ANDNOT	10.10		
	36	TIM	009		
			#15		
11	37	LD	TIM009		
	38	ANDNOT	10.10		
	39	TIM	010		
			#10		
12	40	LD	TIM010		
	41	ANDNOT	10.10		
	42	ANDNOT	11.14		
	43	TIM	011		
			#40		
13	44	LD	TIM011		
	45	ANDNOT	10.10		
	46	TIM	012		
			#15		
14	47	LD	TIM001		
	48	ANDNOT	TIM002		
	49	OR	11.11		
	50	ANDNOT	11.12		
	51	ANDNOT	11.13		
	52	ANDNOT	11.14		
	53	OR	40.11		G01
	54	OUT	10.00		G01

Run#	Step	Instruction	Operand	Value	Comment	
15	55	LD	0.02		imergency1	
	56	OR	30.00			
	57	ANDNOT	TIM081		imerg timer 1	
16	58	OUT	30.00			
	59	LD	30.00			
	60	ANDNOT	11.12			
	61	ANDNOT	11.13			
	62	ANDNOT	11.14			
	63	OUT	11.11			
	64	TIM	081 #90		imerg timer 1	
17	65	LD	TIM002			
	66	ANDNOT	TIM003			
	67	ANDNOT	11.12			
	68	ANDNOT	11.11			
	69	ANDNOT	11.13			
	70	ANDNOT	11.14			
	71	OR	40.12		Y01	
	72	OUT	10.01		Y01	
	18	73	LD	TIM004		
		74	ANDNOT	TIM005		
75		OR	11.12			
76		ANDNOT	11.11			
77		ANDNOT	11.13			
78		ANDNOT	11.14			
79		OR	40.14		G02	
80		OUT	10.02		G02	
19		81	LD	0.03		imergency2
		82	OR	30.01		
	83	ANDNOT	TIM082		imerg timer 2	
	84	OUT	30.01			
20	85	LD	30.01			
	86	ANDNOT	11.11			
	87	ANDNOT	11.13			
	88	ANDNOT	11.14			
	89	OUT	11.12			
	90	TIM	082 #90		imerg timer 2	
21	91	LD	TIM005			
	92	ANDNOT	TIM006			
	93	ANDNOT	11.12			
	94	ANDNOT	11.11			
	95	ANDNOT	11.13			
	96	ANDNOT	11.14			
	97	OR	40.15		Y02	
	98	OUT	10.03		Y02	
	22	99	LD	TIM007		
100		ANDNOT	TIM008			
101		OR	11.13			
102		ANDNOT	11.12			
103		ANDNOT	11.11			
104		ANDNOT	11.14			
105		OR	41.01		G03	
106		OUT	10.04		G03	
23		107	LD	0.04		imergency3
		108	OR	30.02		
	109	ANDNOT	TIM083		imerg timer 3	
	110	OUT	30.02			
24	111	LD	30.02			
	112	ANDNOT	11.12			
	113	ANDNOT	11.11			
	114	ANDNOT	11.14			
	115	OUT	11.13			
	116	TIM	083 #90		imerg timer 3	

Rung	Step	Instruction	Operand	Value	Comment	
25	117	LD	TIM008			
	118	ANDNOT	TIM009			
	119	ANDNOT	11.13			
	120	ANDNOT	11.14			
	121	ANDNOT	11.12			
	122	ANDNOT	11.11			
	123	OR	41.02		Y03	
	124	OUT	10.05		Y03	
26	125	LD	TIM010			
	126	ANDNOT	TIM011			
	127	OR	11.14			
	128	ANDNOT	11.12			
	129	ANDNOT	11.11			
	130	ANDNOT	11.13			
	131	OR	41.04		G04	
	132	OUT	10.06		G04	
27	133	LD	0.05		imergency4	
	134	OR	30.03			
	135	ANDNOT	TIM084		imerg timer 4	
	136	OUT	30.03			
28	137	LD	30.03			
	138	ANDNOT	11.11			
	139	ANDNOT	11.12			
	140	ANDNOT	11.13			
	141	OUT	11.14			
	142	TIM	084		imerg timer 4	
29	143	LD	TIM011			
	144	ANDNOT	TIM012			
	145	ANDNOT	11.14			
	146	ANDNOT	11.12			
	147	ANDNOT	11.11			
	148	ANDNOT	11.13			
	149	OR	41.05		Y04	
	150	OUT	10.07		Y04	
	30	151	ILC(03)			
	32	152	LD	0.06		sensor
153		LD	TIM090		reset sensor	
154		OR	TIM030			
155		CNT	020			
33	156	LD	0.06		sensor	
	157	OR	20.00			
	158	ANDNOT	CNT020			
	159	ANDNOT	TIM030			
	160	OUT	20.00			
	34	161	LD	20.00		
34	162	ANDNOT	CNT020			
	163	ANDNOT	TIM040		RESET TIM030	
	164	TIM	030			
			#100			
35	165	LD	20.00			
	166	ANDNOT	CNT020			
	167	TIM	040		RESET TIM030	
36	168	LD	CNT020			
	169	ANDNOT	TIM050		RESET 090	
	170	TIM	090		reset sensor	
37	171	LD	CNT020			
	172	TIM	050		RESET 090	
38	173	LD	CNT020			
	174	OUT	40.00		normal/night (1	
	39	175	LD	0.07		sensor2
39	176	LD	TIM031			
	177	OR	TIM091			
	178	CNT	021			
			#2			

Run#	Step	Instruction	Operand	Value	Comment
40	179	LD	0.07		sensor2
	180	OR	20.01		
	181	ANDNOT	CNT021		
	182	ANDNOT	TIM031		
	183	OUT	20.01		
41	184	LD	20.01		
	185	ANDNOT	CNT021		
	186	ANDNOT	TIM041		RESET TIM031
	187	TIM	031		
			#100		
42	188	LD	20.01		
	189	ANDNOT	CNT021		
	190	TIM	041		RESET TIM031
			#102		
43	191	LD	CNT021		
	192	ANDNOT	TIM051		RESET 091
	193	TIM	091		
			#300		
44	194	LD	CNT021		
	195	TIM	051		RESET 091
			#302		
45	196	LD	CNT021		
	197	OUT	40.01		normal/night (2)
46	198	LD	0.08		sensor3
	199	LD	TIM032		
	200	OR	TIM092		
	201	CNT	022		
			#2		
47	202	LD	0.08		sensor3
	203	OR	20.02		
	204	ANDNOT	CNT022		
	205	ANDNOT	TIM032		
	206	OUT	20.02		
48	207	LD	20.02		
	208	ANDNOT	CNT022		
	209	ANDNOT	TIM042		RESET TIM032
	210	TIM	032		
			#100		
49	211	LD	20.02		
	212	ANDNOT	CNT022		
	213	TIM	042		RESET TIM032
			#102		
50	214	LD	CNT022		
	215	ANDNOT	TIM052		RESET 092
	216	TIM	092		
			#300		
51	217	LD	CNT022		
	218	TIM	052		RESET 092
			#302		
52	219	LD	CNT022		
	220	OUT	40.02		normal/night (3)
53	221	LD	0.09		sensor4
	222	LD	TIM033		
	223	OR	TIM093		
	224	CNT	023		
			#2		
54	225	LD	0.09		sensor4
	226	OR	20.02		
	227	ANDNOT	CNT023		
	228	ANDNOT	TIM033		
	229	OUT	20.03		
55	230	LD	20.03		
	231	ANDNOT	CNT023		
	232	ANDNOT	TIM043		RESET TIM033
	233	TIM	033		
			#100		
56	234	LD	20.03		
	235	ANDNOT	CNT023		
	236	TIM	043		RESET TIM033
			#102		

Run#	Step	Instruction	Operand	Value	Comment
57	237	LD	CNT023		
	238	ANDNOT	TIM053		RESET 093
	239	TIM	093		
58	240	LD	#300		
	241	TIM	CNT023		RESET 093
			053		
59	242	LD	#302		
	243	OUT	CNT023	40.03	normal/night (4)
	244	LD	11.11		
61	245	OR	11.12		
	246	OR	11.13		
	247	OR	11.14		
	248	OR	21.11		imerg relay
	249	ANDNOT	TIM000		imerg cut night
	250	OUT	21.11		imerg relay
	251	TIM	000		imerg cut night
			#400		
62	252	LDNOT	40.00		normal/night (1)
	253	ANDNOT	40.01		normal/night (2)
	254	ANDNOT	40.02		normal/night (3)
	255	ANDNOT	40.03		normal/night (4)
	256	ANDNOT	21.11		imerg relay
	257	OUT	10.10		
	258	LDNOT	TIM072		
63	259	ANDNOT	10.14		
	260	AND	10.10		
	261	TIM	061		
			#40		
64	262	LD	TIM061		
	263	AND	10.10		
	264	ANDNOT	10.11		
	265	TIM	062		
65	266	LD	#01		
	267	AND	TIM062		
	268	TIM	10.10		
			063		
66	269	LD	#01		
	270	AND	TIM063		
	271	TIM	10.10		
			064		
67	272	LD	#40		
	273	AND	TIM064		
	274	ANDNOT	10.10		
	275	TIM	10.12		
			065		
68	276	LD	#01		
	277	AND	TIM065		
	278	TIM	10.10		
			066		
69	279	LD	#01		
	280	AND	TIM066		
	281	TIM	10.10		
			067		
70	282	LD	#40		
	283	AND	TIM067		
	284	ANDNOT	10.10		
	285	TIM	10.13		
			068		
71	286	LD	#01		
	287	AND	TIM068		
	288	TIM	10.10		
			069		
			#01		

Runq	Step	Instruction	Operand	Value	Comment
72	289	LD	TIM069		
	290	AND	10.10		
	291	TIM	070		
73	292	LD	#40		
	293	AND	TIM070		
	294	ANDNOT	10.10		
	295	TIM	10.14		
				071	
74	296	LD	#01		
	297	AND	TIM071		
	298	TIM	10.10		
75	299	LD	072		
	300	OR	#01		
	301	ANDNOT	0.06		sensor
	302	ANDNOT	10.11		
	303	ANDNOT	10.12		
	304	AND	10.13		
	305	ANDNOT	10.14		
	306	OUT	10.10		reset
307	TIM	TIM095		reset	
76	308	LD	10.11		
	309	ANDNOT	10.12		
	310	ANDNOT	10.13		
	311	ANDNOT	10.14		
	312	ANDNOT	40.12		Y.01
	313	ANDNOT	TIM062		
	314	OUT	TIM063		
	315	LD	10.11		
77	316	ANDNOT	10.12		
	317	OR	10.13		
	318	ANDNOT	10.14		
	319	ANDNOT	10.10		
	320	ANDNOT	TIM095		
	321	OUT	10.11		G01
	322	LD	0.07		sensor2
	323	OR	10.12		
	324	ANDNOT	10.11		
	325	ANDNOT	10.13		
326	ANDNOT	10.14			
78	327	AND	10.10		
	328	ANDNOT	TIM096		
	329	OUT	10.12		
	330	TIM	096		
	331	LD	#030		
	332	ANDNOT	TIM065		
	333	ANDNOT	TIM066		
	334	ANDNOT	10.11		
	335	ANDNOT	10.12		
	336	ANDNOT	10.13		
337	OUT	10.14		Y02	
80	338	LD	40.15		
	339	ANDNOT	TIM064		
	340	OR	TIM065		
	341	ANDNOT	10.12		
	342	ANDNOT	10.11		
	343	ANDNOT	10.13		
	344	OUT	10.14		G02

Run#	Step	Instruction	Operand	Value	Comment
81	345	LD	0.08		sensor3
	346	OR	10.13		
	347	ANDNOT	10.11		
	348	ANDNOT	10.12		
	349	ANDNOT	10.14		
	350	AND	10.10		
	351	ANDNOT	TIM097		
	352	OUT	10.13		
	353	TIM	097		
82	354	LD	#30		Y03
	355	ANDNOT	TIM068		
	356	ANDNOT	TIM069		
	357	ANDNOT	10.11		
	358	ANDNOT	10.12		
	359	ANDNOT	10.13		
	359	ANDNOT	10.14		
	360	OUT	41.02		
	361	LD	TIM067		
83	362	ANDNOT	TIM068		G03 sensor4
	363	OR	10.13		
	364	ANDNOT	10.12		
	365	ANDNOT	10.11		
	366	ANDNOT	10.14		
	367	OUT	41.01		
	368	LD	0.09		
84	369	OR	10.14		Y04
	370	ANDNOT	10.11		
	371	ANDNOT	10.12		
	372	ANDNOT	10.13		
	373	AND	10.10		
	374	ANDNOT	TIM098		
	375	OUT	10.14		
	376	TIM	098		
	377	LD	#30		
85	378	ANDNOT	TIM071		Y04
	378	ANDNOT	TIM072		
	379	ANDNOT	10.11		
	380	ANDNOT	10.12		
	381	ANDNOT	10.13		
	382	ANDNOT	10.14		
	383	OUT	41.05		
86	384	LD	TIM070		G04
	385	ANDNOT	TIM071		
	386	OR	10.14		
	387	ANDNOT	10.11		
	388	ANDNOT	10.12		
	389	ANDNOT	10.13		
	390	OUT	41.04		
87	391	END(01)			