LACO - 3

LOS ANGELES COUNTY

DEPARTMENT OF PUBLIC WORKS

TRAFFIC SIGNAL CONTROL PROGRAM

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LACO-3 USER'S MANUAL

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INTRODUCTION

The Los Angeles County Traffic Signal Control Program #3 (LACO-3) has been developed to satisfy the requirements of many complex intersections. LACO-3 is based on the LACO-1 program currently in use in the majority of L. A. County intersections and retains much of the LACO-1 traffic control philosophy. Since the development of the LACO-1 program, both traffic density and intersection complexity in the County have increased dramatically. LACO-3 was developed as a tool to help Traffic Engineers more efficiently move this increased traffic. It incorporates many non-standard features that can be selectively used to address special situations encountered at the many "unique" intersections found in the County, but at the same time, it can be used to control the most basic of intersections.

GENERAL DESCRIPTION

USING THIS MANUAL

This manual is written with the Traffic Engineer as its main audience. It is assumed that the user is familiar with basic traffic control concepts. Therefore, in-depth explanations will only be provided for those operations or functions that are unique to this program. Section I provides a broad overview of the LACO-3 Program. Following this page are the hardware requirements for running LACO-3. After that summary descriptions of the main LACO-3 features are provided. Page numbers are given for each entry indicating where to find more detailed information on that entry. Several figures that define the software/hardware relationship in a 332 or 337 controller cabinet come after that. These will be helpful to the person who must modify a cabinet for some configuration that cannot be implemented with software. At the end of Section I is a detailed explanation of the operation of the 170 controller with separate sections on keyboard operation and Function display/Call light interpretation.

Section II , Program Operation, gives a more detailed description of the LACO-3 operating modes and special features described briefly in Section I. At the end of this section is an in-depth description of the data validation process performed on user entered data. Section III contains the manual Appendices, which include blank Timing Sheets, RAM maps, a Glossary of the terms and acronyms found throughout this manual and 2 Timing Sheet cross references; one sorted by keystroke sequence and the other sorted by Timing Sheet location. After the cross references, there are several blank pages for notes followed by four pages of LACO-3 Interval Description forms that are sized to fit in the 170 controller front panel card holder. Finally, an Index is provided for quick look-up of a term or topic.

This manual is intended to be "reader friendly". A table of contents for the entire manual is located after the title page for quick reference to a section. Located at the beginning of each Section is a "mini" table of contents, with more detailed references to that section. Plain language is used as much as possible, wordiness is avoided and the use of jargon kept to a minimum. Figures are used extensively to enhance a functional description or to illustrate a concept.

MODEL 170 CONTROLLER HARDWARE REQUIREMENTS

Basic intersection operation:	1 KByte RAM at address 0000h
Time Based (Table) Coordination:	Novram at address 1000h
Timing saver feature:	Novram at address 7000h
Full diagnostic capabilities:	1 KByte RAM at address 0400h
Full Coordination capabilities:	Two serial ports (ACIA's)

GENERAL PROGRAM DESCRIPTION

The key feature of LACO-3 is its flexibility. All of the Phase flag parameters can be set to any Phase(s) and a wide variety of configurations that previously required cabinet modifications can now be achieved with software.

LACO-3 provides the following features:

COORDINATION:

- Master, Slave or Master/Slave operation
- 2 wire (Modem) Compatible with Caltrans ML2 format
- Time Based, with WWV Clock support
  - or with 2 wire (Modem) time and date transfer
- Offset Timing

OVERLAPS:

- Six Normal: Two 2-color and Four 3-color overlaps
- Six Railroad: Two 2-color and Four 3-color overlaps
- Six Emergency Vehicle: Two 2-color and Four 3-color overlaps.
- Overlaps can be programmed to continue into or out of Preempt, 3-color overlap outputs can be redirected to unused Vehicle load switches or to unused Ped load switches as 2-color overlaps, 2-color overlap outputs can be redirected to unused Ped load switches
- All overlaps have independent programmable Red Clearance, Yellow Change and Green Extension Timers
- All overlaps are Phase programmable
- All overlaps have programmable Green Omit
- Overlaps can be programmed to "Start Up in Yellow"

PREEMPTS:

- One Railroad Preempt input that can be configured as a Railroad Flash preempt (RR1) or a Limited Service preempt (RR2). RR1 option provides selectable First Phases after Flash.
- Four Emergency Vehicle Preempt inputs with individually selectable Clearance Phases, Clearance times and Delay times.
- Emergency Vehicle Preempt operation in RR2 Limited Service.

MISCELLANEOUS:

Very flexible Restricted Phasing capabilities

Selectable RED REST phases with programmable delay timer.

Selectable GREEN REST phases with programmable delay timer

Protected/Permissive left turn arrow logic

Manual Control

Supports up to 4 serial ports

Mid-block Ped crossing

Associated Phase recall

Convenient diagnostic capabilities

Automatic error checking of keyboard data

Write protection of critical RAM data

Ped Recall via "Rest-in-Walk" or STA mode

Programmable Lag phases for Free operation and each of 3 Dials

Driveway Flash for Vehicle or Overlap outputs

Extended memory addressing and numerous other minor enhancements

GENERAL COORDINATION DESCRIPTION

The LACO-3 program can be coordinated in either interconnected systems or non-interconnected systems. As a Master, this program uses its real time clock to access tables which determine the coordination plan to act on. This plan is continuously sent out on the 7-wire outputs and can also be sent out via Modem on a selected Serial Port. As a Slave in an interconnected system, the data is received via Modem on the selected Serial Port (7-wire inputs to the cabinet must be converted to serial data for use by the Modem). This serial data is compatible with the Caltrans Diamond Interchange program (ML2 format).

The coordination plan is in a 3 Dial/3 Offset format. Time of Day, Annual and Holiday tables are used to change the plans. The operator can turn the coordination on and off manually or force it to one of the 9 plans.

Offset Timing is an optional Slave mode operation. It provides the user with a coordination scheme which is triggered by an event rather than a Sync Pulse in a fixed background cycle. The basic coordination functions are maintained and programmed the same as with the conventional Slave mode. The operation is essentially the same except that the intersections goes Free after each cycle is completed.

For more information on Coordination, see Page 2-10.

GENERAL OVERLAP DESCRIPTION

LACO-3 Overlaps are significantly more flexible than previous traffic control programs used by the County. The program provides up to 6 Overlaps, two of them are limited to 2-color operation with the other four capable of 2-color or 3-color operation. All 6 Overlaps are output continuously to the Auxiliary Outputs, but they can be redirected (echoed) to unused Vehicle and Ped outputs. Each Overlap has its own timer which can be programmed with Green Extension, Yellow Change and Red Clearance times independent of the other Overlaps. Overlaps are subject to the same Red Revert rules as normal Vehicle phases. Parent phases for each Overlap must be set individually for Normal, Railroad or Emergency Vehicle operation, but they need not be the same phases. Green Omit can be set to any Phase(s) for each Overlap. Any Overlap can be programmed to output Yellow at Start Up as long as at least one of its parent phases is flagged for Yellow Start Up also. Any Overlap can be set to Driveway Flash.

For more information on Overlaps, see Page 2-37.

GENERAL PREEMPTION DESCRIPTION

Preemption in LACO-3 is almost identical to the Preemption routine found in LACO-1. Again, the major difference is in the flexibility it gives the user. As the word "preemption" indicates, a Railroad or Emergency Vehicle (EV) input causes the existing configuration at an intersection to be replaced by a special configuration. This temporary configuration allows the safe and orderly "clearance" of traffic from the path of the Emergency Vehicle or train. An EV preempt input can be serviced during Normal operation or during the Limited Service portion of a RR2 preempt. A Railroad preempt input is serviced immediately, even if the input is active at power up. If a Railroad input is sensed during an EV preempt, it will cause the EV preempt to terminate in the same manner that it terminates Normal operation.

LACO-3 has four Emergency Vehicle (EV) inputs and one Railroad input. The single Railroad input can be configured to provide two entirely different operations. These are referred to as Railroad 1 (RR1) Flash and Railroad 2 (RR2) Limited Service. After the clearance portion of the preempt, RR2 allows normal operation only on phases that the Engineer determines can be safely used. RR1, on the other hand, puts the intersection into software flash for as long as the Railroad input is active. At the end of the Railroad preempt, RR2 provides a smooth transition back to Normal operation. RR1 resumes Normal operation by implementing a procedure resembling Start Up after a long power outage. First it outputs an all-Red period. Then it either allows normal demand to serve phases first or serves the user-set RR1 Exit phases.

For more information on Preemption, see Page 2-39.

GENERAL RESTRICTED PHASING DESCRIPTION

The most basic characteristic of a Restricted Phase is that it can never time concurrently with another Restricted Phase. This can be useful when phases on the same street need to be served in a specific sequence. When using Restricted phases to control an intersection, the basic Ring progression may be modified to provide a logical and equitable servicing sequence.

For more information on Restricted Phasing, see Page 2-45.

HARDWARE INFORMATION

Figures 1 through 6 on the following pages have been included to assist both users and maintenance personnel with installation, maintenance and troubleshooting of controller cabinets that have the LACO-3 program installed.

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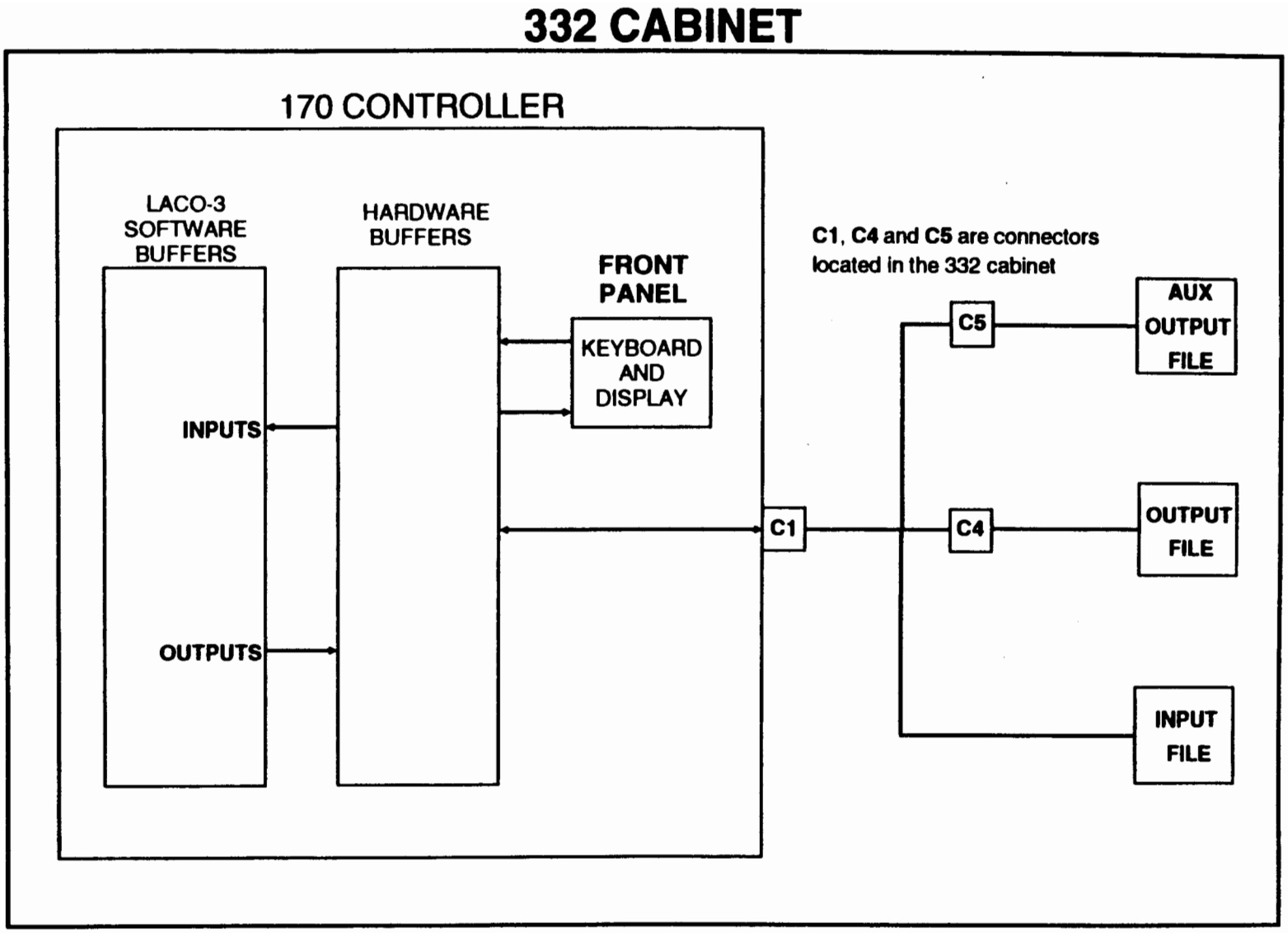

FIGURE 1 - LACO-3 / 170 Controller / 332 Cabinet; I / O Diagram

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PIN	I/O	FUNCTION	PIN	I/O	FUNCTION
1	•••••	LOGIC GROUND	53	I2-7	PED B/ MANUAL ENABLE
2	01-2	4 PED DON'T WALK	54	I2-8	SYSTEM ALARM (FUTURE USE)
3	01-2	4 PED WALK	55	I3-1	DETECTOR J1U/L
4	01-3	PHASE 4 RED	56	I3-2	DETECTOR I1U/L
5	01-4	PHASE 4 YELLOW	57	I3-3	DETECTOR J5U/L
6	01-5	PHASE 4 GREEN	58	I3-4	DETECTOR I5U/L
7	01-6	PHASE 3 RED	59	I3-5	DETECTOR J9U
8	01-7	PHASE 3 YELLOW	60	I3-6	DETECTOR I9U
9	01-8	PHASE 3 GREEN	61	I3-7	DETECTOR J9L
10	02-1	2 PED DON'T WALK	62	I3-8	DETECTOR I9L
11	02-2	2 PED WALK	63	I4-5	DETECTOR I3U
12	02-3	PHASE 2 RED	64	I46	DETECTOR J3U
13	02-4	PHASE 2 YELLOW	65	I4-7	DETECTOR I7U
14	•••••	LOGIC GROUND	66	I4-8	DETECTOR J7U
15	02-5	PHASE 2 GREEN	67	I5-1	2 PED PUSHBUTTON
16	02-6	PHASE 1 RED	68	I5-2	6 PED PUSHBUTTON
17	02-7	PHASE 1 YELLOW	69	I5-3	4 PED PUSHBUTTON
18	02-8	PHASE 1 GREEN	70	I5-4	8 PED PUSHBUTTON
19	03-1	8 PED DON'T WALK	71	I5-5	EV A
20	03-2	8 PED WALK	72	I5-6	EV B
21	03-3	PHASE 8 RED	73	I5-7	EV C
22	03-4	PHASE 8 YELLOW	74	I5-8	EV D
23	03-5	PHASE 8 GREEN	75	I6-1	SYSTEM ALARM (FUTURE USE)
24	03-6	PHASE 7 RED	76	I6-2	DETECTOR I3L
25	03-7	PHASE 7 YELLOW	77	I6-3	DETECTOR J3L
26	03-8	PHASE 7 GREEN	78	I6-4	DETECTOR I7L
27	04-1	6 PED DON'T WALK	79	I6-5	DETECTOR J7L
28	04-2	6 PED WALK	80	I6-6	PED A/ MANUAL ADVANCE
29	04-3	PHASE 6 RED	81	I6-7	(FUTURE USE)
30	04-4	PHASE 6 YELLOW	82	I6-8	CABINET STOP TIME
31	04-5	PHASE 6 GREEN	83	O6-1	FUNCTION 6
32	04-6	PHASE 5 RED	84	O6-2	DIAL 3
33	04-7	PHASE 5 YELLOW	85	O6-3	OVERLAP F RED
34	04-8	PHASE 5 GREEN	86	O6-4	OVERLAP F YELLOW
35	05-1	OVERLAP A GREEN	87	O6-5	OVERLAP F GREEN
36	05-2	OVERLAP B GREEN	88	O6-6	OVERLAP E RED
37	05-3	OVERLAP A YELLOW	89	O6-7	OVERLAP E YELLOW
38	05-4	OVERLAP B YELLOW	90	O6-8	OVERLAP E GREEN
39	I1-1	DETECTOR I2U	91	07-1	OFFSET 1
40	I1-2	DETECTOR J2U	92	•••••	DC GROUND
41	I1-3	DETECTOR I6U	93	07-2	OFFSET 3
42	I1-4	DETECTOR J6U	94	07-3	OVERLAP D RED
43	I1-5	DETECTOR I2L	95	07-4	OVERLAP D YELLOW
44	I1-6	DETECTOR J2L	96	07-5	OVERLAP D GREEN
45	I1-7	DETECTOR I6L	97	07-6	OVERLAP C RED
46	I1-8	DETECTOR J6L	98	07-7	OVERLAP C YELLOW
47	I2-1	DETECTOR I4U/L	99	07-8	OVERLAP C GREEN
48	I2-2	DETECTOR J4U/L	100	O5-5	DIAL 2
49	I2-3	DETECTOR I8U/L	101	O5-6	OFFSET 2
50	I2-4	DETECTOR J8U/L	102	O5-7	DETECTOR RESET
51	I2-5	OFFSET TIMING	103	O5-8	WATCHDOG
52	I2-6	RR1/RR2 PREEMPT	104	•••••	DC GROUND

FIGURE 2 - C1 Connector Pins

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LACO-3 MNEMONIC	SOFTWARE ADDRESS	BIT 8	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	HARDWARE ADDRESS
IN1	**E80**	J6L	I6L	J2L	I2L	J6U	I6U	J2U	I2U	**5001**
IN2	**E81**	SYSTEM ALARM (FUTURE)	PED B / MANUAL ENABLE	RAILROAD	OFFSET TIMING	J8U/L	I8U/L	J4U/L	I4U/L	**5002**
IN3	**E82**	I9L	J9L	I9U	J9U	I5U/L	J5U/L	I1U/L	J1U/L	**5003**
IN4	**E83**	J7U	I7U	J3U	I3U	UNUSED	UNUSED	UNUSED	UNUSED	**5004**
IN5	**E84**	EV D	EV C	EV B	EV A	8 PED PUSH BUTTON	4 PED PUSH BUTTON	6 PED PUSH BUTTON	2 PED PUSH BUTTON	**5005**
IN6	**E85**	CABINET STOP TIME	FLASH SENSE	PED A / MANUAL ADVANCE	J7L	I7L	J3L	I3L	SYSTEM ALARM (FUTURE)	**5006**
IN7	**E86**	UNUSED	UNUSED	FRONT PANEL STOP TIME	MSB KEYPAD CHAR	NMSB KEYPAD CHAR	NLSB KEYPAD CHAR	LSB KEYPAD CHAR	KEYPAD KEY DOWN	**5007**

FIGURE 3 - Model 170 Controller Inputs

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LACO-3 MNEMONIC	SOFTWARE ADDRESS	BIT 8	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	HARDWARE ADDRESS
OUT1	E90	Ø3 GREEN	Ø3 YELLOW	Ø3 RED	Ø4 GREEN	Ø4 YELLOW	Ø4 RED	4 PED WALK	4 PED DON'T WALK	5001
OUT2	E91	Ø1 GREEN	Ø1 YELLOW	Ø1 RED	Ø2 GREEN	Ø2 YELLOW	Ø2 RED	2 PED WALK	2 PED DON'T WALK	5002
OUT3	E92	Ø7 GREEN	Ø7 YELLOW	Ø7 RED	Ø8 GREEN	Ø8 YELLOW	Ø8 RED	8 PED WALK	8 PED DON'T WALK	5003
OUT4	E93	Ø5 GREEN	Ø5 YELLOW	Ø5 RED	Ø6 GREEN	Ø6 YELLOW	R E D	6 PED WALK	6 PED DON'T WALK	5004
OUT5	E94	WATCH DOG	DET RESET	OFFSET 2	DIAL2	O'LAP B YELLOW	O'LAP A YELLOW	O'LAP B GREEN	O'LAP A GREEN	5005
OUT6	E95	O'LAP C GREEN	O'LAP C YELLOW	O'LAP C RED	O'LAP D GREEN	O'LAP D YELLOW	O'LAP D RED	DIAL 3	FUNC 6	5006
OUT7	E96	O'LAP E GREEN	O'LAP E YELLOW	O'LAP E RED	O'LAP F GREEN	O'LAP F YELLOW	O'LAP F RED	OFFSET3	OFFSET 1	5007

FIGURE 4 - Model 170 Outputs

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I - INPUT FILE

I1 (56)	I2U (39)	I3U (63)	I4 (47)	I5 (58)	I6U (41)	I7U (65)	I8 (49)	I9U (60)	UNUSED	PED A / MANUAL ADVANCE (80)	2 PED PPB (67)	6 PED PPB (68)	FLASH SENSE (81)
	I2L (43)	I3L (76)			I6L (45)	I7L (78)		I9L (62)	UNUSED	PED B / MANUAL ENABLE (53)	4 PED PPB (69)	8 PED PPB (70)	CABINET STOP TIME (82)

J - INPUT FILE

J1 (55)	J2U (40)	J3U (64)	J4 (48)	J5 (57)	J6U (42)	I7U (66)	J8 (50)	J9U (59)	UNUSED	SYSTEM ALARM (FUTURE) (54)	EV - A (71)	EV - C (73)	OFFSET TIMING (51)
	J2L (44)	I3L (77)			J6L (46)	J7L (79)		J9L (61)	UNUSED	SYSTEM ALARM (FUTURE) (75)	EV - B (72)	EV - D (74)	RxR PREEMPT (52)

Numbers in parentheses indicate C1 Connector pin numbers

FIGURE 5 - 332 Input File Layout

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SPARE TERMINALS

1	2	3	4	5	6	7	8	9	10	11
UNUSED	UNUSED	UNUSED	UNUSED	UNUSED	EV - A (71)	R X R (52)	STOP TIME (82)	FLASH SENSE (C4-4)	UNUSED	UNUSED

1	2	3	4	5	6	7	8	6	10	11
I2U (39)	I3U (63)	I6U (41)	I7U (65)	J2U (40)	J3U (64)	2 PPB (67)	6 PPB (68)	FLASH SENSE (81)	PED A/ MANUAL ADVANCE (80)	SYSTEM ALARM (FUTURE) (54)
I2L (43)	I4 (47)	I6L (45)	I8 (49)	J2L (44)	J4 (48)	4 PPB (69)	UNUSED	OFFSET TIMING (51)	PED B/ MANUAL ENABLE (53)	SYSTEM ALARM (FUTURE) (75)

Numbers in parentheses indicate C1 Connector pin numbers

FIGURE 6 - 337 Input File Layout

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337 OUTPUT FILE

LS1	LS2	LS3	LS4	LS5	LS6
AUX1 RED (97)	Ø2 RED (12)	Ø4 RED (4)	Ø6 RED (29)	2PED WALK (11)	4PED WALK (3)
AUX1 YEL (98)	Ø2 YEL (13)	Ø4 YEL (5)	Ø6 YEL (30)	6PED WALK (28)	6PED D. WALK (27)
AUX1 GRN (99)	Ø2 GRN (14)	Ø4 GRN (6)	Ø6 GRN (31)	2PED D. WALK (10)	4PED D. WALK (2)

332 OUTPUT FILE

LS1	LS2	LS3	LS4	LS5	LS6
Ø1 RED (16)	Ø2 RED (12)	2PED WALK (11)	Ø3 RED (7)	Ø4 RED (4)	4PED WALK (3)
Ø1 YEL (17)	Ø2 YEL (13)	O'LAP "A" GRN (35)	Ø3 YEL (8)	Ø4 YEL (5)	O'LAP "A" YEL (37)
Ø1 GRN (18)	Ø2 GRN (15)	2PED D. WALK (10)	Ø3 GRN (9)	Ø4 GRN (6)	4PED D. WALK (2)
LS7	**LS8**	**LS9**	**LS10**	**LS11**	**LS12**
Ø5 RED (32)	Ø6 RED (29)	6PED WALK (28)	Ø7 RED (24)	Ø8 RED (21)	8PED WALK (20)
Ø5 YEL (33)	Ø6 YEL (30)	O'LAP "B" GRN (36)	Ø7 YEL (25)	Ø8 YEL (22)	O'LAP "B" YEL (38)
Ø5 GRN (34)	Ø6 GRN (31)	6PED D. WALK (27)	Ø7 GRN (26)	Ø8 GRN (23)	8PED D. WALK (19)

Numbers in Parentheses indicate C1 connector pins

"LS" = Load Switch

FIGURE 7 - 332/337 Cabinet Output File Layout

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AUXILIARY OUTPUT FILE

1	2	3	4	5	6
OVERLAP "C" RED	OVERLAP "D" RED	OFFSET 1	OVERLAP "E" RED	OVERLAP "F" RED	FUNCTION 6
OVERLAP "C" YEL	OVERLAP "D" YEL	OFFSET 2	OVERLAP "E" YEL	OVERLAP "F" YEL	DIAL 2
OVERLAP "C" GRN	OVERLAP "D" GRN	OFFSET 3	OVERLAP "E" GRN	OVERLAP "F" GRN	DIAL 3

FIGURE 8 - Auxiliary Output File Layout

170 CONTROLLER OPERATION

FRONT PANEL CONTROLS AND INDICATORS (see FIGURE 9)

Controls and indicators required for operation of the Model 170 Traffic Signal Controller are located on the front panel. All interval times for each Phase are displayed and entered using the front panel mounted keyboard and read-out. The current Phase, Interval and interval timer are displayed, along with vehicle and pedestrian calls. Typical Phase related functions, such as Recall, Detector Memory, Double Entry and Red Rest, are displayed and may be modified. The front panel is illustrated in FIGURE 8. A brief description of the controls and indicators is as follows:

A. BATTERY CHARGING LIGHT - This light senses the charging current for the backup battery. Some manufacturers of the "170 E" Model, which has no battery, (and therefore, no Battery Charging Light) remove the light completely. Others have assigned a new function to it: WDT (Watch Dog Timer) which echoes the 170 Watch Dog output to the CMU.

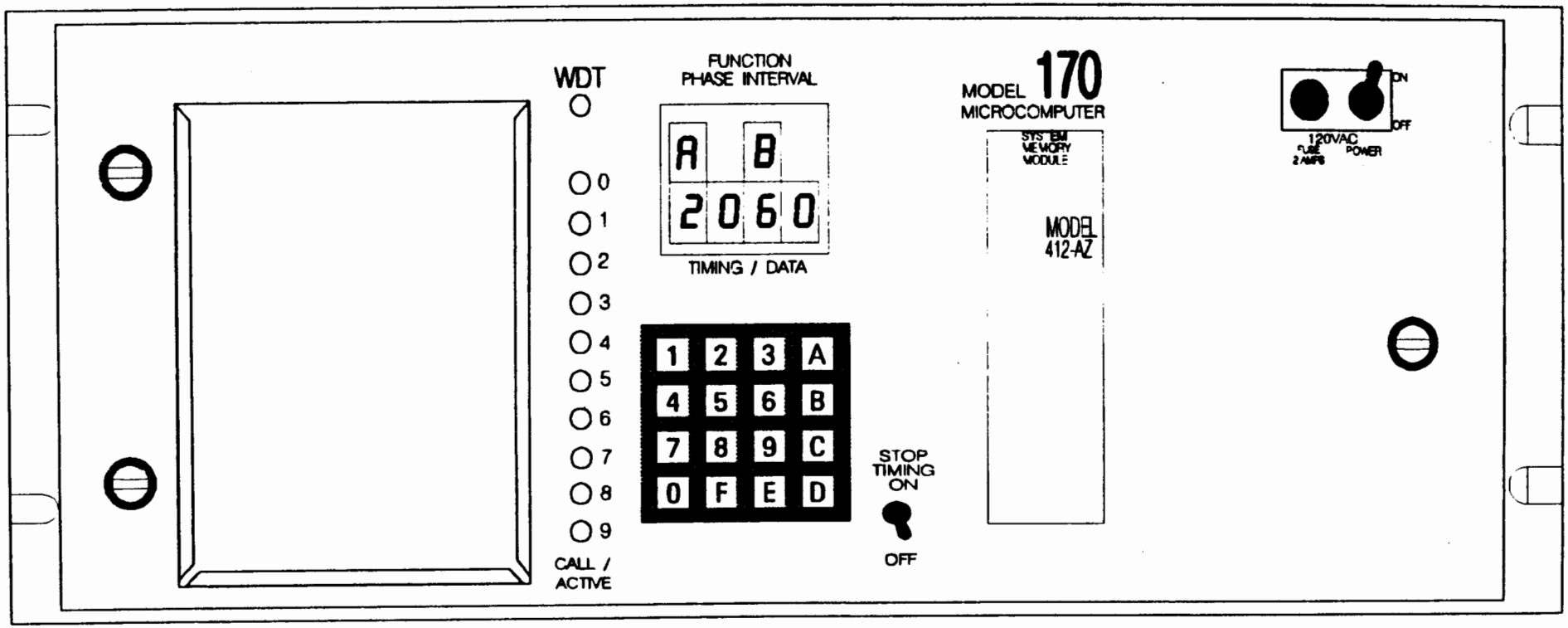
B. CALL/ACTIVE LIGHTS - These ten indicator lights are used to indicate the presence of traffic demand, Preemption status, Coordination status or error/status flags within some memory locations. An individual light is illuminated whenever there is a demand for the Phase indicated by the numbers "1" through "8". The lights will flash whenever the associated Phase has a pedestrian call. Call lights "1" through "7" are also used to indicate days of the week when in Real Time Clock or Table display modes. Call light "8" flashes when in Real Time Clock display mode. Call light "9" flashes when in Table display mode and is on continuously when a Preempt is active. Call light "0" provides Coordination status and Sync Pulse state.

C. FUNCTION DISPLAY - This LED display is used to show Phase and Interval timing in the Base display mode and Detailed Ring display mode. It is also used to show timing data when accessing memory locations.

D. KEYBOARD - The keyboard is made up of 16 keys consisting of the numbers "0" through "9" and the letters "A" through "F". The keyboard is used to access memory locations, enter timing data, set operation modes and enter other operation commands into the Model 170 Controller Unit.

E. STOP TIMING SWITCH - The Stop Timing switch is used to stop the program from timing the interval in effect. The interrupted interval continues timing when the Stop Time switch is turned off. Coordination timers are not affected by this switch.

F. POWER SWITCH - The power switch is used to turn the Model 170 Controller Unit on and off.



This 170 Front Panel is typical of the various manufacturers. Note that the Call / Active light labeled "WDT" is for the newer generation of 170E controllers that do not use a battery for data retention. On older models, this Call / Active light is labeled "BATTERY CHARGING"

FIGURE 9 - Type 170 Controller Front Panel

DISPLAY INTERPRETATION

The 170 controller uses one of four display modes to communicate data to the user as follows.

A. RING DISPLAY mode (see FIGURE 10)- This is the default display mode and is active after a long power down. It provides current Phase and interval status. The Ring Display mode includes the Base Display and the Detailed Ring displays. The Base display shows the Phase and interval of both Ring A and Ring B. The Detailed Ring display shows the Phase, interval and current interval timer of the selected Ring. From the Base display, press "A" to go to Ring A Detail Display, or "B" to go to Ring B Detail Display. Press any key, except "d", from the Ring B detail display, and any key, except "C" or "d", from the Ring A detail display, to return to the Base Display.

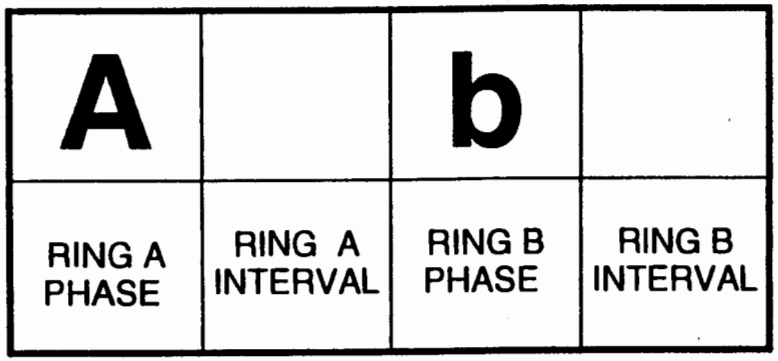
B. MEMORY DISPLAY mode- The Memory display mode is active whenever a specific location in RAM is accessed. There are two types of data shown when in the Memory display mode; timing data and Phase/flag data. When in the Memory display mode , the memory location being accessed is shown in the left hand digit of the Timing/Data window, and the Phase and Interval digits. If the memory location accessed is Phase/Flag data, then that data is reflected in call lights "1" through "8" and the Timing/Data window shows the Local Cycle Timer (see FIGURE 11). If the memory location holds Timing data, it will be displayed in the Timing/Data window and the call lights will show the same data as in the Base display (see FIGURE 12).

C. TABLE DISPLAY mode (see FIGURE 13) shows the Coordination Table data using all of the Function Display LED's and call lights "1" through "9".

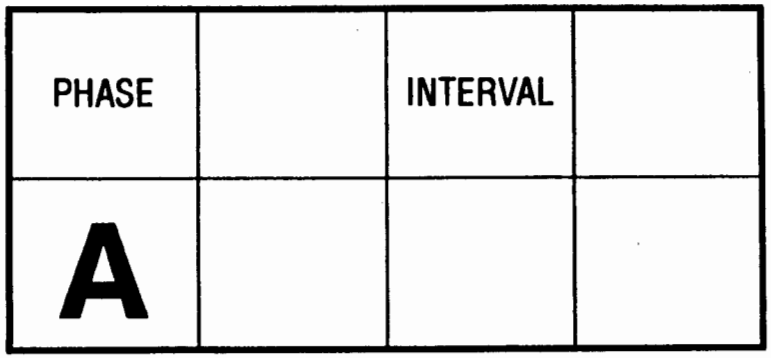
D. REAL TIME CLOCK DISPLAY mode (see FIGURE 14) has two displays, the Time display and the Date display. The Time display shows the Hour, Minute and units digit of Seconds of the 170's internal clock while the Date display shows the Day-in-month, last two digits of the year and current month. Both displays indicate the Day-of-week in call lights "1" through "7".

E. CALL/ACTIVE LIGHTS indicate:
   1. Vehicle and Pedestrian calls
   2. Real Time Clock display mode when call light "8" is flashing.
   3. Preemptions/Table display mode when call light "9" is on/flashing.
   4. Active phases when setting Phase related functions.
   5. Active flags when accessing status/error types of memory.
   6. Coordination status in call light "0".

F. TO BLANK THE DISPLAY:
   1. Go to the Base Display
   2. Press "B" followed by "d" for Blank display. The Function display will go black and all Call lights will be extinguished. Pressing any key will unblank the Function display and Call lights, and return to the Base display.



BASE DISPLAY

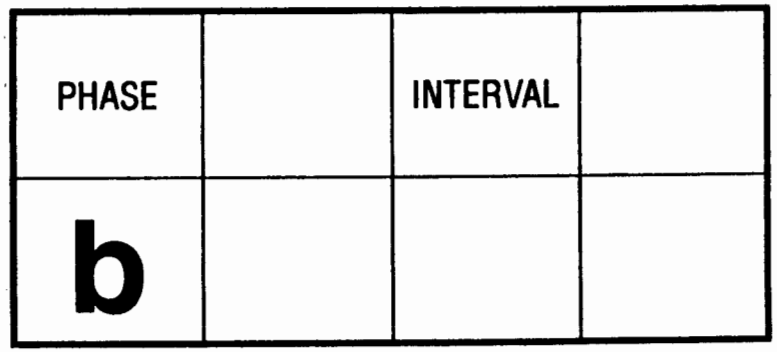


RING A DETAILED DISPLAY

FROM BASE DISPLAY PRESS:

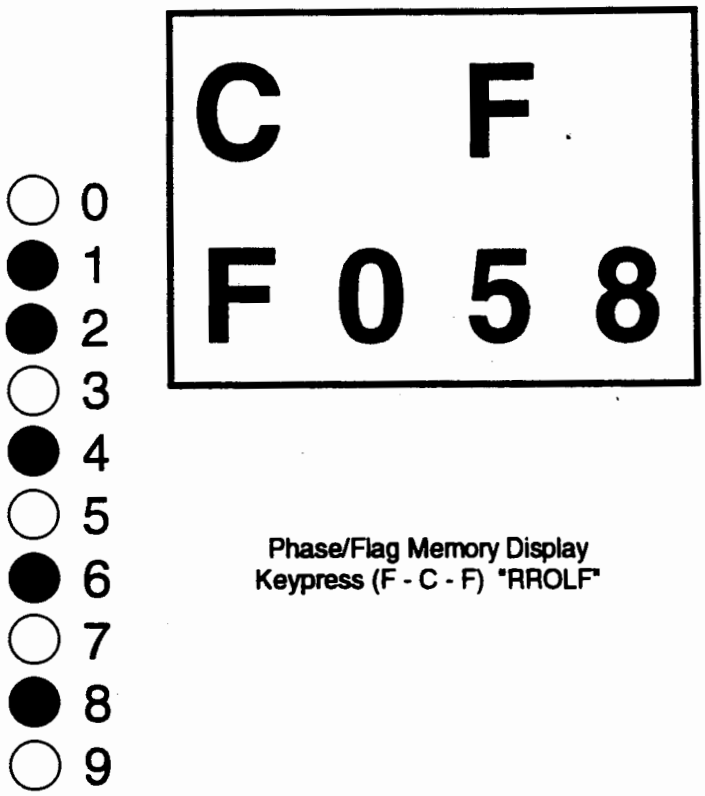
"A" FOR RING A DETAILED DISPLAY

"B" FOR RING B DETAILED DISPLAY



RING B DETAILED DISPLAY

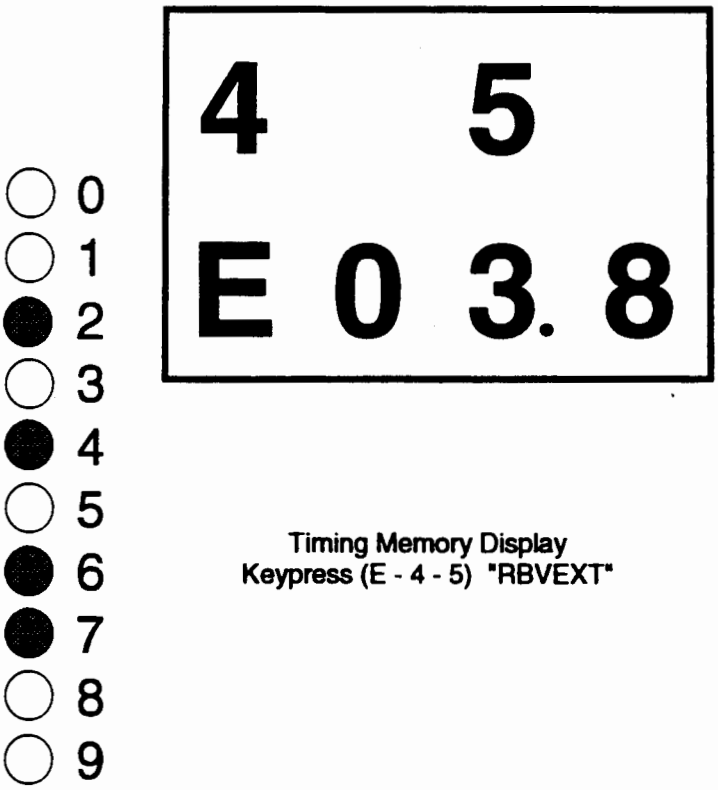
FIGURE 10 - Ring Display Mode



Phase/Flag Memory Display
Keypress (F - C - F) "RROLF"

This display shows the data in memory location F-C-F, "RROLF" (Railroad Overlap F Phases). This location holds Phase/Flag data which is displayed in Call lights "1" through "8". The data shown indicates that the Overlap Parent Phases for Railroad Overlap "F" are 1, 2, 4, 6 and 8. Tl Function display shows that the address of RROLF is "F-C-F" and that the Local Cycle Timer ha: counted 58 seconds into its cycle.

FIGURE 11 - Phase/Flag Memory Display



This display shows the data in memory location E-4-5, "RBVEXT" (Ring B Vehicle Extension). This location holds Timing data which is displayed in the Function display. The data shown indicates that the Ring B Vehicle Extension Time is set for 3.8 seconds. The Function display also shows that the address of RBVEXT is "E-4-5". The Call lights show demand for Phases 2, 4, 6 and 7.

FIGURE 12 - Timing Memory Display

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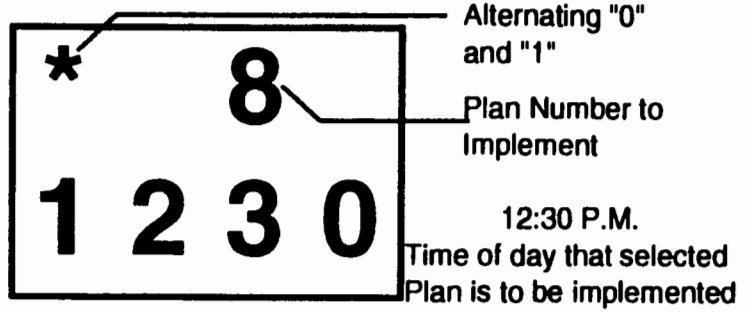


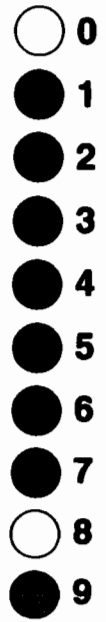
Alternating "0" and "1"

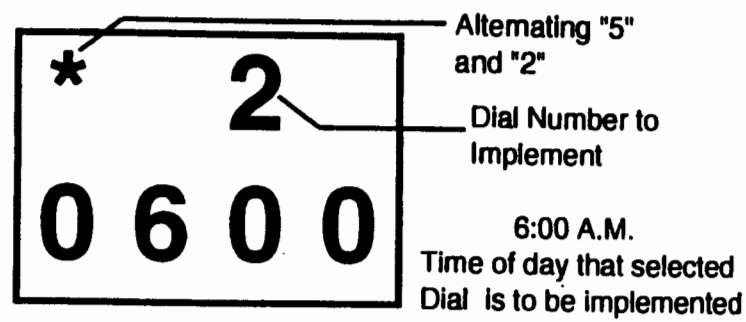
Plan Number to Implement

12:30 P.M.
Time of day that selected Plan is to be implemented

Call lights 2 through 6 (for Monday through Friday), the Days of Week that Plan is to be implemented. Flashing call light 9 indicates Table Mode display.

TABLES 0 THROUGH 4 - DAILY TABLES
Example shown: Table 0, Event 1





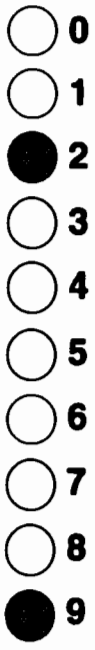
Alternating "5" and "2"

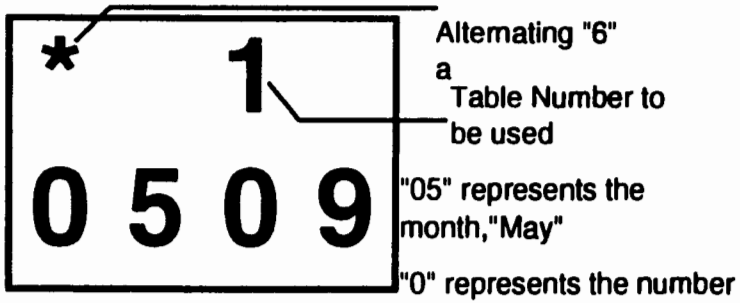
Dial Number to Implement

6:00 A.M.
Time of day that selected Dial is to be implemented

Call lights 1 through 7 (for Sunday through Saturday), the Days of Week that the indicated Dial is to be implemented. Flashing call light 9 indicates Table Mode display.

TABLE 5 - SLAVE MODE TABLE
Example shown: Table 5, Event 2





Alternating "6" a

Table Number to be used

"05" represents the month,"May"

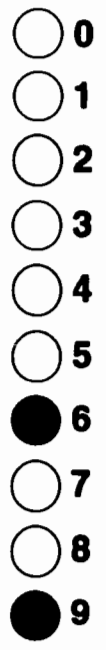
"0" represents the number of days to extend the use of the selected Table

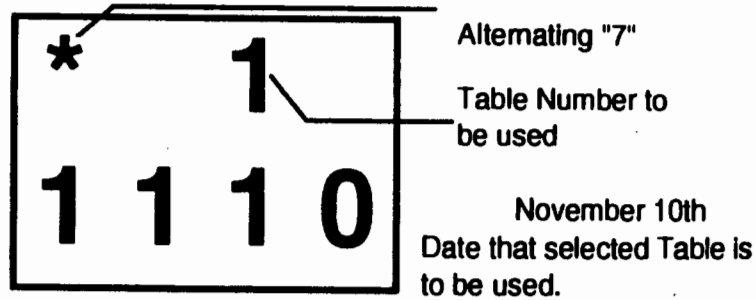
Call light "2" represents the Day of Week, "Monday"

Flashing call light 9 indicates Table Mode display

"9" represents the "last" occurrence in the month (of the Day of Week shown in Call lights 1 through 8)

TABLE 6 - FLOATING HOLIDAYS TABLE
Example shown: Table 6, Event 2





Alternating "7"

Table Number to be used

November 10th
Date that selected Table is to be used.

Call light 6 (for Friday), the Day of Week that November 10th must fall on for selected Table to be used. Flashing call light 9 indicates Table Mode display.

TABLES 7, 8 and 9 - ANNUAL TABLES
Example shown: Table 7, Event 4

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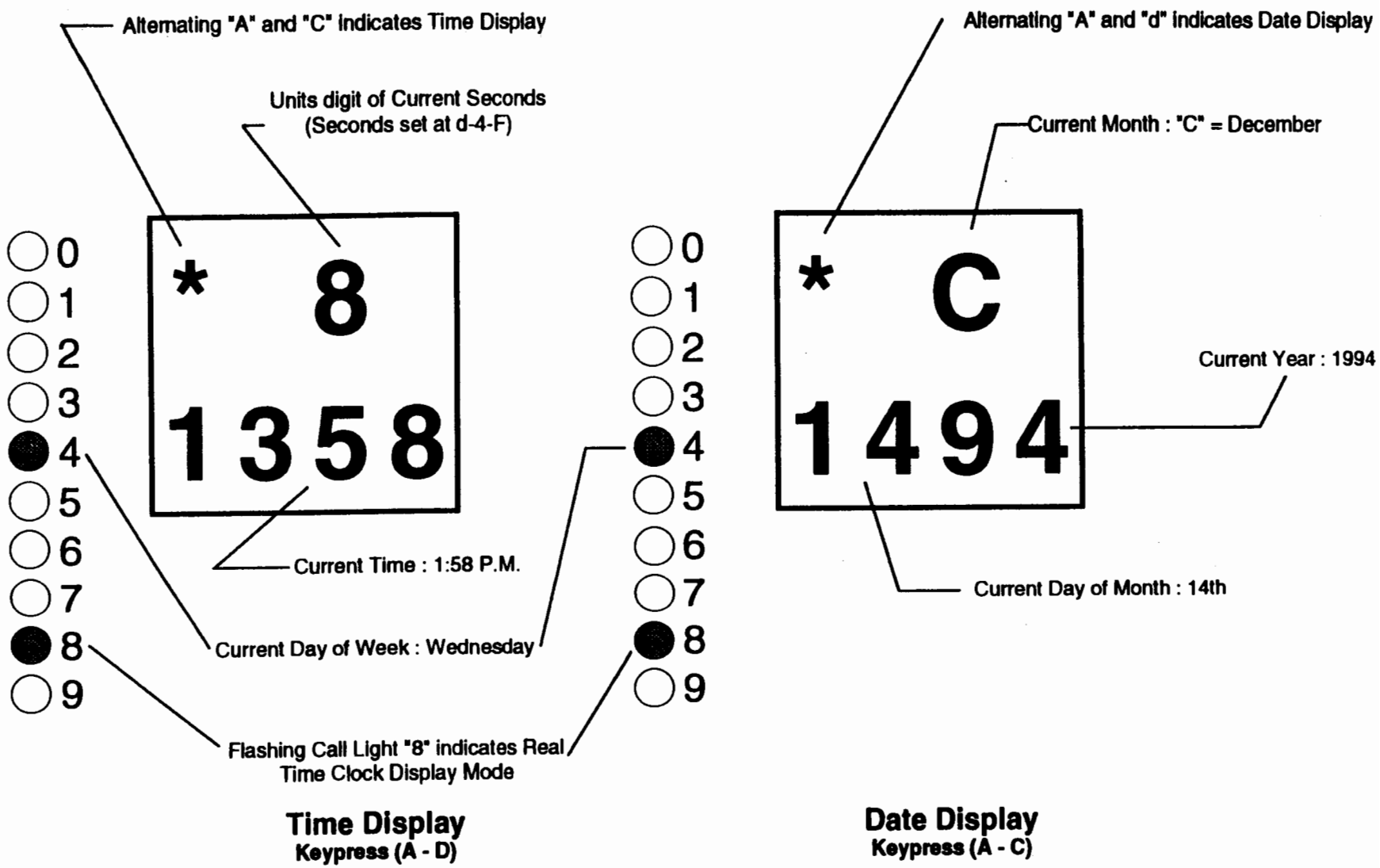


FIGURE 14 - Real Time Clock Displays

CALL LIGHT INTERPRETATION

The Call / Active lights (Call lights) on the 170 controller Front Panel provide a wide range of information about an intersection's timing and operation. There are 10 Call lights, numbered "0" through "9". Call lights "1" through "9" have different interpretations, depending on which display mode the Function display is in. Call light "0", on the other hand, **always** reflects Coordination status regardless of the display mode. See Page 2-35 for a detailed description of Call light "0" interpretation.

Call Lights "1" through "8"

In the Ring Display mode (Base and Detailed Ring displays) Call lights "1" through "8" represent the Call status of Phases 1 through 8. A steady "on" indication means there is a vehicle demand for the corresponding phase. Pedestrian demand is indicated when a Call light flashes at a 5 Hz rate. A Call light flashing at a 1 Hz rate means the corresponding Phase is flagged for Leading Left Turn operation (at F-F-b) and its demand will not be satisfied until a Barrier crossing occurs. If a Ped call is placed for a Leading Left Turn phase that must wait for a Barrier crossing, both flash rates are combined. That is, the Call light will be extinguished for .5 seconds and flash at a 5 Hz rate for the next .5 seconds.

The preceding also applies when the Function display is in Memory Display mode and accessing a Timing data location. When in Memory Display mode and accessing a Phase/Flag data location, Call lights "1" through "8" indicate the data at that location. If a Call light is "on" then the Phase or Flag at that location is enabled or set.

In either Table Display mode or Real Time Clock Display mode, call lights "1" through "7" represent the days of the week, "Sunday" through "Saturday" respectively. Also, Call light "8" will flash at a 2.5 Hz rate in Real Time Clock Display mode (key press A-C or A-d).

Call Light "9"

Call light "9" is a status indicator only. It is used to indicate Preempt status while in Ring Display mode, Real Time Clock Display mode or Memory Display mode. It will be "on" from the moment the Preempt input is recognized and stay "on" until the end of the Preempt sequence.

Call light "9" is also used to indicate that the Table Display mode is active when entering or observing Coordination Table data. In this case it will flash at a 2.5 Hz rate.

If the Table Display mode is accessed while a Preempt is active, Call light "9" will appear to flicker since it is only turned "off" for .1 second every .5 seconds.

KEYBOARD OPERATION

"A" KEY - This key is used to change from the Base Display to the Ring A Detailed Ring display. Any key pressed next, except for the "C" or "D" key, returns to the Base display. If the second key press is a "C", the Clock display appears. If the second key press is a "D", the Date display appears. In either of these displays, the "A", "C", "D" or "F" key toggles between the Clock display and the Date display. Any numerical key pressed in the Time or Date displays begins data entry. The "E" or "B" key returns to the Base display.

"B" KEY - This key is used to change from the Base Display to the Ring B Detailed Ring display. If the next key pressed is the "d" key, the Function display is blanked. Pressing any other key returns to the Base Display.

"C" KEY - This key is used to access the data on page C of RAM, the Coordination page. From the Base display the C key is pressed, followed by the keys defining the RAM page coordinates. The data in columns 0 through 3 is decimal and shown in the Timing/Data window. The data in columns 4 through F is Phase data as indicated by the call lights "1" through "8".

"D" KEY - This key is used to access the data on page D of RAM, the Detector page. From the Base display the D-key is pressed followed by the keys defining the RAM coordinates. The data in columns 1 through A is decimal while columns B through F contain Phase/flag data.

"E" KEY - This key is used to access the data on the E page of RAM. From the Base display the E-Key is pressed, followed by the keys defining the RAM coordinates. Columns 3, 4 and F are decimal data and all other columns are Phase/flag data.

"F" KEY - This key is used to access the data on page F of RAM, the Phase Timing page. From the Base display, the F key is pressed, followed by the keys defining the RAM coordinates. The columns A, B, C, D and F contain Phase/flag data and the rest are decimal data.

KEYS "0" through "9". These keys are used to access the Coordination tables. From the Base display press the key corresponding to the desired table. The next key press, "0" through "F", shows the selected Interval/Event in the Table display. These keys are also used to enter data in Memory, Table or Real Time Clock display modes.

DISPLAY MOVEMENT KEYS (see FIGURE 15)

There are four keys used to move around RAM when viewing or changing data. These keys are used after a memory location has been accessed and the Function display is in Memory Display mode.

"A" (ADVANCE) KEY will move down a RAM column. This key may also be used in the Table Display mode to scan down successive table entries.

"C" (COLUMN BACK) KEY will move left to the next RAM column.

"D" (DECREASE) KEY will move up a RAM column. This key may also be used in the Table Display mode to scan up and view previous table entries .

"F" (FORWARD) KEY will move right to the next RAM column.

ENTERING DATA

TIMING DATA (see FIGURE 16) is entered by first entering the address in RAM to be changed, then entering the decimal value required and pressing the "E" key to enter data in RAM. The Function display will blink briefly indicating the new data has been accepted. By using the display movement keys, other RAM locations may also be viewed and changed. Pressing either the "B" or "E" key at any time while in the Timing Display mode will return the 170 controller to the Base Display mode.

PHASE/FLAG DATA (see FIGURES 17 and 18) is entered by first accessing the desired memory location. Next press keys "1" through "8" to turn on the call light(s) that correspond(s) to the Phase(s) required. It is not necessary to press the "E" key to save Phase/flag values. If the "E" key is used, the Function display will return to the Base Display mode. The display movement keys may be used in a Phase related display to access other RAM locations. The "0" key may be used to cancel all of the Phase related display lights. The "9" key reverses the state of call lights 1 thru 8, that is, all illuminated lights are extinguished and all extinguished lights are illuminated.

COORDINATION TABLE DATA (see FIGURE 19) is entered by first pressing keys "0" through "9" to access the desired table and then keys "0" through "F" to access the desired event/interval within that table. Tables 0 through 5 contain Time-of-Day data and tables 6 through 9 contain Event data. Data entry is the same for both. When accessing the Coordination Tables, call light "9" will flash and the Phase digit of the Function display will alternately show the Table number and Interval/Event number. If they are the same, for instance Table 5, Interval 5, the Phase digit does not change. The following description is given for Time-of-Day tables with Event table fields in parentheses.

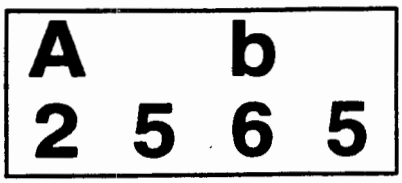
After accessing the desired table, the next four keystrokes provide the Hour:Min (Month/Day) data, The fifth keystroke is the Plan (Table) data, and the sixth keystroke is "E" to save the data. Next press the keys corresponding to the days of the week, where "1" through "7" represent "Sunday" through "Saturday", "8" sets all days, "9" sets week days and "0" clears all days. The days of the week data is saved immediately. The "E" or "B" key then returns to the base display, or press "A" or "F" for the *next* Interval/Event, or "C" or "D" for the *previous* Interval/Event. Table data must be entered in the order shown. If an item needs to be changed, for example days of the week, the process has to be started from the beginning, re-entering all data even if it is unchanged.

Table 6 data is slightly different than the other Event tables although the keystroke sequence is the same. See Timing Sheet page 5 for more information.

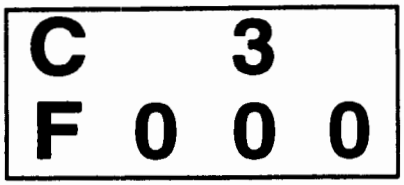
REAL TIME CLOCK DATA (see FIGURES 20 and 21) is entered in the same sequence as Table data. To access the Time display, press "A" followed by "C". Keys "0" through "9" are used to enter the Hour (in 24 hour format) followed by a "0" for seconds then "E" to save the time. Next press keys "1" through "7" to indicate day-of-week, "Sunday" through "Saturday". Pressing "E" or "B" will return to the Base display, or pressing "A", "C", "D" or "F" will advance to the Date display. In this display, enter "00" through "31" for day-in-month followed by the last two digits of the year, and then enter "1" through "C" for the months, "January" through "December". Press "E" to save the date. Setting the day-of-week in either the Time display or the Date display will automatically set day-of-week in both displays.

EXTENDED MEMORY locations, memory above the "C" page, can also be accessed from the keyboard. At location F-0-9 enter the decimal equivalent of the most significant byte of the RAM location you want to access. Return to the Base display and press "C" followed by the least significant byte of the RAM location. The entire Function display will flash continuously (indicating an Extended memory address is being displayed) to avoid confusion with data located on the "C" page. In this display mode, all data, whether Phase/Flag data or Timing data, is shown in the Timing/Data digits and is the actual hexadecimal data used by the program.

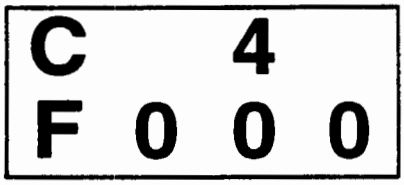
This feature in conjunction with the Hardware information provided previously can be very useful for trouble shooting problems with hardware such as WWV Clocks and Modems. Any memory location from 0000h to FFFFh can be examined using this feature. Note that the only memory that is write protected under LACO-3 is on the "E" Page (locations 000h through 0FFh). Therefore, care must be exercised when using this feature to ensure that critical data is not changed. When finished with the Extended Memory feature, set location F-0-9 back to "000".



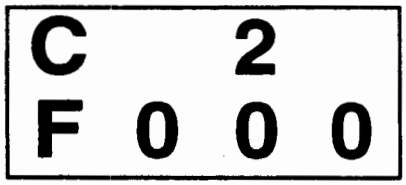
Base Display



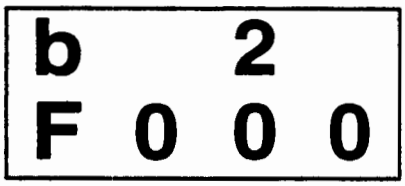
ASSOC3



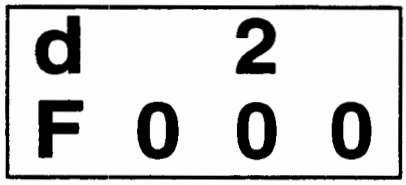
ASSOC4



ASSOC2



DYNOLC



EVDFZ

Portion of "F" Page RAM Map

F9	FA	FB	FC	FD	FE	FF
FLOATS	DRWYFZ	DYNOLA	UNUSED	EVAFZ	RRSEL	PERMIT
D1_O1	YRNGFZ	DYNOLB	ASSOC1	EVBFZ	RRCLTM	RLOCK
D2_O1	DRWYOL	***DYNOLC***	***ASSOC2***	***EVCFZ***	RR1RED	YLOCK
D3_O1	YRNGOL	DYNOLD	***ASSOC3***	EVDFZ	RRMXTP	VRCAL
D1_O2	PED2OL	DYNOLE	***ASSOC4***	RRCLFZ	MRKTIM	WREST
D2_O2	PED4OL	DYNOLF	ASSOC5	RRLMFZ	EVADLT	GREST
D3_O2	PED6OL	UNUSED	ASSOC6	RRXTFZ	EVACLT	STA

Starting from the Base display (upper left hand figure), keys "F", "C" and "3" are pressed to access location F-C-3 (ASSOC3). This results in the next figure down.

Pressing the "A" key moves the memory pointer from F-C-3 to F-C-4, resulting in the next figure down (ASSOC4).

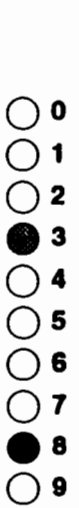
Pressing the "D" key twice moves the memory pointer from F-C-4 to F-C-2 resulting in the next figure down (ASSOC2).

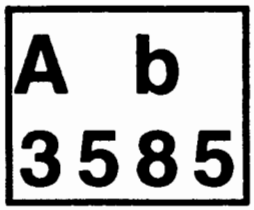
Pressing the "C" key moves the memory pointer from F-C-2 to F-b-2 resulting in the next figure down (DYNOLC).

Pressing the "F" key twice moves the memory pointer from F-b-2 to F-d-2 resulting in the bottom figure (EVDFZ).

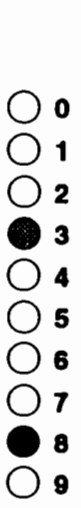
FIGURE 15- LACO-3 Display Movement Keys

Key press sequence to access Location C-0-9 (MAXCY) and enter 120 seconds

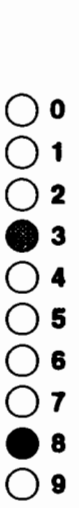




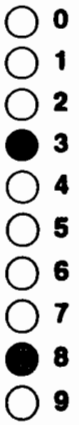
Starting from Base Display, this display would result assuming that Phases 3 and 8 are calling and timing Vehicle Extension.

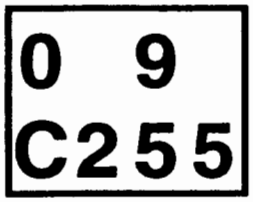


1st key press, "C", results in this display.

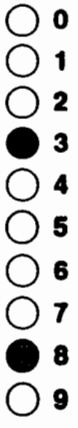


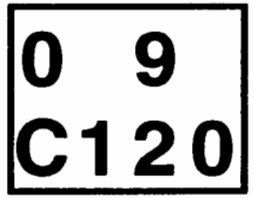
2nd key press, "0", results in this display.



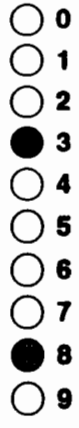


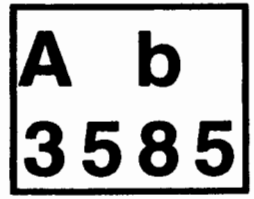
3rd key press, "9", results in this display assuming that the existing data at MAXCY was "255" seconds.





Next 3 keypresses, "1", "2" and "0", sets the desired time. Pressing "E" stores the data at location C-0-9. Notice that call lights "1" through "8" reflect Phase demand status throughout this sequence.





Pressing "B" or "E" returns to Base Display as shown. Pressing "A", "C", "D" or "F" moves the display to one of the 4 memory locations adjacent to C-0-9.

FIGURE 16 - Setting Timing Data

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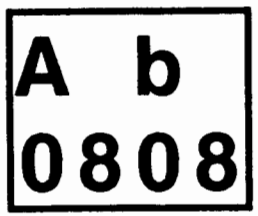
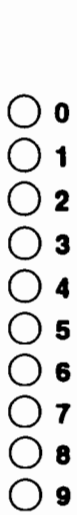
Key press sequence to access Location F-F-0 (Permitted Phases) and set Phases 1,2,3,4,5 & 6 as Permitted

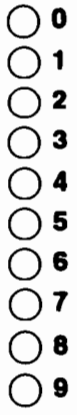


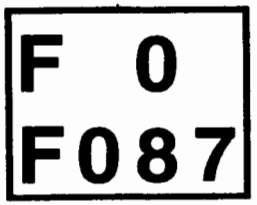
Starting from Base Display with no Phases permitted.



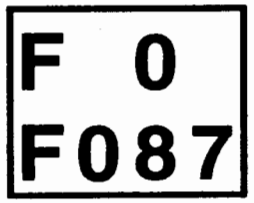
1st key press, "F", results in this display.

2nd key press, "F", results in this display.

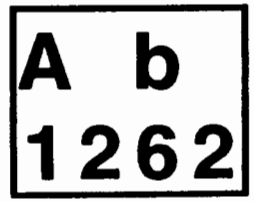




3rd key press, "0", results in this display. Permitted Phases may now be set by pressing the keys that correspond to the desired Phases. The "087" is an example of what the value of the Local Cycle Timer (C-0-b) might be.



As each Phase is selected, its corresponding call light illuminates.



Pressing "b" or "E" returns to Base Display. This display would result, assuming that there were calls on Phases 1, 2, 3 and 6.

FIGURE 17 - Setting Phase Data

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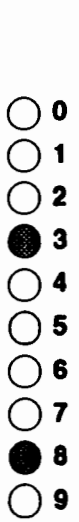
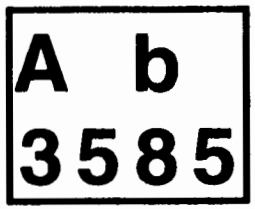
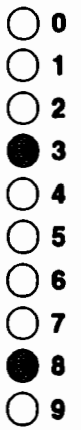
Key press sequence to access Location d-E-F (User Flag), set flag 7 and clear flag 1



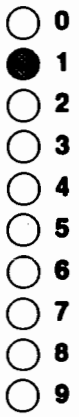


Starting from Base Display, this display would result assuming that Phases 3 and 8 are calling and timing Vehicle Extension.

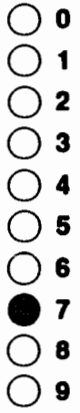
1st key press, "F", results in this display.



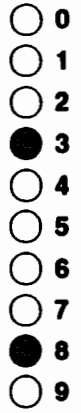
2nd key press, "E", results in this display.

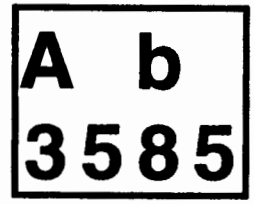


3rd key press, "F", results in this display. The call lights indicate that True Max Extension is already enabled (Call light "1" ON). The "087" is an example of what the value of the Local Cycle Timer (C-0-b) might be.



As each flag is selected, its corresponding call light illuminates. Pressing "7" enables Manual Mode and pressing "1" disables True Max Termination.





Pressing "B" or "E" returns to Base Display. This display would result, assuming that Phases 3 and 8 are still calling and timing Vehicle Extension.

FIGURE 18 - Setting Flag Data

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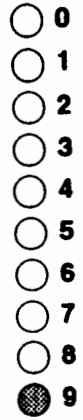
Key press sequence to access Table Display, and set Table 0, Event 2 to start Plan 4 every weekday at 5:30 A.M.


```
A  b
0808
```

Starting from Base Display.

1st keypress,"0", blanks the display.




```
*  C
0530
```

Next 2 keypresses, "3" and "0", for the minutes, results in this display which represents 5:30 A.M.


```
*  0
0000
```

2nd keypress, "2", results in this display (assuming no data was entered at this location previously). "*" indicates alternating "0" and "2".

Flashing Call light "9" indicates Table Display mode.


```
*  4
0530
```

Next keypress, "4" (for Plan 4), results in this display.

Press "E" to save this data.


```
*  C
05CC
```

Next 2 keypresses, "0" and "5", for the hour,results in this display.


```
*  4
0530
```

Last keypress, "9", turns on Call lights "1" through "5" representing "Monday" through " Friday". Pressing "B" or "E" returns to Base Display. Pressing "A" or "F" goes to next Event. Pressing "C" or "D" goes to previous Event.

FIGURE 19 - Setting Table Data

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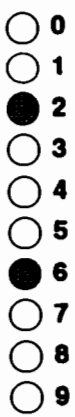
Key press sequence to access Real Time Clock, Time Display, and set current time to Friday, at 2:45 P.M.



2 5
A02.0

Pressing "A" in Base Display, brings up Detailed Ring Display as shown.

*** 0**
0000

Next key press, "C", brings up Time Display. * indicates alternating "A" and "C". In this display mode, call light "8" flashes continuously.

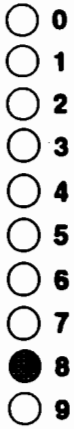
*** C**
1CCC

Next key press, "1" results in this display.

*** C**
14CC

Next key press, "4" results in this display.

"14" represents 2 P.M.



*** C**
144C

Next key press, "4" results in this display.

*** C**
1445

Next key press, "5" results in this display.

Display now shows 2:45 P.M.

*** 0**
1445

Next key press, "0" results in this display. Current seconds now equals 0. **Now press** "E" to save current time.

*** 0**
1445

Final key press selects the Day of Week. Press "6" for "Friday". Setting Day of Week in Time Display automatically sets Day of Week in Date Display. Press "B" or "E" for Base Display.

FIGURE 20 - Setting 170 Controller Time

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Key press sequence to access Real Time Clock, Date display, and set current date to Friday, November 25, 1994

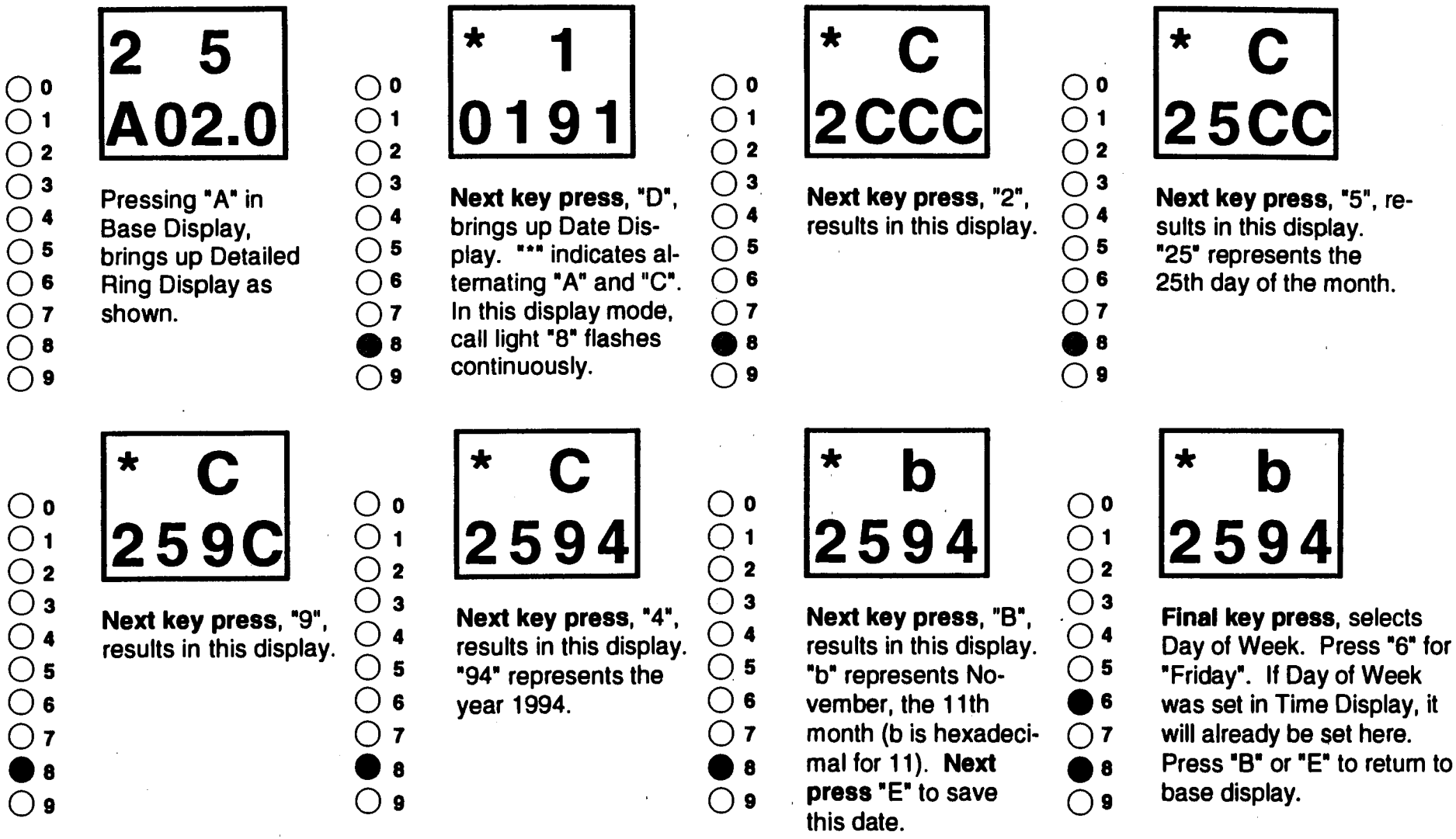

FIGURE 21 - Setting 170 Controller Date

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SECTION II
PROGRAM INFORMATION
Table of Contents

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PROGRAM INITIALIZATION

The first time that the 170 controller is powered up with a LACO-3 program installed, all data in the CPU base RAM is cleared and the 1000h NOVRAM data is initialized to L. A. County defaultIts. At this point the 170 will be in the following state:

No phases permitted

No Phase timing set except all yellows set to 5.0 seconds

No peds enabled

No preempts enabled

No overlaps selected

and the Function display shows

A		b	
0	8	0	8

The 170 is now ready to accept data entry.

NOTE

As each Phase is permitted, a default time of 10 Seconds will be set in its Minimum Green location and, if demand exists when a Phase is permitted, that Phase will immediately be served.

PROGRAM SELF TESTS

On power up, and every .1 second thereafter, the LACO-3 program continually checks the CPU Base RAM for data integrity. If corrupted data is detected, the Function display will immediately show "bAdA" as inicated below. Toggling the Front Panel Stop Timing switch will clear the bad data and restart the program.

A		b	
b	A	d	A

Every 2.5 seconds the program performs a calculates the checksum of the entire EPROM. If an invalid checksum results, the Function display will immediately show "bAdE" as indicated below. In this case the EPROM **must** be replaced, even if it appears to be operating normally.

A		b	
b	A	d	E

POWER UP SEQUENCES

The program has two power up sequences; one after a short power down (less than 2 seconds) and the other after a long power down. When power is restored after a short power down, the program continues on as if no interruption occurred *as long as the battery back-up is operational.* A long power down sets the program into a Start-up condition. This condition puts the controller through one of two structured start-up sequences as follows:

1. START UP ALL RED - Location F-F-E (Yellow Start Up) has no phases flagged. In this case the 170 outputs Red to all load switches and enabled Peds. Two-color overlaps and disabled Peds which are kept dark. The intersection stays all Red for 5.0 seconds (this time is fixed). At the end of this period, the program looks at location F-F-d (First Phases After Start Up). If any phases are set there, they are served before any other phases in demand, regardless of their position in the Ring. If no phases are set to serve first, then the program starts looking at Phase 1 for Ring A and Phase 5 for Ring B and stops at the first Permitted Phase that it finds in each Ring. These phases become the default First Phases After Start Up.

   Example:
   F-F-0 (Phases Permitted) = 1,2,3,4,6,7,8
   F-F-d (First Phases) = none flagged

   After the 5.0 seconds of all Red, Phase 1 and Phase 6 will go Green. If Phase 6 was not Permitted either, then Phase 1 would start alone.

2. START UP IN YELLOW - Location F-F-E (Yellow Start Up) has phases set. In this case the 170 outputs Yellow to the Yellow Start Up phases and Overlap Yellow Start Up overlaps (if selected at F-F-F) for a period of 5.0 seconds. Red Clearance (if any is set) is timed and then operation is the same as a START UP ALL RED. Note that the Yellow interval of 5.0 seconds at Start Up is not selectable and does not affect the Yellow Change times set for inividual Phases or Overlaps.

INPUTS

DETECTION

Vehicle: Twenty-eight inputs supported. All inputs can have any Phase or combination of phases assigned. Each input can also be programmed with a choice of nine attributes.

Pedestrian: Up to 6 fully actuated Ped inputs. Four of the inputs are dedicated and two inputs are shared with Manual Operation mode. Each Ped input can be programmed to time with any Vehicle Phase (including non-Permitted phases for use during RR Limited Service).

PREEMPTION

Four Emergency Vehicle inputs and one Railroad input

COORDINATION

Accepts 2 wire inputs via Modem for Dial/Offset information or Time/Date updates.

Also accepts one Offset input for Offset Timing mode.

MISCELLANEOUS

A Manual Enable input and a Manual Advance input for use when Manual Control Mode is selected (Location d-E-F bit 7 set).

A Stop Time input and a Flash Sense input from CMU and cabinet switches.

Two inputs for future System use.

DETECTION

VEHICLE DETECTION

LACO-3 supports twenty-eight Vehicle inputs. Each input can be programmed to call any Phase or combination of phases. Each input can also be programmed with a choice of nine attributes. On program initialization, all phases and all attributes are cleared for every detector input. Once a Phase is assigned to a detector input, it will respond to vehicle actuation. All discussion in this section refers to detectors operating in "presence" mode (as opposed to "pulse" mode) of operation. All vehicle detectors include delay timers (0 to 255 seconds) and extended call timers (0 to 25.5 seconds). Both functions can be set concurrently but delay times are effective only when the detector Phase is Red and extended call times are effective only when the detector Phase is Green. Each detector has three basic functions (assuming no attributes are set):

a. It places a call to its assigned Phase(s) for the duration of the actuation.
b. It causes Vehicle Extension to be timed if any Extension time is set in Phase Timing.
c. It counts vehicle actuations during Ø Red, incrementing the count once for each actuation. This last function is disabled if the detector has multiple phases assigned to it.

This basic mode of operation can be modified by selecting one or more of the detector attributes. This is accomplished by turning on the bit (as reflected in the call lights) corresponding to the desired attribute.These are

1. Red Lock
2. Red and Yellow Lock
3. Yellow Disconnect
4. Red Calling
5. Queue Clearing
6. Non-counting
7. Special Delay Option 1
8. Special Delay Option 2
9. Special Delay Option 3

The detector attribute is programmed by selecting the desired flag at locations D-D-0 through D-D-D (for I File detectors) and D-E-0 through D-E-D (for J File detectors). See Timing Sheets, Page 2. Each attribute is defined as follows:

1. **Red Lock** (Bit 1)- Causes operation identical to the Red Lock Phase attribute but only applies to individual detectors. When a Red Lock detector is actuated during its Phase Red interval, it places a Locked call to that Phase. This Locked call remains in effect until the Phase goes Green. The detector behaves as a basic detector during its Phase Green and Yellow intervals.
2. **Red and Yellow Lock** (Bit 2)- Causes operation identical to the Red and Yellow Lock Phase attribute but again, only applies to individual detectors. With this attribute, a Locked call is placed when actuation occurs during its Red **or** Yellow interval.

3. **Yellow Disconnect** (Bit 3)- Ignores detection calls during the Yellow interval. A typical application is for a Phase with a mix of advance and near (first vehicle) presence detectors. In this situation, the Phase should be on Red & Yellow Lock for the advance detectors and the near detectors should be disconnected during the Yellow interval to prevent unnecessary recalls from vehicles that enter the intersection on yellow.

NOTE

When both Yellow Disconnect and Red & Yellow Lock attributes are set, the resulting operation is identical to Red Lock only operation.

4. **Red Calling** (Bit 4) - Allows a call to be placed **only** when the Vehicle actuation occurs during its Red interval. Any other attribute may be set in conjunction with Red Calling, but the Queue Clearing attribute is meaningless since it requires Vehicle actuation only during the Green Interval.
5. **Queue Clearing** (Bit 5) - Implemented when a value other than zero is set for Queue Max. Queue Clearing operation is as follows:
   a. During the Red interval, a demand on a Queue Clearing detector will place a call to its Phase.
   b. During the Green interval, a "HOLD" is placed on that Phase in response to the continuous call (including extended call) of all Queue Clearing detectors on that Phase. Queue "HOLD" is indicated by a "3" displayed in Ring Display.
   c. The "HOLD" will continue to be placed until Vehicle actuation first ceases (gaps) on the flagged detector or until the Queue Maximum Limit is reached. Once "HOLD" has been released, this detector will not be reapplied until the start of the next Green.
   d. Vehicle actuation during the Yellow interval is ignored.
   e. The "counting" basic function is inhibited when a the Queue Clearing bit is set.

   Queue detectors are frequently used near stop bars where otherwise undetected vehicles could become trapped during a red indication. They also include provision to retain Green with presence or extended call detection. Vehicle extension does not time from a Queue detector. "Calling" detector operation is provided when the Queue Clearing detector maximum limit (Queue Max-0-255) is set to zero. Queue Clearing detectors do not place vehicle calls during their Green interval to activate the Phase vehicle extension timing. The equivalent extension interval may be generated either from a long loop configuration or from extended call timing. This permits uniform timing from these typically first vehicle detectors while extension timing from advance detectors may be in a gap reduction mode.

6. **Non-Counting** (Bit 6) - Inhibits the "counting" function. With this attribute set, the detector becomes an extension-only detector. Selecting multiple phases or the Queue Clearing attribute for a detector also disables counting. The extension only detector may be used where its counted actuations would affect added minimum Green calculations, usually for right turn Overlap movements.
7. **Special Delay Option 1** (Bit 7) - Bypasses the detector's delay when the selected Option Phase is Green. The Option Phase is selected at location D-D-E and multiple phases may be selected.
8. **Special Delay Option 2** (Bit 8) - Same as Special Delay Option 1 except Option phases are selected at D-D-F
9. **Special Delay Option 3** (Both bits 7 & 8) - Bypasses the detector's delay when the supplemental phase to the detector's phase is **NOT** Green. Option phases are not selectable. For example, if detector input I2U is flagged for Phase 2 and has attribute bits 7 and 8 set, then the detector's delay will be bypassed whenever Phase 1 is not Green.

PEDESTRIAN DETECTION

LACO-3 supports up to 6 Ped inputs, 4 of which are dedicated and 2 that are shared with the Manual Operation inputs. Each of the 6 Ped Phases may be programmed to time with any single Permitted Vehicle Phase. A Ped Phase may also time by itself, during Railroad 2 Limited Service, if its assigned Vehicle Phase is not flagged for Limited Service at F-d-5.

The Vehicle Phase that each Ped times with is set as follows:

PED 2- Location d-F-4
PED 4- Location d-F-5
PED 6- Location d-F-6
PED 8- Location d-F-7
PED A- Location F-9-A
PED B- Location F-9-b

Only one Vehicle phase may be entered at any one location although the same Vehicle phase may be entered for more than one Ped. The Ped timing is entered in the phase timing column corresponding to the selected Vehicle Phase. For example, if PED 6 is set to time with Vehicle Phase 5 (at d-F-6), then PED 6 Walk time must be entered at F-5-0 and PED 6 Don't Walk time entered at F-5-1.

The Ped inputs are located as follows:

PED 2- I12U
PED 4- I12L
PED 6- I13U
PED 8- I13L
* PED A- I11U
* PED B- I11L

* When Manual Control is enabled (d-E-F bit 7 set), these inputs are ignored as PED A/B actuations.

PED A and PED B are output to Overlap A and Overlap B load switches respectively by entering the Vehicle Phase they are to time with at F-9-A (PED A) or F-9-b (PED B).

If Overlap A (B) is assigned then PED A (B) will not be output, i, e. in the event of a conflict between Overlap A (B) and PED A (B), the Overlap assignment takes priority.

A Ped actuation places a locked call to the both the Ped and its associated Vehicle Phase.

Each Ped output is dedicated to a particular load switch. PED 2, PED 4, PED 6 and PED 8 are labels, referring to their load switch positions only. These labels should not be confused with the Vehicle phases that they time with. For example, the PED 2 load switch may be assigned to output with Vehicle Phase 5.

COORDINATION

LACO 3 will operate as a 3 dial 3 offset Master/Slave program. As a Master it will read its time of day tables to determine the plan to run. It will output this plan on the C5 connector to run a 7-wire direct interconnect system and can also output the data via modem on a selected serial port. As a Slave it will interface to the standard 2 wire modem interconnect called the "CALTRANS" Diamond Interchange program or ML2 Master. For Slave mode operation, the operator must enter an "11" at the Local Manual location (C-0-1). This program provides for the coordination of fully actuated signals within the constraints of a background cycle. The intersection is normally structured and timed the same as an isolated intersection. Coordination is achieved by implementing intervals of *Force Off*, *Hold*, *Pedestrian Restrict* and *Call*, set and timed by the Local Cycle Timer, while servicing phases on demand. The controller maintains two cycle timers, the Master Cycle Timer and the Local Cycle Timer. The Master Cycle Timer is kept in step by a "sync" pulse which is generated internally when in the Master mode or externally from the interconnect in the Slave mode. The Local Cycle Timer times the Coordination functions and always lags the Master Cycle Timer by the offset time corresponding to the offset number selected for that plan The Master Cycle Timer has limits which are user set to allow some control over the sync pulse reset. This allows for a minimum and a maximum cycle to be set. Two maximum extension intervals per Phase have been provided. MAX 1 operates under Free conditions and MAX 2 operates under coordination. Lag phases may be set independently for "Free", Dial 1, Dial 2, and Dial 3.

Set Minimum Cycle	C-0-8
Set Maximum Cycle	C-0-9
Observe Master Cycle Timer	C-0-A
Observe Local Cycle Timer	C-0-b

Dial: A dial is the timing cycle (0 to 255 seconds) which contains the intervals used for programming the Coordination functions. There can be up to 3 dials used per system.

Set Dial 1 cycle length	C-1-0
Set Dial 2 cycle length	C-2-0
Set Dial 3 cycle length	C-3-0

Interval: An interval is a selectable time during the dial when a Coordination function is turned on or off. There can be up to 15 intervals per dial.

Set Dial 1 intervals	C-1-1 thru C-1-F
Set Dial 2 intervals	C-2-1 thru C-2-F
Set Dial 3 intervals	C-3-1 thru C-3-F

Offset: An offset is the amount of time that the local controller lags behind the System Master. There are up to three offsets per dial. The offset is timed from the Master sync pulse and is selectable in seconds from 0 to 255.

Set Offset 1 for Dial 1	F-9-1
Set Offset 1 for Dial 2	F-9-2
Set Offset 1 for Dial 3	F-9-3
Set Offset 2 for Dial 1	F-9-4
Set Offset 2 for Dial 2	F-9-5
Set Offset 2 for Dial 3	F-9-6
Set Offset 3 for Dial 1	F-9-7
Set Offset 3 for Dial 2	F-9-8
Set Offset 3 for Dial 3	F-9-9

Observe the current offset number (1-3) at C-0-4

Observe the current offset time at C-0-C

COORDINATION FUNCTIONS

While in Coordination, functions are implemented during the intervals set on the dial. These are implemented with respect to the Local Cycle Timer. Each of these functions is selected by Phase per interval within a Dial. Coordination functions can be observed in the call lights along with the Local Cycle Timer in the timing/data display.

Force Off	D-F-F
Hold	D-F-D
Ped Restrict	D-F-E
Call	D-F-C

FORCE OFF: A *Force Off* will terminate a Phase if there is an opposing call and the minimum Green and/or pedestrian timing have expired. Pedestrian timing will not start during a *Force Off* interval for that Phase. If a call is not present for a conflicting Phase during the *Force Off* interval, the Phase operation will be unchanged, except; pedestrian timing will not start during a *Force Off* interval. *Force Off* will prevail over *Hold* set for the same Phase. If a Phase is Red when the *Force Off* interval is applied, it will not prevent the start of Green for that Phase.

HOLD: When *Hold* is applied to a Phase it will prevent the "gap out" or "max out" termination of that Phase Green. All other Phase timing is unchanged and, when *Hold* is released, continues from its present status.

PED RESTRICT: A *Ped Restrict* will prevent a pedestrian movement from starting but will not cut short any timing currently in progress. If pedestrian timing is in progress when the interval is applied, the timing will continue uninterrupted to completion. If a pedestrian call is placed during *Ped Restrict*, the call will not be registered (nor will it show in the Phase call light) until the restriction has ended. If the pedestrian call to the Phase is existing prior to the restriction, and timing has not started, both the Ped call and its associated Vehicle call are deleted for

the duration of the restriction. When the Ped Restrict is removed the Ped call is restored. A Ped Restrict does not prevent the Ped's associated Vehicle phase from responding to detector actuations.

In general, the *Ped Restrict* interval, in conjunction with normal controller sequencing and operation, is used to limit pedestrian signal timing to those portions of the cycle where this timing will not interfere with system coordination.

****** Caution ******

Care must be taken to assure a start of pedestrian timing (per pedestrian Phase) each cycle. If the *Ped Restrict* interval is set to begin at the start of Green, the Ped intervals for that phase will not time because the Ped must start timing with the start of its Vehicle Phase. If the Ped movement does not start at that time, it must wait until the next time that its Vehicle Phase is served. Provide at least 1 second time after the start of Green before the restriction is started.

CALL: The *Call* function is the same as placing a constant vehicle actuation to that Phase. All rules for gap out and max out still apply as in Free operation.

FUNCTION 6: When Function 6 is requested by the System, the local will select either a DIAL or FREE operation as set by the operator at C-0-6 (FUNC 6). The setting shall be 1, 2 or 3 for the dials or 14 for FREE operation. When a dial is set for Function 6 operation, the following operations occur:

a. If Function 6 is in response to an input from the System Master, the Dial set at C-0-6 will time in response to the Master.

b. If Function 6 is in response to loss of the Master sync input, the Function 6 dial will time in Offset 1 and the cycle length (viewed at the local Master Cycle Timer, C-0-A) will be the cycle time as set for the selected Dial 1,2,or 3.

c. Time of Day Dial (or Free) selection will override a System command for Function 6 (see "a." preceding). If the interconnect fails during Time of Day selection, Function 6 operation will prevail (see "b." preceding).

PHASE SEQUENCE

Each dial and Free operation has a Phase sequence selection available. This permits the operator to select the lead-lag sequence for each dial as desired. The operator must set the designated Phase which lags each Phase pair. The quad configuration contains 4 Phase pairs, phases 1 and 2, 3 and 4, 5 and 6 and 7 and 8. Typical operation has the even numbered Phase lagging the odd numbered Phase. Consequently, phases 2, 4, 6 and 8 would be designated as the lag phases. One and only one Phase of each Phase pair may be set as a lag Phase. The operator sets LAG 0 (D-F-0) through LAG 3 (D-F-3) using the CALL/ACTIVE lights as he would for setting recalls, etc. LAG 0 is used during Free operation, and LAG 1, LAG 2 and LAG 3 are utilized with Dial 1, Dial 2 and Dial 3 respectively, during coordinated operation.

MANUAL OPERATION

There are two manual entry locations. The first one, System Manual, is at C-0-0. It can be used to override the Time of Day tables to force the entire system to a selected plan. Second is the Local Manual located at C-0-1. As its name implies, it only affects

the local controller's operation. The operator can manually select a dial and offset, or Free operation independent of the System operation. To select a dial and offset, set the dial required into Local Manual (C-0-1) and the offset in (C-0-4). This dial and offset will be implemented immediately. The cycle length will be the time corresponding to the selected dial, and the offset time will be determined by the selected offset. Therefore, the operator may select a dial and offset to override the Master, and the Slave will "sync" with the Master.

To restore the 3 dial 3 offset system, Local Manual (C-0-1) should be set to "zero". To have the intersection operate Free set Local Manual (C-0-1) to 14.

Following is a list of functions that can be called from the manual locations:

SYSTEM MANUAL C-0-0

- 0 = Automatic time based mode
- 1-9 = Force to the selected manual plan
- 14 = Request the Function 6 output from Local controller

LOCAL MANUAL C-0-1

- 0 = Automatic time based mode
- 1-3 = Force local to Dials 1,2 or 3
- 10(A) = Disable the leading left turn arrow Phases
- 11(b) = Slave mode
- 12(C) = Offset timing mode
- 13(d) = Time of Day output (detector reset)
- 14(E) = Free
- 15(F) = Turn off both A and D

The letters "A" through "F" are the hexadecimal equivalents of the numbers "10" through "15" and are used when entering Plan/Funtions into coordination Tables.

IMPORTANT

If LLT phases are disabled either by Time of Day Table or manual operation, they will remain disabled even if the controller is set Free by entering a "14" at C-0-1. To restore LLT arrow Phases a "15" must be entered at C-0-1. The same is true for Time of Day output, "13".

SYNC PULSE

The controller will look for "sync" pulses within the limits set by the operator. These sync pulses are the result of pulling low (i.e A.C. voltage equals 0) the active offset line. The minimum amount of time the offset line must be off can be set at D-0-F (MINPUL) in tenths of a second. The maximum time is set at D-0-E (MAXPUL), also in tenths of a second. These values have been initially set at 1.0 and 4.0 seconds respectively. Therefore, the offset line has to be off for more than 1 second to be recognized as a "sync" pulse and cannot be off longer than 4 seconds. If the pulse is greater than 4 seconds, the controller will go to "FUNCTION 6" and generate a "sync" for the dial selected or go "Free". If the offset line is "off" less than 1 second, the pulse will be ignored. Multiple offset inputs will be interpreted as Offset 1 and multiple dial inputs will be interpreted as Free.

OFFSET TIMING

An optional offset timing coordination program has been provided for use where it is not desired to have a fixed background cycle. When in either the Master or Slave modes, Offset Timing can be implemented by Time of Day or by manually setting a 12 in the Local Manual location C-0-1. This will inhibit the Local's 3 dial 3 offset system. Dial 3 must be reserved to run the Offset Timing functions which are set up as in normal coordination. Receiving an input from the adjacent intersection (Pin 51-C1 connector, J14U), the 170 controller will time the Dial 3 cycle length once and then go Free. During the offset period, coordinated functions will be implemented as set. Once this process is initiated, it will continue through its full cycle before acting upon another input.

COORDINATION TIMING

This coordination program provides timing and functions to enable the user to modify the timing and operation of a fully traffic actuated controlled intersection to time in harmony with System control of a background cycle. Traffic moving through a system of signals will usually be more concentrated in the early portion of the through Green band while the flow during the later part of the band is usually relative to the demand on the system. For example, assume a system band of 36 seconds. In off peak periods perhaps only the first 8 to 10 seconds may have a flow of traffic that might be considered relevant to the system, but during peak periods the flow of traffic may frequently be heavy and continuous during the entire band time. The coordination program can "guide" the controller into a condition to provide a period of assured Green during the initial portion of the band, leaving the remainder of the band to be self generated by vehicle actuations. If, after the assured Green period, traffic flow is insufficient to continue the Green, the controller will "gap out" and transfer to a conflicting call. In the case of peak traffic demand, the Green will be held following the assured Green period by vehicle actuations until either a gap appears or the Phase *Force Off* is applied. The coordination functions can also be utilized to allow the controller to respond to conflicting Phases late in the cycle and still return in time for the assured Green.

Some other points to consider:

Walk and Don't Walk intervals will not be abbreviated by maximum extension or *Force Off*. Emergency Vehicle preemption will terminate the Walk interval immediately to Flashing Don't Walk. Railroad preemption has priority over pedestrian timing and will terminate either interval to a solid Don't Walk indication.

Either type of preemption will temporarily suspend Coordination control of the intersection, although it will continue to cycle in the background. This allows a seamless return to Coordination control after preemption.

Minimum Green or Added Minimum Green will not be terminated by *Force Off* or Emergency Vehicle preemption, but will terminate to Railroad preemption, as in non-coordinated operation.

Queue Clearing *Hold* will not terminate to maximum extension, but will end at *Force Off* or any preemption.

Yellow Change, Red Clearance and Red Revert intervals time as normal.

COORDINATION EXAMPLES

Two examples of intersection coordination timing are provided to illustrate a typical application. The example traffic conditions are as follows:

The arterial street, a primary route with a moderately high traffic volume, has a system of coordinated signals. The system is timed to an 80 second background cycle. For these examples, only one Dial and one Offset are needed. Example A is an intersection with a local residential street with light traffic and pedestrian volumes. Most cross street traffic at this location turns either left or right onto the arterial street. Example B is an intersection with a secondary route with a moderate traffic volume. The cross street traffic at this location is mostly through traffic.

COORDINATION EXAMPLE "A"

Example A operates with arterial phases on "vehicle recall " and the cross street phases on "non-lock" (see Example A Timing Sheets). The arterial advance detectors are about 4 seconds travel time from the intersection. First vehicle area detection is provided in the arterial left turn pockets and on the cross street.

Interval 0-1: *Force Off* 2, 6 ends arterial Green if a Phase 4 call exists.

Interval 1-2: *Hold* 2,6 in conjunction with the following *Pedestrian Restrict* and Phase 4 "non-lock" status will prevent a late transfer to Phase 4 in response to a pedestrian call only (Pedestrian timing would not be accommodated and the controller, after a " red revert " would return to the recalled Phases 2 and 6).

Interval 2-3-4: *Pedestrian Restrict* 4 prevents Phase 4 pedestrian timing from starting with insufficient time to end before the start of Phase 2 and 6 Green for the coordination band .

Interval 3-4-5-6: *Hold* 2, 6 prevents late transfer to Phase 4 with insufficient time to return to Phases 2 and 6 Green for the coordination band. The Hold maintains 2 and 6 Green until 10 seconds after the start of the band at the advance detectors, (detectors are 4 seconds from the intersection).

Interval 4-5: *Force Off* 4 limits Phase 4 timing to return Green to Phases 2 and 6 for coordination timing. Phase 4, by controller timing, is limited to a 25-second maximum Green. Transfer to Phase 4 may occur after Interval 6 until Interval 3 if Phases 2 and 6 are gapped and a guaranteed transfer will occur at 0 if a Phase 4 call exists while 2 and 6 are in extension.

Interval 7-0: *Pedestrian Restrict* 2, 6 prevents Phase 2 or 6 pedestrian timing overrunning the Phase 2 and 6 *Force Off* set at Interval 0-1.

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LOS ANGELES COUNTY
DEPARTMENT OF PUBLIC WORKS
TRAFFIC AND LIGHTING DIVISION
TRAFFIC SIGNAL TIMING

LACO - 3

TYPE 170 PROGRAM

Intersection: EXAMPLE "A"
T.S. No.:

Date Requested: By:
Date Completed: By:

PHASE TIMING		*Keystrokes:* F + Phase + Interval							
Phase #		1	2	3	4	5	6	7	8
Minimum Walk	0		7		7		7		
Flashing Don't Walk	1		5		15		5		
Minimum Green	2		10		5		10		
Queue Maximum	3		0		0		0		
Added Green/Actuation	4		2.2		0		2.2		
Vehicle Extension	5		4.0		3.0		4.0		
Maximum Gap	6		0.0		0.0		0.0		
Minimum Gap	7		0.0		0.0		0.0		
Max Extension 1 (Free)	8		40		20		40		
Max Extension 2 (Coord)	9		80		20		80		
		OVLP A	OVLP B	OVLP C	OVLP D	OVLP E	OVLP F		
Ovlp Green Extension	A								
Ovlp Yellow Clearance	b								
Ovlp Red Clearance	C								
Reduce 0.1 Sec. Every...	d		1.0		0.0		1.0		
Yellow Clearance	E		4.0		3.0		4.0		
Red Clearance	F		0.0		0.0		0.0		

Red Rest Delay	F-0-7	
Green Rest Delay	F-0-8	
Max Added Green	F-0-E	2.0
Red Revert	F-0-F	2.0

Remarks:

PREEMPTION		
Keystrokes: F + E + Function		
RR Select (0, 1, 2)		0
RR Track Clearance		1
RR1 All Red		2
RR2 Maximum (Minutes)		3
Free Time After Preempt		4
EV- A Delay		5
EV- A Clearance		6
EV- B Delay		7
EV- B Clearance		8
EV- C Delay		9
EV- C Clearance		A
EV- D Delay		b
EV- D Clearance		C
EV Maximum (Seconds)		d
EV Delay/Clearance Timer		E
RR Delay/Clear/Mark Timer		F

PREEMPTION PHASES									
Keystrokes: F + d + Function									
		1	2	3	4	5	6	7	8
EV - A	0								
EV - B	1								
EV - C	2								
EV - D	3								
RR Track Clear	4								

PHASE FUNCTION FLAGS									
Keystrokes: F + F + Function									
		1	2	3	4	5	6	7	8
Phases Permitted	0		X		X		X		
Red Lock	1								
Red & Yellow Lock	2		X				X		
Minimum Vehicle Recall	3		X				X		
Pedestrian Recall & Rest In Walk	4								
Green Rest → (Set Delay F- 0- 8)	5								
Red Rest → (Set Delay F- 0- 7)	6								
Semi Traffic Actuated Mode	7								
Double Entry	8								
Maximum Vehicle Recall	9								
Restricted Phases	A								
Protected / Permissive Left Turn	b								
Barrier Recall	C								
First Phases After Start Up	d								
Yellow Start Up	E		X				X		
Overlap Yellow Start Up:	→	A	b	C	d	E	F		
(Parents *must* be Yellow Start Up)	F								

LAG PHASE FLAGS		1	2	3	4	5	6	7	8
Lag Free	d-F-0		X		X		X		X
Lag Dial 1	d-F-1		X		X		X		X
Lag Dial 2	d-F-2								
Lag Dial 3	d-F-3								
PEDESTRIAN PHASES									
2 Ped Load Switch	d-F-4		X						
4 Ped Load Switch	d-F-5				X				
6 Ped Load Switch	d-F-6						X		
8 Ped Load Switch	d-F-7								

True North	Phase North	1	2	3	4
		5	6	7	8

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LOS ANGELES COUNTY
DEPARTMENT OF PUBLIC WORKS
TRAFFIC AND LIGHTING DIVISION
TRAFFIC SIGNAL TIMING

LACO-3 DETECTOR ASSIGNMENTS

Page

Intersection: EXAMPLE "A" *Date Requested:* _____ *By:* ____
T.S. No.: _____ *Date Completed:* _____ *By:* ____

NOTE: Ensure ALL Blank Data Fields are set to ZERO or CLEARED.			Detector Timing					Detector Assignments																	
			File-Slot-Channel	Delay		Extended Call		Phase Flags									Attribute Flags								
App	Lanes	Description		Code	Seconds	Code	Seconds	Code	1	2	3	4	5	6	7	8	Code	1	2	3	4	5	6	7	8
			I1U	d10		d30		db0									dd0								
			I1L																						
E	1	ADVANCE	I2U	d11		d31		db1									dd1								
E	2	ADVANCE	I2L	d12		d32		db2									dd2								
E	LT	1st VEHICLE	I3U	d13		d33		db3									dd3								
			I3L	d14		d34		db4									dd4								
			I4U	d15		d35		db5									dd5								
			I4L																						
			I5U	d16		d36		db6									dd6								
			I5L																						
N	ALL	1st VEHICLE	I6U	d17		d37		db7									dd7								
S	ALL	1st VEHICLE	I6L	d18		d38		db8									dd8								
			I7U	d19		d39		db9									dd9								
			I7L	d1A		d3A		dbA									ddA								
			I8U	d1b		d3b		dbb									ddb								
			I8L																						
			I9U	d1C		d3C		dbC									ddC								
			I9L	d1d		d3d		dbd									ddd								
			J1U	d20		d40		dC0									dE0								
			J1L																						
W	1	ADVANCE	J2U	d21		d41	2.0	dC1									dE1								
W	2	ADVANCE	J2L	d22		d42	2.0	dC2									dE2								
W	LT	1st VEHICLE	J3U	d23		d43		dC3									dE3								
			J3L	d24		d44		dC4									dE4								
			J4U	d25		d45		dC5									dE5								
			J4L																						
			J5U	d26		d46		dC6									dE6								
			J5L																						
			J6U	d27		d47		dC7									dE7								
			J6L	d28		d48		dC8									dE8								
			J7U	d29		d49		dC9									dE9								
			J7L	d2A		d4A		dCA									dEA								
			J8U	d2b		d4b		dCb									dEb								
			J8L																						
			J9U	d2C		d4C		dCC									dEC								
			J9L	d2d		d4d		dCd									dEd								

REMARKS:

DETECTOR ATTRIBUTES	
FLAG 1 - Red Lock	FLAG 5 - Queue Clearing
FLAG 2 - Red & Yellow Lock	FLAG 6 - Non-Counting
FLAG 3 - Yellow Disconnect	FLAG 7 - Special Delay Option
FLAG 4 - Red Calling	FLAG 8 - Special Delay Option

SPECIAL DETECTOR DELAY ASSIGNMENTS		Phase					
	Code	1	2	3	4	5	6
All options: Delay Timer resets during detector phase yellow.							
Special Delay Option 1 (Attribute Bit 7) - Bypasses delay while flagged phase(s) are timing.	d-d-E						
Special Delay Option 2 (Attribute Bit 8) - Bypasses delay while flagged phase(s) are timing.	d-d-F						

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LOS ANGELES COUNTY
DEPARTMENT OF PUBLIC WORKS
TRAFFIC AND LIGHTING DIVISION
TRAFFIC SIGNAL TIMING

LACO-3 COORDINATION

T.S. No.:_____ Intersection:_____EXAMPLE "A"_____

System Limits :_____

Remote Master:_____ Date Requested:_____ By:___

System No.:_____ Date Completed:_____ By:___

TIME OF DAY OPERATION SUMMARY			
	Dial 1	Dial 2	Dial 3 / Offset Timing
Offset 1	Continuous		
Offset 2			
Offset 3			
Free			
Special			

* Set Local Manual to 14 (free) before setting or changing dial intervals & functions. Setting either of the Manuals to 0 will release that Manual.

Local Manual C
11 = Slave Mode
12 = Offset Timing Mode
14 = Free Operation

Observe:
Calls d
Hold d
Ped Restrict d
Force Off d
Local Cycle Timer with Field Calls (

SYNC PARAMETERS
d-0-d System Sync Width 2.0 Seconds
d-0-E Set Maximum Width 4.0 Seconds
d-0-F Set Minimum Width 1.0 Seconds

Remarks:

Keystrokes:
C + Column + Row

		INTERVALS (in seconds)			FUNCTION FLAGS											
					DIAL 1				DIAL 2				DIAL 3 / OFFSET TIMING			
Coordination Parameters		Dial 1	Dial 2	Dial 3	Force Off	Hold	Ped Restrict	Call	Force Off	Hold	Ped Restrict	Call	Force Off	Hold	Ped Restrict	Call
0	Int	1	2	3	4	5	6	7	8	9	A	b	C	d	E	F
System Manual *	0	80			2,6		-'-									
Local Manual *	1	1			-'-	2,6										
Master Dial	2	5				-'-	4									
Local Dial	3	17				2,6	4									
Offset Number	4	27			4	2,6										
Time of Day Plan	5	28				2,6										
Function 6	6	50				-'-										
Current Table	7	68					2,6									
Minimum Cycle	8	80					-'-									
Maximum Cycle	9															
Master Timer	A															
Local Timer	b															
System Timer	C															
Current Offset	d															
Last Master Cycle	E															
Last Local Cycle	F															

This interval, set at 80 seconds, will time only when the dial is extended during resynchronization and will end Phase 2 and Phase 6 Ped Restrict

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COORDINATION EXAMPLE "B"

Example B operates with Phases 2, 4, 6 and 8 on red and yellow "lock", and Phases 1 and 5 on "non-lock" and "Rest in Red " (see Example B Timing Sheets). All approaches have advance detectors about 4 seconds travel time from the intersections and 40 feet queue clearing loops at the stop lines. Left turn Phases 1 and 5 are provided with 100-foot area loops. Phases 4 and 5 have 25-foot area loops in the left turn pockets to hold (extend) Green for left turning vehicles.

Interval 0-1: Force Off 2, 6 ends Phase 2 and/or 6 green extension if a call exists for a conflicting Phase.

Interval 2-3-4 : *Pedestrian Restrict* 4, 8 plus Interval 4-5 Force Off 4, 8 plus the sequencing call placed for 2 and 6 at interval 3-4 *Call* 2, 6 will prevent Phase 4 and 8 pedestrian timing from overrunning the start of arterial green band time.

Interval 3-4: *Call* 2,6 starts a period of *Hold*, plus a sequencing call for Phases 2 and 6. This *Hold* is continued in Intervals 4-5-6-7-8. *Hold* 2, 6 and is used to retain arterial green for the coordination bands.

Interval 4-5: *Force Off* 4, 8 limits Phase 4 and 8 timing to allow Phases 1 and 5 to time prior to return to arterial green.

Interval 6-7: Force off 1, 5 limits Phase 1 and 5 timing for return to arterial green.

Interval 9-0: *Pedestrian Restrict* 2,6 prevents Phases 2 and 6 pedestrian timing from overrunning the Phase 2 and 6 *Force Off* set at Interval 0-1.

The timing at this location could have been done in a variety of forms, suitable to various traffic conditions. For example: The arterial Phases 2 and 6 could have been on "recall" as at Intersection A, or the intersection could have been left entirely to actuation. This example timing uses an interval of "*Call*" to place a sequencing call. Had it been desired to place a sequencing call early, it could have been placed simultaneously with *Force Off* (*Force Off* prevails over *Hold*. the end result is a *Force Off* with a call placed). If a different plan had been desired for a period of the day, an alternate dial could have been provided by the Time of Day Event Table .

Prior to utilizing time of day operations the 170 Real Time Clock must be set. Once the clock is set it will remain accurate even through power outages of up to 4 hours and 15 minutes. During normal power conditions the clock is derived from the power line frequency. This provides a stable long term time clock. During power outages, the length of the outage is measured by a highly accurate quartz crystal and battery backup. Upon restoration of power, the length of the power outage is added to the time at which the power failure occurred to arrive at the current time of day. For power outages greater than 4 hours and 15 minutes, the additional time will be lost. For accurate time based operation a WWV clock can be used to update the 170 controller's time and date. As an alternative, a Slave 170 can have its internal clock updated every minute by a Master with a WWV clock via direct interconnect and modem.

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LOS ANGELES COUNTY
DEPARTMENT OF PUBLIC WORKS
TRAFFIC AND LIGHTING DIVISION
TRAFFIC SIGNAL TIMING

LACO - 3

TYPE 170 PROGRAM

Intersection: EXAMPLE "B" *Date Requested:* _____ By: _____

T.S. No.: _____ *Date Completed:* _____ By: _____

PHASE TIMING		Keystrokes: F + Phase + Interval							
Phase #		1	2	3	4	5	6	7	8
Minimum Walk	0	0	7		7	0	7		7
Flashing Don't Walk	1	0	9		14	0	9		14
Minimum Green	2	4	5		5	4	5		5
Queue Maximum	3	0	20		20	0	20		2.0
Added Green/Actuation	4	0.0	0.0		0.0	0.0	0.0		0.0
Vehicle Extension	5	0.2	4.0		3.0	0.2	4.0		3.0
Maximum Gap	6	0.0	0.0		0.0	0.0	0.0		0.0
Minimum Gap	7	0.0	0.0		0.0	0.0	0.0		0.0
Max Extension 1 (Free)	8	20	40		40	20	40		40
Max Extension 2 (Coord)	9	20	80		40	20	80		40
		OVLP A	OVLP B	OVLP C	OVLP D	OVLP E	OVLP F		
Ovlp Green Extension	A								
Ovlp Yellow Clearance	b								
Ovlp Red Clearance	C								
Reduce 0.1 Sec. Every...	d	0.0	1.0		1.0	0.0	1.0		1.0
Yellow Clearance	E	3.0	4.0		3.5	3.0	4.0		3.5
Red Clearance	F	0.0	0.0		0.0	0.0	0.0		0.0

Red Rest Delay	F-0-7	
Green Rest Delay	F-0-8	
Max Added Green	F-0-E	

Remarks:

PREEMPTION		
Keystrokes: F + E + Function		
RR Select (0, 1, 2)		0
RR Track Clearance		1
RR1 All Red		2
RR2 Maximum (Minutes)		3
Free Time After Preempt		4
EV- A Delay		5
EV- A Clearance		6
EV- B Delay		7
EV- B Clearance		8
EV- C Delay		9
EV- C Clearance		A
EV- D Delay		b
EV- D Clearance		C
EV Maximum (Seconds)		d
EV Delay/Clearance Timer		E
RR Delay/Clear/Mark Timer		F

PREEMPTION PHASES		Keystrokes: F + d + Function							
		1	2	3	4	5	6	7	8
EV - A	0								
EV - B	1								
EV - C	2								
EV - D	3								
RR Track Clear	4								

PHASE FUNCTION FLAGS		Keystrokes: F + F + Function							
		1	2	3	4	5	6	7	8
Phases Permitted	0	X	X		X	X	X		X
Red Lock	1								
Red & Yellow Lock	2		X		X		X		X
Minimum Vehicle Recall	3								
Pedestrian Recall & Rest in Walk	4								
Green Rest → (Set Delay F- 0- 8)	5								
Red Rest → (Set Delay F- 0- 7)	6								
Semi Traffic Actuated Mode	7								
Double Entry	8		X		X		X		X
Maximum Vehicle Recall	9								
Restricted Phases	A								
Protected / Permissive Left Turn	b								
Barrier Recall	C								
First Phases After Start Up	d								
Yellow Start Up	E		X				X		
Overlap Yellow Start Up:	→	A	b	C	d	E	F		
(Parents *must* be Yellow Start Up)	F								

LAG PHASE FLAGS		1	2	3	4	5	6	7	8
Lag Free	d-F-0		X		X		X		X
Lag Dial 1	d-F-1		X		X		X		X
Lag Dial 2	d-F-2								
Lag Dial 3	d-F-3								
PEDESTRIAN PHASES									
2 Ped Load Switch	d-F-4		X						
4 Ped Load Switch	d-F-5				X				
6 Ped Load Switch	d-F-6						X		
8 Ped Load Switch	d-F-7								X

True North	Phase North	1	2	3	4
			←		↑
		5	6	7	8

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LOS ANGELES COUNTY
DEPARTMENT OF PUBLIC WORKS
TRAFFIC AND LIGHTING DIVISION
TRAFFIC SIGNAL TIMING

LACO-3 DETECTOR ASSIGNMENTS

Intersection: EXAMPLE "B" *Date Requested:* _____ *By:* ____
T.S. No.: _____ *Date Completed:* _____ *By:* ____

NOTE: Ensure ALL Blank Data Fields are set to ZERO or CLEARED.			Detector Timing					Detector Assignments																	
			File-Slot-Channel	Delay		Extended Call		Phase Flags									Attribute Flags								
App	Lanes	Description		Code	Seconds	Code	Seconds	Code	1	2	3	4	5	6	7	8	Code	1	2	3	4	5	6
N	LT	100' LT LOOP	I1U	d10		d30		db0									dd0						
			I1L																				
E	1 & 2	ADVANCE	I2U	d11		d31		db1									dd1						
			I2L	d12		d32		db2									dd2						
			I3U	d13		d33		db3									dd3						
			I3L	d14		d34		db4									dd4						
E	1 & 2	QUEUE CLEARING	I4U	d15		d35		db5									dd5					X	
			I4L																				
			I5U	d16		d36		db6									dd6						
			I5L																				
N	1 & 2	ADVANCE	I6U	d17		d37		db7									dd7						
N	LT	25' 1st VEHICLE	I6L	d18		d38		db8									dd8			X			
			I7U	d19		d39		db9									dd9						
			I7L	d1A		d3A		dbA									ddA						
N	1 & 2	QUEUE CLEARING	I8U	d1b		d3b		dbb									ddb					X	
			I8L																				
			I9U	d1C		d3C		dbC									ddC						
			I9L	d1d		d3d		dbd									ddd						
E	LT	100' LT LOOP	J1U	d20		d40		dC0									dE0						
			J1L																				
W	1 & 2	ADVANCE	J2U	d21		d41		dC1									dE1						
			J2L	d22		d42		dC2									dE2						
			J3U	d23		d43		dC3									dE3						
			J3L	d24		d44		dC4									dE4						
W	1 & 2	QUEUE CLEARING	J4U	d25		d45		dC5									dE5					X	
			J4L																				
			J5U	d26		d46		dC6									dE6						
			J5L																				
S	1 & 2	ADVANCE	J6U	d27		d47		dC7									dE7						
S	LT	25' 1st VEHICLE	J6L	d28		d48		dC8									dE8			X			
			J7U	d29		d49		dC9									dE9						
			J7L	d2A		d4A		dCA									dEA						
S	1 & 2	QUEUE CLEARING	J8U	d2b		d4b		dCb									dEb					X	
			J8L																				
			J9U	d2C		d4C		dCC									dEC						
			J9L	d2d		d4d		dCd									dEd						

REMARKS:

DETECTOR ATTRIBUTES	
FLAG 1 - Red Lock	FLAG 5 - Queue Clearing
FLAG 2 - Red & Yellow Lock	FLAG 6 - Non-Counting
FLAG 3 - Yellow Disconnect	FLAG 7 - Special Delay Option
FLAG 4 - Red Calling	FLAG 8 - Special Delay Option

SPECIAL DETECTOR DELAY ASSIGNMENTS		Phase					
	Code	1	2	3	4	5	6
All options: Delay Timer resets during detector phase yellow.							
Special Delay Option 1 (Attribute Bit 7) - Bypasses delay while flagged phase(s) are timing.	d-d-E						
Special Delay Option 2 (Attribute Bit 8) - Bypasses delay while flagged phase(s) are timing.	d-d-F						
Special Delay Option 3 (Attribute Bits 7 & 8) - Bypasses delay when <u>other</u> phase in same quadrant IS NOT Green (1:2) (3:4) (5:6) (7:8).							
Example: Ø1 Detector delay will be overridden while Ø2 is Yellow or Red.							

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LOS ANGELES COUNTY
DEPARTMENT OF PUBLIC WORKS
TRAFFIC AND LIGHTING DIVISION
TRAFFIC SIGNAL TIMING

LACO-3 COORDINATION

T.S. No.:_____ Intersection:_____"EXAMPLE B"_____

System Limits :_____

Remote Master:_____ Date Requested:_____ By:__

System No.:_____ Date Completed:_____ By:__

TIME OF DAY OPERATION SUMMARY			
	Dial 1	Dial 2	Dial 3 / Offset Timing
Offset 1			
Offset 2			
Offset 3			
Free			
Special			

* Set Local Manual to 14 (free before setting or changing di intervals & functions. Setting either of the Manuals to 0 wil release that Manual.

Local Manual
11 = Slave Mode
12 = Offset Timing Mode
14 = Free Operation

Observe:
Calls
Hold
Ped Restrict
Force Off
Local Cycle Timer with Field Calls

SYNC PARAMETERS
d-0-d System Sync Width 2.0 Seconds
d-0-E Set Maximum Width 4.0 Seconds
d-0-F Set Minimum Width 1.0 Seconds

Remarks:

Keystrokes: C + Column + Row

Coordination Parameters		INTERVALS (in seconds)			FUNCTION FLAGS: DIAL 1				DIAL 2				DIAL 3 / OFFSET TIMING			
		Dial 1	Dial 2	Dial 3	Force Off	Hold	Ped Restrict	Call	Force Off	Hold	Ped Restrict	Call	Force Off	Hold	Ped Restrict	Call
0	Int	1	2	3	4	5	6	7	8	9	A	b	C	d	E	F
System Manual *	0	80			2,6		-,-									
Local Manual *	1	1			-,-											
Master Dial	2	7					4,8									
Local Dial	3	23				2,6	4,8	2,6								
Offset Number	4	28			4,8	2,6	-,-	-,-								
Time of Day Plan	5	33			-,-	2,6										
Function 6	6	41			1,5	2,6										
Current Table	7	42			-,-	2,6										
Minimum Cycle	8	50				-,-										
Maximum Cycle	9	64					2,6									
Master Timer	A	80					-,-									
Local Timer	b															
System Timer	C															
Current Offset	d															
Last Master Cycle	E															
Last Local Cycle	F															

This interval, set at 80 seconds, will time only when the dial is extended during resynchronization and will end Phase 2 and Phase 6 Ped Restrict

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COORDINATION TABLES

Coordination tables come in different varieties depending on what they specify and how they do it. Tables 0 through 4 are the Daily Tables and specify as their output a particular Plan (1 - 9) or Function (A - F) which is used by the System to decide what combination of Dials and Offsets (including Function 6), or Functions to output. Table 5 is the Slave Mode Table and only outputs a specific Dial. Tables (6 through 9) specify which of the Daily Tables will be in effect.

DAILY TABLES (TABLES 0-4)

Daily Table "inputs" consist of a list of times of day and a chart of days of the week. Its "outputs" consist of Plans and Functions. The LACO-3 program continuously compares its Internal clock to the times entered in the Hour:Min column of the Table (Tables 0-4). If a coincidence is found, and the present day of the week has been flagged for that time in the Sunday through Saturday columns to the right, then the action called for under the Plan column is taken. For example, it can command the local intersection into Slave Mode which will direct the local controller to take its System commands (Dials, Offsets, etc.) from an external input (i.e., over wires from a remote Master Controller).

Entries in the Hour:Min column of Tables 0-4 may appear redundant at times when actually they are not. For example, it may be desirable to go to Plan 2 (Dial 2, Offset 1) at 05:30 if it is a Sunday but to Plan 6 (Dial 3, Offset 2) at 05:30 if it is a Monday. Therefore, two lines will list 05:30. One will have an "X" in the Sunday column and will specify a "2" in the Plan column. The other will have an "X" in the Monday column and will list a "6" in the Plan column.

Another point worth noting is that the times listed in Tables 0-4 need not be in chronological order (even though that is the way they will usually be listed). The program merely scans the whole list for matches and will act on them without reference to where in the list they occurred.

SLAVE MODE TABLE (TABLE 5)

This table is in a category by itself and is not used or referred to by any of the other tables. It comes into play only when the Local controller is in the Slave Mode. This can happen by entering an "11" at the Local Manual location (C-0-1) or by entering a "b" in the Plan column of Tables 0-4. No matter how Slave Mode is established, the Local controller involved will be directed to take its Dial and Offset Commands (including impressed Sync pulse) from an external source via communications port. However, first the Slave Mode Table 5 will be searched for valid entries. If a number from 1-3 is found in the Dial column, that dial will be implemented in preference to any Dial command being received externally. Note that in either case, the externally commanded Offset and the Sync pulse riding on it will be used.

FLOATING HOLIDAY TABLE (TABLE 6) see FIGURE 28

Table 6 is used for those holidays that don't fall on a fixed **date** every year or that cause a change in traffic patterns for a time period of more than one day. For example, Thanksgiving is defined as the fourth Thursday in November, but the Friday after Thanksgiving is generally treated as a holiday also (in terms of traffic patterns). To implement Table 2 on this holiday we would list under the Month/C/Nth column, "11/1/4." We would next put a "2" in the Table column and flag Thursday on that line. The "C" in the Month/C/Nth column allows us to extend the action taken on the holiday by the number of days we list in that sub-column. That is, the "1" we put there for Thanksgiving extends Table 2 operation through Friday as well.

Control defaults to Table 0 unless otherwise directed by another event in Tables 6 through 9. Events 6-0 through 6-4, listed on Page 5 of the LACO-3 Timing Sheets, are those used by Los Angeles County. They may be changed to suit the individual agency's needs.

EXCEPTION DAY TABLE (TABLE 7) see FIGURE 28

Table 7 works in a similar manner to Table 6, but it allows other choices on specific days of specific months. If the date entered in the Month/Day column matches a flagged day of the week, control will be forced to the Daily Table number listed in the Table column. At the end of that day control defaults to Table 0, unless otherwise directed by another event in Tables 6 through 9. Events 7-0 through 7-9, listed on Page 5 of the LACO-3 Timing Sheets, are those used by Los Angeles County. They may be changed to suit the individual agency's needs.

ANNUAL EVENT TABLES (TABLES 8 AND 9)

These tables have the same format as Table 7 but the operation is different. The dates listed in the Month/Day column are STARTING dates. Beginning on the date entered, the designated Daily Table number will be put into effect each time a day of the week flagged on that line occurs. That Table will continue to be implemented for each occurrence of the flagged days until changed by another later date with the same day(s) flagged, or until the end of that calendar year. Entries in Tables 8 and 9 change the "default" table for the flagged days of the week from Table 0 to some other Daily Table.

As an example, let's suppose that every Thursday and Friday, during June, July and August, a city sponsors a Farmers' Market that requires a modified traffic coordination, the specifics of which will be entered in Table 3. That is, every Thursday and Friday during June, July and August, we want Table 3 to be in effect. On a line in Table 8 or 9 enter 06/01 in the Month/Day column; enter a "3" in the Table column; and flag columns 5 and 6 (Thursday and Friday) in the day-of-the-week columns. On each Thursday and Friday (until changed by another line), Plan 3 will be in effect as the "default" Plan unless overridden on specific days by Tables 6 and 7.

On September 1, the city wishes to resume normal patterns of coordination for Thursdays and Fridays so another line is inserted in Tables 8 or 9 with 09/01 in the Month/Day column, with a "0" in the Plan column, and with Thursday and Friday flagged in the day-of-week columns.

CONFLICTS BETWEEN / WITHIN TABLES

In the case when different tables command conflicting actions, the EXCEPTION DAY TABLE (Table 7) has priority over the FLOATING HOLIDAY TABLE (Table 6) which has priority over the ANNUAL EVENT TABLES (Tables 8 and 9). Within a given table, if two events direct different actions at the same time, the event closest to the bottom of the table will be implemented.

ENTRY NUMBER	ENTRY TRANSLATION	ACTUAL HOLIDAY	DAYS TO CONTINUE / TABLE
0	3rd Monday in January	Martin Luther King's Birthday	None / 1
1	3rd Monday in February	President's Day	None / 1
2	Last Monday in May	Memorial Day	None / 1
3	1st Monday in September	Labor Day	None / 1
4	4th Thursday in November	Thanksgiving	1 / 1

TABLE 6- FLOATING HOLIDAYS

ENTRY NUMBER	EXCEPTION DATE / TABLE	ACTUAL EXCEPTION DAY
0	January 1 / 1	New Year's Day if on a Weekday
1	January 2 / 1	Day after New Year's Day if on a Monday
2	July 4 / 1	Independence Day if on a Weekday
3	July 5 / 1	Day after Independence Day if on a Monday
4	November 10 / 1	Veteran's Day if on a Friday
5	November 11 / 1	Day after Veteran's Day if on a Weekday
6	November 12 / 1	2nd day after Veteran's Day if on a Monday

TABLE 7 - EXCEPTION DAYS

These are the default Floating Holidays and Exception Days use by Los Angeles County. They are permanently programmed in the LACO-3 Program chip but may be modified to si individual agency needs. After modifying these Tables, save the new data to tne 7000h NOVRAM by entering "071" at location F-0-A. Entering "999" at F-0-A will restore the L.A County defaults.

FIGURE 28 - Tables 6 and 7 Translations

LOCATIONS TO OBSERVE WHEN IN COORDINATION

C-0-0: System Manual (usually set to 0)

0 = Automatic Mode

1-9 = Plan 1, 2, 3, 4, 5, 6, 7, 8 or 9

14 = System requesting Function 6

C-0-1: Local Manual (usually set to 0)

0 = Master Mode (Automatic)

1-3 = Dial 1, 2 or 3

11 = for Slave Mode

12 = for Offset Timing Mode

14 = Free

C-0-2: the Dial that the System Master is calling for

C-0-3: the Dial that the Local controller is using

C-0-4: the Offset number that the Local controller is using

C-0-5: the plan selected by the Time Of Day tables (Tables 0 - 4)

C-0-6: the user set default dial for Free operation (Function 6)

C-0-7: the Table Number from which the plan (shown at C-0-5) was selected

C-0-8: the minimum cycle length allowable

C-0-9: the maximum cycle length allowable

C-0-A: the Master Cycle Timer

C-0-B: the Local Cycle Timer

C-0-C: the System Cycle Timer

C-0-D: the current Offset time

C-0-E: the last Master cycle length

C-0-F: the last Local cycle length

CALL LIGHT "0"

Call light "0" reflects Coordination status, regardless of the 170 Display mode. Interpretation of Call light "0" is as follows:

Constant Off indicates that a "14" is entered at C-0-1 (Local Manual) and that the Local controller will not respond to System commands. C-0-3 will also show a "14".

Constant On indicates that the Local controller is in Coordination and operating normally. C-0-3 will show the current Dial (or C-0-6 entry if in Function 6). In this mode Call Light "0" will extinguish only for the duration of the Master Sync Pulse.

On .5 Seconds and Off .5 Seconds indicates a Coordination error condition, specifically loss of sync. If sync is restored, Call light "0" returns to a constant on condition. If "14" is entered at C-0-1, Call light "0" returns to a constant off condition.

On 1 second, Off 1 second indicates that the Local controller is in Offset Timing Mode and is Free waiting for an input from an adjacent intersection. When this input is sensed, Call light "0" returns to a constant on condition for the duration of the Dial 3 cycle length.

COMMUNICATIONS PORTS

LACO-3 supports up to 4 Communications Ports (Ports) which may be configured in a variety of ways. Port assignment locations are:

COMM PORT 1 - d-0-7

COMM PORT 2 - d-0-8

COMM PORT 3 - d-0-9

COMM PORT 4 - d-0-A

Each Comm Port can be assigned any one of 8 functions as follows:

0 = Disables the Comm Port

1 = WWV Radio Receiver

2 = Send Coordination Dial/Offset (in ML2 Protocol) to Slave

4 = Send or Receive Coordination Dial/Offset (in ML2 Protocol)

7 = Receive Coordination Dial/Offset (in ML2 Protocol) from Master

8 = Remote Monitoring (For future use)

12 = Send Time/Date string

17 = Receive Time/Date string

Functions "12" and "17" can only be assigned to Comm Port 1. The remaining functions may be assigned to any Comm Port. However, no function should be assigned to more than one Comm Port. In the case of duplicate function assignments, the program will only recognize the lowest numbered Comm Port. Functions assigned to Comm Ports that are not installed are ignored. Observe which Comm Ports are installed in the 170 at location E-5-F. If a Comm Port is installed and functional, the Call light corresponding to its port location will be "ON". Call lights "1" through "4" indicate the existence of Comm Ports 1 through 4 respectively. Additionally, Call lights "5" through "8" indicate which (if any) Comm Port is assigned the WWV Radio Receiver function. For example, if Call lights 1,2,3,4 and 7 are "ON" then the 170 controller has 4 Comm Ports installed and Comm Port 3 is configured for WWV Radio Receiver.

OVERLAPS

Overlaps are used when a particular Vehicle movement (as opposed to Vehicle Phase) can time safely with a normally incompatible movement. For example, the right turn movements of North/South traffic can usually proceed safely while the left turn movements of the East/West traffic are Green. These situations are usually implemented using two-color Overlaps. Another example might be where a road crosses an unusually wide artery with islands separating opposing traffic. In this case, three-color Overlaps would be used for "inside" and "outside" clearance. Used in conjunction with detector delays and other parameters, Overlaps can help an intersection run more efficiently by eliminating unnecessary calls to cross street traffic.

LACO-3 supports six Overlaps (A through F) in three different modes of operation (Normal, Railroad and EV). An Overlap may have a different set of parents phases in Normal than it does in Railroad. However, since Emergency Vehicle is a sub-operation of either Normal or Railroad operation, EV parent phases must be a subset of Normal and/or Railroad parent phases. Overlap parent phases are set as follows:

OVERLAP	NORMAL *	RAILROAD **	EV
A	F-A-A	F-C-A	F-d-A
B	F-A-b	F-C-b	F-d-b
C	F-A-C	F-C-C	F-d-C
D	F-A-d	F-C-d	F-d-d
E	F-A-E	F-C-E	F-d-E
F	F-A-F	F-C-F	F-d-F

* Must be part of Permitted Phases (F-F-0)

** Must be part of Railroad Track Clearance Phases (F-d-4) or Railroad Limited Service Phases (F-d-5)

Since Overlap parent phases can change when entering or leaving a Preempt, the program uses separate memory to keep track of the *current* parent phases. These locations are referred to as Dynamic Overlap parent phases and can be observed on the Call lights at the following locations:

Dynamic Overlap A	d-F-0
Dynamic Overlap b	d-F-1
Dynamic Overlap C	d-F-2
Dynamic Overlap d	d-F-3
Dynamic Overlap E	d-F-4
Dynamic Overlap F	d-F-5

Monitoring these locations when transitioning into and out of Preempt will help familiarize the user with the Overlap control structure.

Overlaps flagged with Green Omit parents will show no color when that parent is Green. Green Omit parents for each Overlap remain the same regardless of Preempt status. Green Omit parent phases are set as follows:

OVERLAP	GREEN OMIT
A	F-b-A
b	F-b-b
C	F-b-C
d	F-b-d
E	F-b-E
F	F-b-F

Each Overlap has its own set of termination times (Green Extension, Yellow Change and Red Clearance) that are set as follows:

OVERLAP	GREEN EXTENSION	YELLOW CHANGE	RED CLEARANCE
A	F-1-A	F-1-b	F-1-C
b	F-2-A	F-2-b	F-2-C
C	F-3-A	F-3-b	F-3-C
d	F-4-A	F-4-b	F-4-C
E	F-5-A	F-5-b	F-5-C
F	F-6-A	F-6-b	F-6-C

When an Overlap parent phase is terminated, a Locked call is placed on the Phase that caused the termination, so that it is serviced next even if the Vehicle actuation drops. If an Overlap terminates and then restarts immediately, it must time Red Revert (set at F-0-F) just as a Vehicle Phase must do. Each Overlap has its own termination and Red Revert timers which can be observed as follows:

OVERLAP	TERMINATION TIMER	RED REVERT TIMER
A	E-F-0	E-F-6
b	E-F-1	E-F-7
C	E-F-2	E-F-8
d	E-F-3	E-F-9
E	E-F-4	E-F-A
F	E-F-5	E-F-b

PREEMPTS

RAILROAD PREEMPTION

The LACO-3 program recognizes one Railroad preempt input that can be configured in two different ways, RR1 Flash or RR2 Limited Service. Entering a "1" at RR Select (F-E-0) sets the RR1 Flash sequence. If the value at RR Select is a "2", then the RR2 Limited Service sequence is used. If there is a "0" at RR Select, then the program ignores any Railroad preempt input altogether. A Railroad preempt input must be "true" for .5 seconds before the preemption sequence begins.

Once the program begins a Railroad preempt sequence, regardless of which one is selected, a fixed series of events takes place. A Hold is put on the RR Track Clearance phases selected at F-d-4. These phases are also placed on Recall. All other Vehicle phases and all Ped phases are disallowed. This causes any Vehicle or Ped Phase already in service to immediately be advanced out of service, no matter where it is in its cycle (the only exception to this is that any RR Track Clearance Phase already Green, stays in service). At the same time, the RR Track Clearance time entered at F-E-1 is loaded into the RR Clearance Timer (F-E-F). As soon as all RR Track Clearance phases are Green, the RR Track Clearance timer begins to count down. Once started, the RR Track Clearance sequence continues until the Track Clearance timer counts down to 0 seconds, even if the preempt input drops before then. At the end of RR Track Clearance, the program continues with whichever RR Preempt sequence is selected until the preempt input has dropped.

If the RR1 sequence is selected (a "1" at F-E-0), the Track Clearance phases are terminated and the intersection is put into RR1 Flash (software flash) for the duration of the preempt. When the preempt input is dropped, the intersection shows all Red for the length of time set at F-E-2 (RR1 All Red). The default is 5 seconds. If (F-d-6) has any phases set, they will go Green first after which all other Permitted phases (both Ped and Vehicle) are put on Recall for one cycle. If nothing is set at location F-d-6, then phases are served on a normal demand basis.

If the RR2 sequence is selected (a "2" at F-E-0), when the Track Clearance timer reaches 0 seconds the intersection goes into Railroad 2 Limited Service. This mode of operation is identical to Normal operation except that Allowed phases (observed at E-7-A) are the phases set at RR2 Ltd. Service (F-d-5), **not** the Permitted phases set at F-F-0. The only functions that are not available in RR2 Limited Service are Coordination and Manual Control Mode. Any RR Track Clearance phases that are not also RR2 Ltd. Service phases are terminated immediately. Demand for a Permitted Vehicle Phase, if not also set for RR2 Ltd. Service, will be ignored but demand for its associated Ped Phase will be serviced. An Emergency Vehicle preempt will be serviced if any of the EV clearance phases are also flagged as RR2 Ltd. Service phases (F-d-5). Otherwise it is ignored. RR2 Max (set at location F-E-3, observe at E-F-F) may be set to limit the length of time that the intersection is allowed to operate in RR2 Limited Service. When the RR2 Max timer counts down to 0 minutes, any Phase(s) in service will be forced off after timing Minimums and the intersection will be put into RR1 Flash. From that point, operation continues as in RR1 above. Note that a value of "000" entered at RR2 Max means that there will be NO time limit on RR2 Limited Service.

ADDITIONAL POINTS

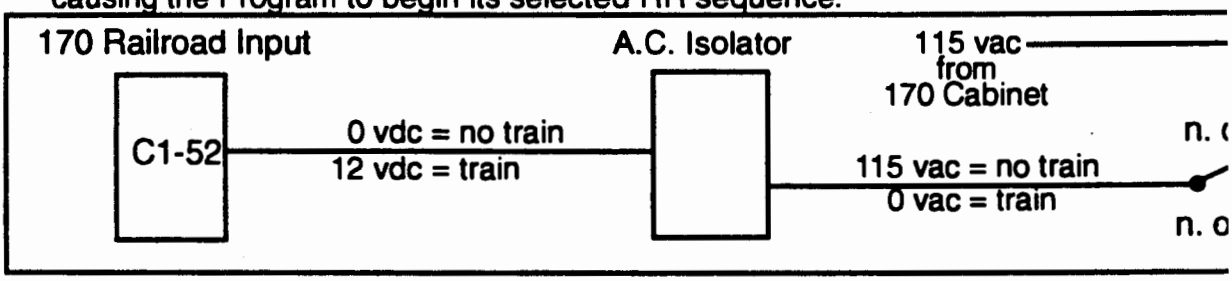
1 Track Clearance phases will not go Green until **incompatible** Overlaps have completely terminated.

2 Turning on call light 5 at d-E-F (USER FLAG OPTIONS), delays Track Clearance Phase Green until **all** Overlaps have terminated.

3 If in Coordination when a RR preempt occurs, the Local intersection goes Free until the preempt ends and Free Time After Preempt (set at F-E-4 and observed at F-E-F) times out.

4 During either Railroad sequence, any phases called (both Ped and Vehicle) that cannot be serviced are saved and put on Recall for one cycle after exiting from a preempt condition. Observe saved Ped calls at E-7-0 (SVPED) and saved Vehicle calls at E-7-1 (SVVEH).

5 The program senses a RR Preempt when the voltage at the C1 connector, Pin 52, is 12 vdc. This means that the RR Preempt circuit must be connected to the Railroad relay using its normally closed (n. c.) contacts. When an approaching train is sensed, the Railroad switch opens, removing the voltage to the Isolator, causing the Program to begin its selected RR sequence.



6 If a "1" or a "2" is entered at F-E-0, and the RR Preempt circuit is not in place, the program will begin its RR Preempt sequence immediately. The only way to end the RR Preempt sequence in this situation is to restore the RR Preempt circuit or enter "0" at F-E-0 followed by a long power down.

7 After an A.C. power failure, if power is restored to the 170 controller while the preempt input is active, the Program will initiate a software flash condition immediately on Startup. The software flash will remain until the RR preempt input is removed, at which time a normal RR1 exit sequence takes place.

8 Once a Railroad Preempt is started, even if it drops immediately, the Track Clearance phases are guaranteed to time until either the Track Clearance Timer expires or Minimum Green expires, whichever is greater.

9 In RR1, if no Track Clearance phases are flagged, a preempt input will cause immediate termination of any phases timing and go directly to RR1 Flash. If the preempt input drops before RR1 Flash, then the terminating phases will red revert or transition directly to other called phases.

10 If RR2 is selected at F-E-0 but no Track Clearance Phases or Limited Service Phases are flagged, then the Timing/Data portion of the 170 display will alternately show a "000" and "002". This indicates to the user that all of the requirements for a RR2 Preempt sequence have not been met. In this case the Program will respond to a RR preempt input with the RR1 sequence.

EMERGENCY VEHICLE (EV) PREEMPTION

(see FIGURE 29)

LACO-3 recognizes four EV Preempt inputs although it will only service one at a time. When an EV Preempt input goes active, the following events take place:

a. A HOLD is put on the EV Clearance phases and they are put on Recall for the duration of the EV Preempt sequence.

b. All other phases are "disAllowed" and any phases in service, including Peds, will be permitted to time out minimums before being forced off

c. If there is any EV Maximum time (set at F-E-d, observe at E-F-E), it will start to count down as soon as the EV input is sensed.

d. If there is any EV Delay time (set at F-E-5, F-E-7, F-E-9 or F-E-b, observe at F-E-E) it will start to count down as soon as the EV input is sensed. The EV sequence will not start until the EV Delay has timed out. Any EV Clearance Phase that is serviced during EV Delay will stay Green because of the Hold placed on it.

e. The EV Clearance time (set at F-E-6, F-E-8, F-E-A or F-E-C, observe at F-E-E) will begin to count down only when EV Clearance phases are Green, the EV Delay times out and the EV input is removed.

Additional Points:

1. If multiple EV inputs occur simultaneously, they will be serviced in the following priority:

   EV D before all others

   EV C before EV B and EV A

   EV B before EV A

2. A Ped Restrict is placed on all enabled Peds for the duration of the EV Preempt sequence. This will prevent any Ped calls from being served during the preempt.
3. Turning on call light 2 at d-E-F (USER FLAG OPTIONS), causes all Pedestrian protection to end immediately when an EV input is sensed.
4. EV Clearance phases will not go Green until **conflicting** Overlaps have timed out.
5. Turning on call light 8 at d-E-F (USER FLAG OPTIONS), delays EV Clearance Phase Green until **all** Overlaps have timed out.
6. If the EV input becomes active again while the EV Timer (F-E-E) is decrementing, then the EV Timer is reset to the full EV Clearance time and will not resume timing until the EV input is removed.
7. If in Coordination when an EV Preempt occurs, the Local intersection goes Free until the preempt ends and Free Time After Preempt (set at F-E-4 and observed at F-E-F) times out. The Coordination plan continues to time in the background.
8. During the EV sequence, any calls to non-Allowed phases (both Ped and Vehicle) are saved and put on Recall for one cycle after exiting from a preempt condition. Observe saved Ped calls at E-7-0 (SVPED) and save Vehicle calls at E-7-1 (SVVEH).

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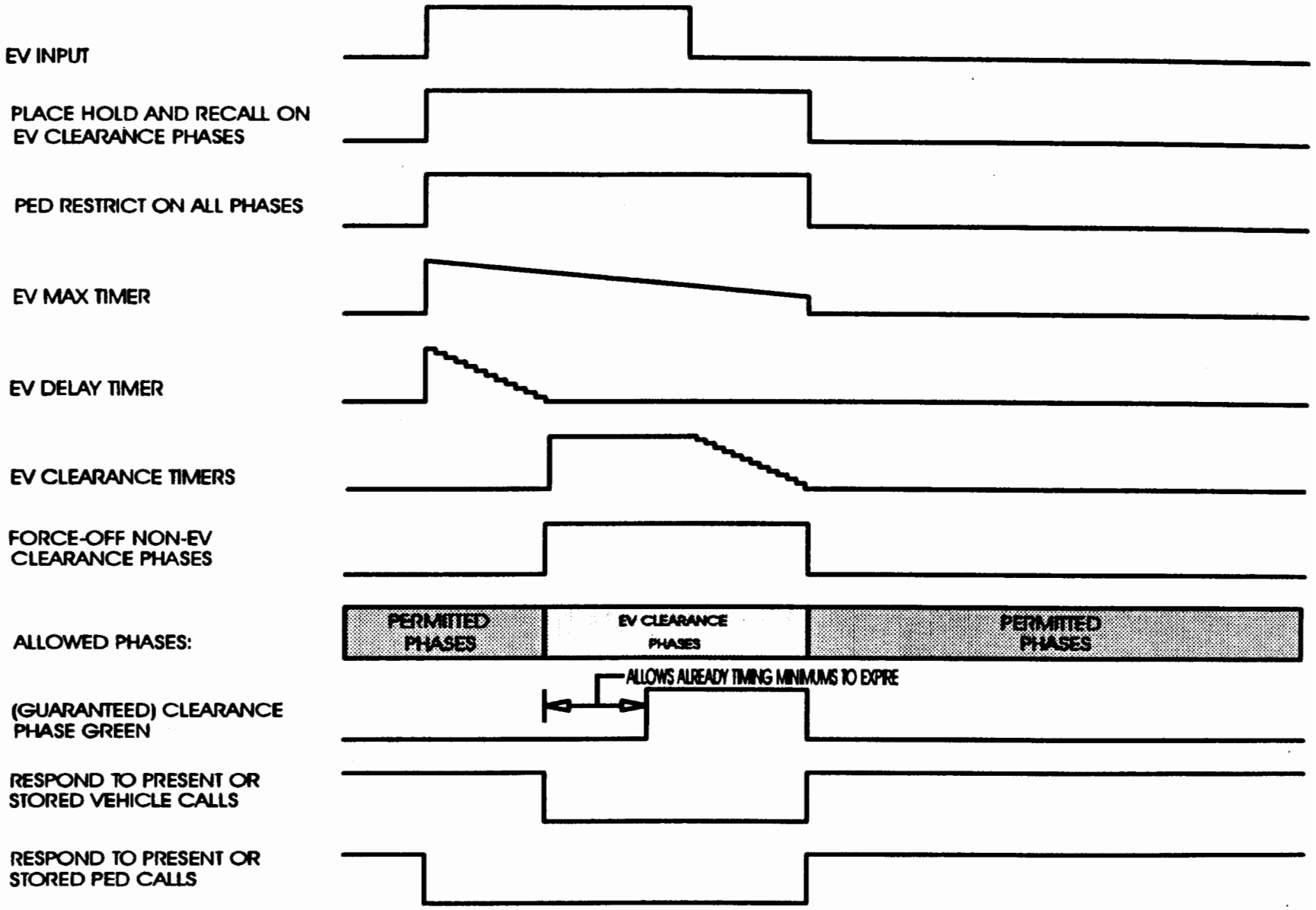

FIGURE 29 - EV Preempt Sequence Timing Diagram

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RESTRICTED PHASING

The concept of Restricted phasing is not new to 170 programs. There has always been "implicit" restriction with supplemental phases and with cross street phases. For example, Phase 1 cannot time with Phase 2 and Phases 1, 2, 5 or 6 cannot time with Phases 3, 4, 7 or 8. The LACO-3 Restricted phasing feature just extends that concept to normally compatible phases. It is used when a factor (such as safety or the geometry of an intersection) prevents normally concurrent phases from timing together. A typical situation that might require Restricted phasing is where a left turn movement has two lanes and there is not enough room in the intersection for the opposite approach left turn movement to proceed at the same time. Restricted phases are set at F-F-A.

IMPORTANT POINTS TO REMEMBER WHEN USING RESTRICTED PHASES

1. Restricted phasing applies the same rules to "Ped only" movements (during RR2 Limited Service) as it does to Vehicle movements.
2. When crossing the Barrier to a street with Restricted Phases, a Lead Phase call is always serviced first. Start up after a Long power down is treated as a barrier crossing. If no phases are flagged at F-F-D (First Phases after Start Up), and Phases 1 and 5 are Restricted, the program will accept both phases as default first phases and serve Phase 1 first followed by Phase 5. However, if Phase 1 is not Permitted and Phases 2 and 5 are Restricted, then Phase 5 will be served first (because it is a Lead phase) followed by Phase 2. If this operation is undesirable, the user can set Phases 2 and 6 for Yellow Start Up at F-F-E. In this case the default first phases will be Phase 3 and 7 (if Permitted).
3. A Restricted Phase in one Ring must terminate before a non-Restricted Phase in the other Ring can terminate in order to serve its Restricted supplemental Phase. This characteristic needs to be considered when implementing Coordination as it may cause one or more phases to be skipped during a cycle.
4. A change in Restricted Phases (F-F-A) will only take effect at Barrier crossing or after a long power down.
5. A Restricted phasing configuration is defined by the flagged phases' Lead/Lag status. Therefore, if Lag phases change with a Dial change, then the Restricted phasing configuration may change also.

RESTRICTED PHASING WITH OVERLAPS

Occasionally Restricted Phasing rules conflict with Overlap rules. Since Restricted Phasing is usually implemented for safety considerations, its operation continues unchanged. When there is a conflict between Restricted Phasing and Overlaps, the Restricted Phasing operation takes precedence and the Overlap operation is adjusted to accommodate it.

USER DATA VALIDATION

LACO-3 has been designed to be as forgiving as possible in terms of User entered data. The assumption was made early on that the Users of this program would have a basic knowledge of Traffic terminology and concepts. Experience has shown, however, that human error or other factors could allow invalid data to be entered in critical parameters. Rather then have several warnings on every page of this manual, it was decided to test (and modify if necessary) all critical data used by this program. The following Table lists all timing entries by Timing Sheet page giving the data name, its keystroke sequence, the restrictions on data, and the result of entering invalid data. Following the table is the description of the Invalid Data Indication codes. Further, **all** data on the E-Page, is write protected. Finally, the most effective prevention available is common sense. For example, one wouldn't expect to see both phases in a quadrant flagged as Lag phases (although that particular case has been tested for). The user should take particular care when entering data in those locations that are not tested.

TIMING SHEET PAGE ONE			
Data Name	Keystrokes	Data Restrictions	Invalid Data Indications
PHASE FUNCTION FLAGS			
Phases Permitted	F-F-0	Phases 1-8	None
Red Lock	F-F-1	Phases 1-8	None
Red & Yellow Lock	F-F-2	Phases 1-8	None
Minimum Vehicle Recall	F-F-3	Phases 1-8	None
Ped Recall/Rest in Walk	F-F-4	Enabled Ped Phases	A
Green Rest	F-F-5	Phases 1-8	None
Red Rest	F-F-6	Phases 1-8	None
STA Mode	F-F-7	Enabled Ped Phases	B
Double Entry	F-F-8	Phases 1-8	B
Max Vehicle Recall	F-F-9	Phases 1-8	None
Restricted Phases	F-F-A	Phases 1-8	None
Prot/Perm Left Turns	F-F-b	Phases 1-8	None
Barrier Recall	F-F-C	Phases 1-8	None
First Phases	F-F-d	1 Phase/Ring, both cannot be Restricted	A
Yellow Start Up	F-F-E	Same as F-F-d	A
Overlap Yellow Start Up	F-F-F	Overlaps A-F, at least 1 parent in F-F-E	C
LAG PHASE FLAGS			
Lag Phases during FREE	d-F-0	Phases 1-8, only 1 Phase per Quadrant	D
Dial 1 Lag Phases	d-F-1	Same as d-F-0	D
Dial 2 Lag Phases	d-F-2	Same as d-F-0	D
Dial 3 Lag Phases	d-F-3	Same as d-F-0	D
PEDESTRIAN PHASE FLAGS			
2 Ped Load Switch	d-F-4	Phases 1-8, 1 Phase	A
4 Ped Load Switch	d-F-5	Phases 1-8, 1 Phase	A
6 Ped Load Switch	d-F-6	Phases 1-8, 1 Phase	A
8 Ped Load Switch	d-F-7	Phases 1-8, 1 Phase	A

TIMING SHEET PAGE ONE			
Data Name	Keystrokes	Data Restrictions	Invalid Data Indications
PREEMPTION			
RR Select	F-E-0	0,1 or 2	E
RR Track Clearance	F-E-1	1 to 255 seconds	F
RR1 All Red	F-E-2	.1 to 25.5 seconds	G
RR2 Max	F-E-3	0 to 255 minutes	None
FREE time after preempt	F-E-4	0 to 255 minutes	None
EV A Delay	F-E-5	0 to 255 seconds	H
EV A Clearance	F-E-6	0 to 255 seconds	H
EV B Delay	F-E-7	0 to 255 seconds	H
EV B Clearance	F-E-8	0 to 255 seconds	H
EV C Delay	F-E-9	0 to 255 seconds	H
EV C Clearance	F-E-A	0 to 255 seconds	H
EV D Delay	F-E-b	0 to 255 seconds	H
EV D Clearance	F-E-C	0 to 255 seconds	H
EV Maximum	F-E-d	0 to 255 seconds	None
PREEMPTION FLAGS			
EV-A	F-d-0	1 Phase per ring, both cannot be Restricted	A
EV-B	F-d-1	Same as F-d-0	A
EV-C	F-d-2	Same as F-d-0	A
EV-D	F-d-3	Same as F-d-0	A
RR Track Clearance	F-d-4	Phases 1-8	None
RR Limited Service	F-d-5	Phases 1-8	None
RR1 Exit Phases	F-d-6	Same as F-d-0	A
MISCELLANEOUS PHASE TIMES			
Red Rest Delay	F-0-7	0 to 25.5 seconds	None
Green Rest Delay	F-0-8	0 to 25.5 seconds	None
Max Added Green	F-0-E	0 to 255 seconds	None
Red Revert	F-0-F	0 to 25.5 seconds	None

TIMING SHEET PAGE ONE

Data Name	Keystrokes	Data Restrictions	Invalid Data Indications
PHASE TIMING (Only Phase 1 is shown; Phases 2 through 8 are identical)			
Minimum Walk	F-1-0	1 to 255 seconds	I
Flashing Don't Walk	F-1-1	1 to 255 seconds	I
Minimum Green	F-1-2	1 to 255 seconds	J
Queue Maximum	F-1-3	0 to 255 seconds	None
Added Green per Actuation	F-1-4	0 to 25.5 seconds	None
Vehicle Extention	F-1-5	0 to 25.5 seconds	None
Maximum Gap	F-1-6	0 to 25.5 seconds	None
Minimum Gap	F-1-7	0 to 25.5 seconds	None
Maximum Extension 1	F-1-8	0 to 255 seconds	None
Maximum Extension 2	F-1-9	0 to 255 seconds	None
Reduce 0.1 Seconds Every...	F-1-d	0 to 25.5 seconds	None
Yellow Clearance	F-1-E	3.0 to 6.0 seconds	K
Red Clearance	F-1-F	0 to 25.5 seconds	None
OVERLAP TIMING (Only Overlap A is shown. Overlaps B through F entered in Phases 2 through 6)			
Ovlp Green Extension	F-1-A	0 to 25.5 seconds	None
Ovlp Yellow Clearance	F-1-b	3.0 to 6.0 seconds	L
Ovlp Red Clearance	F-1-C	0 to 25.5 seconds	None

TIMING SHEET PAGE TWO			
Data Name	Keystrokes	Data Restrictions	Invalid Data Indications
DETECTOR TIMING			
Delay			
(I File)	d-1-0 to d-1-d	0 to 255 seconds	None
(J File)	d-2-0 to d-2-d	0 to 255 seconds	None
Extended Call			
(I File)	d-3-0 to d-3-d	0 to 25.5 seconds	None
(J File)	d-4-0 to d-4-d	0 to 25.5 seconds	None
Phase Flags			
(I File)	d-b-0 to d-b-d	Phase 1 to 8	None
(J File)	d-C-0 to d-C-d	Phase 1 to 8	None
Phase Attributes			
(I File)	d-d-0 to d-d-d	Call Lights 1 to 8	None
(J File)	d-E-0 to d-E-d	Call Lights 1 to 8	None
Special Delay Option 1	d-d-E	Phase 1 to 8	None
Special Delay Option 2	d-d-F	Phase 1 to 8	None

TIMING SHEET PAGE THREE

Data Name	Keystrokes	Data Restrictions	Invalid Data Indications
COORDINATION PARAMETERS			
System Manual	C-0-0	0, 14* or Plans 1 to 9	M
Local Manual**	C-0-1	0, Dials 1 to 3, 10* to 15*	M
Function 6	C-0-6	14* or Dials 1 to 3	M
Minimum Cycle	C-0-8	0 to 254 seconds and less than Maximum Cycle (C-0-9)	None
Maximum Cycle	C-0-9	1 to 255 seconds and greater than Minimum Cycle (C-0-8).	None
* The numbers 10, 11, 12, 13, 14 and 15 at these locations correspond to the Functions A, B, C, D, E and F used as Plan entries in the Coordination Tables.			
** When entering Functions 10, 13 or 15 (A, D or F) the Function display restores the prior Dial or Function. To verify that the above entries were accepted, observe location E-6-3 (MAX2) and see that Call light "8" is on for Function 10, Call light "4" is on for Function 13 and both Call lights are off for Function 15.			
INTERVALS AND FUNCTIONS FLAGS			
Dial 1 Cycle Length	C-1-0	4 to 255 seconds	N
Dial 1 Intervals	C-1-1 to C-1-F	0 to Max Cycle and Current Interval time must be greater than Last Interval time	None
Dial 1 Force Off	C-4-0 to C-4-F	Phases 1 - 8	None
Dial 1 Hold	C-5-0 to C-5-F	Phases 1 - 8	None
Dial 1 Ped Restrict	C-6-0 to C-6-F	Phases 1 - 8	None
Dial 1 Call	C-7-0 to C-7-F	Phases 1 - 8	None
Dial 2 Cycle Length	C-2-0	4 to 255 seconds	N
Dial 2 Intervals	C-2-1 to C-2-F	0 to Max Cycle and Current Interval time must be greater than Last Interval time	None
Dial 2 Force Off	C-8-1 to C-8-F	Phases 1 - 8	None
Dial 2 Hold	C-9-1 to C-9-F	Phases 1 - 8	None
Dial 2 Ped Restrict	C-A-1 to C-A-F	Phases 1 - 8	None
Dial 2 Call	C-b-1 to C-b-F	Phases 1 - 8	None
Dial 3 Cycle Length	C-3-0	4 to 255 seconds	N

TIMING SHEET PAGE FOUR			
Data Name	Keystrokes	Data Restrictions	Invalid Data Indications
OVERLAP PHASE FLAGS			
Overlap A	F-A-A	Phases 1 -8	None
Overlap B	F-A-b	Phases 1 -8	None
Overlap C	F-A-C	Phases 1 -8	None
Overlap D	F-A-d	Phases 1 -8	None
Overlap E	F-A-E	Phases 1 -8	None
Overlap F	F-A-F	Phases 1 -8	None
OVERLAP GREEN OMIT FLAGS			
Overlap A	F-b-A	Phases 1 -8	None
Overlap B	F-b-b	Phases 1 -8	None
Overlap C	F-b-C	Phases 1 -8	None
Overlap D	F-b-d	Phases 1 -8	None
Overlap E	F-b-E	Phases 1 -8	None
Overlap F	F-b-F	Phases 1 -8	None
RAILROAD PREEMPT OVERLAP FLAGS			
Overlap A	F-C-A	Phases 1 -8	None
Overlap B	F-C-b	Phases 1 -8	None
Overlap C	F-C-C	Phases 1 -8	None
Overlap D	F-C-d	Phases 1 -8	None
Overlap E	F-C-E	Phases 1 -8	None
Overlap F	F-C-F	Phases 1 -8	None
EMERGENCY VEHICLE PREEMPT OVERLAP FLAGS			
Overlap A	F-d-A	Phases 1 -8	None
Overlap B	F-d-b	Phases 1 -8	None
Overlap C	F-d-C	Phases 1 -8	None
Overlap D	F-d-d	Phases 1 -8	None
Overlap E	F-d-E	Phases 1 -8	None
Overlap F	F-d-F	Phases 1 -8	None

TIMING SHEET PAGE FOUR

Data Name	Keystrokes	Data Restrictions	Invalid Data Indications
LOAD SWITCH ASSIGNMENTS			
Ped A to Overlap A	F-9-A	Enabled Ped Phases	0
Ped B to Overlap B	F-9-b	Enabled Ped Phases	0
Send Overlap to Phase			
Overlap C	F-9-C	Unused Phases 1 to 8	P
Overlap D	F-9-d	Unused Phases 1 to 8	P
Overlap E	F-9-E	Unused Phases 1 to 8	P
Overlap F	F-9-F	Unused Phases 1 to 8	P
USER FLAG OPTIONS			
True Maximum Extension(All Phases)	d-E-F Bit 1	Ignores further vehicle extensions after max out (independent of other ring).	None
EV Pedestrian Clearance NOT Protected	d-E-F Bit 2	EV Pedestrian Clearance is NOT protected when this flag is set.	None
Mid-Block Pedestrian Crossing	d-E-F Bit 4	Phases 2 & 6 Red Flashes during Phase 4 Ped Protection.	None
Delay RR Track Clearance Phase Green	d-E-F Bit 5	Delays Track Clearance until ALL Overlaps time out.	None
Echo Remote Coordination Input to Output	d-E-F Bit 6	SUB-MASTER OPERATION: Echo Slave Data to Master Ouptut.	None
Enable Manual Control	d-E-F Bit 7	Enables Manual Advance Operation. Requires MANUAL Pushbutton Switch.	None
Delay EV Clearance Phase Green	d-E-F Bit 8	Delays EV Clearance until ALL Overlapps time out.	None
ASSOCIATED PHASE RECALL			
Phase 1	F-C-1	Phases 1 -8	None
Phase 2	F-C-2	Phases 1 -8	None
Phase 3	F-C-3	Phases 1 -8	None
Phase 4	F-C-4	Phases 1 -8	None
Phase 5	F-C-5	Phases 1 -8	None
Phase 6	F-C-6	Phases 1 -8	None

TIMING SHEET PAGE FOUR			
Data Name	Keystrokes	Data Restrictions	Invalid Data Indications
PHASE/OVERLAP REASSIGNMENT FLAGS			
Driveway Flash(Phase)	F-A-0	Phases 1 to 8	None
Yellow Ranging(Phase)	F-A-1	Phases 1 to 8	None
Driveway Flash(O'Lap)	F-A-2	Overlaps A - F	None
Yellow Ranging(O'Lap)	F-A-3	Overlaps A - F	None
Ped 2 Load Switch is Overlap	F-A-4	Overlaps C - F	Q
Ped 4 Load Switch is Overlap	F-A-5	Overlaps C - F	Q
Ped 6 Load Switch is Overlap	F-A-6	Overlaps C - F	Q
Ped 8 Load Switch is Overlap	F-A-7	Overlaps C - F	Q
TIMING SHEET PAGE SIX			
OFFSETS			
Plans 1 to 3 (Offset 1 / Dials 1 to 3)	F-9-1 to F-9-3	0 to 255 seconds	None
Plans 4 to 6 (Offset 2 / Dials 1 to 3)	F-9-4 to F-9-6	0 to 255 seconds	None
Plans 7 to 9 (Offset 3 / Dials 1 to 3)	F-9-7 to F-9-9	0 to 255 seconds	None
COMMUNICATIONS ASSIGNMENTS			
Port 1 to 4	d-0-7 to d-0-A	0, 1, 2, 4, 7, 8, 12, or 17	None

TIMING SHEET PAGE 5 and 6 (LACO-3 EVENT TABLES and ANNUAL TABLES)

LACO-3 does not perform any testing on Table Data.

INVALID DATA INDICATION CODES

When entering time data, the 170 hardware only recognizes the the numbers "000" through "255" (the decimal equivalent of "00" through "FF" in hexadecimal). If a number greater than 255 is entered, the controller will subtract 256 until the remainder is less than 256. This result is the time that will be entered. Example: at d-2-0 the number "587" is entered. The 170 will subtract 256 twice leaving 75 which is the value that will be stored at d-2-0. Following are the invalid data indication codes referenced in the preceding pages.

A. Invalid data is erased. If F-F-A (Restricted Phases) is changed after these Phase flags are set, the invalid data will be erased when E-b-1 (Dynamic Restricted phases) is updated (after a Long power down or after Barrier crossing).

B. Invalid data is ignored.

C. Invalid data is erased on next Long power down

D. Invalid data modified after Long power down or at Barrier crossing. If no Lag Phase is set in a quadrant, then the even Phase gets set. If both Phases are set as Lag in a quadrant, then the odd Phase gets cleared.

E. If other than "0, 1 or 2", then data is reset to "1". If "2" selected then F-d-4, (RR Track Clear) and F-d-5 (RR2 Ltd Service) must be set. If they are not, the "2" at F-E-0 will alternate with a "0" every half second as an invalid data indication and the program will process a Railroad input as RR1 Flash.

F. If "0" is entered, the program enters "10" seconds

G. If "0" is entered, the program enters "5.0" seconds

H. If Clearance phases are selected for EV x, some value other than "0" must be entered at EV x Delay **or** EV x Clearance. If not, the program enters "1" second at EV x Clearance.

I. If "0" is entered and that Ped Phase is not enabled it will not change. If that Ped Phase **is** enabled the program will enter a "1".

J. If "0" is entered and that Vehicle Phase is not Allowed, it will not change. If that Vehicle Phase **is** Allowed, the program will enter a "1".

K. If a value less than 3.0 is entered, the program enters "3.0". If a value greater than 6.0 is entered, the program enters "6.0". If a Phase is flagged at F-A-1 (Yellow Ranging, Phase), valid data for that Phase is 0 to 25.5 seconds.

L. If a value less than 3.0 is entered, the program enters "3.0". If a value greater than 6.0 is entered, the program enters "6.0". If an Overlap is flagged at F-A-3 (Yellow Ranging, Overlap), valid data for that Phase is 0 to 25.5 seconds.

M. Invalid data is changed to "000".

N. Invalid data is changed to "060" (60 seconds).

O. Invalid Ped phase entry is changed to "000". Also, if Overlap A or Overlap B are enabled, and the user attempts to enter a valid Ped phase at Ped A or Ped B, the Function display will alternate the phase entry with "000" every second and the Ped A or Ped B entry will be ignored.

P. Any number other than "1" through "8" is changed to "000"

Q. Invalid data is cleared (Call light is extinguished).

MISCELLANEOUS FEATURES

The LACO-3 program incorporates several procedures and features that make it useful in wide variety of unusual situations. These are:

Data Transfer Procedures
Reinitialization Procedures
Phase/Dial Copy Procedures
Dial/Table Edit Procedures
Associated Phase Recall
Manual Control
Driveway Flash
Yellow "Ranging"

DATA TRANSFER PROCEDURES

UPLOAD FROM CPU RAM/1000h NOVRAM TO 7000h NOVRAM

1. At F-0-A enter "071" and "E".
2. The "071" on the Function display will change to "000" to indicate a successful upload. You may also view location E-b-F (MEMFLG); call lights 1, 2 and 3 should be on (memory status bits) and call lights 4 through 8 should be off (error bits).
3. If the Function display blanks after an upload attempt, view location E-b-F. Either call light 3 will be extinguished indicating a bad or missing 7000h Novram, or call light 4 and/or call light 5 will be on, indicating a data transfer error. In either situation, CPU RAM remains unchanged.

DOWNLOAD FROM 7000h NOVRAM TO CPU RAM/1000h NOVRAM

1) At F-0-A enter "170" followed by "E".
2) The "170" on the Function display will change to "000" to indicate a successful download and a recall will be placed on all allowed vehicle and ped phases.
3) If a download is attempted with a bad or missing 7000h Novram, the Function display will blank and no download will occur. The CPU RAM will remain unchanged. Location E-b-F, in this case, will show call light 3 extinguished and call light 5 lit, indicating a bad Novram download because of a bad or missing 7000h Novram.
4) If a download is attempted with a bad or missing 1000h Novram, the 7000h Novram data will be downloaded to CPU RAM and the "170" on the Function display will change to "000" as in step 2 above. Note that even though there is no Novram at 1000h, when Table data is viewed from the keyboard, all tables will display "9595" for "time" data, "F" for plan/dial data and call lights 1-7 will be lit. This is a hardware peculiarity only and the displayed "data" cannot be changed.

REINITIALIZATION PROCEDURES

TO CLEAR CPU BASE RAM

(See IMPORTANT note on next page)

1) At F-0-A enter "888" and "E".
2) The 170 Function display will immediately show the following:

A		b	
b	A	d	A

Any phases timing a green interval will terminate after timing Minimums at which time the intersection will be put in software flash and the Watchdog output will stop toggling. This in turn will cause the CMU to put the intersection in hardware flash.

Note Although the 170 displays "BADA", the keyboard routine allows normal data entry and viewing capabilities. Of course, when the Front Panel stop time switch is placed to the "ON" position, all data will be overwritten by the Reinitialization routine.

3) To complete reinitialization, place the front panel Stop Time switch to the "ON" position. The Function display will blank, the intersection will go all red, and the Watchdog output will resume toggling.
4) At this point, the 170 will contain the following timing:

   No Phases Permitted

   No Phase timing set except all yellows set to 5.0 seconds

   No peds enabled

   No preempts enabled

   No overlaps selected

   and the Function display will show

A		b	
0	8	0	8

In addition, as a Phase is permitted, a default time of 10 Seconds will be set in its Minimum Green location (unless a value other than "000" is already entered) and, if demand exists when a Phase is permitted, that Phase will immediately be served.

TO REINITIALIZE FROM 7000H NOVRAM

(See IMPORTANT note below)

1) At F-0-A enter "777" and "E"
2) The 170 Function display will immediately show the following:

A		b	
b	A	d	A

Any phases timing a Green interval will terminate after timing Minimums at which time the intersection will be put in software flash and the Watchdog output will stop toggling. This in turn will cause the CMU to put the intersection in hardware flash.

Note Although the 170 displaying "BADA", the keyboard routine allows normal data entry and viewing capabilities. Of course, when the Front Panel stop time switch is placed in the "ON" position, all data will be overwritten by the Reinitialization routine.

3) To complete reinitialization, place the front panel Stop Time switch to the "ON" position. At this point the data in the 7000h Novram is downloaded and the 170 is put into a long power down recovery condition. That is, the 170 behaves as if the power was shut off for more than 2.0 seconds.

Note If there is a bad or missing 7000h Novram and reinitialization from 7000h Novram is attempted, LACO-3 will perform a reinitialization from Eprom instead. It would be wise, therefore, to view location E-b-F prior to reinitializing and verify that call light 3 is set (indicating that the 7000h Novram installed)

IMPORTANT

In either of the procedures described above, if the Stop Time switch is already in the "ON" position when the reinitialization is started, there will be no orderly termination of current phases and no "BADA" software flash. That is, the program will **immediately** go to all Red or Yellow Startup phases, depending on which reinitialization method was used. Both of these procedures should only be used when the intersection is on Hardware Flash.

TO REINITIALIZE THE 1000h NOVRAM

1. At F-0-A enter "999" followed by "E".
2. The "999" on the display will change to "000", Tables 0 through 5, and tables 8 and 9 will be cleared. Tables 6 and 7 will be initialized to L A County floating Holidays and exception days. LACO-3 does not have the ability to reinitialize either of the Novrams to all 0's, but when data is written to the Novrams using F-0-A, all of their memory locations are zeroed out first.

PHASE / DIAL COPY FEATURE

LACO-3 provides a convenient Phase/Dial copy feature. The Phase copy routine copies the 13 Phase timing parameters (the Overlap times are not copied) of one Phase to any of the remaining 7 phases. The Dial copy routine will copy the Interval **and** Function flags of one Dial to either of the remaining Dials. The Edit routine permits inserting and deleting a specific Interval and its associated Function flags to or from any Dial or inserting and deleting an entry from any Coordination Table.

PHASE COPY PROCEDURE

At F-0-0 (Source) enter the Phase number to copy data **from** and press "E". Press the "A" key to advance to F-0-1 (Dest) and enter the Phase number to copy data **to** followed by "E". The Function Display will return to "0". If multiple Phase copying is desired, simply enter each destination Phase followed by "E". The Overlap termination timers (intervals "A", "B" and "C") are not copied.

DIAL COPY PROCEDURE

This procedure is identical to the Phase copy procedure except enter "11", "12" or "13" for Dial 1, 2 or 3, respectively, in place of the Phase number above.

DIAL / TABLE EDIT FEATURE

DIAL EDIT PROCEDURE (see Figure 30)

TABLE EDIT PROCEDURE (see Figure 31)

ASSOCIATED PHASE RECALL

Associated Phase Recall allows the user to implement a conditional locked Vehicle call. The condition is that a Phase or Phases will be called only when a particular phase goes Green. Select the Phase(s) to be called at locations F-C-1 (for Phase 1) to F-C-8 (for Phase 8). For example, the program places a locked call to any Phases flagged at F-C-1 when Phase 1 goes Green. The call is dropped when the flagged Phase goes Green. In the rare case where no vehicle detection exists, the intersection can be programmed to serve a wide variety of Phase sequences by using this feature.

MANUAL CONTROL MODE

LACO-3 provides limited Manual control of an intersection. To enable Manual Control Mode, at USER FLAG OPTIONS (d-E-F) turn on Call light "7". This disables any Ped A or Ped B operation and reassigns their inputs to Manual Control Mode functions. To activate Manual Control Mode, the Manual Enable input (I11L) must be set "On" (usually by plugging in the Manual Advance push-button switch in the cabinet Police panel). When this happens Manual Control Mode is initialized by putting all Permitted Vehicle phases and their associated enabled Ped Phases on continuous Minimum Recall. A phase, when served, will have a Hold placed on it and it will time all of its Minimums (Walk, Flashing Don't Walk, Minimum Green and Added Initial Green). When minimums have timed out the 170 controller holds in Green (displaying interval "6", coordination HOLD) waiting for a Manual Advance input. When the Manual Advance push-button is actuated, any Phase that has timed its Minimums will have its Hold removed and is Forced Off to the next sequential Phase in its Ring. If the next Phase requires a barrier crossing it will wait until the other Ring is ready to cross before both

terminate simultaneously. This is a very restricted mode of operation in that the only real control one has is to prolong the Phase Green beyond its Minimums by delaying the Manual Advance.

Additional Points

a. Manual Control Mode disables Coordination timing.
b. Manual Control Mode is disabled during EV or RR preempts.
c. Any operation that normally extends the Green time beyond minimums is ignored.

DRIVEWAY FLASH

This feature provides a modified output during the Green interval of the Phase or Overlap selected. Instead of the usual constant Green output, the Driveway Flash feature causes the output to flash ON for .5 seconds, then OFF for .5 seconds. When this feature is used the Green lens on the signal head is replaced with a Yellow lens. This indicates to motorists that they may proceed with caution. The phase Yellow output times normally and does not flash. Select the Driveway Flash Phases at (F-A-0) and the Driveway Flash Overlaps at (F-A-2).

YELLOW "RANGING"

Normally, the LACO-3 data validation routine restricts the time entered for any Yellow timer to between 3.0 seconds and 6.0 seconds inclusive. The Yellow Ranging feature lifts these restrictions and allows setting the Vehicle and Overlap Yellow clearance times to any value from 0.0 seconds to 25.5 seconds. This feature would only be used when timing a "dummy" phase (with no outputs to the street) in an effort to reduce the all Red period for the other phase while the "dummy" is in service.

Select the Yellow Ranging Phase at (F-A-1) and set the Yellow Ranging Overlap at (F-A-3).

USER FLAG OPTIONS (d-E-F)

This location allows the user to alter some basic program operations. There are seven options available by turning on call lights "1", "2" or "4" through "8". More than one option may be selected at the same time. The options and their descriptions follow.

TRUE MAX EXTENSION (Call light 1)

The L A County Max Extension philosophy requires that both Rings either Max Out or Gap Out as a condition for cross barrier termination. This may be described logically as:

[Ring A Max * Ring B Max] + [Ring A Gap * Ring B Gap]

where "*" is the logical AND operator and "+" is the logical OR operator.

True Max Extension allows any combination of Max Out and/or Gap Out to cause cross barrier termination and may be described as:

[Ring A Max + Ring A Gap] * [Ring B Max + Ring B Gap]

If only one Ring is in service, a cross barrier termination will occur with either a Gap Out **or** a Max Out.

EV PED CLEARANCE NOT PROTECTED (Call light 2)

In normal operation, if an EV preempt occurs during the Walk interval of a non-Clearance Phase Ped, the remainder of the Walk time is ended and the Flashing Don't Walk time is allowed to time out. An EV preempt occurring during the Flashing Don't Walk interval has no effect on that interval. If an EV preempt occurs when flag "2" is set at d-E-F, all Walk and Flashing Don't Walk time is ended and the Ped head indicates steady Don't Walk.

MID-BLOCK PEDESTRIAN CROSSING (Call light 4)

This flag modifies Ø2 and Ø6 outputs to flash during their Red intervals only when Phase 4 is timing Flashing Don't Walk and Yellow Change intervals. To implement this option, Phases 2, 4 and 6 must be permitted and Phase 4 enable for Ped.

DELAY RR TRACK CLEARANCE PHASE GREEN (Call light 5)

In a normal Railroad Track Clearance sequence, the Track Clearance Phases cannot go Green until all **incompatible** Overlaps have terminated. This option makes the Track Clearance Phases wait until **all** Overlaps have timed out.

ECHO REMOTE COORDINATION INPUT TO OUTPUT (Call light 6)

Where two Systems intersect, the 170 controller has the capability of operating in a dual mode as the Master in one System and a Slave in the other. This is referred to as Sub-Master Operation. In this case, the Dial/Offset information sent out from the Master function is normally generated by the Master itself. Selecting this option causes the program to take the Dial/Offset information it receives at its Slave input and transmit it as its Master output.

ENABLE MANUAL CONTROL (Call light 7)

When this option is selected, the PED A (I11U) and PED B (I11L) inputs are reassigned as MANUAL ADVANCE (I11U) and MANUAL MODE ENABLE (I11L). This in itself does not put the 170 controller into Manual Control Mode. The MANUAL MODE ENABLE input must also be held "True" (by plugging in the Police Panel push-button switch) before Manual Mode is active and the Manual Advance push-button can be used. Also, when this option is selected, the PED A and PED B functions are ignored. When this option is removed, Ped A and Ped B functions are restored.

DELAY EV CLEARANCE PHASE GREEN (Call light 8)

This option delays the start of EV Clearance phases until **all** Overlaps have terminated (instead of just those Overlaps that are incompatible with EV Clearance phases).

	INTERVALS (in seconds)			Dial 1 Function Flags			
	Dial 1	Dial 2	Dial 3	Force Off	Hold	Ped Rstrict	Call
Int							
0	90			2,5,6			
1	1			-,-,-	2,6		
2	9			5	2,6		
3	13			-	-,-	8	
4	18				2,6	8	
5	30			8	2,6	8	
6	37			8	2,6	-	
7	46			-	2,6		
8	48			1	2,6		
9	49			-	2,6		
A	58				-,-		
b	62					2	
C	66					2,6	
d	78			6		2,6	
E	90			-		-,-	
F							

	INTERVALS (in seconds)			Dial 1 Function Flags			
	Dial 1	Dial 2	Dial 3	Force Off	Hold	Ped Rstrict	Call
Int							
0	90			2,5,6			
1	1			-,-,-	2,6		
2	9			5	2,6		
3	13			-	-,-	8	
4	18				2,6	8	
5	30			8	2,6	8	
6	37			8	2,6	-	
7							
8	46			-	2,6		
9	48			1	2,6		
A	49			-	2,6		
B	58				-,-		
C	62					2	
D	66					2,6	
E	78			6		2,6	
F	90			-		-,-	

	INTERVALS (in seconds)			Dial 1 Function Flags			
	Dial 1	Dial 2	Dial 3	Force Off	Hold	Ped Rstrict	Call
Int							
0	90			2,5,6			
1	1			-,-,-	2,6		
2	13			-	-,-	8	
3	18				2,6	8	
4	30			8	2,6	8	
5	37			8	2,6	-	
6	38			-	2,6		
7	48			1	2,6		
8	49			-	2,6		
9	58				-,-		
A	62					2	
B	66					2,6	
C	78			6		2,6	
D	90			-		-,-	
E							
F							

To the left is an example of a portion of the Coordination page (Timing Sheet page 3). In order to insert a new interval between the existing ones at 6 and 7, one would have to reenter every entry from the new interval 7 until the new interval F (the current interval E). The LACO-3 program provides a means to insert a blank interval at the desired location.

The following steps will essentially "push" all entries, from interval 7, down one row. This will leave the "new" interval 7 blank so that the desired Dial 1 data can be added. See example at left.

1. At F-0-2 enter the Dial number to be edited: "11" to "13" for Dials "1" to "3" respectively. In this case "11". Press "E".
2. At F-0-3 enter the number of the interval that will contain the new data: "01" to "15" for intervals "1" to "F" and "16" for interval "0". In this case "07" for interval 7. Press "E". Coordination page entries will now look like the example at left.
3. Examine the data across the interval 7 row (press C-1-7 then the "F" key to step across the row). Note that all locations are cleared.
4. Examine the data across the interval 8 row (press C-1-8 then the "F" key to step across the row). Note that the data in this row is the same as the original interval 7 data.
5. Enter new interval 7 data.

The same process can be used to delete an interval from the middle of the Coordination page. To delete interval 2 from the original Coordination page above, perform the following.

1. At F-0-2 enter the Dial number to be edited: "11" to "13" for Dials "1" to "3" respectively. In this case "11". Press "E".
2. At F-0-3 enter "101" to "115" for intervals "1" to "F" or "116" for interval "0". In this case "102" to delete interval 2. Press "E". Coordination page entries will now look like the example at left.
3. Access interval 2 data as described above and note that the data that was at interval 3 is now at interval 2 and so on.

FIGURE 30 - LACO-3 Dial Edit Example

EXCEPTION DAYS			s	m	t	w	t	f	s
Code	Month/Day	Table	1	2	3	4	5	6	7
7-0	01 / 01	1		X	X	X	X	X	
7-1	01 / 02	1		X					
7-2	07 / 04	1		X	X	X	X	X	
7-3	07 / 05	1		X					
7-4	11 / 10	1						X	
7-5	11 / 11	1		X	X	X	X	X	
7-6	11 / 12	1		X					
7-7	12 / 24	1		X	X	X	X	X	
7-8	12 / 25	1		X	X	X	X	X	
7-9	12 / 26	1		X				X	
7-A									
7-b									
7-C									
7-d									

To the left is an example of Coordination Table 7 In order to insert a new entry between the existing ones at 7-1 and 7-2, one would have to reenter every entry from the new 7-2 until the new 7-A (th current 7-9). The LACO-3 program provides a means to insert a blank row at the desired locatior

EXCEPTION DAYS			s	m	t	w	t	f	s
Code	Month/Day	Table	1	2	3	4	5	6	7
7-0	01 / 01	1		X	X	X	X	X	
7-1	01 / 02	1		X					
7-2									
7-3	07 / 04	1		X	X	X	X	X	
7-4	07 / 05	1		X					
7-5	11 / 10	1						X	
7-6	11 / 11	1		X	X	X	X	X	
7-7	11 / 12	1		X					
7-8	12 / 24	1		X	X	X	X	X	
7-9	12 / 25	1		X	X	X	X	X	
7-A	12 / 26	1		X				X	
7-b									
7-C									
7-d									

The following steps will essentially "push" all entries, from 7-2, down one row. This will leave the "new" entry 7-2 blank so that the desired Exceptio Day data can be added.

1. At F-0-2 enter the Table number to be edite "1" to "9" for Tables "1" to "9" and "10" for T ble "0". In this case "7" for Table 7. Press "E".
2. At F-0-3 enter the number of the row that wi contain the new data: "01" to "15" for rows "1" to "F" and "16" for row "0". In this case "2" for row "2". Press "E". Table 7 entries w now look like the example at left.
3. Access Table 7, event 2 and note that there is no data set. Access Table 7, event 3 an note that the data that was at 7-2 is now at 3 and so on.
4. Enter new Table data at 7-2.

EXCEPTION DAYS			s	m	t	w	t	f	s
Code	Month/Day	Table	1	2	3	4	5	6	7
7-0	01 / 01	1		X	X	X	X	X	
7-1	01 / 02	1		X					
7-2	07 / 04	1		X	X	X	X	X	
7-3	11 / 10	1						X	
7-4	11 / 11	1		X	X	X	X	X	
7-5	11 / 12	1		X					
7-6	12 / 24	1		X	X	X	X	X	
7-7	12 / 25	1		X	X	X	X	X	
7-8	12 / 26	1		X				X	
7-9									
7-A									
7-B									
7-C									
7-D									

The same process can be used to delete an entr from the middle of a Table. To delete entry 7-3 fro the original Table 7 above, perform the following.

1. At F-0-2 enter the Table number to be edite "1" to "9" for Tables "0" to "9" and "10" for T ble "0". In this case "7" for Table 7. Press "E".
2. At F-0-3 enter "101" to "115" for rows "1" to "15" and "116" for row "0". In this case "10 to delete row "3". Press "E". Table 7 entries will now look like the example at left.
3. Access Table 7, event 3 and note that the data that was at 7-4 is now at 7-3 and so on

FIGURE 31 - LACO-3 Table Edit Example

CALL SUMMARY

Calls in the LACO-3 program fall into two categories; program generated and hardware generated. Hardware calls are generated by detector or Ped pushbutton actuation. Program generated calls fall into two sub-categories; soft calls and hard calls. A hard call is one that, once generated, does not drop until serviced. A soft call, on the other hand is dependent on conditions at the intersection and may be dropped or reestablished at any time as those conditions change. Below is a table of parameters that generate software calls and their classification as hard or soft calls.

HARD CALLS	SOFT CALLS
Minimum Veh Recall (F-F-3)	Green Rest (F-F-5)
Ped Recall/Rest in Walk (F-F-4)	Double Entry (F-F-8)
Semi Traffic Actuated (STA) (F-F-7)	Barrier Recall (F-F-C)
Maximum Veh Recall (F-F-9)	
Associated Phase Recall (F-C-1 thru F-C-8)	
1st Phases after Startup (F-F-d)	
Preemption	
Coordination Call	

Note that if a Soft call is generated for a Phase that has one of the following Phase Function Flags set, then it becomes a Hard call. That is, the call will not drop until serviced.

Locking Calls

There are several call "locking" mechanisms in the LACO-3 program:

- Phase Function Flags
  - Red Lock (F-F-1)
  - Red and Yellow Lock (F-F-2)
  - Minimum Vehicle Recall (F-F-3)
  - Ped Recall/Rest in Walk (F-F-4)
  - Semi-Traffic Actuated (STA)(F-F-7)
  - Maximum Vehicle Recall (F-F-9)
  - Barrier Recall (**after** Barrier crossing) (F-F-C)
  - First Phases after Startup (F-F-E)
- Detector Attributes
  - Red Lock
  - Red and Yellow Lock
- Actuation on a non-Allowed phase during preemption
- Any Ped Call
- Termination of an Overlap Parent Phase
- Track Clearance phases once Railroad preempt sequence has begun
- EV Clearance phases once EV preempt input is sensed

RECALL SUMMARY

The LACO-3 program employs a variety of Recall mechanisms. Recall is defined as a recurring demand for a vehicle or pedestrian phase set by program flag.

MINIMUM VEHICLE RECALL (F-F-3)

A flag which places a recurring call to a Vehicle Phase during its Red and Yellow intervals, but does not act to extend Green timing beyond minimums.

GREEN REST (F-F-5)

This flag places a continuous call to Vehicle Phases **only** if there are no other hard calls present.

MAXIMUM VEHICLE RECALL (F-F-9)

A flag which places a continuous call to a Vehicle Phase and extends the Green interval to the "Max Extension" limit exactly like a constant Vehicle detector input would.

BARRIER RECALL (F-F-C)

This flag places a locked call **only** when service has crossed to the flagged phase's side of the barrier as the result of other demands.

ASSOCIATED PHASE RECALL (F-C-1 through F-C-8)

This feature assures that if a particular phase goes Green, one or more other flagged phases will receive a locked call. This call is dropped when its phase goes Green.

PED RECALL/ REST IN WALK (F-F-4) and STA MODE (F-F-7)

Both of these flags place a recurring call to a Pedestrian Phase and its associated Vehicle Phase. Once served, they cause service to remain in the Walk interval until an opposing call is received.

The above are all software generated recalls but there is also a hardware generated Ped Recall. This generally refers to a constant Pedestrian call through an external input by means of a switch on the Ped Isolator. Operation is the same as a software generated Ped Recall with one exception. This condition can be differentiated from a software generated Ped Recall by observing the Ped indication. With a Ped Isolator recall, after timing down the Walk interval, one second of the Flashing Don't Walk interval is timed and then the Walk interval is restarted. With the software generated Ped Recall, the Walk interval times down to 1 second and remains in that interval.

Hardware problems external to the controller cabinet can generate false Vehicle and/or Ped calls. A stuck Ped pushbutton, for example, will cause the same operation as Ped recall via the Ped Isolator switch. Open loop wiring or a defective loop detector module will have the same effect as setting a Vehicle Phase on Maximum Vehicle Recall.

PHASE FUNCTION FLAGS

General

LACO-3's Phase Function Flags allow the user to operate an intersection in a wide variety of configurations. Taken individually, the operation of each of these flags is very straightforward. When used in combination, however, exceptions to individual operation occur. An attempt is made to point out all of these exceptions but, i*t is the responsibility of the person implementing timing for a specific intersection to verify its operation.*

Phases Permitted (F-F-0)

Permitted Phases are those phases that the program recognizes during Normal operation. Permitted Phases do not change once set, unless modified via the 170 keypad. Any change in Permitted Phases takes effect immediately. If a phase is added to Permitted Phases and there is no Phase timing entered for that phase, its Minimum Green is set to 10 seconds and its Yellow Clearance is set to 5.0 seconds. If a phase is removed from Permitted Phases and that phase is timing its Green interval, it will continue in Green until its Minimums have timed out. At that point the program terminates the phase via force off (with or without an opposing call present).

Red Lock (F-F-1)

See Quick Reference Chart on Page 2 - 69

Red and Yellow Lock (F-F-2)

See Quick Reference Chart on Page 2 - 69

Minimum Recall (F-F-3)

See Quick Reference Chart on Page 2 - 69

Pedestrian Recall/Rest in Walk (F-F-4)

This feature is typically used when no Ped push buttons exist for a Ped Phase. An internal call is placed to the flagged Ped Phase (and a locked call to its associated Vehicle Phase) during its Flashing Don't Walk interval (including the solid Don't Walk portion). When the Walk interval begins again, it times down and stops with 1 second remaining and does not transition to Flashing Don't Walk until an opposing call occurs.

Green Rest (F-F-5)

Green Rest, in effect, acts as a conditional Minimum Vehicle recall causing an internal call to be placed for any flagged phases that are in their Red interval, as long as there is no external demand for other phases. Once the flagged phases are Green, or whenever a "hard" call is placed, the Green Rest recalls are dropped. A Green Rest call is not locked.

Normal phase selection would be the main street through phases (i. e. Ø2 and Ø6), but there is no restriction on which or how many phases may be flagged. As an extreme example, all 8 phases could be flagged. In this situation, the entire intersection would act as if it was on Minimum Vehicle recall until a vehicle actuation is sensed. At that time, all Green Rest generated calls are dropped until the actuation disappears. Operation of Green Rest may be delayed by entering Green Rest Delay time at F-0-8. The Green Rest Delay timer may be observed at E-F-d.

Red Rest (F-F-6)

Normally, when a phase gaps out and there are no opposing calls, it will continue to output Green, or "rest" in Green. This condition continues until an opposing call is placed. If, however, the phase is flagged for Red Rest, it will terminate when its gap timer expires. If the user has entered any Red Rest Delay time at F-0-7, the flagged phase will delay Red Rest operation until the Red Rest Delay timer (at E-1-F for Ring A and E-2-F for Ring B) expires. Red Rest does not cause a call to be placed, therefore the intersection will not go all Red unless the flagged phases are the last ones served.

Semi-Traffic Actuated (STA) Mode (F-F-7)

STA Mode is intended for situations in which the coordinated phase has no actuation of any kind, neither vehicle nor pedestrian. If such an intersection were non-coordinated the non-actuated phase(s) would naturally be flagged for "Ped Recall/Rest-in-Walk" at F-F-4. Flagging phases for STA Mode at F-F-7 achieves a similar result for the coordinated case. In fact, in "Free" operation, flags at F-F-7 result in the same operation as if F-F-4 were flagged.

"Rest-in-Walk" is achieved by timing out the Walk interval and stopping with one second remaining. When coordination is enabled, everything associated with the coordination works in the usual manner with the following DIFFERENCES:

a.)When an STA phase is timing, an opposing call will have no effect unless and until a Force Off is applied.

b.)If the minimums have timed and the signals are resting in Walk, the application of a Force Off, with an opposing call, will finish the remaining one second of the Walk interval and initiate Flashing Don't Walk.

c.)Once it has initiated the Flashing Don't walk sequence, the Force Off can be removed and the Flashing Don't Walk will continue to time to termination as long as the opposing call remains in place.

d.)If the opposing call is removed during the Flashing Don't Walk interval, service will revert to the beginning of a new Walk interval, even if the Force Off remains in place the whole time.

Double Entry (F-F-8)

The purpose of Double Entry is to guarantee that on a Barrier crossing, both Rings will be served, even if there is a call in only one Ring. If no call exists in a Ring at a Barrier crossing, a phase in the Ring flagged for Double Entry will receive a call at that time. A Double Entry cannot on its own cause a Barrier crossing.

Flagging a phase for Double Entry does not guarantee that it will always be served. For example, if Ø4 is flagged for Double Entry, and there is a call on Ø3, then at the Barrier crossing, Ø3 will time and **no** call will be placed for Ø4.

Double Entry phases are usually flagged in pairs (one Ring A phase and one Ring B phase on the same street, i.e. Ø4 and Ø8), although it is legitimate to flag only one phase. Note that it is meaningless to flag one phase in a quadrant for any type of "hard" recall and to flag the other phase in the same quadrant for Double Entry.

Maximum Recall

See Quick Reference Chart on Page 2 - 69

Restricted Phases (F-F-A)

For a detailed explanation of Restricted Phases see Page 2 - 45.

Protected/Permissive Left Turn (F-F-b)

Protected/Permissive Left Turn (PPLT) is designed to prevent the entrapment condition that can occur when a lag phase is terminated to reservice a Leading Left turn phase. Once the flagged phase's supplemental phase is served, the program will ignore any call to the flagged phase until a barrier crossing occurs. The flagged phase's call light will flash at a 1 Hz rate to indicate this condition.

A lag phase flagged for PPLT operation will never be served. This characteristic may be used to disable a particular LLT phase during Coordination without implementing coordination function "A", which would disable all LLT phases. Simply set the Lag phasing in the desired Dial so that the LLT phase is changed from lead to lag.

Barrier Recall (F-F-C)

Barrier Recall is used to guarantee service of one or more phases on crossing the barrier. A call is placed to the flagged phases when the opposite street is in service and there is a call to the same street as the flagged phases. If the cross street call drops before the barrier crossing occurs, the call to the Barrier Recall phases drops also. Once barrier crossing has occurred, the calls to Barrier Recall phases on that side of the barrier are locked.

First Phases after Startup (F-F-d)

This program allows the user to select the first phases to be served after a long power down. Only one phase in each Ring will be accepted. The phases flagged here will go Green after the 5.0 seconds of all Red (or Yellow Startup phases if any are flagged at F-F-E). If no phases are set at this location, the program will look for the first Permitted phases in each Ring to serve by default. LACO-3 will not allow more than one Restricted Phase to be set at F-F-d.

Yellow Startup (F-F-E)

Phases set at this location will output Yellow for a period of 5.0 seconds. Note that the Yellow interval of 5.0 seconds at Start Up is not selectable and does not affect the Yellow Clearance times set for individual Phases.

Overlap Yellow Startup (F-F-F)

Under normal Startup conditions, all 4 color Overlaps are set to output Red while 2 color Overlaps are set black. Any Overlap flagged at this location will start up Yellow if at least one of its parent phases is flagged for Yellow Startup at F-F-E. The flagged Overlap(s) will output Yellow for 5.0 seconds regardless of the Overlap Yellow Clearance time set on Page 1 of the LACO-3 timing sheets.

PHASE FUNCTION FLAGS QUICK REFERENCE			
INTERVAL	KEYSTROKES	FUNCTION	DESCRIPTION
0	F-F-0	Phases Permitted	Phases selected for Normal operation.
1	F-F-1	Red Lock	Red Lock causes any Vehicle actuation made during the Red interval of the flagged phases to place a locked call to those phases.
2	F-F-2	Red and Yellow Lock	Red and Yellow Lock causes any Vehicle actuation made during the Red **OR** Yellow interval of the flagged phases to place a locked call to those phases.
3	F-F-3	Minimum Vehicle Recall	Places Vehicle call only during the Red Interval of the flagged Vehicle Phase(s). Guarantees a recurring minimum Green interval for flagged phases.
4	F-F-4	Pedestrian Recall and Rest in Walk	Places a Pedestrian **AND** Vehicle call during the Flashing Don't Walk Interval of the flagged Pedestrian Phase. It will "Rest" in Walk at the end of its Walk interval in the absence of an opposing call.
5	F-F-5	Green Rest	Green Rest causes a call to be placed to flagged phases in the absence of **ANY** calls. Flagged phase(s) will "Rest" in Green after timing the minimums.
6	F-F-6	Red Rest	Red Rest causes the termination of flagged phase(s) as if in the presence of an opposing call. The terminated Phase then "Rests" in Red (Interval 8 is displayed).
7	F-F-7	Semi-Traffic Actuated (STA)	Identical to F-F-4, except the Walk Interval can only be terminated by a Coordination Force Off (in the presence of an opposing call) or Preemption.
8	F-F-8	Double Entry	Places a call for flagged Phase(s) only if crossing the Barrier **AND** if there is no other demand for that Phase's Ring on the new street. If cross Barrier call drops before Double Entry Phase is served then calls to Double Entry Phases drop also.
9	F-F-9	Maximum Vehicle Recall	Places a continuous Vehicle call to the flagged Phase(s). Termination of the flagged phase(s) is by Max or Force Off.
A	F-F-A	Restricted Phases	Prohibits flagged phases from timing concurrently.
b	F-F-b	Protected/Permissive Left Turns	Prevents a Lag Phase from "backing up" to its Lead Phase.
C	F-F-C	Barrier Recall	Barrier Recall places a locked call to the flagged phase when crossing to its side of the Barrier.
d	F-F-d	First Phases After Startup	Flagged phase(s) will be the first phases to start green after Red or Yellow Start-Up.
E	F-F-E	Yellow Startup	Flagged phases start in Yellow interval after a long power down and always time for 5.0 seconds.
F	F-F-F	Overlap Yellow Startup	Flagged Overlaps start in Yellow after a long power down (only if Overlaps' parent phase is flagged at F-F-E)

FIGURE 32 - LACO3 Phase Function Flags

WWV CLOCK

In order to implement Time Based Coordination an accurate time source must be used to periodically update the 170 controller's Real Time Clock. The Radio Corrected Time Base (RCTB) WWV Clock used by Los Angeles County receives and decodes the WWV/WWVH radio broadcasts transmitted by NIST (National Institute of Standards and Technology, formerly the National Bureau of Standards). It automatically corrects for Leap Year and Daylight Savings Time and, in the event of a power failure, automatically locks on to the WWV broadcast when power is restored.

The 170 controller downloads this extremely accurate time in a number of ways:

1. It automatically polls the WWV Clock after a power outage, either long or short.
2. It automatically polls the WWV Clock every hour on the hour.
3. It can manually poll the WWV Clock via the Front Panel keypad.

Before the 170 controller can utilize the WWV Clock data, the following conditions must be satisfied:

1. The desired Comm Port must be configured for WWV.

   Decide which Comm Port will be used for WWV. Comm Port 1, 2, 3 and 4 are configured at locations d-0-7, d-0-8, d-0-9 and d-0-A, respectively. Enter "1" at the desired location followed by "E". Only one Comm Port can be configured for WWV

2. The WWV Clock cable must be connected to the correct Comm Port.

   Viewing the 170 controller from the rear, the designations are, from left to right, Comm Port 1, Comm Port 2, Comm Port 3 (if installed) and Comm Port 4 (if installed).

3. The WWV Clock must be "locked on" to the WWV signal.

   If the WWV Clock has not "locked on" to the WWV signal, then the LACO-3 program will not allow a download. This is to prevent erroneous time from being downloaded.

To fmanually poll the WWV Clock, at location d-0-0 enter "1" followed by "E". A successful download is indicated if the Function display shows the Time display for 2.5 seconds followed by the Date display for 2.5 seconds followed by a retum to the Base display (pressing any key during the time/date display will retum immediately to Base display). If the display changes to "000" then the poll attempt was unsuccessful. Viewing location E-b-b (CLKERR) will provide a probable cause. Call light "8" indicates a defective WWV Clock. Call light "7" means that no Comm Port or multiple Comm Ports have been configured for WWV. Call light "6" indicates that the WWV Clock cable is not connected to the assigned Comm Port. If the display retains the "001" but changes to "000" briefly every 2 seconds, then the 170 is not receiving valid data (E-b-b call lights "1" or "2"), or the WWV Clock is not "locked on" (E-b-b call light "3"). In this situation the 170 will continually repoll until valid data is received from the WWV Clock, or a "0" is entered at location d-0-0. Disconnecting the WWV Clock or cable while performing a repoll (not recommended) fowill abort the repoll process.

SECTION III
APPENDICES

Table of Contents

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LOS ANGELES COUNTY
DEPARTMENT OF PUBLIC WORKS
TRAFFIC AND LIGHTING DIVISION
TRAFFIC SIGNAL TIMING

LACO - 3

TYPE 170 PROGRAM

Intersection: _____

T.S. No.: _____

Date Requested: _____ By: _____

Date Completed: _____ By: _____

PHASE TIMING

Keystrokes: F + Phase + Interval

Phase #		1	2	3	4	5	6	7	8
Minimum Walk	0								
Flashing Don't Walk	1								
Minimum Green	2								
Queue Maximum	3								
Added Green/Actuation	4								
Vehicle Extension	5								
Maximum Gap	6								
Minimum Gap	7								
Max Extension 1 (Free)	8								
Max Extension 2 (Coord)	9								
		OVLP A	OVLP B	OVLP C	OVLP D	OVLP E	OVLP F		
Ovlp Green Extension	A								
Ovlp Yellow Clearance	b								
Ovlp Red Clearance	C								
Reduce 0.1 Sec. Every...	d								
Yellow Clearance	E								
Red Clearance	F								

Red Rest Delay	F-0-7	
Green Rest Delay	F-0-8	
Max Added Green	F-0-E	
Red Revert	F-0-F	

Remarks:

PREEMPTION

Keystrokes: F + E + Function

RR Select (0, 1, 2)		0
RR Track Clearance		1
RR1 All Red		2
RR2 Maximum (Minutes)		3
Free Time After Preempt		4
EV- A Delay		5
EV- A Clearance		6
EV- B Delay		7
EV- B Clearance		8
EV- C Delay		9
EV- C Clearance		A
EV- D Delay		b
EV- D Clearance		C
EV Maximum (Seconds)		d
EV Delay/Clearance Timer		E
RR Delay/Clear/Mark Timer		F

PREEMPTION PHASES

Keystrokes: F + d + Function

		1	2	3	4	5	6	7	8
EV - A	0								
EV - B	1								
EV - C	2								
EV - D	3								
RR Track Clear	4								

PHASE FUNCTION FLAGS

Keystrokes: F + F + Function

		1	2	3	4	5	6	7	8
Phases Permitted	0								
Red Lock	1								
Red & Yellow Lock	2								
Minimum Vehicle Recall	3								
Pedestrian Recall & Rest in Walk	4								
Green Rest → (Set Delay F-0-8)	5								
Red Rest → (Set Delay F-0-7)	6								
Semi Traffic Actuated Mode	7								
Double Entry	8								
Maximum Vehicle Recall	9								
Restricted Phases	A								
Protected / Permissive Left Turn	b								
Barrier Recall	C								
First Phases After Start Up	d								
Yellow Start Up	E								
Overlap Yellow Start Up:	→	A	b	C	d	E	F		
(Parents *must* be Yellow Start Up)	F								

LAG PHASE FLAGS		1	2	3	4	5	6	7	8
Lag Free	d-F-0								
Lag Dial 1	d-F-1								
Lag Dial 2	d-F-2								
Lag Dial 3	d-F-3								
PEDESTRIAN PHASES		1	2	3	4	5	6	7	8
2 Ped Load Switch	d-F-4								
4 Ped Load Switch	d-F-5								
6 Ped Load Switch	d-F-6								
8 Ped Load Switch	d-F-7								

True North	Phase North	1	2	3	4
		5	6	7	8

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LOS ANGELES COUNTY
DEPARTMENT OF PUBLIC WORKS
TRAFFIC AND LIGHTING DIVISION
TRAFFIC SIGNAL TIMING

LACO-3 DETECTOR ASSIGNMENTS

*Intersection:*_____ *Date Requested:*_____ *By:*____

*T.S. No.:*_____ *Date Completed:*_____ *By:*____

NOTE: Ensure ALL Blank Data Fields are set to ZERO or CLEARED.			Detector Timing					Detector Assignments														
			File-Slot-Channel	Delay		Extended Call		Phase Flags								Attribute Flags						
App	Lanes	Description		Code	Seconds	Code	Seconds	Code	1	2	3	4	5	6	7	8	Code	1	2	3	4	5	6
			I1U	d10		d30		db0									dd0						
			I1L																				
			I2U	d11		d31		db1									dd1						
			I2L	d12		d32		db2									dd2						
			I3U	d13		d33		db3									dd3						
			I3L	d14		d34		db4									dd4						
			I4U	d15		d35		db5									dd5						
			I4L																				
			I5U	d16		d36		db6									dd6						
			I5L																				
			I6U	d17		d37		db7									dd7						
			I6L	d18		d38		db8									dd8						
			I7U	d19		d39		db9									dd9						
			I7L	d1A		d3A		dbA									ddA						
			I8U	d1b		d3b		dbb									ddb						
			I8L																				
			I9U	d1C		d3C		dbC									ddC						
			I9L	d1d		d3d		dbd									ddd						
			J1U	d20		d40		dC0									dE0						
			J1L																				
			J2U	d21		d41		dC1									dE1						
			J2L	d22		d42		dC2									dE2						
			J3U	d23		d43		dC3									dE3						
			J3L	d24		d44		dC4									dE4						
			J4U	d25		d45		dC5									dE5						
			J4L																				
			J5U	d26		d46		dC6									dE6						
			J5L																				
			J6U	d27		d47		dC7									dE7						
			J6L	d28		d48		dC8									dE8						
			J7U	d29		d49		dC9									dE9						
			J7L	d2A		d4A		dCA									dEA						
			J8U	d2b		d4b		dCb									dEb						
			J8L																				
			J9U	d2C		d4C		dCC									dEC						
			J9L	d2d		d4d		dCd									dEd						

REMARKS:

DETECTOR ATTRIBUTES	
FLAG 1 - Red Lock	FLAG 5 - Queue Clearing
FLAG 2 - Red & Yellow Lock	FLAG 6 - Non-Counting
FLAG 3 - Yellow Disconnect	FLAG 7 - Special Delay Option
FLAG 4 - Red Calling	FLAG 8 - Special Delay Option

SPECIAL DETECTOR DELAY ASSIGNMENTS		Phase					
	Code	1	2	3	4	5	6
All options: Delay Timer resets during detector phase yellow.							
Special Delay Option 1 (Attribute Bit 7) - Bypasses delay while flagged phase(s) are timing.	d-d-E						
Special Delay Option 2 (Attribute Bit 8) - Bypasses delay while flagged phase(s) are timing.	d-d-F						
Special Delay Option 3 (Attribute Bits 7 & 8) - Bypasses delay when other phase in same quadrant IS NOT Green (1:2) (3:4) (5:6) (7:8).							
Example: Ø1 Detector delay will be overridden while Ø2 is Yellow or Red.							

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LOS ANGELES COUNTY
DEPARTMENT OF PUBLIC WORKS
TRAFFIC AND LIGHTING DIVISION
TRAFFIC SIGNAL TIMING

LACO-3 COORDINATION

T.S. No.:_____ Intersection:_____

System Limits :_____

Remote Master:_____ Date Requested:_____ By:__

System No.:_____ Date Completed:_____ By:__

TIME OF DAY OPERATION SUMMARY			
	Dial 1	Dial 2	Dial 3 / Offset Timing
Offset 1			
Offset 2			
Offset 3			
Free			
Special			

SYNC PARAMETERS

d-0-d System Sync Width 2.0 Seconds

d-0-E Set Maximum Width 4.0 Seconds

d-0-F Set Minimum Width 1.0 Seconds

Remarks:

* Set Local Manual to 14 (free before setting or changing di intervals & functions. Setting either of the Manuals to 0 will release that Manual.

Local Manual C

11 = Slave Mode

12 = Offset Timing Mode

14 = Free Operation

Observe:

Calls d

Hold d

Ped Restrict d

Force Off d

Local Cycle Timer with Field Calls C

Keystrokes: C + Column + Row

		INTERVALS (in seconds)			FUNCTION FLAGS											
					DIAL 1				DIAL 2				DIAL 3 / OFFSET TIMING			
Coordination Parameters		Dial 1	Dial 2	Dial 3	Force Off	Hold	Ped Retrict	Call	Force Off	Hold	Ped Retrict	Call	Force Off	Hold	Ped Retrict	Call
0	Int	1	2	3	4	5	6	7	8	9	A	b	C	d	E	F
System Manual *	0															
Local Manual *	1															
Master Dial	2															
Local Dial	3															
Offset Number	4															
Time of Day Plan	5															
Function 6	6															
Current Table	7															
Minimum Cycle	8															
Maximum Cycle	9															
Master Timer	A															
Local Timer	b															
System Timer	C															
Current Offset	d															
Last Master Cycle	E															
Last Local Cycle	F															

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LOS ANGELES COUNTY
DEPARTMENT OF PUBLIC WORKS
TRAFFIC AND LIGHTING DIVISION
TRAFFIC SIGNAL TIMING

LACO-3 SPECIAL FUNCTIONS

*Intersection:*_____ *Date Requested:*_____ *By:*__

*T.S. No.:*_____ *Date Completed:*_____ *By:*__

OVERLAP PHASE FLAGS

Phases →		1	2	3	4	5	6	7	8
Overlap A	F-A-A								
Overlap B	F-A-b								
Overlap C	F-A-C								
Overlap D	F-A-d								
Overlap E	F-A-E								
Overlap F	F-A-F								

OVERLAP GREEN OMIT FLAGS

Phases →		1	2	3	4	5	6	7	8
Overlap A	F-b-A				\				
Overlap B	F-b-b								
Overlap C	F-b-C								
Overlap D	F-b-d								
Overlap E	F-b-E								
Overlap F	F-b-F								

RAILROAD PREEMPT OVERLAP FLAGS

Phases →		1	2	3	4	5	6	7
Overlap A	F-C-A							
Overlap B	F-C-b							
Overlap C	F-C-C							
Overlap D	F-C-d							
Overlap E	F-C-E							
Overlap F	F-C-F							

EMERGENCY VEHICLE PREEMPT OVERLAP FLAGS

Phases →		1	2	3	4	5	6	7	8
Overlap A	F-d-A								
Overlap B	F-d-b								
Overlap C	F-d-C								
Overlap D	F-d-d								
Overlap E	F-d-E								
Overlap F	F-d-F								

LOAD SWITCH ASSIGNMENT

Ped A to Overlap A **	F-9-A	
Ped B to Overlap B **	F-9-b	
Send Overlap C Output to Phase	F-9-C	
Send Overlap D Output to Phase	F-9-d	
Send Overlap E Output to Phase	F-9-E	
Send Overlap F Output to Phase	F-9-F	

Overlap Notes:

2-Color Overlap (A - B) 3-Color Overlap (C -

Unused Right Turn Overlap outputs may be assigned as additional Peds.

PED A uses J11U for Ped Pushbutton Input.

PED B uses J11L for Ped Pushbutton Input.

** Set Vehicle Phases for Ped A/B to time wit

USER FLAG OPTIONS

Keystrokes: d + E + F

			USER FLAG NOTES
True Maximum Extension	1		The True Maximum Extension flag does NOT allow a maxed out Phase to extenc
EV Pedestrian Clearance NOT Protected	2		EV Clearance is NOT protected when this flag is set.
	3		Unused.
Mid-Block Pedestrian Crossing	4		Phases 2 & 6 Red Flash during Phase 4 Ped Protection.
Delay RR Track Clearance Phase Green	5		Delays Track Clearance until Overlaps time out.
Echo Remote Coordination Input to Output	6		SUB-MASTER OPERATION: Echo Slave Data to Master Output.
Enable Manual Control	7		Enables Manual Advance Operation. Requires MANUAL Switch.
Delay EV Clearance Phase Green	8		Delays EV Clearance until Overlaps time out.

ASSOCIATED PHASE RECALL

A Locked Call is placed on the Flagged Phase when the Associated Recall Phase is Green.

Flagged Phase →		1	2	3	4	5	6	7	8
Phase 1	F-C-1								
Phase 2	F-C-2								
Phase 3	F-C-3								
Phase 4	F-C-4								
Phase 5	F-C-5								
Phase 6	F-C-6								
Phase 7	F-C-7								
Phase 8	F-C-8								

PHASE / OVERLAP REASSIGNMENTS

Phases →		1	2	3	4	5	6	7	8
Phase Driveway Flash	F-A-0								
Phase Yellow Ranging *	F-A-1								
Overlaps →		**A**	**B**	**C**	**D**	**E**	**F**		
Overlap Driveway Flash	F-A-2								
Overlap Yellow Ranging *	F-A-3								
Ped 2 Load Switch Overlap	F-A-4								
Ped 4 Load Switch Overlap	F-A-5								
Ped 6 Load Switch Overlap	F-A-6								
Ped 8 Load Switch Overlap	F-A-7								

Notes:

* Phase / Overlap Yellow Ranging - These Flags remove the minimum a maximum limits on the yellow settin

Remarks:

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LOS ANGELES COUNTY
DEPARTMENT OF PUBLIC WORKS
TRAFFIC AND LIGHTING DIVISION
TRAFFIC SIGNAL TIMING

LACO - 3 EVENT TABLES

*Intersection:*_____ *Date Requested:*_____ *By:*___

*T.S. No.:*_____ *Date Completed:*_____ *By:*___

TABLE 0 - DEFAULT			s	m	t	w	t	f	s
Code	Hour : Min	Plan	1	2	3	4	5	6	7
0-0	:								
0-1	:								
0-2	:								
0-3	:								
0-4	:								
0-5	:								
0-6	:								
0-7	:								
0-8	:								
0-9	:								
0-A	:								
0-b	:								
0-C	:								
0-d	:								
0-E	:								
0-F	:								

TABLE 3			s	m	t	w	t	f	s
Code	Hour : Min	Plan	1	2	3	4	5	6	7
3-0	:								
3-1	:								
3-2	:								
3-3	:								
3-4	:								
3-5	:								
3-6	:								
3-7	:								
3-8	:								
3-9	:								
3-A	:								
3-b	:								
3-C	:								
3-d	:								
3-E	:								
3-F	:								

SLAVE MODE TABLE			s	m	t	w	t
Code	Hour : Min	Dial	1	2	3	4	5
5-0	:						
5-1	:						
5-2	:						
5-3	:						
5-4	:						
5-5	:						
5-6	:						
5-7	:						
5-8	:						
5-9	:						
5-A	:						
5-b	:						
5-C	:						
5-d	:						
5-E	:						
5-F	:						

TABLE 1			s	m	t	w	t	f	s
Code	Hour : Min	Plan	1	2	3	4	5	6	7
1-0	:								
1-1	:								
1-2	:								
1-3	:								
1-4	:								
1-5	:								
1-6	:								
1-7	:								
1-8	:								
1-9	:								
1-A	:								
1-b	:								
1-C	:								
1-d	:								
1-E	:								
1-F	:								

Plan = Plan Number

O/D	D1	D2	D3
O1 =	1	2	3
O2 =	4	5	6
O3 =	7	8	9

Keys:

0 = No Days
8 = All Days
9 = Week Days

Functions:

A = Protected/Permissive Arrows (F-F-b) Disabled.

b = Slave Mode (2 Wire / 7 Wire Input).

C = Offset Timing Mode

d = T.O.D. Output (Detector Reset Line) "ON".

E = Free

F = Reset Functions A & d.

Table 6:

C = Continue the Floating Holiday by C (0-9) days.

N^{th} = The number of the occurence in the month (1-5, 9 = Always the last occurence in the month).

i.e. Thanksgiving = 11/1/4 [table] flag Thursday and continues 1 extra day.

FLOATING HOLIDAYS			s	m	t	w	t
Code	Month / C / N^{th}	Table	1	2	3	4	5
6-0	01 / 0 / 3	1		X			
6-1	02 / 0 / 3	1		X			
6-2	05 / 0 / 9	1		X			
6-3	09 / 0 / 1	1		X			
6-4	11 / 1 / 4	1					X
6-5	/ /						
6-6	/ /						
6-7	/ /						
6-8	/ /						
6-9	/ /						
6-A	/ /						
6-b	/ /						
6-C	/ /						
6-d	/ /						
6-E	/ /						
6-F	/ /						

TABLE 2			s	m	t	w	t	f	s
Code	Hour : Min	Plan	1	2	3	4	5	6	7
2-0	:								
2-1	:								
2-2	:								
2-3	:								
2-4	:								
2-5	:								
2-6	:								
2-7	:								
2-8	:								
2-9	:								
2-A	:								
2-b	:								
2-C	:								
2-d	:								
2-E	:								
2-F	:								

TABLE 4			s	m	t	w	t	f	s
Code	Hour : min	Plan	1	2	3	4	5	6	7
4-0	:								
4-1	:								
4-2	:								
4-3	:								
4-4	:								
4-5	:								
4-6	:								
4-7	:								
4-8	:								
4-9	:								
4-A	:								
4-b	:								
4-C	:								
4-d	:								
4-E	:								
4-F	:								

EXCEPTION DAYS			s	m	t	w	t	f
Code	Month / Day	Table	1	2	3	4	5	6
7-0	01 / 01	1		X	X	X	X	X
7-1	01 / 02	1		X				
7-2	07 / 04	1		X	X	X	X	X
7-3	07 / 05	1		X				
7-4	11 / 10	1						X
7-5	11 / 11	1		X	X	X	X	X
7-6	11 / 12	1		X				
7-7	12 / 24	1		X	X	X	X	X
7-8	12 / 25	1		X	X	X	X	X
7-9	12 / 26	1		X				X
7-A	/							
7-b	/							
7-C	/							
7-d	/							
7-E	/							
7-F	/							

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LOS ANGELES COUNTY
DEPARTMENT OF PUBLIC WORKS
TRAFFIC AND LIGHTING DIVISION
TRAFFIC SIGNAL TIMING

LACO-3 ANNUAL TABLES

*Intersection:*_____ *Date Requested:*_____ *By:*__

*T.S. No.:*_____ *Date Completed:*_____ *By:*__

ANNUAL EVENTS			s	m	t	w	t	f	s
Code	Month / Day	Table	1	2	3	4	5	6	7
8-0	/								
8-1	/								
8-2	/								
8-3	/								
8-4	/								
8-5	/								
8-6	/								
8-7	/								
8-8	/								
8-9	/								
8-A	/								
8-b	/								
8-C	/								
8-d	/								
8-E	/								
8-F	/								

ANNUAL EVENTS			s	m	t	w	t	f	s
Code	Month / Day	Table	1	2	3	4	5	6	7
9-0	/								
9-1	/								
9-2	/								
9-3	/								
9-4	/								
9-5	/								
9-6	/								
9-7	/								
9-8	/								
9-9	/								
9-A	/								
9-b	/								
9-C	/								
9-d	/								
9-E	/								
9-F	/								

NOTES ON USING TABLES:

Starting from the base display [A/b], Tab
access is gained with a two digit Table C
Access is verified by the flashing of Call
Light 9.

Five keypresses will be required followe
[E] to enter the data and open the flag m
Day of Week flags can now be set.

ADDITIONAL KEY CODES:

A-C = Clock Display
A-d = Date Display

d-0-0 = 1 Force Repoll of WWV Receiver
d-0-1 = Hour of Last Repoll
d-0-2 = Minute " "
d-0-3 = Second " "
d-0-4 = Month " "
d-0-5 = Day " "
d-0-6 = Year " "

OBSERVE ONLY :

E-3-8 = Ring A Max Timer
E-4-8 = Ring B Max Timer
E-6-3 - 4 T.O.D. Output
E-6-3 - 5 Offset Timing Mode
E-6-3 - 6 Slave Mode
E-6-3 - 7 Maximum Extension 2 (Coord)
E-6-3 - 8 Leading LT phases Disabled

F-0-0 = Phase / Dial Copy - Source
Phase (1-8) Dial (11-13)
F-0-1 = Phase / Dial Copy - Destination
Phase (1-8) Dial (11-13)
F-0-2 = Table/Dial Insert/Delete - Target
Table (1-9), Table 0 (10) Dial (11-
F-0-3 = Table/Dial Insert/Delete - Interva
Insert 001-015 (16 = Interval 0)
Delete 101-115 (16 = Interval 0)
F-0-4 = Program Number.
F-0-5 = Version Number.

F-0-A = 071 Save Timing to Prom Modu
F-0-A = 170 Download Timing into 170.
F-0-A = 777 Reinitialization from NOVR
F-0-A = 888 Reinitialization from EPRO
F-0-A = 999 Clears All Tables and Load
Default Holiday Events.

OFFSETS			
Keystrokes: F + 9 + CODE			
OFFSET 1	Dial 1	1	
	Dial 2	2	
	Dial 3	3	
OFFSET 2	Dial 1	4	
	Dial 2	5	
	Dial 3	6	
OFFSET 3	Dial 1	7	
	Dial 2	8	
	Dial 3	9	

COMMUNICATIONS ASSIGNMENTS		
Keystrokes: d + 0 + FUNCTION		
PORT 1	7	
PORT 2	8	
PORT 3	9	
PORT 4	A	

0 = Off
1 = WWV Radio Receiver
2 = ML2 Protocol - Coord OUT only
4 = ML2 Protocol - Coord IN & OUT
7 = ML2 Protocol - Coord IN only
8 = Remote Monitoring (Future)
12 = Sends Time/Date String Out of Modem
17 = Receives Time/Date String from Modem

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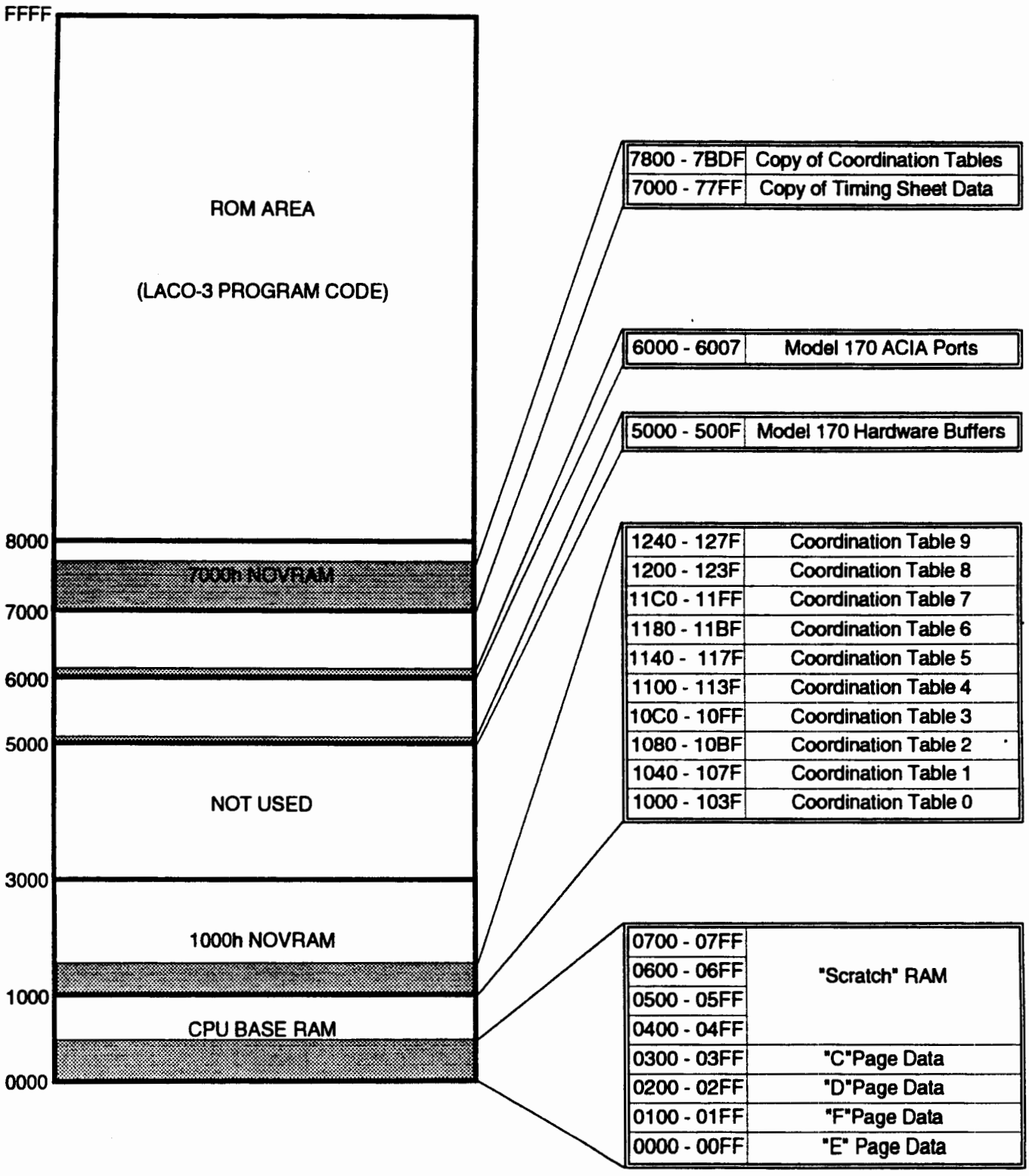
Type 170 Controller Memory Mapping under LACO-3



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	E0	E1	E2	E3	E4	E5	E6	E7	E8	E9	EA	EB	EC	ED	EE	EF	
0	DISPFG	RAIDX	RBIDX	RAWALK	RBWALK	XTEMP	SICBIT	SVPED	IN1	OUT1	GFAZE	STRFLG	TEMP			OLATMR	0
1	PGADD	RAFZAT	RBFZAT	RADWLK	RBDWLK		ICBIT	SVVEH	IN2	OUT2	WFAZE	DYNRST	TEMP1			OLBTMR	1
2		RASPFZ	RBSPFZ	RAMGRN	RBMGRN	XTEMP1	RMT7WR	EVCLRT	IN3	OUT3	DWFAZE	VNMI	TEMP2			OLCTMR	2
3	KEYFLG	RBTERM	RATERM	RAINIT	RBINIT		MAX2	EVTYPE	IN4	OUT4	YFAZE	PFLAG	TEMP3			OLDTMR	3
4	SAVFZ	RBRFAZ	RARFAZ	RACGAP	RBCGAP	XTEMP2	CRDERR	RRPED	IN5	OUT5	RFAZE	ADDX	TEMP4			OLETMR	4
5	SAVINT	RANEXT	RBNEXT	RAVEXT	RBVEXT		CLITE0	RRPRE	IN6	OUT6	FAZIN		TEMP5			OLFTMR	5
6	BCD1	RATEMP	RBTEMP	RAMXGP	RBMXGP	RNGIDX	MTRDLX	EVPRE	IN7	OUT7	OGFAZE	BPTSAV	TEMP6			OLARVT	6
7	BCD2	RBSTAT	RASTAT	RAMGAP	RBMGAP			UNUSED	IN8	OUT8	OYFAZE		TEMP7			OLBRVT	7
8	BCD3	RATRMF	RBTRMF	RACRMX	RBCRMX	BARSET	DIALX	RRTYPE	IN1L	OUT9	LOKPAR	BYTCNT	QSTACK			OLCRVT	8
9	HEX1	RAFAZD	RBFAZD	RASEC	RBSEC	DETRLK		EVTEMP	IN2L	OUTA	LAG	BYTTIM				OLDRVT	9
A	TABLE	RAINTD	RBINTD	RACINT	RBCINT	DETYLK	QUEACT	ALLOW	IN3L	OUT90	ADVAN	BYTCTR				OLERVT	A
B	EVENT	RALAST	RBLAST	RARREV	RBRREV	CHKSUM	LOCK	PED	IN4L	CALLIT	IRCALL	CLKERR				OLFRVT	B
C	KEYPTR	RACOLR	RBCOLR	RAQULM	RBQULM	MEMTST	LOKNON	LEAD	IN5L	OLFZIN	XBARFZ	ERRFLG				RRSEC	C
D				RASTEP	RBSTEP		RSTFLG	RNGOTH	IN6L	OLGFZ	VCALL	FOUND				GRSTMR	D
E	FLOATB	RATIMX	RBTIMX	RAYCLR	RBYCLR	SYMFLG	C17M	N17M	IN7L	OGNOMT	PCALL	SYSFLG				EVMAX	E
F	KEYBRD	RARTMR	RBRTMR	RARCLR	RBRCLR	PORTFG	C100M	N100M	IN8L	RSTNXT	CALL	MEMFLG			STACK	RR2MAX	F
	E0	E1	E2	E3	E4	E5	E6	E7	E8	E9	EA	EB	EC	ED	EE	EF	

"E" Page RAM Map

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	F0	F1	F2	F3	F4	F5	F6	F7	F8	F9	FA	FB	FC	FD	FE	FF	
0	SOURCE	FAZ1TIM	FAZ2TIM	FAZ3TIM	FAZ4TIM	FAZ5TIM	FAZ6TIM	FAZ7TIM	FAZ8TIM	FLOATS	DRWYFZ	DYNOLA	UNUSED	EVAFZ	RRSEL	PERMIT	0
1	DEST									D1_O1	YRNGFZ	DYNOLB	ASSOC1	EVBFZ	RRCLTM	RLOCK	1
2	INSDEL									D2_O1	DRWYOL	DYNOLC	ASSOC2	EVCFZ	RR1RED	YLOCK	2
3	NTRVAL									D3_O1	YRNGOL	DYNOLD	ASSOC3	EVDFZ	RRMXTP	VRCAL	3
4	RAMTST									D1_O2	PED2OL	DYNOLE	ASSOC4	RRCLFZ	MRKTIM	WREST	4
5	RAMTST1									D2_O2	PED4OL	DYNOLF	ASSOC5	RRLMFZ	EVADLT	GREST	5
6	RAMTST2									D3_O2	PED6OL	UNUSED	ASSOC6	RRXTFZ	EVACLT	RREST	6
7	RRSTIM									D1_O3	PED8OL	UNUSED	ASSOC7	UNUSED	EVBDLT	STA	7
8	GRSTIM									D2_O3	RANTVL	UNUSED	ASSOC8	UNUSED	EVBCLT	DBLENT	8
9	PAGKEY									D3_O3	RBNTVL	UNUSED	CRSRNG	UNUSED	EVCDLT	VXCALL	9
A	SPFUNC									PEDA	OVLPA	AGOMIT	RROLA	EVOLA	EVCCLT	RSTRCT	A
B	UNUSED									PEDB	OVLPB	BGOMIT	RROLB	EVOLB	EVDDLT	LLAROW	B
C	PWRL									OVLPSC	OVLPC	CGOMIT	RROLC	EVOLC	EVDCLT	BARIER	C
D	PWRS									OVLPSD	OVLPD	DGOMIT	RROLD	EVOLD	EVMXTP	FAZ1ST	D
E	MXINIT									OVLPSE	OVLPE	EGOMIT	RROLE	EVOLE	EVTMR	START	E
F	REVRT									OVLPSF	OVLPF	FGOMIT	RROLF	EVOLF	MRKTMR	STRTOL	F
	F0	F1	F2	F3	F4	F5	F6	F7	F8	F9	FA	FB	FC	FD	FE	FF	

"F" Page RAM Map

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	D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	DA	DB	DC	DD	DE	DF	
0	TXMSG	DETIDX	DETJDX	DETICO	DETJCO	DETIVA	DETJVA	DTIDTM	DTFJTM	DTICTM	DTJCTM	IDETFZ	JDETFZ	IDETAT	JDETAT	LAG0	0
1	WHOUR															LAG1	1
2	WMINUT															LAG2	2
3	WSECND															LAG3	3
4	WMONTH															PED2	4
5	WDAY															PED4	5
6	WYEAR															PED6	6
7	COMPRT1															PED8	7
8	COMPRT2															UNUSED	8
9	COMPRT3															UNUSED	9
A	COMPRT4															DATER1	A
B	MONERR															DATER2	B
C	NOMFLG															COCALL	C
D	SYSYNC															HOLD	D
E	MAXPUL	NEWOFF	CYCLEN	MSYNC	SLVCP	TXDLY	RMTSNC	TIMTMR	DATTMR	UNUSED	MINDN	COMERR	RXBC	DELOP1	UNUSED	PEDRST	E
F	MINPUL	HOUR	MINUTE	DOW	SECOND	DOM	YEAR	DATDOW	MONTH	DIM	SECDN	CRDATA	TXBC	DELOP2	USERFG	FORCE	F
	D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	DA	DB	DC	DD	DE	DF	

"D" Page RAM Map

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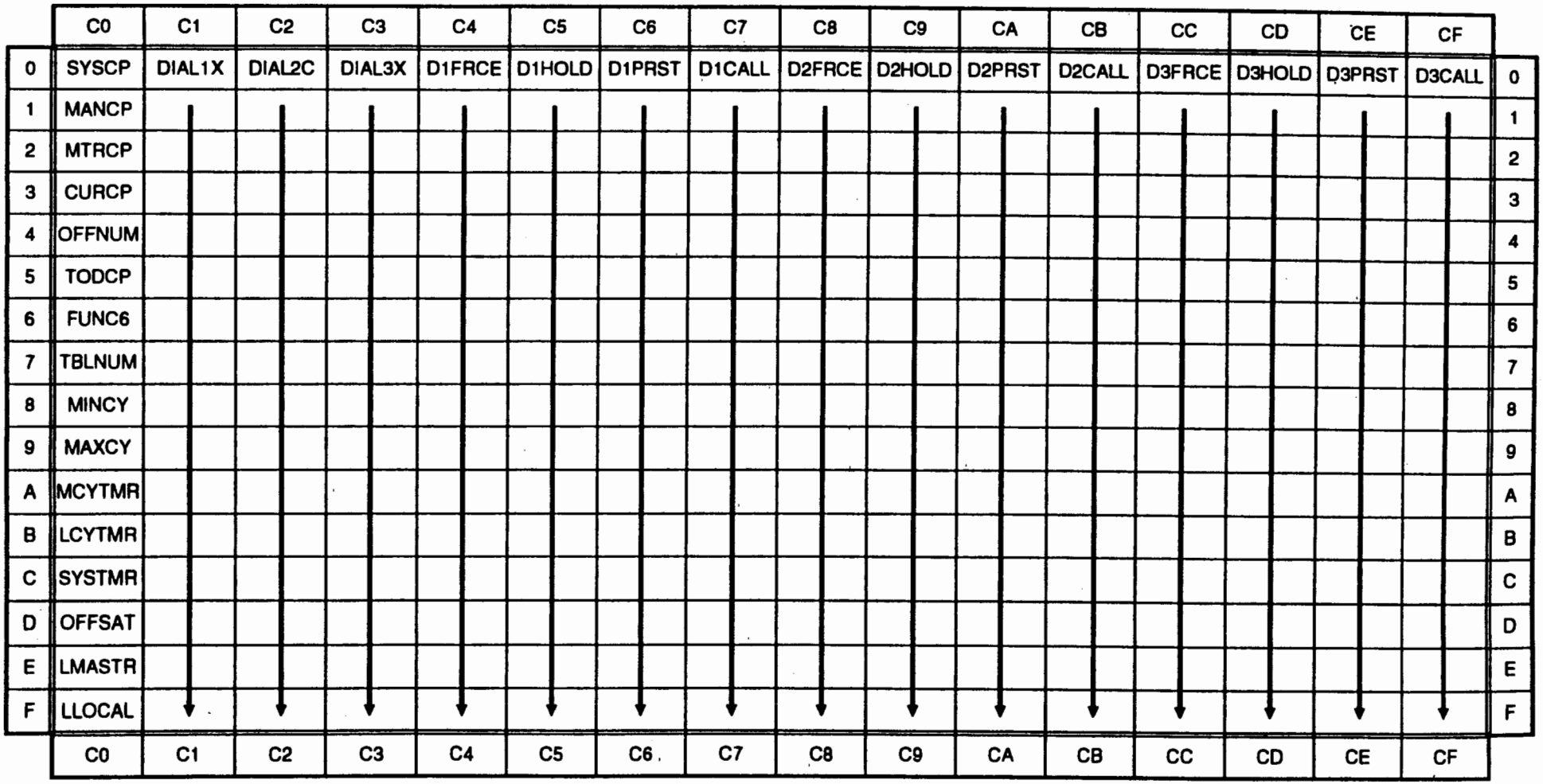

"C" Page RAM Map

GLOSSARY of TERMS and ACRONYMS

TERMS

Ø - see Phase.

Added Green Per Actuation- Typically used for Advance loops where no First Vehicle loops exist. Each actuation of the Advance loops during Phase Red increments a counter which is used in place of Minimum Green if its value exceeds that parameter

Advance- Cause immediate termination of a Phase in service at the beginning of a Railroad preempt. see also Manual Advance.

Advance Loop- Position of loops typically 200 to 250 feet ahead of an intersection.

Allowed Phases- The phases that the Program is currently recognizing as valid. These may change with a Railroad or EV preempt.

Alternate Phase- see Supplemental Phase

Artery- A primary route with a moderately high traffic volume. A Main street as opposed to a Side street.

Associated Phase Recall- A feature that assures that if a particular Phase goes Green, one or more other flagged phases will receive a locked call.

Asynchronous Communications Input Adapter (ACIA)- Serial data port. Allows communications between the 170 controller and external hardware.

Attribute- One of 9 assignable characteristics specifying a particular Detector operation.

BADA- An indication on the Function display that shows during reinitializatin or when the program detects corrupted data in the CPU Base RAM. Toggling the Front Panel Stop Time switch clears the RAM and restarts the program.

BADE- An indication on the Function display that shows when the program detects corrupted data on the EPROM chip itself. In this case the EPROM must be replaced.

Barrier- The imaginary line that separates Main street phases/movements from Side street phases/movements.

Barrier Recall (F-F-C)- BARRIER RECALL places a locked call to the flagged Phase when service crosses to its side of the Barrier.

Call- see Demand

Call/Active light- One of eleven red LEDs located on the Front Panel of the 170 controller used to indicate various conditions, flags or data.

Caltrans- California Department of Transportation.

Clearance- In the most general sense, any phase or interval intended to empty an intersection in preparation for another phase or condition (such as flash). Examples include Railroad clearance, EV clearance, Yellow clearance, Ped clearance and Exit clearance. In a more narrow context, the term is often used to denote those intervals from the beginning of Yellow to the beginning of Green of the next conflicting phase.

Clearance phases- see Clearance.

Concurrent phases- Phases that may be in service at the same time.

Conflict- Condition where 2 or more non-concurrent phases erroneously time together.

Conflict Monitor Unit (CMU)- Safety device whose primary function is to detect a Conflict condition and set hardware Flash.

Coordination- A system for synchronizing the operation of successive intersections to assure uninterrupted traffic flow.

Counts- A total of Vehicle actuations for any particular detector input occurring during Phase Red.

Cycle- The time allotted for one complete Coordination sequence.

Day of Week (DOW)- Sunday, Monday, Tuesday, Wednesday, Thursday, Friday or Saturday. Used in Time of Day tables and Real Time Clock displays.

Default- A value set by the Program in the absence of user set data.

Delay- The postponement of program action for a programmable time interval following some event such as a Vehicle detector call.

Demand- A request for service by a Ped/Vehicle movement.

Density- A measure of how many vehicles per second are passing a particular point in a lane street.

Detection- The sensed presence of a vehicle or the equipment assigned to this task.

Detector- The electronic module responsible for sensing the presence of a vehicle over a loop at a particular position in a lane and placing a call to the controller.

Dial- An imaginary clock (in analogy to older mechanical units) with user- defined time markers used to toggle on and off Coordination Functions (Call, Hold, Force Off, Ped Restrict). It runs continuously in the background and makes one revolution in one cycle before repeating.

Diamond Interchange Program- A program developed by Caltrans for freeway ramp monitoring.

Don't walk- see Ped Clearance

Double Entry (F-F-8)- Guarantees service to selected Ring(s) when crossing the Barrier. A Phase so flagged will be served when crossing the barrier if no other calls exist in that ring on that side of the barrier.

Down Time Accumulator (DTA)- A timer inside the 170 controller which keeps track of the duration of any A. C. power failures up to a total of 255 minutes. It is used by the program to correct the 170 Real Time clock when power is restored.

Driveway Flash- A phase so flagged will flash its Green output when timing its normal Green intervals. Other intervals and outputs for that phase are unaffected.

Emergency Vehicle (EV)- A preempt routine intended to clear an intersection and give right-of-way to certain phases being used by emergency vehicles.

Entrapment- A situation where a vehicle may legally turn left on a Yellow ball indication but is prevented from safely completing the turn because the opposite through Phase remains Green. If the Yellow interval expires, the vehicle may be trapped in the middle of the intersection facing a Red indication but unable to turn.

Erasable Programmable Read Only Memory (EPROM)- A data memory device in the 170 controller which can be read but not written to by the controller.

EV clearance- That portion of an EV preempt where the intersection rests in the phases devoted to giving right-of-way to emergency vehicles.

EV delay- A timer which postpones the Forcing off of non-EV clearance Phases.

Event- A programmable time marker used to initiate or disable Coordination functions.

Event table- A listing of specific times (Months, Days, Hours, Minutes) defining Coordination events and selecting the action to be taken at that time.

Exception days- Special calendar days which depart from normal Coordination.

Exclusive Phase- A Phase that has no concurrent phases, i. e. can only time by itself.

Exit Clearance- A Vehicle Phase or movement devoted to moving vehicles out of an intersection. Typically used at very wide intersections to extend the Green in order to clear out the intersection after the normal through Phase terminates.

Exit phases- The first regular Phases served upon leaving a RR1 Flash preempt.

Extension- The amount of time a vehicle actuation (call) prolongs the green time for a particular Phase.

First Phases After Start Up (F-F-d)- Flagged phases will be first phases to start Green after Red or Yellow start up.

Flag- A User settable indication of the ON/OFF status of any of a number of program parameters. Generally it indicates one or more of eight items which, when selected, light up LEDs on the 170 Controller Front Panel.

Flash- A condition of the signals where the Yellow and Green indications are dark and all Red indications alternate ON and OFF at approximately 1 Hz.

Flashing Don't Walk- The interval during which the Pedestrian signals flash Red ("DON'T WALK" or "HAND" symbol).

Floating holidays- Those holidays that fall on different calendar days from year to year.

Force Off- To cause termination of the Phase presently timing. Effective only if there is an opposing call and the "Minimum" intervals (Minimum Green, Added Initial, Walk and Flashing Don't Walk) have expired.

Free- Not coordinated.

Function 6- A Coordination input which forces the Coordination into a preselected Dial or Free.

Gap- A space between moving vehicles or the time interval between sequential detector actuations caused by that spacing.

Gap Out- The termination of a phase, in the presence of a conflicting call, caused by a gap of sufficient duration.

Gap Reduction- A programmed diminishing of the Gap time required to allow termination of a Phase.

Gap Termination- Same as "Gap Out"

Green band- An interval of guaranteed Green time on a Time-Space diagram that progresses from one intersection to the next along with an assumed platoon of vehicles to assure that they can continue through adjacent intersections uninterrupted.

Green Extension- An interval which delays the Green to Yellow transition of an Overlap beyond the Green to Yellow transition of its parent Phase when the two would otherwise occur simultaneously.

Green Omit- A flag to omit from an Overlap the Green interval of one or more of its parent Phases. Typically used with two-color right turn Overlaps to turn off the Green arrow during the through phase Ped and Green intervals.

Green Rest (F-F-5)- GREEN REST Places a call to flagged phases in the absence of **any** calls. Flagged Phase(s) will "rest" in Green after timing minimums.

Hardware Flash- A flash condition wherein the Red signal indications are removed from program control by switching them with mechanical relays to be driven by separate dedicated flasher units. The CMU initiates flash by utilizing this capability. (Compare with Software Flash)

Hold-To extend the duration of the Green interval beyond its normal timing constraints. Typically implemented by Coordination timing but also used for Queue timing and preemption.

Holding loop- Typically, a loop in a left turn pocket which extends or "holds" the through phase.

Holiday Table- A list of special days which depart from normal Coordination.

I file- In a Model 332 controller cabinet, the upper of two racks for plug-in electronic detector modules that comprise the Input file. (see also J file)

Initialization- The process of loading CPU RAM with EPROM default timing on initial power up of the 170 running under LACO-3.

In service- Timing some interval (Green, Yellow or Red Clearance) of a Phase.

Interconnect- A means of coordinating adjacent intersections by synchronizing signals transmitted between them, typically on wires. Sometimes used as a generic term to refer to any kind of Coordination scheme.

Intersection- The crossing place of two or more streets.

Interval- In general, the time devoted to any particular condition of operation wherein the signal indications do not change. Specifically, any of 16 defined controller conditions or states of operation such as Minimum Green, Walk, Flashing Don't Walk, Vehicle Extension, Yellow, etc.

Isolator- A plug-in electronic module which allows the 170 controller to receive a field input while preventing any electrical continuity between the controller and field circuits.

J file- In a Model 332 controller cabinet, the lower of two racks for plug-in electronic detector modules that comprise the Input file. (see I file)

Lag- To follow in time sequence.

Lag Phase- The phase of a quadrant pair that follows (lags) the Lead Phase. The last phase of a quadrant pair to be served before crossing the barrier (assuming both phases calling).

Lead- To precede in a time sequence.

Lead Phase- The phase of a quadrant pair that would be served first when crossing the barrier (assuming both phases calling).

Leading Green Arrow- same as Leading Left Turn

Leading Left Turn (LLT)- A Protected/Permissive left turn or any other left turn where anti-backup operation is desired. see Protective/Permissive Left Turn.

Leading Left turn Arrow (LLA)- same as Leading Left Turn.

Load switch- A plug-in module that switches A. C. current to the signal lamps at the command of the 170 controller. Also referred to as "switch pack".

Local Cycle Timer (C-0-b)- Timer used by the Local controller to output its coordination functions. Lags the Master cycle timer by a programmable offset time.

Lock- To latch and remember a call until it is serviced.

Long power down- A power outage lasting 2 or more seconds.

Loop- Specifically, a coil of wire embedded in the pavement for the purpose of sensing the presence of vehicles. Loosely, the detector or detector channel associated with a particular loop or set of loops.

Ltd.- Limited, as in Railroad Limited Service

Manual advance- A 170 controller input which, when in Manual Operation, allows a pushbutton to Force Off the Phase presently timing in order to advance service to the next phase.

Manual enable- A 170 controller input which must be held "TRUE" in order for the "Manual Advance" input to be effective.

Master- In a Coordination system, the controller serving as a reference for the relative offsets of the other intersections in the system.

Master Cycle Timer (C-0-A)- The main Coordination timer, which all other Coordination functions are slaved to.

Max- Maximum

Max Added Green (F-0-E)- A limit set on the maximum value of added Green per actuation.

Max Extension 1- In uncoordinated (Free) operation, the maximum time vehicles can extend the Green, beginning with the first opposing call after Minimum Green.

Max Extension 2- In coordinated operation, the maximum time vehicles can extend the Green, beginning with the first opposing call after Minimum Green.

Maximum Gap- A Phase timing parameter that sets the upper value for a calculated ramp used in the Gap Reduction routine.

Max Out- see "Max Termination"

Max Termination- The termination of a Phase in the presence of an opposing call because the Max Extension timer has expired (not because of a gap in traffic).

Maximum Vehicle Recall (F-F-9)- Places a continuous Vehicle call to the flagged Phase(s). Termination of flagged phases must be by Max Termination or Force Off.

Min- Minimum

Minimums- The portions of the Green interval that are guaranteed to time (except when overridden by a Railroad preempt). Any combination of Walk, Flashing Don't Walk, Minimum Green and Variable Initial Green.

Minimum Gap- The lowest value the Vehicle Extension may achieve during Gap Reduction.

Minimum Green- An interval which guarantees the minimum amount of time a Vehicle Phase will be Green under normal (no preempt) conditions. The first vehicle Green interval to time.

Minimum Vehicle Recall (F-F-3)- Places Vehicle call only during the RED interval of the flagged Vehicle Phase(s). Guarantees a minimum Green interval only.

Minimums- The portion of the Green interval made up of Walk, Flashing Don't Walk, Minimum Green and Variable Initial Green.

ML2 format- A type of serial communications protocol used by CalTrans.

Modem- MOdulator/DEModulator. A plug-in electronic module which enables serial communication between intersections by means of coded audio tone bursts on dedicated wires.

Non-Volatile Random Access Memory (NOVRAM)- A read-write memory in the 170 controller not subject to data loss during power failures.

Offset- Amount of time that the local controller lags behind the system master.

Offset Timing- A method of Coordination based on an "event" rather than time-of-day.

Opposing call- A call to non-concurrent (conflicting) Phase.

Overlap- An auxiliary Vehicle Phase defined to time concurrently with one or more regular Vehicle Phases designated as "parent" phases. If one parent phases terminates and the next phase is also a parent phase of that Overlap, then the Overlap will remain Green during the transition. The Overlap will only terminate when a parent phase transitions to a non-parent phase.

Overlap Yellow Start Up (F-F-F)- A Phase Function flag that causes flagged Overlaps to output Yellow on startup after a long power down.

Parent Phase- A Vehicle Phase from which an Overlap is derived. If Overlap A is defined as "8 + 1", then 8 and 1 are parent Phases.

Ped- Pedestrian

Ped clearance- The time during which the flashing "DON'T WALK" or flashing hand symbol is displayed.

Ped protection- The total time from the beginning of Flashing Don't Walk to the beginning of a conflicting Phase. Generally, the sum of the Flashing Don't Walk, Yellow and Red Clearance intervals for a Phase.

Ped push button (PPB)- Actuating device that causes a Ped Call to be placed.

Ped Recall/Rest in Walk (F-F-4)- Places a Pedestrian **and** Vehicle call during the DON'T WALK interval of the flagged Pedestrian Phase. Will "rest" in WALK interval in the absence of an opposing call.

Ped Restrict- A Coordination feature which stores a Ped call but delays its service until the end of Ped Restriction.

Permitted Phases (F-F-0)- Phases selected for Normal operation.

Phase- 1) A particular traffic movement. 2) The direction associated with a traffic movement. 3) A time interval associated with a traffic movement.

Phase flag- A flag which selects one of eight possible phases and turns on the associated Call light.

Phase North- The direction parallel to that leg or approach of an intersection defined to be north for purposes of assigning unambiguous loop designations.

Plan- One of the 9 possible combinations of 3 Dials and 3 Offsets.

Port- A serial port provided in the 170 controller. Same as Comm Port or Communications Port.

Preempt- An interruption of normal intersection operation to provide special right-of-way for emergency vehicles or railroad trains. Same as Preemption.

Presence- A mode of detector operation wherein a constant call is placed to the 170 controller as long as a vehicle is sensed over the loop. Contrasted with "pulse".

Programmable Read Only Memory (PROM)- A data memory device in the 170 controller which can be read but not written to by the controller. The data is written once by use of special equipment but cannot thereafter be altered or erased. As a slang term, "PROM" is often used to refer to any of a whole class of semi-permanent memory devices including EPROMs.

PROM module- An electronic memory module which plugs into 170 controller. It can accept NOVRAM and EPROM chips which are used in some cases to store, upload and download programs and data.

Protected/Permissive Left Turn (F-F-b)- A Vehicle movement that allows left turns on either the through Phase Green ball (permissive) or on a dedicated Green arrow (protected).

Quadrant- A Lead/Lag pair of vehicle Phases (including ass[illegible]ed Ped Phases) comprising one quarter of a standard dual Ring 8-Phase Ph[illegible] diagram. That is, Ø1, Ø2 and 2Ped are in the same quadrant, Ø5, Ø6 and 6Ped are in another quadrant, etc.

Queue- Pertaining to a line of vehicles. Often used as an abbreviation for "Queue Clearing" detector.

Queue Clearing loop- A loop devoted only to clearing out an initial line of vehicles present when a Phase turns Green. The Phase is held Green until the first gap or the Queue Max timer expires, then the loop is disconnected until the next Phase Red.

Queue Maximum- A timer which starts with Phase Green. When the timer expires, the Queue clearing loops for that Phase are disabled until the next Phase Red

Radio Corrected Time Based (RCTB)- A method of implementing coordination using a WWV Clock as the time standard.

Railroad 1 (RR1)- A special railroad preempt routine which, following Track Clearance, results in a Red Flash condition until the preempt ends.

Railroad 2 (RR2)- A special railroad preempt routine which, following Track Clearance, resumes Limited Service automatic operation, with selected Phases omitted, until the preempt ends.

Random Access Memory (RAM)- A read-write memory device in the 170 controller used to store user entered data as well as other data under program control.

Recall- A recurring demand for a Vehicle or Ped Phase set by program

Red and Yellow lock (F-F-2)- A flag which causes any call to that Phase during Red or Yellow intervals to be locked (remembered) until that Phase is served.

Red Clearance- A clearance interval, that follows the Yellow interval and prevents the next right-of-way Phase from going Green.

Red Lock (F-F-1)- A flag which causes any call to that Phase during its Red interval to be locked (remembered) until that Phase is served.

Red Rest (F-F-6)- RED REST causes termination of flagged Phase(s) after it has Gapped out. The terminated Phase then "rests" in Red (Interval 8 is displayed).

Red Revert- A Red interval timed by individual Vehicle Phases or Overlaps when they are set to go Green again immediately after terminating.

Reduce 0.1 sec every ....- A timing parameter which defines how often the Vehicle extension gap is reduced by a tenth second once Gap Reduction has begun.

Reinitialization- The process of restoring the CPU RAM and/or 1000h NOVRAM to a known state.

Repoll- To request the current Time and Date from the WWV Clock to update the Real Time Clock.

Rest in Walk- see Pedestrian Recall/Rest in Walk

Restricted phases (F-F-A)- A Phase Function flag which prohibits flagged Phases from timing concurrently.

Right-of-Way- The right of a particular traffic movement to take precedence over others in the use of the roadway, indicated by a Green or Yellow signal.

Ring- A group of sequential conflicting Phases. Typically Phases 1, 2, 3 and 4 comprise Ring A and Phases 5, 6, 7 and 8 Ring B.

RR1- see Railroad 1

RR2- see Railroad 2

RR2 Limited Service- A partial, automatic operation during Railroad 2 preempt where certain designated phases are served and all other phases are omitted. The portion of RR2 Preempt that allows service of any movement that does not cross the RR tracks. see also Railroad 2

RR Track Clearance- The portion of RR Preempt that ensures clearance of traffic from the RR tracks before the train reaches the intersection.

Semi-Traffic Actuated (STA)(F-F-7)- Identical to F-F-4, except the Walk interval can only be terminated by a Coordination Force-Off or Preemption.

Serve (a Phase)- To give right-of-way to a Phase.

Service- To give right-of-way to a Phase in response to a Call to that Phase. A phase is considered to be in service from the beginning of its Green interval until the end of its Red clearance time, if any.

Short power down- A loss of power for less than 2 seconds.

Simultaneous gap- When crossing the barrier, Phases in both rings must gap out together in order to terminate the Green interval.

Simultaneous termination- The exactly coincident Green to Yellow transition of a pair of concurrent Phases. A condition required for barrier crossing.

Slave- A 170 controller running Coordination and receiving its Dial, Offset and sync information from the Master controller via direct interconnect.

Software Flash- A flash condition in which all outputs to the signals remain under program control in contrast to a flash condition caused by activation of the controller cabinet Flash relays.

Split- A measure of the fraction of a complete cycle devoted to each Phase.

Startup- Controller operation just following initial application of A. C. power after a long power down.

Stop time- To suspend controller operation in the interval it is presently timing by means of external input or the 170 Front Panel Stop Time switch.

Supplemental phases- A Lead Phase and Lag Phase pair located in the same quadrant, for example 1 and 2.

Sync pulse- The period of time that the Offset line is in a FALSE state.

System- A group of adjacent intersections that run under the same Coordination timing.

System Cycle Timer (C-0-C)- The timer that synchronizes operation of all 170 controllers in a system.

Table- Used in Coordination, a list of time-of-day OR calendar events or functions.

Termination- In general, the ending of a particular Phase. More specifically, termination can be thought of as the interval beginning at the transition from Green to Yellow and continuing until any Red clearance has timed.

Time based- A system to coordinate intersections not physically interconnected, but which instead relies on precisely synchronized clocks at each location.

Time space diagram- A special kind of graph showing the relative locations of a string of intersections and the time needed to traverse the intervening distances at a particular vehicle speed. It is used in the design of Coordination systems.

Time Of Day (TOD)- Referring to the actual time during the 24 hours in a day.

True Max Termination- The condition for barrier crossing logically described as: [Ring A Max out **or** Gap out] **and** [Ring B Max out **or** Gap out].

True North- The actual geographic north, which may or may not be parallel with any street direction. see also Phase north.

Variable initial green- same as Added Green per Actuation.

Vehicle Extension- The continuation of Green time beyond minimum Green (in the presence of an opposing call) by means of vehicle actuations on the Phase presently timing.

Walk- Time during which "WALK" or walking person symbol is displayed.

Watch Dog Timer (WDT)- A software generated pulse stream output of the 170 controller which is monitored by the CMU to detect controller failures. A pulse missing for a specified time causes a hardware flash condition.

WWV Clock- An electronic unit containing a radio receiver and a clock which is updated from broadcasts by the National Bureau of Standards. The time is then transmitted to the 170 controller via serial communications port.

Yellow Change- The first interval following the Green right-of-way interval in which the signal indication for that Phase is Yellow.

Yellow Clearance- same as Yellow Change.

Yellow disconnect- When an entire Phase has been flagged for "Red & Yellow Lock" at F-F-2, any individual detector flagged for "Yellow Disconnect" will be exempted from locking calls during Phase Yellow.

Yellow Ranging- A flag which allows the selected Phase to time a Yellow interval longer or shorter than the minimum and maximum times customarily enforced by the program for safety reasons.

Yellow Start Up (F-F-E)- YELLOW START UP phases start in Yellow interval after a long power down and always time for 5.0 seconds.

ACRONYMS

ACIA- Asynchronous Communications Input Adapter
CMU- Conflict Monitor Unit
DOW- Day Of Week
DTA- Down Time Accumulator
EPROM- Erasable Programmable Read Only Memory
EV- Emergency Vehicle
LLA- Leading Left turn Arrow
LLT- Leading Left Turn
NOVRAM- NOn-Volatile Random Access Memory
PPB- Ped Push Button
PPLT- Protected Permissive Left Turn
PROM- Programmable Read Only Memory
RAM- Random Access Memory
RCTB- Radio Corrected Time Base
STA- Semi-Traffic Actuated
TOD- Time Of Day
WDT- Watch Dog Timer

LACO-3 TIMING SHEET CROSS REFERENCE I

KEYSTROKE SEQUENCE TO TIMING SHEET LOCATION

KEY STROKES	LOCATION	KEY STROKES	LOCATION
C-0-0	System Manual	d-C-0 to d-C-d	Detector Phases (J File)
C-0-1	Local Manual	d-d-0 to d-d-d	Detector Attributes (I File)
C-0-6	Function 6	d-d-E	Special Delay Option 1
C-0-8	Minimum Cycle Length	d-d-F	Special Delay Option 2
C-0-9	Maximum Cycle Length	d-E-0 to d-E-d	Detector Attributes (J File)
C-1-0	Dial 1 Cycle Length	d-F-0	Lag Phases during FREE
C-1-1 to C-1-F	Dial 1 Intervals	d-F-1	Dial 1 Lag Phases
C-2-0	Dial 2 Cycle Length	d-F-2	Dial 2 Lag Phases
C-2-1 to C-2-F	Dial 2 Intervals	d-F-3	Dial 3 Lag Phases
C-3-0	Dial 3 Cycle Length	d-F-4	2 Ped Load Switch
C-3-1 to C-3-F	Dial 3 Intervals	d-F-5	4 Ped Load Switch
C-4-0 to C-4-F	Dial 1 Force Offs	d-F-6	6 Ped Load Switch
C-5-0 to C-5-F	Dial 1 Holds	d-F-7	8 Ped Load Switch
C-6-0 to C-6-F	Dial 1 Ped Restricts	F-0-7	Red Rest Delay Time
C-7-0 to C-7-F	Dial 1 Calls	F-0-8	Green Rest Delay
C-8-1 to C-8-F	Dial 2 Force Offs	F-0-E	Max Added Green
C-9-1 to C-9-F	Dial 2 Holds	F-0-F	Red Revert Time
C-A-1 to C-A-F	Dial 2 Ped Restricts	F-1-0	Walk, Ø1
C-b-1 to C-b-F	Dial 2 Calls	F-1-1	Flashing Don't Walk, Ø1
C-C-1 to C-C-F	Dial 3 Force Offs	F-1-2	Minimum Green, Ø1
C-d-1 to C-d-F	Dial 3 Hold	F-1-3	Queue Maximum, Ø1
C-E-1 to C-E-F	Dial 3 Ped Restricts	F-1-4	Added Green per Actuation, (
C-F-1 to C-F-F	Dial 3 Calls	F-1-5	Vehicle Extension, Ø1
d-0-7	COMM Port 1 ASSIGNMENT	F-1-6	Maximum Gap, Ø1
d-0-8	COMM Port 2 ASSIGNMENT	F-1-7	Minimum Gap, Ø1
d-0-9	COMM Port 3 ASSIGNMENT	F-1-8	Maximum Extension 1, Ø1
d-0-A	COMM Port 4 ASSIGNMENT	F-1-9	Maximum Extension 2, Ø1
d-1-0 to d-1-d	Detector Delay Times (I File)	F-1-A	Overlap A Green Extension
d-2-0 to d-2-d	Detector Delay Times (J File)	F-1-b	Overlap A Yellow Clearance
d-3-0 to d-3-d	Detector Extension Times (I File)	F-1-C	Overlap A Red Clearance
d-4-0 to d-4-d	Detector Extension Times (J File)	F-1-d	Reduce 0.1 Seconds Every, (
d-5-0 to d-5-d	Detector Vehicle Counts (I File)	F-1-E	Yellow Clearance Time, Ø1
d-6-0 to d-6-d	Detector Vehicle Counts (J File)	F-1-F	Red Clearance Time, Ø1
d-7-0 to d-7-d	Detector Delay Timers (I File)	F-2-0	Walk, Ø2
d-8-0 to d-8-d	Detector Delay Timers (J File)	F-2-1	Flashing Don't Walk,Ø2
d-9-0 to d-9-d	Detector Extension Timers (I File)	F-2-2	Minimum Green, Ø2
d-A-0 to d-A-d	Detector Extension Timers (J File)	F-2-3	Queue Maximum, Ø2
d-b-0 to d-b-d	Detector Phases (I File)	F-2-4	Added Green per Actuation,(

KEY STROKES	LOCATION	KEY STROKES	LOCATION
F-2-5	Vehicle Extension, Ø2	F-4-d	Reduce 0.1 Seconds Eve
F-2-6	Maximum Gap, Ø2	F-4-E	Yellow Clearance Time, Ø
F-2-7	Minimum Gap, Ø2	F-4-F	Red Clearance Time, Ø4
F-2-8	Maximum Extension 1, Ø2	F-5-0	Walk, Ø5
F-2-9	Maximum Extension 2, Ø2	F-5-1	Flashing Don't Walk, Ø5
F-2-A	Overlap B Green Extension	F-5-2	Minimum Green, Ø5
F-2-b	Overlap B Yellow Clearance	F-5-3	Queue Maximum, Ø5
F-2-C	Overlap B Red Clearance	F-5-4	Added Green per Actuatic
F-2-d	Reduce 0.1 Seconds Every, Ø2	F-5-5	Vehicle Extension, Ø5
F-2-E	Yellow Clearance Time, Ø2	F-5-6	Maximum Gap, Ø5
F-2-F	Red Clearance Time, Ø2	F-5-7	Minimum Gap, Ø5
F-3-0	Walk, Ø3	F-5-8	Maximum Extension 1, Ø
F-3-1	Flashing Don't Walk, Ø3	F-5-9	Maximum Extension 2, Ø
F-3-2	Minimum Green, Ø3	F-5-A	Overlap E Green Extensic
F-3-3	Queue Maximum, Ø3	F-5-b	Overlap E Yellow Clearan
F-3-4	Added Green per Actuation, Ø3	F-5-C	Overlap E Red Clearance
F-3-5	Vehicle Extension, Ø3	F-5-d	Reduce 0.1 Seconds Eve
F-3-6	Maximum Gap, Ø3	F-5-E	Yellow Clearance Time, Ø
F-3-7	Minimum Gap, Ø3	F-5-F	Red Clearance Time, Ø5
F-3-8	Maximum Extension 1, Ø3	F-6-0	Walk, Ø6
F-3-9	Maximum Extension 2, Ø3	F-6-1	Flashing Don't Walk, Ø6
F-3-A	Overlap C Green Extension	F-6-2	Minimum Green, Ø6
F-3-b	Overlap C Yellow Clearance	F-6-3	Queue Maximum, Ø6
F-3-C	Overlap C Red Clearance	F-6-4	Added Green per Actuatic
F-3-d	Reduce 0.1 Seconds Every, Ø3	F-6-5	Vehicle Extension, Ø6
F-3-E	Yellow Clearance Time, Ø3	F-6-6	Maximum Gap, Ø6
F-3-F	Red Clearance Time, Ø3	F-6-7	Minimum Gap, Ø6
F-4-0	Walk, Ø4	F-6-8	Maximum Extension 1, Ø
F-4-1	Flashing Don't Walk, Ø4	F-6-9	Maximum Extension 2, Ø
F-4-2	Minimum Green, Ø4	F-6-A	Overlap F Green Extensic
F-4-3	Queue Maximum, Ø4	F-6-b	Overlap F Yellow Clearan
F-4-4	Added Green per Actuation, Ø4	F-6-C	Overlap F Red Clearance
F-4-5	Vehicle Extension, Ø4	F-6-d	Reduce 0.1 Seconds Eve
F-4-6	Maximum Gap, Ø4	F-6-E	Yellow Clearance Time, Ø
F-4-7	Minimum Gap, Ø4	F-6-F	Red Clearance Time, Ø6
F-4-8	Maximum Extension 1, Ø4	F-7-0	Walk, Ø7
F-4-9	Maximum Extension 2, Ø4	F-7-1	Flashing Don't Walk, Ø7
F-4-A	Overlap D Green Extension	F-7-2	Minimum Green, Ø7
F-4-b	Overlap D Yellow Clearance	F-7-3	Queue Maximum, Ø7
F-4-C	Overlap D Red Clearance	F-7-4	Added Green per Actuatic

KEY STROKES	LOCATION
F-7-5	Vehicle Extension, Ø7
F-7-6	Maximum Gap, Ø7
F-7-7	Minimum Gap, Ø7
F-7-8	Maximum Extension 1, Ø7
F-7-9	Maximum Extension 2, Ø7
F-7-d	Reduce 0.1 Seconds Every, Ø7
F-7-E	Yellow Clearance Time, Ø7
F-7-F	Red Clearance Time, Ø7
F-8-0	Walk, Ø8
F-8-1	Flashing Don't Walk, Ø8
F-8-2	Minimum Green, Ø8
F-8-3	Queue Maximum, Ø8
F-8-4	Added Green per Actuation, Ø8
F-8-5	Vehicle Extension, Ø8
F-8-6	Maximum Gap, Ø8
F-8-7	Minimum Gap, Ø8
F-8-8	Maximum Extension 1, Ø8
F-8-9	Maximum Extension 2, Ø8
F-8-d	Reduce 0.1 Seconds Every, Ø8
F-8-E	Yellow Clearance Time, Ø8
F-8-F	Red Clearance Time, 8
F-9-1	Plan 1 OFFSET VALUE
F-9-2	Plan 2 OFFSET VALUE
F-9-3	Plan 3 OFFSET VALUE
F-9-4	Plan 4 OFFSET VALUE
F-9-5	Plan 5 OFFSET VALUE
F-9-6	Plan 6 OFFSET VALUE
F-9-7	Plan 7 OFFSET VALUE
F-9-8	Plan 8 OFFSET VALUE
F-9-9	Plan 9 OFFSET VALUE
F-9-A	Ped A to Overlap A
F-9-b	Ped B to Overlap B
F-9-C	Overlap C to Load Switch x
F-9-d	Overlap D to Load Switch x
F-9-E	Overlap E to Load Switch x
F-9-F	Overlap F to Load Switch x
F-A-0	Driveway Flash (Phase)
F-A-1	Yellow Ranging (Phase)
F-A-2	Driveway Flash (OverLap)
F-A-3	Yellow Ranging (OverLap)

KEY STROKES	LOCATION
F-A-4	Overlap x to Ped 2 Output
F-A-5	Overlap x to Ped 4 Output
F-A-6	Overlap x to Ped 6 Output
F-A-7	Overlap x to Ped 8 Output
F-A-A	Normal Overlap A Parents
F-A-b	Normal Overlap B Parents
F-A-C	Normal Overlap C Parents
F-A-d	Normal Overlap D Parents
F-A-E	Normal Overlap E Parents
F-A-F	Normal Overlap F Parents
F-b-A	Overlap Green Omit A
F-b-b	Overlap Green Omit B
F-b-C	Overlap Green Omit C
F-b-d	Overlap Green Omit D
F-b-E	Overlap Green Omit E
F-b-F	Overlap Green Omit F
F-C-1	Associated Phase Recall, Ø1
F-C-2	Associated Phase Recall, Ø2
F-C-3	Associated Phase Recall, Ø3
F-C-4	Associated Phase Recall, Ø4
F-C-5	Associated Phase Recall, Ø5
F-C-6	Associated Phase Recall, Ø6
F-C-7	Associated Phase Recall, Ø7
F-C-8	Associated Phase Recall, Ø8
F-C-A	Railroad Overlap A Parents
F-C-b	Railroad Overlap B Parents
F-C-C	Railroad Overlap C Parents
F-C-d	Railroad Overlap D Parents
F-C-E	Railroad Overlap E Parents
F-C-F	Railroad Overlap F Parents
F-d-0	EV A Clearance Phases
F-d-1	EV B Clearance Phases
F-d-2	EV C Clearance Phases
F-d-3	EV D Clearance Phases
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F-d-A	EV Overlap A Parents
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F-d-C	EV Overlap C Parents

KEY STROKES	LOCATION	KEY STROKES	LOCATION
F-d-d	EV Overlap D Parents		
F-d-E	EV Overlap E Parents		
F-d-F	EV Overlap F Parents		
F-E-0	RR Select		
F-E-1	RR Track Clearance Time		
F-E-2	RR1 All Red Time		
F-E-3	RR2 Max Time		
F-E-4	FREE time after preempt		
F-E-5	EV A Delay Time		
F-E-6	EV A Clearance Time		
F-E-7	EV B Delay Time		
F-E-8	EV B Clearance Time		
F-E-9	EV C Delay Time		
F-E-A	EV C Clearance Time		
F-E-b	EV D Delay Time		
F-E-C	EV D Clearance Time		
F-E-d	EV Max Time		
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F-F-1	Red Lock Phases		
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F-F-3	Minimum Vehicle Recall Phases		
F-F-4	Ped Recall/Rest in Walk		
F-F-5	Green Rest Phases		
F-F-6	Red Rest Phases		
F-F-7	STA Mode Phases		
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F-F-9	Max Vehicle Recall Phases		
F-F-A	Restricted Phases		
F-F-b	Prot/Perm Left Turn Phases		
F-F-C	Barrier Recall Phases		
F-F-d	First Phases after Startup		
F-F-E	Yellow Start Up Phases		
F-F-F	Overlap Yellow Start Up Phases		

LACO-3 TIMING SHEET CROSS REFERENCE II

TIMING SHEET LOCATION TO KEYSTROKE SEQUENCE

LOCATION	KEY STROKES	LOCATION	KEY STROKES
2 Ped Load Switch	d-F-4	Detector Vehicle Counts (J File)	d-6-0 to d-6-d
4 Ped Load Switch	d-F-5	Dial 1 Calls	C-7-0 to C-7-F
6 Ped Load Switch	d-F-6	Dial 1 Cycle Length	C-1-0
8 Ped Load Switch	d-F-7	Dial 1 Force Offs	C-4-0 to C-4-F
Added Green per Actuation, Ø1	F-1-4	Dial 1 Holds	C-5-0 to C-5-F
Added Green per Actuation, Ø2	F-2-4	Dial 1 Intervals	C-1-1 to C-1-F
Added Green per Actuation, Ø3	F-3-4	Dial 1 Lag Phases	d-F-1
Added Green per Actuation, Ø4	F-4-4	Dial 1 Ped Restricts	C-6-0 to C-6-F
Added Green per Actuation, Ø5	F-5-4	Dial 2 Calls	C-b-1 to C-b-F
Added Green per Actuation, Ø6	F-6-4	Dial 2 Cycle Length	C-2-0
Added Green per Actuation, Ø7	F-7-4	Dial 2 Force Offs	C-8-1 to C-8-F
Added Green per Actuation, Ø8	F-8-4	Dial 2 Holds	C-9-1 to C-9-F
Associated Phase Recall, Ø1	F-C-1	Dial 2 Intervals	C-2-1 to C-2-F
Associated Phase Recall, Ø2	F-C-2	Dial 2 Lag Phases	d-F-2
Associated Phase Recall, Ø3	F-C-3	Dial 2 Ped Restricts	C-A-1 to C-A-F
Associated Phase Recall, Ø4	F-C-4	Dial 3 Calls	C-F-1 to C-F-F
Associated Phase Recall, Ø5	F-C-5	Dial 3 Cycle Length	C-3-0
Associated Phase Recall, Ø6	F-C-6	Dial 3 Force Offs	C-C-1 to C-C-F
Associated Phase Recall, Ø7	F-C-7	Dial 3 Hold	C-d-1 to C-d-F
Associated Phase Recall, Ø8	F-C-8	Dial 3 Intervals	C-3-1 to C-3-F
Barrier Recall Phases	F-F-C	Dial 3 Lag Phases	d-F-3
COMM Port 1 ASSIGNMENT	d-0-7	Dial 3 Ped Restricts	C-E-1 to C-E-F
COMM Port 2 ASSIGNMENT	d-0-8	Double Entry Phases	F-F-8
COMM Port 3 ASSIGNMENT	d-0-9	Driveway Flash (OverLap)	F-A-2
COMM Port 4 ASSIGNMENT	d-0-A	Driveway Flash (Phase)	F-A-0
Detector Attributes (I File)	d-d-0 to d-d-d	EV A Clearance Phases	F-d-0
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Detector Extension Timers (J File)	d-A-0 to d-A-d	EV C Clearance Time	F-E-A
Detector Extension Times (I File)	d-3-0 to d-3-d	EV C Delay Time	F-E-9
Detector Extension Times (J File)	d-4-0 to d-4-d	EV D Clearance Phases	F-d-3
Detector Phases (I File)	d-b-0 to d-b-d	EV D Clearance Time	F-E-C
Detector Phases (J File)	d-C-0 to d-C-d	EV D Delay Time	F-E-b
Detector Vehicle Counts (I File)	d-5-0 to d-5-d	EV Max Time	F-E-d

LOCATION	KEY STROKES	LOCATION	KEY STROKES
EV Overlap A Parents	F-d-A	Maximum Gap, Ø1	F-1-6
EV Overlap B Parents	F-d-b	Maximum Gap, Ø2	F-2-6
EV Overlap C Parents	F-d-C	Maximum Gap, Ø3	F-3-6
EV Overlap D Parents	F-d-d	Maximum Gap, Ø4	F-4-6
EV Overlap E Parents	F-d-E	Maximum Gap, Ø5	F-5-6
EV Overlap F Parents	F-d-F	Maximum Gap, Ø6	F-6-6
First Phases after Startup	F-F-d	Maximum Gap, Ø7	F-7-6
Flashing Don't Walk, Ø1	F-1-1	Maximum Gap, Ø8	F-8-6
Flashing Don't Walk, Ø2	F-2-1	Minimum Cycle Length	C-0-8
Flashing Don't Walk, Ø3	F-3-1	Minimum Gap, Ø1	F-1-7
Flashing Don't Walk, Ø4	F-4-1	Minimum Gap, Ø2	F-2-7
Flashing Don't Walk, Ø5	F-5-1	Minimum Gap, Ø3	F-3-7
Flashing Don't Walk, Ø6	F-6-1	Minimum Gap, Ø4	F-4-7
Flashing Don't Walk, Ø7	F-7-1	Minimum Gap, Ø5	F-5-7
Flashing Don't Walk, Ø8	F-8-1	Minimum Gap, Ø6	F-6-7
FREE time after preempt	F-E-4	Minimum Gap, Ø7	F-7-7
Function 6	C-0-6	Minimum Gap, Ø8	F-8-7
Green Rest Delay	F-0-8	Minimum Green, Ø1	F-1-2
Green Rest Phases	F-F-5	Minimum Green, Ø2	F-2-2
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Maximum Extension 2, Ø5	F-5-9	Overlap B Red Clearance	F-2-C
Maximum Extension 2, Ø6	F-6-9	Overlap B Yellow Clearance	F-2-b
Maximum Extension 2, Ø7	F-7-9	Overlap C Green Extension	F-3-A
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LOCATION	KEY STROKES
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Overlap C Yellow Clearance	F-3-b
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Overlap D Red Clearance	F-4-C
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Overlap E Red Clearance	F-5-C
Overlap E to Load Switch x	F-9-E
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3	QUEUE HOLD
4	ADDED INITIAL GREEN
5	VEHICLE EXTENSION
6	COORDINATION/PREEMPT HOLD
7	GAP REDUCTION
8	RED REST (OUT OF SERVICE)
9	PREEMPT CLEARANCE
A	STOP TIME
b	RED REVERT
C	GAP OUT YELLOW
d	MAX OUT YELLOW
E	FORCE OFF YELLOW
F	RED CLEARANCE

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E	FORCE OFF YELLOW
F	RED CLEARANCE

LACO-3 INTERVAL DESCRIPTIONS

0	WALK
1	FLASHING DON'T WALK
2	MINIMUM GREEN
3	QUEUE HOLD
4	ADDED INITIAL GREEN
5	VEHICLE EXTENSION
6	COORDINATION/PREEMPT HOLD
7	GAP REDUCTION
8	RED REST (OUT OF SERVICE)
9	PREEMPT CLEARANCE
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