SECTION 1 INTRODUCTION

General

Hardware Requirements

Memory Map

GENERAL

LACO-4 (Los Angeles County – 4) is the latest in a series of traffic signal control programs written for the County of Los Angeles, CA. It is preceded by four others (LACO-1, LACO-1R, LACO-2 and LACO-3) dating back to the late 1980's. All four of these previous programs were based on the granddaddy of all Type 170 controller programs, the Caltrans Q5. This program was written when Computer Science as a "science" was still evolving. As a result, programs written in assembly language (the Q5 and its derivatives) did not apply some of the precepts and methods considered as standard today. Concepts like "structured programming" were never applied to assembly language code and some of those older programs are classic examples of "spaghetti" code.

The Type 170 controller was designed to accommodate the traffic control needs of the late 70's. As time passed and the Los Angeles area grew, traffic volumes and intersection designs outgrew the Q5 program's capabilities. LACO-4 is the first 170 program designed from scratch in over a decade. It was created using structured programming techniques. The result is a program that was easier to code, test and debug. It also makes LACO-4 much easier to maintain and expand. Inherent inadequacies of the base version need not be propagated to its derivatives. It also results in a "leaner", more efficient program thus making optimum use of the limited resources of the 170 architecture.

Highlights of LACO-4

- Flexible Barrier Structure – This program is not restricted to the "Standard 8 phase quad" ring structure of most traffic control programs. It allows the user to customize the ring structure of each intersection in a variety of configurations.
- AB3418 Slave and/or Master – Complies with the original AB3418 Specification for Slave mode. Also supports AB3418 Master mode in that it can transmit Time and Date to AB3418 compliant Slave controllers.
- Multiple Communication capabilities – LACO-4 is capable of central system to controller communications via modem, and controller to controller communications using modem or 7-wire data transmission.
- Two Coordination Methods – Supports Los Angeles County standard coordination and Zip Coordination, an abbreviated form of coordination logic.

Most user-friendly User Interface available for a 170 platform – No memory paging schemes. All memory is directly accessible with three keystrokes (for addresses in 1st 2 Kbytes of memory) or five keystrokes (for all other memory locations). Any memory location in the entire 170-memory map can be viewed in either hexadecimal or decimal format.

- Built in User-Data Validation – LACO-4 filters most critical data continuously to protect the program from invalid data entry.
- Intuitive Programmable Logic feature.
- Integrated Intersection Flashout feature – This feature allows maintenance personnel to verify field to controller wiring without swapping out program EPROMS.
- Supports Motorola 6800/6802/6808 processors and can be easily ported to Type 170 controllers driven by the Motorola 68HC11 processor.

HARDWARE REQUIREMENTS

The 170 controller must be specifically configured for operation with the LACO-4 program. This requires a custom memory mapping EPROM from the manufacturer. On the next page is a pictorial representation of the LACO-4 memory map. The custom EPROM's supplied by the manufacturer should conform to this mapping. There are also two jumpers on the CPU board that tell the CPU where to find the LACO-4 EPROM and 7000h Non-Volatile RAM (NOVRAM). Depending on how these jumpers are set, either (or both) of the LACO-4 EPROM and 7000h NOVRAM can be installed on the CPU board or the System Program Module (variously referred to as "PROM Module" and "Timing Saver Module"). See the Operation and Maintenance Manual of the appropriate controller for details.

Most important of the hardware requirements is that **the CPU must run in "high speed" mode**. This entails placing a jumper on the CPU board to the 6.14 MHz (or similarly labeled) position.

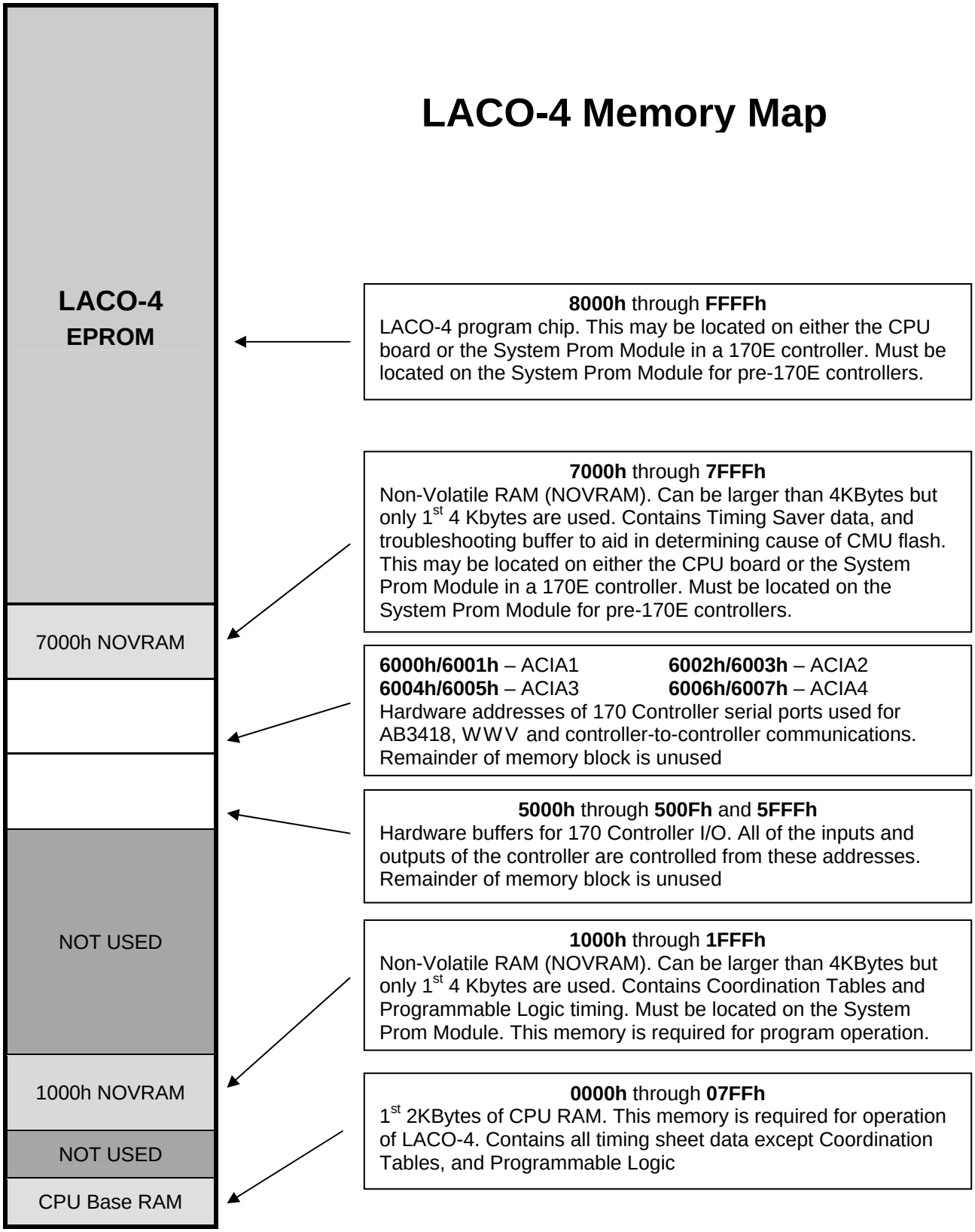
Memory requirements for operation of the LACO-4 program are as follows:

- 2Kbytes of SRAM [0000h through 0700h] – All of the signal timing and program scratch memory resides here. If the controller is powered down and the battery (or super cap) is discharged, the timing will be lost. The program will not run without this memory.
- 4Kbytes of NOVRAM [1000h through 1FFFh] – Contains the Stack, Coordination tables and Programmable Logic data. The program will not run without this memory. This memory device must be installed on the PROM Module in the "LS" socket.
- 4Kbytes of NOVRAM [7000h through 7FFFh] – The program will run without this memory but timing backup and certain diagnostics will not be available.
- The program contains a memory location that provides the user with memory configuration status. Pressing 0-B-1 on the keypad accesses the MEMFLG byte. The call lights are defined as:

  1 = 2ND 2KBytes OF BASE RAM INSTALLED
  2 = 1000h NOVRAM INSTALLED
  3 = 7000h NOVRAM INSTALLED
  4 = 170 "E" CONTROLLER
  5 = future use
  6 = not used
  7 = not used
  8 = not used

- On 170E controllers, call lights 1 through 4 should be illuminated. For pre-170E controllers, call light 4 should be extinguished and call light 1 may or may not be illuminated.

MEMORY MAP


LACO-4 Memory Map
LACO-4
EPROM
7000h NOVRAM
NOT USED
1000h NOVRAM
NOT USED
CPU Base RAM
8000h through FFFFh
LACO-4 program chip. This may be located on either the CPU board or the System Prom Module in a 170E controller. Must be located on the System Prom Module for pre-170E controllers.
7000h through 7FFFh
Non-Volatile RAM (NOVRAM). Can be larger than 4KBytes but only 1st 4 Kbytes are used. Contains Timing Saver data, and troubleshooting buffer to aid in determining cause of CMU flash. This may be located on either the CPU board or the System Prom Module in a 170E controller. Must be located on the System Prom Module for pre-170E controllers.
6000h/6001h – ACIA1
6002h/6003h – ACIA2
6004h/6005h – ACIA3
6006h/6007h – ACIA4
Hardware addresses of 170 Controller serial ports used for AB3418, WWV and controller-to-controller communications. Remainder of memory block is unused
5000h through 500Fh and 5FFFh
Hardware buffers for 170 Controller I/O. All of the inputs and outputs of the controller are controlled from these addresses. Remainder of memory block is unused
1000h through 1FFFh
Non-Volatile RAM (NOVRAM). Can be larger than 4KBytes but only 1st 4 Kbytes are used. Contains Coordination Tables and Programmable Logic timing. Must be located on the System Prom Module. This memory is required for program operation.
0000h through 07FFh
1st 2KBytes of CPU RAM. This memory is required for operation of LACO-4. Contains all timing sheet data except Coordination Tables, and Programmable Logic

SECTION 2 DISPLAY AND KEYBOARD

DISPLAY MODES

- BASE DISPLAY MODE
- TABLE DISPLAY MODE
- CLOCK DISPLAY MODE
- CPU MEMORY DISPLAY MODE
- EXTENDED MEMORY DISPLAY MODE
- CALL LIGHT INTERPRETATION

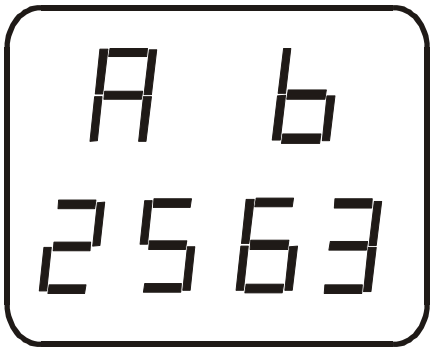
CALL LIGHT INTERPRETATION

KEY PRESS SEQUENCES

DISPLAY MODES

BASE DISPLAY MODES

This is the default display mode for LACO-4 (and all Q5 program derivatives).



In the figure to the left, the “A” represents Ring A while the “25” directly beneath it represents Phase 2 and Interval 5 (Vehicle Extension), respectively.

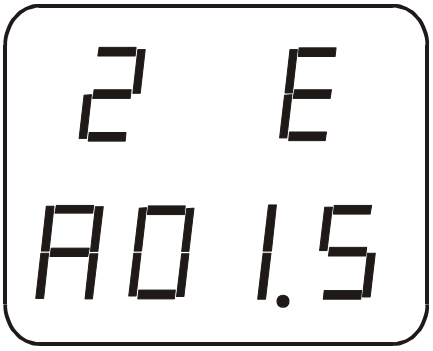
The “b” represents Ring B and the “63” directly beneath it represents Phase 6 and Interval 3 (Queue Hold), respectively.

In this display mode, Call Light 0 indicates Coordination status, Call Lights 1 through 8 indicate phase call status, and Call Light 9 indicates preemption status.

DETAILED RING DISPLAY MODE

This display mode provides timer information for the selected Ring (A or B).

Ring A

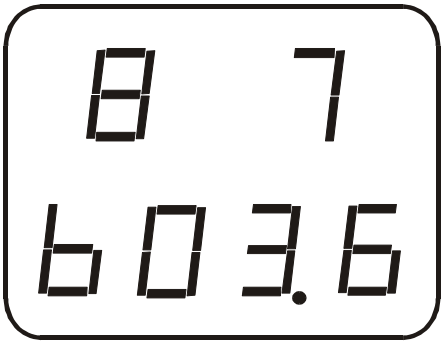


In the figure to the left, the “2" represents Phase 2 while the “E” represents Interval E (Yellow Clearance due to Force Off/Advance).

In the bottom portion of the display, the “A” represents Ring A and the “01.5” represents the Yellow Clearance time (in seconds) remaining for Phase 2.

In this display mode the Call lights reflect the same information as in the Base Display Mode above.

Ring B



In the figure to the left, the “8” represents Phase 8 while the “7” represents Interval 7 (Gap Reduction Green).

In the bottom portion of the display, the “b”: represents Ring B, and the “03.6” represents the amount of time in the Ring B Gap Out Timer.

In this display mode the Call lights reflect the same information as in the Base Display mode above.

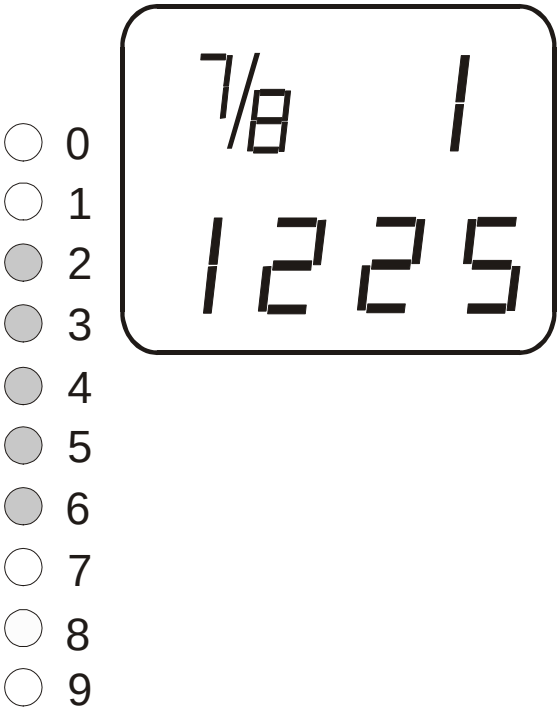
TABLE DISPLAY MODE

There are two basic types of tables in LACO-4, Time of Day tables and Exception tables. The table at the lower left shows an Exception table. The “7/8” represents Table 7/Event 8 (the two numbers are alternately displayed). The number displayed for the shortest duration (0.3 seconds) is the Table number while the one displayed for the longest duration (0.7 seconds) is the Event number. The “1” indicates the Coordination table to be searched and the “1225” specifies the month/day (in this case Christmas) on which the Exception table search should occur. Call lights 2 through 6 ON indicate that this event will only be implemented on weekdays (Monday through Friday).

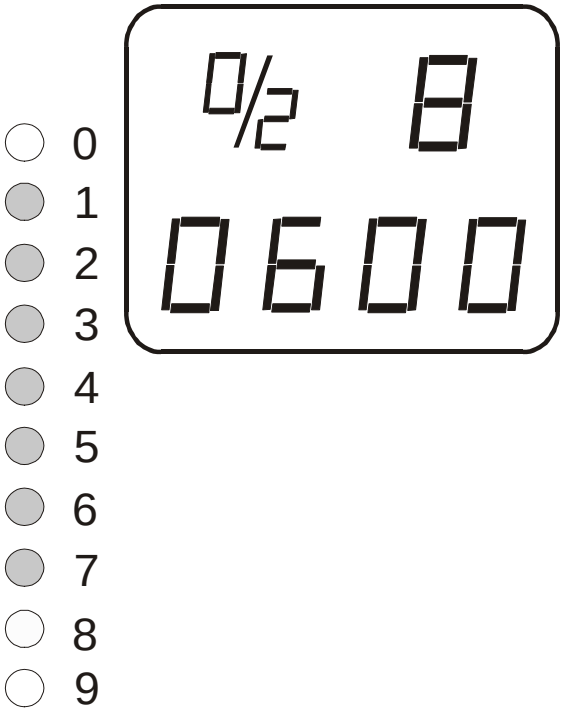
On the lower right is an example of a Time of Day table. The “0/2” represents Table 0/Event 2. The two numbers are alternately displayed at the same rate as the Exception Tables. The Coordination Plan/Function is shown in the upper right digit (in this case Plan 8). At the bottom of the display, the “0600” indicates the time of day that the Coordination Plan/Function is scheduled to start. Call lights 1 through 7 are illuminated indicating that Plan 8 should be run every day of the week starting at 6:00 a.m. Call lights 1 through 7 ON indicate that this event will be implemented every day of the week.

As in all display modes, Call Light 0 indicates Coordination status and Call Light 9 indicates Preemption status. Call Lights 1 through 7, however, indicate the days of the week that a Plan/Function is scheduled to run (for Tables 0 through 4) or that an Exception Table is to be searched (for Tables 5 through 7).

Exception Table

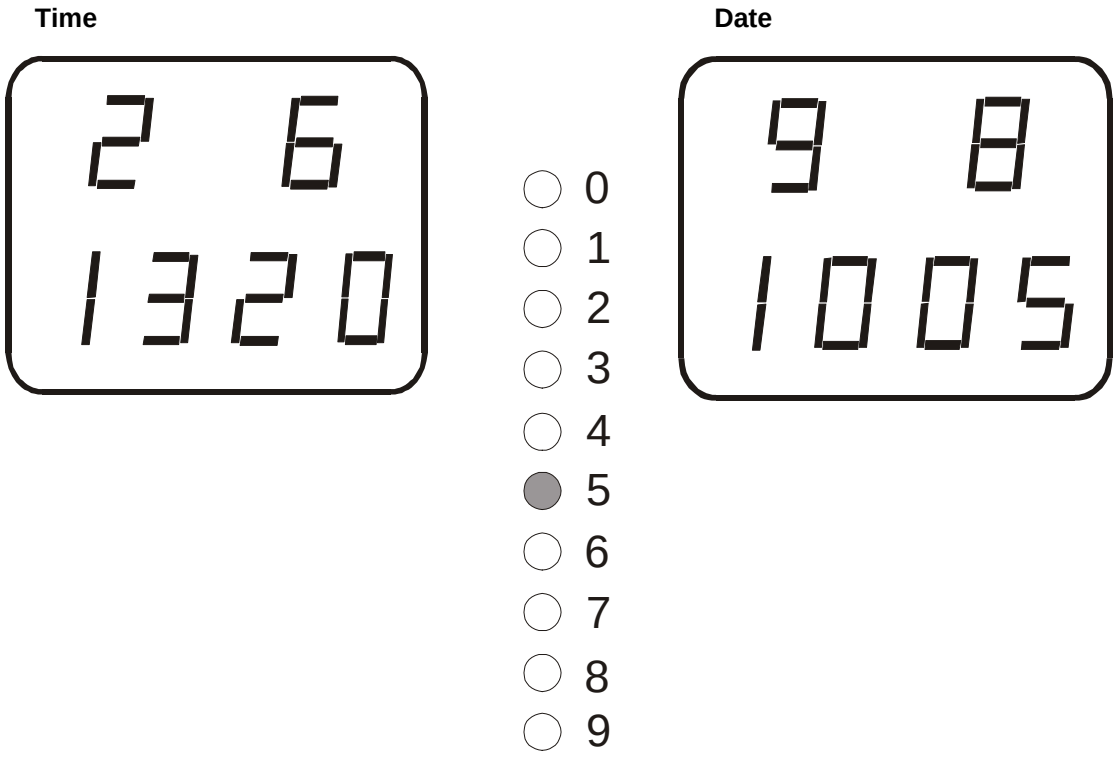


Time of Day Table



CLOCK DISPLAY MODE

The Clock Display mode is used to display the Time and Date of the 170 Real Time Clock. The time/date are shown in the LED Display, while Call Lights 1 through 7 indicate the Day of Week (Sunday through Saturday). The example at the lower left shows the time to be 13:20 (or 1:20.26 P.M.). The Day of Week is shown in call lights 1 through 7. On the right, the date is shown as October 5, 1998 which is a Thursday, so call light 5 would be illuminated (the call light data is only shown once here since it is the same for both Time and Date display).

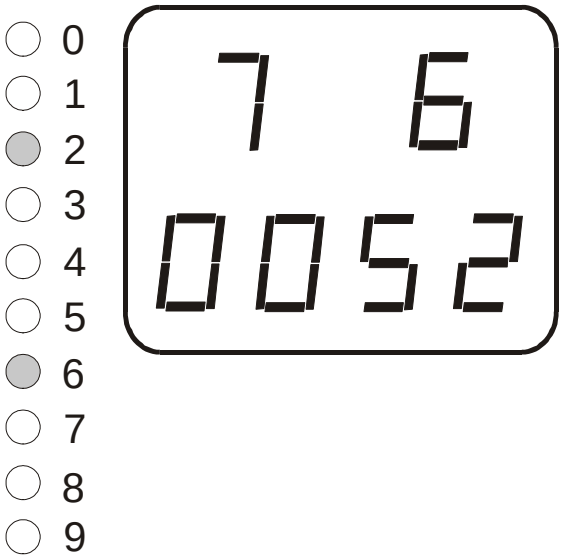


When modifying the time or date displays the first keypress will set all display digits to “C” except for the left most Timing/Data digit, which will reflect the key just pressed. Each successive keypress will modify the next digit to the right until the rightmost Timing/Data digit is modified. Finally the Phase and Interval digits are updated with the last two keypresses. See Appendix A14, Setting The Real Time Clock, for more detailed information.

CPU MEMORY DISPLAY MODE

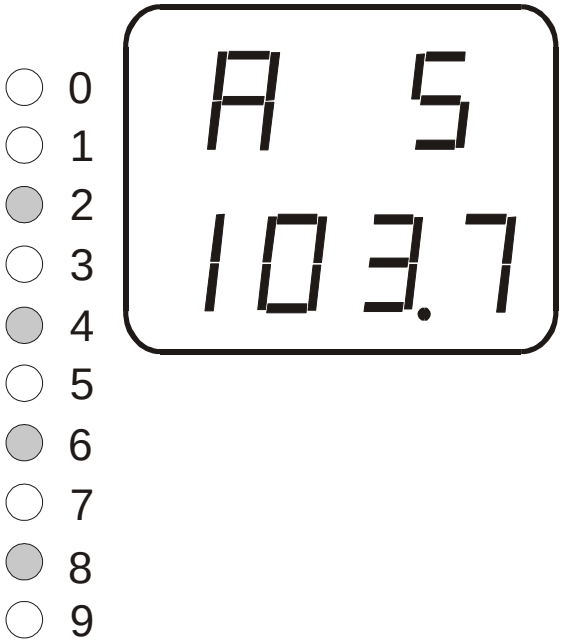
This display mode can only be used to show data in memory locations 0000h through 07FFh. CPU memory holds two types of data, Flag and Decimal. Flag data is displayed in Call Lights 1 through 8 and represents phases or control options. Decimal data is shown in the bottom portion of the LED Display and generally is used to display timers. The RAM maps in Appendix F of this manual indicate the data type for each CPU memory location. Call Lights “0” and “9” reflect Coordination status and Preemption status, respectively.

Flag Data Display



This example shows that memory location 076 (FAZNXT) has been accessed. Since this is Flag type data, its value is shown in the Call Lights. This example shows that phases 2 and 6 are the next phases to be served. The current value of the Local Cycle Timer (in this case “052”) is always shown in the LED Display when Flag data is being accessed.

Decimal Data Display

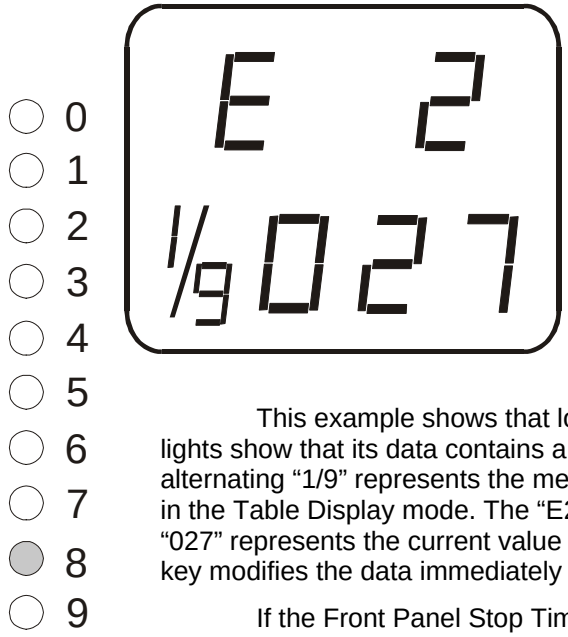


This example shows that memory location 1A5 (RAVEXT) has been accessed. Since this is Decimal type data, its value is shown in the lower portion of the LED Display. This example shows that the Ring A Vehicle Extension Timer has 3.7 seconds remaining. Current Call status is always shown in the Call Lights when Decimal data is being accessed. In this case all of the even numbered phases are calling.

EXTENDED MEMORY DISPLAY MODE

Extended Memory Display mode can show the same data in two different ways, Decimal Display and Flag Display. When first accessing memory in this mode, the Flag Display is shown. Every time the Front Panel Stop Time switch is set to the ON position the LED display toggles between Decimal Display and Flag Display. This feature is particularly useful for the maintenance person. See the chapter on Diagnostics and Troubleshooting for more detailed information on this display mode.

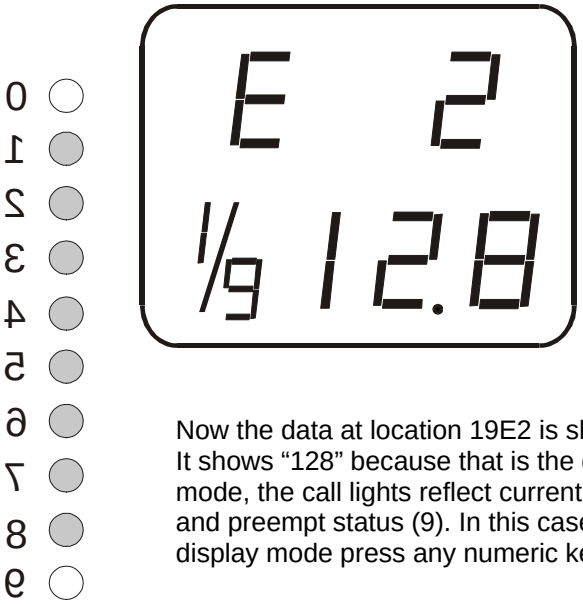
Flag Display



This example shows that location 19E2h has been accessed and the call lights show that its data contains a value of 80h (in hexadecimal format). The alternating “1/9” represents the memory Page (19h) and has the same display rate as in the Table Display mode. The “E2” indicates the column and row, respectively. The “027” represents the current value of the Local Cycle Timer. Pressing any numeric key modifies the data immediately in this mode.

If the Front Panel Stop Time switch is placed to the ON position, the display format changes to Decimal Display as shown below.

Decimal Display



Now the data at location 19E2 is shown (in decimal form) in the Timing/Data digits. It shows “128” because that is the decimal equivalent of 80h. Also, in this display mode, the call lights reflect current Coordination status (0), call status (1 through 8) and preempt status (9). In this case, all phases have calls. To modify data in this display mode press any numeric key followed by “E” to save.

CALL LIGHT INTERPRETATION

The Call/Active (call lights) on the 170 controller front panel provide a wide range of information about an intersection's timing and operation. There are ten call lights, numbered "0" through "9".

Call Light 0

Call light "0" always reflects the Local Coordinator status regardless of the display mode. It will be OFF when Local Manual (location 4-0-1) is set to "014". Otherwise it will be ON except when the coordination Sync Pulse is TRUE. The exception to this is when the Local Coordinator is running in Offset Timing mode. In this case, call light "0" comes ON Offset Timing trigger is sensed and stays on for the duration of the cycle. At the end of the cycle, call light "0" goes OFF until the next Offset Timing trigger is sensed.

Call Lights 1 – 8

Call lights "1" through "8" have different interpretations, depending on which display mode the Function display is in. In both the Base display mode and Detailed Ring display mode, call lights "1" through "8" represent the call status of phases 1 through 8. A steady ON indication means there is a vehicle call for the corresponding phase. A ped call is indicated when the call light flashes at a rapid rate (5 Hz). If the call light is flashing at a slow rate (1 Hz), it means that the corresponding phase is flagged for Protected/Permissive Left Turn operation (at location 1-F-B) and has a call. If this same phase is also configured as a ped phase, and a ped call is present for this phase, then the both flash rates are combined. That is, the call light will alternately be OFF for .5 seconds and then flash at a 5 Hz rate for .5 seconds.

The preceding description is also true when the Function display is in CPU Memory display mode and accessing decimal data. If flag data is being accessed, the call lights represent the actual data (in hexadecimal format) at that location. This can either be "phase/overlap" data or "flag" data.

Call Light 9

Call light "9" always reflects the preemptor status regardless of the display mode. It will be ON whenever an EV or Railroad preempt sequence is active. It will be OFF at all other times.

KEY PRESS SEQUENCES

(see the LACO-4 key press map on the following page)

Keys 0 through 7

CPU Memory Display mode. This is a 3 key sequence to access any byte of memory from 0000h to 07FFh. The first key press selects a memory location Page. The second key press selects a memory location Column and the third key press selects a memory location Row. At this point, displayed data can be modified (using numeric keys) or direction keys (A, C, D, or F) can be pressed to access adjacent memory locations. Pressing “B” or “F” will return to Base Display Mode.

Key 8

Extended Memory Display mode. This is a 5-key sequence to access any byte in the entire memory range of the 170 Controller (0000h through FFFFh). The first key press, “8,” sets Extended Memory Display mode. The second and third key presses select a memory location Page, and any number between 00h and FFh. The fourth and fifth key presses select a memory location Column and Row, respectively. When a memory location is accessed, its data is displayed in Call Lights 1 through 8 (in hexadecimal format). The LED display shows the address of the memory location and the Local Cycle Timer. Toggling the Front Panel Stop Time switch changes the display format. Now the data is displayed in the LED display (in decimal format) and the Call Lights reflect Call status. Each time the Front Panel Stop Time switch is toggled, the display mode also toggles.

Key 9

Table Display mode. This mode is used to enter or view Coordination Table data. The first key press sets Table Display mode.

Key A

Detailed Ring Display mode (Ring A). Pressing any key except “C” or “D” returns to Base Display mode. Pressing the “C” key puts the 170 into Clock Display mode showing the Time Display, while pressing “D” puts the 170 into Clock Display mode showing the Date Display. These key press sequences have been retained for those users familiar with LACO-3. See “Key C” below for key press details on the Clock Display mode.

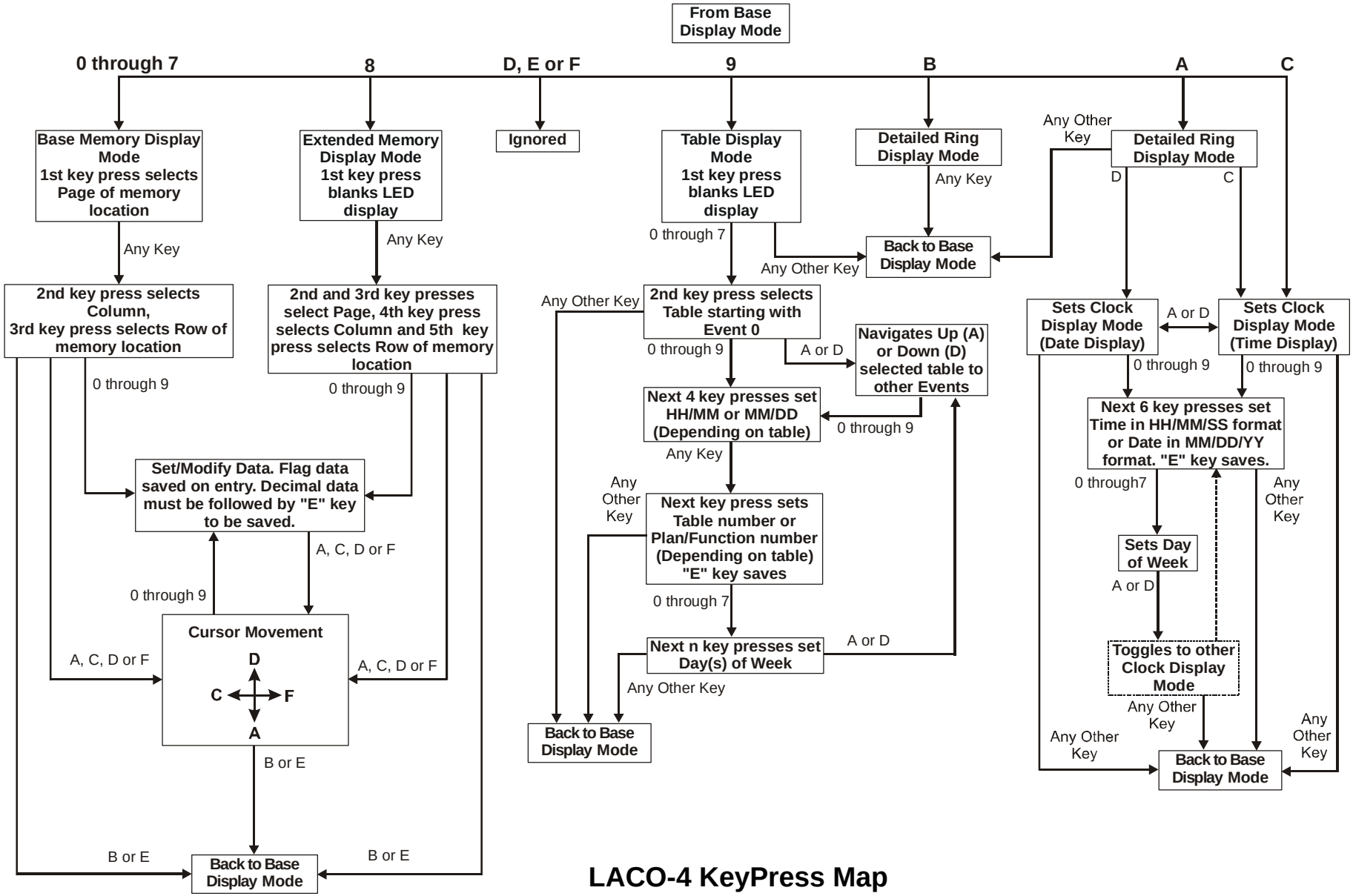
Key B - Detailed Ring Display mode (Ring B). Pressing any key returns to Base Display mode.

Key C

Clock Display mode. The first key press, “C,” sets the Clock Display mode showing the Time Display. Pressing “A” or “D” next toggles back and forth between the Time Display and the Date Display. Pressing “B” or “F” returns to Base Display Mode. Pressing “C” allows the user to modify the Seconds component directly in the Time Display. If the 170 is configured with WWV, pressing the “E” key from the Time Display forces a repoll from WWV. Pressing any numeric key initiates Data Modification mode. This allows the user to modify Seconds, minutes, Hours, and Day of Week in the Time Display and Year, Month, Day in Month and Day of Week in the Date Display. The Day of Week need only be set in either the Time or Date Display. It will automatically update the other Display. See Appendix A14, Setting The Real Time Clock.

Keys D, E, and F

Perform no action as first key press.



LACO-4 KeyPress Map

SECTION 3 DETECTION and I/O

GENERAL

VEHICLE DETECTION

DETECTOR ATTRIBUTES

PED DETECTION

OTHER INPUTS

RS232 INPUTS

OUTPUTS

RS232 OUTPUTS

GENERAL

LACO-4 supports forty-four physical inputs and fifty-six physical outputs via the C1 connector. These inputs and outputs have default mappings assigned to them based on the Caltrans 170 specification. LACO-4 offers exceptional I/O customization and almost any input or output can have its default function reassigned. All references to input and output mapping in this section are in relation to the Caltrans 332 Input and Output Files. For a complete listing of this and other cabinet type default I/O, see Appendix E.

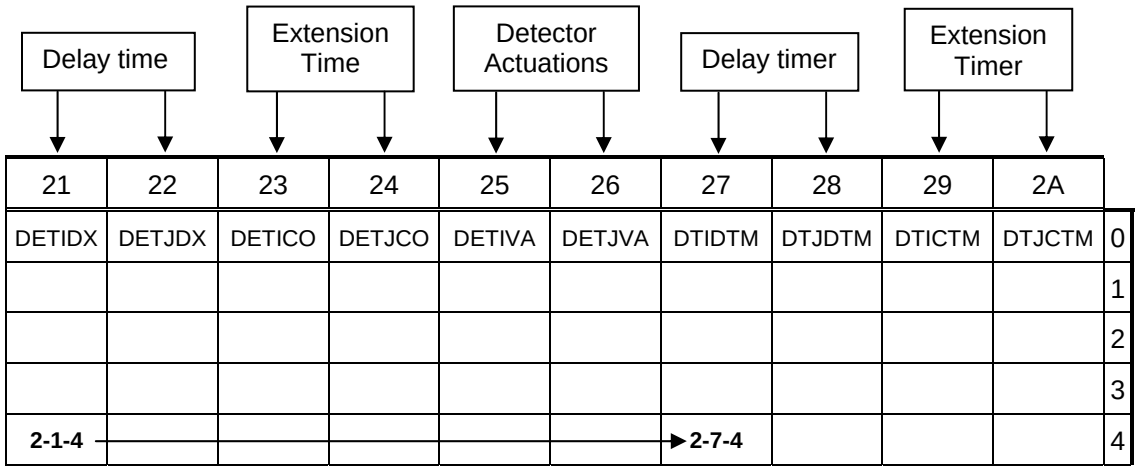
VEHICLE DETECTION

Up to twenty-eight-vehicle detector inputs are supported. Any single phase or multiple phases can be assigned to a detector. To simplify the programming effort, LACO-4 defaults phase assignments to the L. A. County default configuration. If a particular detector receives an actuation, and no phase is explicitly set for that detector, then the default phase for that detector will be called. The default phase assignments for each detector are indicated on the Detector timing sheet as a shaded block under the phase. Along with a phase assignment, each detector can have its basic operation modified by assigning any of seven detector attributes. Basic detector operation is such that each detector (on actuation) will call or extend its assigned phase(s) and will accumulate counts. Note that detector counts (for purposes of Added Initial Green computation) are disabled for detectors with multiple phase assignments.

Detector Extension (Carryover) timers are provided for each detector along with Detector Delay timers. Both timers can operate up to 255 seconds with the default being zero seconds. A detector's Delay timer will count down while the detector is actuated and its assigned phase is Red. If the actuation is dropped, the Delay timer will be reset to its initial value. The detector's Extension timer is only active during the assigned phase's Green interval. If the input goes False (vehicle call is dropped), the detector's actuation will be extended for the duration of the Extension timer.

Each detector's delay **timer** location is offset by "60" (in hexadecimal) from the delay **time** location. For example, to *set* the delay **time** for detector I6U, go to location 2-1-4 and enter the desired delay time. To *view* the delay **timer** for detector I6U, go to location 2-7-4 (214 + 60 = 274), or simply press the "F" key six times from location 2-1-4. The same is true for a detector's extension timer and actuation counters. Below is a portion of the Detector Page RAM map that illustrates this.

`



DETECTOR ATTRIBUTES

As mentioned earlier, each detector can be assigned any combination of up to eight attributes as follows:

System Detector – This attribute allows a vehicle detector, normally (but not limited to) an advance detector, to accumulate counts separate from those counts used for Added Initial Green. These counts are used to generate Volume, Occupancy and Speed data. Selection of this attribute does not modify any other operation of the detector. That is, any detector can operate as a vehicle detector exclusively, or both a vehicle and system detector. Up to sixteen System detectors are supported.

Red & Yellow Lock – This attribute causes an actuation to be locked if it occurs during the Red or Yellow interval of the phases selected for the detector. The locked actuation will drop when any of the selected phases begins service.

Yellow Disconnect – Causes an actuation to be ignored during the selected phase's Yellow interval. Results in a "Red Lock only" operation when used in conjunction with the Red & Yellow Lock attribute above.

Queue Clearing – A Queue Clearing detector calls but will not extend a phase. This attribute provides stop bar "extension" without the restriction of a gap out timer. That is, once the detector's assigned phase goes Green, the call to the phase is dropped and a Queue Hold is applied to that phase. The phase will stay Green (showing interval "3" in the front panel display) as long as the actuation is present and the phase's Queue Limit timer has not expired. If either of these two conditions is not satisfied, the detector is disconnected until the next phase red.

Non-Counting – This attribute inhibits the detector's count accumulator so that the Added Initial Green function for the detector's assigned phase will not be operational.

Special Delay Option 1 – Selection of this attribute provides modified detector delay operation. This option causes the detector's Delay timer to be ignored during while the selected phases are timing.

Special Delay Option 2 – Same as Special Delay Option 1.

PED DETECTION

Up to six ped pushbuttons (PPB) inputs are supported; the four standard PPB's and two optional PPB's (called PedA and PedB) that can be remapped from the Manual Control inputs. An actuation on any of these inputs will cause a locked ped call to be placed to their assigned phases. When the assigned phase goes green, ped service will start with it and the ped call will be dropped. The ped inputs are default mapped as follows:

PedA – I11U, PedB – I11L, Ped2 – I12U, Ped4 – I12L, Ped6 – I13U, Ped8 – I13L

Note: If either PedA or PedB input is configured, Manual Control logic is disabled.

OTHER INPUTS

LACO-4 supports up to six preempt inputs, two Railroad (RR) and four Emergency Vehicle (EV). The RR A input initiates flashing operation while the RR B input initiates limited service operation. The RR inputs use "Ground TRUE" logic. That is, *presence* of 115vac at the isolator input sets the 170 controller input FALSE and is treated as "Preempt OFF", while *absence* of 115vac at the isolator input sets the 170 controller input TRUE and is treated as "Preempt ON". Consequently, the RR inputs require an AC Isolator with inverted outputs in order for the input to be sensed properly. A RR input must be on for a minimum of ½ second before it is recognized.

The four EV (A through D) inputs use "Ground FALSE" logic. A standard 252 AC Isolator is typically used in the input file. LACO-4 does not currently support the Opticom discriminator (oscillating) inputs therefore the input must be steady ON for the preempt logic to operate properly. The four EV inputs are default mapped as follows:

EV A – J12U, EV B – J13U, EV C – J12L, EV D – J13L

Manual Control inputs include Enable and Advance. These two inputs are default mapped to the I11U (Advance) and I11L (Enable) input file slots. These inputs are routed to the Police Panel Manual Control jack. When a plug is inserted in this jack, the Manual Control Enable input is set ON and the Manual Control Advance input is controlled by the toggling device attached to the plug. As mentioned above, if either PedA or PedB phases are selected, these inputs will act as the PPB inputs and Manual Control logic will be disabled.

The Flash Sense input is usually not user controlled. It is wired directly to the Conflict Monitor Unit (CMU) and is set ON whenever the CMU latches an error condition. This input is default mapped to the I14U input file slot.

The External Stop Time input, like the Flash Sense input, is wired directly to the CMU and is set ON whenever the Flash Sense input is set ON. It also can be turned ON by setting either the cabinet FLASH/AUTO switch or the Police Panel FLASH/NORMAL switch to FLASH. This does not affect the Flash Sense input. This input is default mapped to the I14L input file slot.

RS232 INPUTS

Hard Wire Interconnect (HWI) inputs are provided for compatibility with some non-LACO programs. Four inputs are supported, two dial inputs (Dial2 and Dial3), one Sync input and one Free input. These four inputs work together to let the controller act as a slave to another, downstream controller. The four HWI inputs are default mapped as follows:

- Dial2 – C1 pin 81 (I14U)
- Dial3 – C1 pin 51 (J14U)
- Free – C1 pin 54 (J11U)
- Sync – C1 pin 75 (J11L)

The Offset Timing input is another optional input. When the controller is operating in the Offset Timing mode of coordination, this input provides control for start-of-cycle. The default mapping for this input is input slot C1 pin 51 (J14U). This also happens to be the default input for the RR A and Dial3 inputs. If the controller is in Offset Timing coordination mode, then an actuation on this input will be treated as the Offset Timing cycle start trigger and RR A logic will be ignored. Otherwise an input sensed here will start a RR A preemption sequence.

OUTPUTS

LACO-4 is capable of driving twelve 3-color outputs (signal heads), with any combination of eight phases and four 3-color overlaps. Additionally, up to six 2-color outputs can be accommodated with any combination of six peds and six 2-color overlaps (all six of the overlaps can be used to drive 2-section signal heads). By default, phases 1 through 8 and Ped2, Ped4, Ped6, Ped8, overlap A and overlap B outputs are directed to the cabinet's Output File. The four 3-color overlaps (C, D, E and F) are directed to the Auxiliary Output File (Aux File). Since the Aux File is typically not standard equipment, the 3-color overlaps may be redirected to any unused load switch in the Output File.

The 170 controller also outputs a WatchDog Timer (WDT) signal to let the CMU know that the controller is still "alive". This is a 5 Hz signal that can be observed in an LED on the 170 Front Panel (usually labeled WDT on newer controllers). When the WDT signal is interrupted for more than .9 seconds, the CMU latches an error and puts the cabinet into flash

The Detector Reset output is normally connected to each of the Input File slots. LACO-4 does not currently directly drive this output. However, it can be used in conjunction with the Programmable Logic feature to perform a user-defined operation.

Four Hardwire Interconnect (HWI) outputs are available to allow the 170 controller to operate as a coordination Master. The HWI logic sets outputs as follows:

- Aux File load switch 3 (AUX3) Red – Sync Pulse
- Aux File load switch 6 (AUX6) Red – Free
- AUX6 Yellow – Plan 2
- AUX6 Green – Plan3

The Preemption indicator drives the AUX3 Yellow output. This is user settable at location 3-C-0 and can be set to come on when any preemption or Manual Control is active.

Finally, the Time of Day Special Function (TODSPF) output can be turned on or off by the coordination TOD tables. This logic drives the AUX3 Green output and is useful for controlling signs/flashers at schools.

RS232 OUTPUTS

LACO-4 offers a broad range of serial outputs that can be used to send a variety of information to any controller on the same, twisted pair interconnect. Coordination data, Time/Date, AB3418 messaging and phase Green or Yellow can be sent with very simple configuration. The receiving controllers must be set to the same communications protocol that LACO-4 uses to transmit to the data. Details about the serial outputs are provided in Section 7, Communications.

SECTION 4 SIGNAL TIMING

INITIAL POWER UP

SIGNAL TIMING PARAMETERS

PHASE TIMING
CONFIGURATION
DETECTORS
OVERLAPS
PREEMPTION
ZIP COORDINATION
COORDINATION
COORDINATION ATTRIBUTES
COORDINATION TABLES
PROGRAMMABLE LOGIC

INITIAL POWER UP

When the 170 controller is started for the first time with a LACO-4 EPROM installed (and no LACO-4 timing saved on the Prom Module), signal timing is initialized as follows.

Location	Function	Value
1-E-0	Main Street Phases	1, 2, 5, 6
1-E-1	Side Street Phases	3, 4, 7, 8
1-0-F	Red Revert Time	02.0 seconds
1-1-E	Phase 1 Yellow Clearance	05.0 seconds
1-2-E	Phase 2 Yellow Clearance	05.0 seconds
1-3-E	Phase 3 Yellow Clearance	05.0 seconds
1-4-E	Phase 4 Yellow Clearance	05.0 seconds
1-5-E	Phase 5 Yellow Clearance	05.0 seconds
1-6-E	Phase 6 Yellow Clearance	05.0 seconds
1-7-E	Phase 7 Yellow Clearance	05.0 seconds
1-8-E	Phase 8 Yellow Clearance	05.0 seconds
4-0-0	System Manual	014 (Free)
4-0-1	Local Manual	014 (Free)
4-0-9	Maximum Cycle Length	255 seconds
1-0-4	Program Number	004
All other Timing Sheet locations are set to zero time/no flags.		

These timings provide the controller with the minimum data necessary to start operation for the first time. The controller will start up with phases 4 and 8 timing Red Clearance (interval “F”) as shown on the front panel display. After the 5 seconds of Red Clearance, the intersection will rest in red.

Basic 8 Phase fixed time operation can be quickly implemented by setting the following parameters:

- Permitted phases – Select all phases
- Minimum Vehicle Recall phases – Select all phases
- Ped Recall phases – Select all enabled Peds
- Phase Minimum Green times – As desired
- Phase Yellow and/or Red Clearance times – As desired
- Ped Walk and Flashing Don’t Walk times – As desired

SIGNAL TIMING PARAMETERS

The remainder of this section addresses the LACO-4 Timing Sheet entries starting at Page 1 (Phase Timing) and continuing through Page 12 (Programmable Logic). A minimum of two pages (Phase Timing and Configuration) is required to implement basic intersection timing. An intersection that takes advantage of all of the program's features could require up to 11 pages. The timing sheets are designed so that a major feature or function is implemented on one sheet. For instance, Detectors, Preemption, Overlaps, and Programmable Logic are all on separate pages and if any of those particular functions is not required, then the respective timing sheet can be omitted. The header of each Timing Sheet has the label "Page ___ of ___" so that any combination of Timing Sheets can be assembled as a package and still be numbered sequentially. The table below lists each of the timing sheets and their applicable data categories.

Timing Sheet	Data Categories
Phase Timing	Phase interval, Phase diagram, Miscellaneous timers
Configuration	Phase Function flags, Street Configuration flags, Miscellaneous flags, Communications Options, Manual Control Configuration
Detectors	Extension/Delay time, Phase flags, Attribute flags
Overlaps	Parent phase assignment, Clearance and Delay time, Load Switch assignment
Preemption	Railroad configuration, EV configuration, Preempt output configuration
Zip Coordination	Zip Coordination enable and configuration
Coordination 1	Plans 1 thru 9 Offsets, Plans 1 thru 3 Interval and Function flags
Coordination 2	Plans 4 thru 6 Interval and Function flags
Coordination 3	Plans 7 thru 9 Interval and Function flags
Coordination Attributes	Coordination Phase flags
Coordination Tables	Time of Day, Holiday and Exception tables
Programmable Logic	Logic Gates, Latches, Relays and Timers

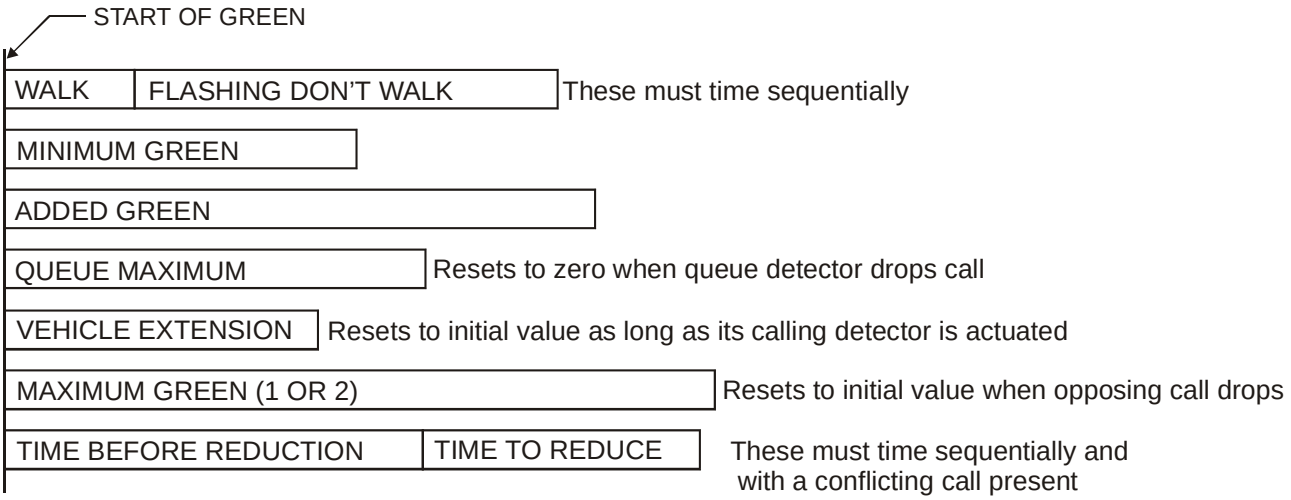
Following the twelve timing sheets are three information sheets that can be included in a timing sheet package to assist maintenance personnel. They include the Programmable Logic Worksheet, Real Time Clock instructions/information, and one Maintenance Information sheet, which provides information on memory locations that are useful for equipment diagnostics or troubleshooting an intersection. In the following pages, each section of the LACO-4 timing sheets, beginning with sheet 1 (Phase Timing) is replicated with a description of the parameters therein. The majority of LACO-4 Phase Timing is the same as in previous LACO programs and users familiar with those programs will easily adapt to this version. Appendix D offers guidance in converting LACO-1R and LACO-3 program timing sheets to LACO-4 format.

PHASE TIMING

The first timing sheet, Phase Timing, includes all of the per-phase intervals, miscellaneous timers and the Phase Diagram block, which provides space to include information on the geometry of the intersection. The fields for Minimum Green and Yellow Clearance show the default values for all Permitted phases (set at location 1-F-0), if no data is entered for those parameters. The default values shown for pedestrian intervals only apply if that phase is flagged as a pedestrian movement (at locations 1-E-2 through 1-E-7). The bold, bracketed numbers following each interval description indicate the range of values that the interval will accept. Numbers with decimal points time in 0.1 second increments. Whole numbered intervals time in one-second increments.

Timing Intervals

The Walk, Flashing Don't Walk, and Minimum Green intervals comprise a quantity referred to as "Minimums." Minimums are those portions of the green interval that are guaranteed to time, except when overridden by Preemption. As shown below, all green timers count down concurrently from start of green, and continue until zero (with exceptions noted below).



NOTE: The Walk, Flashing Don't Walk and Minimum Green timers **cannot** be overridden by a Force Off but **can** be overridden by Railroad preempt Advance. A Force Off or Railroad preempt Advance will override all other green timers.

Keystrokes: 1 + Phase + Interval		Phase							
Interval		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Walk	**0**	0	1	0	1	0	1	0	1
Flashing Don't Walk	**1**	0	1	0	1	0	1	0	1
Minimum Green	**2**	10	10	10	10	10	10	10	10
Queue Maximum	**3**	0	0	0	0	0	0	0	0
Added Green per Actuation	**4**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Vehicle Extension	**5**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Time Before Reduction	**6**	0.0	0.0	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	0.0	0.0
Max Green 1 (Free)	**8**	0	0	0	0	0	0	0	0
Max Green 2 (Coordination)	**9**	0	0	0	0	0	0	0	0
Max Added Green	**A**	0	0	0	0	0	0	0	0
Unused	**B**								
Unused	**C**								
Time to Reduce	**D**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Yellow Clearance	**E**	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Red Clearance	**F**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Walk - The amount of time that the international walk symbol or "WALK" message is displayed on the pedestrian signal head. The minimum Walk time that can be entered into the 170 is 1 second. The Walk interval must time out completely unless an EV or Railroad Preempt occurs. In which case, the Walk timer is forced to zero and the Walk interval ends immediately. [**0 to 255**]

Flashing Don't Walk - The amount of time that the flashing international Don't Walk symbol or "DON'T WALK" message is displayed on the Pedestrian Head. The minimum Flashing Don't Walk time that can be entered into the 170 is 1 second. As with the Walk time, the Flashing Don't Walk interval must time out completely unless an EV or Railroad Preempt occurs. In the case of a Railroad Preempt, the Flashing Don't Walk timer is forced to zero and the flashing DON'T WALK indication goes to a steady DON'T WALK immediately. With an EV Preempt, LACO-4 allows two options. The default operation is to allow the Flashing Don't Walk interval to time out completely. By setting the appropriate flag on the Preemption Timing Sheet, the second option results in the immediate termination of the Flashing Don't Walk Interval. [**0 to 255**]

Minimum Green - The minimum length of time that a Vehicle indication will stay green (in the absence of a Preemption condition). [**0 to 255**]

Queue Maximum - The maximum length of time that a queue detector will hold a phase green. Queue Maximum times concurrently with Minimum Green. [**0 to 255**]

Added Green per Actuation - The amount of time that Added Green is increased for each calling detector actuation. Added Green times concurrently with Minimum Green. [**0.0 to 25.5**]

Vehicle Extension - The length of time that a phase will be held green (extended) in the absence of a detector actuation for that phase. Vehicle Extension begins timing when there is no actuation for the current phase and resets to its initial value when a call is reasserted. [**0.0 to 25.5**]

Time Before Reduction (TBR) - The amount of time that a phase waits before it begins timing Gap Reduction. TBR starts timing the moment when a conflicting call is present during the green. If no conflicting call is present the TBR timer resets to its initial value. [**0.0 to 25.5**]

Minimum Gap - The lower limit that a phase's Gap Out timer will be reached during Gap Reduction. Vehicle Extension will reduce down to this value only after the Time Before Reduction timer has expired. [**0.0 to 25.5**]

Max Green 1 and 2 - The maximum amount of green time that a phase will time. Max Green 1 is used during Free operation and Max Green 2 is used during coordinated operation. The Max Green timer begins timing at the start of the green interval. [**0 to 255**]

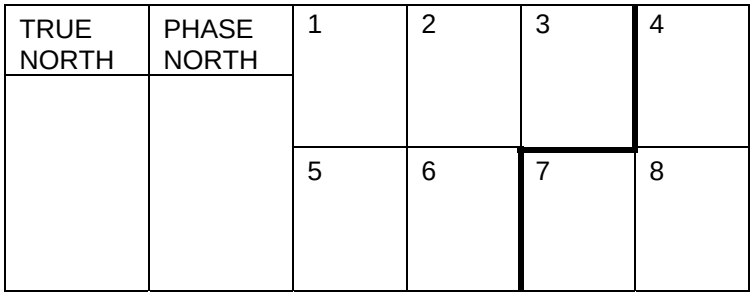
Max Added Green - The maximum amount of Added Green time that a phase can time. Limits the amount of Added Green resulting from excessive detector actuations**.** [**0 to 255**]

Time to Reduce (TTR) - The length of time to reduce the Gap Out timer (reduce Vehicle Extension time to Minimum Gap time). [**0.0 to 25.5**]

Yellow Clearance - The length of time that Yellow is displayed. Unless a phase is flagged for Yellow Ranging (at location 1DE), values less than 3.0 seconds will be changed to 3.0 seconds, and values greater than 5.0 seconds will be changed to 5.0 seconds. [**3.0 to 5.0**]

Red Clearance - The amount of time after the Yellow Clearance interval that a phase will display red. While this timer is active, no other phase in the same ring can start. [**0.0 to 25.5**]

Phase Diagram



This is where the intersection phasing is to be indicated. The directions of True North and Phase North, and the movements associated with each phase should be indicated here. Overlap movements should also be identified in this diagram along with Restricted and/or Exclusive phases. Highlight the barrier-phase boundaries to emphasize the quad structure of the intersection. The example above shows Main Street phases (as set in location 1-E-0) to be 1, 2, 3, 5, and 6 with the barrier phases being 3 and 6. (Default barrier phases are 2 and 6).

Miscellaneous Timers

These are the timers that are not on a per-phase basis. Red Rest Delay, Green Rest Delay and Red Revert are per-ring intervals while Stuck All Red Fail Delay is a per-controller interval.

MISCELLANEOUS TIMERS		
Time/Timer	**Location**	
Red Rest Delay Time	**106**	0
Green Rest Delay Time	**107**	0
Stuck All Red Fail Delay Time	**10E**	30
Red Revert Time	**10F**	2.0

Red Rest Delay Time - The time before a phase that is flagged to Rest in Red starts its termination sequence. At the beginning of green of the Red Rest phase, this value is copied to the respective Ring delay timer. Rings A and B have separate Red Rest Delay Timers that can be viewed at locations 1-A-C and 1-B-C, respectively. The Red Rest Delay Timer will count down when the Red Rest phase is resting in green (timing no interval with no opposing calls). Whenever this condition is not met, the Red Rest Delay Timer resets to the value entered here. [**0 to 255**]

Green Rest Delay Time - The time before a phase that is flagged to Rest in Green causes termination of a non-concurrent, non-Green Rest phase. At the beginning of green of any phase, this value is copied to the Green Rest Delay Timer (shared by both Rings) at location 1-0-8. The Green Rest Delay Timer will count down when any non-Green Rest phase is resting in green. Whenever this condition is not met, the Green Rest Delay Timer resets to the value entered here. [**0 to 255**]

Stuck All Red Fail Delay Time - By default, the Stuck-All-Red logic will put the controller into software flash 30 seconds after an all Red (with calls) condition is detected. This parameter allows the user to vary the failure detection window. A non-zero value entered here overrides the default of 30 seconds. [**0 to 255**]

Red Revert Time - The absolute minimum time that a just terminated phase must wait before it can be served again. At the beginning of each phase green, this value is copied to the respective Ring Red Revert Timer. The Red Revert timer times concurrently with the (just terminated) phase's Red Clearance timer. Ring A and Ring B have separate Red Revert Timers that can be viewed at location 1-A-B and 1-B-B respectively. [**0.0 to 25.5**]

CONFIGURATION

This timing sheet page includes all of the phase "flag" type parameters, controller Communications Options and Manual Control configuration parameters. The Phase Function, Street Configuration and Miscellaneous phase flags further define the intersection's basic operation. Items on this page will generally only be set once.

Phase Function Flags

PHASE FUNCTION FLAGS									
Keystrokes: 1 + F + row		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Permitted Phases	**0**								
Red Lock	**1**								
Red and Yellow Lock	**2**								
Minimum Vehicle Recall	**3**								
Maximum Vehicle Recall	**4**								
Rest in Green	**5**								
Rest in Red	**6**								
Barrier Recall	**7**								
Double Entry	**8**								
Exclusive Phases	**9**								
Restricted Phases	**A**								
Protected/Permissive Left Turn	**B**								
Lag Phases (Free)	**C**		X		X		X		X
First Phases After Start Up	**D**								
Yellow Start-Up Phases	**E**								
Yellow Start-Up Overlaps	**F**								

Permitted Phases - The phases that will time during normal operation of the intersection. Any changes to this location will be implemented immediately. If a Permitted Phase is timing any of its Green Intervals and that phase is removed from Permitted Phases, it will be forced off (after timing its Minimums) and no calls to that phase will be recognized.

Red Lock - Calls placed to any phase set at this location will be locked if those calls are placed during the phase's Red interval. The locked call will be removed when the flagged phase starts its Green interval.

Red and Yellow Lock - The same operation as Red Lock above except it also includes calls placed during the phase's Yellow interval.

Minimum Vehicle Recall - Causes a call to be placed for a phase during its Red interval only. This call will remain in place until the phase goes green.

Maximum Vehicle Recall - Causes a continuous call to be placed for a phase. This results in the phase staying green until its Maximum Green Timer has expired (even if no Vehicle Extension time is set for the phase).

Rest in Green - Causes a call to be placed to a phase if that phase is not in service and no opposing calls to that phase exist.

Rest in Red - Causes a termination sequence to begin for a phase if that phase is resting in green and there are no opposing calls to that phase.

Barrier Recall - Causes a call to be placed at barrier crossing for phases flagged here.

Double Entry - Causes a call to be placed, at barrier crossing, for flagged phase if no other call exists in the quadrant of the flagged phase.

Exclusive Phases - Any phase flagged here must time by itself, even if a normally compatible phase has demand. If a normally compatible phase is in service when an Exclusive phase requests service, the non-Exclusive phase will terminate as if a normally non-compatible phase was requesting service. A barrier crossing is required to implement changes to this location.

Restricted Phases - A phase set in this location will not be permitted to time concurrently with another Restricted phase. Restricted phasing can only be implemented in a standard quad configuration (phases 1, 2, 5, and 6 set to Main Street). Also, Exclusive phasing and Restricted phasing are mutually exclusive operations (on the same street). Exclusive phasing operation has priority over Restricted phasing operation. The data validation logic will not permit selecting a phase as Restricted if any other phases on that street are already selected as Exclusive. However, one street may implement Restricted phasing while the other street implements Exclusive phasing. A barrier crossing is required to implement changes to this location.

Protected/Permissive Left Turn - Used when entrapment conditions exist. Prevents the controller from backing up from a lagging phase to a leading phase. A call placed by a phase flagged for Prot/Perm Left Turn (while a lagging phase is green) will only be answered after the lag phases terminate and the controller crosses the barrier. Until then, the call will be ignored by the controller. A call placed by a Prot/Perm Left Turn phase, when a more lagging phase is green, is indicated by its Call light flashing at a slow rate. The call in this instance will be ignored.

Note:

A *lag* (barrier) phase that is flagged as Prot/Perm Left Turn will **never** be served nor will a call to that phase be recognized or indicated in its call light.

Care should be taken when flagging a lead phase for both Prot/Perm **and** ped operation. The same logic that prevents vehicle service will also prevent ped service.

Lag Phases (Free) - This location sets the lagging-most (barrier) phase for each quadrant, before crossing the barrier, when running Free (not in coordination). If no phases are set, the default is set to all even numbered phases. This location is ignored in non-standard quad configurations and barrier phases will be used as lag phases. A barrier crossing is required to implement changes in this location. Lag phasing for Manual Control Operation is set at location 3-C-2 on the CONFIGURATION timing sheet. Lag phasing for Coordination is set at 7-x-0 (where x = Plan Number) on the Coordination Attributes timing sheet.

First Phases after Startup - Phases set in this location will be the first phases to go green after a long power down restart. Flagged phases must be able to time concurrently or the data validation logic will modify the data so that only concurrent phases remain. If only a single ring is flagged here, any compatible phase may go green once the flagged phase goes green.

Yellow Startup Phases - Flagged phases will start up in Yellow Clearance interval after a long power down restart. As with First phases, flagged phases must be able to time concurrently or the data validation logic will modify the data so that only concurrent phases remain. Flagged phases will time 5.0 seconds of Yellow Clearance regardless of the Yellow Clearance time entered on the Phase Timing Sheet.

Yellow Start Up Overlaps - Causes any flagged Overlap to start up yellow after a long power down restart. At least one of the Overlap's parents must be flagged as a Yellow Start Up Phase at location 1-F-E. Columns 1 through 6 correspond to Overlaps A through F. Flagged Overlaps will time 5.0 seconds of Yellow Clearance regardless of the overlap Yellow Clearance time entered on the Overlap Timing Sheet.

Street Configuration Flags

STREET CONFIGURATION									
Keystrokes: 1 + E + row		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Main Street Phases	**0**	X	X			X	X		
Side Street Phases	**1**			X	X			X	X
2 Ped Load Switch	**2**		X						
4 Ped Load Switch	**3**				X				
6 Ped Load Switch	**4**						X		
8 Ped Load Switch	**5**								X
Ped A Load Switch	**6**								
Ped B Load Switch	**7**								
Ped Recall	**8**								
STA Mode	**9**								
Unused	**A**								
Unused	**B**								
Unused	**C**								
Driveway Flash	**D**								
2 Head Driveway Flash	**E**								
Overlap Driveway Flash	**F**								

Main Street Phases - All phases that will be on the Main Street side of the barrier (even phases that may not be Permitted). On a long power down restart, if this location is not set, the program will default to a standard quad configuration, that is phases 1, 2, 5, and 6 will be set as Main Street phases. Since this parameter is so critical, User Flag Options (location 1-D-B) call light 2 must be turned on before this location can be changed. In addition, the change will not be implemented until a long power down restart occurs. Any phase not flagged as a Main Street phase will automatically be flagged as a Side Street Phase.

Side Street Phases - For observation only; this location cannot be modified by the user. After setting Main Street phases and performing a long power down restart, LACO-4 automatically sets Side Street phases based on phases set in Main Street phases above.

Ped Phase Assignments (locations 1-E-2 through 1-E-7) - Assigns a corresponding vehicle phase to each ped. Only one phase may be set in any of the six Ped assignments. Ped A and Ped B share Overlap A and Overlap B outputs, respectively. If either of these Overlaps is enabled (by setting parent phases on the Overlap Timing Sheet), the corresponding Ped assignment will be cleared. Note that Ped A and Ped B share the Manual Control inputs (I11U/L). If either Ped A or Ped B is set, the Manual Control feature will be disabled.

Ped Recall - Also referred to as Rest in Walk. Causes a ped call to be placed for the flagged Ped phases. The call is continuous except during the flagged Ped's Walk interval. If no opposing call is present, the Ped indication will "rest" in Walk. The Walk interval will time down until 1 second remains in its timer. When an opposing call is placed, the remaining Walk time expires and the Flashing Don't Walk interval begins. If the opposing call drops any time before the phase's Flashing Don't Walk interval ends, the Ped Walk interval restarts and the process begins all over again. Only enabled Peds (as set in locations 1E2 through 1E7 above) can be flagged for Ped Recall.

Semi-Traffic Actuated (STA) Mode - Only enabled Peds (as set in locations 1-E-2 through 1-E-7 above) can be flagged for STA Mode. STA (Semi-Traffic actuated) mode is a modified form of Ped Recall that is used only in Coordination. While the controller is running in coordinated mode, the ped phases flagged here will be placed on recall. When the ped serves, it will time out its Walk interval and rest in Walk until the coordinator sets a Force Off for the phase. At that time the ped will time its Flashing Don't Walk interval and then terminate.

Driveway Flash Phases - Causes the green output of the flagged phase to flash (at the same flash rate as the Ped Clearance interval) while timing its green intervals.

2 Head Driveway Flash - Causes the red output of the flagged phase to be set ON during the flagged phase's yellow interval. Any phase flagged here must also be flagged in Driveway Flash Phases above. Used when a 2 section (red and green only) signal head is providing indications for the flagged phase.

Driveway Flash Overlaps - Causes the green output of the flagged overlap to flash (at the same frequency as the Ped Clearance interval) while in its green interval. The 2 Head Driveway Flash modifier above does not apply to this parameter.

Miscellaneous Flags

MISCELLANEOUS FLAGS									
Keystrokes: 1 + d + row		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Unused	**0**								
Associated Phase Recall-1	**1**								
Associated Phase Recall-2	**2**								
Associated Phase Recall-3	**3**								
Associated Phase Recall-4	**4**								
Associated Phase Recall-5	**5**								
Associated Phase Recall-6	**6**								
Associated Phase Recall-7	**7**								
Associated Phase Recall-8	**8**								
Yellow Calling Phase	**9**								
Yellow Phase Called	**A**								
User Flags	**B**								
Green Offset Sync Pulse	**C**								
Yellow Offset Sync Pulse	**D**								
Yellow Ranging Phase	**E**								
Yellow Ranging Overlap	**F**								

Associated Phase Recall - 1 - Any phase flagged here will have a locked call placed to it when phase 1 goes green. The call is dropped if the flagged phase is green.

Associated Phase Recall - 2 - Any phase flagged here will have a locked call placed to it when phase 2 goes green. The call is dropped if the flagged phase is green.

Associated Phase Recall - 3 - Any phase flagged here will have a locked call placed to it when phase 3 goes green. The call is dropped if the flagged phase is green.

Associated Phase Recall - 4 - Any phase flagged here will have a locked call placed to it when phase 4 goes green. The call is dropped if the flagged phase is green.

Associated Phase Recall - 5 - Any phase flagged here will have a locked call placed to it when phase 5 goes green. The call is dropped if the flagged phase is green.

Associated Phase Recall - 6 - Any phase flagged here will have a locked call placed to it when phase 6 goes green. The call is dropped if the flagged phase is green.

Associated Phase Recall - 7 - Any phase flagged here will have a locked call placed to it when phase 7 goes green. The call is dropped if the flagged phase is green.

Associated Phase Recall - 8 - Any phase flagged here will have a locked call placed to it when phase 8 goes green. The call is dropped if the flagged phase is green.

Yellow Calling Phase - If a phase flagged here is timing its yellow interval, a locked call is placed to all phases flagged in Yellow Phase Called, below.

Yellow Phase Called - A locked call is placed to all phases flagged here if a phase flagged in Yellow Calling Phase, above, is timing it's yellow interval. This parameter is ignored if no phases are flagged in Yellow Calling Phase.

User Flags - Eight flags that enable or disable functions and features. Press the number corresponding to the desired feature to enable/disable it.

User Flag Options (1DB)
1. Mid-Block Ped Crossing
2. Modify Main Street Phases (1E0)
3. Delay RR Track Clearance Phase Green
4. Modified Barrier Crossing (Ignore True Max
5. Disable Daylight Savings Time Update
6. Enable Output File Editing
7. Freeway Offramp Anti-Backup Logic
8. Ignore Stuck-All-Red Failure

1 = Mid-Block Ped Crossing – Enables the special field indications for the vehicle phase when phase 4 ped is active. (see Section 8.3)

2 = Modify Main Street Phases – This flag must be set in order to change the Main Street phases at location 1-E-0. A long power down is then required to implement the change at which time the flag is automatically cleared.

3 = Delay Track Clearance Phase Green until All overlaps have terminated - Inhibits the start of Track Clearance Green if any overlap is timing any of its clearance intervals.

4 = Modified Barrier Crossing – Permits a barrier crossing when any combination of Max-out and Gap-out occurs. If this flag is cleared, both rings must either Gap out or Max out.

5 = Disable Daylight Savings Time Update – Prevents the automatic “Fall back” and “Spring ahead” time adjustment for those agencies that do not recognize Daylight Savings Time.

6 = Disable Ped Recycle logic – Disables Ped Recycle logic for peds flagged as either STA Mode or Ped Recall.

7 = Freeway Offramp Anti-Backup Logic – Used to prevent freeway offramp traffic from backing up onto the freeway lanes. Causes priority service of the offramp phase when its advance detector stays actuated for a specified length of time. (see Section 8.4)

8 = Ignore Stuck-All-Red Failure - Prevents the intersection from going into software flash if it gets stuck in an all-Red condition with active calls for more than 30 seconds. (Does not prevent the intersection from getting stuck all Red).

Green Offset Sync Phase - Used to notify another controller (usually the next one downstream in a communications link) when the flagged phase is green. Generally only one phase should be flagged at this location. Only used if one of this controller’s Comm Ports is configured for comm option 6, Transmit Plan Data (see next page).

Yellow Offset Sync Phase - Used to notify another controller (usually the next one downstream in a communications link) when the flagged phase is yellow. Generally only one phase should be flagged at this location. Only used if one of this controller’s Comm Ports is configured for comm option 6, Transmit Plan Data (see next page).

Yellow Ranging Phase - Allows the flagged phase to accept a time of less than 3.0 seconds (including 0.0 seconds) or greater than 5.0 seconds for its Yellow Clearance time.

Yellow Ranging Overlap - Allows the flagged overlap to accept a time of less than 3.0 seconds (including 0.0 seconds) or greater than 5.0 seconds for its Yellow Clearance time.

Communications Options (see Section 7 for more information on communications)

COMMUNICATIONS OPTIONS		
System ID	190	
Comm Port 1	191	
Comm Port 2	192	
Comm Port 3	193	
Comm Port 4	194	

System ID = 1 through 255
Comm Port Options
1. WWV
2. Transmit 7 Wire Data
3. Receive 7 Wire Data
4. Transmit Time and Date
5. Receive Time and Date
6. Transmit Plan Data
7. Transmit AB3418 (Time and Date)
8. Receive AB3418

System I.D - Communications address for the controller. Provides a unique identifier to an external polling system, on-street master, etc. Range is from 1 to 255, 0 means unassigned.

Comm Port 1 - Assigns one of eight Communications options to Communications Port 1 (C2S). Any of the options may be assigned to any Comm Port. Any value other than the ones described below are ignored.

01 = *WWV* - Sets up the Comm Port to communicate with a *WWV* Clock.

02 = *Transmit 7 Wire Data* - Sets up the Comm Port to transmit coordination information in 7-Wire format.

03 = *Receive 7 Wire Data* - Sets up the Comm Port to receive coordination information in 7-Wire format. This is either serial data transmitted from another controller via modem or actual 7 wire parallel data that has been converted to serial data within the cabinet and then routed to the controller's Comm Port.

04 = *Transmit Time and Date* - Sets up the Comm Port to transmit the controller's time and date information. Data is transmitted once per minute. Six bytes are sent; Hours, Minutes, Day of Week, Day, Month and Year.

05 = *Receive Time and Date* - Sets up the Comm Port to receive time and date information from another 170 controller. The received time and date overwrites the controller's existing time and date.

06 = *Transmit Plan Data* - Sets up the Comm Port to transmit Master information to another LACO-4 controller. Sends plan number, sync pulse, Midnight Sync pulse and Offset Timing trigger to Slave controllers.

07 = *Transmit AB3418* (Time and Date) - Sets up the Comm Port to transmit the controller's time and data information in AB3418 format to any type controller that is capable of receiving AB3418 messages. This information is sent once per hour, on the hour.

08 = *Receive AB3418* - Sets up the Comm Port to receive and respond to AB3418 polling messages from a central system.

Comm Port 2 - Assigns one of eight Communications options to Communications Port 2 (C20S). Any of the options may be assigned to any Comm Port. Any value other than the ones described below are ignored.

01 = WWV - Sets up the Comm Port to communicate with a *WWV* Clock.

02 = Transmit 7 Wire Data - Sets up the Comm Port to transmit coordination information in 7-Wire format.

03 = Receive 7 Wire Data - Sets up the Comm Port to receive coordination information in 7-Wire format. This is either serial data transmitted from another controller via modem or actual 7 wire parallel data that has been converted to serial data within the cabinet and then routed to the controller's Comm Port.

04 = Transmit Time and Date - Sets up the Comm Port to transmit the controller's time and date information. Data is transmitted once per minute. Six bytes are sent; Hours, Minutes, Day of Week, Day, Month and Year.

05 = Receive Time and Date - Sets up the Comm Port to receive time and date information from another 170 controller. The received time and date overwrites the controller's existing time and date.

06 = Transmit Plan Data - Sets up the Comm Port to transmit Master information to another LACO-4 controller. Sends plan number, sync pulse, Midnight Sync pulse and Offset Timing trigger to Slave controllers.

07 = Transmit AB3418 (Time and Date) - Sets up the Comm Port to transmit the controller's time and data information in AB3418 format to any type controller that is capable of receiving AB3418 messages. This information is sent once per hour, on the hour.

08 = Receive AB3418 - Sets up the Comm Port to receive and respond to AB3418 polling messages from a central system.

Comm Port 3 - Assigns one of eight Communications options to Communications Port 3 (C30S). Any of the options may be assigned to any Comm Port. Any value other than the ones described below are ignored.

01 = WWV - Sets up the Comm Port to communicate with a *WWV* Clock.

02 = Transmit 7 Wire Data - Sets up the Comm Port to transmit coordination information in 7-Wire format.

03 = Receive 7 Wire Data - Sets up the Comm Port to receive coordination information in 7-Wire format. This is either serial data transmitted from another controller via modem or actual 7 wire parallel data that has been converted to serial data within the cabinet and then routed to the controller's Comm Port.

04 = Transmit Time and Date - Sets up the Comm Port to transmit the controller's time and date information. Data is transmitted once per minute. Six bytes are sent; Hours, Minutes, Day of Week, Day, Month and Year.

05 = Receive Time and Date - Sets up the Comm Port to receive time and date information from another 170 controller. The received time and date overwrites the controller's existing time and date.

06 = Transmit Plan Data - Sets up the Comm Port to transmit Master information to another LACO-4 controller. Sends plan number, sync pulse, Midnight Sync pulse and Offset Timing trigger to Slave controllers.

07 = Transmit AB3418 (Time and Date) - Sets up the Comm Port to transmit the controller's time and data information in AB3418 format to any type controller that is capable of receiving AB3418 messages. This information is sent once per hour, on the hour.

08 = Receive AB3418 - Sets up the Comm Port to receive and respond to AB3418 polling messages from a central system.

Comm Port 4 - Assigns one of eight Communications options to Communications Port 4 (C40S). Any of the options may be assigned to any Comm Port. Any value other than the ones described below are ignored.

01 = *WWV* - Sets up the Comm Port to communicate with a *WWV* Clock.

02 = *Transmit 7 Wire Data* - Sets up the Comm Port to transmit coordination information in 7-Wire format.

03 = *Receive 7 Wire Data* - Sets up the Comm Port to receive coordination information in 7-Wire format. This is either serial data transmitted from another controller via modem or actual 7 wire parallel data that has been converted to serial data within the cabinet and then routed to the controller's Comm Port.

04 = *Transmit Time and Date* - Sets up the Comm Port to transmit the controller's time and date information. Data is transmitted once per minute. Six bytes are sent; Hours, Minutes, Day of Week, Day, Month and Year.

05 = *Receive Time and Date* - Sets up the Comm Port to receive time and date information from another 170 controller. The received time and date overwrites the controller's existing time and date.

06 = *Transmit Plan Data* - Sets up the Comm Port to transmit Master information to another LACO-4 controller. Sends plan number, sync pulse, Midnight Sync pulse and Offset Timing trigger to Slave controllers.

07 = *Transmit AB3418* (Time and Date) - Sets up the Comm Port to transmit the controller's time and data information in AB3418 format to any type controller that is capable of receiving AB3418 messages. This information is sent once per hour, on the hour.

08 = *Receive AB3418* - Sets up the Comm Port to receive and respond to AB3418 polling messages from a central system.

Manual Control Configuration (see Section 5 for more information on Manual Control operation)

Manual Control Configuration									
Option	**Location**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Omit Phases	**3C1**								
Lag Phases	**3C2**								
Recall Type	**309**								

Omit Phases - Phases to be omitted while in Manual Control operation. All phases flagged here will be ignored when the Manual Control Enable input is ON.

Lag Phases - This location sets the last phase for each quadrant (before crossing the barrier) while in Manual Control operation. If no phases are set, the default is all even numbered phases. This location is ignored in non-standard quad configurations and barrier phases will be used as lag phases. A barrier crossing is required to implement changes in this location

Recall Type - This location determines what type of recall is in force during Manual Control operation. Any value other than the ones described below are ignored.

00 = Disable Manual Control - Causes Manual Control operation to be ignored.

01 = No recall - Only phases or peds with detector actuations will be served.

02 = Vehicle Recall Only - All Permitted phases will be placed on recall while in the Manual Control Enable input is ON.

03 = Ped and Vehicle Recall - All Permitted phases and enabled peds will be placed on recall while the Manual Control Enable input is ON.

DETECTORS

The Detector timing sheet contains all of the parameters related to vehicle or system detection. This is where the phases to be called by a detector are assigned along with any “attributes” which may modify the basic operation of each detector. Additionally, the detector Delay and Extension times are set here. Several other fields are provided for textual description only. A representative portion of the Detector Timing sheet is shown below

			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
				210		230		2B0									2D0								
				211		231		2B1									2D1								
				212		232		2B2									2D2								

Delay Time - (For each of 28 detectors). Any time entered here will cause the detector’s actuation to be ignored for the duration of the delay timer. The delay timer resets to its initial value whenever the detector is **not** actuated or when its assigned phase is yellow. If multiple phases are assigned to a detector, the delay timer reset is disabled during any assigned phase yellow interval. The delay timer will count down to zero as long as an actuation is present. The delay timer is ignored when the detector’s assigned phase is not red. **[0 to 255]**

Extended Call Time - (For each of 28 detectors). A time entered here will cause the detector’s actuation to be extended (or carried over) for the duration of the extension timer. The extension timer resets to its initial value whenever the detector is actuated and counts down to zero as long as there is no actuation. The extension timer is ignored when the detector’s assigned phase is not green. **[0 to 25.5]**

Phase Flags - (For each of 28 detectors) Default phase assignments are indicated by shaded boxes. If no phase is assigned for a detector, then actuation of that detector will cause the shaded phase to be called. Any phase entry for a particular detector will disable the default calling logic for that detector. Any phase or phases can be assigned to any detector. Some detector attributes (described below) will be ignored if multiple phases are assigned.

Attribute Flags - (For each of 28 detectors) Select the number of the desired Attribute(s).

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

1 = System Detector - This attribute allows a vehicle detector to also be used as a System Detector thus causing Volume, Occupancy and Speed (VOS) data to be calculated from it. Only sixteen of the possible twenty-eight detectors will generate VOS data. They are located in the 332 cabinet input file as follows:

Sample I-File input rack

	2I2U	2I3U			4I6U	4I7U		
	2I2L	2I3L			4I6L	4I7L		
	6J2U	6J3U			8J6U	8J7U		
	6J2L	6J3L			8J6L	8J7L		

2 = Red and Yellow Lock - Causes an actuation to be locked if it occurs during the detector phase's Red or Yellow interval.

3 = Yellow Disconnect - Causes an actuation to be ignored if it occurs during the detector phase's Yellow interval.

4 = Red Calling Only - Causes an actuation to place a call to the detector's assigned phase **only** if it occurs during the detector phase's Red interval.

5 = Queue Clearing - Allows a detector to use Queue Clearing logic. A call will be placed to the detector's phase only during the phase's Red or Yellow interval. When the phase goes green, a Queue hold will be placed on the phase. If the actuation drops or the Queue Max timer expires, the detector will become disabled for the remainder of the current phase's service. Actuation of this type detector during its assigned phase green interval will not cause phase extension to occur.

6 = Non-Counting - This attribute will inhibit count accumulation for the purposes of Added Initial Green computations.

7 = Special Delay Option 1 - Allows the user to select phases that, when in service, override the detector's delay timer. These phases are selected in Special Delay Option 1 Phases (location 2-F-8).

8 = Special Delay Option 2 - Allows the user to select phases that, when in service, override the detector's delay timer. These phases are selected in Special Delay Option 2 Phases (location 2-F-9).

SPECIAL DETECTOR DELAY ASSIGNMENTS		Phase							
All Options: Delay Timer resets during detector phase yellow.	Code	1	2	3	4	5	6	7	8
Special Delay Option 1 (Attribute Bit 7) - Bypasses delay while flagged phases are timing.	2F8								
Special Delay Option 2 (Attribute Bit 8) - Bypasses delay while flagged phases are timing.	2F9								

Special Delay Option 1 Phases - Used in conjunction with Detector Attribute 7. When phases selected here are in service, the detector's delay timer is overridden and actuation is registered immediately. Multiple phases may be selected here.

Special Delay Option 2 - Used in conjunction with Detector Attribute 8. When phases selected here are in service, the detector's delay timer is overridden and actuation is registered immediately. Multiple phases may be selected here.

OVERLAPS

(see section 5 for details on Overlap operation)

Note: Only Overlap A timing is described here but timings for Overlaps B through F are identical.

OVERLAP A									
Keystrokes: 3 + row + A		1	2	3	4	5	6	7	8
NORMAL PARENTS	A								
GREEN OMIT PARENTS	B								
RR PREEMPT PARENTS	C								
EV PREEMPT PARENTS	D								
LOAD SWITCH ASSIGNMENT	0								
DELAY TIME	1								
GREEN EXTENSION TIME	2								
YELLOW CLEARANCE TIME	3								
RED CLEARANCE TIME	4								

Normal Parents - (For each of 6 overlaps) Parent phases to be used during normal (i.e. non-preempt) service. Phases flagged here must be flagged as Permitted (location 1-F-0) or they will be ignored.

Green Omit Parents - (For each of 6 overlaps) Prevents the overlap green output from coming on when any parent phase flagged here is green.

RR Preempt Parents - (For each of 6 overlaps) Parent phases to be used during Railroad preemption. Phases flagged here must also be flagged for Railroad Limited Service (location 3-A-3) or they will be ignored.

EV Preempt Parents - (For each of 6 overlaps) Parent phases to be used during Emergency Vehicle preemption. Phases flagged here must also be flagged as Normal parents and/or RR Preempt parents.

Load Switch Assignment - (For overlaps C, D, E or F only) Allows a three-color overlap output to be sent to any available load switch **in addition** to its default load switch assignment. This will override the output that is normally sent to this load switch. The value entered here corresponds to the CMU channel number assigned to each load switch. “00” means “not echoed”, “01” thru “08” sends the overlap output to a vehicle load switch and “13” thru “16” echoes the overlap output to a ped load switch. Any other value is treated as “00”. [**1 thru 8 or 13 thru 16**]

Delay Time - (For each of 6 overlaps) Causes the start of overlap green to be delayed for the length of time specified here. The overlap delay timer is set to its initial value whenever the overlap goes red. When any parent phase (not set as a Green Omit Parent) goes green, the delay timer begins to decrement. As long as the delay timer is active, the overlap will output red. When the delay timer expires, if a parent phase is still green, the overlap will go green. [**0 to 25.5**]

Green Extension Time - (For each of 6 overlaps) Causes the overlap to continue to output green beyond its normal termination point. If another overlap parent goes green while this timer is active, the timer will be reset until the next overlap termination sequence begins. [**0 to 25.5**]

Yellow Clearance Time - (For each of 6 overlaps) The length of time that the overlap will output yellow when it terminates. The time entered here is restricted to between 3.0 and 5.0 seconds unless the overlap is selected in Yellow Ranging Overlap (location 1-D-F). [**3.0 to 5.0**]

Red Clearance Time - (For each of 6 overlaps) The length of time that the overlap will display red during termination. [**0 to 25.5**]

PREEMPTION

(see section 5 for details on Preemption operation)

RAILROAD CONFIGURATION		
RAILROAD SELECT (1, 2 or 3)	**360**	
ALL RED TIME AFTER RAILROAD FLASH	**361**	
RAILROAD TRACK CLEARANCE TIME	**362**	
LIMITED SERVICE MAX TIME	**363**	
RAILROAD LINK TO EV (see note to right)	**364**	
FREE TIME AFTER PREEMPT	**365**	
FREE TIME AFTER PREEMPT, TIMER	**366**	
MAX TIMER, MINUTES	**367**	
MAX TIMER, SECONDS	**368**	

Railroad Configuration

Railroad Select - Sets the Railroad mode for this controller as follows:

01 = Railroad A only - Responds to the Railroad A input only and can only be configured for RR Flash operation only.

02 = Railroad B only - Responds to the Railroad B input only and can be configured for RR Flash or Limited Service operation.

03 = Railroad A and Railroad B - Responds to both Railroad A and Railroad B inputs with Railroad A configured for RR Flash operation and Railroad B configured for Limited Service operation.

Any other value entered here will be changed to “01” automatically and treated as Railroad A only.

All Red After RR Flash - The length of time that the intersection will display all-Red after RR Flash stops at the end of preempt. **[0 to 25.5]**

Track Clearance Time - The length of time that the phases flagged for Track Clearance (location 3-A-0) will spend in the green interval. If no time is entered here, then the intersection will go into RR Flash after all phases have terminated, regardless of what is entered for Railroad Select. **[0 to 25.5]**

Limited Service Max Time - The maximum length of time (in minutes) that Railroad B service will provide Limited Service operation. When this timer expires and the Railroad B input is still active, all phases in service will terminate and the intersection will go to RR Flash. If this location is set to “00”, then RR Flash will never occur. **[0 to 255]**

Railroad Link to EV - This enables an EV preempt sequence that will service automatically following the end of a Railroad preempt sequence. This can be used to provide guaranteed service (as defined by the linked EV’s parameters) to selected phases after a RR preempt. **[1, 2, 3 or 4 (for EV A, B, C or D)]**

Free Time After Preempt - Causes the intersection to remain Free after a preempt sequence has ended. Allows phases to serve by demand only in order to clear any backup that may have occurred during the preempt. **[0 to 25.5]**

Railroad Phases

RAILROAD PHASES		1	2	3	4	5	6	7	8
TRACK CLEARANCE	3A0								
RAILROAD EXIT	3A1								
RAILROAD PED ONLY	3A2								
LIMITED SERVICE	3A3								

Track Clearance Phases - The phases that become active in order to clear vehicles from the railroad tracks before a train arrives at the intersection. If no phases are selected here, then the intersection will go into RR Flash after all phases have terminated regardless of what is entered for Railroad Select. Phases entered here must be able to time concurrently.

Railroad Exit Phases - The phases that will service first after the Railroad preempt sequence ends. Phases entered here must be able to time concurrently.

Railroad Ped Only Phases - Ped movements that will service without a corresponding vehicle service. Generally set for phases for which ped service is desired but which are not selected as Limited Service Phases. Phases entered here must also be enabled on the Configuration timing sheet.

Limited Service Phases - Phases that will time normally after the Track Clearance interval of a Railroad B preempt service. Any phases may be entered here.

Aux 3 Yellow Output Control

AUX 3 YELLOW OUTPUT CONTROL (Keypress 3+C+0)		
	1	Railroad A
	2	Railroad B
	3	Emergency Vehicle A
	4	Emergency Vehicle B
	5	Emergency Vehicle C
	6	Emergency Vehicle D
	7	Manual Control
	8	unused

Aux 3 Yellow Output Control - Allows the Aux 3 Yellow output to reflect the status of preemption and Manual Control. This output can be used to provide advance warning to motorists, etc. The Aux 3 Yellow output will go ON whenever any of the flagged functions is active.

EV Configuration

EV CONFIGURATION		1	2	3	4	5	6	7	8
EV FLAGS	390								
EV A CLEARANCE PHASES	391								
EV B CLEARANCE PHASES	392								
EV C CLEARANCE PHASES	393								
EV D CLEARANCE PHASES	394								

EV Flags - Modifies the default EV operation as follows:

1 = Forces EV A to display all-Red clearance instead of Green clearance.

2 = Forces EV B to display all-Red clearance instead of Green clearance.

3 = Forces EV C to display all-Red clearance instead of Green clearance.

4 = Forces EV D to display all-Red clearance instead of Green clearance.

5 = EV A truncates Ped Flashing Don't Walk interval. If the EV preempt occurs during the Walk interval, the Flashing Don't Walk interval will be skipped. If the EV preempt occurs during the Flashing Don't Walk interval, the remainder of the Flashing Don't Walk time will be skipped.

6 = EV B truncates Ped Flashing Don't Walk interval. If the EV preempt occurs during the Walk interval, the Flashing Don't Walk interval will be skipped. If the EV preempt occurs during the Flashing Don't Walk interval, the remainder of the Flashing Don't Walk time will be skipped.

7 = EV C truncates Ped Flashing Don't Walk interval. If the EV preempt occurs during the Walk interval, the Flashing Don't Walk interval will be skipped. If the EV preempt occurs during the Flashing Don't Walk interval, the remainder of the Flashing Don't Walk time will be skipped.

8 = EV D truncates Ped Flashing Don't Walk interval. If the EV preempt occurs during the Walk interval, the Flashing Don't Walk interval will be skipped. If the EV preempt occurs during the Flashing Don't Walk interval, the remainder of the Flashing Don't Walk time will be skipped.

EV A Clearance Phases - Those phases that will serve during the EV A clearance interval. Flagged phases must also be either Permitted phases or Railroad Limited service phases. Phases entered here must be able to time concurrently. If no phases are set, the preempt is ignored.

EV B Clearance Phases - Those phases that will serve during the EV B clearance interval. Flagged phases must also be either Permitted phases or Railroad Limited service phases. Phases entered here must be able to time concurrently. If no phases are set, the preempt is ignored.

EV C Clearance Phases - Those phases that will serve during the EV C clearance interval. Flagged phases must also be either Permitted phases or Railroad Limited service phases. Phases entered here must be able to time concurrently. If no phases are set, the preempt is ignored.

EV D Clearance Phases - Those phases that will serve during the EV D clearance interval. Flagged phases must also be either Permitted phases or Railroad Limited service phases. Phases entered here must be able to time concurrently. If no phases are set, the preempt is ignored.

EVA Setup

EV A SETUP		
DELAY	**310**	
ACTIVE	**311**	
CLEARANCE	**312**	
MAXIMUM	**313**	
LINK TO EV	**314**	
MINIMUM	**315**	

Delay - Prevents any EV preempt from taking control of the intersection. The delay timer (observed at location 3-0-0) gets set and begins timing when an EV preempt input goes TRUE. While the delay timer is active, no Holds, Calls or Force Offs will be placed by the preempt logic. **[0 to 255]**

Active - The active timer (observed at location 3-0-1) gets set when an EV preempt input goes TRUE. When the delay timer expires, the active timer begins. During this period, the preempt logic places Holds and Calls to all of the EV Clearance phases. **[0 to 255]**

Clearance - This is the guaranteed length of time that the EV Clearance phases will display green. The clearance timer (observed at location 3-0-2) gets set when an EV preempt input goes TRUE. The clearance timer counts down after both the active and delay timers have expired and once all EV Clearance phases are green. If this time is not set, then the preempt sequence will go out of service as soon as the EV Clearance phases go green. **[0 to 255]**

Maximum - This time is used as a safeguard against a stuck ON preempt input. The max timer (observed at location 3-0-3) gets set when an EV preempt input goes TRUE. It begins to count down, in whole seconds, after both the active and delay timers have expired. **NOTE**: If this time is not set, then there will be no protection against stuck ON preempt inputs. **[0 to 255]**

Link to EV - This enables an EV preempt sequence that will service automatically following the end of this preempt sequence. This can be used to provide guaranteed service (as defined by the linked EV's parameters) to selected phases after a RR preempt. The EV will not be permitted to link to itself. Also, any value greater than "004" will be ignored. **[1, 2, 3 or 4]**

Minimum - This parameter is used to inhibit reservice of a preempt sequence for a set time. The EV minimum timer (location 3-1-6 for EVA, 3-2-6 for EVB, 3-3-6 for EVC and 3-4-6 for EVD) gets set when the preempt input goes ON. When the EV Clearance expires (indicating end of the preempt sequence), the EV minimum timer counts down to zero. As long as this timer is non-zero, further EV input actuations will be ignored. **[0 to 255]**

ZIP COORDINATION

(see section 6 for details on Zip Coordination operation)

The following parameters are common to both Zip Coordination and Standard Coordination and are described in the Coordination subsection:

- System Manual (4-0-0)
- Local Manual (4-0-1)
- Minimum Cycle Length (4-0-8)
- Maximum Cycle Length (4-0-9)
- Plan Offsets (7-A-1 through 7-A-9)
- Midnight Sync Pulse Hour (7-A-B) and Minute (7-A-C)
- Offset Timing Plan (7-A-A)

The following parameters apply to Zip Coordination only:

Parameters		Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Plan 6	Plan 7	Plan 8	Plan 9
		1	2	3	4	5	6	7	8	9
Cycle Length	0									
Force Off Ø 1	1									
Force Off Ø 2	2									
Force Off Ø 3	3									
Force Off Ø 4	4									
Force Off Ø 5	5									
Force Off Ø 6	6									
Force Off Ø 7	7									
Force Off Ø 8	8									
Hold Release	9									

Zip Coord Enable - Set this location to any non-zero value to enable the Zip Coord timing and disable the Standard Coordination timing.

NOTE: The following parameters can be set for each of nine plans.

Cycle Length - The length of the coordination cycle to be timed. This time must be greater than the Minimum Cycle Length and less than the Maximum Cycle Length above. **[0 to 255]**

Force Off 1 (*through Force Off 8*) - The point in the current cycle at which a Force Off is placed for the applicable phase. Force Off 1 applies to phase 1 and so on through Force Off 8. The Force Off is applied for 1 second. The time entered here must be less than the cycle length. **[0 to 255]**

Hold Release - The point in the cycle at which the coordination Hold is released from phases 2 and 6 (the default coordinated phases). The time entered here must be less than the cycle length. **[0 to 255]**

COORDINATION

(see section 6 for details on Coordination operation)

The following parameters are common to both Zip Coordination and Standard Coordination. Refer to the Coordination 1 Timing Sheet (Appendix A7).

Plan Offset Times - The desired offset time between the Master Cycle Timer and the Local Cycle Timer, for each of the nine plans. Values entered here should be less than the plan's Cycle Length. **[0 to 255]**

Offset Timing Plan - This defines which plan number to run when the Local Coordinator is configured for Offset Timing Mode. If no plan is entered, the default is Plan 3. **[1 to 9]**

Midnight Sync Pulse - The Hour and Minute that the Midnight Sync pulse will be transmitted to slave controllers in the "Transmit Plan" and "Transmit 7-Wire" communication messages. Hour **[0 to 23]**, Minute **[0 to 59]**

System Manual - This parameter sets the Master operating mode. Available entries are:

0 = Automatic Time Base mode. Searches the Time Of Day table (as indicated in location 4-0-5) and runs the plan/function found there.

1 through *9* = The Master coordinator is manually set to operate the plan number indicated.

14 = Manually sets the Master coordinator to operate in the Free mode.

Any Other entry = The entry is ignored and the last commanded plan is used.

Local Manual - A non-zero value here overrides the plan commanded by the Master (as indicated in System Manual, above). The available entries are:

0 = Automatic Time Base mode. Searches the Time of Day table (as indicated in location 4-0-5) and run the plan/function found there.

1 through *9* = Run the plan number selected here.

10 = Manually turns the Special Function output ON.

11 = Manually turns the Special Function output OFF.

12 = Manually causes the local coordinator to run in Slave Mode.

13 = Manually causes the local coordinator to run in Offset Timing Mode.

14 = Manually sets the controller to operate in Free mode (disables local coordination).

Any other values are ignored.

Minimum Cycle Length - The minimum cycle length that can be timed. If this value is set to "255", it will automatically be changed to "254". **[0 to 254]**

Maximum Cycle Length - The maximum cycle length that can be timed. This value must be greater than the Minimum Cycle Length, above, or it will automatically be changed to 255. **[11 to 255]**

The remaining entries in this first column (Column 0) are controlled by the program and are for observation only.

- Master Plan (4-0-2) – The Plan number being commanded by the Master Coordinator.
- Local Plan (4-0-3) – The Plan number actually implemented by the Local Coordinator.
- TMC Override (4-0-4) – Future Use.
- Time of Day Plan (4-0-5) – The Plan number that is selected by the Local Coordinator's TOD logic.
- Special Function (4-0-6) – The currently commanded state of the Special Function output.
- Current Table (4-0-7) – The TOD table that the Local Coordinator is using to select the Time of Day Plan.
- Master Cycle Timer (4-0-A) – The current value of the Master Cycle timer, updated each second.
- Local Cycle Timer (4-0-B) – The current value of the Master Cycle timer, updated each second.
- New Offset Time (4-0-C) – The Offset time associated with the currently timing Plan.
- Current Offset Time (4-0-D) – The current offset time. This may be different from
- Last Master Cycle (4-0-E) – The time in the Master Cycle timer when the last Sync Pulse was sensed.
- Last Local Cycle (4-0-F) – The time in the Local Cycle timer when the last Sync Pulse was sensed.

Intervals – Intervals are discrete points within a plan cycle when a coordination function is turned ON or OFF. The first interval (row 0) defines the plan's Cycle Length and should be the largest value of any entry in that column. Interval times should be in increasing value with increasing row number and cannot be greater than the cycle length. Also, all entries must be sequential (no entry can be skipped). **[0 to 255]**

Coordination Functions:

Coordination Functions work in conjunction with the Interval parameter above. For example, if there is a time entered for interval 3 of Plan 2 (location 4-2-3), then the functions below will be applied to the phases entered in row 3 of Plan 2 (locations 4-8-3, Force Off; 4-9-3, Hold; 4-A-3, Ped Restrict; 4-B-3, Call).

Force Offs – Indicates the phases to be terminated at the desired interval when an opposing call is present. The Force Off will remain in effect until the phases are no longer indicated in the subsequent intervals (or cycle zero if there are no subsequent intervals).

Holds - Indicates the phases to be held at the desired interval. The Hold will remain in effect the phases are no longer indicated in the subsequent intervals (or cycle zero if there are no subsequent intervals).

Ped Restricts - Indicates the phases to be for which the ped operation will be restricted at the desired interval. The Ped Restrict will remain in effect until the phases are no longer indicated in the subsequent intervals (or cycle zero if there are no subsequent intervals).

Calls - Indicates the phases to be called at the desired interval. The Call will remain in effect the phases are no longer indicated in the subsequent intervals (or cycle zero if there are no subsequent intervals).

COORDINATION ATTRIBUTES

		PLAN 1							
Attributes		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Coordination Lagging Phases	**0**								
Minimum Vehicle Recall Phases	**1**								
Pedestrian Recall Phases	**2**								
Maximum Vehicle Recall Phases	**3**								
Barrier Recall Phases	**4**								
Green Calling Phases	**5**								
Green Call-To Phases	**6**								
	7								
Phases to use Max 1	**8**								
Red Rest Phases	**9**								
Omitted Phases	**A**								
Phases to Omit Systems Detectors	**B**								
STA Mode Phases	**C**								
	D								
	E								
	F								

The coordination phase attributes operate the same as the Phase Function Flags on the Configuration Timing Sheet. The coordination phase attributes are only active when their corresponding coordination plan is active. Any phases flagged here must also be flagged as Permitted phases (location 1-F-0).

Any phases flagged here will be **in addition** to any phases flagged for the equivalent Phase Function Flag (on Timing Sheet 2). For example, if phases 2 and 6 are flagged for Phase Function Flag minimum recall and phases 3 and 7 are flagged for Plan 2 Coordination Minimum Recall, then phases 2, 3, 6 and 7 will all be on minimum recall while Plan 2 is active.

Coordination Lagging Phases - This location sets the lagging-most (barrier) phase for each quadrant, before crossing the barrier, when running coordinated. If no phases are set, the default is set to all even numbered phases. This location is ignored in non-standard quad configurations and barrier phases will be used as lag phases. A barrier crossing is required to implement changes in this location. If no phases are selected here, then those phases set at location 1-F-C (LAGFRE) will be used.

Minimum Vehicle Recall - Causes a call to be placed for a phase during its Red interval only. This call will remain in place until the phase goes green.

Ped Recall - Causes a ped call to be placed for the flagged Ped phases. The call is continuous except during the flagged Ped's Walk interval. If no opposing call is present, the Ped indication will "rest" in Walk. The Walk interval will time down until 1 second remains in its timer. When an opposing call is placed, the remaining Walk time expires and the Flashing Don't Walk interval begins. If the opposing call drops any time before the phase's Flashing Don't Walk interval ends, the Ped Walk interval restarts and the process begins all over again. Only enabled Peds (as set in locations 1E2 through 1E7) can be flagged for Ped Recall.

Maximum Vehicle Recall - Causes a continuous call to be placed for a phase. This results in the phase staying green until its Maximum Green Timer has expired (even if no Vehicle Extension time is set for the phase).

Barrier Recall - Causes a call to be placed at barrier crossing for flagged phase(s).

Green Calling - This parameter works in conjunction with Green Call-To phases, below. While any phase flagged here is green, the Green Call-To phases will have a locked call placed for them. Both of these parameters must be set or they will be ignored.

Green Call-To - This parameter works in conjunction with Green Calling phases, above. A locked call will be placed to all phases flagged here whenever any Green Calling phases are green. Both of these parameters must be set or they will be ignored.

Max I - Forces the flagged phases to use Max I green time instead of the default Max II green time.

Red Rest - Causes a phase to terminate and rest in red if that phase is resting in green and there are no opposing calls to that phase.

Omitted - Causes the program logic to ignore all phases flagged here while the configured plan is active. If a flagged phase is in service when the plan takes effect, it will be forced off (even if there is no call to a conflicting phase).

Omit System Detectors - Future implementation.

STA (Semi-Traffic Actuated Mode) - Only enabled Peds (as set in locations 1E2 through 1E7) can be flagged for STA Mode. While the controller is running in coordinated mode, the ped phases flagged here will be placed on recall. When the ped serves, it will time out its Walk interval and rest in Walk until the coordinator sets a Force Off for the phase. At that time the ped will time its Flashing Don't Walk interval and then terminate.

COORDINATION TABLES

(see section 6 for details on Coordination Tables)

Coordination tables provide the user with more flexibility and options as to what Plan or Function to run and when to run it. The tables fall into two categories, Time of Day tables and "Exception" tables. Table 0 is the default Time of Day table.

Time of Day Tables (0 through 4)

TABLE 0 - Time Of Day

Event	Hour:Min	Plan or Function	Sun 1	Mon 2	Tue 3	Wed 4	Thu 5	Fri 6	Sat 7
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
A									
B									
C									
D									
E									
F									

Plan:
1 through 9
Function:
A – Special Function Output Steady ON
B – Special Function Output Flashing
C – Offset Timing Mode
D – Special Function Output OFF
E – Free Mode
F – Time of Day Flash

Hour: Min - Specifies the time of day, military time, that the indicated plan or function is to take effect.

Plan or Function - One of nine coordination plans or six coordination functions to take effect at the specified time and day.

Day of Week - Indicates which days of the week a plan or function is to take effect.

Floating Holiday Table (5)

This table is populated with the Los Angeles County default Floating Holiday data.

TABLE 5 - Floating Holidays

Event	Month/Day	Table	Sun 1	Mon 2	Tue 3	Wed 4	Thu 5	Fri 6	Sat 7
0	01/03	1		X					
1	02/03	1		X					
2	05/09	1		X					
3	09/01	1		X					
4	11/04	1					X		
5									
6									
7									
8									
9									
A									
B									
C									
D									
E									
F									

Month/Day - Indicates the month and on which occurrence of the specified day of week that specified table is to be used. For example, Event 0 will invoke Time of Day table 1 on the 3rd Monday in January.

Table - Enter Time of Day table number (0 through 4) to be used for the specified holiday.

Day of Week - Indicates which day of week that the holiday must fall on in order for the indicated table to be run.

Exception Day Table (6)

This table indicates all fixed holidays. All fixed holidays observed by Los Angeles County are defaulted here.

TABLE 6 - Exception Days

Event	Month/Day	Table	Sun 1	Mon 2	Tue 3	Wed 4	Thu 5	Fri 6	Sat 7
0	01/01	1		X	X	X	X	X	
1	01/02	1		X					
2	07/04	1		X	X	X	X	X	
3	07/05	1		X					
4	11/10	1						X	
5	11/11	1		X	X	X	X	X	
6	11/12	1		X					
7	12/24	1		X	X	X	X	X	
8	12/25	1		X	X	X	X	X	
9	12/26	1		X				X	
A									
B									
C									
D									
E									
F									

Month/Day – Enter the month and day, in MM/DD format, of the exception day to be searched for.

Table – Enter the Time of Day table number (tables 0 through 4) to be used when the exception day occurs.

Day of Week – Enter the day(s) of the week that the exception day must fall on in order to run the selected table.

Annual Event Table (7)

This table is used for any user-defined Annual events.

TABLE 7 - Annual Events

Event	Month/Day	Table	Sun 1	Mon 2	Tue 3	Wed 4	Thu 5	Fri 6	Sat 7
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
A									
B									
C									
D									
E									
F									

Month/Day – Enter the month and day, in MM/DD format, of the annual event to be searched for.

Table – Enter the Time of Day table number (tables 0 through 4) to be used when the annual event occurs.

Day of Week – Enter the day(s) of the week that the annual event must fall on in order to run the selected table.

PROGRAMMABLE LOGIC

(see Section 8.2 for details on data entry, parameter descriptions and operation)

This feature is new to the LACO series of programs. It provides all common logic operations including AND, OR and XOR gates (plus their negations), a Set/Reset Latch, a Relay, and Delay, Extension and One-Shot timers. Only C1 input pins can be modified but both C1 input pins and output pins can be used to modify the input. This timing sheet uses "logic" pin numbers that are derived from the I/O port and bit numbers. The logic pin numbers (and their associated I/O function and C1 pin number) can be found on the Programmable Logic Worksheet in Appendix E12, Appendix E1 (Inputs) and Appendix E2 (Outputs). See section 8.2 for details on this feature including operation of each of the gates/functions and examples.

Note that this data is accessed using the Extended Memory Display mode. This requires that the first key press be "8" followed by the 4-digit memory location. For example, to enter data for Input 1 of And Gate 1, the 5-key sequence would be "8-1-2-8-0". See section 2.1.6 for details on the Extended Memory Display mode.

Logic Gate Inputs – Enter the logic pin number of the input, output or logic gate link that is to be used for the desired logic operation. Logic pin numbers are entered just as they appear in the appendix referenced above. For example "22" corresponds to the I1 detector input.

Logic Gate Outputs – Enter the logic pin number of the input that gate logic is to act on (or logic gate link if this output is to be used as in input for another logic function).

Latch Inputs - Enter the logic pin number corresponding to the input, output or logic gate link that is to be used as the latch Set or Reset input.

Latch Outputs – Enter the logic pin number of the input that the Latch logic is to act on (or logic gate link if this output is to be used as in input for another logic function).

Relay Input - Enter the logic pin number corresponding to the input, output or logic gate link that is to be used as the Relay input.

Relay Coil - Enter the logic pin number corresponding to the input, output or logic gate link that is to be used as the Relay Coil control.

Relay Outputs - Enter the logic pin number of the input that the Relay logic is to act on (or logic gate link if this output is to be used as in input for another logic function).

Timer Input - Enter the logic pin number corresponding to the input, output or logic gate link that is to be used as the Timer input.

Timer Type – This parameter allows the user to select the timer type. The available options are:

01 = .1 second Delay timer *10* = Whole second Delay timer

02 = .1 second Extension timer *20* = Whole second Extension timer

03 = .1 second One Shot timer *30* = Whole second One Shot timer

Timer Time – Enter the desired timer interval here. The time entered here depends on the scale of the selected timer type. For a 3.0 second "tenth seconds" timer, enter "030". For a 3 second "whole second" timer enter "003".

Timer Output – Enter the logic pin number of the input that the Timer logic is to act on (or logic gate link if this output is to be used as in input for another logic function).

SECTION 5 OVERLAPS and PREEMPTION

OVERLAPS

PREEMPTION

PREEMPTION OUTPUT

RAILROAD

EMERGENCY VEHICLE

MANUAL CONTROL

OVERLAPS

LACO-4 offers the industry standard Overlap functionality with a few enhancements:

- Parents can be selected separately for Normal, RR or EV operation.
- All 3-color overlap outputs can be redirected to unused vehicle or ped load switches.
- All overlaps can be configured to time a delay prior to start of green.
- Green Omit logic is available to overlaps for ped protection on right turns.
- Individual clearance times available for green, yellow and red indications.

Basic overlap logic is such that when any parent phase is green, the overlap is also green. Additionally, the overlap will remain green if a parent phase to that overlap is terminating to another parent phase. The only exception to this logic is when a green parent phase is also flagged as a Green Omit parent. When *any* Green Omit parent phase is green, the overlap will be **dark**. This is true of 3-color overlaps as well as 2-color overlaps.

NOTE

The Green Omit feature is intended for two section field displays. Any 3-color overlap that uses the Green Omit feature should be redirected to an unused ped load switch. If that is not possible, the output channel should be configured in the cabinet such that a Red Fail condition is not sensed when the green indication goes dark.

The LACO-4 logic normally allows selection of FAZNXT (the phases to serve next) up until the last 0.1 second of the terminating phase's Red Clearance time. This provides crisp response to actual intersection demand. An exception is made when an overlap is green. When an overlap parent phase terminates, the phase that caused termination of the parent phase is locked at the beginning of the terminating phase's yellow interval. This phase will be serviced next even if the demand drops.

As mentioned above, each overlap can have separate parent phase assignments for Normal operation, Railroad preempt or Emergency preempt. For Normal parents, the selected phases must also be permitted phases. For Railroad parents, the selected phases must also be either Track Clearance phases or Limited Service phases. For Emergency Vehicle parents, the selected phases must also be either permitted phases or Limited Service phases. If an overlap is in service during Normal operation, and a Railroad preempt sequence starts, the overlap will continue or terminate, based on the parent phases selected for each operation.

If an overlap is due to terminate (because its parent phase is terminating to a non-parent phase) across the barrier, and a parent phase exists in a non-calling ring across the barrier, then a call will be placed to the first parent phase in the non-calling ring so that the overlap may continue. This is done to eliminate the occurrence of an inactive ring in such situations. This logic is analogous to the phase Barrier Recall logic but is fixed and cannot be disabled by the user.

Any 3-color overlap output can be redirected to any of the Output File load switches. This is done by entering the location of the new load switch for the desired overlap, i.e. location 3-0-D for Overlap D. The CMU channel numbering system was used as a model for these parameter. Enter "001" through "008" to redirect to the phase load switches or "013" through "016" to redirect to the ped load switches. Any other value will be reset to "000" and no redirection will take place. Note that this is a "blind" redirection in that the redirected overlap will overwrite any other indications being sent to the load switch. Therefore, care should be taken to ensure that the load switch is not being used by another phase or ped.

PREEMPTION

LACO-4's preemption logic is exceptionally flexible and versatile as indicated below:

Railroad

- Three different modes of operation
- Two prioritized (concurrent) inputs
- Both limited service and flash operation supported
- Concurrent emergency vehicle service is supported during limited service operation
- Ped only logic supported during limited service operation
- Can link to a selected EV sequence following the Railroad sequence
- Three timers provided
- Four phase flags provided

Emergency Vehicle

- Four equal priority inputs
- Vehicle and Ped output modifiers
- Five timers provided
- Can link to a (different) selected EV sequence following the actuated sequence

Manual Control

- Dedicated Omitted phases
- Dedicated Lag phases
- Three phase/ped recall options

PREEMPT OUTPUT

Auxiliary output file slot 3 (AUX 3) can be set to output preemption and manual control indications. At location 3-C-0, select any combination of Railroad preempt, Emergency Vehicle preempt or Manual Control desired. When any of the selected operations is active, the Aux 3 Yellow output will be turned on. This output can then be used to provide a visible preempt condition at the intersection or it can be sent up/down stream to provide preempt status to adjacent controllers. This can be useful if the receiving controller has some form of programmable logic similar to LACO-4.

RAILROAD

The Railroad preemption feature contains logic that one would expect to find in the higher end ATC controllers, plus it has one function that is unique to LACO programs alone. All conventional programs provide two Railroad preempts and four Emergency Vehicle preempts. Some also offer an additional four low priority preempts, generally intended for implementation of Bus Priority Service. LACO-4 provides the same six preempts with two significant enhancements.

- **The two Railroad inputs are processed concurrently providing prioritization of railroad service.** The higher priority input, RR A, results in Flash operation while the lower priority input, RR B, results in Limited Service operation. If the RR B preempt is active, a RR A input will override the RR B sequence. Conversely, the RR B input is ignored when the RR A sequence is active.
- **An Emergency Vehicle preempt sequence can serve concurrently under a Railroad Limited Service preempt sequence (nested preempts).** Any EV preempt sequence with Clearance phases that are also Railroad Limited Service phases may be serviced while that Limited Service operation is active.

The following parameters can be used in any combination to provide customized response to Railroad preemption:

Railroad Select - Three operating modes; RR Flash only (single input), Limited Service only (single input) or RR Flash and Limited Service together (dual input).

All Red time after Flash - Default is 5.0 seconds. This must be a non-zero value or the data validation logic will restore the default value of 5.0 seconds.

Railroad Track Clearance time - This would be the minimum length of time that the Track Clearance phases can output a green indication. If this value is set to zero, then track clearance is skipped and the intersection defaults to RR Flash operation, regardless of the entry in Railroad Select.

Limited Service Max time - If a non-zero value is entered here, when the RR Max timers expire, the intersection will revert to RR Flash operation for the duration of the preempt sequence. If zero is entered here, no time limit is placed on the duration of the Limited Service sequence.

Railroad Link to EV - Entering an EV number here causes that EV sequence to service immediately following the end of the Railroad preempt sequence. This can provide a more controlled transition from Railroad operation to Normal operation.

Free Time After Preempt - This parameter is used for both Railroad and EV operation. When any preempt sequence goes active, the local coordinator is suspended control of the coordination function outputs is given to the preemption logic. After the preemption sequence ends, the Free Time After Preempt *timer* must expire before control of the coordination function outputs is passed back to the local coordinator. This allows a period of Free operation following a preemption sequence.

Track Clearance phases - Select the phase numbers corresponding to the movements that cross the path of the oncoming train. Phases entered here must be concurrent. The data validation logic prohibits entry of non-concurrent phases. If no phases are selected here, then track clearance is skipped and the intersection defaults to RR Flash operation, regardless of the entry in Railroad Select.

Railroad Exit phases - Under default operation, when a preempt sequence ends, the next phases to be served is determined by which railroad mode was in operation. For RR Flash, the next phases (with demand) following the preempted phase(s) will serve first. This includes any phases which may have been called by actuation (even if later dropped) while the preempt sequence was active. For Limited Service, the next phases (with demand) following the last phases in service when the preempt sequence ended will serve first. In both of these cases, Railroad Exit phases will override the default operation and serve first. Only concurrent phases can be entered here. The data validation logic prohibits entry of non-concurrent phases.

Railroad Ped Only phases - This parameter allows ped operation for a disallowed phase during Limited Service operation only. Normally, any phase not selected as a Limited Service phase has both its vehicle and ped logic disabled. However, it's not unusual to desire ped service for a phase that can't allow vehicle service. When the railroad preempt sequence begins its Limited Service segment, the controller will respond to all ped calls (actuated or recall) the same as in Normal operation. During the ped service, the vehicle indication will remain Red and only the Walk, Don't Walk, Yellow Clearance and Red Clearance intervals will time.

Mode 1 Operation

This mode uses the RR A input only and results in Flashing operation. Typically, when the RR A input (C1-51) goes ON, all phases in service go immediately to their termination sequence. No ped service is permitted during Track Clearance and all ped indications go immediately to solid Don't Walk. If an overlap is Green and at least one of the Track Clearance phases is selected as a Railroad Overlap parent, then the overlap will continue Green through those phases. Once all Track Clearance phases have gone Green, the Track Clearance timer begins counting down to zero. When the Track Clearance timer expires, all phases and overlaps in service terminate. When no phases or overlaps are in service, the controller puts the intersection into software flash and the ped heads go dark. Flashing operation remains in effect until the RR A input goes OFF. At this point the controller outputs all red (steady Don't Walk for the ped indications) for the length of time set in All Red Time After Railroad Flash (location 3-6-1). When this timer expires, Railroad Exit phases will service first if set. Otherwise, service will begin for the first phase (with demand) after the phase(s) in service when preemption started.

Mode 2 Operation

This mode uses the RR B input only and results in either Flashing operation or Limited Service operation. Typically when the RR B input (C1-52) goes ON, all phases in service go immediately to their termination sequence. No ped service is permitted during Track Clearance and all ped indications go immediately to solid Don't Walk. If an overlap is Green and at least one of the Track Clearance phases is selected as a Railroad Overlap parent, then the overlap will continue Green through those phases. Once all Track Clearance phases have gone Green, the Track Clearance timer begins counting down to zero. When the Track Clearance timer expires, all phases and overlaps in service terminate.

If neither Limited Service phases nor Railroad Ped Only phases have been set, the operation is the same as in Mode 1 above (Flashing Operation). If either of those two parameters is set, then vehicle, overlap (using Railroad Overlap parents) and ped service will occur as during Normal operation. Additionally, this mode allows Emergency Vehicle (EV) service during the Limited Service segment. EV service is the same as during Normal operation except only those EV Clearance phases that are **also** Limited Service phases will serve.

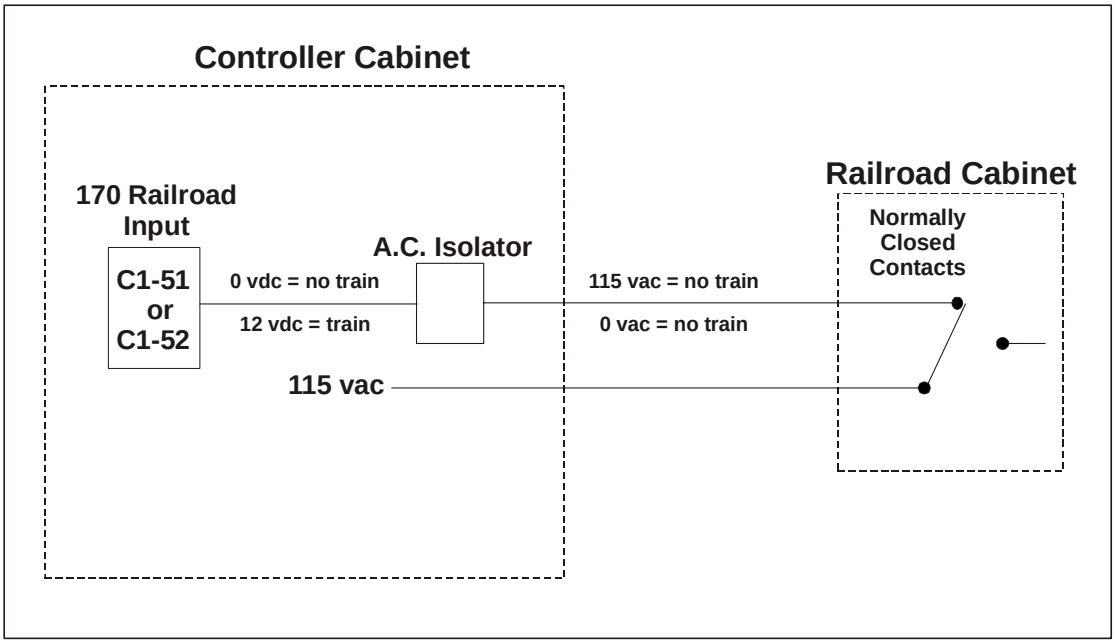
Mode 3 Operation

This mode uses both of the railroad inputs and, as in Mode 2 above can result in either Flashing operation, or Limited Service operation or both (sequentially) depending on the order of actuation. The RR A input has priority over the RR B input. Therefore, anytime the RR A input goes ON, the result will be Flashing operation. If the RR B input comes on first, Limited Service operation will result until a RR A input goes ON. At that point, Limited Service phases are terminated immediately and the result is Flashing operation. This mode is useful when multiple parallel tracks are present with trains of different speeds on different tracks (for example slow freight train and fast commuter line).

Railroad relay requirements

The program senses a Railroad preempt when the voltage at C1-51 or C1-52 is 12vdc. This means that the Railroad preempt circuit must be connected to the normally closed contracts of the railroad cabinet relay. An approaching train causes the railroad cabinet relay to energize, causing the normally closed contacts to become open. This removes the 115 vac from the A.C. isolator input and, if properly configured, the Railroad preempt sequence begins.

Typical Railroad Preempt Circuit



Additional Points

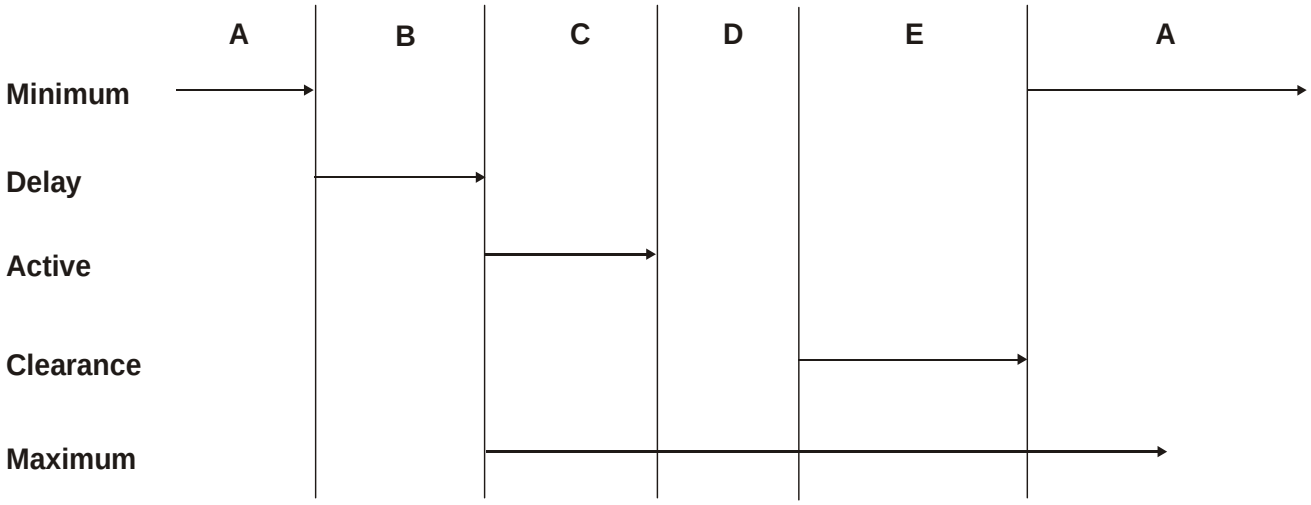
- Both Track Clearance time **and** Track Clearance phases must be set or the resulting operation will default to Flash as soon as all phases have terminated.
- If a Railroad preempt occurs while the local coordinator is active, it will continue to run in the background (maintaining cycle position) but updating of the coordination function outputs will be suspended until the preemption sequence ends and the Free After Preempt timer (set at location 3-6-5) expires.
- A Railroad preempt will override Manual Control operation until the preemption sequence completes.
- A Railroad preempt will override Emergency Vehicle operation until the preempt sequence completes or until the Railroad preempt sequence begins Limited Service operation.
- Track Clearance phases will not start green until all **incompatible** overlaps have completely terminated.
- Turning on call light 3 at location 1-D-B delays the start of Track Clearance green until **all** overlaps have completely terminated.
- After an A.C. power failure, if power is restored to the 170 while the preempt input is active, the program will initiate a software flash condition immediately on start up. The software flash will remain in effect until the RR preempt input is removed, at which time a normal railroad exit sequence will take place.

EMERGENCY VEHICLE

As with Railroad preemption, LACO-4 Emergency Vehicle (EV) preemption logic offers a variety of timers, and phase and control flags that give the user optimum control over EV operation. Minimum EV operation requires that both EV Clearance phases and EV Clearance time be set. If only Clearance phases are set and a preempt input goes ON, call light 9 will flash briefly to indicate that the preempt in insufficiently configured. All other parameters for that preempt will be ignored.

Assuming all parameters are utilized, an EV preempt operation is as follows:

- When an EV input first goes ON, its Minimum timer is checked. If the timer is active, the preempt is ignored.
- If the Minimum timer is zero, the preempt's Clearance phases are checked. If *no* Clearance phases are set, the preempt is ignored.
- If Clearance phases *are* set, the preempt's Clearance time is checked. If no Clearance time is set, call light 9 will flash briefly and the preempt will be ignored.
- If the Delay time is set, the preempt will do nothing except decrement the Delay timer until it expires. Call light 9 is illuminated during this time to indicate that a preempt input is active.
- When the Delay timer is zero, Ped Restricts are placed on all phases, and Holds and Calls are placed on all Clearance phases. All Walk intervals are terminated to Flashing Don't Walk immediately. If the EV is flagged to truncate Ped Clearance in EVFLAG (location 3-9-0), then all Flashing Don't Walk intervals will be terminated also. The Active timer is checked. While the Active timer is active, no other logic is performed. During this time, any Clearance phases that are Green or go Green will stay Green because of the Holds placed on them.
- When the Active timer is zero, a Force Off is placed on all non-Clearance phases, causing them to terminate after satisfying minimum green intervals. When all Clearance phases are Green **and** all non-Clearance phases are out of service **and** the preempt input is no longer active, the Clearance interval begins. Whether the EV is flagged to time All-Red clearance in EVFLAG (location 3-9-0) or normal Green clearance, interval "9" will show on the Front Panel display.
- The normal Minimum Green interval times in the background during the Clearance interval. When the Clearance timer expires, if the Minimum Green timer has not expired, the phase times out its remaining Minimum Green time and shows interval "2" in the Front Panel Display. If no Minimum Green time remains, the phase(s) will revert to Normal operation.
- If the Maximum time is set, its timer gets loaded when the Delay timer expires and times concurrently with the Active and Clearance timers. If the preempt sequence has not finished by the time the Maximum timer expires, that preempt sequence will be ignored and the controller will return to Normal operation.



The figure above shows the relationship between the various EV timers with details provided below.

- Interval A = Minimum timer active. All EV logic is ignored. This timer gets set at the beginning of the preempt sequence and begins timing at the end of the preempt sequence.
- Interval B = Delay timer active. Call light 9 comes on to indicate an active preempt input. No other logic runs during this interval. Once this timer expires, an active preempt sequence is latched until either the Maximum timer expires, or the input goes OFF **and** the Clearance timer has expired.
- Interval C = Active timer active. Ped Restricts are placed on all phases, Hold and Call are placed on Clearance phases. Any Clearance phases already Green will show interval “6” (Hold) on the Front Panel display. Ped Clearance truncation takes place here.
- Interval D = Transition to Clearance phases. Adds Force Off placed on all non-Clearance phases. Force Off honors phase minimums. If all Clearance phases are in service when the Active timer expires, this interval is skipped and Interval E begins. There is no EV-specific timer associated with this interval.
- Interval E = Clearance timer active. The Clearance timer will not start to decrement until the EV input goes OFF. Clearance phases show interval “9” (Preempt Clearance).
- The Maximum time, if set, will time concurrently with the Active and Clearance timers. If the Maximum timer expires before the Clearance timer expires, then the preempt logic will return the intersection to Normal operation until the next preempt input OFF -> ON transition occurs. If the Maximum time is not set (i.e. equals “000”), then this Maximum logic is ignored.

Additional Points

- All four EV inputs have equal priority. If any EV is in service and another input goes ON, that input will be overridden until the existing EV finishes service. If multiple EV inputs go ON simultaneously, the lowest numbered input will be serviced.
- If an EV preempt occurs while the local coordinator is active, it will continue to run in the background (maintaining cycle position) but updating of the coordination function outputs will be suspended until the preemption sequence ends and the Free After Preempt timer expires.
- An EV preempt will override Manual Control operation until the preemption sequence completes.
- A Railroad preempt will override Emergency Vehicle operation until the preempt sequence completes or until the Railroad preempt sequence begins Limited Service operation.
- The Maximum time logic will be ignored if the Maximum timer is set to zero.

MANUAL CONTROL

The Manual Control feature allows on-site override of automatic operation of the intersection controller. Several conditions must be true before Manual Control logic can operate.

- No preemption can be active
- MANCON (location 3-0-9) must be set to a non-zero value
- Both PedA and PedB must be disabled
- The Manual Control Enable input must be ON (Police panel pushbutton inserted in jack)

Once all of these conditions are satisfied, the local coordinator, if active, will be disabled. Depending on the value entered at MANCON, calls will be placed to the controller as follows:

MANCON value	Call logic
000	Manual Control logic disabled: No calls placed
001	Intersection is fully actuated (both vehicle and ped)
002	All permitted phases are placed on recall
003	All permitted phases and enabled peds are placed on recall
Any other value	Same as “003” above

When Manual Control begins, all phases currently green will have a Hold placed on them. Any phases concurrent to the green phases will start service (including ped service, if so configured) and have a Hold placed on them also. Any minimum greens will time out and the active phases will rest in green. The Interval display will show interval “6” indicating that the phases are being held. Whenever the Manual Advance (Police panel pushbutton) input is ON, all green phases that have timed their minimums will be terminated and the next calling phases in ring sequence will be served. All other normal phase logic applies including simultaneous termination at barrier crossings.

Phases can be omitted during Manual Control Operation by selecting the desired phases at location 3-C-1. The phases selected here will only apply when Manual Control logic is active. Also, lag phasing specific to Manual Control operation can be set at location 3-C-2. The phases set here will override any other lag-phasing configuration that was in effect at the start of Manual Control operation. This location is subject to the same constraints as Lag Phases Free (location 1-F-C) and coordination lag phases

When the Manual Control Enable input is OFF, the controller reverts immediately back to normal operation. Any remaining calls generated by the Manual Control logic will remain in place until serviced. If the local coordinator is still active, then it will time out the value entered in Free Time After Preempt (location 3-6-5) before updating the coordination function outputs.

If Manual Control is active and a railroad or emergency vehicle service starts, the Manual Control logic will be overridden. And, if any phases are selected at either PedA (location 1-E-6) or PedB (location 1-E-7), the Manual Control logic will also be overridden.

SECTION 6 COORDINATION

GENERAL

LA COUNTY STANDARD COORDINATION

MASTER COORDINATOR

LOCAL COORDINATOR

COORDINATION OUTPUTS

COORDINATION FUNCTIONS

COORDINATION TABLES

ZIP COORDINATION

GENERAL

This coordination program provides timing and functions that enable the user to modify the operation of a fully (or semi-) 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 or 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 over the entire band time.

The coordination program can “guide” the controller into a condition that provides 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 phase calls late in the cycle and still return in time for the assured Green.

LA COUNTY STANDARD COORDINATION

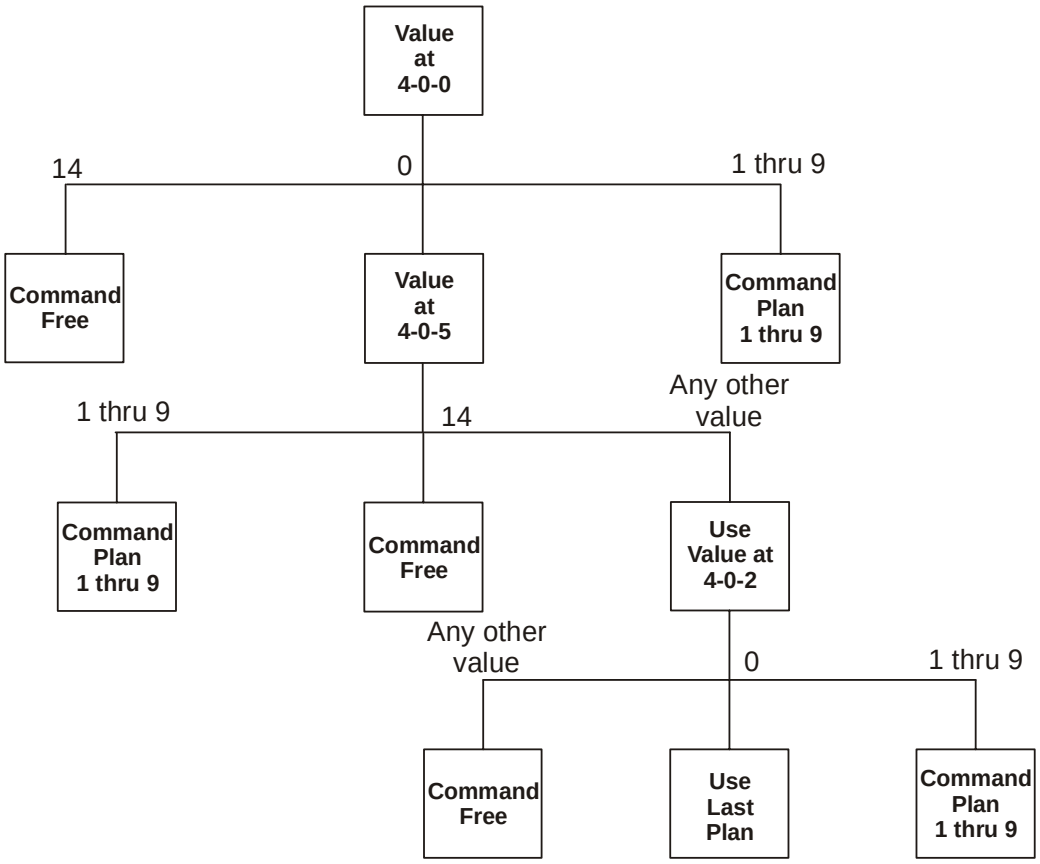
In LACO-4, both the Master and Local Coordinator functions run on all controllers. Controllers are physically configured as either stand-alone or interconnected. For stand-alone configurations, (essentially) there is no “Master” controller. All controllers are “slaves” and the Local Coordinator determines its operation directly from the “local” Master Coordinator (since both share the same memory). For interconnected configurations, the Local Coordinator determines its operation from data received from the “remote” Master Coordinator. This data can be sent via the conventional 7-wire interconnect, across twisted pair wire using the RS232 protocol or as a single wire pair that carries an event (start of a phase Green for instance) to trigger an Offset Timing cycle in the slave controller. See Section 7 for more information on the wide variety of controller to controller communications available.

MASTER COORDINATOR

The Master Coordinator has two main functions.

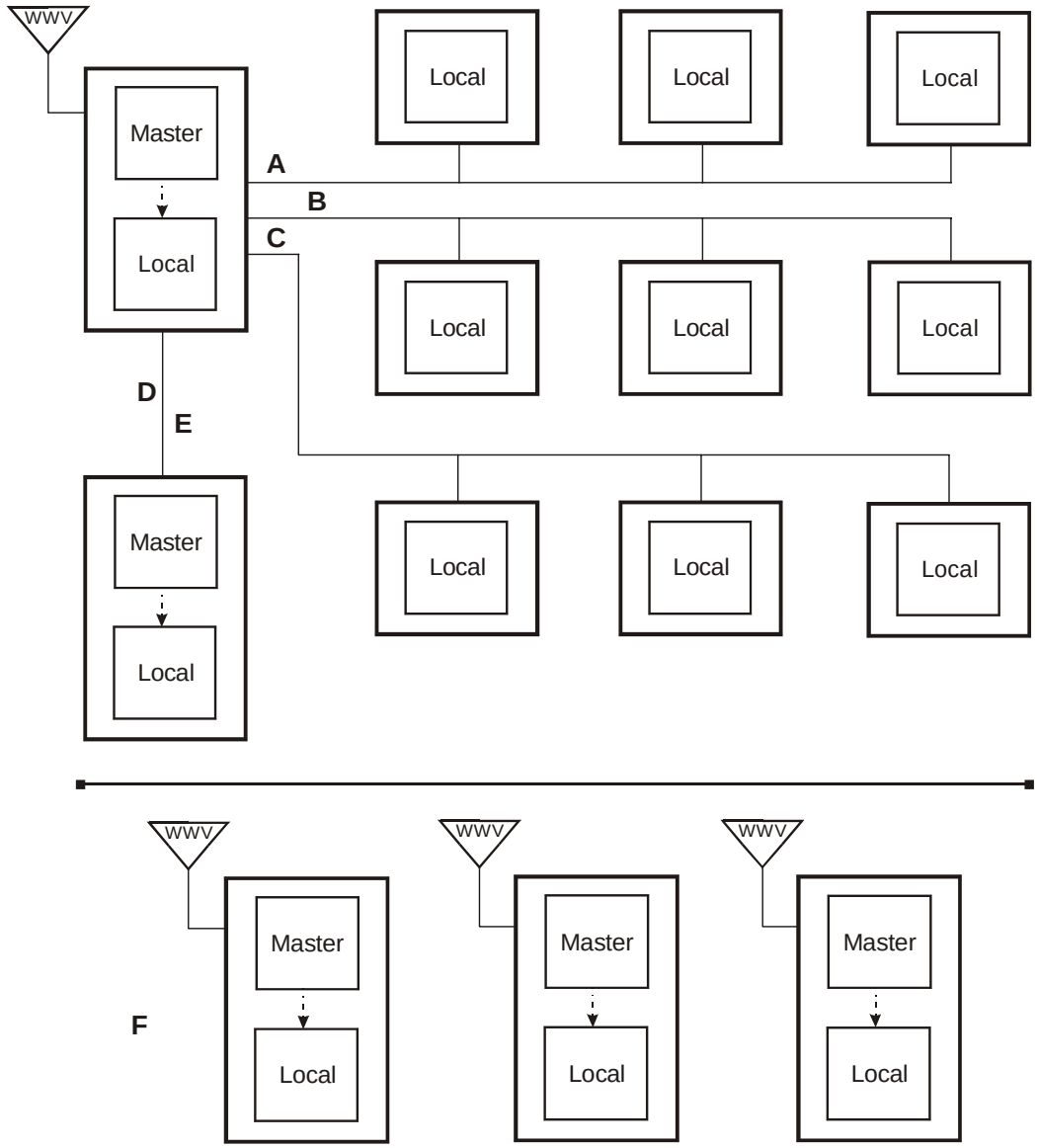
- Determine which plan to command to the Local Coordinator (either local or remote).
- Manage the Master Cycle timer, the master clock for all of the coordination timers.

The LACO-4 Master Coordination Map below shows the hierarchy of options that the Master Coordinator uses to determine its plan choice. It can command any of nine plans or Free.



LACO-4 Master Coordination Map

The Master Coordinator makes its plan choice available to Local Coordinators in a variety of ways as illustrated in the figure below. A single 170E controller with four comm ports can provide coordination and Time/Date updates six different ways.



A. LACO-4 Master sends plan/sync pulse/midnight sync pulse/offset timing pulse to other LACO-xx controllers via modem. (Comm Option 2)
B. LACO-4 Master sends plan/sync pulse/midnight sync pulse/offset timing pulse to other LACO-4 controllers via modem (Comm Option 6)
C. LACO-4 Master sends 3 Plan/1 Offset information or an “event” (start of phase Green for instance) via hardwire interconnect to 7-Wire compliant controllers (both LACO and non-LACO).
D. LACO-4 controller sends Time and Date updates to other LACO-xx controllers running standalone (no other interconnect). (Comm Option 4)
E. LACO-4 controller sends Time and Date updates to AB3418 compliant controllers. (Comm Option 7)
F. Controllers in standalone mode send coordination information internally.

LOCAL COORDINATOR

The Local coordinator has three main functions:

- Determine the appropriate plan, function or mode to process.
- Update the Local Cycle timer.
- Update the Plan (Dial) outputs.

The primary function of the Local Coordinator is to determine the plan with which to drive the coordination outputs. This plan depends on which of the two local modes of operation is active. The modes are Time of Day (TOD) and Manual Override. There are four submodes to Manual Override: Manual Plan, Slave, Offset Timing (Yield coordination), and Free. Eight coordination tables are provided for fine-tuning of event driven operation; five Time of Day (TOD) tables and three Exception tables (Floating Holidays, Exception Days and Annual Events). Each of the Exception tables is searched once per minute on the minute to determine which TOD table is applicable for the current date. That TOD table is then searched for the most recent time and current Day of Week. Additionally, twelve coordination phase attribute flags (per plan) are available. See Section 2 for descriptions of the coordination tables and parameters.

The Local Coordinator also maintains the Local Cycle timer which controls the setting and clearing of the coordination outputs. The Local Cycle timer lags the Master Cycle timer by the Offset value specified for each plan.

Once the Local Coordinator has determined its command source, it runs the commanded operation setting the coordination outputs (ForceOffs, Holds, Ped Restricts and Coordination Calls) as specified in the Timing Sheets.

MODES OF OPERATION

Time of Day (TOD) mode - The Local Coordinator receives sync and plan information internally from the local Master Coordinator. Depending on the current TOD table event, the Local Coordinator can run one of nine plans, turn on or off the TOD Output (for driving signs, etc), run in Slave Mode or Offset Timing mode (see below), output software flash or run Free.

Manual Override mode – In this mode, the Local Coordinator ignores what the local Master Coordinator is commanding and instead responds to the value that is entered at location 4-0-1. The four submodes to this mode depend on the value entered here.

1 through 9 (Manual Plan submode) – As in TOD mode, the Local Coordinator receives its sync pulse from the local Master Coordinator based on the Plan number entered at location 4-0-1.

B (Slave submode) - The Local Coordinator receives sync and plan information from an external source via modem or 7-wire interconnect. If the master controller is running LACO-4, then the slave controller should be configured to receive data via modem. If the master controller is running LACO-1R or LACO-3 (or any other vendor's program that sends "standard" 7-wire interconnect), then the data will be received via 7-wire interconnect and the cabinet input file must be configured accordingly. Slave submode operation is available in both Manual Override and Time Of Day modes. If sync is lost for more than 4 seconds, the intersection will run Free until the next sync pulse is sensed. See Section 7.3 for information regarding the format of data that is sent from a LACO-4 Master controller and received by a LACO-4 Slave controller. To remain compatible with pre-LACO-4 programs, only three Dials and one Offset (corresponding to Plans 1, 2 and 3) are supported when receiving 7-Wire information. If Slave mode is configured, then the controller requires Plan and Sync pulse information from an external source.

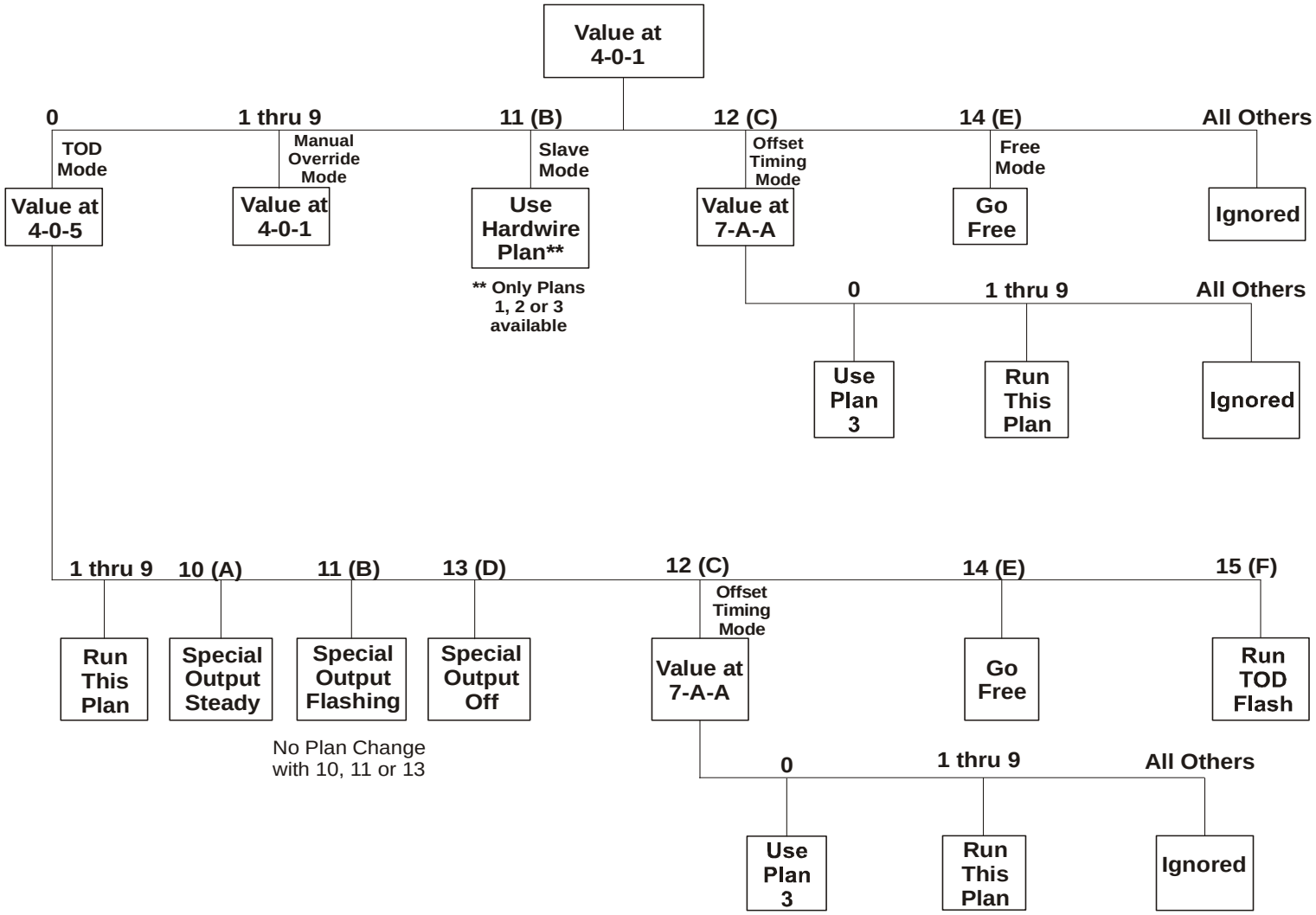
C (Offset Timing submode) (or Yield Coordination) – This submode uses an event driven form of coordination instead of the familiar time based cycle. The event can be transmitted via modem or hardwire interconnect. The modem event can be the start of (a selectable) phase Yellow or Green while the hardwire interconnect event can be anything that the sending controller is capable of outputting. Either transmission method can be used when the sending controller is also running LACO-4. The slave controller checks its comm port options to see if any of them are configured. If only the master controller is running LACO-4, then the event would be sent via the traditional hardwire interconnect (on a single pair) to the non-LACO-4 Slave controller. The user can select any of the nine plans (at location 7-A-A) to use but if none is selected it will default to plan 3. The selected plan is run to completion (one cycle) at which time the Local Coordinator is turned off (set Free) and the routine waits for the next event. This operation is available in both TOD and Manual Override modes. See Section 7.3 for information on the data that gets passed from a LACO-4 Master controller to a LACO-4 Slave controller. If Offset Timing mode is configured, then the controller requires Sync pulse information from an external source.

E (Free submode) - The Local Coordinator releases all control of the intersection. Call light 0 is extinguished. In this mode the Local Cycle timer runs continuously to “255” and rolls over to “000” again.

The local dial routine will be overridden when preemption or manual control is in operation or the while the “Free After Preempt” timer is active. This user set timer allows the intersection to run free after preemption for up to 255 seconds.

LOCAL COORDINATION MAP (see next page)

This figure illustrates the logic that the Local Coordinator uses to determine it’s operating mode. The program first looks at the value in location 4-0-1 (Local Manual). If this is a non-zero value, then the Local Coordinator is in Manual Override Mode and the value determines which “submode” to run.



LACO-4 Local Coordination Map

COORDINATION OUTPUTS

Call light 0 is a Front Panel indication of the general status of the Local Coordinator. When this light is extinguished, the Local Coordinator is disabled and the intersection is running Free. This is can be confirmed by observing “014” at location 4-0-3 (Local Plan). When the Local Coordinator is in a valid coordination mode, call light 0 will be ON steady except for the last two seconds of the coordination cycle. During that period it will be extinguished. This represents the current plan’s Sync pulse.

Auxiliary output file slot 3 (AUX 3) can be set to output coordination indications. AUX3 Red echoes the Sync pulse (for 7-wire communication to a Slave controller) and AUX3 Green is used for the TOD Special Function output. This is a time of day output from the event tables. It will be turned ON **steady** when a TOD table event occurs with an “A” in its Plan/Function column. It will be turned ON **flashing** when a TOD table event occurs with an “B” in its Plan/Function column. It will be turned OFF when a TOD table event occurs with an “D” in its Plan/Function column. This output will also be automatically echoed to the 4Ped Yellow output as long as no 2-color overlap or Ped A is in use.

Auxiliary output file slot 6 (AUX6) is used to drive the remaining 7-wire outputs to Slave controllers. AUX6 Red = Free, AUX6 Yellow = Dial 2, and AUX6 Green = Dial 3. Dial 1 is indicated when both Dial 2 and Dial 3 are extinguished. These can also be used to provide TOD outputs for school crossings etc.

Finally there is a Dynamic Coordination display (viewed at location 7-F-F) which provides the operator a composite status of all four of the coordination functions on the 170 front panel call lights at the same time. The four functions have a different flash rate to help distinguish them:

- Force Off = solid
- Hold = fast flash
- Ped Restrict = slow flash
- Cocall (Coordination calls) = pulsed

If, for instance, phases 2 and 6 have a (coordination) Hold applied and phases 4 and 8 have a Ped Restrict applied, then call lights 2 and 6 will be ON steady while call lights 4 and 8 will show a slow flashing indication.

COORDINATION FUNCTIONS

	INTERVALS (in seconds)			PLAN 4			
	Plan 4	Plan 5	Plan 6	Force Off	Hold	Ped Restrict	Call
	1	2	3	4	5	6	7
0							
1							
2							
3							
4							
5							
6							
7							
8							
9							
A							
B							
C							
D							
E							
F							

Coordination functions consist of ForceOffs, Holds, Ped Restricts and (coordination) Calls. With careful use of these four parameters and a proper cycle length/offset, the user can achieve the desired Green Band for each intersection. Each plan has an associated Cycle Length entered in row “0” of the respective Plan column (column 1, for Plan 4, in the example shown). Beneath the Cycle Length, time intervals for setting and clearing of the coordination functions are entered. Row zero is also considered “local cycle zero”. The value of each row in this column must be greater than in the preceding row and no row may be greater than the Cycle Length (row “0”).

Columns 4 through 7 (for Plan 4) are used for setting the desired phase flags for the coordination functions. Any phases may be flagged but only Allowed phases will be recognized. The coordinated phases should be flagged in row “0” of the ForceOff column (column 4). At local cycle zero, which occurs at master cycle zero plus the plan’s offset value, these phases will be forced off, if they are timing and have satisfied Minimum Greens. The ForceOffs will remain in effect until the next interval (corresponding to the next row) is reached. Any phases flagged in this row of the ForceOff column will have a ForceOff applied to them. All phases not flagged will have the ForceOff removed. The same operation is true of the Hold, Ped Restrict and Call functions.

COORDINATION TABLES

Coordination tables come in different varieties depending on what they specify and how they do it. Tables 0 through 4 are the Time of Day (TOD) tables and specify as their output a particular Plan (1 - 9) or Function (A - F) which is used by the Local Coordinator to decide what plan or functions to output. Tables 5 through 7 determine which of the TOD tables will be in effect.

TOD Tables (tables 0-4)

Each TOD table consists of a list of times of day and a chart of days of the week. It uses this data to turn ON/OFF the coordination functions and/or the Special Function outputs. The LACO-4 program continuously compares its internal clock to the times entered in the Hour:Min column of the table. If a match is found, and the present day of the week has been flagged for that time in the “Sun” through “Sat” columns to the right, then the action called for under the Plan column is taken. For example, it can command the intersection to output program flash (TOD Flash).

Entries in the Hour:Min column of TOD tables may appear redundant at times when actually they are not. For example, it may be desirable to go to Plan 2 at 05:30 if it is a Sunday but to Plan 6 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.

Floating Holidays Table (table 5)

Table 5 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 1 on this holiday we would list under the Month/Day column, "11/04." We would next put a "1" in the Table column and flag Thursday on that line. The program automatically extends Table 1 operation through the Friday after Thanksgiving as well.

Control defaults to Table 0 unless otherwise directed by another event in Tables 6 or 7. Events 5-0 through 5-4, listed on the Coordination Tables Timing Sheet, are those used by Los Angeles County. They may be changed to suit the individual agency's needs.

Exception Days Table (table 6)

Table 6 works in a similar manner to Table 5, 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 TOD 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 5 through 7. Events 6-0 through 6-9, listed on the Coordination Tables Timing Sheet, are those used by Los Angeles County. They may be changed to suit the individual agency's needs.

Annual Events Table (table 7)

This table has the same format as Table 6 but the operation is different. The dates listed in the Month/Day column are “starting” dates. Beginning on the date entered, the designated TOD 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 Table 7 change the "default" table for the flagged days of the week from table 0 to some other TOD table.

As an example, 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 7 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 5 and 6.

On September 1, the city wishes to resume normal patterns of coordination for Thursdays and Fridays so another line is inserted in Tables 7 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 6) takes priority over the Floating Holiday Table (Table 5) which takes priority over the Annual Event Table (Table 7). 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.

Additional points

- Walk and Don’t Walk intervals will not be abbreviated by Max Extension or Force Off.
- Emergency Vehicle preemption will terminate the Walk interval immediately to Flashing Don’t Walk (or steady Don’t Walk, if selected at locations 3-9-1, 3-9-2, 3-9-3 or 3-9-4).
- Railroad preemption has priority over pedestrian timing and will terminate either interval to steady Don’t Walk indication.
- All preemption modes (including Manual Control) will temporarily suspend Local coordinator control of the intersection. The Master cycle will continue to time in the background, allowing a seamless return to coordination after preemption.
- Minimum Green or Added Minimum Green will not be terminated by Force Off or Emergency Vehicle preemption. However, as in non-coordinated operation, a Railroad preemption immediately terminates all vehicle and pedestrian intervals.
- Queue Clearing Hold will not terminate to Max Extension but will end in the presence of a coordination or preemption Force Off.
- Yellow Clearance, Red Clearance and Red Revert intervals time as normal.

ZIP COORDINATION (ZipCoord)

ZipCoord is a user selectable alternative to the standard LACO-4 coordination function logic. Its name reflects the basic logic that ZipCoord provides. This basic logic is apparent on comparison of the ZipCoord timing (1 timing sheet) versus the standard coordination timing (4 timing sheets). It consists of nine plans where the user can only set a single force off point for each phase and the Hold Release point for the sync phase(s).

The sync phases' ForceOff points must be set to the cycle length. These phases will be forced off at local cycle zero. After local cycle zero, a Hold will be placed on these phases until the next local cycle zero or until the Hold Release interval is reached, if set. If the Hold Release is set, it will end the Hold on the sync phases and let them operate off detector actuation so the side street can be serviced early. The side street phases will time, if called, until one of the following occurs:

- Their Max2 time is reached
- They are forced off
- They gap-out occurs

When the sync phases go green again, they will hold in green until the next Hold Release point (local cycle zero). ZipCoord parameters are entered on a separate timing sheet from the standard coordination parameters.

ZipCoord timing occupies the same memory page (Page 4) as the first coordination timing sheet (Coordination 1) of the standard coordination timing. By default, the standard coordination timing is mapped into memory. To enable the ZipCoord memory map, enter any non-zero value at ZipCoord Enable (location 7-A-D). When this location is set to a non-zero value, all of the standard coordination timing is automatically erased. That is, the user set locations on memory Pages 4, 5, 6 and 7 will be set to "000". This corresponds to the Coordination 1, Coordination 2, Coordination 3 and Coordination Attributes timing sheets.

If a value of zero is entered at ZipCoord Enable, the standard coordination memory map will be re-enabled. At this point all user-set data will be erased from memory Page 4, which corresponds to the Zip Coordination timing sheet.

Other points to consider for Zip Coord usage:

- ZipCoord only affects how coordination functions are implemented
- Master and Local functionality do not change between ZipCoord and standard coordination
- Coordination Attributes are disabled for ZipCoord.
- Coordination Tables are not affected by changes made to ZipCoord Enable.

SECTION 7 COMMUNICATIONS

PEER TO PEER

WWV

AB3418

PEER TO PEER (Controller To Controller)

All controller-to-controller communications complies with the RS232 serial communications specification.

TRANSMIT TIME AND DATE

LACO-4 provides two methods of sending one controller's local time and date to another controller. One uses an L.A. County proprietary message for transmission between County owned controllers. The other is the Caltrans specified AB3418 *SetTime* message. See section 7.3 for more information on AB3418 messaging.

Only one comm port may be configured for transmitting time and date using the County message. If more than one port is configured, the lowest numbered port will be used and the others will be ignored for this message. To use the County proprietary message, determine which port to use and enter "4" followed by "E" at locations:

- 1-9-1 for the C2S connector
- 1-9-2 for the C20S connector
- 1-9-3 for the C30S connector
- 1-9-4 for the C40S connector

Once the 170 controller is configured, it will send its local time and date out of the configured comm port once per minute, on the minute. The time and date are sent in a six-byte string with the entire six-byte string being sent within 1 second. The six bytes sent are:

- Hour
- Minute (seconds are not sent)
- Day of Week
- Month
- Day of Month
- Year

This transmission is suspended whenever a WWV repoll operation is active. Selection of this comm method automatically configures the comm port with the following protocol:

- 8 bits
- No parity
- 1 Stop bit

The baud rate is determined by a hardware jumper on the 170 CPU board and can not be set by software. The sending and receiving controllers must be configured likewise for the received data to be recognized. The communications cable should have pins 2 and 3 of the transmitting controller connected to pins 3 and 2 (i.e. reversed) of the receiving controllers.

RECEIVE TIME AND DATE

As with transmitting Time and Date, LACO-4 controllers can receive Time and Date using both the AB3418 protocol and the L.A. County proprietary protocol. See section 7.3 for more information on AB3418 messaging.

Only one comm port may be configured for receiving time and date using the County message. If more than one port is configured, the lowest numbered port will be used and the others will be ignored for this message. To use the County proprietary message, determine which port to use and enter “5” followed by “E” at locations:

- 1-9-1 for the C2S connector
- 1-9-2 for the C20S connector
- 1-9-3 for the C30S connector
- 1-9-4 for the C40S connector

Once the 170 controller is configured, it will monitor the assigned comm port for any activity. When it receives Time and Date data from the sending controller, it automatically updates its local time and date from the received data. Selection of this communication method automatically configures the comm port with the following protocol:

- 8 bits
- No parity
- 1 Stop bit

The baud rate is determined by a hardware jumper on the 170 CPU board and can not be set by software. The sending and receiving controllers must be configured likewise for the received data to be recognized. The communications cable should have pins 2 and 3 of the transmitting controller connected to pins 3 and 2 (i.e. reversed) of the receiving controllers.

TRANSMIT 7-WIRE (VIA MODEM)

Only one comm port may be configured for transmitting 7-wire data. If more than one port is configured, the lowest numbered port will be used and the others will be ignored for this message. To use the this message, determine which port to use and enter “2” followed by “E” at locations:

- 1-9-1 for the C2S connector
- 1-9-2 for the C20S connector
- 1-9-3 for the C30S connector
- 1-9-4 for the C40S connector

This routine sends the controllers’ Master Coordinator data, once each second, in 7-Wire format but the data is transmitted via modem instead of the conventional seven conductors carrying 115vac. First, the desired port must be setup for Comm Option 2. The coordination Master extracts the current plan number and its associated sync pulse status and encodes it into the first six bits of a single byte of data. In addition to this information, two more bits are encoded with Offset Timing pulse and Midnight Sync Pulse information. The Offset Timing pulse bit will be ON when either the phase(s) flagged in Green Offset Sync Pulse (location 1-D-C) are Green or the phases flagged in Yellow Offset Sync Pulse (location 1-D-D) are Yellow. This bit will be OFF at all other times.

The Midnight Sync Pulse bit will be ON when the 170 Real Time Clock reaches the hour and minute set at MSP Hour (location 7-A-B) and MSP Minute (location 7-A-C). This pulse will be ON for only 1/10th of a second and OFF at all other times. If a value of "025" is entered at MSP Hour, then bit 7 will be ON for 1/10th of a second for **every** second. The data is transmitted in the following format:

	8	7	6	5	4	3	2	1	
MSB	Offset Timing	Midnight Sync Pulse	Free	Dial3 (Plan 3)	Dial2 (Plan 2)	unused	unused	Sync	**LSB**

Note that if the sending controller is in Manual Override mode and commanding the Slave submode ("B" at location 4-0-1), then only the Offset Timing and Midnight Sync Pulse data will be sent. Note also that, for compatibility with older LACO programs, only Plans 1, 2 or 3 should be configured in the Master Coordinator. The Sync pulse will represent Offset 1 in the receiving controller.

TRANSMIT 7-WIRE (VIA 7-WIRE INTERCONNECT)

LACO-4 still supports this conventional method of sending 7-Wire data to a peer controller. However, since LACO-4 coordination uses a nine Plan format versus the conventional three Dial/three Offset format, only Plans 1, 2 and 3 should be configured in the Master coordinator of the sending controller. Similarly, only the Dial1/Offset1, Dial2/Offset1 or Dial3/Offset 1 combinations should be configured on the receiving controller if it is running a non-LACO-4 program. The 7-Wire outputs are as follows:

- AUX3 Red output = Sync Pulse (representing Offset 1 only)
- AUX6 Yellow output = Plan 2 **
- AUX6 Green output = Plan 3 **
- AUX6 Red output = Free
- Cabinet Neutral Bus = Signal Return

** Lack of both the Plan 2 and Plan 3 outputs indicates that Plan 1 is in effect.

TRANSMIT PLAN

Only one comm port may be configured for transmitting 7-wire data. If more than one port is configured, the lowest numbered port will be used and the others will be ignored for this message. To implement this LACO-4 proprietary message, determine which port to use and enter “6” followed by “E” at locations:

- 1-9-1 for the C2S connector
- 1-9-2 for the C20S connector
- 1-9-3 for the C30S connector
- 1-9-4 for the C40S connector

This routine sends coordination data, once each second, via modem only in the following format.

	8	7	6	5	4	3	2	1	
MSB	Offset Timing	Midnight Sync Pulse	unused	Plans 1 through 9 encoded in these four bits (i.e. 0111 = Plan 7).				Sync	**LSB**

The “Offset Timing” bit and “Midnight Sync Pulse” bit are as defined in the Transmit 7-Wire section above. The “Master is in Flash” bit will be ON whenever the controller’s Flash Sense input (C1 Pin 81) is ON.

WWV

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:

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

Disconnecting the WWV Clock or cable while performing a repoll will abort the repoll process. This is not recommended since it could possibly cause the controller to lock up, requiring a long power down.

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

- **The WWV Clock hardware must be properly configured**
- **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 1-9-1, 1-9-2, 1-9-3 and 1-9-4, respectively. Enter "1" at the desired location followed by "E". Any **one** Comm Port can be configured for WWV.
- **The WWV Clock cable must be connected to the configured Comm Port** - Viewing the 170 controller from the rear, the designations are, from left to right, Comm Port 1 (C2S), Comm Port 2 (C20S), Comm Port 3 (C30S, if installed) and Comm Port 4 (C40S, if installed).
- **The WWV Clock must be connected to the cable and have power available to it**
- **An antenna of the correct type must be connected to the WWV Clock**
- **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-4 program will not allow a download. This is to prevent erroneous time from being set.

To manually poll the WWV Clock, access the Time display by pressing “A-C” or “C”. Pressing the ”E" key at this display will force a manual poll. 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 return to the Base display (pressing any key during the time/date display will return immediately to Base display). If the display changes to “000" then the poll attempt was unsuccessful. Viewing the call lights at location 0-A-5 (WWVERR) will provide a probable cause as follows:

1 Not used.

2 Not used.

3 = *No ports or multiple ports configured for WWV* - No Comm Port or multiple comm ports have been configured for WWV.

4 = *Bad or unrecognized data received from Clock* – Indicates a probable bad ACIA on the 170 CPU board. Reconfiguring WWV operation for an unused comm port will verify this.

5 = *No response from Clock* – Indicates that the 170 comm port configured for WWV has not received any data back from the WWV Clock in response to its poll request.

6 = *ACIA error* - Indicates a probable defective WWV Clock.

7 = *Not locked on* – Indicates that the WWV Clock has not locked on to the WWV radio signal transmitted by NIST.

8 = *Bad or disconnected cable* - Indicates that the WWV Clock cable is not connected to the assigned Comm Port or the cable is faulty.

If the display retains the “001" but changes to ”000" briefly every 2 seconds, then the 170 is not receiving valid data (call lights “4" or ”5"), or the WWV Clock is not “locked on” (call light “7"). In this situation, the 170 will continually repoll until either valid data is received from the WWV Clock or the WWV function is removed from the comm port option.

AB3418

More information on the AB3418 protocol can be found in Standard Communications Protocol for Traffic Signals in California, Specification and Implementation Requirements. The URL where this information can be found is **www.dot.ca.gov/hq/traffops/elecsys/ab3418**.

The following AB3418 messages are currently supported by LACO-4:

- GetControllerID
- SetTime
- SetPattern
- GetShortStatus

GetControllerID – Provides information that identifies the controller to the polling system. Causes the 170 to respond to the polling system with the following information:

- Number of bytes in message response = **17**
- Number of bytes in Manufacturer's ID = **4**
- Manufacturer's ID = **LACO** (Los Angeles County)
- Number of bytes in Model Number = **1**
- Model Number = **4** (LACO-4)
- Number of bytes in protocol version = **9**
- Protocol Version = **AB3418 V1**

SetTime – Causes the 170 controller's time and date to change to the time and date sent from the polling system.

SetPattern – Causes the 170 controller to implement the coordination plan sent from the polling system. This can be plans "1" through "9" or "255" for Free operation. The commanded plan can be observed at location 4-0-4 (TMCPLN) and will begin at the beginning of the next cycle.

GetShortStatus – Causes the 170 controller to return its current Green phases, status and current plan to the polling system. The status byte provides the following information:

- If any preempt input is ON
- If the Flash Sense input is ON
- If the Local Cycle timer has passed through 000 since the last poll
- If the Manual Control Enable input is ON
- If the controller has been set FREE manually (location 4-0-1 = "014")
- If the External Stop Time input is ON (usually because of CMU Flash)

When the selected port is configured to receive AB3418, LACO-4 automatically sets the controller's ACIA protocol to 8 data bits, 1 stop bit and No parity. Any of the controller's Comm Ports may be set to transmit or receive AB3418 protocol (though typically only one port would be configured to receive). First go to location 1-9-0 (System ID) and enter a unique address for this controller. This identifies the 170 to the polling system. To configure the controller's Comm Port 1 to *receive* AB3418 communication (controller responds to commands from polling system) go to location 1-9-1 (Comm Port 1) and enter "8" followed by "E". To set the controller up to *transmit* AB3418 (controller sends time and date information only) enter "7" at location 1-9-1. Follow the same steps to configure Comm Port 2 (at location 1-9-2), Comm Port 3 (location 1-9-3) and Comm Port 4 (location 1-9-4).

See Appendix E12 for information on cabling requirements for AB3418 communications.

SECTION 8 MISCELLANEOUS FEATURES

USER DATA VALIDATION

PROGRAMMABLE LOGIC

MID-BLOCK PED CROSSING

FREEWAY OFFRAMP RELEASE LOGIC

OUTPUT FILE EDITING

USER DATA VALIDATION

FLASHOUT PROGRAM

REINITIALIZATION

MEMORY MANAGEMENT

TIMING COPYING

USER DATA VALIDATION

LACO-4 provides automatic validation of all the critical data in the program. This data falls into four general categories:

1. Phase Time Parameters

   - Minimum Green – If a phase is selected for Permit or Railroad Limited Service, its Minimum Green time will be automatically set to 10 seconds if no time is set there.
   - Yellow Clearance – Yellow Clearance time for all phases must be between 3.0 seconds and 5.0 seconds. If it is less than 3.0 seconds, it will be automatically set to 3.0 seconds. If it is greater than 5.0 seconds, it will automatically be set to 5.0 seconds. If a phase is selected for Yellow Ranging, then its Yellow Clearance time can be set to any value between .1 second and 25.5 seconds.
   - Red Revert times – The default time for Red Revert is 2.0 seconds. Any value other than zero can be entered for Red Revert. If zero is entered, it will automatically be changed to 2.0 seconds.
   - Main Street phases – At least one phase must be selected as a Main Street phase. If no phase is selected, then phases 1, 2, 5 and 6 will automatically be selected.
   - Side Street phases – Side street phases are automatically set to the opposite of Main Street phases.
   - First phases – First phases must also be selected in Permit phases. All First phases must be able to time concurrently with regards to ring, street, Exclusive phasing and Restricted phasing.
   - Yellow Startup phases – Same as First phases.
   - Ped phases – Only one phase may be selected for each ped. If more than one phase is selected, only the last selected phase will be saved. If Overlap A/B have parent phases selected, then Ped A/B are disabled. Phases selected will be erased. Only configured peds (i.e. peds with phases assigned) can be selected as STA Mode, Ped Recall or Railroad-Only peds (RRPED).
   - Exclusive phases – Only lead phases or lag phases may be selected as Exclusive phases.
   - Restricted phases – Only lead phases or lag phases may be selected as Restricted phases. Restricted phases cannot be selected on the same street with Exclusive phases. If Restricted phases are selected, they will be erased.
   - Free Lag phases – If no phases are selected for a quadrant or multiple phases are selected for a quadrant, then only the quadrant's barrier phase will be saved.
   - Manual Control Lag phases – Same as Free Lag phases, above

2. Preempt Parameters
    - Railroad Mode Select – Only “01”, “02”, or “03” are recognized as valid Railroad modes. Any other value will be changed to “00”.
    - All Red time after RR Flash – The default value is 5.0 seconds. Any value other than zero can be entered. If no value is set, it will automatically be changed to 5.0 seconds.
    - EV Clearance phases – EV Clearance phases must also be selected as either Permitted phases or Railroad Limited Service phases (RRBLIM). They must also be able to time concurrently as in First phases, above.
    - RR Track Clearance phases – Same as EV Clearance phases, above.
    - RR Exit phases – Railroad Exit phases must also be selected as Permitted phases and be able to time concurrently as in First phases, above.
    - EV Link – An EV will not be permitted to link to itself. If, for example, EV A Link is set to “001” (for EV A), the location will automatically be changed to “000”. Also, any value other than “001”, “002”, “003” or “004” will be treated as zero.
3. Overlap Parameters
    - Yellow Clearance time – Same as phase Yellow Clearance.
    - Load Switch assignments – Only 3-color overlaps (C, D, E and F) can have their outputs redirected. A value entered for overlaps A or B will be erased. Only phase load switches (“1” through “8”) or ped load switches (“13” through “16”) can be entered here. Any other value will be erased.
    - Yellow Ranging overlaps/Driveway Flash overlaps/Yellow Startup overlaps – Only overlaps A through F (call lights 1 through 6) can be selected. Any other selection (7 or 8) will be erased.
4. Coordination Parameters
    - Cycle lengths – Default Cycle lengths for plans 1 through 9 are set to 60 seconds. If zero is entered for any plan’s Cycle length, it will be automatically changed to 60 seconds. Any value (other than zero) may be entered here. However, if the Cycle length is less than 10 seconds, the plan will use 60 seconds instead and the value entered here will remain unchanged.
    - Max Cycle Length – The Max Cycle length cannot be zero and it must be greater than the Min Cycle length. If either of these two conditions is not met, the value will automatically be changed to 255 seconds.
    - Plan Lag phases – Same as Free Lag phases, above.

PROGRAMMABLE LOGIC (PL)

Refer to Appendices A13 (Programmable Logic worksheet), E1 (Input Function Map) and E2 (Output Function Map) for this discussion. This feature is very powerful in that it almost completely eliminates the need for external wiring to achieve special logic operation. **PL** provides the following logic gates and operations:

- four each 2-input/2-output AND gates
- four each 2-input/2-output OR gates
- four each 2-input/2-output Exclusive OR (XOR) gates
- four each 2-input/2-output Set/Reset (S/R) Latches
- four each Relay with switched input, and coil controls
- four each Multifunction Timers
- the bottom output of all gates except the Timer are the complement of the top output

PL is implemented in very straightforward manner. Users already familiar with logic operations and basic electrical devices will adapt to this feature very quickly. The key to facilitating this feature is in understanding the mechanism used to connect the 170 controller inputs and outputs to the logic devices. Every input and output in the 170 controller is mapped to a "port". There are eight input ports (Appendix E1) and seven output ports (Appendix E2). Each port is further broken down into bits. A port is one byte long and therefor has eight bits. Appendices E1 and E2 show this port/bit relationship and associate three pieces of information with each one:

1. The LACO-4 default (and, in some cases optional) functions
2. The C1 pin assignment based on the Caltrans 170 specification
3. The "logic" pin associated with the port/bit which is used on the PL Timing Sheet

Notice that input logic pins are 2-digit numbers and output logic pins are 3-digit numbers. This is a convenient way to separate the inputs from the outputs for both the users and the controller program. For those who may be interested, the logic pin is defined thusly:

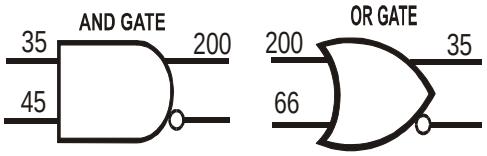
Logic pin = ((port number-1) * 10) + bit position

For instance, the EV B input is located in *input* port 5 ("5005" in the hardware address column of Appendix E1) at bit position 6. Hence its logic pin number is:

((5-1) *10) + 6 = 46

Note that the AUX3 Yellow output, which is located in *output* port 5 at bit position 6 has the same logic pin number as the EV A input except that it is preceded with a "1", (**1**46).

Dummy pins are used as a connection mechanism between logic devices. These pins are not used in the 170 controller and have no input or output function. Any pin with a number greater than "199" will be treated as a dummy pin. A dummy pin (pin 200 below) must be specified twice. First, it will be used to identify the *output* of logic device X (the AND gate below) and then it will be used to identify the *input* of logic device Y (the OR gate below) that is connected to logic device X.



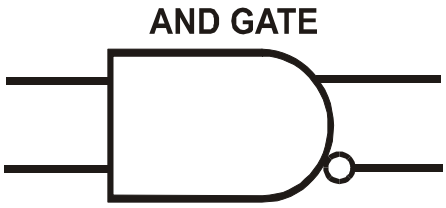
Note: The above is explained in Example A, following the logic gate descriptions.

Gates can be linked together by wrapping an output of one gate to the input of any other gate "below" it (higher memory address). Gates in a column can be linked to any gate in any column, which is to the right of it (higher address). This means that (viewing the Programmable Logic timing sheet) the AND1 outputs *can* be used as inputs to any other gate on the timing. By contrast, the TIMER4 outputs *cannot* be used as inputs to any other gate. An output that feeds back to the input of the same gate will be processed in the next 10th sec.

The logic and simplicity of this numbering system will become apparent to the user upon examination of Appendices E1 and E2. Additionally, a real world example is provided on the Programmable Logic Worksheet (Appendix A13). This example and others are explained in detail following the logic device descriptions.

LOGIC DEVICES

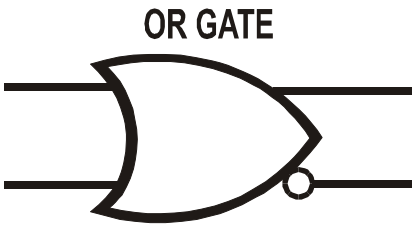
AND Gate



In 1	In 2	Out 1	Out 2
0	0	0	1
1	0	0	1
0	1	0	1
1	1	1	0

As long as both inputs are ON, Out1 will be ON and Out2 will be OFF. If either input is OFF, Out1 will be OFF and Out2 will be ON.

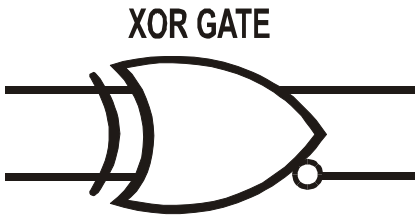
OR Gate



In 1	In 2	Out 1	Out 2
0	0	0	1
1	0	1	0
0	1	1	0
1	1	1	0

As long as either input is ON, Out1 will be ON and Out2 will be OFF. When both inputs are OFF, Out1 will be OFF and Out2 will be ON.

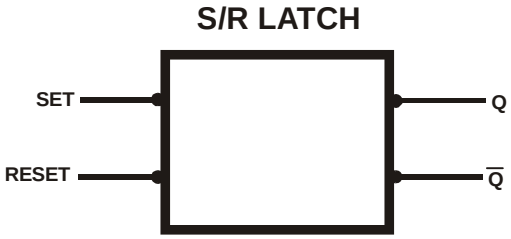
XOR (Exclusive Or) Gate



In 1	In 2	Out 1	Out 2
0	0	0	1
1	0	1	0
0	1	1	0
1	1	0	1

As long as both inputs are different (one ON and one OFF), Out1 will be ON and Out2 will be OFF. When both inputs are the same (both ON or both OFF), Out1 will be OFF and Out2 will be ON.

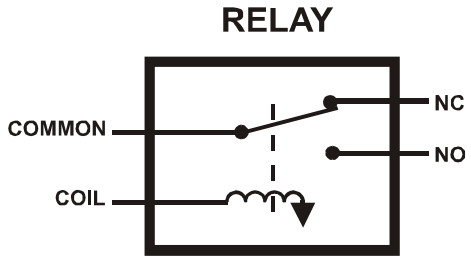
Set/Reset Latch



There is no truth tale associated with this device. The two outputs are always in the opposite state from one another. The default state for this device has the Q output = 1 (set). Each .1 second the SET and RESET inputs are monitored for change. If both of the inputs are ON together or the RESET input is ON by itself, then the Latch is reset and the Q output = 0 (clear) while the other output = 1. If only the SET input is ON, then the Latch will be set. Four entries need to be defined for each S/R Latch block:

- Set – The logic pin of the input or output used to toggle the Latch to its SET state.
- Reset – The logic pin of the input or output used to toggle the Latch to its RESET state.
- Q – The logic pin of the input that is desired to be latched.
- $\overline{Q}$ – The logic pin of the input that is required to always be in the opposite state as the Q pin.

Relay



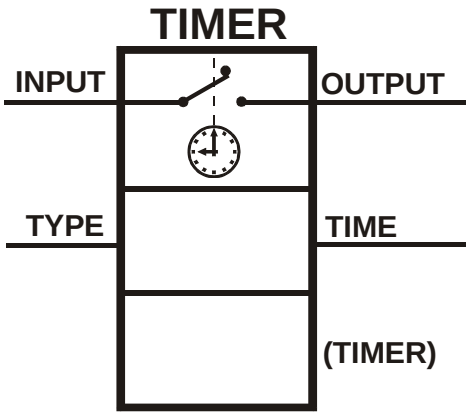
There is no truth tale associated with this device. The default state for this device has the normally closed (NC) output connected to the COMMON input. Each .1 second the COIL input is monitored for change. If the COIL input is ON, then the COMMON input will be connected to the normally open (NO) output. There are four entries for each Relay block:

- Common – The logic pin of the input to be switched.
- NC – The logic pin of the Normally Closed contact. This would normally be the same as the Common logic pin number but is not restricted to that. This must be an input logic pin.
- NO – The logic pin of the Normally Open contact. This could be, for instance, the input to one of the logic gates (e.g. a Dummy pin) that might invert the Common input state.
- Coil – The logic pin of the input or output which, when ON connects the Common to the Normally Open contact.

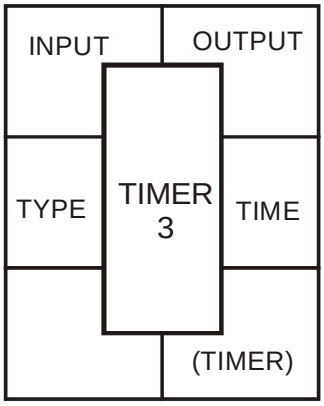
Timer

There is no truth table associated with this device. This logic block is a multipurpose timer that acts as an extension, delay or one-shot timer, which counts in either whole second or .1 second increments. There are four entries for each Timer block:

- Input – The logic pin of the input to be modified by the timer.
- Output – The logic pin of the timer modified input. This would normally the same as the Input logic pin number but is not restricted to that.
- Type – One of six combinations of as indicated below
- "01" = .1 second Delay timer. Delays input logic until timer expires.
- "02" = .1 second Extension timer. Extends input logic until timer expires.
- "03" = .1 second One Shot timer. Enables input logic until timer expires at which time the input logic is disabled until the input is reactuated.
- "10" = 1 second Delay timer. Delays input logic until timer expires.
- "20" = 1 second Extension timer. Extends input logic until timer expires.
- "30" = 1 second One Shot timer. Enables input logic until timer expires at which time the input logic is disabled until the input is reactuated.
- Time – The duration of the timer. To implement a 6.0 second timer using Types 01,02 or 03, enter "60" at this location (60 times .1 second = 6.0 seconds). To implement a 6 second timer using Types 10, 20 or 30, enter "6" at this location.



Functional Diagram



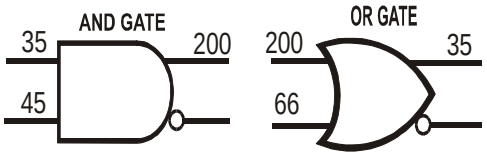
Timing Sheet Equivalent

The figures above depict the Timer block. When the controller starts up, the (Timer) location is initialized with the value entered in the Time location. Depending on the value entered in the Type location, the Timer block operates as follows:

- Types 01 and 10 (Delay) – The switch controlled by the (Timer) location will remain open until the timer reaches zero.
- Types 02 and 20 (Extension) – The switch will remain closed until the timer reaches zero.
- Types 03 and 30 (One Shot) – The switch will remain closed until the timer reaches zero and will remain closed until the Input logic pin goes OFF then back ON.

Examples

Example A - General



This example takes the I3 Upper detector slot input (logic pin 35) and AND's it with the EV A input (logic pin 45). The output of the AND gate is linked to input1 of the OR gate (via dummy pin 71) and is OR'd with the Front Panel Stop Time switch. OR gate output1 then replaces the original I3 Upper detector slot input. Logically, this means that the detector I3U input will only place a call to its assigned phase if:

(((detector I3U is actuated) AND (the EV A input is ON))

OR

(The Front Panel Stop Time switch is ON))

Functionally, this means that phase 2 (the default phase for detector I3U) will be called whenever:

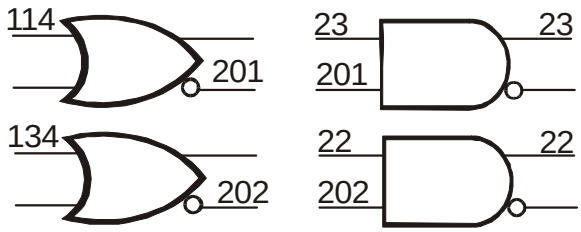
1. The Front Panel Stop Time switch is placed ON **OR**
2. Detector I3U is actuated **AND** EV A input in ON (even if EV A is not configured!)

This is admittedly an example with limited application, but it serves to illustrate that the only limitation to this logic feature is the user's imagination. Users are urged to replicate this and the following examples to familiarize themselves with the power of the PL feature. To implement the above example, enter the following data:

Location	1-2-8-0	1-2-8-1	1-2-9-0	1-2-8-2	1-2-8-3	1-2-9-2
Data	35	45	200	200	66	35
Function	Det I3U	EV A	Dummy	Dummy	F.P Stop Time	Det I3U

REMINDER – When accessing memory locations with 4 digits, the first key press must be "8".

Example B – Anti-Backup logic: Phase 1 detector actuation only places a call when phase 6 is not yellow and phase 5 detector actuation only places a call when phase 2 is not yellow

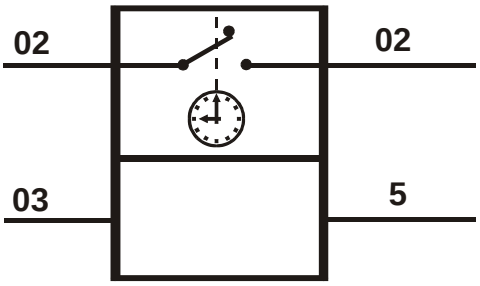


Location	1-2-A-2	1-2-B-3	1-2-C-0	1-2-C-1	1-2-D-0
Data	114	201	23	201	23
Function	Phase 2 Yel	Dummy	Det J5	Dummy	Det J5

Location	1-2-C-2	1-2-D-3	1-2-E-0	1-2-E-1	1-2-F-0
Data	134	202	22	202	22
Function	Phase 6 Yel	Dummy	Det I1	Dummy	Det I1

REMINDER – When accessing memory locations with 4 digits, the first key press must be “8”.

Example C - Pulsed Detector Call: One Shot operation turns constant J2 Upper detector actuation into a .5 second pulsed actuation. The actual .5 second timer can be observed at location 1-2-9-C.

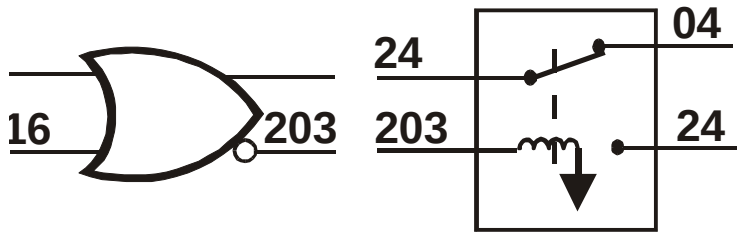


Location	1-2-8-A	1-2-8-B	1-2-9-A	1-2-9-B
Data	02	03	02	05
Function	Det J2U	.1sec One Shot	Det J2U	.5 sec

REMINDER – When accessing memory locations with 4 digits, the first key press must be “8”.

Example D – Left Turn Arrow comes on (Protected movement of Protected/Permissive Left Turn gets called) **only** during Railroad preempt. An actuation on input I5 (phase 3 detector) gets transferred to the J6 Upper input (phase 8 detector) during normal operation. When the Railroad B input is active, the I5 actuation gets transferred to I5 (itself) and phase 3 gets called resulting in a Protected left turn arrow. Notice that the Railroad B input is inverted before being used as the Relay coil control. This is because LACO-4 uses negative logic when monitoring the Railroad inputs. That is, when the input goes OFF, the preemptor logic sees it as a TRUE input and begins a preemption sequence. However, this logic translation is accomplished within the preemption module. The PL module only knows input ON or OFF so the inverter is added to compensate for that fact.

.



Location	1-2-C-3	1-2-D-3	1-2-E-8	1-2-E-9	1-2-F-8	1-2-F-9
Data	16	203	24	203	04	24
Function	RRB	Dummy	Det I5	Dummy	Det J6U	Det I5

REMINDER – When accessing memory locations with 4 digits, the first key press must be “8”.

MID-BLOCK PED CROSSING

As the name implies, this feature sets up field indications for a Pedestrian crossing that is not located at an intersection. To implement this feature, turn on call light 1 at User Flag (location 1-D-B). This feature requires that phase 2 and/or 6 are used to drive the vehicle indication and phase 4 is used to drive the ped indication. Operation is the same as a normal intersection except that the vehicle head flashes its Red ball when the ped is timing its Flashing Don't Walk and/or its Yellow Clearance intervals. It is common to select phase 4 as Yellow Ranging (location 1-D-E) so that the phase 4 Yellow Clearance can be set as low as .1 second. This way only the ped intervals time. An additional all-Red time may be added, between the end of Flashing Don't Walk and the start of the vehicle phase Green, by setting the desired time in the phase 4 Red Clearance.

FREEWAY OFFRAMP RELEASE LOGIC

One of the primary reasons that state agencies cite for not relinquishing control of a freeway off-ramp to a local agency is that there is no provision in the local agency's controller firmware to prevent the off-ramp from backing up onto the freeway. LACO-4 has a user selectable feature that does just that. When enabled, the off-ramp's advance detector is continuously monitored for actuation. When this occurs, if the off-ramp phase is red, and either of phase 2 and phase 6 are in service, the program clears all coordination holds and zero's out both rings' Max Green timers. This will cause phases 2 and 6 to terminate (max out) which allows the off-ramp phase to service sooner than it would without the logic.

Configure for Freeway Offramp Anti-Backup logic as follows:

- Set location 1-D-B (User Flags) call light 7 to ON. This enables the logic.
- Select the desired off-ramp phase in location 2-B-B (detector I8). The default is phase 4.
- Set selected detector's delay time (location 2-1-B). This should be set to a value that will reduce false "backup" indications.

OUTPUT FILE EDITING

(see figure on next page)

This feature is ideal for performing a Conflict Monitor test while the controller is installed in a cabinet or in a shop/lab environment. It allows the technician to turn ON or OFF (in any combination) each of the fifty-six 170 outputs (36 output file, 18 aux file, Detector Reset and the WatchDog Timer). The table on the next page provides information that maps the field outputs to the editable buffers. The 170 controller's output buffers are located on RAM page 00. This RAM page is write protected to protect the integrity of the program, therefore the RAM page 00 buffers are copied to the RAM page 19 whenever the FP Stop Time switch is placed ON, and the output modification takes place on that page only. The RAM page 00 buffers are never modified.

Use of this feature requires that data be displayed in Flag Display mode of the Extended Memory Display (See Section 2). In this display, every time the FP Stop Time switch is set to ON, the display mode toggles between Decimal Display mode and Flag Display mode. When the extended memory location is first accessed, the display mode defaults to Flag Display mode, so that data is indicated in the call lights (in hexadecimal format). To avoid confusion, when using this feature, always set the FP Stop Time switch to ON *first*. Then access the desired editable output buffer. This way the FP display will always be in the correct display mode.

Output states should not be tampered with during normal operation, so this feature requires some deliberate action in order to avoid accidental activation:

1. The Front Panel (FP) Stop Time switch must be ON
2. The LED Display must be showing locations 1980 through 1986

While both of these conditions are True, the field indications are controlled by the Front Panel keypad. If either condition is False, field indications are driven by the LACO-4 Signals logic.

First set the Front Panel (FP) Stop Time switch to ON. Then access the desired editable output buffer (locations 1980 through 1986) by pressing 8-1-9-8-x, where "x" corresponds to buffers (ports) 0 through 6. Next, using the table on the following page as a reference, press any of keys "1" through "8" to toggle the state of that call light (bit). The corresponding indication wired to that port/bit combination will go ON/OFF each time the key is pressed. The WatchDog timer can be turned ON/OFF but it is updated every .1 second by the program logic to prevent the CMU (if connected) from triggering a WatchDog failure.

Location (Output Port)	Call Light (Bit)	Function	Location (Output Port)	Call Light (Bit)	Function
1-9-8-0 (OUT1)	1	4Ped Don't Walk	1-9-8-1 (OUT2)	1	2Ped Don't Walk
	2	4Ped Walk		2	2Ped Walk
	3	Phase 4 Red		3	Phase 2 Red
	4	Phase 4 Yel		4	Phase 2 Yel
	5	Phase 4 Grn		5	Phase 2 Grn
	6	Phase 3 Red		6	Phase 1 Red
	7	Phase 3 Yel		7	Phase 1 Yel
	8	Phase 3 Grn		8	Phase 1 Grn
1-9-8-2 (OUT3)	1	8Ped Don't Walk	1-9-8-3 (OUT4)	1	6Ped Don't Walk
	2	8Ped Walk		2	6Ped Walk
	3	Phase 8 Red		3	Phase 6 Red
	4	Phase 8 Yel		4	Phase 6 Yel
	5	Phase 8 Grn		5	Phase 6 Grn
	6	Phase 7 Red		6	Phase 5 Red
	7	Phase 7 Yel		7	Phase 5 Yel
	8	Phase 7 Grn		8	Phase 5 Grn
1-9-8-4 (OUT5)	1	Overlap A Grn	1-9-8-5 (OUT6)	1	Aux 6 Red (Free)
	2	Overlap B Grn		2	Aux 6 Grn (Plan3)
	3	Overlap A Yel		3	Aux 5 Red (Olp F Red)
	4	Overlap B Yel		4	Aux 5 Yel (Olp F Yel)
	5	Aux 6 Yel (Plan2)		5	Aux 5 Grn (Olp F Grn)
	6	Aux 3 Yel (Preempt)		6	Aux 4 Red (Olp E Red)
	7	Detector Reset		7	Aux 4 Yel (Olp E Yel)
	8	Watch Dog Timer		8	Aux 4 Grn (Olp E Grn)
1-9-8-6 (OUT7)	1	Aux 3 Red (Sync)			
	2	Aux 3 Grn (SpeclFunc)			
	3	Aux 2 Red (Olp D Red)			
	4	Aux 2 Yel (Olp D Yel)			
	5	Aux 2 Grn (Olp D Grn)			
	6	Aux 1 Red (Olp C Red)			
	7	Aux 1 Yel (Olp C Yel)			
	8	Aux 1 Grn (Olp C Grn)			

Output Editing Map

FLASHOUT PROGRAM

(see figure on next page)

LACO-4 comes with an integrated Intersection Flashout Routine. This routine allows maintenance personnel to verify cabinet-to-field wiring by turning on individual load switch outputs. This routine can be run while the intersection is dark or in program (red) flash.

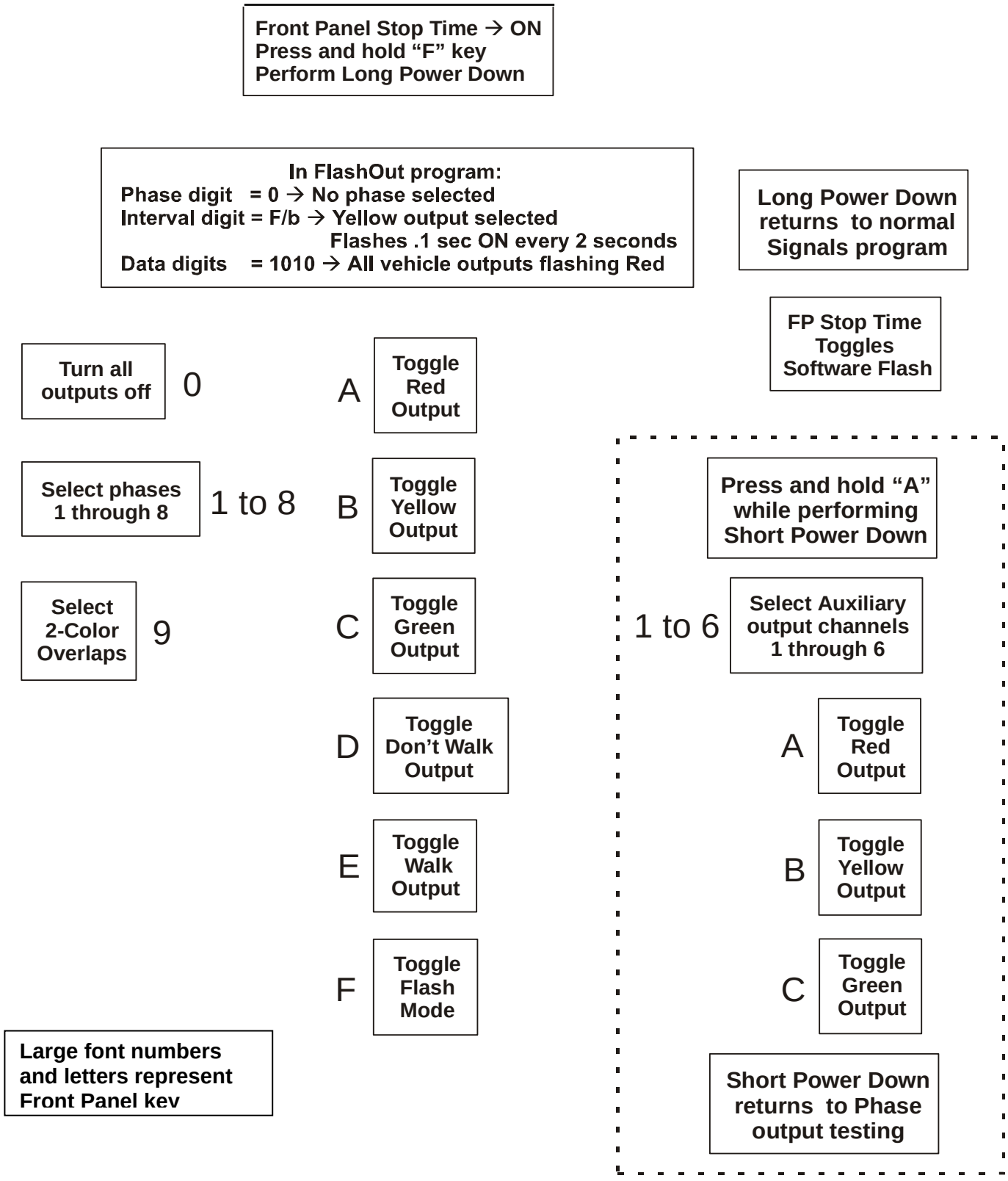
To run the Flashout program, the 170 must be restarted. The cabinet should be in maintenance flash prior to starting the controller. Put the Front Panel Stop Time switch in the “ON” position and, while holding down the “F” key, turn the 170 power switch “ON.” The Flashout program starts up in Flash mode (software flash). The Front Panel Stop Time switch controls the dark/flash mode; ON equals program flash, OFF equals dark. The keyboard is used to select the phase (signal head) and interval (color). Press “1” through “8” to select the signal heads wired to phase 1 through 8 and observe that the phase digit on the Front Panel display changes to the selected phase. Press “A” for Red, “B” for Yellow, “C” for Green, “D” for ped Don’t Walk, or “E” for ped Walk. Observe that the interval digit on the Front Panel display changes to the selected interval. Pressing the “F” key toggles the output state of the selected phase and interval, either solid ON or .1 second ON/1.9 seconds OFF.

Pressing “9” will enable testing of the unused ped Yellow outputs which normally drive the 2-color overlap indications. Press “C” to test 2Ped Yellow (overlap A Green), “E” to test 4Ped Yellow (overlap B green), “B” to test 6Ped Yellow or “D” to test 8Ped Yellow.

The Flash mode is used for testing the intersection indications when the intersection must be in flashing operation (for instance if traffic is present). This mode allows the operator to momentarily display an output for .1 second every two seconds, which would be too fast to confuse motorists but slow enough for the technician to see. To toggle the Flash mode, press the "F" key. Observe that the interval digit is either solid (indicating non-flash mode) or alternating between the color selection (“A” through “E”) and “F” (indicating Flash mode).

To test the auxiliary output file, hold down the "A" key and perform a short power down restart while in the Flashout program. The phase digit will alternate between the selected aux file slot and “A”. The aux file slots are numbered 1 through 6. As with the output file above, select the slot to be tested then select the output to test (Red, Yellow or Green) by pressing the “A”, “B” or “C” key. All other operation is identical to the output file operation described above except the “D” and “E” keys have no effect.

To change back to testing the output file, simply perform a short power down. To exit out of the Flashout program, perform a long power down of the controller. It will restart in LACO-4 with the last timing that was entered.



FLASHOUT KEY PRESS MAP

REINITIALIZATION

Method 1

Set 1-0-A = “888”. CAUTION: THIS MUST NOT BE DONE WHILE THE INTERSECTION IS ON AUTOMATIC! This will cause the program to clear all memory locations and load default timing from the EPROM. The program will set the outputs all Red and the 170 display will show “0808.” Data on the Timing Saver Module is not affected. Permitted Phases (location 1-F-0) is set to 0, as are all Phase Intervals. The default timing is as follows.

Location	Function	Value
1-E-0	Main Street Phases	1, 2, 5, 6
1-E-1	Side Street Phases	3, 4, 7, 8
1-0-E	Stuck All Red Fail Delay Time	03.0 seconds
1-0-F	Red Revert Time	02.0 seconds
1-1-E	Phase 1 Yellow Clearance	05.0 seconds
1-2-E	Phase 2 Yellow Clearance	05.0 seconds
1-3-E	Phase 3 Yellow Clearance	05.0 seconds
1-4-E	Phase 4 Yellow Clearance	05.0 seconds
1-5-E	Phase 5 Yellow Clearance	05.0 seconds
1-6-E	Phase 6 Yellow Clearance	05.0 seconds
1-7-E	Phase 7 Yellow Clearance	05.0 seconds
1-8-E	Phase 8 Yellow Clearance	05.0 seconds
4-0-0	System Manual	014
4-0-1	Local Manual	014
4-0-9	Maximum Cycle Length	255 seconds
1-0-4	Program Number	004
All other Timing Sheet locations are set to 000.		

Timing can now be reentered from scratch or (if the Timing Saver Module data is valid) it can be downloaded by entering “170” at location 1-0-A. If the timing on the Timing Saver Module is for a LACO-4 program, (and the data checksum is correct) the data will be downloaded and the 170 will restart with all phases and peds on a one-time recall. If the timing on the Timing Saver Module is for a non-LACO-4 program, the 170 will load EPROM default data as in Method 1. If it is LACO-4 timing data, but the data checksum is wrong, the 170 will show “BADD” and continue in software flash. At this point the operator can set location 1-0-A to “171” to force a download from the Timing Saver Module. In this case, all timing should be verified since the checksum mismatch indicates that some data corruption has probably occurred.

Method 2

Set location 1-0-4 to “000.” This method can be used safely while the signal is in automatic. The program will Force Off all phases and peds, allowing Minimums (Walk, Flashing Don’t Walk, Minimum Green) to time out. When the intersection is all red, the 170 will output software flash, the Base Display will show “BADA,” and the WatchDog output will be disabled causing CMU hardware flash. At this point, the cabinet Maintenance Flash switch should be placed “ON”.

Placing the Front Panel Stop Time switch to “ON” will cause the 170 to attempt to reinitialize from the Timing Saver Module as in Method 1 above with one exception; a successful download will be indicated by a Long Power Down startup.

MEMORY MANAGEMENT

LACO-4 offers a variety of "memory management shortcuts" that fall into two categories; Memory erasure/initialization and Signal Timing saving/restoration. These functions are initiated from location 1-0-A. The different codes that can be entered at location 1-0-A and the resulting operations are as follows:

- 111 - **All user-entered data on RAM Page 01 is cleared**. All data entered on the Phase Timing and Configuration timing sheets will be set to zero (erased).
- 222 - **All user-entered data on RAM Page 02 is cleared**. All data entered on the Detector timing sheet will be set to zero (erased).
- 333 - **All user-entered data on RAM Page 03 is cleared**. All data entered on the Overlap and Preemption timing sheets will be set to zero (erased).
- 444 - **All user-entered data on RAM Page 04 is cleared**. All data entered on Zip Coordination and Coordination 1 timing sheets will be set to zero (erased).
- 555 - **All user-entered data on RAM Page 05 is cleared**. All data entered on the Coordination 2 timing sheet will be set to zero (erased).
- 666 - **All user-entered data on RAM Page 06 is cleared**. All data entered on the Coordination 3 timing sheet will be set to zero (erased).
- 777 - **All user-entered data on RAM Page 07 is cleared**. All data entered on the Coordination Attributes timing sheet will be set to zero (erased).
- 888 - **All user-entered data (except Coordination tables) is cleared**. Signal timing is reinitialized from EPROM defaults.
- 999 - **All Coordination tables are cleared**. Tables 6 and 7 are initialized to L.A. County defaults.
- 071 - **Copies all user-entered data to the 7000h NOVRAM**.
- 170 - **Restores signal timing that was saved to 7000h NOVRAM back to CPU RAM**. Assumes that the saved data checksum is valid. If checksum is not valid, display shows "BADD" (BAD Data). Use "171" (see below) to override the "BADD" result.
- 171 - **Overrides 7000h data checksum test and restores signal timing that was saved to 7000h NOVRAM back to CPU RAM**. USE WITH CAUTION! An invalid data checksum indicates possible corrupted data. Signal timing should be thoroughly checked after this option is invoked. The stored data must be from LACO4 timing for this operation to be successful.
- 123 - **Initializes signal timing from 7000h NOVRAM unconditionally**. USE WITH EXTREME CAUTION! Program module may contain timing from a non-LACO4 program!

TIMING COPYING

LACO-4 allows the user to copy both phase timing (from phase to phase) and coordination timing (from plan to plan). Both operations use the same two memory locations to initiate the data transfer. The Source phase/plan should be entered at CPYFRM (location 1-0-0) and the Destination phase/plan is entered at CPYTO (location 1-0-1). These are both decimal type data and the "E" key must be pressed after each entry. For phase copying, simply enter the Source and Destination phase numbers (1 through 8). For plan copying, enter the plan number preceded by a "1" for both the Source and Destination plan numbers (1 through 9). That is, Plan1 = 11, Plan2 = 12, etc. The program knows whether Zip Coord or Standard coordination is being used and copies the appropriate data automatically. Both Source and Destination locations must be valid and compatible. The program will not allow a phase to plan copy or vice versa. A successful copy is indicated by the Source or Destination location (whichever is set last) being reset to zero.

When the phase copy operation is invoked, all sixteen rows of the Source phase timing column are copied to the Destination phase timing column. When the plan copy operation is invoked, one of two sequences takes place depending on the type of coordination in effect.

1. For Zip Coord, all eleven rows of the Source plan column are copied to the Destination plan column.
2. For Standard Coordination, all sixteen rows of six columns of data are copied:
    - The Interval column of the Destination plan
    - The four Coordination Function Flag columns of the Destination plan
    - The Coordination Attributes column of the Destination plan

For most intersections, all of the even phase numbers have similar if not identical data and all of the odd phases as well. With this feature, one would first enter the timing for Phase 1, then set location 1-0-0 to "001". Next set location 1-0-1 to "003" and press "E". This will copy the phase 1 data to the phase 3 column. Then set location 1-0-1 to "005" followed by "E", and then "007" followed by "E" to copy the remaining odd phases. Repeat that process, first setting the phase 2 timing and then copying that data to phases 4, 6 and 8.

This feature is even more of a convenience when entering Standard coordination data since six columns worth of data must be entered for each plan. By first setting the plan with the most common data, the remaining plans (as many as 768 locations, 6 columns for each of 8 plans) can be populated quickly with approximate timing and then individual locations can be modified as needed.

APPENDICES

APPENDIX A. TIMING SHEETS

Timing Sheets

A1. Phase Timing
A2. Configuration
A3. Detectors
A4. Overlaps
A5. Preemption
A6. Zip Coordination
A7. Coordination 1
A8. Coordination 2
A9. Coordination 3
A10. Coordination Attributes
A11. Coordination Tables
A12. Programmable Logic

Information Sheets

A13. Programmable Logic Worksheet
A14. Setting The Real Time Clock
A15. Maintenance Information Sheet 1

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LACO-4 PHASE TIMING

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

Keystrokes: 1 + Phase + Interval		Phase							
Interval		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Walk	**0**								
Flashing Don't Walk	**1**								
Minimum Green	**2**								
Queue Maximum	**3**								
Added Green per Actuation	**4**								
Vehicle Extension	**5**								
Time Before Reduction	**6**								
Minimum Gap	**7**								
Max Green 1 (Free)	**8**								
Max Green 2 (Coordination)	**9**								
Max Added Green	**A**								
unused	**B**								
unused	**C**								
Time to Reduce	**D**								
Yellow Clearance	**E**								
Red Clearance	**F**								

TRUE NORTH	PHASE NORTH	1	2	3	4
		5	6	7	8

MISCELLANEOUS TIMERS		
Timer	**Location**	
Red Rest Delay Time	**106**	
Green Rest Delay Time	**107**	
Stuck All Red Fail Delay Time	**10E**	
Red Revert Time	**10F**	

NOTES:

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LACO-4 CONFIGURATION

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

PHASE FUNCTION FLAGS									
Keystrokes: 1 + F + row		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Permitted Phases	**0**								
Red Lock	**1**								
Red and Yellow Lock	**2**								
Minimum Vehicle Recall	**3**								
Maximum Vehicle Recall	**4**								
Rest In Green	**5**								
Rest In Red	**6**								
Barrier Recall	**7**								
Double Entry	**8**								
Exclusive Phases	**9**								
Restricted Phases	**A**								
Prot/Perm Left Turn	**B**								
Lag Phases (Free)	**C**								
First Phases (after startup)	**D**								
Yellow Startup Phases	**E**								
Yellow Startup Overlaps	**F**								

STREET CONFIGURATION FLAGS									
Keystrokes: 1 + E + row		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Main Street Phases	**0**								
Side Street Phases	**1**								
2 Ped Load Switch	**2**								
4 Ped Load Switch	**3**								
6 Ped Load Switch	**4**								
8 Ped Load Switch	**5**								
Ped A Load Switch	**6**								
Ped B Load Switch	**7**								
Ped Recall (Rest in Walk)	**8**								
STA Mode	**9**								
unused	**A**								
unused	**B**								
unused	**C**								
Driveway Flash	**D**								
2 Head Driveway Flash	**E**								
Overlap Driveway Flash	**F**								

MISCELLANEOUS FLAGS									
Keystrokes: 1 + D + row		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
unused	**0**								
Assoc. Phase Recall - 1	**1**								
Assoc. Phase Recall - 2	**2**								
Assoc. Phase Recall - 3	**3**								
Assoc. Phase Recall - 4	**4**								
Assoc. Phase Recall - 5	**5**								
Assoc. Phase Recall - 6	**6**								
Assoc. Phase Recall - 7	**7**								
Assoc. Phase Recall - 8	**8**								
Yellow Calling Phases	**9**								
Yellow Phases Called	**A**								
User Flags	**B**								
Green Offset Sync Pulse	**C**								
Yellow Offset Sync Pulse	**D**								
Yellow Ranging Phase	**E**								
Yellow Ranging Overlap	**F**								

COMMUNICATIONS OPTIONS		
System ID	**190**	
Comm Port 1	**191**	
Comm Port 2	**192**	
Comm Port 3	**193**	
Comm Port 4	**194**	

System ID = 1 to 255
Comm Port Options
1 - WWV
2 - Transmit 7 Wire
3 - Receive 7 Wire
4 - Transmit Time/Date
5 - Receive Time/Date
6 - Transmit Plan
7 - Transmit AB3418 (Time/Date)
8 - Receive AB3418

MANUAL CONTROL CONFIGURATION									
Option	**Location**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Omit Phases	**3C1**								
Lag Phases	**3C2**								
Recall Type	**309**								

Recall Type Options (309)
00 = Manual Control Disabled
01 = Fully Actuated
02 = Vehicle Recall Only
03 = Ped and Vehicle Recall

User Flag Options (1DB)
1. Enable Mid-Block Ped Crossing logic
2. Modify Main Street Phases (1E0)
3. Delay RR/EV Clearance until all overlaps finish terminating
4. Modified Barrier Crossing (Ignore True Max)
5. Disable Daylight Savings Time Update
6. Disable Ped Recycle logic for STA Mode and Ped Recall phases
7. Enable Freeway Off-Ramp Anti-Backup logic
8. Ignore Stuck-All-Red Failure

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LACO-4 DETECTORS

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

App	Lanes	Description	File/ Slot/ Channel	Delay Code	Delay Seconds	Extended Call Code	Extended Call Seconds	Phase Flags Code	1	2	3	4	5	6	7	8	Attribute Flags Code	1	2	3	4	5	6	7	8
				210		230		2B0	■								2D0								
				211		231		2B1		■							2D1								
				212		232		2B2		■							2D2								
				213		233		2B3		■							2D3								
				214		234		2B4		■							2D4								
				215		235		2B5		■							2D5								
				216		236		2B6			■						2D6								
				217		237		2B7				■					2D7								
				218		238		2B8				■					2D8								
				219		239		2B9				■					2D9								
				21A		23A		2BA				■					2DA								
				21B		23B		2BB				■					2DB								
				21C		23C		2BC	■								2DC								
				21D		23D		2BD			■						2DD								
				220		240		2C0					■				2E0								
				221		241		2C1						■			2E1								
				222		242		2C2						■			2E2								
				223		243		2C3						■			2E3								
				224		244		2C4						■			2E4								
				225		245		2C5						■			2E5								
				226		246		2C6							■		2E6								
				227		247		2C7								■	2E7								
				228		248		2C8								■	2E8								
				229		249		2C9								■	2E9								
				22A		24A		2CA								■	2EA								
				22B		24B		2CB								■	2EB								
				22C		24C		2CC					■				2EC								
				22D		24D		2CD							■		2ED								

REMARKS:

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

Note: Shaded Phase Flags call by default

SPECIAL DETECTOR DELAY ASSIGNMENTS		Phase 1	2	3	4	5	6	7	8
All Options: Delay Timer resets during detector phase yellow.	Code								
Special Delay Option 1 (Attribute Bit 7) - Bypasses delay while flagged phases are timing.	2F8								
Special Delay Option 2 (Attribute Bit 8) - Bypasses delay while flagged phases are timing.	2F9								

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LACO-4

OVERLAPS

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

OVERLAP A

Keystrokes: 3 + row + A		1	2	3	4	5	6	7	8
NORMAL PARENTS	A								
GREEN OMIT PARENTS	B								
RR PREEMPT PARENTS	C								
EV PREEMPT PARENTS	D								
LOAD SWITCH ASSIGNMENT	0								
DELAY TIME	1								
GREEN EXTENSION TIME	2								
YELLOW CLEARANCE TIME	3								
RED CLEARANCE TIME	4								

OVERLAP B

Keystrokes: 3 + row + B		1	2	3	4	5	6	7	8
NORMAL PARENTS	A								
GREEN OMIT PARENTS	B								
RR PREEMPT PARENTS	C								
EV PREEMPT PARENTS	D								
LOAD SWITCH ASSIGNMENT	0								
DELAY TIME	1								
GREEN EXTENSION TIME	2								
YELLOW CLEARANCE TIME	3								
RED CLEARANCE TIME	4								

OVERLAP C

Keystrokes: 3 + row + C		1	2	3	4	5	6	7	8
NORMAL PARENTS	A								
GREEN OMIT PARENTS	B								
RR PREEMPT PARENTS	C								
EV PREEMPT PARENTS	D								
LOAD SWITCH ASSIGNMENT	0								
DELAY TIME	1								
GREEN EXTENSION TIME	2								
YELLOW CLEARANCE TIME	3								
RED CLEARANCE TIME	4								

OVERLAP D

Keystrokes: 3 + row + D		1	2	3	4	5	6	7	8
NORMAL PARENTS	A								
GREEN OMIT PARENTS	B								
RR PREEMPT PARENTS	C								
EV PREEMPT PARENTS	D								
LOAD SWITCH ASSIGNMENT	0								
DELAY TIME	1								
GREEN EXTENSION TIME	2								
YELLOW CLEARANCE TIME	3								
RED CLEARANCE TIME	4								

OVERLAP E

Keystrokes: 3 + row + E		1	2	3	4	5	6	7	8
NORMAL PARENTS	A								
GREEN OMIT PARENTS	B								
RR PREEMPT PARENTS	C								
EV PREEMPT PARENTS	D								
LOAD SWITCH ASSIGNMENT	0								
DELAY TIME	1								
GREEN EXTENSION TIME	2								
YELLOW CLEARANCE TIME	3								
RED CLEARANCE TIME	4								

OVERLAP F

Keystrokes: 3 + row + F		1	2	3	4	5	6	7	8
NORMAL PARENTS	A								
GREEN OMIT PARENTS	B								
RR PREEMPT PARENTS	C								
EV PREEMPT PARENTS	D								
LOAD SWITCH ASSIGNMENT	0								
DELAY TIME	1								
GREEN EXTENSION TIME	2								
YELLOW CLEARANCE TIME	3								
RED CLEARANCE TIME	4								

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

LACO-4 PREEMPTION

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

RAILROAD CONFIGURATION		
RAILROAD SELECT (1, 2 or 3)	360	
ALL RED TIME AFTER RAILROAD FLASH	361	
RAILROAD CLEARANCE TIME	362	
LIMITED SERVICE MAX TIME	363	
RAILROAD LINK TO EV (see note to right)	364	
FREE TIME AFTER PREEMPT	365	
FREE TIME AFTER PREEMPT, TIMER	366	
MAX TIMER, MINUTES	367	
MAX TIMER, SECONDS	368	

RAILROAD PHASES		1	2	3	4	5	6	7	8
TRACK CLEARANCE	3A0								
RAILROAD EXIT	3A1								
RAILROAD PED ONLY	3A2								
LIMITED SERVICE	3A3								

Observation Only

EV CONFIGURATION		1	2	3	4	5	6	7	8
EV FLAGS	390								
EV A CLEARANCE PHASES	391								
EV B CLEARANCE PHASES	392								
EV C CLEARANCE PHASES	393								
EV D CLEARANCE PHASES	394								

EV FLAGS
1. EV A times All-Red Clearance
2. EV B times All-Red Clearance
3. EV C times All-Red Clearance
4. EV D times All-Red Clearance
5. EV A truncates Ped Flashing Don't Walk
6. EV B truncates Ped Flashing Don't Walk
7. EV C truncates Ped Flashing Don't Walk
8. EV D truncates Ped Flashing Don't Walk

EV A SETUP		
DELAY	310	
ACTIVE	311	
CLEARANCE	312	
MAXIMUM	313	
LINK TO EV	314	
MINIMUM	315	

EV B SETUP		
DELAY	320	
ACTIVE	321	
CLEARANCE	322	
MAXIMUM	323	
LINK TO EV	324	
MINIMUM	325	

EV SETUP NOTES
1. The length of time before the controller responds to EV Input. HOLD, CALL, ALLOW and Coordination functions are not affected during this time.
2. The length of time that HOLD and CALL are set. Coordination functions are suspended during this time.
3. The length of Green Clearance time. HOLD, CALL and FORCE OFF are set by preemption logic during this time.
4. The maximum time (in seconds) that the preempt will remain in control of the intersection.
5. Causes the selected EV to time after the current EV times out.
6. Minimum time (in seconds) allowed from the end of one EV until the start of another.

EV C SETUP		
DELAY	330	
ACTIVE	331	
CLEARANCE	332	
MAXIMUM	333	
LINK TO EV	334	
MINIMUM	335	

EV D SETUP		
DELAY	340	
ACTIVE	341	
CLEARANCE	342	
MAXIMUM	343	
LINK TO EV	344	
MINIMUM	345	

AUX 3 YELLOW OUTPUT CONTROL (Keypress 3+C+0)		
	1	Railroad A
	2	Railroad B
	3	Emergency Vehicle A
	4	Emergency Vehicle B
	5	Emergency Vehicle C
	6	Emergency Vehicle D
	7	Manual Control
	8	unused

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

LACO-4

ZIP COORDINATION

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

Offset Timing Plan	7-A-A	

Midnight Sync Pulse					
7-A-B	Hour		7-A-C	Min	

** ZIP Coord Enable	7-A-D	

** Set to "000" to **disable** Zip Coordination

OFFSET TIMES

PLAN	Location	Offset
1	7-A-1	
2	7-A-2	
3	7-A-3	
4	7-A-4	
5	7-A-5	
6	7-A-6	
7	7-A-7	
8	7-A-8	
9	7-A-9	

Keypress: 4 + Plan # + Parameter

	Parameters		Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Plan 6	Plan 7	Plan 8	Plan 9
0			1	2	3	4	5	6	7	8	9
System Manual	Cycle Length	0									
Local Manual	Force Off Ø 1	1									
Master Plan	Force Off Ø 2	2									
Local Plan	Force Off Ø 3	3									
TMC Override	Force Off Ø 4	4									
Time of Day Plan	Force Off Ø 5	5									
Special Function	Force Off Ø 6	6									
Current Table	Force Off Ø 7	7									
Min Cycle Length	Force Off Ø 8	8									
Max Cycle Length	Hold Release	9									
Master Cycle Timer											
Local Cycle Timer											
New Offset											
Current Offset											
Last Master Cycle											
Last Local Cycle											

NOTES:

OBSERVATION ONLY

LOS ANGELES COUNTY
DEPARTMENT OF PUBLIC WORKS
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TRAFFIC SIGNAL TIMING

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COORDINATION 1

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

KEYPRESS: 4 + col + row

TIME OF DAY OPERATION SUMMARY					
PLAN 1		PLAN 4		PLAN 7	
PLAN 2		PLAN 5		PLAN 8	
PLAN 3		PLAN 6		PLAN 9	
FREE					

OFFSET TIMES

PLAN	Location	Offset
1	7-A-1	
2	7-A-2	
3	7-A-3	
4	7-A-4	
5	7-A-5	
6	7-A-6	
7	7-A-7	
8	7-A-8	
9	7-A-9	

NOTES

Current Offset	7-A-0	

Offset Timing Plan	7-A-A	

Midnight Sync Pulse					
7-A-B	Hour		7-A-C	Min	

OBSERVATION ONLY

COORDINATION PARAMETERS		INTERVALS (in seconds)			COORDINATION FUNCTION FLAGS											
					PLAN 1				PLAN 2				PLAN 3			
		Plan 1	Plan 2	Plan 3	Force Off	Hold	Ped Restrict	Call	Force Off	Hold	Ped Restrict	Call	Force Off	Hold	Ped Restrict	Call
0		1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
System Manual	0															
Local Manual	1															
Master Plan	2															
Local Plan	3															
TMC Override	4															
Time Of Day Plan	5															
Special Function	6															
Current Table	7															
Minimum Cycle Length	8															
Maximum Cycle Length	9															
Master Cycle Timer	A															
Local Cycle Timer	B															
New Offset Time	C															
Current Offset Time	D															
Last Master Cycle	E															
Last Local Cycle	F															

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TRAFFIC SIGNAL TIMING

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COORDINATION 2

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

KEYPRESS: 5 + col + row

	INTERVALS (in seconds)														
	Plan 4	Plan 5	Plan 6	Force Off	Hold	Ped Restrict	Call	Force Off	Hold	Ped Restrict	Call	Force Off	Hold	Ped Restrict	Call
	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0															
1															
2															
3															
4															
5															
6															
7															
8															
9															
A															
B															
C															
D															
E															
F															

LOS ANGELES COUNTY
DEPARTMENT OF PUBLIC WORKS
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TRAFFIC SIGNAL TIMING

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COORDINATION 3

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

KEYPRESS: 6 + col + row

	INTERVALS (in seconds)			COORDINATION FUNCTION FLAGS											
				PLAN 7				PLAN 8				PLAN 9			
	Plan 7	Plan 8	Plan 9	Force Off	Hold	Ped Restrict	Call	Force Off	Hold	Ped Restrict	Call	Force Off	Hold	Ped Restrict	Call
	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0															
1															
2															
3															
4															
5															
6															
7															
8															
9															
A															
B															
C															
D															
E															
F															

LOS ANGELES COUNTY
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TRAFFIC SIGNAL TIMING

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COORDINATION ATTRIBUTES

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

KEYPRESS: 7 + Plan Number + Attribute

COORDINATION PHASE ATTRIBUTES (Plans 1 through 9)

Attributes		PLAN 1								PLAN 2								PLAN 3							
		1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Coordination Lag Phases	0																								
Minimum Vehicle Recall Phases	1																								
Pedestrian Recall Phases	2																								
Maximum Vehicle Recall Phases	3																								
Barrier Recall Phases	4																								
Green Calling Phases	5																								
Green Call-To Phases	6																								
	7																								
Phases to use Max 1	8																								
Red Rest Phases	9																								
Omitted Phases	A																								
Phases to Omit Systems Detectors	B																								
STA Mode Phases	C																								
	D																								
	E																								
	F																								

Attributes		PLAN 4								PLAN 5								PLAN 6							
		1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Coordination Lag Phases	0																								
Minimum Vehicle Recall Phases	1																								
Pedestrian Recall Phases	2																								
Maximum Vehicle Recall Phases	3																								
Barrier Recall Phases	4																								
Green Calling Phases	5																								
Green Call-To Phases	6																								
	7																								
Phases to use Max 1	8																								
Red Rest Phases	9																								
Omitted Phases	A																								
Phases to Omit Systems Detectors	B																								
STA Mode Phases	C																								
	D																								
	E																								
	F																								

Attributes		PLAN 7								PLAN 8								PLAN 9							
		1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Coordination Lag Phases	0																								
Minimum Vehicle Recall Phases	1																								
Pedestrian Recall Phases	2																								
Maximum Vehicle Recall Phases	3																								
Barrier Recall Phases	4																								
Green Calling Phases	5																								
Green Call-To Phases	6																								
	7																								
Phases to use Max 1	8																								
Red Rest Phases	9																								
Omitted Phases	A																								
Phases to Omit Systems Detectors	B																								
STA Mode Phases	C																								
	D																								
	E																								
	F																								

LOS ANGELES COUNTY
DEPARTMENT OF PUBLIC WORKS
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TRAFFIC SIGNAL TIMING

LACO-4

COORDINATION TABLES

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

KEYPRESS: 9 + Table Number to access Event 0, then A or D to move up or down the table

TABLE 0 - Time Of Day

Event	Hour:Min	Plan or Function	Sun 1	Mon 2	Tue 3	Wed 4	Thu 5	Fri 6	Sat 7
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
A									
B									
C									
D									
E									
F									

TABLE 1 - Time Of Day

Event	Hour:Min	Plan or Function	Sun 1	Mon 2	Tue 3	Wed 4	Thu 5	Fri 6	Sat 7
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
A									
B									
C									
D									
E									
F									

TABLE 2 - Time Of Day

Event	Hour:Min	Plan or Function	Sun 1	Mon 2	Tue 3	Wed 4	Thu 5	Fri 6	Sat 7
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
A									
B									
C									
D									
E									
F									

TABLE 3 - Time Of Day

Event	Hour:Min	Plan or Function	Sun 1	Mon 2	Tue 3	Wed 4	Thu 5	Fri 6	Sat 7
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
A									
B									
C									
D									
E									
F									

TABLE 4 - Time Of Day

Event	Hour:Min	Plan or Function	Sun 1	Mon 2	Tue 3	Wed 4	Thu 5	Fri 6	Sat 7
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
A									
B									
C									
D									
E									
F									

Plan = Plan Number 1 through 9

Function:

- A = Specl Func Output – ON Steady
- B = Specl Func Output – ON Flashing
- C = Offset Timing Mode
- D = Specl Func Output - OFF
- E = Free
- F = Time of Day Flash

Floating Holiday Table:
"Day" refers to the nth occurrence of the DOW flagged. For example, 01/03 indicates the 3rd occurrence of the flagged DOW in January. "0" or greater than "5" is treated as the last occurrence.

TABLE 5 - Floating Holidays

Event	Month/Day	Table	Sun 1	Mon 2	Tue 3	Wed 4	Thu 5	Fri 6	Sat 7
0	01/03	1		X					
1	02/03	1		X					
2	05/09	1		X					
3	09/01	1		X					
4	11/04	1					X		
5									
6									
7									
8									
9									
A									
B									
C									
D									
E									
F									

TABLE 6 - Exception Days

Event	Month/Day	Table	Sun 1	Mon 2	Tue 3	Wed 4	Thu 5	Fri 6	Sat 7
0	01/01	1		X	X	X	X	X	
1	01/02	1		X					
2	07/04	1		X	X	X	X	X	
3	07/05	1		X					
4	11/10	1						X	
5	11/11	1		X	X	X	X	X	
6	11/12	1		X					
7	12/24	1		X	X	X	X	X	
8	12/25	1		X	X	X	X	X	
9	12/26	1		X				X	
A									
B									
C									
D									
E									
F									

TABLE 7 - Annual Events

Event	Month/Day	Table	Sun 1	Mon 2	Tue 3	Wed 4	Thu 5	Fri 6	Sat 7
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
A									
B									
C									
D									
E									
F									

LOS ANGELES COUNTY
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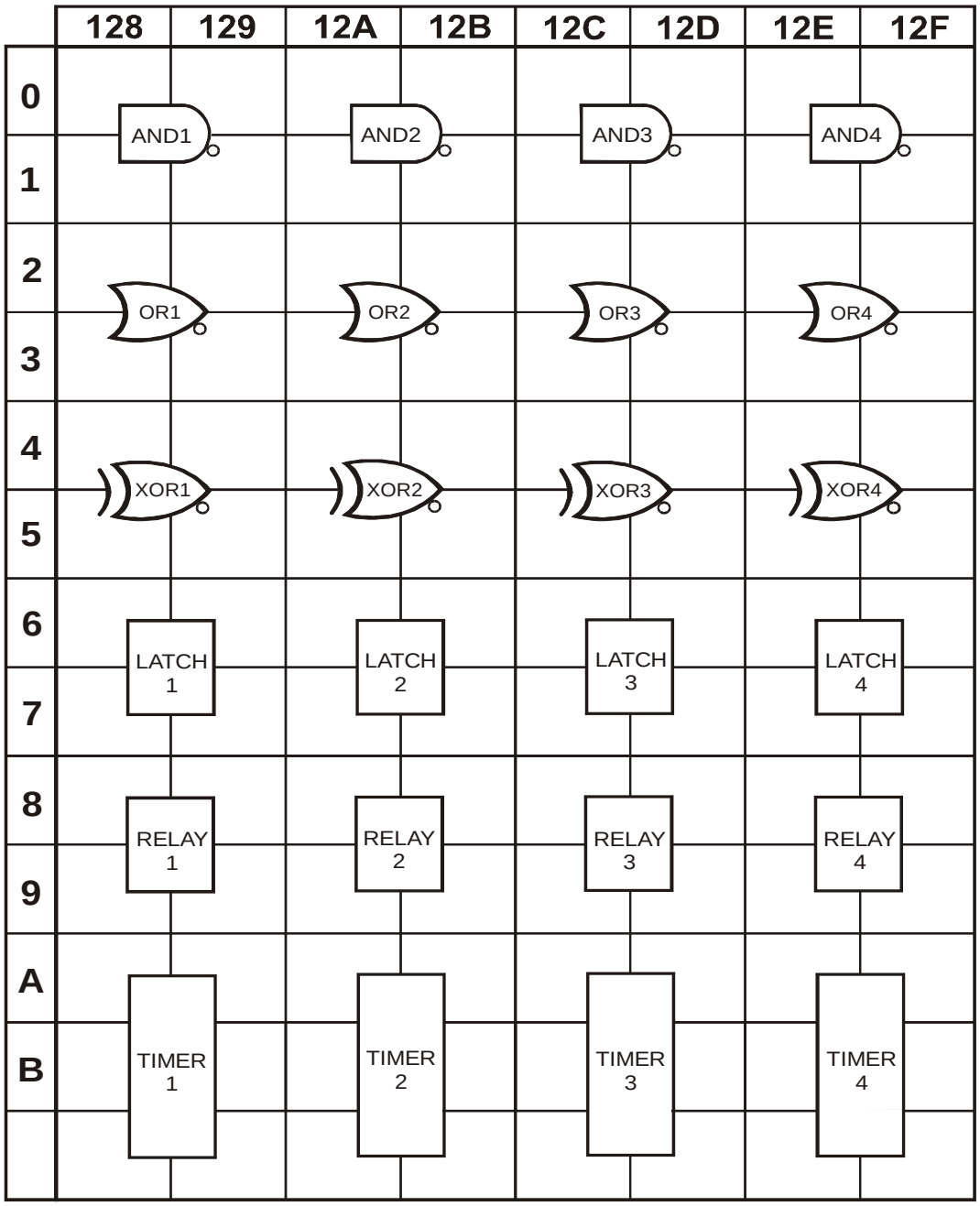
TRAFFIC SIGNAL TIMING

LACO-4

PROGRAMMABLE LOGIC

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

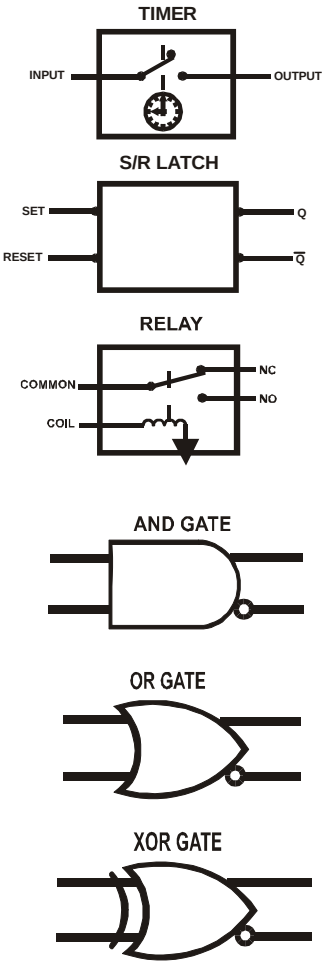
KEYPRESS: 8 + column + row



NOTES:

LACO-4

PROGRAMMABLE LOGIC WORKSHEET



332 INPUT FILE

I1 22	I2U 01	I3U 35	I4 11	I5 24	I6U 03	I7U 37	I8 13	I9U 26		I11U 56	I12U 41	I13U 42	I14U 57
	I2L 05	I3L 52			I6L 07	I7L 54		I9L 28		I11L 17	I12L 43	I13L 44	I14L 58
J1 21	J2U 02	J3U 36	J4 12	J5 23	J6U 04	J7U 38	J8 14	J9U 25		J11U 18	J12U 45	JI3U 47	J14U 15
	J2L 06	J3L 53			J6L 08	J7L 55		J9L 31		J11L 51	J12L 46	JI3L 48	JI4L 16

336 INPUT FILE

I1 22	I2U 01	I5 24	I6U 03	J1 21	J2U 02	J5 23	J6U 04	J14U 15	J12U 45	JI3U 47	I12U 41	I13U 42	I14U 57
I4 11	I2L 05	I8 13	I6L 07	J4 12	J2L 06	J8 14	J6L 08	J14L 16	J12L 46	JI3L 48	I12L 43	I13L 44	I14L 58

332/336 OUTPUT FILE

Ø1		Ø2		Ø2 PED		Ø3		Ø4		Ø4 PED	
116	R	113	R	111	R	106	R	103	R	101	R
117	Y	114	Y	141	Y	107	Y	104	Y	143	Y
118	G	115	G	112	G	108	G	105	G	102	G
Ø5		**Ø6**		**Ø6 PED**		**Ø7**		**Ø8**		**Ø8 PED**	
136	R	133	R	131	R	126	R	123	R	121	R
137	Y	134	Y	142	Y	127	Y	124	Y	144	Y
138	G	135	G	132	G	128	G	126	G	122	G

AUX FILE

AUX1		AUX2		AUX3		AUX4		AUX5		AUX6	
166	R	163	R	161	R	156	R	153	R	151	R
167	Y	164	Y	146	Y	157	Y	154	Y	145	Y
168	G	165	G	162	G	158	G	155	G	152	G

337 INPUT FILE

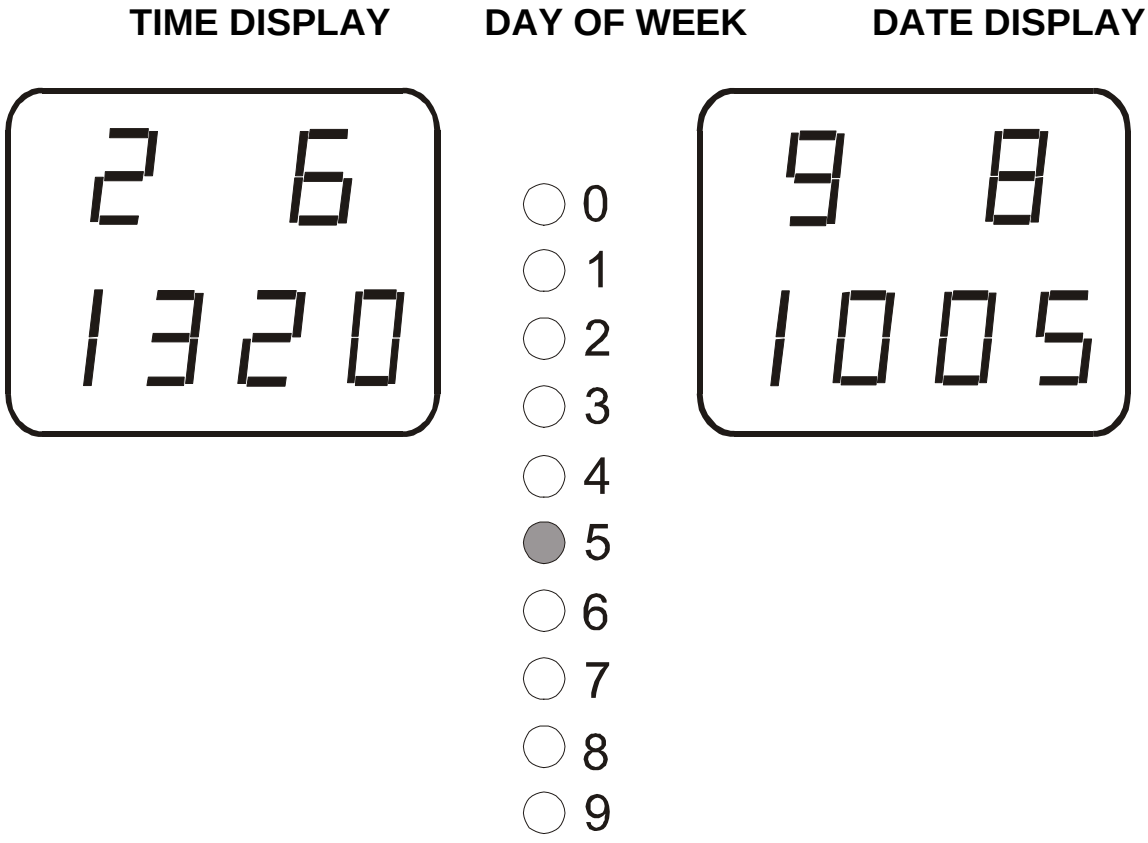
I2U 01	I3U 35	I6U 03	I7U 37	J2U 02	J3U 36	I12U 41	I13U 42	I14U 57	I11U 56	J11U 18
I2L 05	I4 11	I6L 07	I8 13	J2L 06	J4 12	I12L 43	I13L 44	J14U 15	I11L 17	J11L 51

337 OUTPUT FILE

ØA1		Ø2		Ø4		Ø6		Ø2PED		Ø4 PED	
166	R	113	R	103	R	133	R	111	R	101	R
167	Y	114	Y	104	Y	134	Y	131	Y	132	Y
168	G	115	G	105	G	135	G	112	G	102	G

LACO-4

SETTING THE REAL TIME CLOCK



The LACO-4 Clock Display mode consists of two displays, Time and Date. To enter the Clock Display mode, from the Base Display, press “C or “A-C” to bring up the Time display. To show the Date display, from the Base Display, press “A-D”. Pressing “A” or “D” from either display will toggle to the other display.

To set the time and date first access the Time display. If a WWV Clock is installed and configured, pressing the “E” key will cause the 170 to repoll the WWV Clock and update the time and date automatically.

The example above shows, from left to right, the Time display, Day of Week call lights (which is the same for both displays so is only shown once) and Date display. To manually set this time, first access the Time display and enter the time, 13:20.26, in HH/MM/SS format. Press “E” to save then press any number from 1 through 7 (for Sunday through Saturday) to set the Day of Week in the call lights (this also sets the Day of Week in the Date display).

Pressing “A” or “D” from here causes the Date display to appear (pressing any other key returns to the Base display). Enter the date, October 5, 1998, in MM/DD/YY format. Press “E” to save. The Day of Week can be modified or set here, as in the Time display. Press any key other than “A” or “D” to return to the Base display from here.

APPENDIX B. FEEDBACK REPORTS

B1. LACO-4 User Comment Form

B2. LACO-4 Trouble Report Form

LACO-4 User Comment Form

User Information

Organization: _____ Name _____
Phone _____ Fax _____
Email _____
Do you wish to be contacted by a Los Angeles County representative regarding this feedback?
(Yes) (No) (Optional)

Equipment Information

LACO-4 Version _____
Controller Manufacturer and Model _____
Cabinet Type: _____
Conflict Monitor: _____ Modem: _____
Other: _____

Comments

Please circle one: (Problem Report) (Feature Request) (General Comment)
Place comments below. Attach additional pages or information as needed:

_____

_____

_____

_____

_____

_____

_____

_____

_____

Please mail or fax this form to the Los Angeles County DPW office listed below. Thank you.

LACO-4 Trouble Report Form

Agency _____ Reporting Person _____
Phone _____ Date/Time _____
Trouble Location _____
Trouble Description _____

_____

_____

LACO-4 Version: _____

Controller Manufacturer/Model _____ Cabinet Type:

Date and Time Problem was reported _____

Estimated time of problem occurrence _____

Are LED's on load switches illuminated normally? (Yes) (No)

Has the conflict monitor tripped? (Yes) (No)
If Yes:
What is the failure indication? _____
What are the channel indications? _____

What does the controller front panel display show ?
Does the controller respond to the keypad key entries? (Yes) (No)
If Yes, what does the Ring A display show?
If Yes, what does the Ring B display show?
Is the phase timing status still being updated on any of the displays? (Yes) (No)

Is the controller connected to central systems communications? (Yes) (No)
If Yes:
Do lights on controller modem appear to be acting normally? (Yes) (No)
If No(modem does not look normal):
What looks abnormal? _____

Please fax this form to (626) Your Fax Number as soon as possible. Attach additional pages as needed for other information or comments. You may also wish to telephone or page a Los Angeles County DPW representative to report this event. Thank you.

TERMS

∅ - 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 between 200 and 300 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.
BADA - An indication on the Function display that shows during reinitialization 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.
BADD - An indication that invalid data was detected prior to a download of data from the Timing Saver Module (7000h NOVRAM) and CPU RAM.
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.
Call - see Demand
Call/Active light - One of eleven red LED's 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 – In EV preempt, those phases that must serve in order to permit the emergency vehicle to pass through an intersection as quickly as possible.
Concurrent phases - Phases that may safely time together.
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 street lane.
Detection - The sensed presence of a vehicle or the equipment assigned to this task.

Detector (amplifier) - 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
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 that 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. a phase that 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.
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 LED’s 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.
Fully Traffic Actuated (FTA) - Referring to an intersection that operates off of vehicle and ped detectors (ped pushbuttons). As opposed to Semi-Traffic Actuated (STA).
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 the Green interval from an overlap 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.
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 that extends or "holds" the through phase.
Holiday Table - A list of special days that 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-4.
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 (or meeting) 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 that 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 - 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 push-button 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 - The main Coordination timer, which all other Coordination functions are slaved to.
Max - Maximum

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).
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.
Minimums - The portion of the Green interval made up of Walk, Flashing Don't Walk, Minimum Green and Variable Initial Green.
ML2 forma t- 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.
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) - A mechanism whereby ped calls are generated internally every phase sequence cycle.
Ped Restrict - A coordination function which stores a Ped call but delays its service until the end of Ped Restriction.
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 that 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 cycle lengths and 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 that 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 semipermanent memory devices including EPROM's.
PROM module - An electronic memory module which plugs into 170 controller. It can accept NOVRAM and EPROM chips that are used in some cases to store, upload and download programs and data.
Quadrant - A Lead/Lag pair of vehicle Phases (including associated Ped Phases) comprising one quarter of a standard dual Ring 8-Phase Phase diagram. That is, 01, 02 and 2Ped are in the same quadrant, 05, 06 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 that 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 A (RRA) - A special railroad preempt routine which, following Track Clearance, results in a Red Flash condition until the preempt ends.
Railroad B (RRB) - 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 Clearance - A clearance interval, that follows the Yellow interval and prevents the next right-of-way Phase from going Green.
Red Revert - A Red interval timed by individual Vehicle Phases or Overlaps when they are set to go Green again immediately after terminating.
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
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.
RRA - see Railroad A
RRB - see Railroad B
RRB 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
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 phase1 and phase 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.
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 elapsed time 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.
Track Clearance - The portion of RR Preempt that ensures clearance of traffic from the RR tracks before the train reaches the intersection.
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 Institute of Standards and Technology. 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 Ranging - A flag that 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.

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
FTA - Fully Traffic Actuated
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

APPENDIX D. TIMING SHEET CONVERSIONS

D1. LACO-1R to **LACO-4**

D2. LACO-3 to **LACO-4**

LACO-1R to LACO-4			
Page	**LACO-1R**	**Page**	**LACO-4**
1	**Phase Timing**	1	**Phase Timing**
1	Minimum Walk	1	Walk
1	Flashing Don't Walk	1	Flashing Don't Walk
1	Minimum Green	1	Minimum Green
1	Queue Maximum	1	Queue Maximum
1	Added Green/Actuation	1	Added Green per Actuation
1	Vehicle Extension	1	Vehicle Extension
1	Maximum Gap	1	See Note at end of Appendix D2
1	Minimum Gap	1	Minimum Gap
1	Max Extension 1 (Free)	1	Max Green 1 (Free)
1	Max Extension 2 (Coord)	1	Max Green 2 (Coordination)
1	Offset 1/Dial 1	6	Plan 1 Offset
1	Offset 1/Dial 2	6	Plan 2 Offset
1	Offset 1/Dial 3	6	Plan 3 Offset
1	Offset 2/Dial 1	6	Plan 4 Offset
1	Offset 2/Dial 2	6	Plan 5 Offset
1	Offset 2/Dial 3	6	Plan 6 Offset
1	Offset 3/Dial 1	6	Plan 7 Offset
1	Offset 3/Dial 2	6	Plan 8 Offset
1	Offset 3/Dial 3	6	Plan 9 Offset
1	Reduce 0.1 Sec. Every…	1	See Note at end of Appendix D2
1	Yellow	1	Yellow Clearance
1	Red Clearance	1	Red Clearance
1	Max Added Green (for all phases)	1	Max Added Green (per phase)
1	Red Revert	1	Red Revert
1	Preemption	5	Preemption
1	RR Select (0, 1, 2)	5	Railroad Select (0, 1, 2, or 3)
1	Track Clearance	5	Track Clearance
1	RR Red	5	All Red Time After Railroad Flash
1	RR2 Maximum (Minutes)	5	Limited Service Max Time
1	EV-A Delay	5	EV-A Delay
1	EV-A Clearance	5	EV-A Clearance
1	EV-B Delay	5	EV-B Delay
1	EV-B Clearance	5	EV-B Clearance
1	EV-C Delay	5	EV-C Delay
1	EV-C Clearance	5	EV-C Clearance
1	EV-D Delay	5	EV-D Delay

LACO-1R to LACO-4			
1	EV-D Clearance	5	EV-D Clearance
1	EV Maximum (Seconds) (for all EV's)	5	Maximum (per EV)
1	**Phase Function Flags**	2	**Configuration**
1	Phases Permitted	2	Permitted Phases (Phase Function Flags)
1	Red Lock	2	Red Lock (Phase Function Flags)
1	Red & Yellow Lock	2	Red and Yellow Lock (Phase Function Flags)
1	Minimum Vehicle Recall	2	Minimum Vehicle Recall (Phase Function Flags)
1	Ped Recall/Rest In Walk	2	Ped Recall (Street Configuration Flags)
1	Pedestrian Phases	2	Ped 2/4/6/8/A/B Load Switch (Street Configuration Flags)
1	Rest In Red	2	Rest In Red (Phase Function Flags)
1	Semi Traffic Actuated Mode	2	STA Mode (Street Configuration Flags)
1	Double Entry	2	Double Entry (Phase Function Flags)
1	Maximum Vehicle Recall	2	Maximum Vehicle Recall (Phase Function Flags)
1	Overlap A	4	Overlap A Parents (Normal, RR, EV)
1	Overlap B	4	Overlap B Parents (Normal, RR, EV)
1	Barrier Recall	2	Barrier Recall (Phase Function Flags)
1	Rest In Green	2	Rest In Green (Phase Function Flags)
1	Yellow Start Up	2	Yellow Startup Phases (Phase Function Flags)
1	Protected/Permissive Left Turn	2	Prot/Perm Left Turn (Phase Function Flags)
1	Lag Phase Flags		
1	Lag Free	2	Lag Phases (Free) (Phase Function Flags)
1	" "	2	Lag Phases (Manual Control Configuration)
1	Lag Dial 1	10	Lagging Phases – Coordination Attributes (Plans 1/2/3)
1	Lag Dial 2	10	Lagging Phases – Coordination Attributes (Plans 4/5/6)
1	Lag Dial 3	10	Lagging Phases – Coordination Attributes (Plans 7/8/9)
2	**Detector Assignments**	3	**Detector Assignments**
2	Delay	3	Delay
2	Extended Call	3	Extended Call
2	Call (for **programmable** detectors)	3	Phase Flags (for **all** detectors)
2	Yellow Disconnect (for **programmable** detectors)	3	Attribute Flags (for **all** detectors)
2	Queue Clearing (for **programmable** detectors)	3	Attribute Flags (for **all** detectors)
3	WWV Time-Based Coordination	6	Coordination 1/2/3
3	Interconnect Select	2	Communications Options **(Configuration)**
3	Set Maximum Width		NO EQUIVALENT
3	Set Minimum Width		*NO EQUIVALENT*
3	System Manual	6	System Manual
3	Local Manual	6	Local Manual
3	Function 6		NO EQUIVALENT

LACO-1R to LACO-4			
3	Minimum Cycle	6	Minimum Cycle Length
3	Maximum Cycle	6	Maximum Cycle Length
3	Dial 1 Intervals	6	Plan 1/2/3 Intervals
3	Dial 2 Intervals	6	Plan 4/5/6 Intervals
3	Dial 3 Intervals	6	Plan 7/8/9 Intervals
3	WWV Time-Based Coordination	6	Coordination Function Flags
3	Dial 1 Force Off	6	Plan 1/2/3 Force Off
3	Dial 1 Hold	6	Plan 1/2/3 Hold
3	Dial 1 Ped Rstrict	6	Plan 1/2/3 Ped Restrict
3	Dial 1 Call	6	Plan 1/2/3 Call
3	Dial 2 Force Off	6	Plan 4/5/6 Force Off
3	Dial 2 Hold	6	Plan 4/5/6 Hold
3	Dial 2 Ped Rstrict	6	Plan 4/5/6 Ped Restrict
3	Dial 2 Call	6	Plan 4/5/6 Call
3	Dial 3 Force Off	6	Plan 7/8/9 Force Off
3	Dial 3 Hold	6	Plan 7/8/9 Hold
3	Dial 3 Ped Rstrict	6	Plan 7/8/9 Ped Restrict
3	Dial 3 Call	6	Plan 7/8/9 Call
4	**Setting Event Table 9 Data**		NO EQUIVALENT
5	**WWV Time-Base Event Tables**	11	**Coordination Tables**
5	Table 0 – Default TOD	11	Table 0 – Default TOD
5	Table 1 – (TOD)	11	Table 1 – (TOD)
5	Table 2 – (TOD)	11	Table 2 – (TOD)
5	Table 3 – (TOD)	11	Table 3 – (TOD)
5	Table 4 – Floating Holidays	11	Table 5 – Floating Holidays
5	Table 5 – Annual Events		NO EQUIVALENT
5	Table 6 – Annual Events		*NO EQUIVALENT*
5	Table 7 – Annual Events	11	Table 7 – Annual Events
6	**WWV Time-Base Annual Tables**		
6	Table 8 – Exception Days	11	Table 6 – Exception Days
6	Table 9 – Exception Times		NO EQUIVALENT
6	Special Function Table	10	**Coordination Attributes**
6	(Green) Calling Phases	2	Green Calling Phases
6	(Green) Calling To Phases	2	Green Calling-To Phases
6	(Yellow) Calling Phases	2	NO EQUIVALENT
6	(Yellow) Calling To Phases	2	*NO EQUIVALENT*
6	Auxiliary Ovlp A Output	4	Load Switch Assignment
6	Mid-Block Ped Crossing	2	

LACO-1R to LACO-4			
6	Driveway Flash	2	
6	Green Extension		NO EQUIVALENT
6	Sequential Ped	2	
6	EV-A Clearance Phases	5	EV-A Clearance Phases
6	EV-B Clearance Phases	5	EV-B Clearance Phases
6	EV-C Clearance Phases	5	EV-C Clearance Phases
6	EV-D Clearance Phases	5	EV-D Clearance Phases
6	Track Clearance Phases	5	Track Clearance
6	Limited Service Phases	5	Limited Service
6	Coordination Free Time (Seconds) After Preempt	5	Free Time After Preempt
6	Green Rest Delay Time (Seconds)	1	Green Rest Delay Time (Miscellaneous Timers)
6	Railroad Routine Select	5	Railroad Select (1. 2, or 3)
6	Manual Control	2	Recall Type (Manual Control Configuration)
6	**Phase Omits**	10	**Coordination Attributes**
6	Phase Omit for Dial 1	10	Omitted Phases (Plan 1/2/3)
6	Phase Omit for Dial 2	10	Omitted Phases (Plan 4/5/6)
6	Phase Omit for Dial 3	10	Omitted Phases (Plan 7/8/9)
6	**Additional Overlaps**	4	**Overlaps**
6	Aux File 2 Color Ovlp C	4	Load Switch Assignment
6	Aux File 2 Color Ovlp D	4	Load Switch Assignment
6	Phase 7 Load Sw. 3 Color Ovlp E	4	Load Switch Assignment
6	Overlap E Green Omit	4	Green Omit Parents

LACO-3 to LACO-4			
Page	**LACO-3**	**Page**	**LACO-4**
1	**Phase Timing**	1	**Phase Timing**
1	Minimum Walk	1	Walk
1	Flashing Don't Walk	1	Flashing Don't Walk
1	Minimum Green	1	Minimum Green
1	Queue Maximum	1	Queue Maximum
1	Added Green/Actuation	1	Added Green per Actuation
1	Vehicle Extension	1	Vehicle Extension
1	Maximum Gap	1	See Note at end of Appendix D2
1	Minimum Gap	1	Minimum Gap
1	Max Extension 1 (Free)	1	Max Green 1 (Free)
1	Max Extension 2 (Coord)	1	Max Green 2 (Coordination)
1	Ovlp Green Extension (for each overlap)	4	Ovlp Green Extension (for each overlap)
1	Ovlp Yellow Clearance (for each overlap)	4	Ovlp Yellow Clearance (for each overlap)
1	Ovlp Red Clearance (for each overlap)	4	Ovlp Red Clearance (for each overlap)
1	Reduce 0.1 Sec. Every…	1	See Note at end of Appendix D2
1	Yellow	1	Yellow Clearance
1	Red Clearance	1	Red Clearance
1	Red Rest Delay	1	Green Rest Delay Time (Miscellaneous Timers)
1	Green Rest Delay	1	Red Rest Delay Time (Miscellaneous Timers)
1	Max Added Green (for all phases)	1	Max Added Green Time (per phase)
1	Red Revert	1	Red Revert Time
1	Preemption	5	**Preemption**
1	RR Select (0, 1, 2)	5	Railroad Select (0, 1, 2, or 3)
1	RR Track Clearance	5	Track Clearance
1	RR1 All Red	5	All Red Time After Railroad Flash
1	RR2 Maximum (Minutes)	5	Limited Service Max Time
1	Free Time After Preempt	5	Free Time After Preempt
1	EV-A Delay	5	EV-A Delay
1	EV-A Clearance	5	EV-A Clearance
1	EV-B Delay	5	EV-B Delay
1	EV-B Clearance	5	EV-B Clearance
1	EV-C Delay	5	EV-C Delay
1	EV-C Clearance	5	EV-C Clearance
1	EV-D Delay	5	EV-D Delay
1	EV-D Clearance	5	EV-D Clearance
1	EV Maximum (Seconds) (for all EV's)	5	Maximum (per EV)
1	EV-A Clearance Phases	5	EV-A Clearance Phases

LACO-3 to LACO-4			
1	EV-B Clearance Phases	5	EV-B Clearance Phases
1	EV-C Clearance Phases	5	EV-C Clearance Phases
1	EV-D Clearance Phases	5	EV-D Clearance Phases
1	RR Track Clear	5	Track Clearance
1	RR2 Ltd Service	5	Limited Service
1	RR1 Exit Phase	5	Railroad Exit
1	Railroad Routine Select	5	Railroad Select (1. 2, or 3)
1	**Phase Function Flags**	2	**Configuration**
1	Phases Permitted	2	Permitted Phases (Phase Function Flags)
1	Red Lock	2	Red Lock (Phase Function Flags)
1	Red & Yellow Lock	2	Red and Yellow Lock (Phase Function Flags)
1	Minimum Vehicle Recall	2	Minimum Vehicle Recall (Phase Function Flags)
1	Pedestrian Recall & Rest In Walk	2	Ped Recall (Street Configuration Flags)
1	Green Rest	2	Rest In Green (Phase Function Flags)
1	Red Rest	2	Rest In Red (Phase Function Flags)
1	Semi Traffic Actuated Mode	2	STA Mode (Street Configuration Flags)
1	Double Entry	2	Double Entry (Phase Function Flags)
1	Maximum Vehicle Recall	2	Maximum Vehicle Recall (Phase Function Flags)
1	Restricted Phases	4	Restricted Phases (Phase Function Flags)
1	Protected/Permissive Left Turn	2	Prot/Perm Left Turn (Phase Function Flags)
1	First Phases After Start Up	2	First Phases (after setup) (Phase Function Flags)
1	Barrier Recall	2	Barrier Recall (Phase Function Flags)
1	Yellow Start Up	2	Yellow Startup Phases (Phase Function Flags)
1	**Overlap Yellow Start Up**	2	Yellow Startup Overlaps (Phase Function Flags)
1	Lag Phase Flags		
1	Lag Free	2	Lag Phases (Free) (Phase Function Flags)
1	“ “	2	Lag Phases (Manual Control Configuration)
1	Lag Dial 1	10	Lagging Phases – Coordination Attributes (Plans 1/2/3)
1	Lag Dial 2	10	Lagging Phases – Coordination Attributes (Plans 4/5/6)
1	Lag Dial 3	10	Lagging Phases – Coordination Attributes (Plans 7/8/9)
2	**Detector Assignments**	3	**Detector Assignments**
2	All timing entries same as LACO-4	3	All timing entries same as LACO-3
3	WWV Time-Based Coordination	6	Coordination
3	System Sync Width		NO EQUIVALENT
3	Set Maximum Width		NO EQUIVALENT
3	Set Minimum Width		*NO EQUIVALENT*
3	System Manual	6	System Manual
3	Local Manual	6	Local Manual

LACO-3 to LACO-4			
3	Function 6		NO EQUIVALENT
3	Minimum Cycle	6	Minimum Cycle Length
3	Maximum Cycle	6	Maximum Cycle Length
3	Dial 1 Intervals	6	Plan 1/2/3 Intervals
3	Dial 2 Intervals	6	Plan 4/5/6 Intervals
3	Dial 3 Intervals	6	Plan 7/8/9 Intervals
3	WWV Time-Based Coordination	6	Coordination Function Flags
3	Dial 1 Force Off	6	Plan 1/2/3 Force Off
3	Dial 1 Hold	6	Plan 1/2/3 Hold
3	Dial 1 Ped Rstrict	6	Plan 1/2/3 Ped Restrict
3	Dial 1 Call	6	Plan 1/2/3 Call
3	Dial 2 Force Off	6	Plan 4/5/6 Force Off
3	Dial 2 Hold	6	Plan 4/5/6 Hold
3	Dial 2 Ped Rstrict	6	Plan 4/5/6 Ped Restrict
3	Dial 2 Call	6	Plan 4/5/6 Call
3	Dial 3 Force Off	6	Plan 7/8/9 Force Off
3	Dial 3 Hold	6	Plan 7/8/9 Hold
3	Dial 3 Ped Rstrict	6	Plan 7/8/9 Ped Restrict
3	Dial 3 Call	6	Plan 7/8/9 Call
4	**Special Functions**		
4	Overlap Phase Flags (for each overlap)	4	Normal Parents (for each overlap)
4	Overlap Green Omit Flags (for each overlap)	4	Green Omit Parents (for each overlap)
4	Railroad Preempt Overlap Flags (for each overlap)	4	RR Preempt Parents (for each overlap)
4	Emergency Vehicle Preempt Overlap Flags (for each overlap)	4	EV Preempt Parents (for each overlap)
4	Load Switch Assignment (for each overlap)	4	Load Switch Assignment (for each overlap)
4	User Flag Options	2	User Flags (Miscellaneous Flags)
4	Associated Phase Recall (for each phase)	2	Associated Phase Recall (for each phase) (Miscellaneous Flags)
4	Phase Driveway Flash	2	Driveway Flash (Street Configuration Flags)
4	Phase Yellow Ranging	2	Yellow Ranging Phase (Miscellaneous Flags)
4	Overlap Driveway Flash	2	Overlap Driveway Flash (Street Configuration Flags)
4	Overlap Yellow Ranging	2	Yellow Ranging Overlap (Miscellaneous Flags)
4	Ped 2/4/6/8 Load Switch Overlap	2	Load Switch Assignment (for each overlap)
5	**Event Tables**	11	**Coordination Tables**
5	Table 0 – Default TOD	11	Table 0 – Default TOD
5	Table 1 – (TOD)	11	Table 1 – (TOD)
5	Table 2 – (TOD)	11	Table 2 – (TOD)
5	Table 3 – (TOD)	11	Table 3 – (TOD)
5	Table 4 – (TOD)	11	Table 4 – (TOD)

LACO-3 to LACO-4			
5	Table 5 – Slave Mode Table		NO EQUIVALENT
5	Table 6 – Floating Holidays	11	Table 5 – Floating Holidays
5	Table 7 – Exception Days	11	Table 6 – Exception Days
6	**Annual Tables**		
6	Table 8 – Annual Events	11	Table 7 – Annual Events
6	Table 9 – Annual Events		NO EQUIVALENT
6	Offset 1/Dial 1	6	Plan 1 Offset
6	Offset 1/Dial 2	6	Plan 2 Offset
6	Offset 1/Dial 3	6	Plan 3 Offset
6	Offset 2/Dial 1	6	Plan 4 Offset
6	Offset 2/Dial 2	6	Plan 5 Offset
6	Offset 2/Dial 3	6	Plan 6 Offset
6	Offset 3/Dial 1	6	Plan 7 Offset
6	Offset 3/Dial 2	6	Plan 8 Offset
6	Offset 3/Dial 3	6	Plan 9 Offset
1	Communications Assignments	2	Communications Options **(Configuration)**

NOTE:

LACO-4 takes a slightly different approach from LACO-1R and LACO-3 for configuring Gap Reduction (a.k.a. Volume Density Timing). Both LACO-1R and LACO-3 ask the user to set Minimum Gap, Maximum Gap, Vehicle Extension and Reduce .1 Second Every… parameters and the program internally generates the Time Before Reduction and Time to Reduce times internally from these parameters. LACO-4, on the other hand, asks the user to set Minimum Gap, Maximum Gap, Vehicle Extension, Time to Reduce and Time Before Reduction. From these parameters, the program internally generates the Reduce .1 Second Every… time.

Use the following formula to determine Time to Reduce and Time Before Reduction values from LACO-1R or LACO-3 timing.

APPENDIX E. I/O MAPPINGS

E1. LACO-4 Input Function Map

Firmware Address	8	7	6	5	4	3	2	1	Hardware Address
080	8J6L C1 Pin - 46 Logic - 08	4I6L C1 Pin - 45 Logic - 07	6J2L C1 Pin - 44 Logic - 06	212L C1 Pin - 43 Logic - 05	8J6U C1 Pin - 42 Logic - 04	4I6U C1 Pin - 41 Logic - 03	6J2U C1 Pin - 40 Logic - 02	2I2U C1 Pin - 39 Logic - 01	**5001**
081	SYSTEM 1 *FREE* C1 Pin - 54 Logic - 18	MAN ENA *PED B* C1 Pin - 53 Logic - 17	RR B C1 Pin - 52 Logic - 16	RR A *OFF TMG* *DIAL 3* C1 Pin - 51 Logic - 15	8J8 C1 Pin - 50 Logic - 14	4I8 C1 Pin - 49 Logic - 13	6J4 C1 Pin - 48 Logic - 12	2I4 C1 Pin - 47 Logic - 11	**5002**
082	3I9L C1 Pin - 62 Logic - 28	7J9L C1 Pin - 61 Logic - 27	1I9U C1 Pin - 60 Logic - 26	5J9U C1 Pin - 59 Logic - 25	3I5 C1 Pin - 58 Logic - 24	7J5 C1 Pin - 57 Logic - 23	1I1 C1 Pin - 56 Logic - 22	5JI C1 Pin - 55 Logic - 21	**5003**
083	8J7U C1 Pin - 66 Logic - 38	4I7U C1 Pin - 65 Logic - 37	6J3U C1 Pin - 64 Logic - 36	2I3U C1 Pin - 63 Logic - 35	**unused**	**unused**	**unused**	**unused**	**5004**
084	EV D C1 Pin - 74 Logic - 48	EV C C1 Pin - 73 Logic - 47	EV B C1 Pin - 72 Logic - 46	EV A C1 Pin - 71 Logic - 45	8 PPB C1 Pin - 70 Logic - 44	4 PPB C1 Pin - 69 Logic - 43	6 PPB C1 Pin - 68 Logic - 42	2 PPB C1 Pin - 67 Logic - 41	**5005**
085	EXTERNAL STOP TIME C1 Pin - 82 Logic - 58	FLASH SENSE *DIAL 2* C1 Pin - 81 Logic - 57	MAN ADV *PED A* C1 Pin - 80 Logic - 56	8J7L C1 Pin - 79 Logic - 55	4I7L C1 Pin - 78 Logic - 54	6J3L C1 Pin - 77 Logic - 53	2I3L C1 Pin - 76 Logic - 52	SYSTEM 2 *SYNC* C1 Pin - 75 Logic - 51	**5006**
086	**unused**	**unused**	FRONT PANEL STOP TIME Logic - 66	**Internal Use**					**5007**

The first line in each block indicates the LACO-4 default input function. The lines in *italics* show optional input functions. The next to the last line shows the associated C1 pin and the last line shows the Logic pin number used for Programmable Logic data entry.

E2. LACO-4 Output Function Map

↓ Firmware Address	8	7	6	5	4	3	2	1	↓ Hardware Adress
090	Ø3 GREEN C1 Pin - 9 Logic - 108	Ø3 YELLOW C1 Pin - 8 Logic - 107	Ø3 RED C1 Pin - 7 Logic - 106	Ø4 GREEN C1 Pin - 6 Logic - 105	Ø4 YELLOW C1 Pin - 5 Logic - 104	Ø4 RED C1 Pin - 4 Logic - 103	Ø4 WALK C1 Pin - 3 Logic - 102	Ø4 DWALK C1 Pin - 2 Logic - 101	**5001**
091	Ø1 GREEN C1 Pin - 18 Logic - 118	Ø1 YELLOW C1 Pin - 17 Logic - 117	Ø1 RED C1 Pin - 16 Logic - 116	Ø2 GREEN C1 Pin - 15 Logic - 115	Ø2 YELLOW C1 Pin - 13 Logic - 114	Ø2 RED C1 Pin - 12 Logic - 113	Ø2 WALK C1 Pin - 11 Logic - 112	Ø2 DWALK C1 Pin - 10 Logic - 111	**5002**
092	Ø7 GREEN C1 Pin - 26 Logic - 128	Ø7 YELLOW C1 Pin - 25 Logic - 127	Ø7 RED C1 Pin - 24 Logic - 126	Ø8 GREEN C1 Pin - 23 Logic - 125	Ø8 YELLOW C1 Pin - 22 Logic - 124	Ø8 RED C1 Pin - 21 Logic - 123	Ø8 WALK C1 Pin - 20 Logic - 122	Ø8 DWALK C1 Pin - 19 Logic - 121	**5003**
093	Ø5 GREEN C1 Pin - 34 Logic - 138	Ø5 YELLOW C1 Pin - 33 Logic - 137	Ø5 RED C1 Pin - 32 Logic - 136	Ø6 GREEN C1 Pin - 31 Logic - 135	Ø6 YELLOW C1 Pin - 30 Logic - 134	Ø6 RED C1 Pin - 29 Logic - 133	Ø6 WALK C1 Pin - 28 Logic - 132	Ø6 DWALK C1 Pin - 27 Logic - 131	**5004**
094	WATCHDOG C1 Pin - 103 Logic - 148	DETECTOR RESET C1 Pin - 102 Logic - 147	AUX 3 YELLOW Preempt Ind C1 Pin - 101 Logic - 146	AUX 6 YELLOW Plan2 C1 Pin - 100 Logic - 145	OVERLAP B YELLOW C1 Pin - 38 Logic - 144	OVERLAP A YELLOW C1 Pin - 37 Logic - 143	OVERLAP B GREEN C1 Pin - 36 Logic - 142	OVERLAP A GREEN C1 Pin - 35 Logic - 141	**5005**
095	AUX 4 GREEN OVERLAP E C1 Pin - 90 Logic - 158	AUX 4 YELLOW OVERLAP E C1 Pin - 89 Logic - 157	AUX 4 RED OVERLAP E C1 Pin - 88 Logic - 156	AUX 5 GREEN OVERLAP F C1 Pin - 87 Logic - 155	AUX 5 YELLOW OVERLAP F C1 Pin - 86 Logic - 154	AUX 5 RED OVERLAP F C1 Pin - 85 Logic - 153	AUX 6 GREEN Plan3 C1 Pin - 84 Logic - 152	AUX 6 RED Free C1 Pin - 83 Logic - 151	**5006**
096	AUX 1 GREEN OVERLAP C C1 Pin - 99 Logic - 168	AUX 1 YELLOW OVERLAP C C1 Pin - 98 Logic - 167	AUX 1 RED OVERLAP C C1 Pin - 97 Logic - 166	AUX 2 GREEN OVERLAP D C1 Pin - 96 Logic - 165	AUX 2 YELLOW OVERLAP D C1 Pin - 95 Logic - 164	AUX 2 RED OVERLAP D C1 Pin - 94 Logic - 163	AUX 3 GREEN Aux Output C1 Pin - 93 Logic - 162	AUX 3 RED Sync Pulse C1 Pin - 91 Logic - 161	**5007**

The first line (or as many as three lines) in each block indicates the LACO-4 default output function. The next to the last line shows the associated C1 pin and the last line shows the Logic pin number used for Programmable Logic data entry.

∅1 Det 56	∅2 Det 39	∅2 Det 63	∅2 Det 47	∅3 Det 58	∅4 Det 41	∅4 Det 65	∅4 Det 49	∅1 Det 60	Not wired	Man Adv or *PedA* 80	PED2 67	PED6 68	FLASH SENSE or *Dial2* 81
Same as above	∅2 Det 43	∅2 Det 76	*Same as above*	*Same as above*	∅4 Det 45	∅4 Det 78	*Same as above*	∅3 Det 62	Not wired	Man Ena or *PedB* 53	PED4 69	PED8 70	STOP TIME 82

(Upper) Default *Alternate* C1 Pin
(Lower) Default *Alternate* C1 Pin

The Caltrans 332 Cabinet “I” Input File layout is shown above and the format of each slot is shown to the left. The Input File is divided into an Upper slot and a Lower slot. The first row in each slot indicates the LACO-4 default function. An alternate function, if available, is shown on the next row in *italics*. The slot’s associated C1 pin number is on the bottom row. Slot 10 on the Input File is not wired. Slots 1, 4, 5 and 8 have the upper slot output wires connected with jumpers to the lower slot’s outputs (pins F and W).

E3. Caltrans 332 Cabinet “I” Input File Layout

∅5 Det 55	∅6 Det 40	∅6 Det 64	∅6 Det 48	∅7 Det 57	∅8 Det 42	∅8 Det 66	∅8 Det 50	∅5 Det 59	Not wired	SYS 1 or *FREE* 54	EVA 71	EVB 72	OFFSET TIMING or *RxR A* 51
Same as above	∅6 Det 44	∅6 Det 77	*Same as above*	*Same as above*	∅8 Det 46	∅8 Det 79	*Same as above*	∅7 Det 61	Not wired	SYS 2 or *SYNC* 75	EVC 73	EVD 74	RxR B or *DIAL3* 52

(Upper) Default *Alternate* C1 Pin
(Lower) Default *Alternate* C1 Pin

The Caltrans 332 Cabinet "I" Input File layout is shown above and the format of each slot is shown to the left. The Input File is divided into an Upper slot and a Lower slot. The first row in each slot indicates the LACO-4 default function. An alternate function, if available, is shown on the next row in *italics*. The slot's associated C1 pin number is on the bottom row. Slot 10 on the Input File is not wired. Slots 1, 4, 5 and 8 have the upper slot output wires connected with jumpers to the lower slot's outputs (pins F and W).

E4. Caltrans 332 Cabinet "J" Input File Layout

∅1 Det 56	∅2 Det 39	∅3 Det 58	∅4 Det 41	∅5 Det 55	∅6 Det 40	∅7 Det 57	∅8 Det 42	OFFSET TIMING or *RxR A* 51	EVA 71	EVB 72	PED2 67	PED6 68	FLASH SENSE 81
∅2 Det 47	∅2 Det 43	∅4 Det 49	∅4 Det 45	∅6 Det 48	∅6 Det 44	∅8 Det 50	∅8 Det 46	RxR B 52	EVC 73	EVD 74	PED4 69	PED8 70	STOP TIME 82

(Upper) Default *Alternate* C1 Pin
(Lower) Default *Alternate* C1 Pin

The Caltrans 336 Cabinet Input File layout is shown above and the format of each slot is shown to the left. The Input File is divided into an Upper slot and a Lower slot. The first row in each slot indicates the Caltrans default function. An alternate function, if available, is shown on the next row in *italics*. The slot's associated C1 pin number is on the bottom row.

E5. Caltrans 336 Cabinet Input File Layout

∅2 39	∅2 63	∅4 41	∅4 65	∅6 40	∅6 64	PED2 67	PED6 68	FLASH SENSE 81	Man Adv or *PedA* 80	SYS 1 or *FREE* 54
∅2 43	∅2 47	∅4 45	∅4 49	∅6 44	∅6 48	PED4 69	Not wired	OFFSET TIMING or *RxR A* 51	Man Ena or *PedB* 53	SYS 2 or *SYNC* 75

(Upper) Default *Alternate* C1 Pin
(Lower) Default *Alternate* C1 Pin

The L. A. County 337 Cabinet Input File layout is shown above and the format of each slot is shown to the left. The Input File is divided into an Upper slot and a Lower slot. The first row in each slot indicates the LACO-4 default function, with its associated C1 pin number on the second row. An alternate function, if available, is shown on the next row in *italics.* The 337 Input File has only 11 slots. The lower channel of slot 8 has no C1 pin wired to it. Consult the 337 Cabinet prints provided by the manufacturer for details on which (if any) C1 pins are connected to each slot's "SP" (spare) terminal.

E6. L. A. County 337 Cabinet Input File Layout

LS = Load Switch

LS1	LS2	LS3	LS4	LS5	LS6
Ø1 Red C1-16	Ø2 Red C1-12	Ø2 DWALK C1-10	Ø3 Red C1-7	Ø4 Red C1-4	Ø4 DWALK C1-2
Ø1 Yellow C1-17	Ø2 Yellow C1-13	OL A Green C1-35	Ø3 Yellow C1-8	Ø4 Yellow C1-5	OL A Yellow C1-37
Ø1 Green C1-18	Ø2 Green C1-15	Ø2 WALK C1-11	Ø3 Green C1-9	Ø4 Green C1-6	Ø4 WALK C1-3
Ø5 Red C1-32	Ø6 Red C1-29	Ø6 DWALK C1-27	Ø7 Red C1-24	Ø8 Red C1-21	Ø8 DWALK C1-19
Ø5 Yellow C1-33	Ø6 Yellow C1-30	OL B Green C1-36	Ø7 Yellow C1-25	Ø8 Yellow C1-22	OL B Yellow C1-38
Ø5 Green C1-34	Ø6 Green C1-31	Ø6 WALK C1-28	Ø7 Green C1-26	Ø8 Green C1-23	Ø8 WALK C1-20
LS7	**LS8**	**LS9**	**LS10**	**LS11**	**LS12**

E7. Caltrans 332/336 Cabinet Output File Layout

LS = Load Switch

LS1	LS2	LS3	LS4	LS5	LS6
AUX1 Red C1-97	Ø2 Red C1-12	Ø4 Red C1-4	Ø6 Red C1-29	Ø2 DWALK C1-10	Ø4 DWALK C1-2
AUX1 Yellow C1-98	Ø2 Yellow C1-13	Ø4 Yellow C1-5	Ø6 Yellow C1-30	Ø6 DWALK C1-27	Ø6 WALK C1-28
AUX1 Green C1-99	Ø2 Green C1-15	Ø4 Green C1-6	Ø6 Green C1-31	Ø2 WALK C1-11	Ø4 WALK C1-3

E8. Caltrans 337 Cabinet Output File Layout

LS = Load Switch

LS1	LS2	LS3	LS4	LS5	LS6
AUX1 Red C1-97	AUX2 Red C1-94	AUX3 Red C1-91	AUX4 Red C1-88	AUX5 Red C1-85	AUX6 Red C1-83
AUX1 Yellow C1-98	AUX2 Yellow C1-95	AUX3 Yellow C1-101	AUX4 Yellow C1-89	AUX5 Yellow C1-86	AUX6 Yellow C1-100
AUX1 Green C1-99	AUX2 Green C1-96	AUX3 Green C1-93	AUX4 Green C1-90	AUX5 Green C1-87	AUX6 Green C1-84

E9. Caltrans Auxiliary Output File Layout

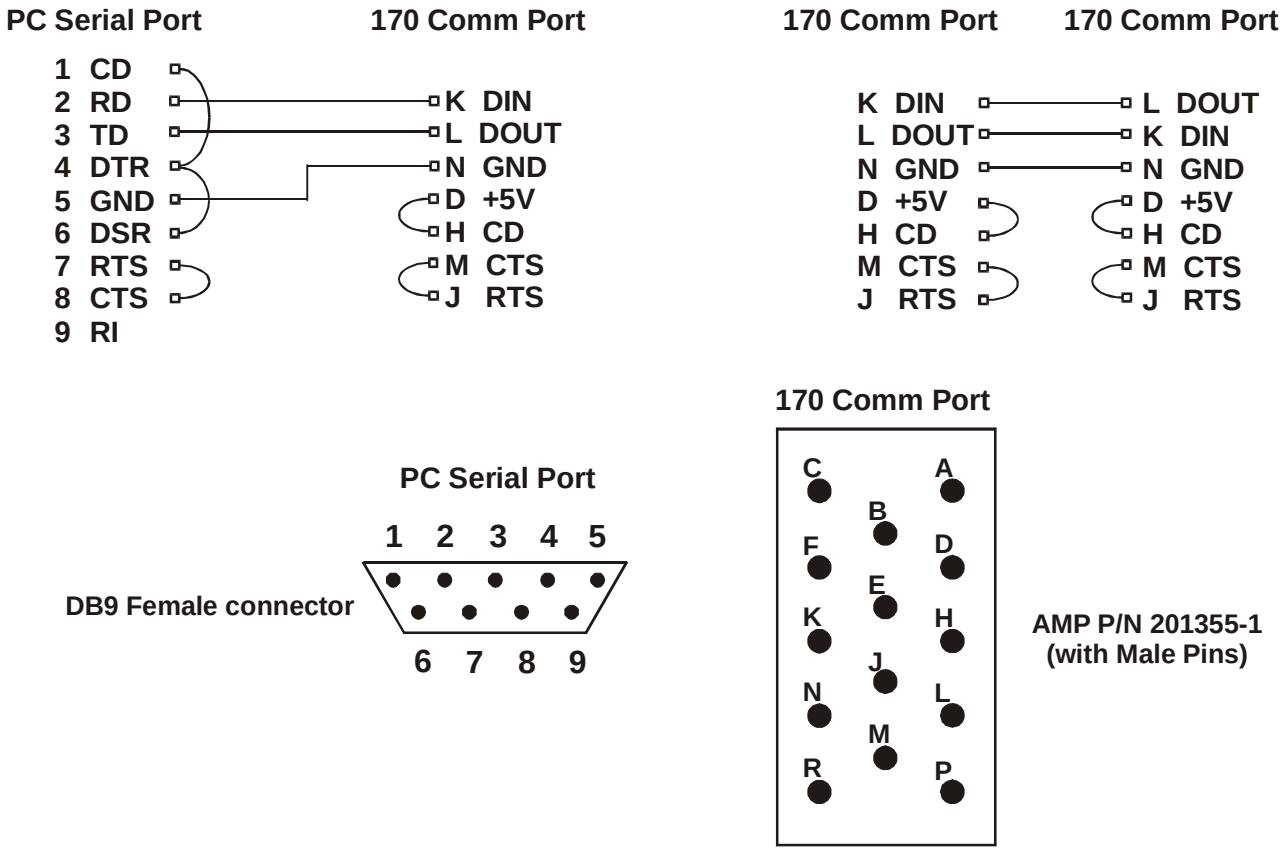
C1	Function	C1	Function	C1	Function	C1	Function
1	Logic Ground	**27**	6 Ped Don't Walk	**53**	Manual Enable (*PedB*)	**79**	Det J7 Lower
2	4 Ped Don't Walk	**28**	6 Ped Walk	**54**	System 1 (*Free*)	**80**	Manual Advance (*PedA*)
3	4 Ped Walk	**29**	Phase 6 Red	**55**	Det J1 Both	**81**	Flash Sense (*Dial2*)
4	Phase 4 Red	**30**	Phase 6 Yellow	**56**	Det I1 Both	**82**	Ext. Stop Time
5	Phase 4 Yellow	**31**	Phase 6 Green	**57**	Det J5 Both	**83**	Aux6 Red (Free)
6	Phase 4 Green	**32**	Phase 5 Red	**58**	Det I5 Both	**84**	Aux6 Green (Plan3)
7	Phase 3 Red	**33**	Phase 5 Yellow	**59**	Det J9 Upper	**85**	Overlap C Red
8	Phase 3 Yellow	**34**	Phase 5 Green	**60**	Det I9 Upper	**86**	Overlap C Yellow
9	Phase 3 Green	**35**	Overlap A Green	**61**	Det J9 Lower	**87**	Overlap C Green
10	2 Ped Don't Walk	**36**	Overlap B Green	**62**	Det I9 Lower	**88**	Overlap D Red
11	2 Ped Walk	**37**	Overlap A Yellow	**63**	Det I3 Upper	**89**	Overlap D Yellow
12	Phase 2 Red	**38**	Overlap B Yellow	**64**	Det J3 Upper	**90**	Overlap D Green
13	Phase 2 Yellow	**39**	Det I2 Upper	**65**	Det I7 Upper	**91**	Aux3 Red (Sync Pulse)
14	Logic Ground	**40**	Det J2 Upper	**66**	Det J7 Upper	**92**	Logic Ground
15	Phase 2 Green	**41**	Det I6 Upper	**67**	2 Ped Pushbutton	**93**	Aux3 Green (TOD Output)
16	Phase 1 Red	**42**	Det J6 Upper	**68**	6 Ped Pushbutton	**94**	Overlap E Red
17	Phase 1 Yellow	**43**	Det I2 Lower	**69**	4 Ped Pushbutton	**95**	Overlap E Yellow
18	Phase 1 Green	**44**	Det J2 Lower	**70**	8 Ped Pushbutton	**96**	Overlap E Green
19	8 Ped Don't Walk	**45**	Det I6 Lower	**71**	EV A	**97**	Overlap F Red
20	8 Ped Walk	**46**	Det J6 Lower	**72**	EV B	**98**	Overlap F Yellow
21	Phase 8 Red	**47**	Det I4 Both	**73**	EV C	**99**	Overlap F Green
22	Phase 8 Yellow	**48**	Det J4 Both	**74**	EV D	**100**	Aux6 Yellow (Plan2)
23	Phase 8 Green	**49**	Det I8 Both	**75**	System 2 (*Sync*)	**101**	Aux3 Yellow (Preempt)
24	Phase 7 Red	**50**	Det J8 Both	**76**	Det I3 Lower	**102**	Detector Reset
25	Phase 7 Yellow	**51**	RR A (*Offset Tmg, Dial3*)	**77**	Det J3 Lower	**103**	Watch Dog
26	Phase 7 Green	**52**	RR B	**78**	Det I7 Lower	**104**	Logic Ground

E10. C1 Connector Map

C1 Pin	Function	C5 Pin
83	Aux 6 Red	**1**
84	Aux 6 Green	**2**
85	Aux 5 Red	**3**
86	Aux 5 Yellow	**4**
87	Aux 5 Green	**5**
88	Aux 4 Red	**6**
89	Aux 4 Yellow	**7**
90	Aux 4 Green	**8**
91	Aux 3 Red	**9**
93	Aux 3 Green	**10**
94	Aux 2 Red	**11**
95	Aux 2 Yellow	**12**
96	Aux 2 Green	**13**
97	Aux 1 Red	**14**
98	Aux 1 Yellow	**15**
99	Aux 1 Green	**16**
100	Aux 6 Yellow	**17**
101	Aux 3 Yellow	**18**

E11. C1/C5 Cross Reference

The figure below provides all of the information needed to construct a cable for PC to 170 serial communications using AB3418. This would be necessary when using a PC (desktop or laptop) to verify AB3418 messaging before installing a controller in the field. This will also be used for Upload/Download of timing data (future implementation). For 170 to 170 communications using AB3418, replace the “PC Serial Port” connector with a “170 Comm Port” connector with pins K and L reversed. That is, the DIN pin on one end of the cable should be connected to the DOUT on the other end. Twisted pair wire should be used for the data lines.



E12. Cabling Information for AB 3418 Communications

APPENDIX F. RAM MAPS

PROGRAM CONTROL

	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	
0	N17M	CALFLG	DSPFLG	TEMP0	XTEMP0	THSRNG	DYNXCL	GFAZE	IN1	OUT1	SYSERR	SYSFLG	RACURR	RBCURR	RAWTIM	RBWTIM	0
1	N100M	PH1FLG	KEYFLG	TEMP1	"	OTHRNG	DYNRST	WFAZE	IN2	OUT2	MEMERR	MEMFLG	RANEXT	RBBEXT	RADTIM	RBDTIM	1
2	C17M	PH2FLG	PGADD	TEMP2	XTEMP1	THISST	BARSET	DWFAZE	IN3	OUT3	MONERR	MONFLG	RALAST	RBLAST	RAHOLD	RBHOLD	2
3	C100M	PH3FLG	"	TEMP3	"	OTHRST	QUEACT	YFAZE	IN4	OUT4	PRTERR	FLSFLG	RALEAD	RBLEAD	RAODD	RBODD	3
4	PFLAG	PH4FLG	PHASE	TEMP4	XTEMP2	RAMAIN	TMPDET	RFAZE	IN5	OUT5	CRDERR	PRTFLG	RATERM	RBTERM	RASUPP	RBSUPP	4
5	DSPTMR	PH5FLG	INTRVL	TEMP5	"	RBMAIN	LLAMSK	FAZIN	IN6	OUT6	WWVERR	CRDFLG	RACOLR	RBCOLR	RAEXT	RBEXT	5
6	DIM	PH6FLG	LSB	TEMP6	XTEMP3	RASIDE	OLPCLR	FAZNXT	IN7	OUT7		CLKFLG	RAFAZD	RBFAZD	RATBR	RBTBR	6
7	KEYBUF	PH7FLG	NLSB	TEMP7	"	RBSIDE	DYNTRM	FAZLST	IN8	OUT8	ERRFLG	DATFLG	RAINTD	RBINTD	RAMGAP	RBMGAP	7
8	PRETMR	PH8FLG	NMSB	TEMP8	XTEMP4	THSQAD	OLGFAZ	OGFAZE	IN1L	OUT9	ACIAXD	LETFLG	RALAG	RBLAG	RAMAX	RBMAX	8
9	OLFZIN	INTMP1	MSB	TEMP9	"	XCLFLG	QHOLD	OYFAZE	IN2L	OUTA	"	NUMFLG	RASTOP	RBSTOP	RAΦBUF	RBΦBUF	9
A	XOLFAZ	INTMP2	EVENT	TEMPA	XTEMP5	RSTFLG	COCALL	ORFAZE	IN3L	LEAD	ACIAXI	STRTUP	RACNTL	RBCNTL	RAMADD	RBMADD	A
B	DYNOFZ	INTMP3	TABLE	TEMPB	"	DYNRRP	PEDRST	IRCALL	IN4L	CLITEO	"	STRFLG	RATFLG	RBTFLG	RAGOT	RBGOT	B
C	KEYPTR	INTMP4	LAGFLG	TEMPC	XTEMP6	RXPTRM	HOLD	DCALL	IN5L	CLITE9	DETLOK	PREFLG	RACALL	RBCALL	RAGRT	RBGRT	C
D	"	"	LAG	TEMPD	"	PED	FORCE1	VCALL	IN6L	CALACT	RESLOK	RNGFLG	RALTRM	RBLTRM	RASTEP	RBSTEP	D
E	CHKFLG	INTMP5	SAVSTK	TEMPE	XTEMP7	CALMSK	FORCE2	PCALL	IN7L	CALLIT	XCLLOK	OLPFLG	RBFLAG	RAFLAG	RATEMP	RBTEMP	E
F	PAGCNT	"	"	TEMPF	"	ALLOW	ADVAN	CALL	IN8L	CNTINU	OLOCK	QADFLG	RABRFZ	RBBRFZ	RALIMT	RBLIMT	F
	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	

FLAG DECIMAL

Page 0000h RAM Map

KeyPress to view = *Column + Row*

***NOTE**: This entire page is write protected*

PHASE TIMING/INTERSECTION CONTROL AND CONFIGURATION

	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	
0	CPYFRM	FZ1TMG	FZ2TMG	FZ3TMG	FZ4TMG	FZ5TMG	FZ6TMG	FZ7TMG	FZ8TMG	SYSNUM	RAWALK	RBWALK			MNSTFZ	PERMIT	0
1	CPYTO									PORT1A	RADWLK	RBDWLK		ASSOC1	SDSTFZ	RLOCK	1
2										PORT2A	RAMGRN	RBMGRN		ASSOC2	PED2	YLOCK	2
3										PORT3A	RAQULM	RBQULM		ASSOC3	PED4	VRCALL	3
4	PRGNUM									PORT4A	RAINIT	RBINIT		ASSOC4	PED6	VXCALL	4
5	VRSION									PORT1X	RAVEXT	RBVEXT		ASSOC5	PED8	GREST	5
6	RRSTIM									PORT2X	RATBRT	RBTBRT		ASSOC6	PEDA	RREST	6
7	GRSTIM									PORT3X	RACGAP	RBCGAP		ASSOC7	PEDB	BARIER	7
8	GRSTMR									PORT4X	RACMAX	RBCMAX		ASSOC8	PREST	DBLENT	8
9	ALLRED										RASEC	RBSEC		CALLΦY	STA	XCLUSV	9
A	SPFUNC										RACINT	RBCINT		CALL2Y		RSTRCT	A
B	NMICNT										RARREV	RBRREV		UFLAG		LLAROW	B
C	PLONG										RARRST	RBRRST		GRNOFF		LAGFRE	C
D	PSHORT										RASTPT	RBSTPT		YELOFF	DRWYFZ	FAZ1ST	D
E	REDALL										RAYCLR	RBYCLR		YRNGFZ	DRWY2H	START	E
F	REDREV	▼	▼	▼	▼	▼	▼	▼	▼		RARCLR	RBRCLR		YRNGOL	DRWYOL	STRTOL	F
	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	

FLAG DECIMAL

Page 0100h RAM Map

KeyPress to view = *Column* + *Row*

WWV CONTROL/DETECTORS

	20	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F	
0	TXMSG	DETIDX	DETJDX	DETICO	DETJCO	DETIVA	DETJVA	DTIDTM	DTFJTM	DTICTM	DTJCTM	IDETFZ	JDETFZ	IDETAT	JDETAT		0
1	WHOUR	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		1
2	WMIN	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		2
3	WSEC	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		3
4	WMONTH	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		4
5	WDAY	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		5
6	WYEAR	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		6
7	HOUR	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		7
8	MINUTE	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	DELOP1	8
9	SECOND	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	DELOP2	9
A	MONTH	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		A
B	DAY	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		B
C	YEAR	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		C
D	DOW	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		D
E	TMCCLK																E
F	WWVCLK																F
	20	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F	

FLAG DECIMAL

Page 0200h RAM Map

KeyPress to view = *Column* + *Row*

PREEMPTION/OVERLAPS/WWV BUFFERS

	30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3D	3E	3F	
0	DELAY	EVADLY	EVBDLY	EVCDLY	EVDDLY		RRSEL		RRACNT	EVFLAG	RRFAZ		PRELIT		WTIME		0
1	ACTIVE	EVAACT	EVBACT	EVCACT	EVDACT		RR1RED		RRBCNT	EVAFAZ	RREXIT		MANOMT	BYTTIM			1
2	CLEAR	EVACLR	EVBCLR	EVCCLR	EVDCLR		RRCLR		EVACNT	EVBFAZ	RRPED		LAGMAN	TXDLAY			2
3	MAX	EVAMAX	EVBMAX	EVCMAX	EVDMAX		RRMAX		EVBCNT	EVCFAZ	RRBLIM	RRCNTL	XCLMSK	REGX			3
4	LINK	EVALNK	EVBLNK	EVCLNK	EVDLNK		RRLNK		EVCCNT	EVDFAZ		RRSTAT		“			4
5	EVCLR	EVAMIN	EVBMIN	EVCMIN	EVDMIN		MRKTIM		EVDCNT	SAVVEH		RRPRE		BUFPNT			5
6		EVATMR	EVBTMR	EVCTMR	EVDTMR		MRKTMR		MANCNT			EVSTAT		“			6
7							RRMIN			EVPRE		EVMAX		TXTIME			7
8							RRSEC			EVACT		ENTFLG		TXBC			8
9	MANCON						RRDLY			EVOLDE		PRESTT		RXBC			9
A	OLALOD	OLADLY	OLAGRN	OLAYEL	OLARED	OLATMR	OADTMR		OLAREV	DYNOLA	OVLPA	AGOMIT	RROLA	EVOLA			A
B	OLBLOD	OLBDLY	OLBGRN	OLBYEL	OLBRED	OLBTMR	OBDTMR		OLBREV	DYNOLB	OVLPB	BGOMIT	RROLB	EVOLB			B
C	OLCLOD	OLCDLY	OLCGRN	OLCYEL	OLCRED	OLCTMR	OCDTMR		OLCREV	DYNOLC	OVLPC	CGOMIT	RROLC	EVOLC			C
D	OLDLOD	OLDDLY	OLDGRN	OLDYEL	OLDRED	OLDTMR	ODDTMR		OLDREV	DYNOLD	OVLPD	DGOMIT	RROLD	EVOLD			D
E	OLELOD	OLEDLY	OLEGRN	OLEYEL	OLERED	OLETMR	OEDTMR		OLEREV	DYNOLE	OVLPE	EGOMIT	RROLE	EVOLE			E
F	OLFLOD	OLFDLY	OLFGRN	OLFYEL	OLFRED	OLFTMR	OFDTMR		OLFREV	DYNOLF	OVLPF	FGOMIT	RROLF	EVOLF	▼		F
	30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3D	3E	3F	

FLAG DECIMAL

Page 0300h RAM Map

KeyPress to view = *Column* + *Row*

Set ZIPCRD (location 7-A-D) = 001
to activate this RAM configuration

		PLAN 1	PLAN 2	PLAN 3	PLAN 4	PLAN 5	PLAN 6	PLAN 7	PLAN 8	PLAN 9						
	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F
0	SYSMAN	CYCLE	→	→	→	→	→	→	→	→						
1	LOCMAN	FORCE1	→	→	→	→	→	→	→	→						
2	MASPLN	FORCE2	→	→	→	→	→	→	→	→						
3	LOCPLN	FORCE3	→	→	→	→	→	→	→	→						
4	TMCPLN	FORCE4	→	→	→	→	→	→	→	→						
5	TODPLN	FORCE5	→	→	→	→	→	→	→	→						
6	TODSPF	FORCE6	→	→	→	→	→	→	→	→						
7	TODTBL	FORCE7	→	→	→	→	→	→	→	→						
8	MINCYC	FORCE8	→	→	→	→	→	→	→	→						
9	MAXCYC	FREE	→	→	→	→	→	→	→	→						
A	MASCYC															
B	LOCCYC															
C	NEWOFF															
D	CUROFF															
E	LMSTER															
F	LLOCAL															
	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F

NOT USED DECIMAL

Alternate Page 0400h RAM Map (when using Zip Coord)

KeyPress to view = *Column* + *Row*

		CYCLE/INTERVALS			PLAN 1 FLAGS				PLAN 2 FLAGS				PLAN 3 FLAGS				
	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	
0	SYSMAN	PLAN1X	PLAN2X	PLAN3X	P1FRCE	P1HOLD	P1PRST	P1CALL	P2FRCE	P2HOLD	P2PRST	P2CALL	P3FRCE	P3HOLD	P3PRST	P3CALL	0
1	LOCMAN																1
2	MASPLN																2
3	LOCPLN																3
4	TMCPLN																4
5	TODPLN																5
6	TODSPF																6
7	TODTBL																7
8	MINCYC																8
9	MAXCYC																9
A	MASCYC																A
B	LOCCYC																B
C	NEWOFF																C
D	CUROFF																D
E	LMSTER																E
F	LLOCAL																F
	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	

FLAG DECIMAL

Page 0400h RAM Map

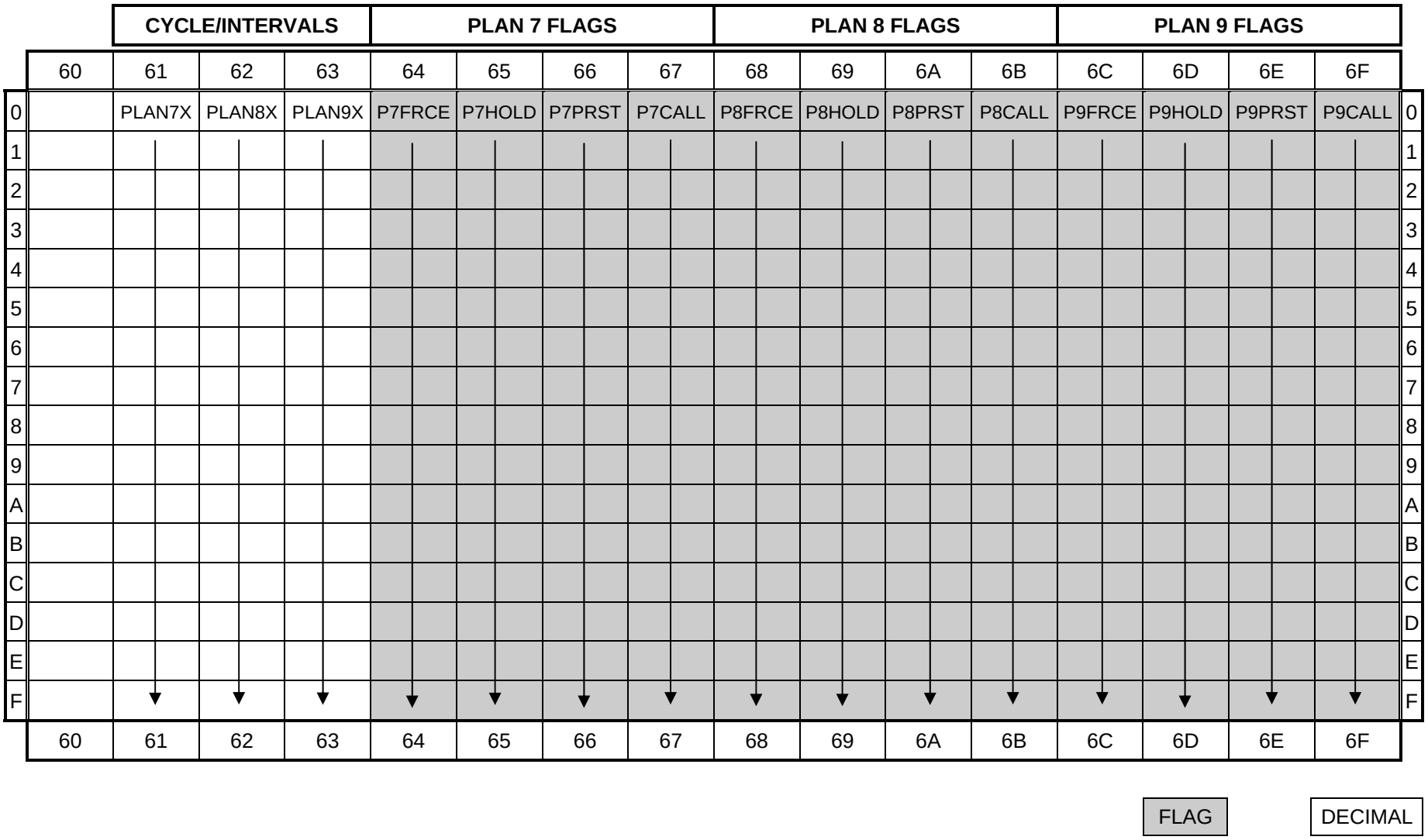
KeyPress to view = *Column* + *Row*

		CYCLE/INTERVALS			PLAN 4 FLAGS				PLAN 5 FLAGS				PLAN 6 FLAGS				
	50	51	52	53	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F	
0		PLAN4X	PLAN5X	PLAN6X	P4FRCE	P4HOLD	P4PRST	P4CALL	P5FRCE	P5HOLD	P5PRST	P5CALL	P6FRCE	P6HOLD	P6PRST	P6CALL	0
1																	1
2																	2
3																	3
4																	4
5																	5
6																	6
7																	7
8																	8
9																	9
A																	A
B																	B
C																	C
D																	D
E																	E
F																	F
	50	51	52	53	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F	

FLAG DECIMAL

Page 0500h RAM Map

KeyPress to view = *Column* + *Row*



Page 0600h RAM Map

KeyPress to view = *Column* + *Row*

COORDINATION ATTRIBUTES

	70	71	72	73	74	75	76	77	78	79	7A	7B	7C	7D	7E	7F	
0	LAG0	LAG1	LAG2	LAG3	LAG4	LAG5	LAG6	LAG7	LAG8	LAG9	OFFST0	CYCLEN			SICBIT	DIALX	0
1	VCALL0	VCALL1	VCALL2	VCALL3	VCALL4	VCALL5	VCALL6	VCALL7	VCALL8	VCALL9	OFFST1	PLNTMC			CORDM	"	1
2	PCALL0	PCALL1	PCALL2	PCALL3	PCALL4	PCALL5	PCALL6	PCALL7	PCALL8	PCALL9	OFFST2	MSYNC			CORDE	SYSDLX	2
3	VXCAL0	VXCAL1	VXCAL2	VXCAL3	VXCAL4	VXCAL5	VXCAL6	VXCAL7	VXCAL8	VXCAL9	OFFST3				CORDO	"	3
4	BARCL0	BARCL1	BARCL2	BARCL3	BARCL4	BARCL5	BARCL6	BARCL7	BARCL8	BARCL9	OFFST4				CORDF	FORCEX	4
5	GRNCL0	GRNCL1	GRNCL2	GRNCL3	GRNCL4	GRNCL5	GRNCL6	GRNCL7	GRNCL8	GRNCL9	OFFST5				FLOATB	"	5
6	GRN20	GRN21	GRN22	GRN23	GRN24	GRN25	GRN26	GRN27	GRN28	GRN29	OFFST6				ADAPTV		6
7											OFFST7				MAX2		7
8	NOMAX0	NOMAX1	NOMAX2	NOMAX3	NOMAX4	NOMAX5	NOMAX6	NOMAX7	NOMAX8	NOMAX9	OFFST8				FUNTMR		8
9	RDRST0	RDRST1	RDRST2	RDRST3	RDRST4	RDRST5	RDRST6	RDRST7	RDRST8	RDRST9	OFFST9						9
A	OMIT0	OMIT1	OMIT2	OMIT3	OMIT4	OMIT5	OMIT6	OMIT7	OMIT8	OMIT9	OFFPLN						A
B	OMTSD0	OMTSD1	OMTSD2	OMTSD3	OMTSD4	OMTSD5	OMTSD6	OMTSD7	OMTSD8	OMTSD9	MSPHR						B
C	COSTA0	COSTA1	COSTA2	COSTA3	COSTA4	COSTA5	COSTA6	COSTA7	COSTA8	COSTA9	MSPMIN						C
D	CONDS0	CONDS1	CONDS2	CONDS3	CONDS4	CONDS5	CONDS6	CONDS7	CONDS8	CONDS9	ZIPCRD						D
E																	E
F																CRDDIS	F
	70	71	72	73	74	75	76	77	78	79	7A	7B	7C	7D	7E	7F	

FLAG DECIMAL

Page 0700h RAM Map

KeyPress to view = *Column* + *Row*

	EVENT TABLE 0				EVENT TABLE 1				EVENT TABLE 2				EVENT TABLE 3				
	100	101	102	103	104	105	106	107	108	109	10A	10B	10C	10D	10E	10F	
0	TABLE0				TABLE1				TABLE2				TABLE3				0
1																	1
2																	2
3																	3
4																	4
5																	5
6																	6
7																	7
8																	8
9																	9
A																	A
B																	B
C																	C
D																	D
E																	E
F																	F
	100	101	102	103	104	105	106	107	108	109	10A	10B	10C	10D	10E	10F	

Page 1000h RAM Map

KeyPress to view = *Column* + *Row*

	EVENT TABLE 4				ANNUAL TABLE 5				FLOAT TABLE 6				EXCEPTION TABLE 7				
	110	111	112	113	114	115	116	117	118	119	11A	11B	11C	11D	11E	11F	
0	TABLE4				TABLE5				TABLE6				TABLE7				0
1																	1
2																	2
3																	3
4																	4
5																	5
6																	6
7																	7
8																	8
9																	9
A																	A
B																	B
C																	C
D																	D
E																	E
F																	F
	110	111	112	113	114	115	116	117	118	119	11A	11B	11C	11D	11E	11F	

Page 1100h RAM Map

KeyPress to view = *Column* + *Row*

	FUTURE TABLE 8				FUTURE TABLE 9				PROGRAMMABLE LOGIC								
	120	121	122	123	124	125	126	127	128	129	12A	12B	12C	12D	12E	12F	
0	TABLE8				TABLE9				INAA1		INAA2		INAA3		INAA4		0
1																	1
2																	2
3																	3
4																	4
5																	5
6																	6
7																	7
8																	8
9																	9
A																	A
B																	B
C																	C
D																	D
E																	E
F																	F
	120	121	122	123	124	125	126	127	128	129	12A	12B	12C	12D	12E	12F	

Page 1200h RAM Map

KeyPress to view = *Column* + *Row*

STACK

	130	131	132	133	134	135	136	137	138	139	13A	13B	13C	13D	13E	13F	
0	STACK																0
1																	1
2																	2
3																	3
4																	4
5																	5
6																	6
7																	7
8																	8
9																	9
A																	A
B																	B
C																	C
D																	D
E																	E
F																TSTACK	F
	130	131	132	133	134	135	136	137	138	139	13A	13B	13C	13D	13E	13F	

Page 1300h RAM Map

KeyPress to view = *Column + Row*

***NOTE**: This entire page is write protected*

AB318/GENERAL COMMUNICATIONS BUFFER

	140	141	142	143	144	145	146	147	148	149	14A	14B	14C	14D	14E	14F	
0	RXBUF						CRCTMP	INDX	GENBUF								0
1							“	“									1
2							PUTLOC	INDX1									2
3							“	“									3
4							TMPD	INDX2									4
5							“	“									5
6							TXPTR	INDX3									6
7							“	“									7
8							TXCNT	INDX4									8
9							TCH	“									9
A							NBYTE	AB7TX									A
B							I1	“									B
C							I2	ABTIME									C
D							T10TH	CRCERR									D
E							BUFFER	ABPLAN									E
F																	F
	140	141	142	143	144	145	146	147	148	149	14A	14B	14C	14D	14E	14F	

Page 1400h RAM Map

KeyPress to view = *Column* + *Row*

AB3418 TRANSMIT BUFFER

	150	151	152	153	154	155	156	157	158	159	15A	15B	15C	15D	15E	15F	
0	TXBUF																0
1																	1
2																	2
3																	3
4																	4
5																	5
6																	6
7																	7
8																	8
9																	9
A																	A
B																	B
C																	C
D																	D
E																	E
F																	F
	150	151	152	153	154	155	156	157	158	159	15A	15B	15C	15D	15E	15F	

Page 1500h RAM Map

KeyPress to view = *Column* + *Row*

TMC COMMUNICATIONS BUFFER

	160	161	162	163	164	165	166	167	168	169	16A	16B	16C	16D	16E	16F	
0	TMCBUF																0
1																	1
2																	2
3																	3
4																	4
5																	5
6																	6
7																	7
8																	8
9																	9
A																	A
B																	B
C																	C
D																	D
E																	E
F																	F
	160	161	162	163	164	165	166	167	168	169	16A	16B	16C	16D	16E	16F	

Page 1600h RAM Map

KeyPress to view = *Column* + *Row*

SYSTEM DETECTION

	180	181	182	183	184	185	186	187	188	189	18A	18B	18C	18D	18E	18F	
0	FRAME	SCRATCH				SYSCNT				SVOL0L	SVOL0	SOCC0L	SOCC0	SYSTMP		SYSACC	0
1	PERIOD									SVOL1L	SVOL1	SOCC1L	SOCC1				1
2	STMP1									SVOL2L	SVOL2	SOCC2L	SOCC2				2
3	STMP2									SVOL3L	SVOL3	SOCC3L	SOCC3				3
4	STMP3									SVOL4L	SVOL4	SOCC4L	SOCC4				4
5	STMP4									SVOL5L	SVOL5	SOCC5L	SOCC5				5
6	STMP5									SVOL6L	SVOL6	SOCC6L	SOCC6				6
7	STMP6									SVOL7L	SVOL7	SOCC7L	SOCC7				7
8	SVOL07									SVOL8L	SVOL8	SOCC8L	SOCC8				8
9	SVOL8F									SVOL9L	SVOL9	SOCC9L	SOCC9				9
A	SOCC07									SVOLAL	SVOLA	SOCCAL	SOCCA				A
B	SOCC8F									SVOLBL	SVOLB	SOCCBL	SOCCB				B
C										SVOLCL	SVOLC	SOCCCL	SOCCC				C
D										SVOLDL	SVOLD	SOCCDL	SOCCD				D
E										SVOLEL	SVOLE	SOCCEL	SOCCE				E
F										SVOLFL	SVOLF	SOCCFL	SOCCF				F
	180	181	182	183	184	185	186	187	188	189	18A	18B	18C	18D	18E	18F	

Page 1800h RAM Map

KeyPress to view = *Column* + *Row*

DIAGNOSTICS/MISCELLANEOUS

	190	191	192	193	194	195	196	197	198	199	19A	19B	19C	19D	19E	19F	
0	12UVEL	12UAVG	DWNTIM	RRTIM	STPTIM	INTMAP	TMC01C	LOC01C	STOP1	RAXMAP	RBXMAP	CMUMAP		S2KERR	ABFLAG	LASTAT	0
1	J2UVEL	J2UAVG	↓	↓	↓	↓	TMC02C	LOC02C	STOP2	↓	↓	↓		S2KCNT	PWRFLG	ABSTAT	1
2	I6UVEL	I6UAVG	↓	↓	↓	↓	TMC03C	LOC03C	STOP3	↓	↓	↓		"	RESFLG	ENSTAT	2
3	J6UVEL	J6UAVG	↓	↓	↓	↓	TMC0C	LOC04C	STOP4	↓	↓	↓		S2KCXT	MSGFLG	CRIT	3
4	I2LVEL	I2LAVG	↓	↓	↓	↓	TMC05C	LOC05C	STOP5	↓	↓	↓		S2LAST	COMERR	PRSTAT	4
5	J2LVEL	J2LAVG	↓	↓	↓	↓	TMC06C	LOC06C	STOP6	↓	↓	↓		S2KTMR	PASTMR	NCRIT1	5
6	I6LVEL	I6LAVG	UPTIME	EVTIME		↓	TMC07C	LOC07C	STOP7	↓	↓	↓				NCRIT2	6
7	J6LVEL	J6LAVG	↓	↓		↓	TMC10C	LOC10C	FAZMAP	↓	↓	↓				NCRIT3	7
8	I2UCNT	I1VEL	↓	↓		↓	TMC11C	LOC11C	↓	↓	↓	↓				SSTAT1	8
9	J2UCNT	I1LVEL	↓	↓		↓	TMC12C	LOC12C	↓	↓	↓	↓				SSTAT2	9
A	I6UCNT		↓	↓		↓			↓	↓	↓	↓					A
B	J6UCNT		↓	↓		↓			↓	↓	↓	↓					B
C	I2LCNT		DWNMIN			↓			↓	↓	↓	↓					C
D	J2LCNT		DWNSEC			↓			↓	↓	↓	↓					D
E	I6LCNT		NOVRED			↓	ROMPAG	ROMSUM	↓	↓	↓	↓					E
F	J6LCNT	N17TST	NOVRIT			↓	"		↓	↓	↓	↓					F
	190	191	192	193	194	195	196	197	198	199	19A	19B	19C	19D	19E	19F	

Page 1900h RAM Map

KeyPress to view = *Column* + *Row*

TROUBLE SHOOTING BUFFER

	7B0	7B1	7B2	7B2	7B4	7B5	7B6	7B7	7B8	7B9	7BA	7BB	7BC	7BD	7BE	7BF	
0	TSBUFF																0
1																	1
2																	2
3																	3
4																	4
5																	5
6																	6
7																	7
8																	8
9																	9
A																	A
B																	B
C																	C
D																	D
E																	E
F																	F
	7B0	7B1	7B2	7B3	7B4	7B5	7B6	7B7	7B8	7B9	7BA	7BB	7BC	7BD	7BE	7BF	

Page 7B00 RAM Map

KeyPress to view = *Column* + *Row*

APPENDIX G. CHECKSUM MAPS

PHASE TIMING/INTERSECTION CONTROL AND CONFIGURATION

	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	
0	CPYFRM	FZ1TMG	FZ2TMG	FZ3TMG	FZ4TMG	FZ5TMG	FZ6TMG	FZ7TMG	FZ8TMG	SYSNUM	RAWALK	RBWALK			MNSTFZ	PERMIT	0
1	CPYTO									PORT1A	RADWLK	RBDWLK		ASSOC1	SDSTFZ	RLOCK	1
2										PORT2A	RAMGRN	RBMGRN		ASSOC2	PED2	YLOCK	2
3										PORT3A	RAQULM	RBQULM		ASSOC3	PED4	VRCALL	3
4	PRGNUM									PORT4A	RAINIT	RBINIT		ASSOC4	PED6	VXCALL	4
5	VRSION									PORT1X	RAVEXT	RBVEXT		ASSOC5	PED8	GREST	5
6	RRSTIM									PORT2X	RATBRT	RBTBRT		ASSOC6	PEDA	RREST	6
7	GRSTIM									PORT3X	RACGAP	RBCGAP		ASSOC7	PEDB	BARIER	7
8	GRSTMR									PORT4X	RACMAX	RBCMAX		ASSOC8	PREST	DBLENT	8
9	ALLRED										RASEC	RBSEC		CALLΦY	STA	XCLUSV	9
A	SPFUNC										RACINT	RBCINT		CALL2Y		RSTRCT	A
B	NMICNT										RARREV	RBRREV		UFLAG		LLAROW	B
C	PLONG										RARRST	RBRRST		GRNOFF		LAGFRE	C
D	PSHORT										RASTPT	RBSTPT		YELOFF	DRWYFZ	FAZ1ST	D
E	REDALL										RAYCLR	RBYCLR		YRNGFZ	DRWY2H	START	E
F	REDREV										RARCLR	RBRCLR		YRNGOL	DRWYOL	STRTOL	F
	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	

Page 0100h Checksum/Copy Mask

TIMING SHEET DATA

DYNAMIC DATA

WWV CONTROL/DETECTORS

	20	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F	
0	TXMSG	DETIDX	DETJDX	DETICO	DETJCO	DETIVA	DETJVA	DTIDTM	DTFJTM	DTICTM	DTJCTM	IDETFZ	JDETFZ	IDETAT	JDETAT		0
1	WHOUR																1
2	WMIN																2
3	WSEC																3
4	WMONTH																4
5	WDAY																5
6	WYEAR																6
7	HOUR																7
8	MINUTE															DELOP1	8
9	SECOND															DELOP2	9
A	MONTH																A
B	DAY																B
C	YEAR																C
D	DOW																D
E	TMCCLK																E
F	WWVCLK																F
	20	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F	

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TIMING SHEET DATA

DYNAMIC DATA

PREEMPTION/OVERLAPS/WWV BUFFERS

	30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3D	3E	3F	
0	DELAY	EVADLY	EVBDLY	EVCDLY	EVDDLY		RRSEL		RRACNT	EVFLAG	RRFAZ		PRELIT		WTIME		0
1	ACTIVE	EVAACT	EVBACT	EVCACT	EVDACT		RR1RED		RRBCNT	EVAFAZ	RREXIT		MANOMT	BYTTIM			1
2	CLEAR	EVACLR	EVBCLR	EVCCLR	EVDCLR		RRCLR		EVACNT	EVBFAZ	RRPED		LAGMAN	TXDLAY			2
3	MAX	EVAMAX	EVBMAX	EVCMAX	EVDMAX		RRMAX		EVBCNT	EVCFAZ	RRBLIM	RRCNTL	XCLMSK	REGX			3
4	LINK	EVALNK	EVBLNK	EVCLNK	EVDLNK		RRLNK		EVCCNT	EVDFAZ		RRSTAT		"			4
5	EVCLR	EVAMIN	EVBMIN	EVCMIN	EVDMIN		MRKTIM		EVDCNT	SAVVEH		RRPRE		BUFPNT			5
6		EVATMR	EVBTMR	EVCTMR	EVDTMR		MRKTMR		MANCNT			EVSTAT		"			6
7							RRMIN			EVPRE		EVMAX		TXTIME			7
8							RRSEC			EVACT		ENTFLG		TXBC			8
9	MANCON						RRDLY			EVOLDE		PRESTT		RXBC			9
A	OLALOD	OLADLY	OLAGRN	OLAYEL	OLARED	OLATMR	OADTMR		OLAREV	DYNOLA	OVLPA	AGOMIT	RROLA	EVOLA			A
B	OLBLOD	OLBDLY	OLBGRN	OLBYEL	OLBRED	OLBTMR	OBDTMR		OLBREV	DYNOLB	OVLPB	BGOMIT	RROLB	EVOLB			B
C	OLCLOD	OLCDLY	OLCGRN	OLCYEL	OLCRED	OLCTMR	OCDTMR		OLCREV	DYNOLC	OVLPC	CGOMIT	RROLC	EVOLC			C
D	OLDLOD	OLDDLY	OLDGRN	OLDYEL	OLDRED	OLDTMR	ODDTMR		OLDREV	DYNOLD	OVLPD	DGOMIT	RROLD	EVOLD			D
E	OLELOD	OLEDLY	OLEGRN	OLEYEL	OLERED	OLETMR	OEDTMR		OLEREV	DYNOLE	OVLPE	EGOMIT	RROLE	EVOLE			E
F	OLFLOD	OLFDLY	OLFGRN	OLFYEL	OLFRED	OLFTMR	OFDTMR		OLFREV	DYNOLF	OVLPF	FGOMIT	RROLF	EVOLF			F
	30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3D	3E	3F	

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TIMING SHEET DATA

DYNAMIC DATA

Set ZIPCRD (location 7-A-D) = 001
to activate this RAM configuration

	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	
		PLAN 1	**PLAN 2**	**PLAN 3**	**PLAN 4**	**PLAN 5**	**PLAN 6**	**PLAN 7**	**PLAN 8**	**PLAN 9**							
0	SYSMAN	CYCLE	→	→	→	→	→	→	→	→							0
1	LOCMAN	FORCE1	→	→	→	→	→	→	→	→							1
2	MASPLN	FORCE2	→	→	→	→	→	→	→	→							2
3	LOCPLN	FORCE3	→	→	→	→	→	→	→	→							3
4	TMCPLN	FORCE4	→	→	→	→	→	→	→	→							4
5	TODPLN	FORCE5	→	→	→	→	→	→	→	→							5
6	TODSPF	FORCE6	→	→	→	→	→	→	→	→							6
7	TODTBL	FORCE7	→	→	→	→	→	→	→	→							7
8	MINCYC	FORCE8	→	→	→	→	→	→	→	→							8
9	MAXCYC	FREE	→	→	→	→	→	→	→	→							9
A	MASCYC																A
B	LOCCYC																B
C	NEWOFF																C
D	CUROFF																D
E	LMSTER																E
F	LLOCAL																F
	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	

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(when using Zip Coord)

TIMING SHEET DATA

DYNAMIC DATA

		CYCLE/INTERVALS			PLAN 1 FLAGS				PLAN 2 FLAGS				PLAN 3 FLAGS				
	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	
0	SYSMAN	PLAN1X	PLAN2X	PLAN3X	P1FRCE	P1HOLD	P1PRST	P1CALL	P2FRCE	P2HOLD	P2PRST	P2CALL	P3FRCE	P3HOLD	P3PRST	P3CALL	0
1	LOCMAN																1
2	MASPLN																2
3	LOCPLN																3
4	TMCPLN																4
5	TODPLN																5
6	TODSPF																6
7	TODTBL																7
8	MINCYC																8
9	MAXCYC																9
A	MASCYC																A
B	LOCCYC																B
C	NEWOFF																C
D	CUROFF																D
E	LMSTER																E
F	LLOCAL	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	F
	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	

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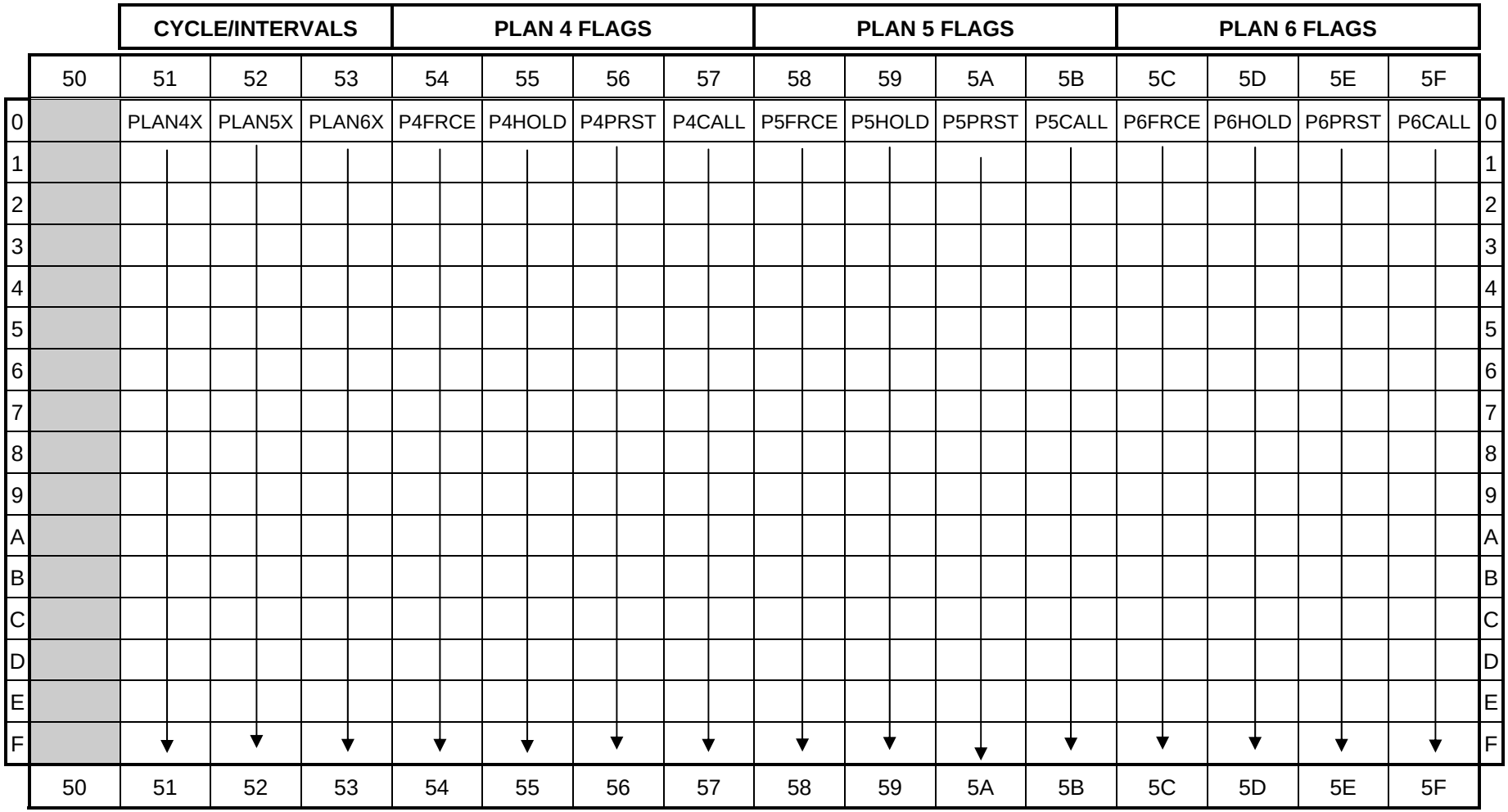
TIMING SHEET DATA

DYNAMIC DATA



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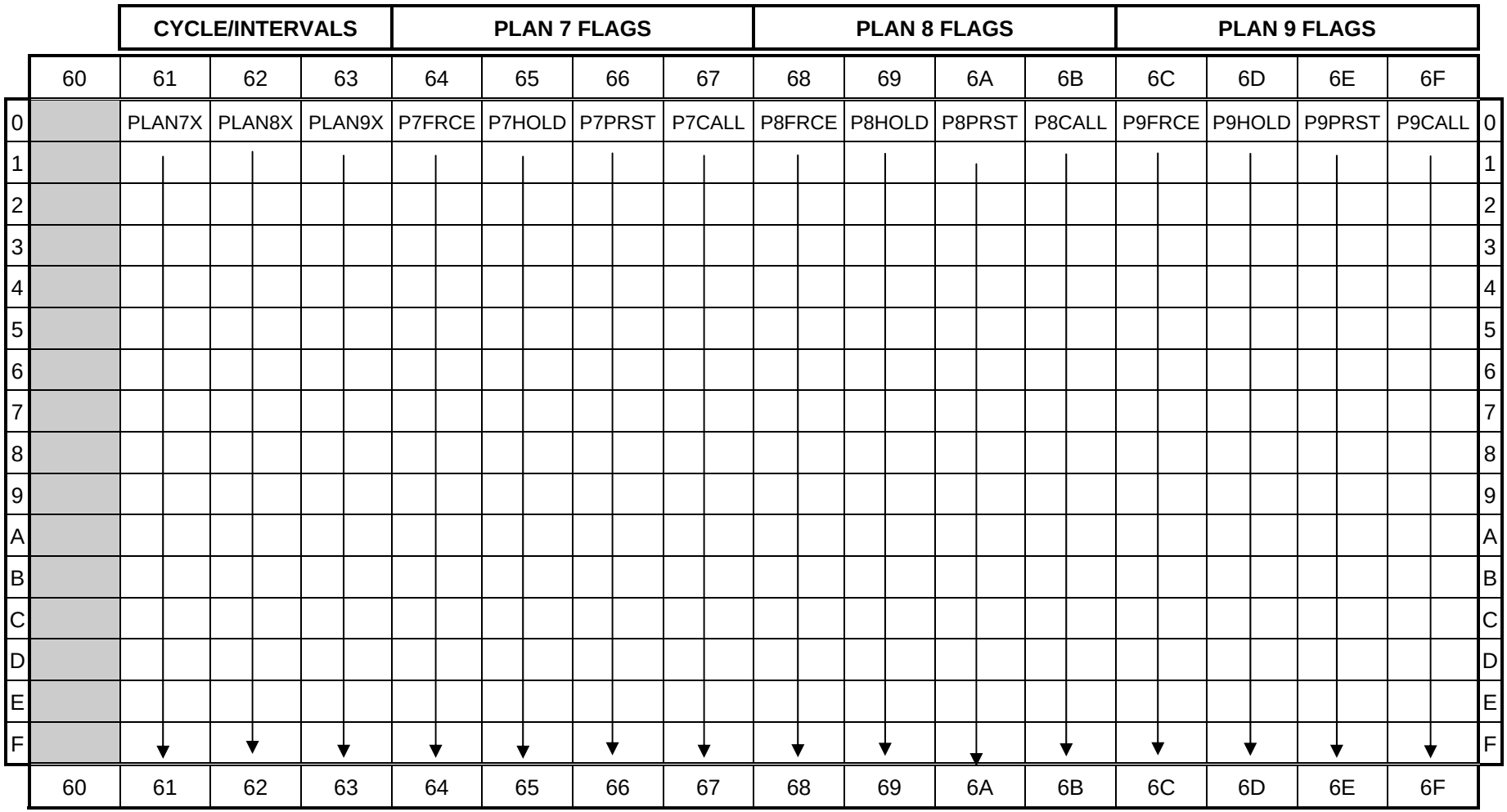
TIMING SHEET DATA

DYNAMIC DATA



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TIMING SHEET DATA

DYNAMIC DATA

COORDINATION ATTRIBUTES

	70	71	72	73	74	75	76	77	78	79	7A	7B	7C	7D	7E	7F	
0	LAG0	LAG1	LAG2	LAG3	LAG4	LAG5	LAG6	LAG7	LAG8	LAG9	OFFST0	CYCLEN			SICBIT	DIALX	0
1	VCALL0	VCALL1	VCALL2	VCALL3	VCALL4	VCALL5	VCALL6	VCALL7	VCALL8	VCALL9	OFFST1	PLNTMC			CORDM	"	1
2	PCALL0	PCALL1	PCALL2	PCALL3	PCALL4	PCALL5	PCALL6	PCALL7	PCALL8	PCALL9	OFFST2	MSYNC			CORDE	SYSDLX	2
3	VXCAL0	VXCAL1	VXCAL2	VXCAL3	VXCAL4	VXCAL5	VXCAL6	VXCAL7	VXCAL8	VXCAL9	OFFST3				CORDO	"	3
4	BARCL0	BARCL1	BARCL2	BARCL3	BARCL4	BARCL5	BARCL6	BARCL7	BARCL8	BARCL9	OFFST4				CORDF	FORCEX	4
5	GRNCL0	GRNCL1	GRNCL2	GRNCL3	GRNCL4	GRNCL5	GRNCL6	GRNCL7	GRNCL8	GRNCL9	OFFST5				FLOATB	"	5
6	GRN20	GRN21	GRN22	GRN23	GRN24	GRN25	GRN26	GRN27	GRN28	GRN29	OFFST6				ADAPTV		6
7											OFFST7				MAX2		7
8	NOMAX0	NOMAX1	NOMAX2	NOMAX3	NOMAX4	NOMAX5	NOMAX6	NOMAX7	NOMAX8	NOMAX9	OFFST8				FUNTMR		8
9	RDRST0	RDRST1	RDRST2	RDRST3	RDRST4	RDRST5	RDRST6	RDRST7	RDRST8	RDRST9	OFFST9						9
A	OMIT0	OMIT1	OMIT2	OMIT3	OMIT4	OMIT5	OMIT6	OMIT7	OMIT8	OMIT9	OFFPLN						A
B	OMTSD0	OMTSD1	OMTSD2	OMTSD3	OMTSD4	OMTSD5	OMTSD6	OMTSD7	OMTSD8	OMTSD9	MSPHR						B
C	CONDS0	CONDS1	CONDS2	CONDS3	CONDS4	CONDS5	CONDS6	CONDS7	CONDS8	CONDS9	MSPMIN						C
D											ZIPCRD						D
E																	E
F																CRDDIS	F
	70	71	72	73	74	75	76	77	78	79	7A	7B	7C	7D	7E	7F	

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TIMING SHEET DATA

DYNAMIC DATA

	TOD TABLE 0				TOD TABLE 1				TOD TABLE 2				TOD TABLE 3				
	100	101	102	103	104	105	106	107	108	109	10A	10B	10C	10D	10E	10F	
0	TABLE0				TABLE1				TABLE2				TABLE3				0
1																	1
2																	2
3																	3
4																	4
5																	5
6																	6
7																	7
8																	8
9																	9
A																	A
B																	B
C																	C
D																	D
E																	E
F																	F
	100	101	102	103	104	105	106	107	108	109	10A	10B	10C	10D	10E	10F	

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TIMING SHEET DATA

DYNAMIC DATA

TOD TABLE 4				ANNUAL TABLE 5				FLOAT TABLE 6				EXCEPTION TABLE 7			
110	111	112	113	114	115	116	117	118	119	11A	11B	11C	11D	11E	11F
TABLE4				TABLE5				TABLE6				TABLE7			
110	111	112	113	114	115	116	117	118	119	11A	11B	11C	11D	11E	11F

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TIMING SHEET DATA

DYNAMIC DATA

	FUTURE TABLE 8				FUTURE TABLE 9				PROGRAMMABLE LOGIC								
	120	121	122	123	124	125	126	127	128	129	12A	12B	12C	12D	12E	12F	
0	TABLE8				TABLE9				INAA1	OUTAA1	INAA2	OUTAA2	INAA3	OUTAA3	INAA4	OUTAA4	0
1																	1
2																	2
3																	3
4																	4
5																	5
6																	6
7																	7
8																	8
9																	9
A																	A
B																	B
C																	C
D																	D
E																	E
F																	F
	120	121	122	123	124	125	126	127	128	129	12A	12B	12C	12D	12E	12F	

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TIMING SHEET DATA

DYNAMIC DATA

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