I. INTRODUCTION

1. The Econolite Model D-4000 Controller is a four-phase unit providing up to four sequential phases with the capabilities of up to four pedestrian movements, with provisions for lead-lag movements. It features modular design yielding maximum flexibility in its applications. The D-4000 is recommended for control of two, three, and four phase intersections utilizing full or semi actuated modes with the following modular options:

a. Actuated vehicle with Pedestrian

b. Actuated vehicle without Pedestrian

c. Modified density module

Figure 11401 Model D-4444 Controller

2. Solid state design utilizing DTL and TTL type integrated circuits provide trouble-free long-life operation as well as easy programming. One of the outstanding features of the D-4000 is the flexibility provided by the module options. By selecting the required module complement, the Traffic Engineer can tailor the D-4000 to virtually any semi actuated or fully actuated intersection configuration he requires.

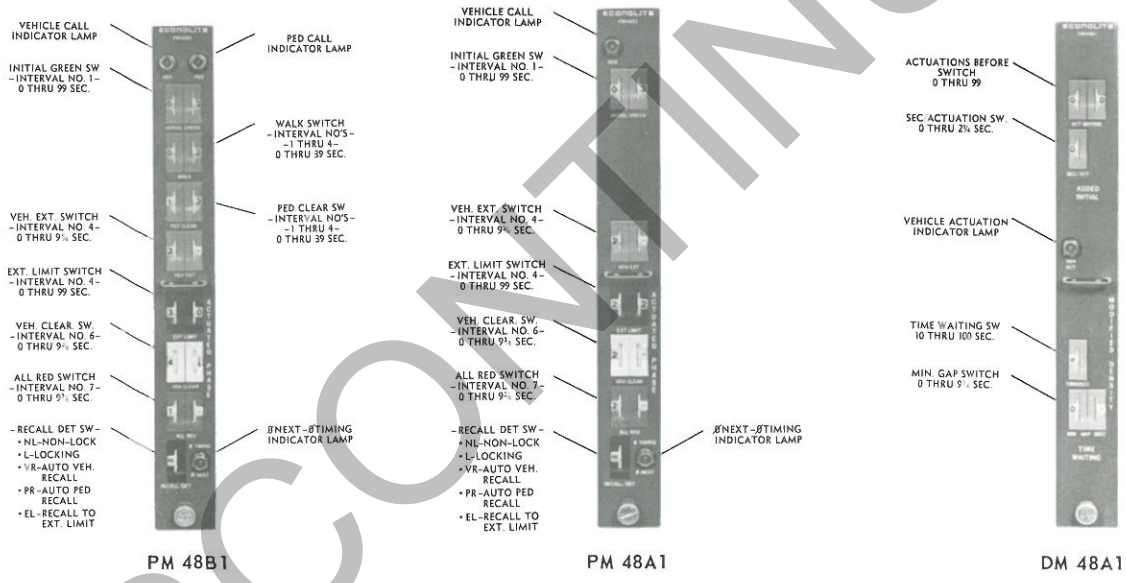


Figure 11402 "Building block" Modules

II. GENERAL DESCRIPTION

1. The D-4000, being of modular design, is in most cases fitted with the modules required by the Traffic Engineer for a specific intersection. This yields a myriad of module-combinations that are identified by the model numbering system which is explained in the catalog price section (page 11491).

2. Operational features of the D-4000 series controllers encompass the full spectrum of capabilities required in controlling a complex intersection. Listed below are some of the more outstanding capabilities of this versatile machine.

a. Stop Time - This input is provided so that the timing of any interval may be stopped at any point in the interval for the purpose of adding extra intervals in the phase by means of auxiliary equipment. When stop time voltage is applied (+24V dc), the detector circuits and associated density timing and logic circuits shall continue in operation. The interrupted interval shall be retimed completely when stop time voltage is removed.

b. Hold - Four inputs shall be provided so that a phase timing module may be held in the rest position by the application of external voltage (+24V dc). The phase timing module will remain in the rest position even though a demand exists on other phases. When the hold voltage is removed by a coordinator or other auxiliary device, the controller will then serve the demand on the other phases subject to vehicle actuations if detectors on the held phase are being utilized. If the phase module is in the semi actuated mode, then the release of hold will cause the phase module to advance from rest to the green transfer position. While in the rest position, the phase being held will show a green and/or walk indication.

c. Force Off - When +24V dc is applied to the force-off input, the phase module that is currently timing will be forced into the vehicle clearance period from any interval except INITIAL, ADDED INITIAL, and WALK intervals. This input is usually implemented by an auxiliary device for coordination purposes. Whenever a phase is forced off, a vehicle detection is placed on that phase.

d. Omit All Red - By applying +24V dc to this input, the all red clearance interval is omitted even though a time is set on the all red switch.

e. Manual - This input is provided so that an intersection may be manually controlled. A pulsed ground input will step the

controller through its various intervals. The controller is usually placed in stop time for manual control. Calls are placed on all phases for manual operation.

f. Omit Manual - By placing a voltage (+24V dc) on this input, the controller can be manually advanced only to those phases where a demand exists.

g. Semi-actuated Mode (K Feature) - When voltage (+24V dc) is applied to this input, the ØA module in the controller will operate in a semi actuated mode even though the phase module is fully actuated, vehicle and pedestrian. The pedestrian and vehicle detectors will be inhibited and the WALK indication will come on at the beginning of green and will stay on until the phase is released. This indication will then change to flashing DON'T WALK which will be timed by the pedestrian clearance interval timer then advancing into vehicle clearance ignoring the vehicle extension and extension limit timing. When no pedestrian timing is used the phase module will time the INITIAL GREEN interval and advance into the REST interval until a demand exists on the other phases. If the HOLD input is not applied, the controller will then advance into green transfer and vehicle clearance ignoring the VEHICLE EXTENSION and EXTENSION LIMIT timing. It may be seen that this mode is used whenever coordination is required.

h. Semi-actuated Mode (K Feature Other) - This input may be used to control phases other than ØA. The operation is the same as described for SEMI ACTUATED MODE (K FEATURE).

i. 12V ac - Output voltage which may be used for special applications.

j. +24V dc - Output which is used to power external devices such as solid state switches or Econologic.

k. Call Away - The controller normally rests in phase green of the last phase to receive a call. Upon other phase demands this phase will time a clearance period before advancing to the next phase. When a voltage (+24V dc) is applied to this input the controller will assume a rest in red condition after all demand has been satisfied. The first phase to receive a

call will immediately advance to green and after satisfying the demand will return to all red until other phases receive detections. This feature may be utilized during periods of light traffic to eliminate the necessity of waiting through a vehicle clearance interval before transferring to the phase with a call.

l. Guaranteed Passage Time - This feature provides the option of adding the balance of time between the MINIMUM GAP interval and the VEHICLE EXTENSION interval in the event of gap out as a result of the TIME WAITING GAP REDUCTION feature. If gap out has occurred at the end of a platoon of traffic, the extra green time allows the last car of that platoon sufficient time to clear the intersection before terminating phase green. No vehicle call is left on the phase. This feature is in effect when GUARANTEED PASSAGE TIME input is grounded.

m. 5k Hz - This output is used in conjunction with solid state switches.

n. 4 PPS Clock Pulses - Output which puts out four pulses per second and may be used to time auxiliary devices.

o. Extension Limit Inhibit - This feature allows external logic, timers, or coordinators to time the extension limit portion of a phase which is timing. When the EXTENSION LIMIT INHIBIT input is grounded, the timing operation of the extension limit timer within the controller is inhibited. A FORCE OFF command should be applied to terminate the external extension limit timing interval. This feature is used whenever a coordinator is used in conjunction with the controller.

p. External Start/ Pre-empt - When voltage (+24V dc) is applied to this input, the controller will immediately go to a preselected restart condition; i.e., main street amber. When this command is applied the controller does not advance through, or time any vehicle or pedestrian clearance intervals. All controller timers are reset to zero.

q. Special Skip - Whenever ground is applied to this input, the associated phase module will be skipped even though a call exists. The phase module that has special skip applied to it may still receive a detection and place it in memory. This call will be served whenever the skip condition is removed. This mode is used whenever a change from normal phase rotation is required.

r. Check - A separate output from each phase module which indicates the presence of a detection in its memory.

s. A five position function select switch located on each Actuated Phase Module provides the following positions:

(1). NL - Non-locking detectors for use with presence type detectors. A Call is registered only when a vehicle is present in the detection area.

(2). L - Locking detectors for use with pulse-type detectors. Any call is locked in memory until the phase has been answered.

(3). VR - Automatic vehicle recall for the phase.

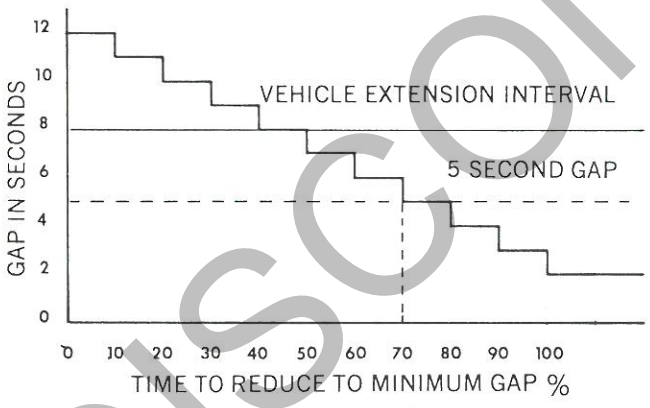
(4). PR - Automatic pedestrian recall for the phase. If this switch setting is used on an Actuated Phase Module without pedestrian timing, it becomes a VR (automatic vehicle recall).

(5). EL - Recall to Extension Limit. This setting causes the full Extension Limit to be timed by simulating the continuous presence of a vehicle actuation from the street.

t. Coded Interval Bits (three for Primary Phases and three for Secondary Phases) are brought out of the controller which may be easily decoded to give the exact interval timing at any point in time. The truth table is as follows:

Interval Bits			Interval Timing
C	B	A	
1	0	0	Initial Green
0	1	1	Added Initial
0	1	0	Rest
0	0	1	Veh/Ext. Limit
0	0	0	Green Transfer
1	1	1	Vehicle Clearance
1	1	0	All Red
1	0	1	Red Transfer

1 = +24V dc
0 = 0V dc



1. Maximum gap is equal to the Vehicle Extension Interval (8 seconds).
2. After 80 seconds (100% of Time to Reduce) minimum gap will remain at 2 seconds.
3. 5 second minimum gap occurs after 70% of Time To Reduce to Minimum Gap has expired.

SETTINGS:

VEHICLE EXTENSION INTERVAL: 8 Seconds
MINIMUM GAP: 2 Seconds
TIME TO REDUCE: 80 Seconds
FIND: Time to reduce to a 5 second gap
SOLUTION:

$$T_1 = \frac{T_2 (C + G_2 - G_1)}{10}$$

$$T_1 = \frac{80 (10 + 2 - 5)}{10}$$

T_1 = 56 Seconds
T_1 = Time to reduce to any gap
T_2 = Time to reduce to minimum gap
G_1 = Gap in seconds
G_2 = Minimum Gap
C = Constant of 10 seconds

Figure 11403 Digital Method of Reducing to Minimum Gap

III. REFERENCE DATA

1. General: These specifications describe the requirements for a multi-phase (2, 3, or 4 phase) controller that utilizes integrated circuitry, digital timing, and modular construction.

2. Case: All modules shall be housed in an attractive aluminum housing having the following dimensions: Height: 19"; Width: 15 1/2"; Depth: 9 3/4". A printed circuit motherboard containing connectors for 13 modules shall be mounted at the rear of the case.

3. Modules: Each module shall be easily removable from the front of the controller without the use of special tools. Each controller shall contain the following modules: 1 power supply module, 1 input interface module, 1 output interface module, 1 sequence control module, 1 interval control module and at least 2 phase timing modules. Modules shall be available so that any or all of the phases will operate with or without actuated pedestrian timing, and with or without modified density.

4. Power Supply Module: The fuse protected power supply shall provide the necessary regulated voltages and currents required for proper internal and external controller operation. The power supply shall also provide over-voltage and short circuit protection.

5. Input and Output Interface Modules: Separate input and output interface modules which are mechanically keyed to prevent improper module insertion into the controller shall be provided. Each module shall contain all necessary level shifter and buffer circuitry. In addition, each module shall be provided with an MS type connector which shall also be keyed to prevent improper interface connections at the controller.

6. Actuated Vehicle Module: The actuated vehicle module shall contain rotary thumbwheel switches for setting the length of each interval to be timed by the module; initial interval, vehicle interval, extension limit, vehicle clearance interval, and all red interval. Two indicator lights shall be provided; one to indicate a vehicle call, the other shall flash during the preceding vehicle clearance interval when this phase is next, and it shall be illuminated while this phase is timing. A five position rotary switch for setting the non-lock, lock, vehicle recall and extension limit mode shall be provided.

7. Actuated Vehicle and Pedestrian Module: In addition to the switches and indicators found on actuated vehicle module, this module shall provide a pedestrian call indicator light, switch for pedestrian recall, walk and pedestrian clearance intervals.

8. Modified Density Module: The modified density module shall contain the rotary switches and circuitry to provide added initial interval timing and time waiting-gap reduction timing, and an indicator light which flashes at each vehicle actuation on this phase.

9. Sequence Control Module: The sequence control module shall determine and establish the phase order.

10. Interval Control Module: The interval control module shall determine and establish the interval order. This module shall contain the necessary indicator lights to indicate the controller interval.

11. Timing Periods: The following adjustable time periods shall be provided:

12. Actuated Vehicle Module:

a. Initial Interval: 0-99 seconds

b. Vehicle Extension: 0-9 3/4 seconds

c. Extension Limit: 0-99 seconds

d. Vehicle Clearance: 0-9 3/4 seconds

e. All Red: 0-9 3/4 seconds

13. Actuated Vehicle and Pedestrian Module:

a. Initial Interval: 0-99 seconds

b. Walk Interval: 0-39 seconds

c. Pedestrian Clearance: 0-39 seconds

d. Vehicle Extension: 0-9 3/4 seconds

e. Extension Limit: 0-99 seconds

f. Vehicle Clearance: 0-9 3/4 seconds

g. All Red: 0-9 3/4 seconds

14. Modified Density:

a. Actuations Before: 0-99 seconds

b. Seconds Per Actuation: 0-2 1/4 seconds

c. Time Waiting: 10-100 seconds

d. Minimum Gap: 0-9 3/4 seconds

15. Power Requirements: The controller shall operate on a 120V 60 Hz power source, and shall not consume more than 150 watts of power.

16. Signal Control Outputs: Each signal control output shall be capable of operating one 170-220 ohm relay or several solid state switches ar 24V dc.

17. Calibration Accuracy and Temperature Range: The accuracy of each program shall correspond to the accuracy of the 60 Hz AC Source without variance, with an ambient temperature range of -30°F. to +165°F., with an input voltage range of 105V to 130V.