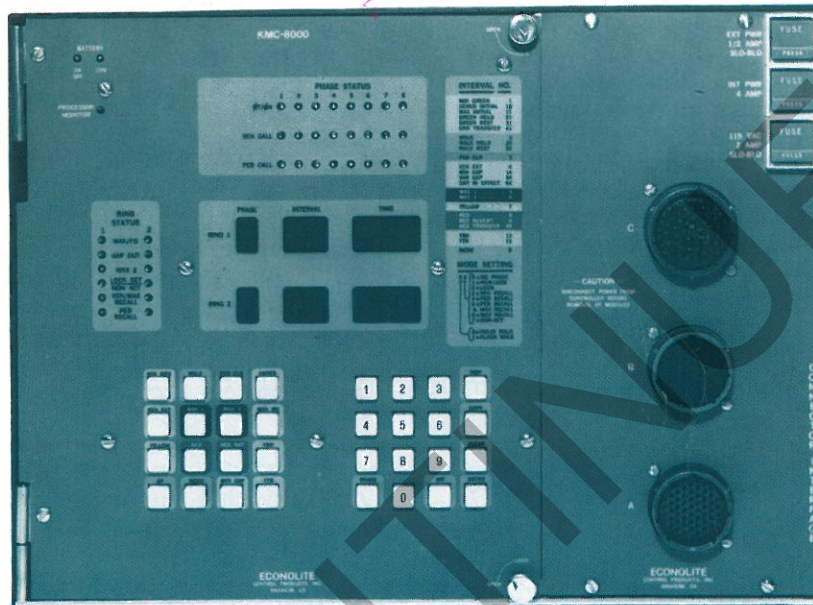## KMC SERIES PROGRAMMABLE MULTIPHASE ACTUATED TRAFFIC CONTROLLERS

- *COMPACT MICROCOMPUTER DESIGN*
- *SIMPLE KEYBOARD PROGRAMMING*
- *PROGRAMMABLE PHASE SEQUENCE*
- *DIGITAL TIMING ACCURACY*
- *INTEGRATED CIRCUIT RELIABILITY*
- *MODULAR CONSTRUCTION*

- *EXPANDED RANGE OF FUNCTIONS*
- *FEWER MODULES*
- *SMALLER SIZE*
- *LOWER COST*
- *COMPLETE FAMILY CONSISTING OF 2, 4, AND 8 PHASE MODELS*

DESIGN
The KMC series controller is a microcomputer-based system structured to function as a full or semiactuated traffic controller. The design makes full use of Econolite's extensive experience with the use of large scale integration (LSI) circuits and the application of microprocessor technology and innovative modular, solid state construction techniques. The introduction of the KMC series into the new family of Econolite controllers expands the product line of compact, low-cost, and reliable equipment that meets, and in many cases, exceeds NEMA standards.

RELIABILITY
Extensive use of LSI circuits and of other state-of-the-art components reduces wiring and parts to a minimum. These factors add up to less power dissipation and a reduction in discrete part failure. Simple and easy to learn keyboard programming assures the reliability of selectable values.

ACCURACY
Digital timing, synchronized to the time base of the 60 Hz power line frequency, assures repeat timing and interval timing accuracy.

VERSATILITY
Versatility of the KMC series controller has been achieved by the use of one basic frame assembly which is designed to accept a number of different plug-in modules. These modules allow the controller to be configured in three basic models:

KMC-2000 — 2 phases
KMC-4000 — 4 phases
KMC-8000 — 8 phases

Each of these models contain the same interchangeable modules and can provide fully-actuated, nonactuated, pedestrian, exclusive pedestrian, or modified density modes of operation.

MAINTENANCE
Ease of maintenance has been provided through the modular design concept. This provides rapid troubleshooting through module interchange techniques and assures the highest "in-time service" available today.

KMC SERIES
ABBREVIATED SPECIFICATIONS

GENERAL
These specifications describe the requirements for a multiphase (2 through 8 phases) controller that utilizes integrated circuitry, digital timing, and modular construction.

ENCLOSURE
All modules shall be housed in an attractive enclosure having the following dimensions: Height: 10½"; Width: 14¼"; Depth: 10½". A printed circuit motherboard containing connectors for three modules shall be mounted at the rear of the enclosure.

MODULES
Each module shall be easily removable from the front of the controller without the use of special tools. A standard controller will be provided with the following:
a. One processor module
b. One I/O interface module
c. One keyboard/display module
d. One power supply module

PROCESSOR MODULE
The processor module shall contain the microprocessor, timing and control logic, and both program and data memory circuits. This module shall control all operations of the controller as determined by a fixed set of instructions stored in the program memory.

I/O INTERFACE MODULE
The I/O interface module shall provide controller interface interconnections linking the processor with external input/output signal transfer. This module shall contain latches for storage of information, buffers for logic level shifting between internal controller logic circuits and external circuits and multiplex circuits for routing input data to the processor. In addition, this module shall contain a connector or interface circuit that accepts a NEMA standard overlap programmer card for programming of overlap phases.

KEYBOARD/DISPLAY MODULE
The keyboard/display module shall provide two keyboards for programming the controller and both light emitting diode (LED) indicators and numeric displays that indicate controller status and operation.

POWER SUPPLY MODULE
The fuse protected power supply shall provide the necessary regulated voltages and currents required for proper internal and external controller operation. A voltage monitor circuit shall be provided.

INPUT AND OUTPUT INTERFACE
All inputs and outputs are true at ground and are pulled up to +24 VDC through a 10 K resistor. All outputs shall be capable of sinking 200 milliamps from an inductive load. The interface shall contain MS-type connectors meeting the interface requirements of the NEMA publication TSI-1976 and the proposed part 13 addition.

INDICATORS
Phase Status Indicators
• PHASE ON/PHASE NEXT
• VEHICLE CALL
• PEDESTRIAN CALL
Ring Status Indicators
• MAX OUT/FORCE OFF
• GAP OUT
• MAX 2
• LOCK DET/NONACT
• VEH/MAX RECALL
• PED RECALL
In addition numeric displays shall be provided that indicate phase, interval, and time for each ring.

Controller Status Indicators
• BATTERY SWITCH STATUS
• BATTERY CHARGING STATUS
• PROCESSOR MONITOR

Two keyboards shall be used to control all operator programmable features. These keyboards shall be of a type providing tactile feedback when depressed. Keyboard entered data shall be retained in a nonvolatile memory that shall be capable of storing the data for a minimum of 30 days when power is removed from the controller.

The keyboards shall allow the operator to control the following:
• Selection of phase to be programmed or displayed
• Selection of timing interval to be programmed or displayed
• Interval timing
• Copying a selected interval timing from a phase to all other phases
• Copying all timing from a selected phase to all other phases
• Displaying special intervals such as gap-in effect, time before reduction, and time to reduce
• Automatic display of all controller timing

KEYBOARD PROGRAMMABLE FUNCTIONS
The following time settings shall be keyboard programmable on a per-phase basis:

a. Minimum green — 0-255 seconds
b. Walk — 0-255 seconds
c. Pedestrian clearance — 0-255 seconds
d. Vehicle extension — 0-25.5 seconds
e. Maximum 1 — 0-255 seconds
f. Maximum 2 — 0-255 seconds
g. Yellow clearance — 0-25.5 seconds
h. Red clearance — 0-25.5 seconds
i. Red revert — 2-25.5 seconds
j. Added initial — 0-25.5 seconds per actuation
k. Maximum initial — 0-25.5 seconds
l. Time before reduction — 0-255 seconds
m. Time to reduce — 0-255 seconds
n. Minimum gap — 0-25.5 seconds

In addition, the keyboard shall be capable of programming each phase to operate in the following modes:
a. No phase (i.e., phase inactive)
b. Nonlocking vehicle detector memory
c. Locking vehicle detector memory
d. Vehicle recall
e. Ped recall
f. Recall to max
g. Recall to max plus ped recall
h. Semiactuated
i. Flashing walk

The keyboard shall also be capable of programming the following functions:
a. Power-on flash time
b. Power-on start phases and interval
c. External start phases and interval
d. Assignments of phases to the call-to-nonactuated inputs
e. Guaranteed passage phase assignments
f. Pedestrian movement only phase assignment
g. Simultaneous gap out
h. Dual entry
i. Actuated rest in walk
j. Pedestrian clearance protection during manual control

BACKUP TIMING
All operator controller timing and program data shall be capable of being programmed internally in the controller. This internal programming shall be retained in a programmable read only memory (PROM). Data contained in this PROM shall be transferred to the keyboard programmable memory when power is first applied to the controller.

STANDARD PROGRAMMABLE FUNCTIONS
The controller shall be capable of having the following functions programmed internally. These shall be programmed by a PROM and shall not be changeable or overridden by keyboard entries.
a. Any possible phase sequence within two timing groups, eight phases, and six concurrent groups
b. Guaranteed minimum yellow clearance
c. Guaranteed minimum pedestrian clearance
d. Reset timing on release of stop time
e. Time one vehicle extension after minimum green

POWER REQUIREMENTS
The controller shall operate on a 120 V 60 Hz power source and shall not consume more than 50 watts of power under full load.

CALIBRATION ACCURACY AND TEMPERATURE RANGE
The accuracy of each program shall correspond to the accuracy of the 60 Hz AC source without variance within an ambient temperature range of $-35°F$ to $+165°F$ and with an input voltage range of 95 V to 135 V.

METHOD OF REDUCING TO MINIMUM GAP
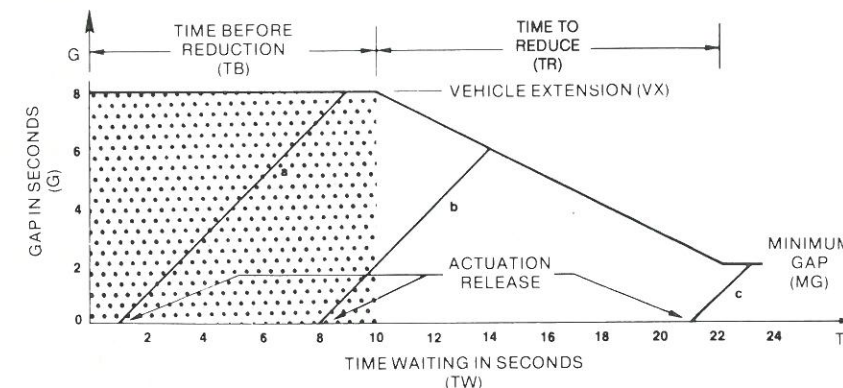
The slope of the reduction is
$$S = \frac{VX - MG}{TR}$$
In this case $S = \frac{8-2}{12} = 0.5$

The gap timed from release of an actuation is given by the following formula.
$$G = \frac{S}{1+S}\left(\frac{VX}{S} + TB - TW\right)$$

The results of the formula are conditioned by the fact that:

1. The maximum gap is equal to VX.
2. The minimum gap is equal to MG.

For instance, of the three examples plotted on the graph, example b gap time is between VX and MG gap time, and is, therefore, not affected by these minimum/maximum limits. Examples a and c, however, show computed gap times that would be affected by the limits.

Computed and actual gap times for the three examples are:

$$G_a = \frac{0.5}{1+0.5}\left(\frac{8}{0.5} + 10 - 1\right) = 8.33 \text{ seconds}$$ (Actual gap is limited to 8 seconds maximum, i.e., equal to VX.)

$$G_b = \frac{0.5}{1+0.5}\left(\frac{8}{0.5} + 10 - 8\right) = 6 \text{ seconds}$$ (Actual gap)

$$G_c = \frac{0.5}{1+0.5}\left(\frac{8}{0.5} + 10 - 21\right) = 1.67 \text{ seconds}$$ (Actual gap is limited to 2 seconds minimum, i.e., equal to MG.)

KMC SERIES
STANDARD FUNCTIONS

PHASE SKIPPING CAPABILITY
Eight phase omit inputs for skipping any phase.

PED SKIPPING CAPABILITY
Eight ped omit inputs for skipping the pedestrian service on any phase.

PHASE HOLDING
Eight hold inputs for coordination and auxiliary logic.

PHASE STATUS OUTPUTS
Eight outputs each indicating phase timing, phase next, and phase check.

STOP TIMING
Two inputs are provided to stop controller timing in either ring.

FORCE OFF
Dual inputs to force the controller out of extendable green in an actuated phase and walk hold in a nonactuated phase.

REST IN RED
Both the primary and secondary phases can be separately called to rest in red in the absence of calls.

OMIT RED CLEARANCE
One input per ring is provided to omit all red timing on all phases within the timing ring.

INHIBIT MAXIMUM TERMINATION
Two inputs to inhibit termination of a phase due to maximum green timing on a per-ring basis.

MAX 2 SELECTION
When this input is applied, the maximum green timing is determined by the MAX 2 settings on a per-ring basis.

EXTERNAL START
One input is provided to cause the controller to revert to its programmed external start initialization phases and interval.

INDICATOR LAMP CONTROL
One input that provides the capability to disable all indicators except battery charging, battery switch status, and processor monitor. This input also inhibits the controller from accepting any information from the keyboards.

PED RECYCLE
One input per timing ring that controls the recycling of pedestrian service.

CLOCK OUTPUTS
Two clock outputs are provided for external use.
a. 1 Hz square wave (flashing logic)
b. 5 Hz

The 1 Hz and 5 Hz are under software control and can be used to indicate processor malfunction.

EXTERNAL MINIMUM RECALL
One input is provided to apply minimum vehicle recall to all phases.

MANUAL CONTROL ENABLE
This input stops interval timing in all intervals except vehicle clearances and places calls on all phases. When used in conjunction with interval advance, the controller can be manually advanced through the green intervals but time the vehicle clearances.

INTERVAL ADVANCE
An input to manually advance the controller.

CALL TO NONACTUATED
Two inputs can be used to call any two sets of phase combinations to nonactuated operation.

WALK-REST MODIFIER
An input that allows a nonactuated phase to rest in walk when no opposing phase calls exist.

OVERLAPS
Outputs are provided for four overlaps, each of which are programmable to any number of phases.

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