CHAPTER 18: TRAFFIC SIGNAL CONTROLLERS

18.1 INTRODUCTION

1 Traffic signals are controlled and switched on and off by electrical or electronic equipment called “traffic signal controllers” (or simply “controllers”). It is normal practice to have a controller for each signalised junction, although one controller may sometimes be used to control signals at two closely space junctions.

2 The controller is essential for the proper and safe operation of a traffic signal. In addition to the basic function of switching signals on and off according to timing plans, it must also be able to prevent green signals being displayed to conflicting traffic movements. When required, the controller must also be able to interface with communication facilities required for co-ordinated control.

3 Traffic signal controllers in South Africa shall comply in all respects with the requirements contained in the South African standard specification SANS 1547: *Traffic signal controllers*.

18.2 CONTROLLER TYPES

1 Various technologies are used in traffic signal controllers. The SANS 1547 specifications classify the technologies as electromechanical, solid state and microprocessor. The controllers are classified as Class A, B and C controllers.

2 Class A electromechanical controllers were the earliest type of controller and use an electrical motor to drive a revolving camshaft that opens and closes electrical contacts. The sequence of signal stages is predetermined and fixed by the sequence of the cam breakouts on the camshaft. These controllers are not generally able to perform the same range of functions as modern electronic controllers. Despite this limitation, however, electromechanical controllers have retained their popularity, mainly because of their robustness.

3 Class B solid state electronic controllers utilise relatively basic transistorised electronic circuitry, although electromechanical relays are used for lamp switching.

4 Class C microprocessor controllers utilise integrated circuits (or microchips) and solid state lamp switching for the control of signals. Some controllers require the “burning” in of programs using various forms of read only memory (ROM). Other controllers utilise general-purpose, industrial type programmable processors that allow software to be readily modified.

18.3 CONTROLLER FUNCTIONS

1 Controllers must be able to serve a variety of functions, not only aimed at improving traffic flow and road safety, but also at reducing the effort required to maintain the traffic signal. Some functions are essential for safe operations, while other functions are provided to improve operational efficiency.

2 Some of the functions of a controller are shown schematically in Figure 18.1. All traffic signal controllers must be capable of providing at least the following minimum subset of functions:

(a) **Manual interface** which allows for the timing of the controller and setting of signal phases. A manual control facility can also be provided.

(b) **Signal timing and phasing** for the control of signal phases and stage intervals.

(c) **Signal switching** which provides for switching each signal light (or groups of signal lights) on or off.

(d) **Conflict monitoring** to prevent a controller giving right of way to conflicting signal groups that could result in traffic accidents.

3 Other additional functions that can optionally be provided by a controller are also shown in Figure 18.1. These are the following:

(a) **Fault monitoring** for the detection of controller and other faults (particularly signal lamps).

(b) **Detector units** used in combinations with vehicle detection devices.

(c) **Communication** functions allowing for communications with other controllers or a central control system.

(d) **Signal synchronisation** used to synchronise traffic signal controllers in a co-ordinate network of traffic signals.

4 A very important requirement of controllers is that they should not lose traffic signal settings in case of power loss or failure. In electronic controllers, this can be achieved by providing non-erasable memory or a backup battery.

18.4 CONFLICT MONITORING

1 Conflict monitoring is an essential function of the controller and is required to prevent a controller giving right of way to conflicting signal groups that could lead to traffic accidents.

2 In electronic controllers, conflict monitoring occurs on the output side of the controller where the power output to signals is monitored. In electromechanical controllers conflict monitoring is provided by locking cams on a single shaft and interlocking of shafts.

3 If it is found that conflicting signals are receiving power at the same time, the signal is switched to flashing mode.

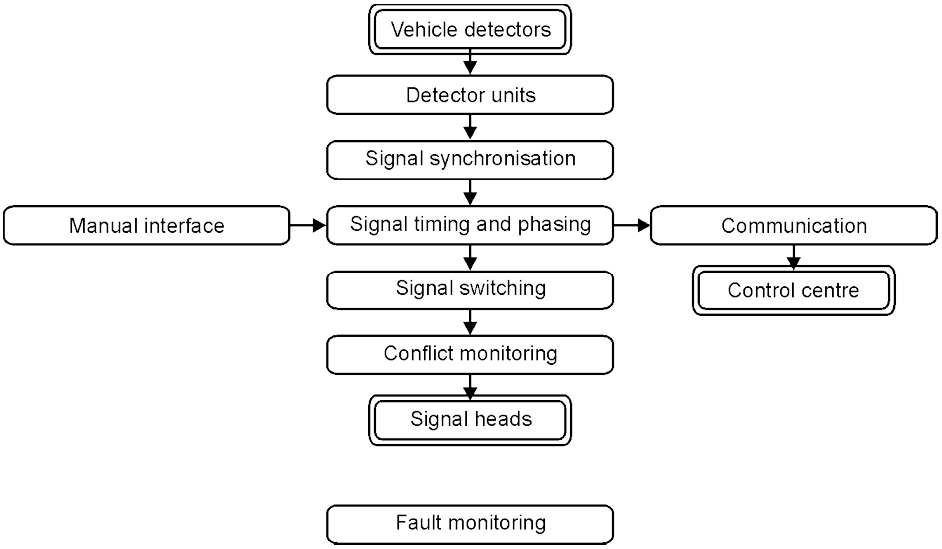

Figure 18.1: Schematic presentation of controller functions

18.5 FAULT MONITORING

1 Fault monitoring is an important function that can be provided by some controllers and is used for the detection of various faults that may occur in traffic control equipment, including the signal lamps.

2 Lamp fault monitoring is used to detect the failure of signal lamps. In its most basic form, it may be used to detect whether all red lamps on one signal group have failed. Should this occur, one or more of the actions listed below are initiated. Where lamp fault monitoring is a requirement, it is recommended that separate signal groups be allocated to each separate approach. This will allow the controller to detect whether all red lamps on one approach have failed.

3 On detection of a fault, the controller can initiate one or more of the following actions:

(a) In the event of a fault compromising the safety of the junction, switch to flashing control.

(b) In the event of other faults, activate a warning light or similar device at the controller.

(c) Report the fault to the central control computer if under central control.

18.6 SIGNAL SYNCHRONISATION

1 Accurate synchronisation of signal controllers is critical to the establishment and maintenance of traffic signal co-ordination. If the time in any of the controllers drifts with respect to other controllers, the signal timings will fall out of step. This could have a serious impact on progression along a road or street.

2 Although accurate timing equipment is available, it is difficult, if not impossible, to achieve perfect synchronisation of controllers. This means that timing units will have to be reset at regular intervals, either manually or by linking with a central control unit. The need for resetting controllers can be reduced by using more accurate timing units (which would reduce communication costs).

3 Different techniques are available to improve the accuracy of the timing unit. These include the following:

(a) Electrical mains frequency.

(b) Electromechanical motors with synchronous motors.

(c) Electronic crystal clocks.

(d) Global positioning system clocks.

4 The **electric mains frequency** of the electrical power supply can be used to improve timing accuracy. Timings may still drift during the day, but synchronisation is still maintained because all the controllers reference the same time source (except where power is taken from different electrical supplies). Synchronisation can, however, not be maintained where there are frequent power interruptions or where the quality of the power is poor.

5 **Electromechanical controllers with synchronous motors** can be used effectively under certain circumstances, again provided that all the controllers receive power from the same source. This, however, is not a very accurate method, and periodic resetting of the controllers will be required to maintain co-ordination.

6 **Electronic crystal clocks** can be utilised to provide a common time base between different traffic signals. This method, however, is still not sufficiently accurate to provide the required accuracy in signal timings over a long period without the clock being corrected periodically.

7 **Global positioning system (GPS)** receivers can be used in controllers to access the time component of the data stream transmitted from one or more GPS satellites on a continuous basis. This provides an exceptionally accurate time signal with the advantage that it does not require periodical resetting of timing units.

18.7 CONTROLLER CABINETS

1 The controller is housed in a cabinet that should be robust, corrosion resistant and generally of high quality.

2 Particular attention should be given to the quality of the doors. Seals and gaskets should be provided that will prevent the ingress of moisture and insects. Doors must be provided with strong locks to prevent unauthorised access. The door should also be fitted with a bracket to allow retaining the door in the open position.

3 Provision should be made inside the cabinet for storage of a controller log and other documents.

4 The controller should preferably be located at a junction or crossing in a position where:

(a) It can be readily accessed for maintenance purposes.

(b) The likelihood of accident damage is a minimum.

(c) Where the cabinet door is unobstructed and can be opened to its fullest extent.

(d) Where most of the traffic signal faces can be readily observed from.