

TRAFFIC ENGINEERING AND MANAGEMENT

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Sustainable Transportation within the Framework of Green Deal - SPHERE

Call: ERASMUS-EDU-2023-CBHE-STRAND-2

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TOPIC: Traffic lights and their basic principles.

Agenda:

1 The concept of traffic light signals;

2 Types of traffic light signals;

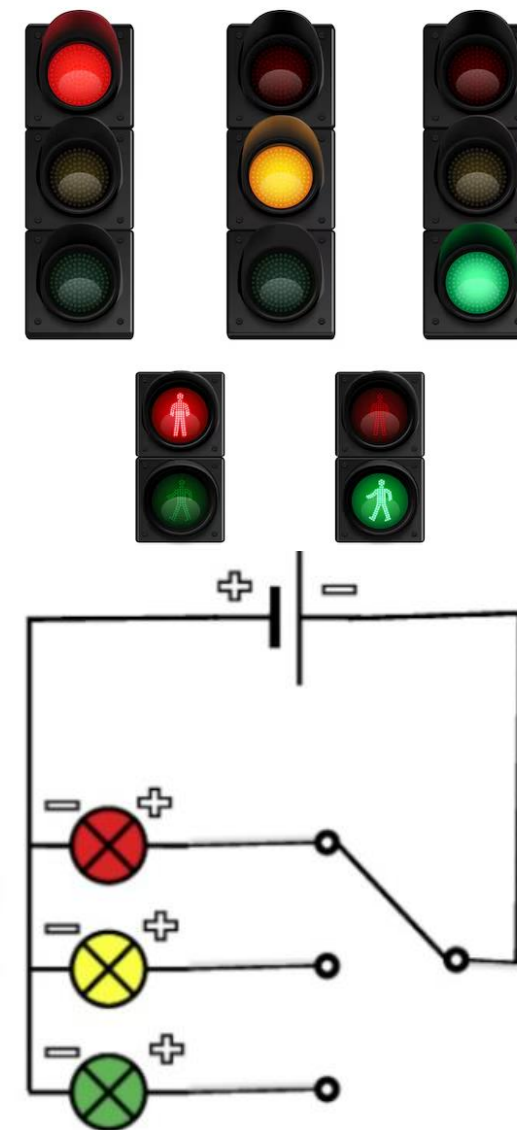
3 Main operating principles;

4 The role in traffic safety;

The concept of traffic light signals

Traffic lights are electrical devices that emit light signals and are used to control and regulate traffic at designated sections of streets and roads where pedestrians and vehicles cross.

The sequence of changes for traffic light signals used in Uzbekistan has been adopted in accordance with O'zDSt 3485:2020, and these road signs and signals comply with the requirements of the international convention.



The use of traffic lights

- a) in conflict situations between transport and pedestrian flows (at junctions, pedestrian crossings);
- b) on sections of road where the direction of traffic is reversed (reversible traffic);
- v) at railway crossings, level crossings, ferries, fords, and similar places;
- g) in managing the movement of public transport.



The working principle of a traffic light

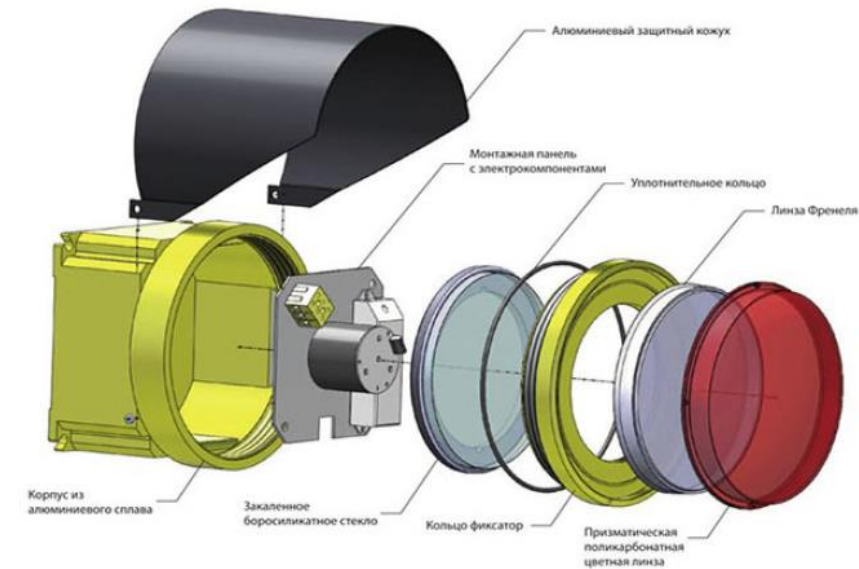
- The principle of a traffic light's operation is based on the use of three coloured signals: red, yellow and green.
- A red traffic light prohibits vehicles from moving. This signal primarily lights up when the traffic light is in its waiting mode. The red light must be visible to all road users so that they can stop and prepare to move.
- A yellow traffic light signal indicates that the light is about to change. This signal is often used to warn drivers to slow down or stop before the light turns green. The amber light should remain on for approximately 3–5 seconds before changing to green.
- The green traffic light allows vehicles to proceed through the junction. This light usually comes on after all vehicles have stopped and are ready to move. The green light must remain on for long enough for all vehicles to pass through the junction, but not for longer than necessary.

It should be borne in mind that traffic lights are not the only source of information for drivers. Road signs, road markings and the signals of traffic controllers also play an important role in regulating traffic on the roads.

The structure of the traffic light device

The traffic light device consists of several main elements:

- Light source. A traffic light has one or more light sources, which can be of different colours (for example, red, yellow or green);
- Motion sensor. Used to detect movement at junctions. It is usually a sensor that detects light from a vehicle's headlights;
- Switch. Used to switch a light source from one colour to another. It can be mechanical or electronic;
- The housing is made of metal or plastic in a shape that matches the design of the traffic light;
- Indicators. The traffic light housing may have indicators showing which colour is illuminated;
- Control system. It can be automatic or manual. In the automatic system, control is carried out by sensors and software, whereas in the manual system it is performed by an operator.



The following key concepts are used in the calculation of the traffic light object

A phase at a traffic light in which one or two signals are illuminated (for example green or red amber);

During the main phase of the traffic light signal, traffic in any direction is permitted;

During the auxiliary or intermediate phase of the traffic light signal, vehicles prepare to move in one direction;

Period - the length of time a signal remains on (e.g. $t(\text{red})=25$ sec, $t(\text{green})=21$ sec, $t(\text{yellow})=4$ sec);

Phase - the sum of the main and auxiliary periods ($t(\text{green}) + t(\text{yellow})$);

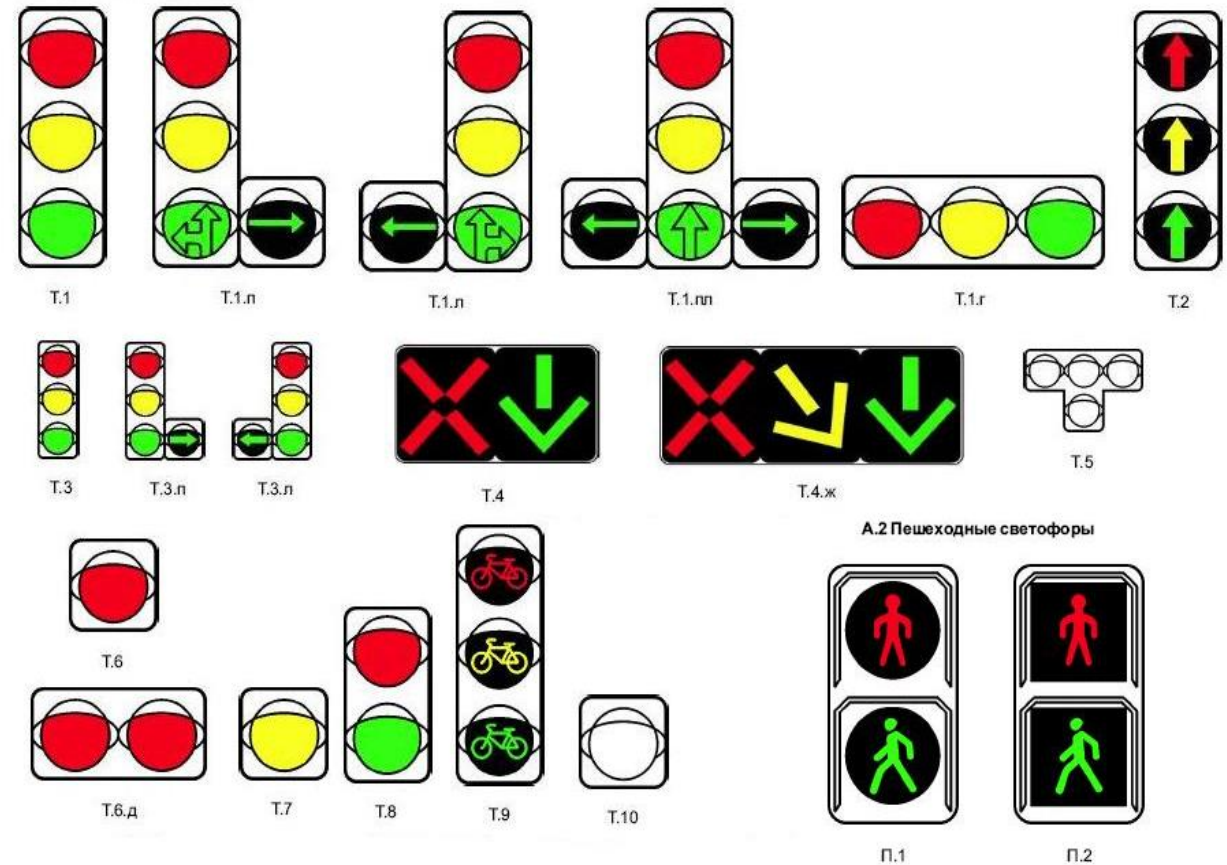
A cycle is the sum of all periods ($t + t + t$).

Traffic light signals

- Traffic light signals may be circular, in the form of an indicator (or indicators), depict a pedestrian or bicycle, or be X-shaped, depending on their function.

- In circular signalised junctions, the signals positioned on the same level as the green lights may include one or two additional arms in the form of a green indicator (or indicators).

- A audible signal can also be added to the traffic light's light signals to inform blind pedestrians that they can cross the carriageway.



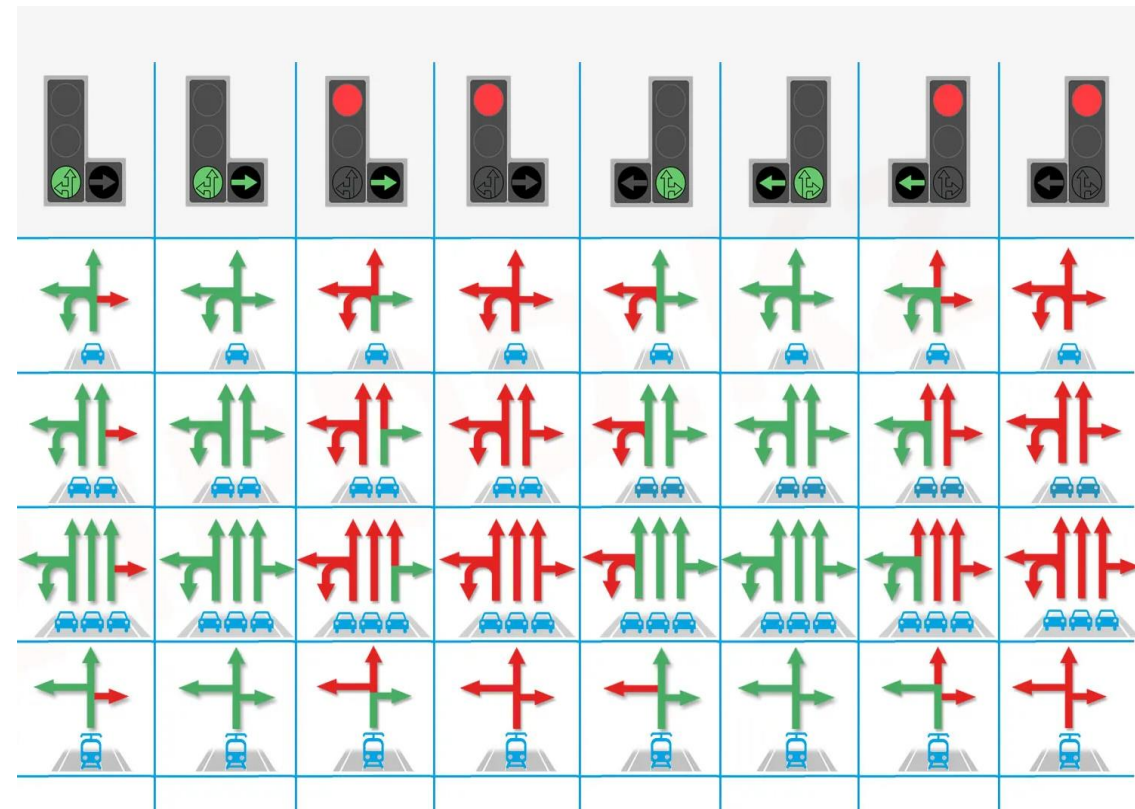
- A steady red signal of a traffic light prohibits movement across the entire width of the carriageway;
- A steady yellow signal requires all drivers to stop at the stop line. To ensure safe traffic conditions, it permits drivers who are unable to stop to proceed;
- The simultaneous flashing of the amber and red signals warns that the green light will come on immediately. A flashing amber signal does not prohibit movement and is used to allow the driver to see the junction from a distance and stop if necessary;
- A steady green signal, in the absence of any additional restrictions and without an extra section of the traffic light, permits movement across the entire width of the carriageway in all directions;
- The flashing green signal warns that the permitted phase (the green signal's operational period) is coming to an end.

The types of green signals and their functions are as follows:

a) a black outline arrow on a green background and a black arrow on a white background with a red arrowhead indicate that movement is permitted in the direction shown;

b) on a square black background, a green arrow pointing downwards indicates that movement is permitted along the lane in which the traffic light is installed;

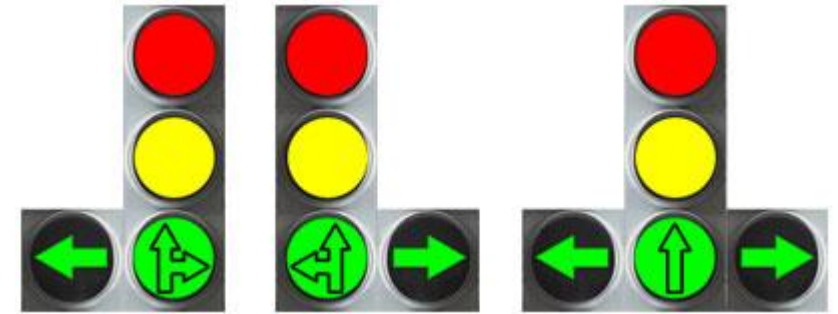
g) the green arrow of an auxiliary section of a traffic light permits movement in the direction indicated by the arrow, regardless of the main traffic light signals, In such a case, when the main traffic light is on red and the green arrow of the auxiliary section is illuminated, vehicles travelling in the direction indicated by the auxiliary section must give way to other vehicles.



- When the indicator for the auxiliary section is switched off, even if the main traffic light is green, it prohibits movement in the direction indicated by the auxiliary section arrow;

- Public transport vehicles may proceed along permitted routes when both the upper and lower signals of a traffic light are illuminated. When the lower signal is extinguished, movement in all directions is prohibited;

- Traffic lights can be described as follows: by their functional purpose – for vehicles and pedestrians – and by their construction. By construction – single-, two- or three-section; three-section with an additional section. By the role they play in the traffic control process – primary, single-location redundant (duplicate) and sequential (series) redundant.



Types of traffic lights

There are several types of traffic lights used to regulate traffic on roads. Some of them are:

- Single-section traffic lights. These are simple traffic lights with a single section that can be green, yellow or red. They are used to indicate the direction of traffic and can be installed in various locations, such as junctions, pedestrian crossings and so on;
- With arrows. These traffic lights have two sections indicating the direction of traffic. One section can be green or amber, the other red. They can be used at junctions and other locations where traffic in multiple directions needs to be controlled;
- With an additional section. These traffic lights also feature a green or amber segment that lights up a few seconds before the main display. This allows drivers to prepare in advance for the upcoming signal and reduces the likelihood of accidents;
- With a solar panel battery. These traffic lights run on solar energy and do not require a connection to the electricity grid. They are installed at junctions or in other locations where there is no access to electricity.



- With motion sensors. They automatically switch on the lights when people appear at a junction or pedestrian crossing. They can be useful for improving road traffic safety and reducing accidents;
- Traffic lights with display boards. They are used to show the time, weather and other information. They can be installed at junctions, lay-bys, bus stops and other locations;
- With voice control. These traffic lights can be configured to recognise voice commands and automatically switch the lights on when certain commands are spoken. They could be useful for people with disabilities or those unable to operate the lights manually;
- With a green wave function, drivers are allowed to travel through several sections at the same time. They are used on major roads and increase traffic capacity;
- Computer control. These traffic lights use complex algorithms and sensors to determine the optimal timing for activating the lights. They can automatically adjust the light cycles according to the number of vehicles at an intersection or other conditions.

Traffic light control methods

Traffic lights can be controlled using various technologies, including:

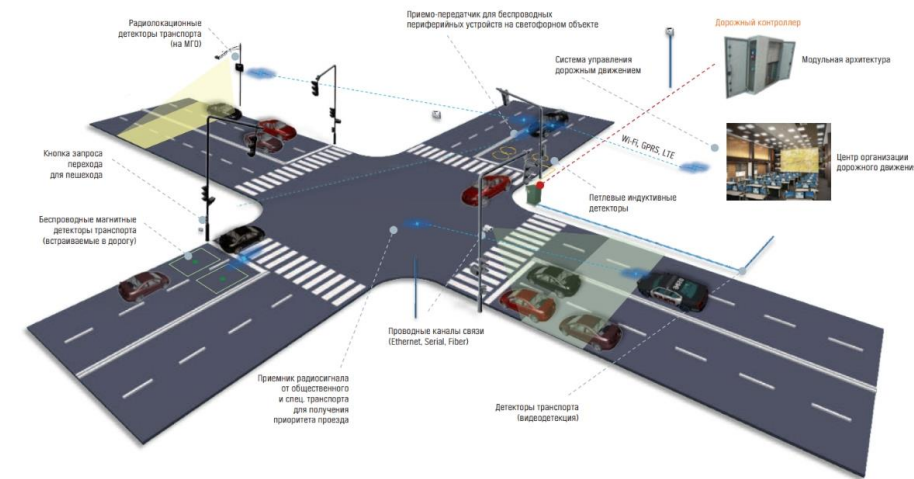
1. Manual control. Traffic lights can be operated manually by an operator in the control room. The operator can use various control systems, such as computer software or a control panel, to alter the traffic light's operation.

2. Automated control system. Traffic lights can also be controlled automatically using special sensors and systems that monitor the movement of vehicles at an intersection. If the sensors detect that there is no traffic congestion at the junction, the traffic lights can automatically switch to green to allow vehicles to pass.

3. Radio Frequency System. Some traffic lights may use a radio frequency system for control. In such cases, the traffic light receives a signal from a central control station that manages the operation of all traffic lights in a particular area.

4. GPS navigation system. Some traffic light control systems use GPS navigation to determine the location of vehicles and adjust the traffic light's operation according to where they are.

Regardless of the chosen technology, traffic light control at junctions must be automated and precise to ensure the safe and efficient movement of vehicles.





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