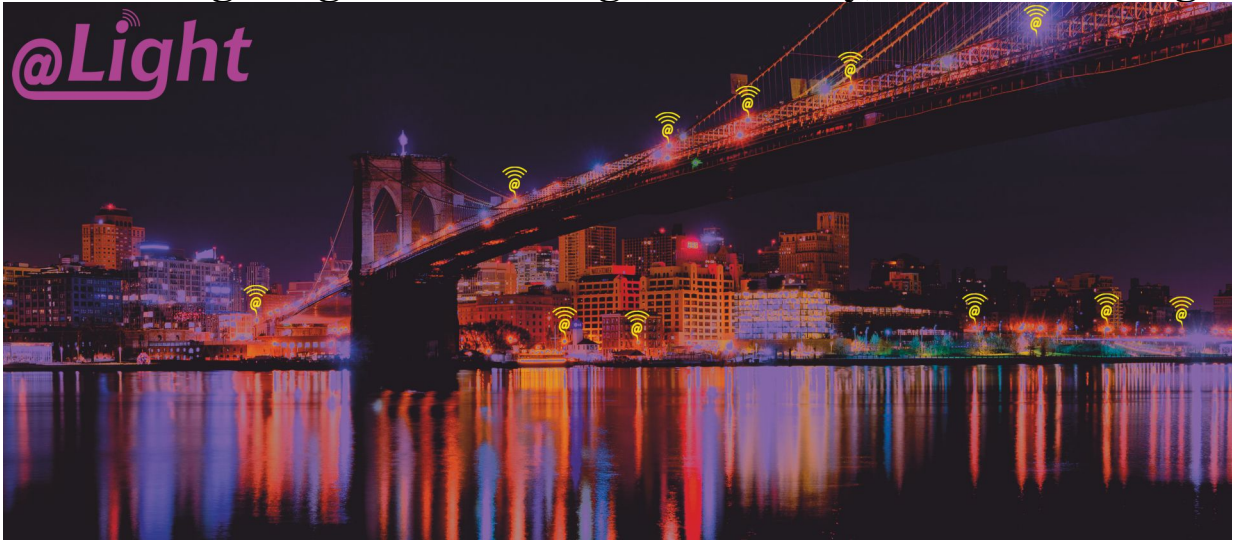


Smart Lighting - Control Lights for City, Road, Building

@Light



@Light

iSys – Intelligent Systems

@City

@AirQ

@Bin

@Light @Metering @Trace

DRAFT

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1. Introduction.

The **@Light** is an integrated system for intelligent lighting control of any type.

Thanks to the very high functionality it is possible to use it for virtually any type of lighting:

- road
- pedestrian crossings
- park
- industrial
- Parking
- office
- Shopping centre

@Light is part of the Smart City "**@City**" system and cooperates with all its applications.

Additional measurements are made every 10 seconds to 15 minutes depending on the communication method and range used, updating data in the **@City Cloud**.

The **@Light** system allows autonomous monitoring of GPS position of lighting and displaying on maps in **@City Cloud** internet portal dedicated to an individual partner or city. Access to the portal can be private (limited to authorized persons) or public (generally available) depending on the application.

The following GPS / GNSS data is available:

- geographical position (longitude, latitude)
- height above sea level
- current speed
- direction of movement
- number of satellites detected (measurement accuracy)

In addition, the system allows the measurement of device parameters thanks to several sensors of various types, e.g. temperature, humidity, flooding, vibration/acceleration, gyroscope, solid particles, VOC, etc.

In the case of large solutions, there is the possibility of a dedicated server or VPS (Virtual Private Server) with different performances, for the portal/website "@City Cloud" for only one partner.

The @Light system is an IoT solution consisting of dedicated intelligent electronic devices for each lamp. The devices can also perform GPS/GNNS position measurement and communication with the "@City Cloud". It is possible to implement hybrid projects: different communication interfaces for one system to optimize solution costs.

Data is sent to the server of the @City system - to a mini-cloud, dedicated to the partner (company, city, commune or region).

The system allows real-time visualization, geo-positioning and display on the map, as well as "information modeling" (BIM) and using them to perform specific reactions. It is also possible to directly send alarm messages as a result of an anomaly or exceeding the value of measurement of critical parameters (e.g. change of lamp position, vibrations, tilting, tipping, twisting, storms).

For highly dispersed devices and the amount of data transmitted, the main type of communication is GSM + GPS transmission. Alternatively, in situations where frequent data refreshing is not necessary and greater coverage is required, communication can be accomplished using LoRaWAN long range technology. However, this requires coverage of the LoRaWAN range with communication gateways. In ideal cases, it is possible to communicate up to 10-15km.

In the case of devices working in industrial plants, parking lots or companies (small dispersion and close range), it is possible to use a system variant based on WiFi or RF wireless communication. This significantly reduces costs and simplifies the communication network infrastructure in relation to LoRaWAN and GSM.

@Light controllers can also be equipped with industrial wired communication interfaces if needed (CAN, RS-485/RS-422, Ethernet) by sending information via the appropriate communication gateway to the @City cloud.

This allows hybrid operation and any combination of communication interfaces required by the system or cost optimization.

In addition to the automatic shutdown/blocking capabilities, the system generates alarms in the event of anomalies, which allows immediate manual action to be taken to prevent damage to devices.

2. The possibilities of the @Light system

Main features of the @Light system:

- Lighting control (on/off - 3 channels or 3 phases), PWM dimming, 1..10V for power supplies (3 channels/colors)
- Possibility of mobile work - with the option of tracking and geo-positioning
- The possibility of stationary work
- Possibility to measure PM 2.5 and 10
- Overall measurement: air quality, pressure, temperature, humidity, harmful gas concentration, lightning/storm
- Possibility of detecting damage, anomalies, vandalism and informing intervention groups (e.g. via SMS).
- The ability to remotely control and turn off devices.
- The possibility of measurements from about 10s to several hours - in real time 24h/day.
- Basic GSM wireless transmission: 2G, 3G, LTE, SMS, USSD (for any operator *), LTE CAT M1 * (Orange), NB-IoT ** (T-Mobile) - requires the SIM card or MIM of the selected operator and subscription fees for data transmission or telemetry tariffs, M2M or long-term contracts.
- Alternative LoraWAN wireless transmission - no additional subscription fees required. It requires providing the right amount of LoRaWAN gateways to cover the area. The range of LoRaWAN is much larger than that of GSM technology, around 10-15km kilometers in a little urbanized area. LoRaWAN at long distances, however, is much slower than GSM technologies and is not suitable for every application.
- Optional transmissions in industrial facilities, warehouses (WiFi, RS-485/422, CAN, RF, Ethernet)
- Optional real-time GPS position measurement (latitude, longitude, altitude, speed, direction)
- Optional self-positioning on maps with current measurement results
- Self protection - alarm and monitoring of measuring devices (against theft and devastation)
- optional BlueTooth, Infrared, NFC short range interfaces

*, ** - depends on the availability of the operator's service in the current location (covering the entire area)

3. Examples of use (real-time systems - online)

3.1. Industrial and parking lamps

- lamp control (on/off max 4 channels/phases) and dimming lamps' power supplies (PWM/0..10V) max 4 channels
- monitoring optimal working conditions (temperature, pressure, humidity, noise, flooding, corrosion, lighting level, light color {RGB + IR})
- 3-axis (X, Y, Z) measurement and monitoring of acceleration, rotation, displacement, shock, vibration, tilt, free fall
- remote switch-off of lamps when exceeding the permissible parameters in order to prevent complete destruction or major failure.
- measurements of electricity consumption and battery charging
- automatic lighting of lamps:
 - (long range (4m) or close (10cm) proximity sensor
 - magnetic field sensor
 - lighting sensor (ALS) vehicle passage and/or twilight sensor
 - short range communication between lamps

3.2. Street lamps, pedestrian crossings, park lamps

- Vibration/acceleration measurement (3 axis accelerometer)
- measurement of deviation changes (3 axis inclinometer)
- torsion measurement (3 axis gyroscope)
- corrosion measurement (resistance sensor)
- proxy detection (range 4m - pedestrian approach) and/or 10cm (lighting activation / gesture)
- self-positioning on maps (GPS / GNSS)
- lighting level measurement (ALS) - automatic lighting switching on when vehicles approach
- measurement of temperature, pressure (altitude), humidity, noise, rainfall, storms, smog, air pollution etc.
- measurement of currents and voltages and lack of power supply

- programmable pedestrian button (e.g. change of lamp color/brightness)
- programmable "Alarm/Panic" button

3.3. Directional and projection lamps, reflectors

- measurement of vibration, acceleration (3 axis accelerometer)
- measurement of deviation changes (3 axis inclinometer)
- torsion/rotation measurement (3 axis gyro)
- lamp positioning (position/direction determination) inclination/elevation (3 axis electronic compass)
- corrosion measurement (resistance sensor)
- detection of approach/attempt to climb the pole (proxymeter) up to 4m
- self-positioning on maps (GPS/GNSS)
- measurement of temperature, pressure (altitude), humidity, noise, rainfall, storms, smog, air pollution etc.
- securing equipment

4. @Light Device Work

The device works 24 hours a day, the minimum measurement and data transfer period is about 10 seconds. This time depends on the total length of all measurements, including the transmission time. The transmission time depends on the transmission medium used, as well as the signal level and transfer rate at a given location.

The device can also measure solid particles (2.5/10um), pressure, temperature, humidity, general air quality - harmful gas level (option B). This allows you to detect weather anomalies (rapid changes in temperature, pressure, humidity), fires as well as some attempts to tamper with the device (freezing, flooding, theft, etc.).

With frequent transmissions from the device to the cloud (from 30sec), it is also an alarm protection for the device in the case of:

- attempts to dismantle
- devastation
- sabotage
- location changes
- e.t.c.

This allows immediate intervention by the police or own staff upon detection of any anomalies.

The device (at the production stage) can be equipped with additional accessories:

- Infrared for short distance communication (sending/receiving)
- measuring sensors: current, voltage, capacity, resistance, color, lighting level (ALS)
- proximity sensors - proxymeter (range of about 10cm), and medium range (range of about 4m)
- 3 axis sensors (X, Y, Z - all directions): acceleration / vibration (accelerometer), magnetometer (magnetic field), gyroscope (detection of rotation angle), inclinometer (displacement sensor)
- storm sensor (with distance determination up to max. 40km)
- Bluetooth connectivity (communication e.g. with a mobile phone), NFC (RFID e.g. for

authorization of persons) with proximity cards or a telephone.

4.1. Communication

Transmission of measurement data is carried out through one communication interface *:

- GSM (2G..4G, USSD, SMS, LTE-M1, NB-IoT) - requires GSM operator subscription fees and full coverage for the selected service. The maximum range is a few kilometers from GSM BTS in the open area.
- LoRaWAN (868MHz) - long range radio communication in the public band (without GPS positioning). Due to the open and free nature of the frequency band, there is a risk of interference and jamming of the device by other devices. LoRaWAN usage, requires the installation of a minimum one LoRaWAN/Internet gateway - ensuring coverage of the entire area (e.g. on tall chimneys or GSM masts or external antennas on high buildings). Maximum range up to 10-15km in low-urban areas.
- For small objects of different types, it is possible to use a WiFi controllers (without measuring GPS position).
- For stationary facilities, it is also possible to use wired interfaces available in the **eHouse** system (RS-422/485, CAN, Ethernet)

* - depending on the selected @Light controller type and modem options

5. Dedicated @City platform (cloud)

The @City platform is a dedicated "mini-cloud" system for individual clients and B2B partners. The platform is not shared among other users and only one client has access to a physical or virtual server (VPS or dedicated servers). The customer can choose one of several dozen data centers in Europe or the world and several dozen tariff plans - related to hardware resources and performance of dedicated hosting.

The @City platform, Back-End/Fron-End are discussed in more detail in the "eCity" document.

6. Equipment Variants

The devices can be in many hardware variants regarding equipment options as well as housings (which gives dozens of combinations). For Air quality metering, the device must be in contact with the flowing outside air, which imposes certain requirements on the housing design.

Therefore, the enclosures can be ordered individually depending on the needs.

6.1. Options for electronics:

- Application of the particulate sensor 2.5/10um
- Use of an environmental sensor (temperature, humidity, pressure, air quality)
- The use of lighting control elements
- The use of any combination of sensors for the selected application (at the production stage of the whole series of product)
- Different power variants (230V, 230V + UPS, battery, Energy harvesting - photovoltaics, magnetic field, etc.)

6.2. Devices Montage

- stationary
- mobile

6.3. Enclosures for the controller

- installation in existing lamp fittings
- dedicated metal stationary/mobile enclosures - selected color, graphic design, printing/stickers, method of attachment
- adapted plastic housings
- dedicated plastic enclosures
- the case depends on the size of the battery

7. Usable information

The laser air pollution sensor used may be damaged if the concentration of dust, tar is too high, and in this case it is excluded from the warranty of the system. It can be purchased separately as a spare part. The warranty excludes mechanical damage caused directly by lightning, acts of vandalism, sabotage on the device (flooding, freezing, smoking, mechanical damage, etc.).

The operating time from an external battery depends on: GSM signal strength, temperature, battery size, frequency and number of measurements and data sent.

8. @Light Devices operating parameters

Main parameters of “@Light” and “@City” controllers are located at “IoT-CIoT-devs-en.pdf” document.