

ConverLight® Dynamic Smart Commercial

CCU Quattro **ConverLight Gateway**

This user manual is intended to describe the properties and installation of ChromoGenics ConverLight Control Unit for the Smart Commercial system.

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Information on the Smart Commercial system

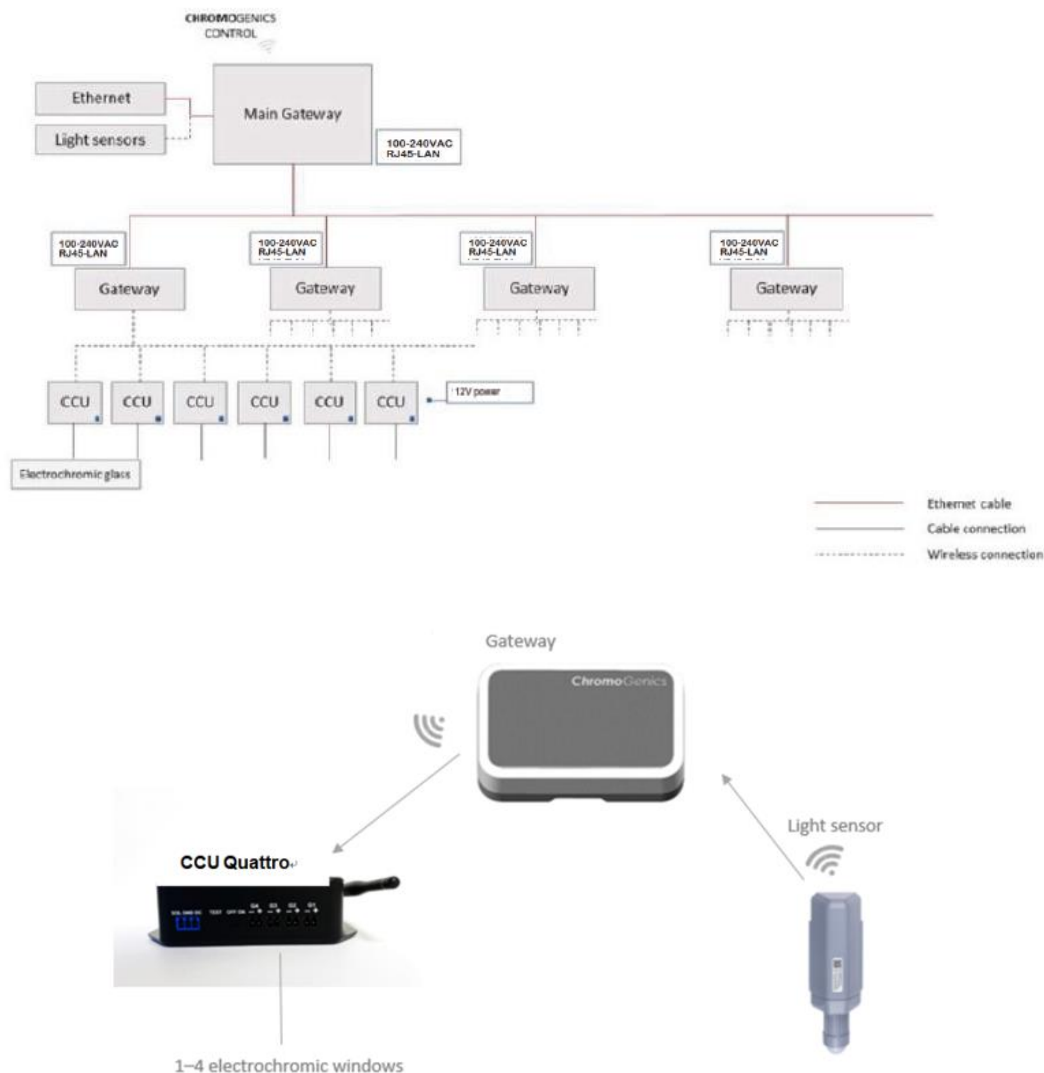
ChromoGenics' system ConverLight Dynamic Smart Commercial is based on a series of control units called CCU, ConverLight Control Unit. All ConverLight Dynamic windows in a property are connected to a CCU. In the Smart Commercial system, all CCU's are in communication with a Gateway through LoRa- radio communication.

The Gateway specifies to the CCU when to color or bleach the windows. When these commands are given depends on information that the Gateway receives from Light sensors which are wirelessly placed on the roof or facade.

The system has a Main Gateway. All Gateways in the property must be connected to the same network as the main. The Main Gateway also communicates with an external service cloud.

LoRa Gateway Master, LoRa Gateway Slave and CCUs are powered by 12.0V connectors (minimum 12W), and light sensors are powered by battery.

Schematic system control



Convert Light Dynamic Smart Commercial - System components

Name	Specifications
CCU Quattro	Can be connected to up to 4 windows – (1-4 windows) Connection: 12.0VDC (minimum 12W) connector (wall plug adapter can be supplied) Power output: ≤1.0VDC (to window) LoRa-radio communication with the Gateway.
Gateway	Connection: 12.0VDC/2.0A wall plug adapter (included). RJ45 LAN-contact (not included). LoRa-radio communication with CCU and Light sensor.
Light sensor	Wireless light sensor. LoRa-radio communication with Gateway. One sensor placed in every direction/zone. Powered by battery.

Safety directions

The control system and its components, excluding the light sensor, are for indoor use only. Never connect anything other than specified connectors or cables to the inputs.

Technical Specifications

CCU Quattro		
Mechanics / Enclosure		
Type	Width x Height x Depth (mm)	Remarks
Box	122 x 100 x 35	Wall/ceiling mount
Antenna	51 x 8	Mounted on the CCU
Input Power		
Voltage		Nominal Power
12VDC, 1.0A		Single mA
Communication		
Type	Connection type	Remarks
LoRa-radio	Wireless	Communication with the Gateway
Radio		
Frequency Range (TX/RX) (MHz)	Transmit Power (dBm)	Remarks
863.1-864.9 MHz, 865.1-867.9 MHz, 868.1-868.5 MHz, 868.8-869.1 MHz, 869.5-869.55MHz, 869.8-869.9 MHz	12.69	ERP

Light sensor			
Type	Power	Communication	Rating
Light sensor (lux)	Battery D size 3.6V Li-SOCI2 Expected lifetime: ~5 years	Wireless (LoRa-radio)	IP66
Communication			
Type	Connection type	Remarks	
LoRa-radio	Wireless	Communication with the Gateway	

Gateway			
Mechanics / Enclosure			
Type	Width x Height x Depth (mm)	Rating	Remarks
Gateway	222 x 137 x 54	-	Can be placed on cable ladders above the ceiling or in technical room
Antenna	154 x 13	-	Mounted on the Gateway
Input Power			
AC Adapter power	Gateway powered with		
100-240V, 50/60Hz,0.8A	12.0VDC,2.0A, 24.0W MAX		
Input Communication			
Type	Contact	Remarks	
Ethernet	RJ45	Needs an internet connection to connect to ChromoGenics Cloud	
Output Communication			
Type	Contact	Remarks	
LoRa-radio	Wireless	Communication with CCU and light sensor	
Radio			
Frequency Range(TX/RX) (MHz)	Transmit Power (dBm)	Remarks	
863.1-864.9 MHz, 865.1-867.9 MHz, 868.1-868.5 MHz, 868.8-869.1 MHz, 869.5-869.55MHz, 869.8-869.9 MHz	13.98	ERP	

Criteria and limitations

	Smart Commercial
Max number of Gateways connected to Main- gateway	No limit
Max number of CCU connected to one Gateway	No limit in number. The limit is based on the structure of the building.
Max distance (m) from CCU to closest Gateway	50/100m depending on walls and possible signal disruptions etc.
Max number of CCU per property	No limit
Max number of CCU in a zone	No Limit
Max number of windows connected to each CCU	4

Operation of system

Generally, the system is controlled by set values of measured light intensity. Light values indicate when to color or bleach zones. A property can be divided into several zones.

To receive full functionality of the system. The Gateway needs to be connected to a network that is either open or is given access to ChromoGenics cloud-website.

Installation requirements

- To ensure safe operation and communication, wires recommended by ChromoGenics should be used.
- In case of splicing, Solder Splice Connectors of suitable dimensions should be used. If cables have been spliced, the cable should be ensured both mechanically and electrically.
- Installation altitude $\leq 2000\text{m}$
- Operation temperature $0 - 50^{\circ}\text{C}$
- If installation height is above 2 meters from the floor take proper safety precautions to minimize your risk of falling.

General project demands

To implement ChromoGenic's control system Smart Commercial with the quality and possibilities that the system offers, there are some demands and conditions that need to be clarified.

Such conditions include:

- Room structure
- Number of zones
- Distances
- Number of windows
- Possible cable wiring
- Possible placements of components

Upon ordering ChromoGenics will go through the possibilities and requirements for each project and dimension the system according to the customers' wishes.

Installation and commissioning

Overview

Preparation:

1. Dimensioning the system together with ChromoGenics – sketch proposal provided by ChromoGenics and installation drawings with all components marked to be completed by ChromoGenics' customer.
2. All windows installed, IDs marked on façade drawings and yellow cable ID tags accessible (visible when connecting the glass to a CCU).

Steps of installation:

1. Place the CCUs according to the drawings, connect the windows, perform the electrical function test and document it in the self-inspection protocol (see Attachment A).
2. Place the Gateway(s) according to the drawing, connect power and network cable.
3. Place light sensors: Mount the light sensors on the roof or façade, facing the specified direction.
4. Book commissioning of the system and send the self-inspection protocols and other required documents to ChromoGenics.
5. Perform the electrical function test of the system (commissioning test) in cooperation with ChromoGenics. A protocol will be provided by ChromoGenics, see Attachment B.
6. Any deviations detected during commissioning must be rectified by the installer and if not possible to do so within the commissioning test time slot, a new test must be booked.

It is the responsibility of the installer to perform and document the electrical function tests as detailed in these instructions. This is mandatory for the warranty to apply.

The following sections provide more detailed instructions on installing and testing of the components and system.

Component labeling

All components are labeled when delivered from ChromoGenics. The labeling complies with the system below.

Device	Labeling	Example
CCU Quattro	CCU4-Serial number	CCU4-001
Gateway	GW-Serial Number	GW-001
Light sensor	LS-Serial Number	LS-001

CCU Quattro

1. Placement

Each CCU has a label CCU4-xxx as described in the previous section. Each unit has a pre-determined position in the building according to drawings. It is important that the right unit is placed in the right position.

2. Installation

All connections are made with the included 2- and 3-pin contacts.

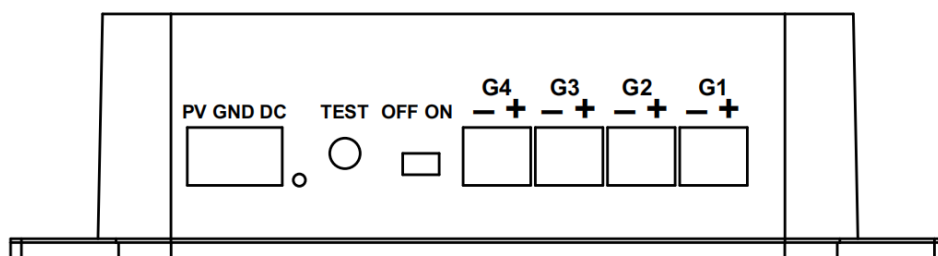
- A 3-pin contact is used for DC-power.
 - o Using provided wall plug adapter: Connect the 3-pin connector to the CCU and the wall plug to a power outlet.
 - o Cable connection: Mount the cables to the 3-pin connector, plus to DC and minus to GND, see picture below.
- 2-pin contacts are used to connect windows to the CCU.



Red cable = + Black cable = -

Ensure that the polarity is correct when connecting the windows!
If the polarity is switched, it may cause irreversible damage to the window.

The connections of the CCU Quattro are shown below:



Explanation:

PV: Solar cell (+)

GND: Minus connection for solar panel and DC-power. (-)

DC: DC-power (+)

TEST: Test button

OFF-ON: Power switch for CCU Quattro

G1-G4: Glass 1 – Glass 4



Once the windows and the power source are connected, turn the unit ON using the switch.

The system is configured before installation so the unit will automatically join the network.

3. Perform and document the electrical function test

- Make sure the CCU is ON and then press the TEST button.
- Document the result for each CCU.
- An example of the protocol can be found at the end of this document, see Attachment A. The protocol must contain the following information: CCU ID, window ID, signature of correct placement and successful tests.

	Note! The test will only check if there is any contact with the window. If the polarity of the cables is switched, the test will still show a green signal if the cables and connections are intact. It is therefore very important to know that the polarity is correct.
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Pressing the button will yield 4 LED-signals next to the button:

Signal 1	Glass 1	Green: Contact with glass OK	Red: No contact with glass / Glass not connected
Signal 2	Glass 2	Green: Contact with glass OK	Red: No contact with glass / Glass not connected
Signal 3	Glass 3	Green: Contact with glass OK	Red: No contact with glass / Glass not connected
Signal 4	Glass 4	Green: Contact with glass OK	Red: No contact with glass / Glass not connected

If 4 windows are connected, 4 green LED-signals are required to know that all connections are correct. If a window signal is red when there is a window connected, the connection/cables need troubleshooting.

Document each test in the self-inspection sheet, see Attachment A.

ChromoCloud

ChromoCloud consists of a simple web-interface, listing existing installations, details about installations, and their status. It also has an API intended for access from LoRa Gateway Masters, which then pushes their status, details and alarms to it.

<https://cloud.chromogenics.com/>

API

For Gateways

LoRa Gateway Masters communicate with the ChromoCloud by pushing information through the API. Installation configurations are uploaded here and later downloaded by connecting gateways. These should include:

A list of CCU-A devices including windows and “zones”

A list of radios, containing radio-type, radio IDs, keys, settings etc.

A list of gateways, containing type, IDs, keys, settings etc.

A pairing between the radio and CCU-A modules is not necessary to make, as it can be auto-discovered.

LoRa Gateway Master

The LoRa Gateway Master runs a full ChirpStack instance consisting of:

Packet Forwarder

ChirpStack Gateway Bridge

MQTT Broker (mosquitto)

ChirpStack Network Server

ChirpStack Application Server

Additionally, the LoRa Gateway Master runs an application responsible for adding and managing devices as they connect to the server, handling and relaying alarms, handling default control configurations and handling control override operations. This application will be referred to as ChromoMGW-App.

LoRa Gateway Slave

LoRa Gateway Slave runs a LoRa Packet-forwarder and a ChirpStack Gateway Bridge (Technically only the forwarder is necessary, however it is restricted in terms of ability of securing the connection as well as reliability, therefore it is better to use the GW-bridge which uses TCP and can be configured with TLS). Their only task is connecting to the LoRa Gateway Master and forwarding any received LoRa packets. They should be connected to the LoRa Gateway Master, which is configured with a static IP, by ethernet for reliability.

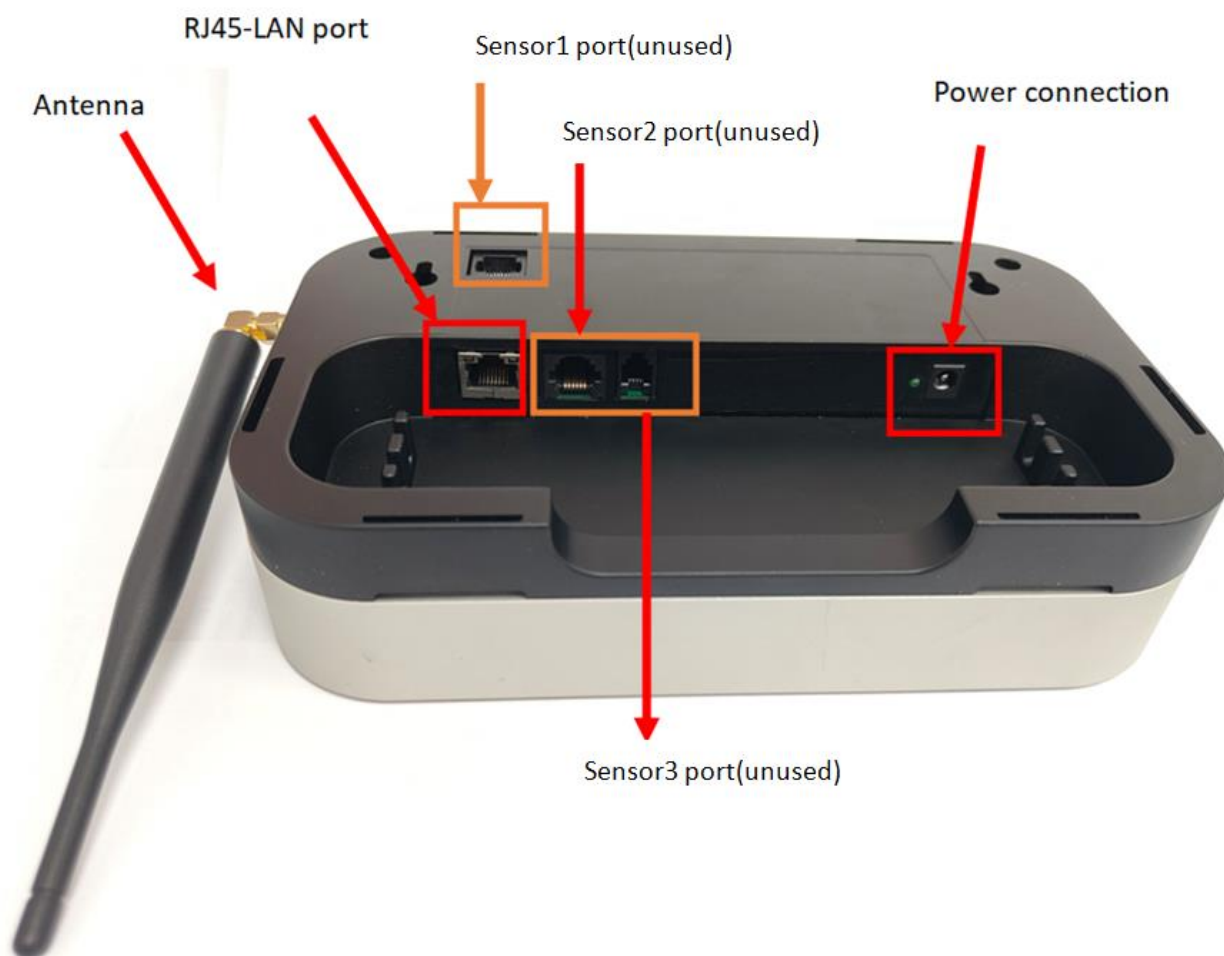
LoRa Gateway Slaves are connected to the system over ethernet through a switch. The LoRa Gateway Master acts as the default network gateway in the system, with DHCP IP assignment to slave gateways and optionally public internet access over its 4G modem, allowing direct VPN access to slave gateways. (<http://srijit.com/how-to-share-3g-4g-connection-over-lan-in-ubuntu/>)

Gateway

All Gateways delivered by ChromoGenics have a serial number and a pre-determined position according to technical drawings.

At the position of each Gateway, there must be access to a power outlet of 100-240VAC and a RJ45 LAN-connection. Connect the provided wall plug adapter and connect the Gateway to the network and it will start automatically.

All Gateways must be connected to the same Ethernet network through RJ45-LAN connections.



Gateway function check

Check the LED signals on the front of the Gateway to see that everything works correctly.

The blue LED means the power is on. The red LED is a solid red if everything works correctly. If the LEDs are solid blue and red, everything works.

If not, there will be a series of four signals from the red LED.

Master Gateway			
Signal 1	Signal 2	Signal 3	Signal 4
Network issues	VPN issues	LoRa issues	Control issues

Secondary Gateway			
Signal 1	Signal 2	Signal 3	Signal 4
Network issues	VPN issues	LoRa issues	Connection with Master Gateway - issues

Short signal means OK, Long signal means something is not working.

For example. Long- Long- Short- Short means there is a problem with the Network and VPN.

Troubleshooting	
Network issues	Check Ethernet cable is connected. Check the network to see if it allows units to reach internet.
VPN issues	Check that the network allows the unit to do the following: Units try to reach <i>cloud.chromogenics.com</i> , IP 3.74.178.15. VPN uses UDP on port 13696 MQTT uses TCP on port 8883 Configuration server uses TCP on port 433
LoRa issues	Restart Gateway. If problem remains, contact ChromoGenics.
Control issues	Restart Gateway. If problem remains, contact ChromoGenics.
Connection with Master Gateway – issues	Check that secondary gateway is on the same LAN as the Master Gateway.

Light sensors

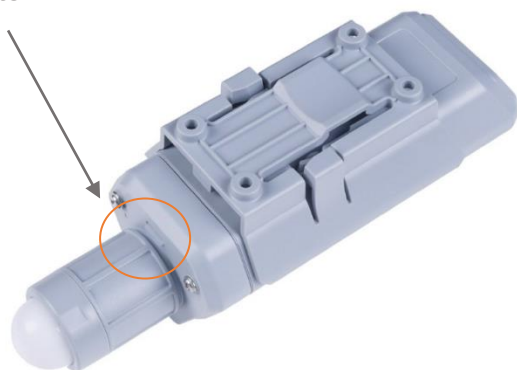
Depending on the number of zones that will be used, the same number of light sensors should be placed in a suitable location.

It is the white bulb that registers the lux value. This means that it is this part that should be placed in the same direction as the windows. Sensors should therefore be placed horizontally if the dynamic glass is placed in a façade. An example of how this was done is shown in the image below, where the sensors were mounted on the roof, all in one place but facing different directions.

Think about accessibility. The sensors should be relatively easy to reach in case of troubleshooting or future battery replacements.

Light sensors are wireless. Once the sensor is placed in the right position, press the button on the sensor once. The button will light up green, start pulsating and will finish with a series of fast blinking signals. The sensor will have joined the LoRa network automatically. If the sensor is not blinking fast the LoRa network has not been found. If so, check that all Gateways are connected properly.

Button



Example of sensor placement

Electrical function test of the system (commissioning test)

When the windows have been installed and the control system connected (including performing the electrical function test for the CCUs) it is time to book the commissioning test. It is the responsibility of the installer to book the test. Test must be booked with at least two weeks' notice.

The installer must be on site to assist and possibly rectify any deviations identified during the commissioning test. ChromoGenics will connect to the system remotely and perform the tests.

It is the responsibility of the installer to ensure this test is completed successfully. A commissioning protocol will be provided by ChromoGenics upon completion, see Attachment B.

ChromoGenics

[illegible]

- Complete self-inspection sheet.
- Revised drawings marked with all ChromoGenics units.

Attachment B – System commissioning letter

This protocol documents the results of the electrical function system test (commissioning test). A successfully completed test is a requirement for the warranty to apply.

Project name:

Project contact person:

ChromoGenics project number:

Date commissioning test:

Zone / Facade	Connection				Comment
	Gateways	CCUs	Light sensors	Window	
South					
East					
West					

I hereby confirm that the system tests have been performed successfully for the entire / parts of the system as specified above.

Person at ChromoGenics performing the test

Name and position:

Signature:

Date: