

1 Introduction

The TL01 is a combination of a temperature sensor, a light sensor and a 3 position switch, capable of transmitting its data over the power lines by means of the X10 extended code protocol. It is available for 110V/60Hz or 220V/50Hz power nets.



With a few exceptions, it conforms to the specification of X10 for extended code 1, type1 devices (<ftp://ftp.x10.com/pub/manuals/xtc798.doc>).

The TL01 is not taking any decisions based on the temperature-, light- or switch changes it detects. It is only capable of transmitting the measured data. The controlling PC program should compare the measured values with threshold levels and take the necessary actions.

Note:

Like all home automation products, the TL01 should never be used for life saving or life-preserving situations. The TL01 is not a replacement for smoke or fire detectors and should not be relied upon as the only means of protecting a home from freezing temperatures.

2 Technical features

2.1 X10 communications:

- 120kHz X10 frequency very stable and accurate (obtained from X-tal)
- 3 phase transmission
- Short transmission cycles (ca. 0.6 seconds; uses extended data format)
- Collision detection and back-off algorithm
- 220V/50Hz or 110V/60Hz units
- X10 addresses fully programmable (different house code/unit code combinations possible for temperature sensor, light sensor and switch)
- A led indicates a transmission from the TL01

2.2 Temperature sensor

- Reports temperature on request in Fahrenheit (-40°F and 127°F) or Celsius (-40°C and 65°C)
- Reports temperature changes automatically (1°F or 0.5°C resolution)
- Temperature resolution: 1°F or 0.5°C
- Temperature accuracy: 2°F or 1°C
- Temperature accuracy: 1°F or 0.5°C (After 1 point calibration)
- Temperature can be requested integrated over 1 minute or 16 minutes
- After power up, or after a programming action, the temperature will automatically be send once.
- Unit of measurement (C or F) can be set by a hardware strap (open = Celsius)

2.3 Light sensor

- Reports Light Intensity on request
- Reports light intensity integrated over the last 16 minutes on request

2.4 Status Switch

- 3 positions
- Changes are reported automatically
- Switch position can be requested by a Status Request (Extended Command)
- After power up, or after a programming action, the status will automatically be send once.
- The returned status data also contains a bit with the C/F setting and the USA/Euro setting

3 Using the TL01

3.1 Installation

Before plugging the unit into a wall outlet, the power/frequency should be checked (at the bottom of the unit). Normally a 220V/50Hz unit is set for measuring temperature in degrees Celsius. A 110V/60Hz unit is set for degrees Fahrenheit.

The unit should be placed in a wall outlet where free airflow is guaranteed and light detection is not obstructed. The wire with the temperature sensor should be below the unit.

3.2 Addressing

The TL01 contains 5 addressable items.

- The current temperature (integrated over 1 minute)
- The mean value of the temperature during the last 16 minutes
- The light intensity
- The mean value of the light intensity during the last 16 minutes
- The status byte (containing switch position, °F or °C, 50Hz or 60Hz)

The X10 address of each of these items can be programmed at the same or at a different House- and Unit Code combination.

Default all the items are mapped at House Code M and Unit Code 1.

3.2.1 Changing addresses

The default addresses can be changed as follows:

- Press the button on the TL01 one time. The Led begins to blink slowly.
- Send an extended command with the HC/UC and the TC (Type/Command) for which you want to change the address. This has to be done within a minute after the button is pressed.
- Continue with other HC/UC/TC combinations you want to change. Again you have 1 minute time to send the command.
- After the last combination has been sent, wait for the Led to stop blinking.
- Temperature and status byte will automatically be send once

3.3 Calibration

The temperature sensor can be calibrated. The measured value can be in- or decreased in steps of 0.25 degree C. (Fahrenheit: 0.45 degree F).

The calibration value can be sent to the TL01 as follows:

- Press the button on the TL01 one time. The Led begins to blink slowly.
- Press the button a second time within 5 seconds. The Led start to blink faster
- Send the HC/UC/TC with the calibration data in the data field to the unit. Note: TC is always 12 (type 1, command 2)

Example: HC: M, UC: 1. To increase the temperature by 1 degree C, the following command has to be sent: M 1 04 13. To decrease the temperature with the same amount, M 1 FC 13 has to be sent (data in two's complement!!).

- After the data has been sent, wait for the Led to stop blinking.
- Temperature measurement will now take the new calibration value into account.
- The temperature and status byte will be send automatically once.

3.4 Data exchange

3.5 Power line data

On the power line an Extended Code 1 transmission resembles the following form:

Start	House code	Ext code	Unit code	Data	Command
1110	HC/HC'	EXT/EXT'	DC/DC'	DATA/DATA'	COM/COM'
4 bits	4 bits	5 bits	4 bits	8 bits	8 bits

A total of 31 main cycles, which take 0.620 ms in a 50Hz situation and 0.5 ms in a 60Hz situation.

3.6 Computer interface

The TL01 is tested in combination with a CM11A, but it should operate with other (compatible) devices.

The communication between a controlling PC and the CM11A is described in the following chapters.

3.6.1 Sending Extended Code

The protocol may be shown as:

PC	CM11 Interface
5 bytes →	Header:Function Code:Unit Code; Data:Command
1 byte ←	Checksum
1 byte →	Acknowledge
1 byte ←	interface ready to receive

The header for an extended transmission is always:

```
Header:      7 6 5 4 3 2 1 0
            0 0 0 0 0 1 1 1
```

Bits 7 to 3 are always zero because the dim level is not applicable to extended transmissions.

Bit 2 must be set to '1' as in all PC header transmissions.

Bit 1 is set to '1' as the extended transmission is always a function.

Bit 0 is set to '1' to define an extended transmission rather than a standard transmission.

The function code byte is:

```
Function Code:  7 6 5 4 3 2 1 0
                <Housecode>0 1 1 1
```

For Extended Code 1, the function code must be 0111.

The unit code byte contains the encoded unit in the lower nibble.

Finally, the data and command bytes may take any value between 0x00 and 0xff.

Note that the checksum is one byte and is defined as:

checksum = (header + function code + unit code + data + command)&0xff

3.6.2 Receiving Extended Code

PC	CM11 Interface
	← 0x5A, poll from interface
0xc3, Ready →	
	← 0x05 (5 byte transmission)
	← 0x01 (byte 1 = function)
	← house and function (ext. code1)
	← unit address
	← data
	← command

3.6.3 Command and data structure

Extended Code 1 has been defined by X-10 and is meant for data and control purposes. Type 1 is dedicated to sensors.

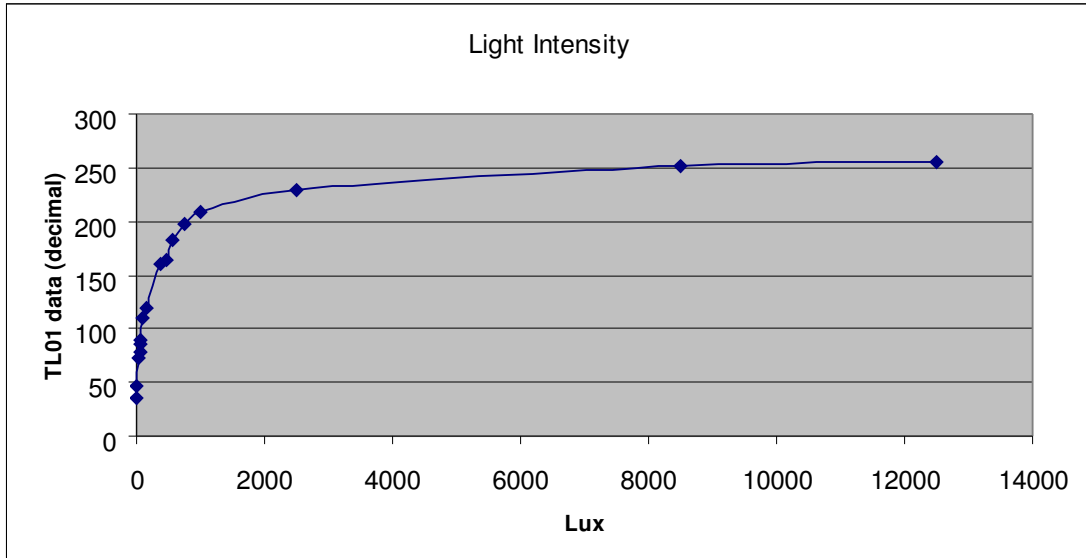
Every Extended Code 1 transmission is initiated by sending a start code and a house code followed by the function code for Extended Code 1: 0111. Only units with Extended Code 1 capability will recognize this command and will interpret the following unit code, and if addressed also the data and command byte.

Data	Type-Command	Description
X X X X X X X X	00010001	Request Average Light Data from the Unit addressed in the HC/DC fields
X X X X X X X X	00010010	Request Instant Temperature from the addressed unit.
X X X X X X X X	00010011	Request Status from addressed unit.
X X X X X X X X	00010100	Request Instant Light Data from the addressed unit.
X X X X X X X X	00010101	Request Average Temp. Data from the addressed unit.(16min. average)
L L L L L L L L	00011011	Ambient Light data from the sensor in the HC/DC fields
T T T T T T T T	00011100	Temperature data from the sensor in the HC/DC fields.
S S S S S S S S	00011101	Status data (bit mapped) from the unit in the HC/DC field

x = don't care

Ambient Light Data

Response of the TL01:



As an indication:

Full sunlight: 11000 lux
 Morning sunlight: 6000 lux
 Bright office: 400 lux
 Moonlight: 1 lux

Note:

By design, the light output data will not become zero at low light levels. The minimum output will be about 32 (decimal).

Temperature Data

(+/-)T64 T32 T16 T8 T4 T2 T1	Range 0 - 127 in integer values. (+/-) = '1' for negative integers. Units are 0.5 °C or 1° F
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Status Data

S1 S2 S3 x x x F/C U/E	Depending on the switch position, one of the 3 bits is 1. Bit 0 set to 1 if USA unit. Bit 1 set to 1 if unit is set for Fahrenheit.
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