TITLE: **TWT0612 – Functional Description**

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PREPARED BY:	Tapio Rautiainen
CHECKED BY:	Toni Närhi
APPROVED BY:	

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DOCUMENT REVISION HISTORY

REVISION	DATE (dd.mm.yyyy)	DESCRIPTION OF CHANGES	BY
0	14.05.2020	Initial release.	TRA
1	07.09.2020	Chapter 2: Added battery information, safety features and MTBF.	TRA

1 INTRODUCTION

The purpose of this document is to describe the components of the TWT0612 Emergency Lighting Unit, the relationships among its components, and their functional requirements.

1.1 PURPOSE

The Emergency Lighting Unit functions as a stand-alone emergency lighting unit. When normal 24 VDC power is present, the emergency lighting unit operates normally. If normal power is lost, the emergency lighting unit provides light output for a minimum of 30 minutes, powered from its internal battery.

1.2 GLOSSARY OF TERMS AND ABBREVIATIONS

The following terms are used in this document.

LiFePO4 Lithium iron phosphate battery

2 TECHNICAL DESCRIPTION

Supply voltage	18 … 32 VDC
• Nominal	24 VDC
Output voltage to LEDs	
• On battery	21 VDC
• Maximum output current (= 18x 1002-0844 LED spots)	1,2A
• Nominal output current (= 15x 1002-0844 LED spots)	1,0A
Battery	LiFePO4
• Allowed charging temperature	3 … 45 °C
• Life expectation (higher than 60% of the initial capacity of the battery: - Temperature 20±5°C - Temperature 60°C - Temperature 70°C	> 3 years / 1200 cycles < 3 months < 1 month
Inputs	
Self-test input	Activated when pulled down
Sensor input	Activated when pulled down
Reset input	Activated when pulled down
Outputs	
Fault output • Voltage output	= Supply voltage (24 VDC nominal, 18 – 32 VDC)
IP code	
TW internal classification	IP20
Self-test	
Recommended test interval	6 months
Safety features	- Power output overload protection - Battery overvoltage protection - Battery overdischarge protection - Battery temperature monitoring
MTBF	
Standard: Siemens SN 29500	
Failure Rate(t=INF) (FITs)	664,2532
MTBF (hrs)	1505500

TWT0612 uses LiFePO4 battery. The LiFePO4 batteries are the safest type of Lithium batteries as they will not overheat, and even if punctured they will not catch on fire. The cathode material in LiFePO4 batteries is not hazardous, and so poses no negative health hazards or environmental hazards. Due to the oxygen being bonded tightly to the molecule, there is no danger of the battery erupting into flames like there is with Lithium-Ion.

3 INPUTS AND OUTPUTS

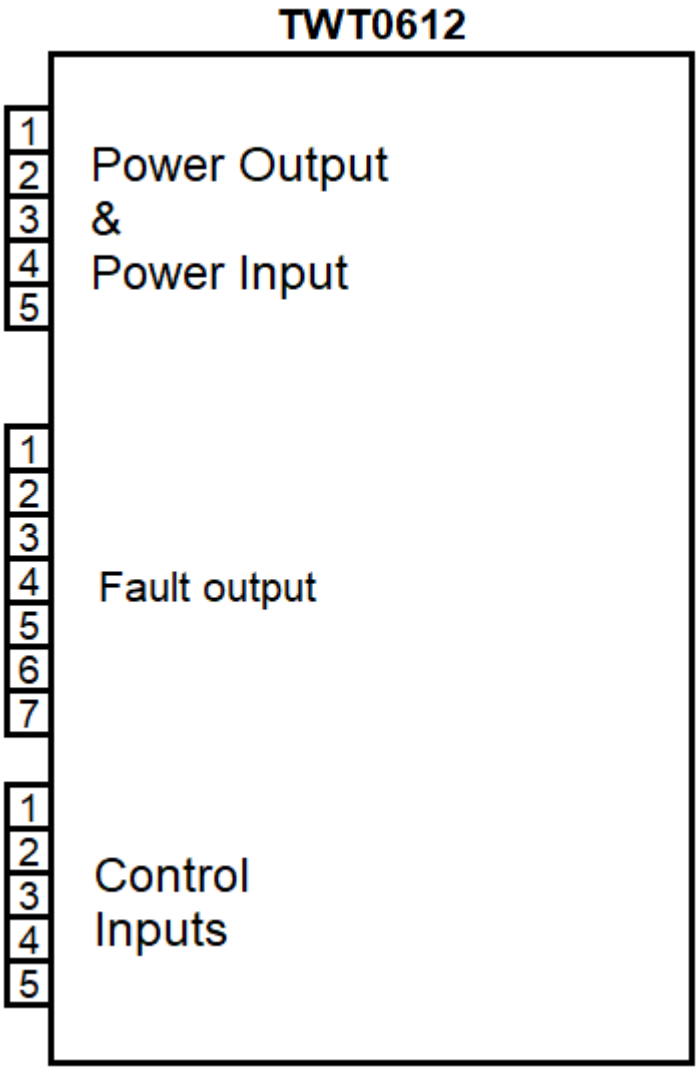


Figure 1 Emergency Lighting Unit inputs and outputs

3.1 POWER INPUT & OUTPUT

Input: Supply power input 24 VDC nominal, allowed range 18-32 VDC.

Output: Constant voltage output for the emergency LED lights (21 VDC on battery power).

Pin number	Description
1	+ OUTPUT
2	+ OUTPUT
3	+ OUTPUT
4	+ INPUT
5	GROUND

3.2 FAULT OUTPUT

Pin number	Description
1	Not in use
2	Not in use
3	Not in use
4	Not in use
5	Not in use
6	Not in use
7	Fault output

3.2.1 FAULT OUTPUT

Error conditions are indicated with this output. Output is high when error has occurred.

Unit can detect load failures and battery pack failures.

Output voltage is same as supply voltage (24 VDC nominal).

3.3 CONTROL INPUTS

Control inputs are internally pulled high. The device reacts to the signal when the input is pulled to the ground, only on falling edge of the signal.

Pin number	Description
1	Not in use
2	Self-test input
3	Not in use
4	Sensor input
5	Reset input

3.3.1 SELF-TEST INPUT

Control signal for TEST MODE. See chapter 3.5.5.

3.3.2 SENSOR INPUT

Control signal input for EMERGENCY MODE. See chapter 3.5.4.

3.3.3 RESET INPUT

Control signal for cancelling TEST MODE or EMERGENCY MODE.

3.4 INDICATOR LIGHTS

The unit has two (2) indicator lights for different stages: Green and Red.

Table 1. Indicator light descriptions.

Image	Description
●	Indicator light is on
⊗	Indicator light is off
◔	Indicator light is blinking/flashing

Table 2. Indicator lights.

Description of modes	INDICATOR LIGHTS	
	GREEN	RED
Operation modes		
Operation modes		
POWEROFF (short blinks)	⊗	◔
EMERGENCY MODE	◔	◔
NORMAL MODE	●	⊗
CHARGING MODE	◔	⊗
SELF-TEST		
SELF-TEST MODE (fast blinking)	◔	⊗
SELF-TEST OK	●	⊗
LOAD FAILURE	⊗	◔
BATTERY CAPACITY FAILURE	⊗	●
INTERNAL FATAL ERROR (fast blinking)	⊗	◔
Failure states (during normal operation)		
LOAD FAILURE	⊗	◔
BATTERY PACK FAILURE	⊗	●
INTERNAL FATAL ERROR (fast blinking)	⊗	◔

3.5 DESCRIPTION OF EMERGENCY LIGHT UNIT

3.5.1 NORMAL MODE

During normal mode the unit is observing the supply voltage, control inputs and the battery level.

If supply voltage is lost, the unit will move to POWEROFF MODE.

If battery level drops below pre-set limit, the unit will move to CHARGING MODE.

Control inputs can set the unit to either TEST MODE or EMERGENCY MODE.

3.5.2 POWEROFF MODE

When the main power of the device is lost, the unit will transfer to POWEROFF MODE. In this mode, the unit will wait for 60 seconds if the Sensor input is activated. If sensor mode is not activated, the device will shut down completely (Figure 2), which means the EMERGENCY MODE cannot be activated before the unit is started again. The device must be shut down properly when the bus is not in use to prevent unnecessary battery wear.

If the sensor input is activated during POWEROFF MODE, the unit will move to EMERGENCY MODE (Figure 3).

If unit was in EMERGENCY MODE before the main power was lost, it will not move to the POWEROFF MODE, the unit will remain in EMERGENCY MODE.

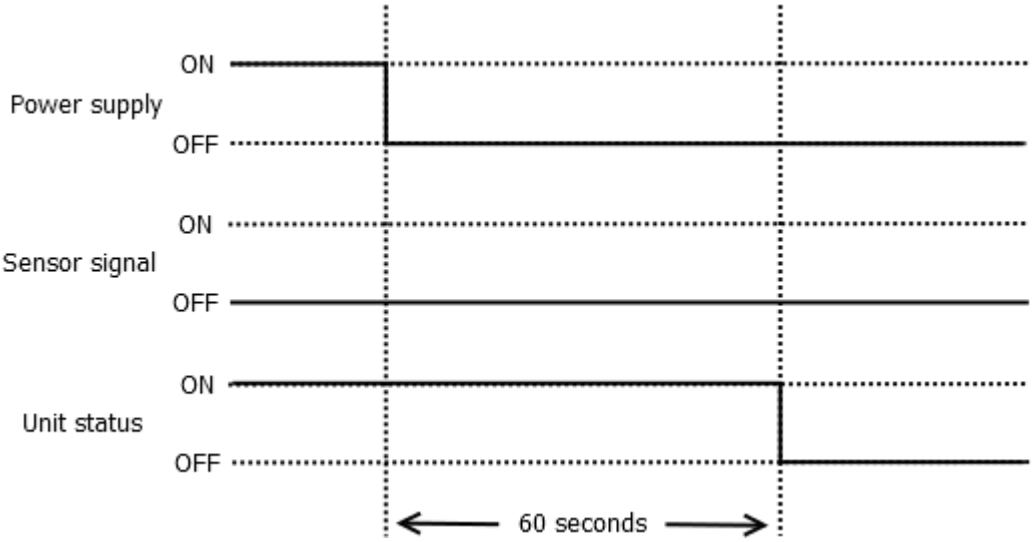


Figure 2. Unit shutdown

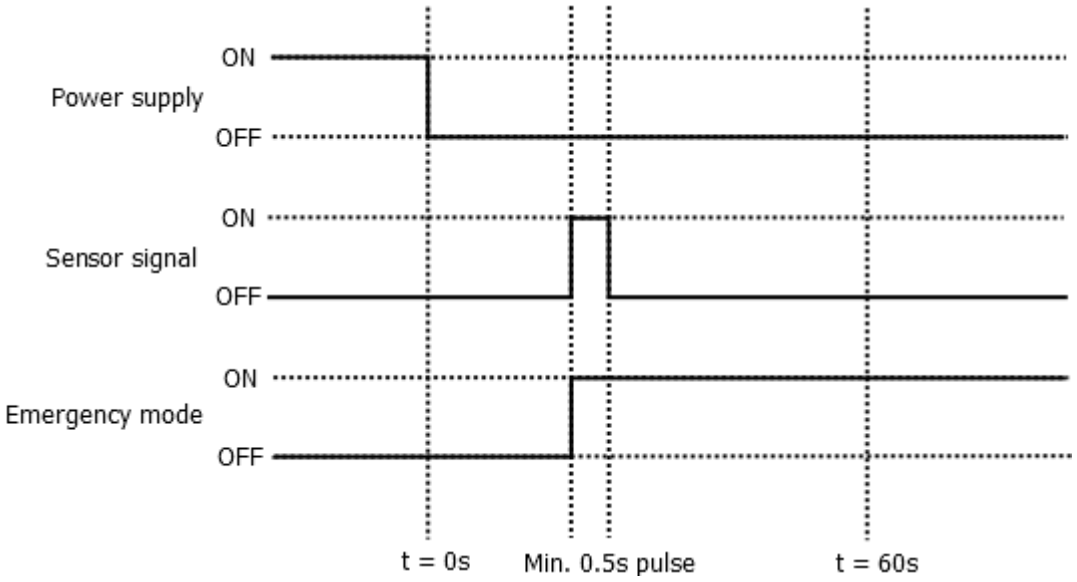


Figure 3. Moving from POWEROFF to EMERGENCY MODE

3.5.3 CHARGING MODE

If the battery voltage shows that the battery is not full, the unit will move to Charging mode. Unit will stay in the charging mode until the battery is full, emergency mode is activated or battery temperature goes beyond allowed charging temperature (+3 – (+45) °C).

3.5.4 EMERGENCY MODE

When emergency mode is activated when sensor input becomes active, the unit will be powered through its internal battery for no less than 30 minutes.

Unit is in *EMERGENCY MODE* until reset input is activated or the battery becomes empty.

If reset input is activated when input power is available, the unit will move to NORMAL MODE or CHARGING MODE, depending on the battery capacity level. If input power is not available, the unit will shut down.

Emergency mode will override following operating stages:

- NORMAL MODE
- CHARGING MODE
- SELF-TEST MODE

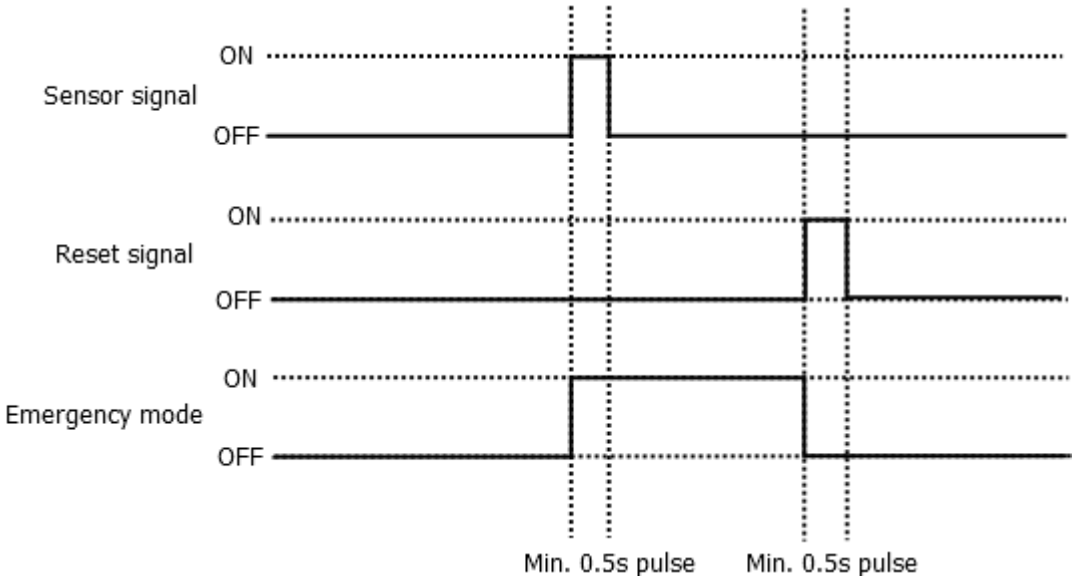


Figure 4. Emergency mode activation and reset.

3.5.5 TEST MODE

Device has self-test capability. Purpose of the test is to check that internal battery is still capable to meet requirements in the emergency situation and that device and loads are operational.

Battery is checked by discharging it. Discharging time corresponds to the required operation time of the device. TWT0612 is tested for 30 minutes.

Device and load check means internal check of the presense of the resistive loads, output voltage and output current.

Testing activity is started **by activating SELF TEST INPUT (signal pulled to the ground)**. Device will start test preparation after the activation.

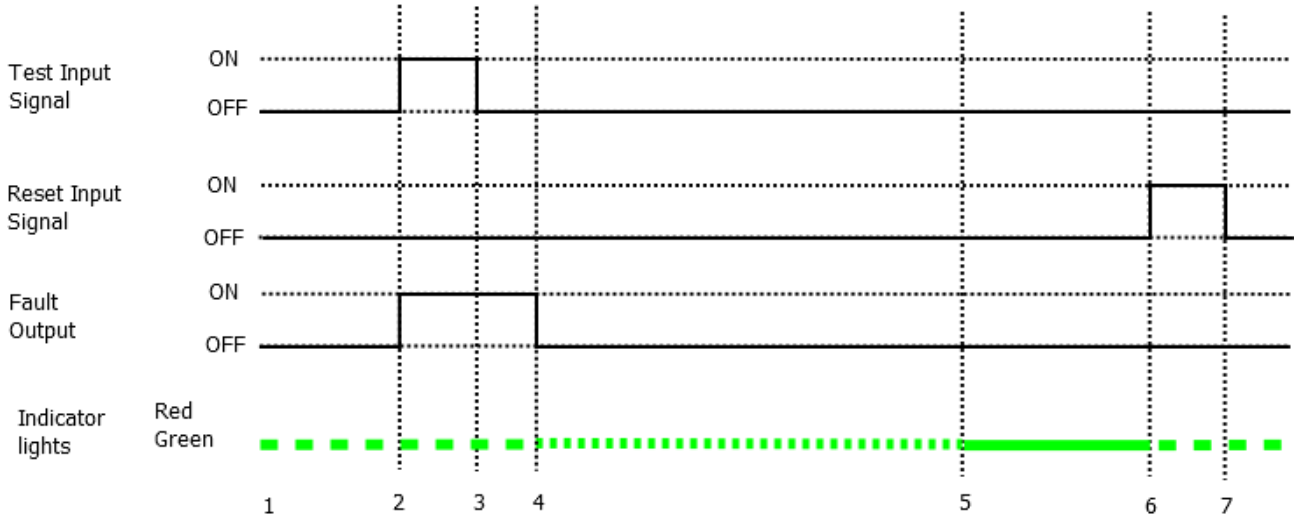
If the battery is not at full capacity it will be detected and FAULT OUTPUT will be set high. Device will charge battery to the maximum level and after that sets the FAULT OUTPUT low. If the battery does not need to be charged FAULT OUTPUT will remain low. Low level on FAULT INPUT indicates that device is ready for the actual test.

Once the device is ready for the test (FAULT INPUT is low) test is started.

In case of fault is found in the test FAULT OUTPUT is set high and the test is stopped immediately. FAULT OUTPUT remains high until reset signal is activated. If self-test was successful, the FAULT OUTPUT will remain low.

The test can be interrupted by activating the reset signal.

3.5.5.1 Test scenario 1



Start state: Battery not fully charged at beginning.
End state: Capacity test is successfully executed.

Figure 5. Test scenario 1: Battery not full when starting, test passed

1. Battery is charging. Green indicator light is flashing.
2. TEST INPUT signal is activated (pulled to the ground). Testing mode activation starts. Fault output becomes high, as the battery is not full and the test cannot be started.
3. TEST INPUT signal becomes inactive. No effect on device.
4. Battery is at 100 % capacity. CAPACITY TEST starts. Load in the output supply is powered by the internal battery. Green indicator is flashing rapidly. Fault output is set low.
5. CAPACITY TEST is completed after 30 minutes and the result is passed. Green indicator is lit meaning to show that device has completed test succesfully.
6. RESET INPUT signal is activated (pulled to the ground). Device is in the normal operation mode. Slow green flash is indicating that the battery is being charged.
7. RESET INPUT signal becomes inactive. No effect on device.

3.5.5.2 Test scenario 2

Start state: Battery fully charged at beginning.

End state: Capacity test is successfully executed.

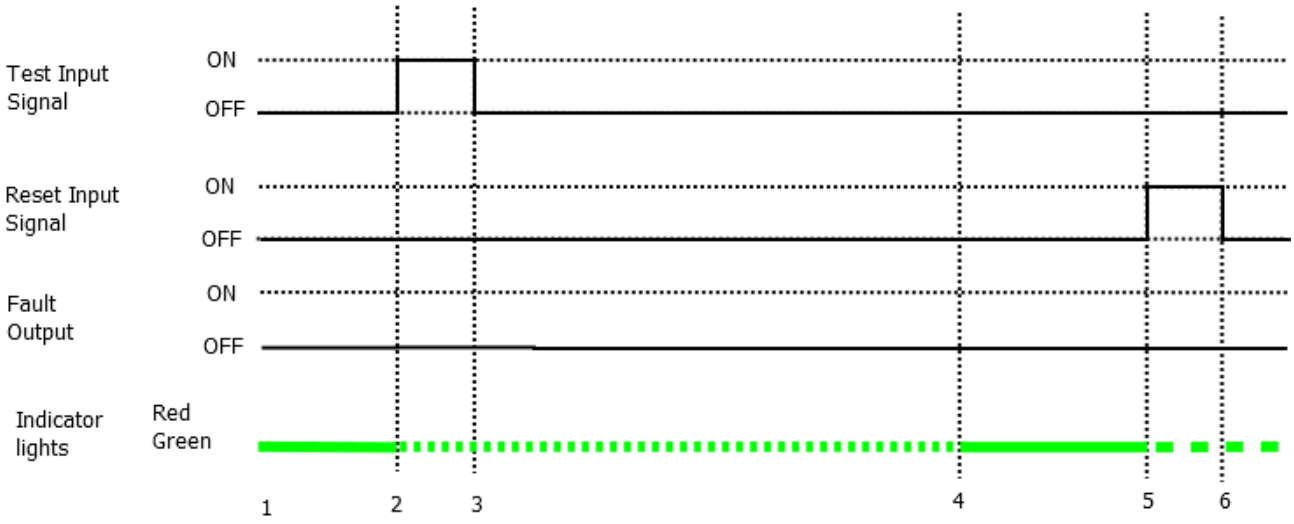


Figure 6. Test scenario 2: Battery full when starting, test passed

1. Battery is fully charged.
2. TEST INPUT signal is activated (pulled to the ground). CAPACITY TEST starts. Load in the output supply is powered by the internal battery. Green indicator is flashing rapidly.
3. TEST INPUT signal becomes inactive. No effect on device.
4. CAPACITY TEST is completed after 30 minutes and the result is passed. Green indicator is lit meaning to show that device has completed test succesfully.
5. RESET INPUT signal is activated (pulled to the ground). Device is in the normal operation mode. Slow green flash is indicating that the battery is being charged.
6. RESET INPUT signal becomes inactive. No effect on device.

3.5.5.3 Test scenario 3

Start state: Battery fully charged at beginning.

End state: Capacity test is NOT successfully executed. Fault in the output load.

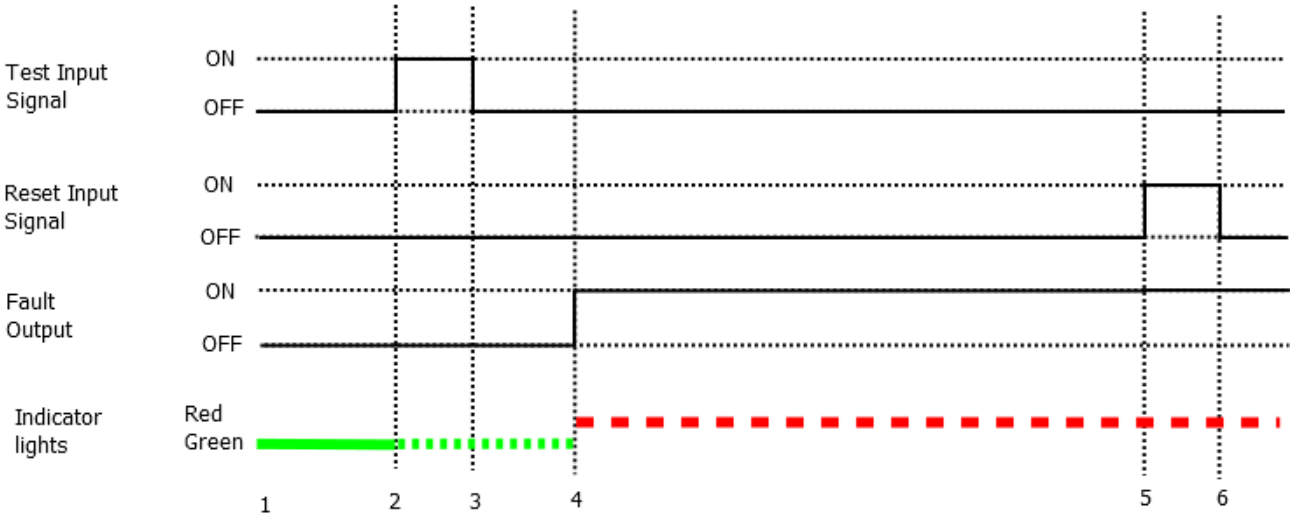


Figure 7. Test scenario 3: Output load fault during test

1. Battery is fully charged.
2. TEST INPUT signal is activated (pulled to the ground). CAPACITY TEST starts. Load in the output supply is powered by the internal battery. Green indicator is flashing rapidly.
3. TEST INPUT signal becomes inactive. No effect on device.
4. CAPACITY TEST is aborted since the device has detected fault in the **output load**. FAULT OUTPUT is set high. Discharging is stopped. Red indicator is flashing to indicate load failure.
5. RESET INPUT signal is activated (pulled to the ground). CAPACITY TEST is finished and the result is failed. FAULT OUTPUT is remains high. Red indicator remains flashing to indicate load failure, which will prevent proper operation in EMERGENCY MODE.
6. RESET INPUT signal becomes inactive. No effect on device.

3.5.5.4 Test scenario 4

Start state: Battery fully charged at beginning.

End state: Capacity test is NOT successfully executed. Fault in the battery capacity.

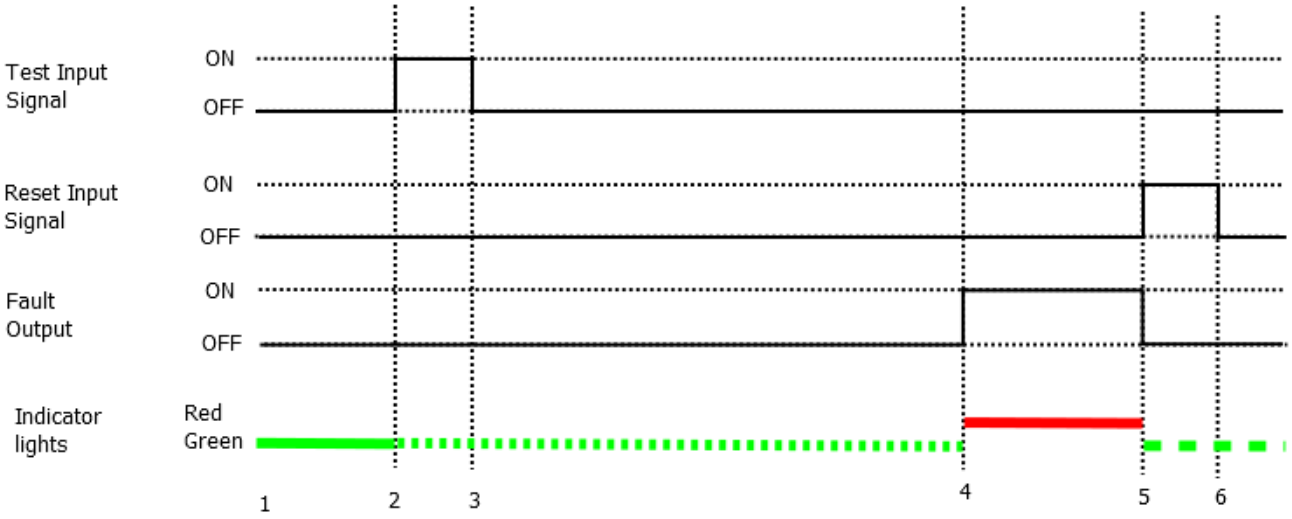


Figure 8. Test scenario 4: Capacity fault during test

1. Battery is fully charged.
2. TEST INPUT signal is activated (pulled to the ground). CAPACITY TEST starts. Load in the output supply is powered by the internal battery. Green indicator is flashing rapidly.
3. TEST INPUT signal becomes inactive. No effect on device.
4. CAPACITY TEST is aborted before 30 minute test time has passed as the device has detected fault in the **battery capacity**. FAULT OUTPUT is set high. Discharging is stopped. Red indicator is lit to indicate load failure.
5. RESET INPUT signal is activated (pulled to the ground). CAPACITY TEST is finished and the result is failed. Device is in the normal operation mode. Slow green flash is indicating that the battery is being charged. Red indicator is no longer lit, as the capacity failure doesn't prevent the activation of the EMERGENCY MODE.
6. RESET INPUT signal becomes inactive. No effect on device.

3.5.5.5 Test scenario 5

Start state: Battery is not fully charged at beginning.

End state: Capacity test is aborted before the charging is completed.

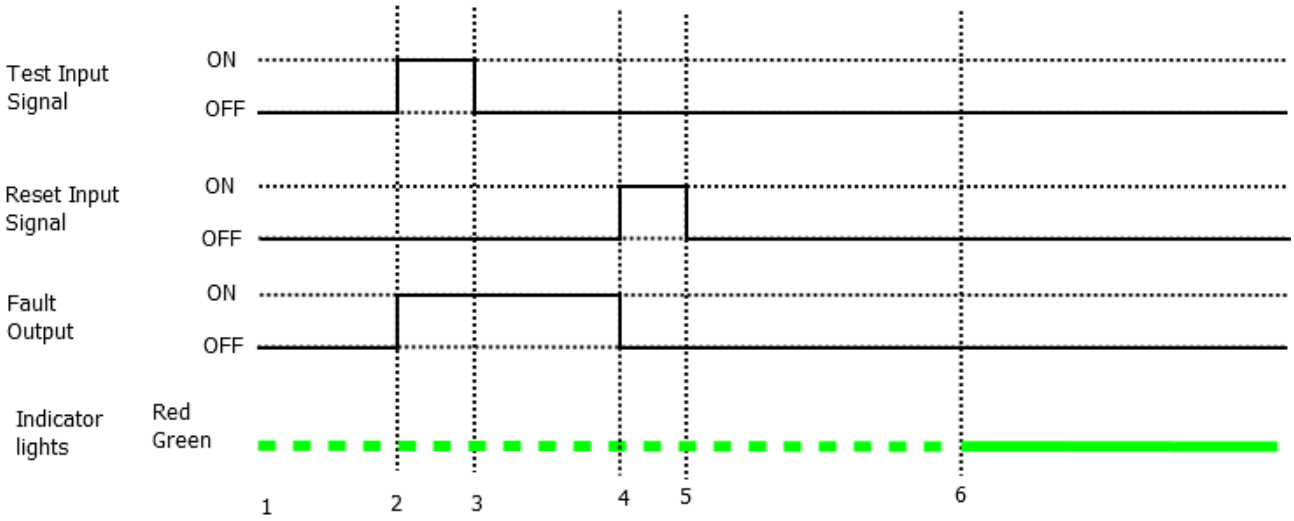


Figure 9. Test scenario 5: Battery not full when starting, test aborted before battery is full

1. Battery is charging. Green indicator light is flashing.
2. TEST INPUT signal is activated (pulled to the ground). Testing mode activation starts. Fault output becomes high, as the battery is not full and the test cannot be started.
3. TEST INPUT signal becomes inactive. No effect on device.
4. RESET INPUT signal is activated (pulled to the ground) before test has started which means that test cycle is aborted. FAULT OUTPUT is set low.
5. RESET INPUT signal becomes inactive. No effect on device.
6. Battery is fully charged.

3.5.5.6 *Test scenario 6*

Start state: Battery fully charged at beginning.

End state: Capacity test is aborted before the **capacity test** is completed.

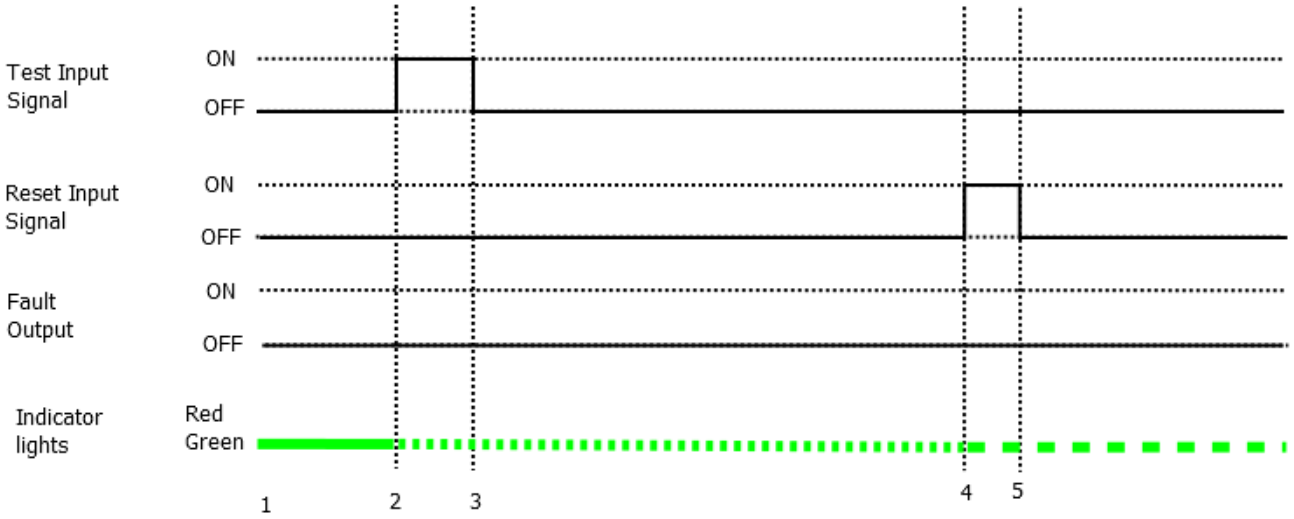


Figure 10. Test scenario 6: Test aborted during capacity test

1. Battery is fully charged.
2. TEST INPUT signal is activated (pulled to the ground). CAPACITY TEST starts. Load in the output supply is powered by the internal battery. Green indicator is flashing rapidly.
3. TEST INPUT signal becomes inactive. No effect on device.
4. RESET INPUT signal is activated (pulled to the ground) before test has has finished which means that test cycle is aborted. FAULT OUTPUT is remains low. Unit starts charging the battery, green indicator light is flashing.
5. RESET INPUT signal becomes inactive. No effect on device.