WHITE PAPER

INSULATION MONITORING DEVICES PMIC TYPE FOR DC CHARGING STATIONS

Guide to wiring and insulation resistance monitoring procedure

Lovato electric

ENERGY AND AUTOMATION

PURPOSE OF THE DOCUMENT

The purpose of this document is to describe the functional procedure for checking the insulation resistance measurement before a charging session with LOVATO Electric insulation monitoring devices PMIC type and the relative process interface with the EVCS control system.

INSTALLATION NOTE

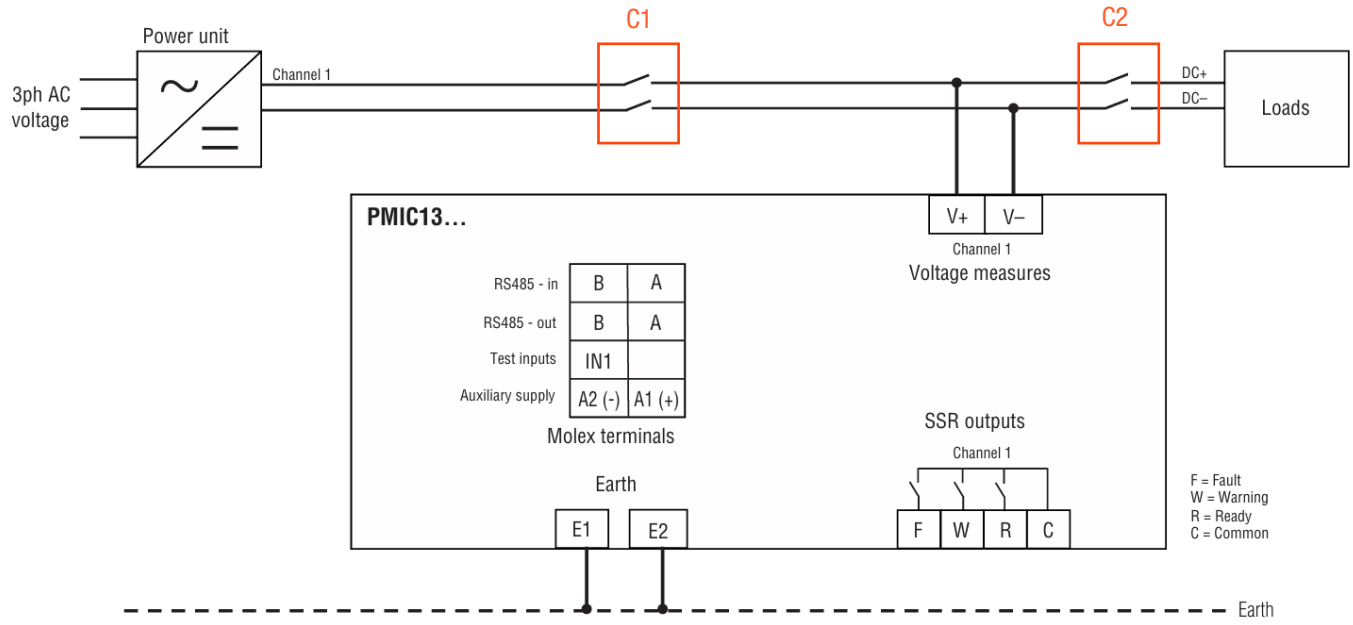
LOVATO Electric PMIC insulation monitoring devices don't generate overheating, eliminating the need for installation clearances from adjacent devices. This provides a significant advantage in terms of installation flexibility and panel space optimization.

WIRING DIAGRAMS

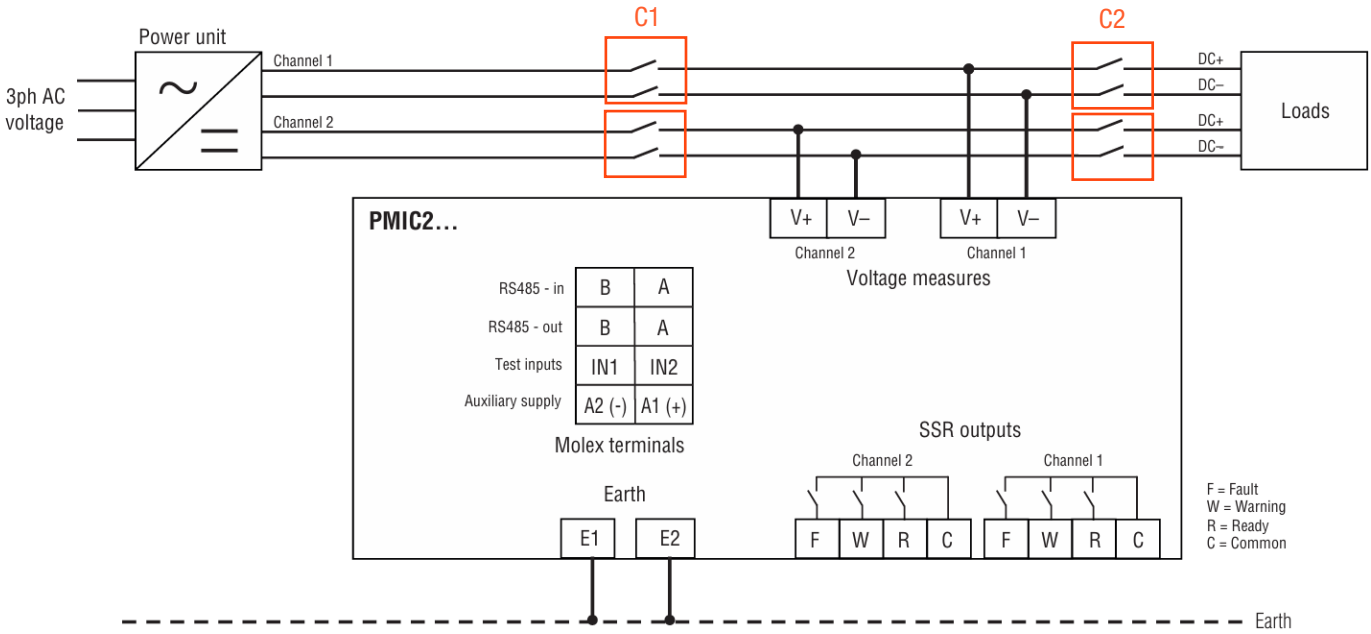
STANDARD CONNECTION

The following diagrams show the wiring configurations for single-channel and dual-channel insulation monitoring devices PMIC type.

Single channel versions (PMIC1... type)

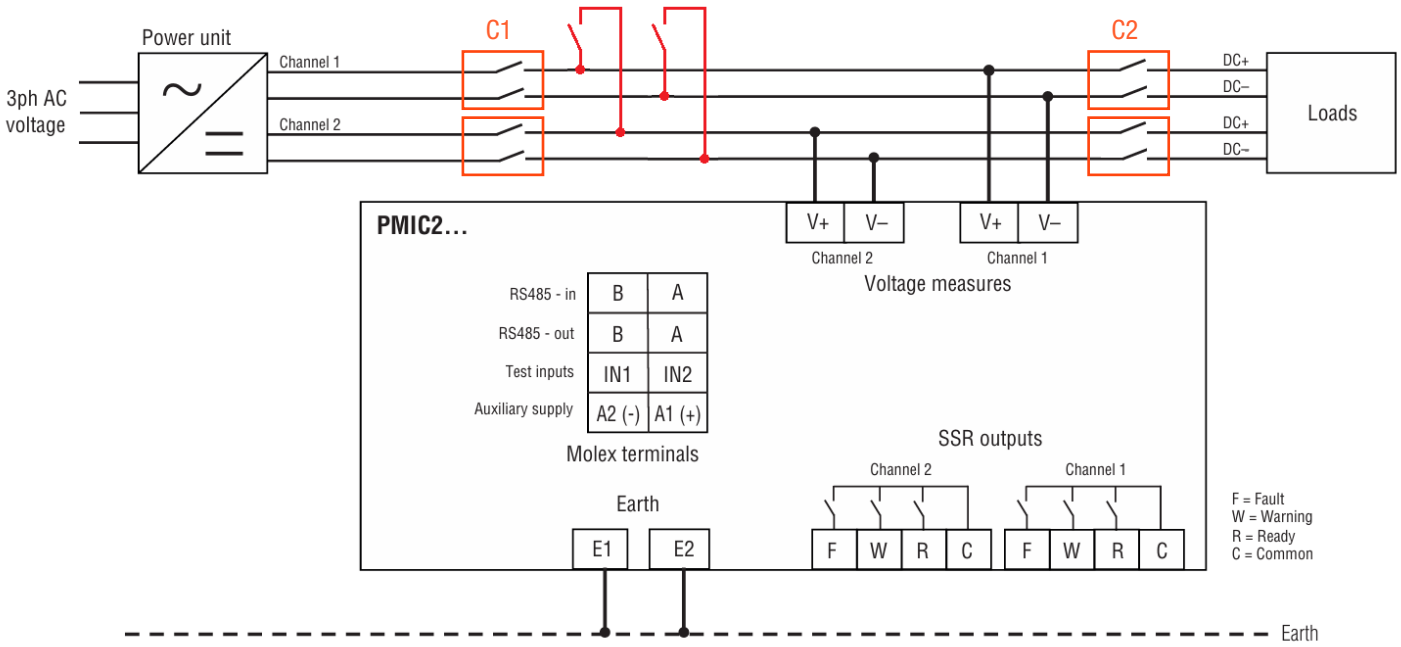


Dual channel version (PMIC2... type)



PARALLEL CONNECTION

The following schematic illustrates a dual-channel PMIC with parallel connection of the two voltage sources.
The same concept can be implemented using two single-channel PMICs, by connecting the two voltage sources in parallel according to the same principle.



NOTE. The schematic showing the parallel connection of the DC lines is provided for **illustrative purposes only** and should **not** be considered a wiring diagram.

IMPORTANT! In the case of parallel connection of two channels:
- When using a dual-channel insulation monitoring device (PMIC2... type), **only one of the two voltage measurement inputs** (channel 1 or channel 2) **shall be used for insulation monitoring**, while the **other voltage measurement input shall be inhibited**.
- When using two single-channel insulation monitoring devices (PMIC1... type) with their voltage sources connected in parallel, **only one PMIC shall be used for insulation monitoring**, while **the other PMIC shall be inhibited**.

Inhibition of a measurement input **does not require electrical disconnection** of the voltage measurement input, which may remain connected. It is sufficient to **disable the measurement function** by configuring the associated built-in **digital input with the "Inhibition" function**, which must be kept permanently closed.

For configuration of the digital input function, refer to the following parameters:
- P03.10 = Inhibition, for inhibition of channel 1
- P04.10 = Inhibition, for inhibition of channel 2 (option available only on PMIC2... type, which integrate two channels within the same device).

INSULATION MONITORING VERIFICATION PROCESS

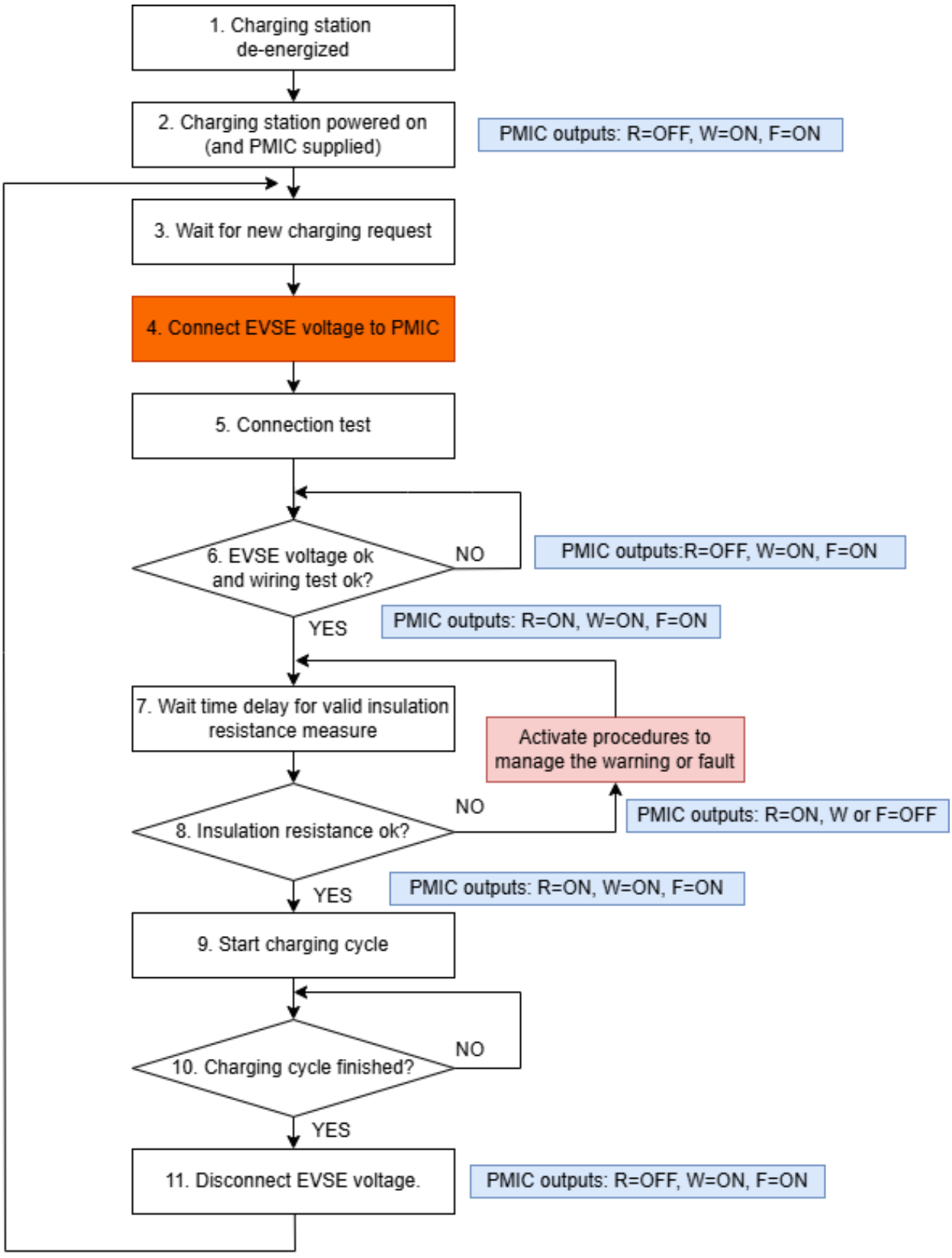
The insulation verification procedure with the PMIC can be performed in two ways:
- By monitoring the onboard SSR outputs;
- Via Modbus-RTU through the built-in RS485 communication port (note. This function is not available on the PMIC10K00B model).

The following chapters describe the two processes, including their respective flowcharts and logical operation.

INSULATION MONITORING VERIFICATION PROCESS WITH THE SSR OUTPUTS

CONTROL VIA SSR OUTPUTS: FLOW CHART

The following flowchart illustrates the PMIC connection procedure and the operating logic for measuring the insulation resistance to earth, monitored through the status of the integrated SSR outputs (R=Ready, W=Warning, F=Fault).



CONTROL VIA SSR OUTPUTS: LOGIC OF OPERATION

The steps presented in the flowchart are described below.

1) Initially, the **charging station is de-energized**.

2) The **charging station is powered on**, and the PMIC receives the 12–24 VDC auxiliary supply.
In this phase, the PMIC does not perform any type of test, as it requires the presence of the EVSE voltage (Electric Vehicle Supply Equipment voltage) to operate.
The three outputs will be in the following states:
- **READY = OFF** (charging station not ready for charging)
- **WARNING = ON** (no insulation resistance issues)
- **FAULT = ON** (no insulation resistance issues)

Note. ON and OFF indicate, in general terms, whether the output is active or not, while the operating logic (NO or NC type) can be configured via a dedicated parameter for each output (default = NC). For further information, refer to manual I799.

3) The user issues a **new charging request**.

4) Inside the charging station, the **contactor between the generator and the bus (C1) is closed**. The PMIC receives the EVSE voltage on terminals V+ and V-.

5) Perform the **connection test.**
With the default factory settings, the **PMIC automatically performs the connection test upon receiving the EVSE voltage** at its V+ and V- terminals, with no additional action required by the user.

Note. Alternatively, if automatic testing is not desired and the test is to be initiated only by a manual command, the integrated digital input IN1must be configured with the function "Test" via parameter P03.10. In this case, the test is performed only when the input is energized, i.e., connected to the negative terminal (-) of the auxiliary supply, and the input must remain closed until the end of the charging cycle.
The same considerations apply to input IN2 (whose function is configured via parameter P04.10) in the case of the dual-channel model PMIC23K00 type.

6) **Check if the measurement is active**:
If the EVSE voltage is within the operating limits (150…1200VDC for models PMIC…K00.., 150…1500VDC for PMIC…K50) the **READY output is energized (R = ON)** since both conditions are met: EVSE voltage is present and the earth connection is correctly established.

7) **Waiting for valid measurement data**: wait approximately 20 seconds to allow the PMIC to properly measure the insulation resistance to earth. This delay typically ranges from 7 to 16 seconds and ensures that the system has stabilized before measuring the true insulation resistance, preventing activation-related transients and the influence of parasitic capacitances that could otherwise distort the measurement.

8) **Check if the insulation resistance is ok**: if both WARNING (W) and FAULT (F) outputs remain in the ON state, it means that the measured insulation resistance is above the configured threshold limits.
If even one of the two outputs (W or F) is OFF, it means that the insultation resistance is below the fault or warning thresholds. Initiate the diagnostic procedures to identify the cause of insulation faults in the system.

9) In the absence of faults (all three outputs are ON), the **contactor supplying voltage to the electric vehicle (C2) is closed**, allowing to start the charging cycle.

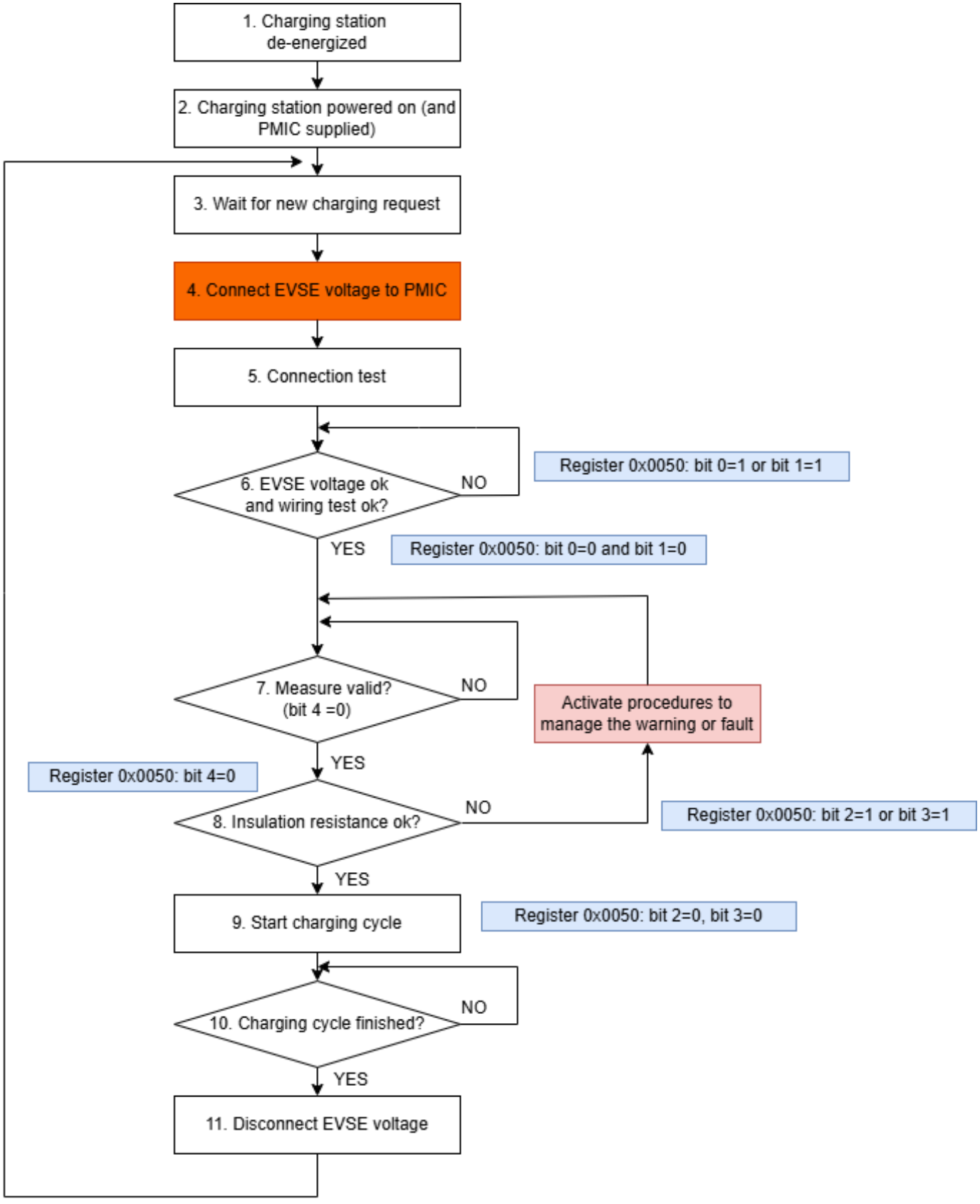
10) Wait until the **charging cycle** is completed.

11) At the end of the charging cycle, The **C1 and C2 contactors open**. The READY output returns to OFF (as the PMIC is unable to perform measurements due to the absence of EVSE voltage), and the cycle restarts, **waiting for a new charging request**.

INSULATION MONITORING VERIFICATION PROCESS VIA MODBUS-RTU (RS485)

CONTROL VIA MODBUS-RTU: FLOW CHART

The following flowchart illustrates the PMIC connection procedure and the operating logic for measuring the insulation resistance to earth, monitored through Modbus-RTU protocol with the built-in RS485.
Note. This function is not available on the PMIC10K00B model.



CONTROL VIA MODBUS-RTU: LOGIC OF OPERATION

1) Initially, the **charging station is de-energized**.

2) The **charging station is powered on**, and the PMIC receives the 12–24 VDC auxiliary supply.
In this phase, the PMIC does not perform any type of test, as it requires the presence of the EVSE voltage (Electric Vehicle Supply Equipment voltage) to operate.

3) The user issues a **new charging request**.

4) Inside the charging station, the **contactor between the generator and the bus (C1) is closed**. The PMIC receives the EVSE voltage on terminals V+ and V-.

5) Perform the **connection test.**
With the default factory settings, the **PMIC automatically performs the connection test upon receiving the EVSE voltage** at its V+ and V- terminals, with no additional action required by the user.

Note. Alternatively, if automatic testing is not desired and the test is to be initiated only by a manual command, the integrated digital input IN1must be configured with the function "Test" via parameter P03.10. In this case, the test is performed only when the input is energized, i.e., connected to the negative terminal (-) of the auxiliary supply, and the input must remain closed until the end of the charging cycle.
The same considerations apply to input IN2 (whose function is configured via parameter P04.10) in the case of the dual-channel model PMIC23K00 type.

6) **Check if the measurement is active**: Read via Modbus-RTU the system output status register 0x0050, length 1 word (2 bytes).
The low byte relates to channel 1 (bit 0…7), the highest byte relates to channel 2 (bit 8…16, to be checked in case of use of dual channel model PMIC23K00 type). The meaning of each bit is detailed below:
- Bit 0: wiring error
- Bit 1: low EVSE voltage
- Bit 2: fault
- Bit 3: warning
- Bit 4: invalid data
- Bit 5: resistance changes too frequently
- Bit 6: impossibility to measure
- Bit 7: not used

The same applies for the bits from 8 to 16 for the channel 2, in case of use of the dual channel model PMIC23K00.
The measurement is active only when both the following conditions are met:
- **Bit 0 = 0** (no wiring error, indicating that the earth connection is correctly established)
- **Bit 1 = 0** (EVSE voltage is present and within the operating range, i.e. 150…1200VDC for PMIC…K00... models, and 150…1500VDC for PMIC…K50 models).

7) **Waiting for valid measurement data**:
The measurement data is considered valid when **bit 4 = 0** of system output status register 0x0050.
The data value is updated at a sampling interval that varies between 1 and 10 seconds. This delay ensures that the system has stabilized before measuring the true insulation resistance, preventing activation-related transients and the influence of parasitic capacitances that could otherwise distort the measurement. Every time a new data sample is updated, an internal counter is increased (or two counters in case of use of the dual channel model). This counter is free-running and updated at every calculation of valid data. The value of the data counter can be read via Modbus-RTU with the register 0x004F, length 1 word (2 bytes). The low byte relates to channel 1, the highest byte relates to channel 2 (in case of use of dual channel model PMIC23K00 type).

The following registers can be used to read the measurements of interest:
- Register 0x000C, length 2 words = insulation resistance of positive pole for channel 1 (ohms, Ω)
- Register 0x000E, length 2 words = insulation resistance of negative pole for channel 1 (ohms, Ω)
- Register 0x0010, length 2 words = parallel insulation resistance for channel 1 (ohms, Ω)
- Register 0x0012, length 2 words = equivalent capacitance value for channel 1 (nanofarads, nF)

In case of use of the dual channel model PMIC23K00 type, the same measures for channel 2 can be read with the registers 0x0024, 0x0026, 0x0028, 0x002A.
Additional measurements are available. For further details, refer to Instruction I848 (PMIC Modbus Manual).

8) **Check if the insulation resistance is ok**:
The insulation resistance is considered ok when the following conditions are met (register 0x0050):
- **Bit 2 = 0** (no fault active)
- **Bit 3 = 0** (no warning active)

If even bit 2=1 or bit 3 = 1, it means that the insultation resistance is below the fault or warning thresholds. Initiate the diagnostic procedures to identify the cause of insulation faults in the system.

9) In the absence of faults (bit 2 = 0 and bit 3 = 0), the **contactor supplying voltage to the electric vehicle (C2) is closed**, allowing to start the charging cycle.

10) Wait until the **charging cycle** is completed.

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