

Negative Ion Module Functional Specification

Model: M28

Version: V1.0

Issue Date:



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1 Overview

1.1 Purpose

This specification is used for development of the negative ion module and defines the functional, operating, and related requirements of the module.

1.2 Scope

This specification applies to vehicles equipped with the negative ion module.

1.3 Reference Documents / Standards

The following reference documents form part of the special descriptions in this specification. Unless otherwise stated, the latest version of each referenced document applies.

Document	Description
F3_ION&PM2.5&EXV_AC_LIN_V1.0 20240229_ION.xlsx	LIN matrix information table
SERES-QR-COP2-04-11-01 S1 Project Fragrance / Negative Ion / PM2.5 Product Development Technical Requirements Template (SOR) V1.7-20230523(2)	Development technical requirements
Q-SK J01.34-2020 Technical Inspection Conditions for Negative Ion Generator Assembly	Technical inspection conditions for negative ion generator assembly
Q-SK J02.87-2022 LIN Communication Requirements Specification	LIN communication requirements specification

2 Negative Ion System Overview

2.1 Product Overview and System Block Diagram

2.1.1 Product Overview

The negative ion module is a device that generates airborne negative ions. Negative ions are the general term for individual gas molecules and hydrogen-ion clusters in ambient air that carry a negative electric charge.

System Block Diagram

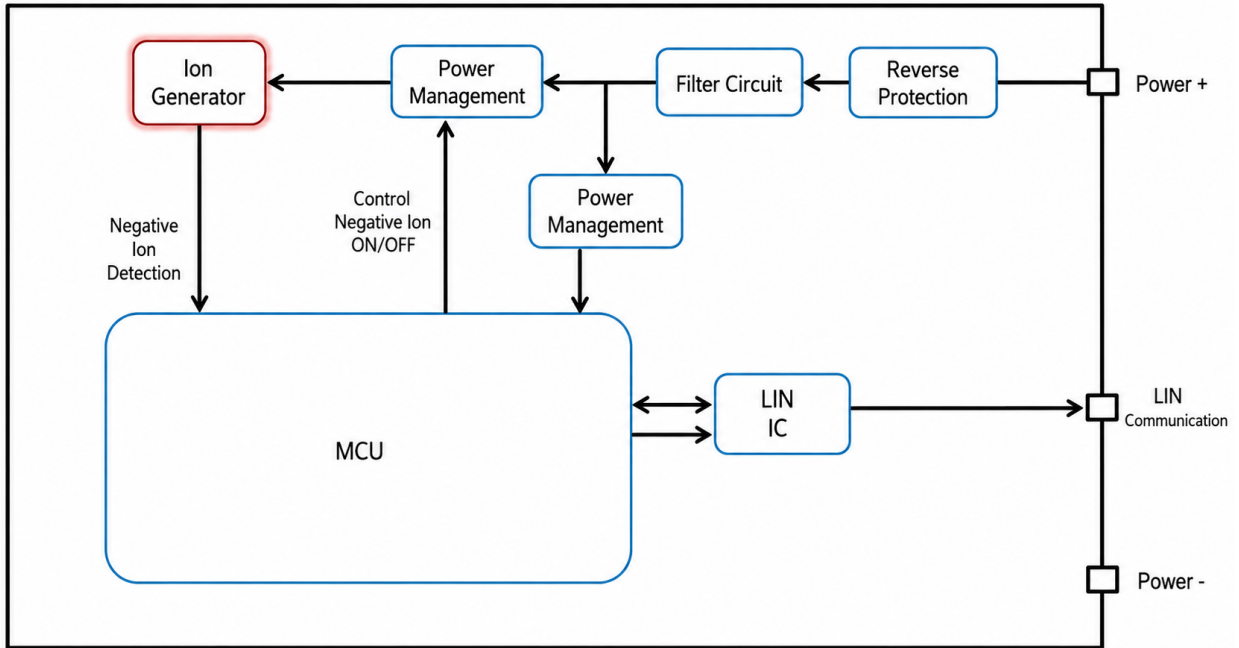


Figure 2-1 Negative Ion Module System Block Diagram

2.2 Technical Parameters

Item	Parameter
Operating Voltage	DC 9-16 V
Operating Current	≤ 100 mA
Standby Current	≤ 0.1 mA
Communication	LIN line communication
Negative Ion Concentration	> 10 million pcs/cm ³ at normal temperature and pressure; test distance 10 cm; air speed 3 m/s
Ozone Concentration	< 1.07 mg/m ³
Operating Temperature	-40 to 85 deg C
Storage Temperature	-40 to 90 deg C
Operating Humidity	35%-85% RH

2.3 Negative Ion Module Structural Diagram



Figure 2-2 Negative Ion Module Overall View

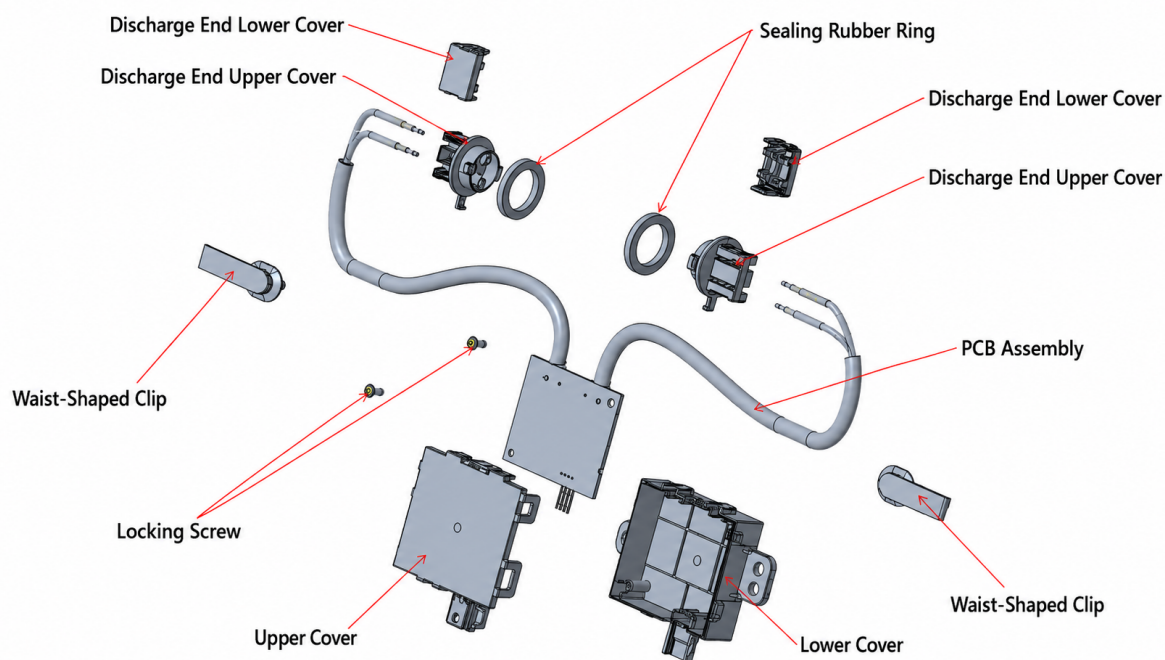


Figure 2-3 Negative Ion Module Exploded View

2.4 Product Operating Mode Description

Standby Mode

- When power is first applied, the negative ion module is in standby mode.
- After receiving a negative-ion-module OFF command from the master node, the module remains in standby mode.

- When the supply is in an over-voltage or under-voltage state, the module turns off negative ion output and enters standby mode.
- If an open-circuit or short-circuit condition is detected while negative ion output is active, the module turns off negative ion output and enters standby mode.

Sleep Mode

- After the master node sends a sleep command, the negative ion module stops operating, turns off all power supplies, and enters sleep mode.
- If no command is received from the master node within 4 seconds after power-on, the module automatically enters sleep mode. In sleep mode, it can receive communication commands from the master node at any time and start negative ion operation.

Operating Mode

After the master node sends an ON command, the negative ion module enters operating mode.

Overall Operating Overview

When power is supplied to the negative ion module, the module enters standby after initialization. The module controls operation according to the ON, sleep, and standby commands received from the master node.

The original document includes a state-transition diagram in this section. The English operating-state description above preserves its functional meaning.

Program Architecture Description

The program uses a simple cyclic pipeline mode.

- After power-on, the lower-level modules are initialized, including clock, I/O, ADC, UART, timer, configuration bits, interrupt, and WDT.
- Variables are initialized.
- Main-loop ADC module detection: after a 0.5 s startup delay or 0.2 s sleep-wakeup delay, ADC detection starts. ADC detection is performed every 20 ms to detect the supply voltage and negative ion voltage and determine their values.
- Main-loop LIN module detection: UART status is detected and data is processed according to different states.
- Main-loop PW module detection: the power state is judged and operating status is managed. If no UART information is received within 4 s or a sleep command is received, the module enters sleep. When the UART receives a LIN synchronization break field, the module wakes up.
- Main-loop ION module detection: control commands are received and executed according to system status.

- Watchdog servicing is performed.

Interrupt handling includes a 2 ms scheduled task for 4 s timing, UART receive timeout, sleep-command delay, and related timing; serial receive interrupt for LIN information; serial transmit interrupt for LIN information; and LIN-signal wakeup during sleep.

3 Negative Ion Subsystem Description

3.1 LIN Communication Section

3.1.1 LIN IC Features

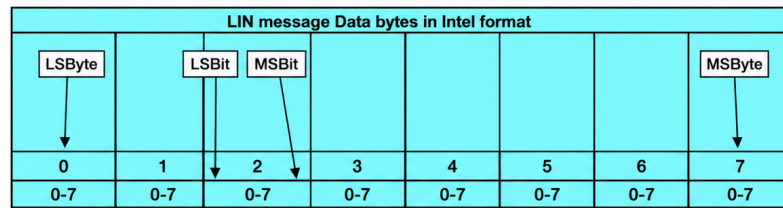
This negative ion product uses a SIT1021QT/1 LIN communication IC from SIT. Key features of this IC include:

- Compliant with "LIN 2.x / ISO 17987-4:2016 (12 V) / SAE J2602" standards.
- AEC-Q100 qualified.
- Built-in over-temperature protection (thermal shutdown).
- Built-in dominant timeout function.
- Bus current-limit protection.
- Battery under-voltage protection.
- Ultra-low-power sleep mode.
- Supports local wakeup and remote wakeup.
- Uses the INH pin to control an external regulator.
- LIN data transmission rate up to 20 kbps.
- High electromagnetic compatibility (EMC).
- Available in DFN3x3-8 small-outline no-lead package.

3.1.2 Network Specification Description

The LIN device in this module is a slave-node device. The data packet protocol format is defined by the LIN bus master-node device.

LIN data formats



Multi-byte data must be stored using "Intel Format". For example, in the BCM_01 message, the LSByte of L_BCM_VehicleSpeed is stored in Byte 1, and the MSByte is stored in Byte 2, as shown on the right.

Multi-bit data must also be stored using "Intel Format". For example, the value of L_BCM_VehicleModel is stored in Bits 5-7 of the BCM_01 message, where Bit 7 is the MSBit and Bit 5 is the LSBit, as shown on the right.

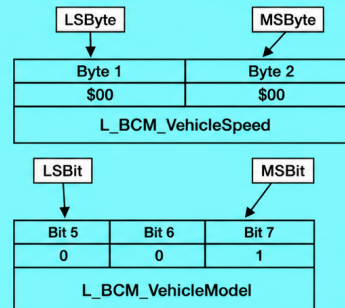


Figure 3-1 LIN Data Formats

3.2 Main-Control MCU Module

The negative ion module uses a 32 MHz microprocessor. The selected IC meets automotive-grade requirements and is AEC-Q100 qualified. Its functions include:

- Internal / external watchdog support and programmable cyclic redundancy check (CRC) module.
- 12-bit A/D converter.
- Integrated 64 KB PFLASH, 32 KB DFLASH, and 16 KB RAM.
- Operating voltage range: 2.7 V to 5.5 V.
- Operating temperature range: -40 to 125 deg C.
- Three LIN channels.
- Full-chip sleep current as low as 20 uA.

4 Interface Information

Connector housing model: TE-1565749-1.

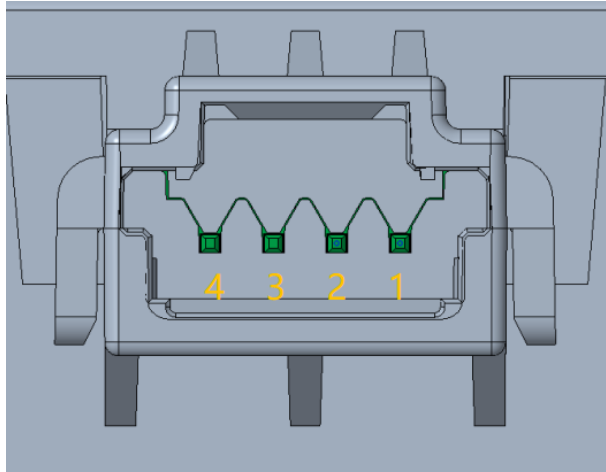


Figure 4-1 Communication Connector Terminal Appearance

The connector interface definition is shown in Table 4-1.

Table 4-1 Connector Interface Definition

No.	Symbol	Function Definition
1	VCC	Power positive
2	LIN	LIN data
3	NC	No connection
4	GND	Power negative

5 Fault Diagnosis Information

5.1 Negative Ion Status Abnormality

During negative ion operation, the system detects the negative ion status in real time. If a short-circuit or open-circuit condition occurs, the module turns off negative ion output and reports the status to the master node.

5.2 Supply Voltage Abnormality

When AD detection indicates that the supply voltage is outside the specified range, the negative ion module enters standby mode, records the over-voltage or under-voltage status, and reports the status to the master node.

5.3 LIN Communication Abnormality

When a checksum abnormality is detected in LIN information received from the master node, or when LIN communication is abnormal, the negative ion module reports LIN_Err to the master node.

Revision History

Version No.	Revision Description	Revised Date	Revised By
1.0	Initial Version		

Revision note translated from the source document: version numbers increase sequentially from 1.0; after 1.9, the next changed version becomes 2.0 and subsequent versions continue in order. Dates are named in year-month-day order.