

Sendyne SIM100 CAN Protocol Implementation

Features

- CAN 2.0B extended frame format
- 500 kbit/s or 250 kbit/s

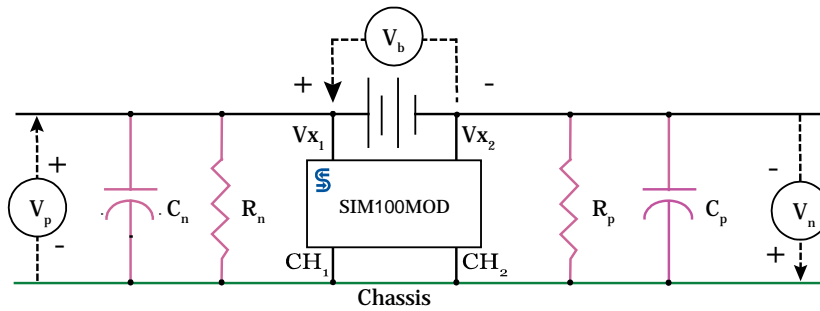


Figure 1: SIM100 isolation monitoring reference diagram

General message format

The Sendyne SIM100 communicates with the host system through a command-response protocol. Communications are initiated by the host issuing a message with extended ID 0xA100101, followed by a byte indicating the type of operation (read, write or command) to be performed. Depending on the type of operation either more or no data may follow as shown in Fig 2.

Ext. ID	byte 0	byte 1	byte 2
0xA100101	Operation Code	MSB	LSB

Figure 2: Host initiated request format

The SIM100 will respond with Ext. ID 0xA100100, followed by the same operation Code and any data pertinent to the transaction.

Ext. ID	byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7
0xA100100	Op. Code	Data	Data	Data	Data	Data	Data	Data

Figure 3: SIM100 response format

Data types

SIM100 data can have the length of a bit, byte, 2-byte unsigned integer or 4-byte unsigned integer depending on the content of the transaction. The data types can be a flag, a character, or an unsigned integer; they are documented in each operation description.

In case of multi-byte data the most significant byte is always first.

Data n	Data n+1	Data n+2	Data n+3
MSB	Data	Data	LSB

Figure 4: Byte ordering within a multi-byte data type always starts with the most significant byte (MSB)

Read requests from the host

Read requests from the host to the SIM100 have the format shown in Fig 5.

Ext. ID	byte 0
0xA100101	Operation Code

Figure 5: Read request format

The following table lists the valid Read Operation Codes.

Code	Name	Description
0xE0	Read isolation state	Provide the potential minimum isolation resistance path in Ω/V and the maximum energy that can be stored in isolation capacitors in mJ calculated with reference to the maximum battery voltage
0xE1	Read isolation resistances	Return the estimated values of isolation resistances R_p and R_n
0xE2	Read isolation capacitances	Return the estimated values of capacitances C_p and C_n
0xE3	Read voltages V_p and V_n	Return voltages V_p and V_n between the battery poles and chassis
0xE4	Read battery voltage V_b	Return value of battery voltage
0xE5	Read SIM100 error flags	Return value of error flags

Table 1: Read operation codes from host to SIM100

Upon receipt of one of the above listed codes the SIM100 will respond with an 8-byte message with the following format.

Ext. ID	byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7
0xA100100	Op. Code	Status	Data		Uncertainty	Data		Uncertainty

Figure 6: Read response format

The response consists of Extended ID 0xA100100, the Code operand and the Status byte. Data requested follow along with the calculated uncertainties expressed as percentage of the values. The only exception is the “Read SIM100 error flags” response that does not contain uncertainties.

Status byte

The status byte consists of flags describing the state of the isolation monitoring system.

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
HE	NE	HU	-	HV	LV	IS1	IS0

Figure 7: Status byte flags

Bit	Symbol	Name	Description
7	HE	Hardware Error	0 – No hardware error 1 – Hardware error. The host should perform a “Read SIM100 Error Flags” operation in order to resolve the issue
6	NE	No New Estimates	0 – The flag is zero when new and unread isolation values have been calculated. 1 – Isolation values have not been updated since the last read. This may happen when a host requests to read isolation values while the SIM100 is in the middle of a calculation. In this case the SIM100 will return the most recent calculated values.
5	HU	High Uncertainty	0 – Uncertainty of calculated values is less than 5% 1 – Uncertainty values are higher than 5%. The uncertainty values always accompany reported data.
4	-	Undefined	Reserved for future use; this bit always has a value of zero
3	HV	High Battery Voltage	0 – Observed battery voltage is less than the specified Maximum Working Voltage. 1 – The observed battery voltage value is higher than the specified maximum working voltage value. The flag will be set if the “Maximum Working Voltage” register has not been set, or if the set value is less than the maximum observed battery voltage value. If this flag is set, isolation resistance and stored energy will be calculated based on the maximum observed battery voltage.
2	LV	Low Battery Voltage	0 – Observed battery voltage higher than 15 V 1 – Observed battery voltage less than 15 V. This flag also set when battery is disconnected.
1-0	IS1-IS0	Isolation status bits	00 – Isolation status OK 10 – Warning. Isolation resistance < 500 Ohm/V limit. 11- Isolation fault. Isolation resistance <100 Ohm/V limit.

Table 2: Definition of Status byte flags

Read Isolation State

This is the most typical transaction between the host and the SIM100, in order to get the safety status of the IT ground system as defined in Federal Motor Vehicle Safety Standards §571.305 and ISO 6469-3.

Request from Host

Ext. ID	byte 0
0xA100101	0xE0

Response from SIM100

Ext. ID	byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7
0xA100100	0xE0	Status	Electrical isolation	Uncertainty	Energy stored	Uncertainty		

Figure 8: Read Isolation State request and response

Electrical isolation

The SIM100 returns the minimum resistance isolation path between the IT grounded system and the chassis. The value is calculated based on the battery's Maximum Working Voltage which is set by the host or observed by SIM100. Units are expressed in Ω/V .

Energy stored

This is the maximum energy that can be stored in the Y capacitors between the battery and chassis at the maximum working voltage. Units are mJ.

Uncertainty

Each reported value is accompanied by the calculated uncertainty. Uncertainty is expressed as percentage of the reported value.

Read isolation resistances**Request from Host**

Ext. ID	byte 0
0xA100101	0xE1

Response from SIM100

Ext. ID	byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7
0xA100100	0xE1	Status	Rp		Uncertainty	Rn		Uncertainty

Figure 9: If the battery voltage is above 15 Volts, “Read isolation resistances” request returns the estimated values of Rp and Rn in kΩ. If a short is detected Rp, Rn along with the associated uncertainties are set to zero.

Read isolation capacitances**Request from Host**

Ext. ID	byte 0
0xA100101	0xE2

Response from SIM100

Ext. ID	byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7
0xA100100	0xE2	Status	Cp		Uncertainty	Cn		Uncertainty

Figure 10: Read isolation capacitances returns the estimated values of capacitances Cp and Cn in nF. If a short is detected Cp, Cn along with the associated uncertainties are set to zero.

Read voltages Vp and Vn**Request from Host**

Ext. ID	byte 0
0xA100101	0xE3

Response from SIM100

Ext. ID	byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7
0xA100100	0xE3	Status	Vp		Uncertainty	Vn		Uncertainty

Figure 11: Read voltages Vp and Vn returns the voltages between battery terminals and chassis in V

Read battery voltage V_b

Request from Host

Ext. ID	byte 0
0xA100101	0xE4

Response from SIM100

Ext. ID	byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7
0xA100100	0xE4	Status	V_b		Uncertainty	V_b, max		Uncertainty

Figure 12: Read battery voltage V_b returns the current value of battery voltage and the maximum value observed since a SIM100 restart, in V

Read SIM100 error flags

Request from Host

Ext. ID	byte 0
0xA100101	0xE5

Response from SIM100

Ext. ID	byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7
0xA100100	0xE5	Status	Error flags	-	-	-	-	-

Error flags

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
V_{X2}	V_{X1}	CH	VxR	V_{EXI}	V_{PWR}	-	-

V_{X2} 0 - V_{X2} connection is good (SIM100 to battery negative terminal connection)
 1 - V_{X2} connection is broken

V_{X1} 0 - V_{X1} connection is good (SIM100 to battery positive terminal connection)
 1 - V_{X1} connection is broken

CH 0 - CH_1 and CH_2 connections are good (chassis connections)
 1 - CH_1 or CH_2 connection is broken

VxR 0 - V_{X1} and V_{X2} connections are correct
 1 - V_{X1} and V_{X2} connections are reversed

V_{EXI} 0 - Excitation voltage level is correct
 1 - Excitation voltage level is out of specs

V_{PWR} 0 - Power supply level is good
 1 - Power supply level is out of range

Figure 13: Read SIM100 error flags returns diagnosed error conditions in the Error flags byte. All other bytes are undefined.

Write requests

Write requests have the following format.

Request from Host

Ext. ID	byte 0	byte 1	byte 2
0xA100101	Op. Code	MSB	LSB

Response from SIM100

Ext. ID	byte 0	byte 1	byte 2
0xA100100	Op. Code	MSB	LSB

Figure 14: A response to a Write command returns the original data

The following write operation is defined.

Set battery Maximum Working Voltage**Request from Host**

Ext. ID	byte 0	byte 1	byte 2
0xA100101	0xF0	MSB	LSB

Response from SIM100

Ext. ID	byte 0	byte 1	byte 2
0xA100100	0xF0	MSB	LSB

Figure 15: Set Maximum Working Voltage command sets the corresponding value in V. When set, this value is used to calculate minimum isolation resistance and maximum capacitance energy.

Read manufacturer's data registers

The SIM100 has a list of 4-byte registers containing manufacturer's information. The following table lists each register's contents. Part name and Version is stored in ASCII format. Serial number is stored in Hex.

Index	Contents
0x01	Part name 0
0x02	Part name 1
0x03	Part name 2
0x04	Part name 3
0x05	Version 0
0x06	Version 1
0x07	Version 2
0x08	Serial number 0
0x09	Serial number 1
0x0A	Serial number 2
0x0B	Serial number 3

SIM100 Part number

Part name 3	Part name 2	Part name 1	Part name 0
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SIM100 software version

Version 2	Version 1	Version 0
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SIM100 IC serial number

Serial number 3	Serial number 2	Serial number 1	Serial number 0
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Table 3: List of manufacturer's data registers. The Host will have to concatenate data in order to recover encoded information.

These registers can be accessed through register read operations as shown in Fig 16.

Request from Host

Ext. ID	byte 0
0xA100101	Index

Response from SFP100

Ext. ID	byte 0	byte 1	byte 2	byte 3	byte 4
0xA100100	Index	MSB	Byte	Byte	LSB

Figure 16: Read registers operation. The SIM100 returns four bytes containing four ASCII characters.

*Sample SIM100 transaction***Set battery Maximum Working Voltage**

In this sample transaction the host sets the Maximum Working Voltage of the battery to 600 Volts

Request from Host

Ext. ID	byte 0	byte 1	byte 2
0xA100101	0xF0	0x02	0x58

Response from SIM100

Ext. ID	byte 0	byte 1	byte 2
0xA100100	0xF0	0x02	0x58

Read isolation state

In this example the host requests the isolation state of the IT system. The SIM100 responds with new data indicating minimum electrical isolation of 550 Ω/V with uncertainty of 2% and maximum energy stored in capacitors under maximum working voltage of 80 mJ with uncertainty of 4%.

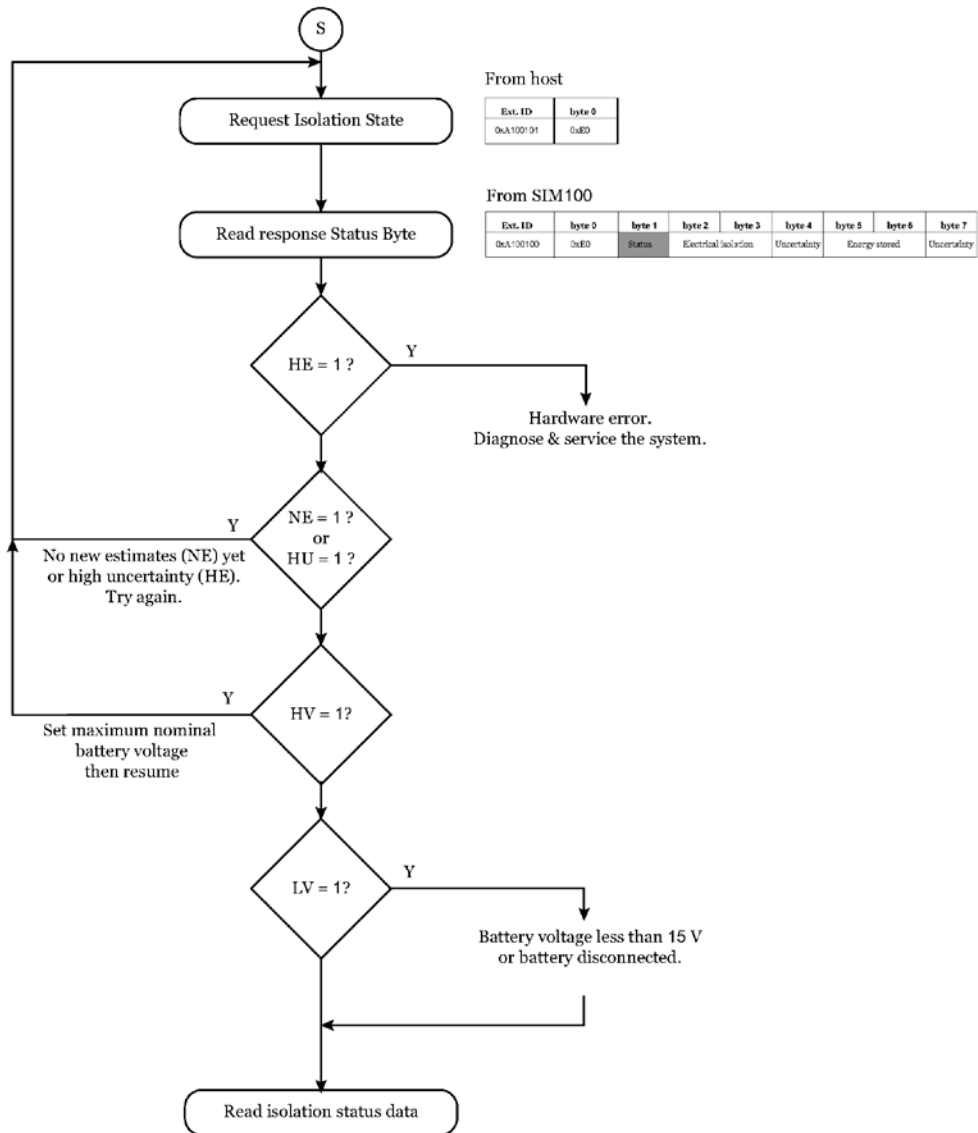
Request from Host

Ext. ID	byte 0
0xA100101	0xE0

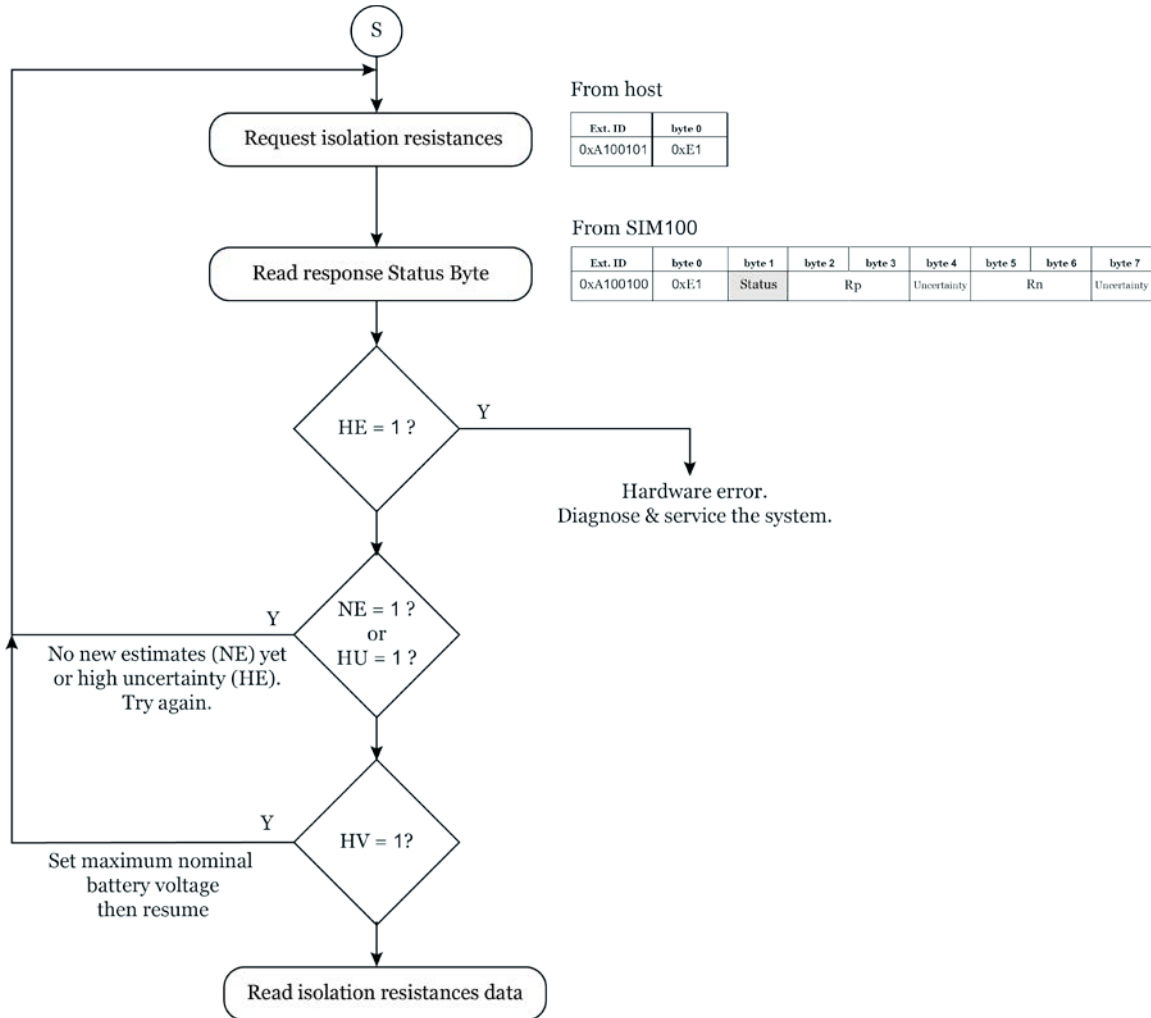
Response from SIM100

Ext. ID	byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7
0xA100100	0xE0	0x00	0x0226		0x02	0x0050		0x04

"Request isolation state" typical flowchart



"Request isolation resistances" typical flowchart



Revision history

V 0.4	SIM100 reports isolation resistances estimates with low voltage present. Prior versions were reporting parallel combination. Clarify behavior when a short is detected (all estimates set to zero).
V 0.3	Defined isolation status bits into Status Byte
V 0.2a	Corrected Serial number encoding description to Hex.
v 0.2	Added flowcharts for typical operations. Description of “Request isolation resistances” when battery is disconnected or below 15 Volts.
v 0.1	Initial release