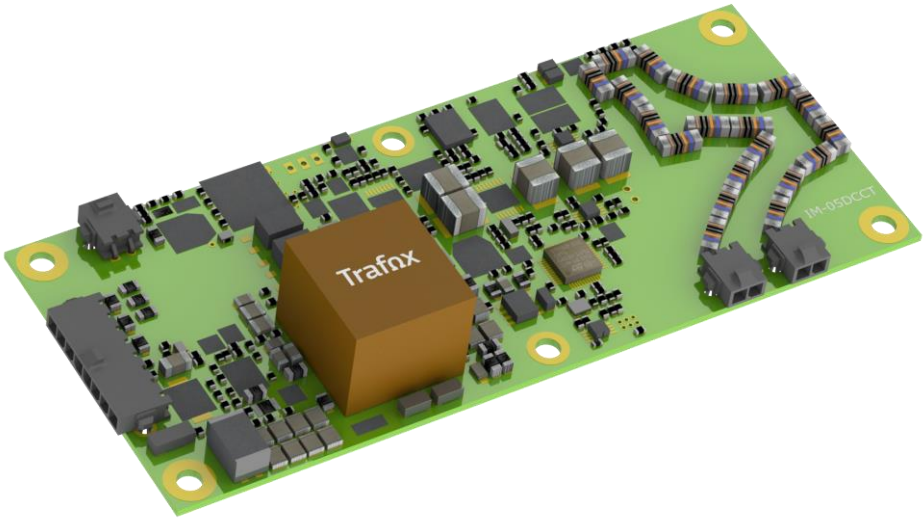
SUPERINTEND IM-05DCCT

IMD Insulation Monitoring device for non-grounded (IT) electrical networks of electric vehicles, charging stations or DC drives

Instructions for installation and use v1.2

AC/DC



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INSTRUCTIONS

These instructions for use are intended for trained electrical engineering professionals. The IM-05DCCT devices are marked with the symbol shown below, which indicates that if the device has been installed incorrectly or used in violation of instructions, safety could be jeopardised. The description of the symbol is presented in this manual instead of on the device due to space constraints. Such sections are marked with the symbol shown below.

A symbol indicating possible danger. A description of the symbol may be placed on the device or provided in the instructions for use.

SYSTEM DESCRIPTION

IM-05DCCT is a device with which the insulation resistance and capacitance of floating electricity networks can be measured and monitored in electric vehicle, charging station or DC drive applications.

INSTALLATION

PHYSICAL CONNECTION

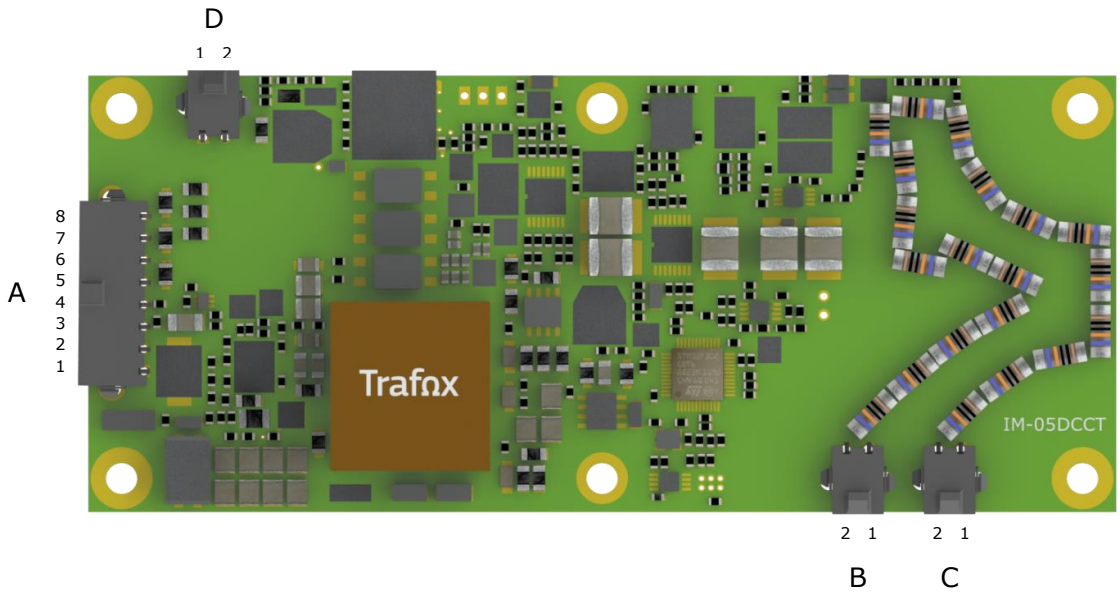
The devices are connected to the electrical network, which may contain dangerous voltage. The device may be installed by a trained electrical engineering professional only. The device contains no user-serviceable parts and must not be opened. Using the device in violation of these instructions may compromise safety.

The IM-05DCCT unit is the main unit of the system. Two IM-05DCCT devices may not be installed galvanically in the same network, for example on the same DC network. The connection is performed as presented in Figure 1. If required by the installation site, the installation and wiring should be performed in accordance with standards IEC 60364 as well as EN 50110.

The IM-05DCCT unit comes with the connections shown in the following table.

Connectors		
A	PCB connector type	TE Connectivity Micro MATE-N-LOK 2-1445088-8
	Crimp contacts	8 x TE Connectivity Micro MATE-N-LOK 1-794606-1
	Housing for crimp contacts	TE Connectivity Micro MATE-N-LOK 1445022-8
	Pin 1	Chassis ground / electronic ground
	Pin 2	Supply voltage
	Pin 3	Chassis ground
	Pin 4	Chassis ground (must be separate wire)
	Pin 5	PWM output (high side)
	Pin 6	PWM output (low side)
	Pin 7	not connected
	Pin 8	Status output (high side)
B	PCB connector type	TE Connectivity Micro MATE-N-LOK 2-1445088-2
	Crimp contacts	2 x TE Connectivity Micro MATE-N-LOK 1-794606-1

	Housing for crimp contacts	TE Connectivity Micro MATE-N-LOK 1445022-2
	Pin 1	HV line +
	Pin 2	HV line +
C	PCB connector type	TE Connectivity Micro MATE-N-LOK 2-1445088-2
	Crimp contacts	2 x TE Connectivity Micro MATE-N-LOK 1-794606-1
	Housing for crimp contacts	TE Connectivity Micro MATE-N-LOK 1445022-2
	Pin 1	HV line -
	Pin 2	HV line -
D	PCB connector type	TE Connectivity Micro MATE-N-LOK 2-1445088-2
	Crimp contacts	2 x TE Connectivity Micro MATE-N-LOK 1-794606-1
	Housing for crimp contacts	TE Connectivity Micro MATE-N-LOK 1445022-2
	Pin 1	CAN_L
	Pin 2	CAN_H



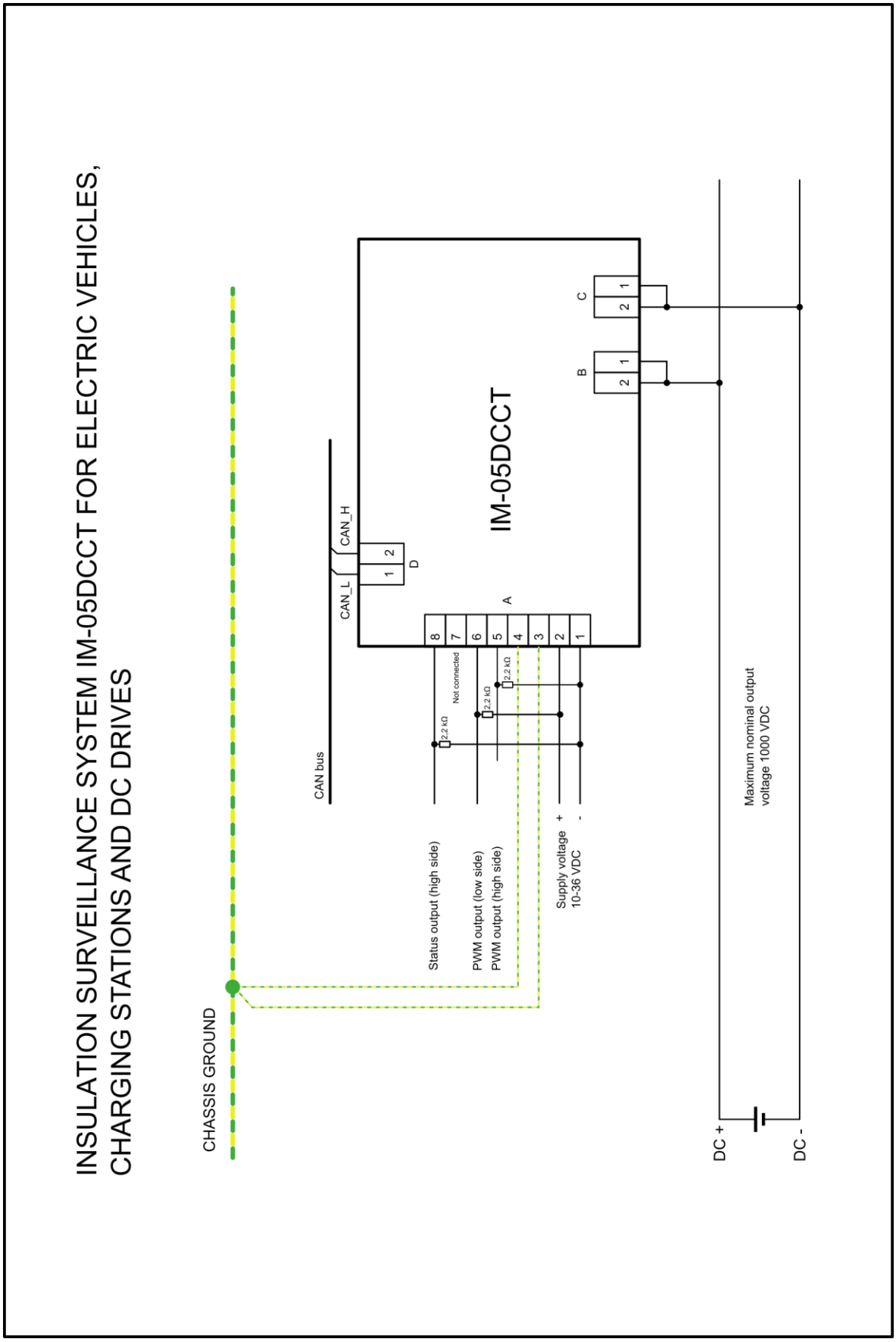


Figure 1. System connection.

USE

IM-05DCCT UNIT

The IM-05DCCT unit independently measures the insulation resistance and capacitance of the IT network to be monitored, in relation to protective earth. The measurement is performed by feeding two summed low frequency alternating voltages between the network and the PE conductor. These generate a low current that travels through the insulation resistance and capacitance to be measured. The insulation resistance and capacitance are calculated by FFT analysing the current and then measuring the amplitude and phase. The insulation resistance values are filtered with averaging filter. The network voltage is monitored and undervoltage conditions are detected. Connection of the earth wires is monitored. A self test is executed automatically every 5 minutes.

The overall status of the system is signaled with status output. The measured insulation resistance value is signaled with PWM output. In case of error, the error type is also signaled with PWM output.

Measurement values can be monitored and settings can be changed using the CAN bus interface.

STATUS OUTPUT

The status output signalises the overall condition of the system. The operating principle of the status output is high side, and an external pull-down resistor is needed. The status output has the following states:

High	System ok, insulation resistance above alarm level
Low	Alarm situation: • insulation resistance below alarm level • system fault • earth wire disconnected • system undervoltage • supply voltage disconnected

PWM OUTPUT

Under normal conditions, the PWM output signalises the measured insulation resistance. Under special conditions, the PWM output signalises some information about the condition. The PWM output has two possible configurations:

Low side	Pin 6	Pull-up resistor needed
High side	Pin 5	Pull-down resistor needed

The PWM output works according to the following table. PWM duty cycle is always determined based on the active time (PWM signal low at the low side configuration and PWM signal high at the high side configuration).

<table>
<tr><td>0 Hz</td><td>Low side
(Pin 6)</td><td>High: pulled up to supply voltage line
Low: device started but the first measurement result is not yet available</td></tr>
<tr><td></td><td>High side
(Pin 5)</td><td>Low: pulled down to ground line
High: device started but the first measurement result is not yet available</td></tr>
<tr><td>10 Hz</td><td colspan="2">• System ok
• System voltage ok
• Insulation resistance R_F can be determined from the PWM duty cycle using the following formula:
$R_F = \frac{90\% \times 1200k\Omega}{D_{PWM} - 5\%} - 1200k\Omega$
D_{PWM} = PWM duty cycle (5…95%)
PWM duty cycle 5 % = ∞
PWM duty cycle 50 % = 1200 kΩ
PWM duty cycle 95 % = 0 kΩ</td></tr>
<tr><td>20 Hz</td><td colspan="2">• System ok
• System undervoltage condition
• Insulation resistance R_F can be determined from the PWM duty cycle using the same formula as with the 10 % frequency</td></tr>
<tr><td>30 Hz</td><td colspan="2">• Device started and the first measurement result is available with the following PWM duty cycles:
PWM duty cycle 5…10 % = insulation resistance above the alarm level
PWM duty cycle 90…95 % = insulation resistance below the alarm level
• The first measurement result is a rough estimate. When the PWM frequency is 30 Hz, the device is performing a calibration. After the calibration, the PWM frequency is changed to 10 Hz or 20 Hz and the PWM duty cycle is set according to the accurate measurement result.</td></tr>
<tr><td>40 Hz</td><td colspan="2">• System fault
PWM duty cycle 47,5…52,5 %</td></tr>
<tr><td>50 Hz</td><td colspan="2">• Earth wire disconnected
PWM duty cycle 47,5…52,5 %</td></tr>
</table>

CAN BUS REMOTE CONTROL

The CAN bus interface of IM-05DCCT uses the OBD II frame format with the following specifications:

- CAN speed: 250 kbps
- Standard frame
- CAN ID: 0x7F1

The following services are supported:

Service 0x60						
PID (hex)		**Units**	**Nbr Data bytes**	**Input**	**Bytes returned**	**Output**
0x01	IMD status	mask	-		2	See below "IMD status mask"
0x02	Insulation resistance	kΩ	-		2	256 * A + B (16 bit unsigned integer)
0x03	Leakage capacitance	0.1 uF	-		2	8 bit signed integer
0x04	Network voltage	V	-		2	256 * A + B (16 bit unsigned integer)
0x05	FW version		-		2	(256 * A + B)/100 -> 123 = 1.23

IMD status mask		
Bit	**Description**	**Status**
0	Self test activity	0=inactive, 1=active
1	Last self test status	0=pass, 1=fail
2	Device condition	0=ok, 1=fault
3	Ground wire connection status	0=ok, 1=fault
4	Insulation alarm status	0=inactive, 1=active
5	Insulation warning status	0=inactive, 1=active
6	Network voltage status	0=ok, 1=undervoltage
7	Calibration activity	0=inactive, 1=active

Service 0x61						
PID (hex)		**Units**	**Nbr Data bytes**	**Input**	**Bytes returned**	**Output**
0x01	Set Alarm level (must be equal or lower than warning level)	kΩ	2	256 * A + B (16 bit unsigned integer), 100…1000	-	
0x02	Set Warning level (must be equal or higher than alarm level)	kΩ	2	256 * A + B (16 bit unsigned integer), 100…1000	-	
0x03	Set Averaging factor		1	8 bit unsigned integer, 1…10	-	
0x04	Set Undervoltage level	V	2	256 * A + B (16 bit unsigned integer), 0, 50…500 (0 = undervoltage detection inactive)	-	
0x05	Self test		1	8 bit unsigned integer, 1 = start self test	-	
Input values outside the allowed range are ignored						

Service 0x62						
PID (hex)		**Units**	**Nbr Data bytes**	**Input**	**Bytes returned**	**Output**
0x01	Get Alarm level	kΩ	-		2	256 * A + B (16 bit unsigned integer), 100…1000
0x02	Get Warning level	kΩ	-		2	256 * A + B (16 bit unsigned integer), 100…1000
0x03	Get Averaging factor		-		2	8 bit unsigned integer, 1…10
0x04	Get Undervoltage level	V	-		2	256 * A + B (16 bit unsigned integer), 0…500 (0 = undervoltage detection inactive)

TECHNICAL SPECIFICATIONS

IM-05DCCT UNIT

Voltage ranges	
Operating voltage [U_S]	10…36VDC
Maximum voltage at the measurement connectors M1 and M2 [U_N]	690VAC / 1000VDC
Frequency range of the network to be monitored	DC, 10…500Hz
Input power	2W

Alarm parameters (set at factory or with the CAN bus interface)	
Alarm limit [R_{an}]	50kΩ…1MΩ
Hysteresis	25%
Averaging factor	1…10
Undervoltage detection threshold	OFF / 50…500V

Measuring specifications	
Measuring range	0kΩ…10MΩ
Relative uncertainty	±20kΩ @ 0…50 kΩ
	±15% @ 50kΩ... 2MΩ
	±25% @ 2MΩ…10MΩ
Measuring voltage U_M	±25V
Measuring current I_M at R_F = 0	50uA
Impedance Z_i at 50 Hz	⩾ 500kΩ
Internal DC resistance R_i	⩾ 500kΩ
System leakage capacitance C_e (nominal measurement specifications)	⩽ 1uF
Response time tan (R_F = 10 MΩ to R_{an}/2; at C_e < 1 µF)	5s

Outputs	
Status output	High side (external pull-down resistor required) High = system ok, insulation resistance above alarm level Low = alarm situation (insulation resistance below alarm level, system fault, earth wire disconnected, system undervoltage or supply voltage disconnected)
PWM output	Low side (external pull-up resistor required) High side (external pull-down resistor required)

	Indication of the measured insulation resistance and possible fault conditions
CAN bus interface	High speed CAN, internal terminating resistor 120 Ω
Outputs are short circuit proof and galvanically isolated from the HV side	

Other details	
Operating temperature	-40…+85°C
Operating humidity (max.)	95% without condensation
Mounting	M4 metal screws
Maximum dimensions - Height	22mm
Maximum dimensions - Width	60mm
Maximum dimensions - Length	140mm
Weight	63g

Standards	
Measurements	IEC 61557-8:2014 (requires alarm indicator and test button implemented at the customer's installation)
Safety	IEC 61010-1:2010 (3rd Edition), IEC 60664-1
EMC	IEC 61326-2-4, ISO 10605
Electrically propelled road vehicles - Safety specifications	ISO 6469-3:2021
Road vehicles — Environmental conditions and testing for electrical and electronic equipment	ISO 16750-1, ISO 16750-2, ISO 16750-3
Environmental tests	IEC 60068-2-14, IEC 60068-2-27, IEC 60068-2-30, IEC 60068-2-38, IEC 60068-2-64

MECHANICAL DIMENSIONS