



## Description:

WE-RCDS 791002004 is a residual current detection sensor designed for wallbox application according to meet IEC 62955: 2018. It is a open loop flux gate current sensor with toroidal core and designed for horizontal PCB mounting with primary conductors.

## Features:

- Compact design for PCB board mounting
- 3-phase primary conductors on module
- DC 6mA residual direct current detecting RDC-M-Module for mode 3 EV charging
- Digital open-drain output, 6mA DC trip indication
- PWM output for DC residual current value indication
- Supply voltage drop monitoring
- Error output for system fault indication
- Designed to meet standard: IEC 62955: 2018
- Module Softw are certified according to ANSI/UL 1998, Class 1
- Partially EMC tested according to IEC 62955: 2018 and EN 60730-1

## Application:

Residual current detection sensor for stationary EV charging devices.

## General Description of Sensor Function:

The sensor is sensitive to DC current and can be used for fault current detection in EV-charging applications to meet IEC 62955: 2018. In the event of a DC fault current, PIN 3 and Pin 4 will change the state from a low level to high impedance state. Error conditions of this sensor are indicated by PIN 1.


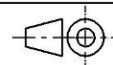

The sensor is only designed to meet the switch-off characteristic of the IEC 62955: 2018 standard (monitoring the residual current). An additional driver-circuit must be used for driving RCBO, RCCB or circuit breaker as defined in IEC 62955.

## Electrical Properties:

Symbol	Description	Min. value	Typ. value	Max. value	Unit
$I_P$	Primary nominal RMS current		32	40	A
$I_{\Delta DC}$	Residual DC operating current		6		mA
$I_{\Delta DC\_tol.}$	Trip tolerance	3	4.6	6	mA
$I_{\Delta R DC}$	Recovery current level for $I_{\Delta DC}$ (absolute value DC)		2.5		mA
X	Resolution @ $I_{\Delta DC}$			0.2	mA
$PWM\_freq$	Frequency	7.52	8	8.48	kHz
$PWM\_out$	PWM duty cycle of the DC component $I_{\Delta DC}$ (for monitoring purpose only)		3.33		%/mA
$V_{PWM\_out}$	PWM output voltage		4.7		V
$f_{BW}$	Frequency range		DC		
$V_{TEST-IN, low}$	TEST-IN input voltage, low level			0.6	V
$V_{TEST-IN, high}$	TEST-IN input voltage, high level	3.1			V
$V_{TRIP-OUT, low}$	TRIP-OUT output voltage, low level			0.4	V
$V_{TRIP-OUT, high}$	TRIP-OUT output voltage, high level			+V <sub>cc</sub>	V

## General Information:

Operating Temperature	-40 °C up to 105 °C
Storage Condition	0 °C up to + 40 °C; up to 75 % RH
Test Conditions of Electrical Properties: +20 °C, 33 % RH if not specified differently	

		CHECKED AlMo	REVISION 000.001	DATE (YYYY-MM-DD) 2023-07-04	GENERAL TOLERANCE DIN ISO 2768-1c	PROJECT ID N METHOD	
 <b>WÜRTH ELEKTRONIK</b> MORE THAN YOU EXPECT		DESCRIPTION <b>WE-RCDS Residual Current Detection Sensor</b>				ORDER CODE <b>791002004</b>	
		SIZE/TYPE Horizontal	BUSINESS UNIT eiSos	STATUS Valid	PAGE 2/11		
Würth Elektronik eiSos GmbH & Co. KG EMC & Inductive Solutions Max-Eyth-Str. 1 74638 Waldenburg Germany Tel. +49 (0) 79 42 945 - 0 www.we-online.com eiSos@we-online.com							

## General Properties:

Symbol	Description	Min. value	Typ. value	Max. value	unit
+V <sub>DD</sub>	Supply voltage	4.85	5	5.15	V
+V <sub>CC</sub>	Pull up voltage			5.5	V
I <sub>CC</sub>	Consumption current	17	24	30	mA
Sclear <sub>pp</sub>	Clearance (primary to primary) <sup>*1</sup>	5.7			mm
Screep <sub>pp</sub>	Creepage (primary to primary) <sup>*1</sup>	6.5			mm
Sclear <sub>ps</sub>	Clearance (primary to secondary) <sup>*2</sup>	6.15			mm
Screep <sub>ps</sub>	Creepage (primary to secondary) <sup>*2</sup>	6.15			mm
Plastic housing flammability rating		UL94 V-0			

\*1 Fulfill the requirements with installed spacer provided by WE.

\*2 Designed and manufactured based on reinforced insulation, insulation material group IIIa, pollution degree 2, altitude ≤ 3000m and overvoltage category III (In accordance with IEC 60664-1:2007). Assume the mounting PCB to be at least material group IIIa.


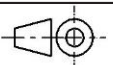

## Absolute Maximum Ratings:

Symbol	Description	Min. value	Max. value	Unit
I <sub>P</sub>	Primary nominal RMS current		40	A
U <sub>MAX</sub>	Maximum rated voltage (AC RMS) of primary conductors (Phase against neutral voltage/Phase against phase voltage)		250/440	V
+V <sub>DD</sub>	Supply voltage	-0.3	5.5	V
+V <sub>CC</sub>	Pull up voltage	-0.3	5.5	V
V <sub>IN</sub>	Input voltage of digital output (PINs 1,3,4)	-0.3	5.5	V
I <sub>S</sub>	Maximum sink current of digital output (PINs 1,3,4)		20	mA
V <sub>TEST-IN, input</sub>	Maximum input voltage of TEST-IN		5.5	V
I <sub>TEST-IN, sink</sub>	Maximum sink current of TEST-IN		±5	mA

Conditions above these ratings may cause permanent damage and may impact the reliability. Therefore, exceeding these values or others are not permitted.

## Certification:

RoHS Approval	Compliant [2011/65/EU&2015/863]
REACH Approval	Conform or declared [(EC)1907/2006]
Halogen Free	Conform [JEDEC JS709B]
Halogen Free	Conform [IEC 61249-2-21]
Software Functional Safety	Compliant [ANSI/UL 1998, Class 1]

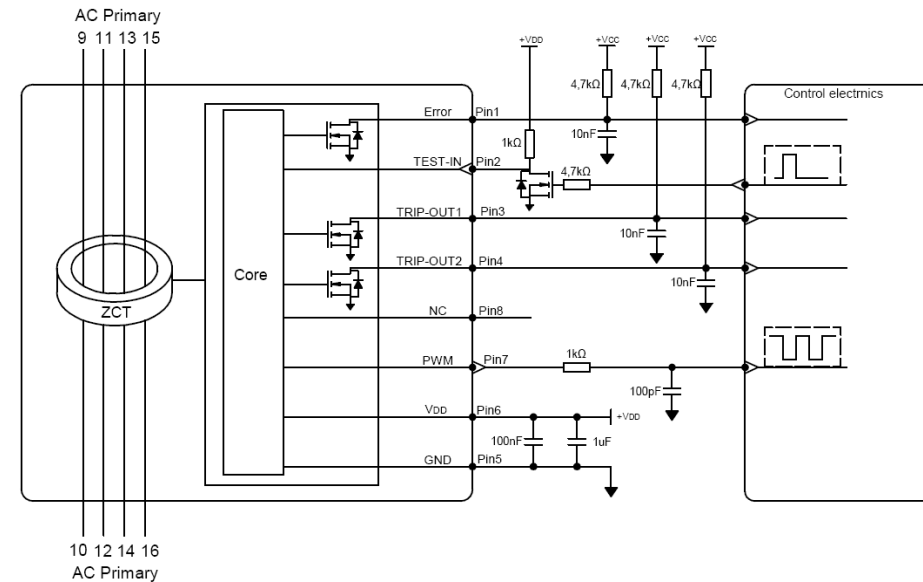
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## Pin Description:

Pin No.	Pin Symbol	Description
Pin 1	Error	Open-drain output pin for system fault condition indication. In normal operation this pin will be conducted to GND. In case a fault occurs, the impedance of this pin will be high.
Pin 2	TEST-IN	By pull down this pin to GND (low level) for a period of 50ms to 1000ms, module will calculate the zero-point-drift and store the value to the internal register to finish the calibration operation. After the calibration is finished, the system will internally generate a simulated residual current, to check whether module provides the correct response.
Pin 3	TRIP-OUT1	If residual current is below pre-set DC trip value, Pin 3 would be in a low level state. In any other case, Pin 3 would be in a high impedance state.
Pin 4	TRIP-OUT2	If residual current is below pre-set DC trip value, Pin 4 would be in a low level state. In any other case, Pin 4 would be in a high impedance state.
Pin 5	GND	Ground
Pin 6	+VDD	Module's power supply Current output capability should be > 100mA. Ripple voltage should be ≤ 150mV. The voltage should remain approximately monotonically increasing as it rises from 10% to 90%
Pin 7	PWM	Indicating of DC residual current from 2.5~30mA DC with duty-cycle of 8kHz PWM. Fluctuation range of duty-cycle of PWM at 6mA DC is from 17% to 21%.
Pin 8	NC	Not connected
Pin 9,11,13,15	AC Primary	AC main circuit input
Pin 10,12,14,16	AC Primary	AC main circuit output

- The PWM signal can only be used to indicate the residual current (from 2.5mA to 30mA) and it can't be used for functional safety related purposes.
- Abnormal frequency of PWM signal (during internal residual current simulation at power-up stage), abnormal power-up timing sequence as well as an error output signal should be considered as system anomaly and the main circuit must be switched off.

## Typical Application Diagram:



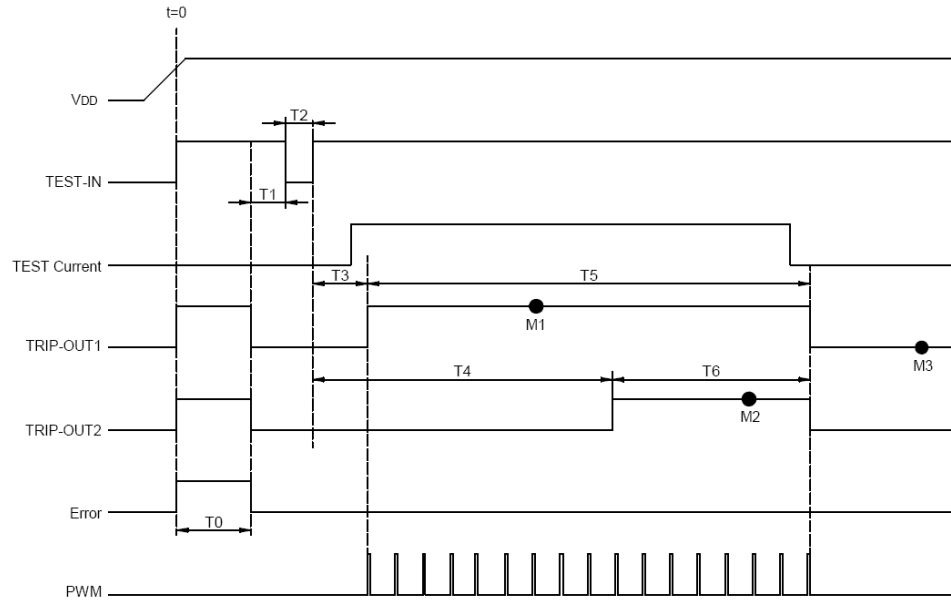
Note: All evaluations and specifications has been defined and verified with this recommended application diagram

## State:

Pin1	Pin3	Pin4	State
Low level	Low level	Low level	Normal condition
Low level	High impedance	High impedance	$I_{\Delta dc} \geq 6mADC$
Low level	High impedance	High impedance	System fault
High impedance	High impedance	High impedance	+VDD fault
High impedance	High impedance	High impedance	Rebooting

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## Timing Diagram:

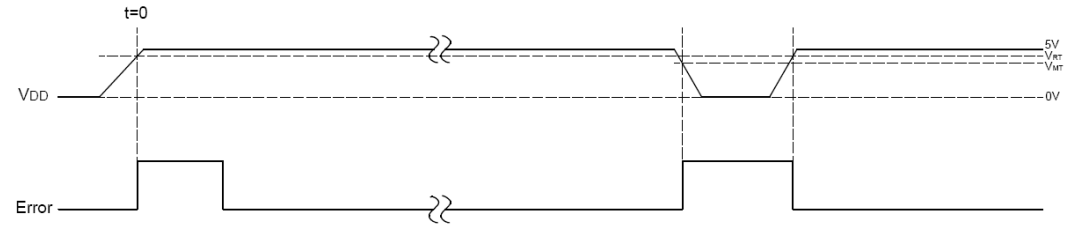


- The ramp up time for stable 5V of VDD should be less than 15ms
- T0: waiting time for system stabilization.  $T0 \approx 270\text{ms}$
- T1: withstanding time of high level TEST-IN signal.  $T1 \geq 100\text{ms}$
- T2: pulling down time of TEST-IN signal.  $50\text{ms} \leq T2 \leq 1000\text{ms}$
- T3: waiting time for TRIP-OUT1 signal generation  $T3 \approx 200\text{ms}$
- T4: waiting time for TRIP-OUT2 signal generation  $T4 \approx 690\text{ms}$
- T5: self-test indication duration time.  $T5 \approx 1580\text{ms}$ . It is suggested to read the TRIP-OUT1 signal after 300ms (M1)
- T6: self-test indication duration time.  $T6 \approx 1090\text{ms}$ . It is suggested to read TRIP-OUT2 signal after 300ms (M2).

### Attention:

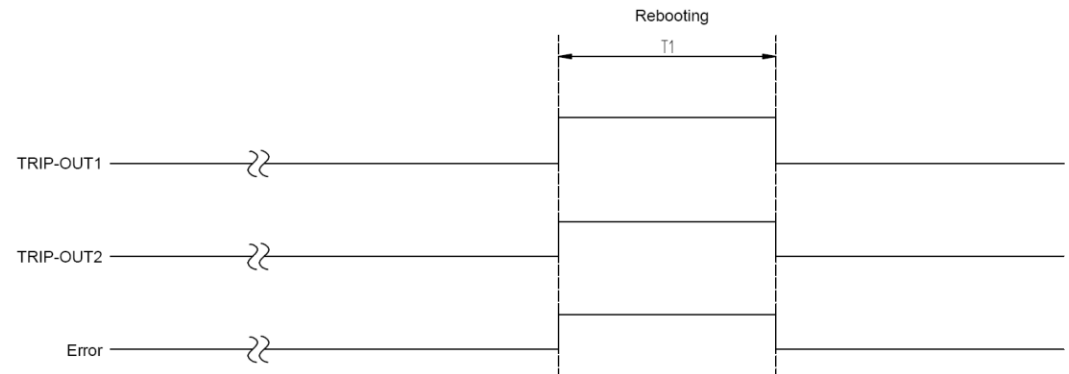
During the complete self-test procedure, the main circuit must be switched off to ensure no residual current is flowing. The frequency of the PWM signal should be in the specified range during the self-test indication duration time T5. TRIP-OUT1 and TRIP-OUT2 have to be low level at M3, to indicate that the sensor self-test procedure is finished.

## Supply Voltage Monitoring Diagram:



The Error pin changes to high impedance if  $+V_{DD}$  drops to the minimum supply voltage threshold ( $V_{MT}$ ) and the Error pin state will be back to low level when  $+V_{DD}$  returns to supply voltage recovery threshold ( $V_{RT}$ ).

## Watchdog Function:



- T1: rebooting time.  $T1 \approx 270\text{ms}$ .

A watchdog timer monitors internal MCU faults to reboot the system.

During rebooting process pins of TRIP-OUT1, TRIP-OUT2 and Error will be in high impedance state.

Pins of TRIP-OUT1, TRIP-OUT2 and Error will return to low level if the MCU is under control after rebooting.

Once a trip or an error signal detected the main circuit must be switched off and a restarting self-test procedure has to be followed.

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SIZE/TYPE Horizontal				BUSINESS UNIT eiSos		STATUS Valid	PAGE 5/11

### Residual Trip-Current:







Wave	Frequency	Min. value	Typ. value	Max. value	Unit
Smooth DC	0Hz	3.0	4.6	6.0	mA
Two phases DC	50Hz	3.5	5.2	7.0	mA
Three phases DC	50Hz	3.1	4.6	6.2	mA

### Residual Current Trip-Time:

Wave	Frequency	Current	Typ. value	Up-limit	Unit
Smooth DC	0Hz	6mA	128	10000	ms
Smooth DC	0Hz	60mA	49	300	ms
Smooth DC	0Hz	200mA	49	100	ms
Two phases DC	50Hz	60mA	55	300	ms
Two phases DC	50Hz	200mA	58	100	ms
Three phase DC	50Hz	60mA	50	300	ms
Three phase DC	50Hz	200mA	49	100	ms

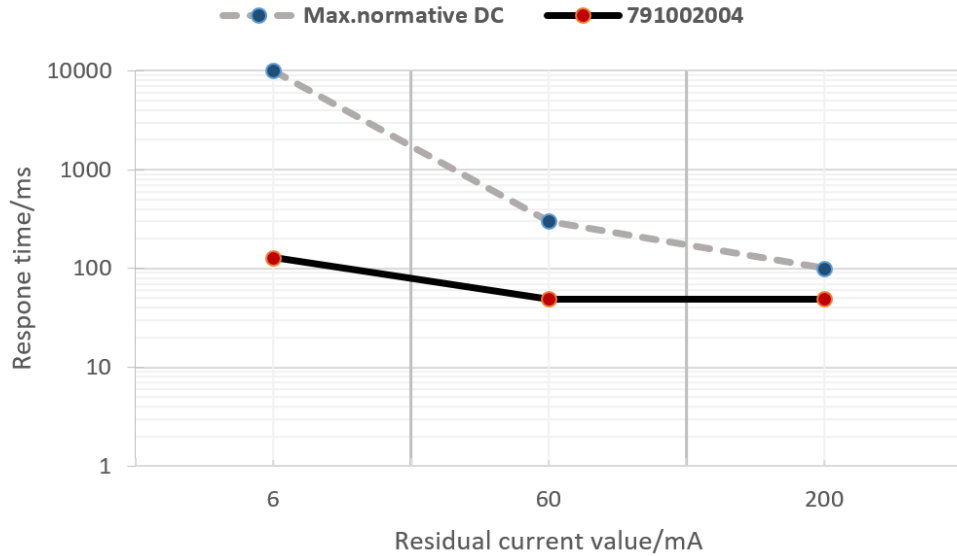
### Residual Current Non-Operating Time:

Wave	Frequency	Current	Min. value	Low-limit	Unit
AC	50Hz	Up to 30mA	∞	∞	ms
AC	50Hz	60mA	∞	300	ms
AC	50Hz	150mA	100	80	ms
AC	50Hz	5A	80	80	ms

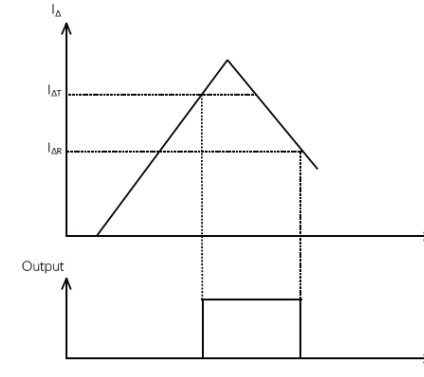
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## DC Fault Response Time:



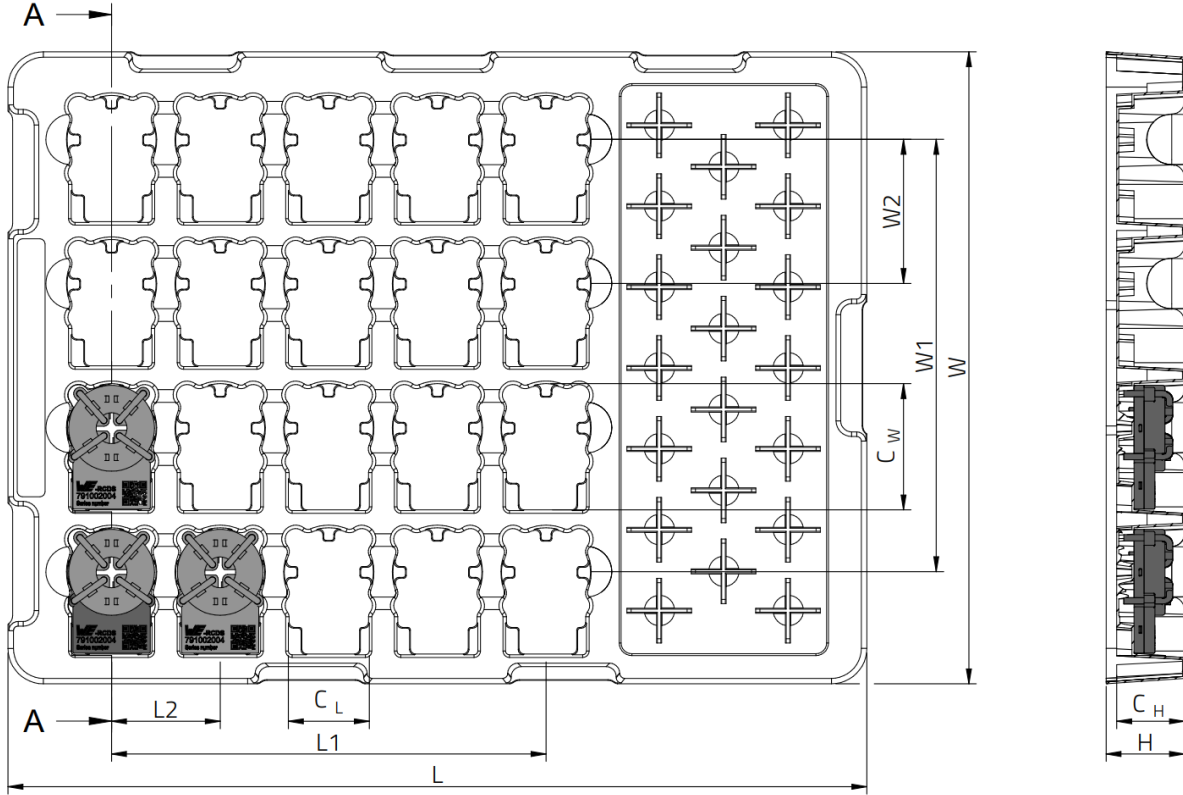
## Meaning of Switching Recovery Level:



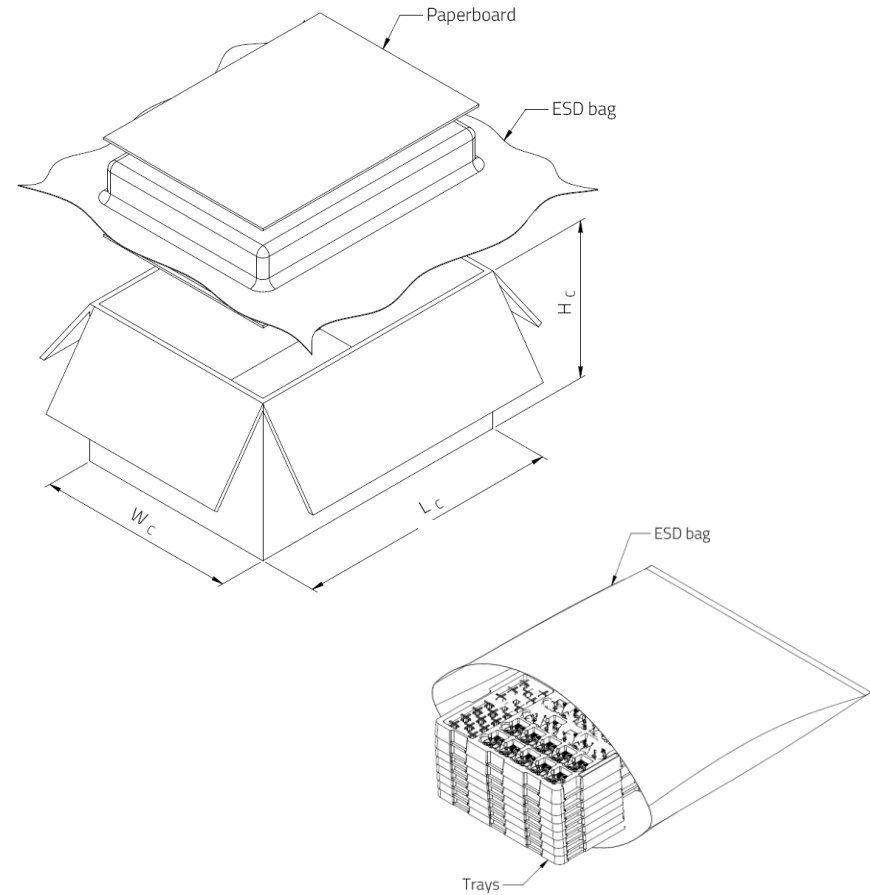
- To avoid signal oscillation, tripping signal output flipping has been set with tripping threshold and recovery threshold.
- When the residual current exceeds the threshold  $I_{\Delta T}$ , TRIP-OUT1 and TRIP-OUT2 pin will change from low level to high impedance and when the residual current decrease to the recovery threshold  $I_{\Delta R}$ , TRIP-OUT1 and TRIP-OUT2 pin will be back to low level state.
- $I_{\Delta T}$  is set as 100% typical tripping value, and  $I_{\Delta R}$  is set as 55% typical tripping value.

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# Packaging Specification - Bulk and Carton: [mm]



	L(mm)	L1 (mm)	L2(mm)	C <sub>L</sub> (mm)	W(mm)	W1(mm)	W2(mm)	C <sub>W</sub> (mm)	H(mm)	C <sub>H</sub> (mm)	Qty. (set.)	Material
<b>Tolerance</b>	typ.	typ.	typ.	typ.	typ.	typ.	typ.	typ.	typ.	typ.		
<b>Value</b>	340.00	172.00	43.00	32.00	250.00	171.00	57.00	50.00	31.00	26.80	20	PET



	L <sub>c</sub> (mm)	W <sub>c</sub> (mm)	H <sub>c</sub> (mm)	No. of Tray (pcs.)	No. of Paperboard (pcs.)	Qty. (set.)	Material
<b>Tolerance</b>	typ.	typ.	typ.				
<b>Value</b>	362.00	272.00	215.00	7	2	140	Paper



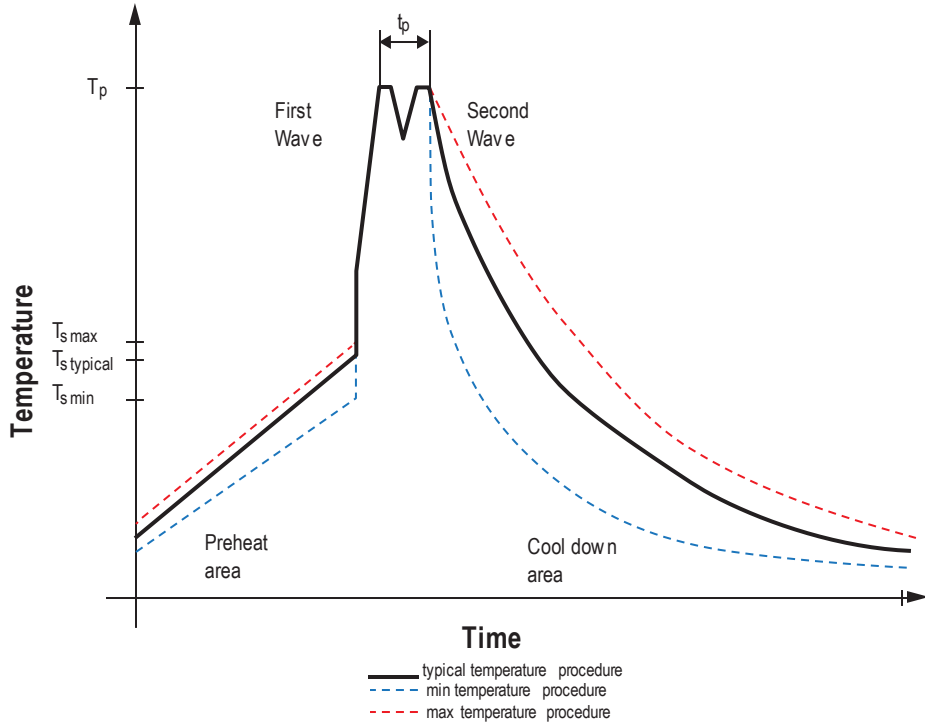
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### Classification Wave Soldering Profile:



### Classification Wave Soldering Profile:

Profile Feature		Pb-Free Assembly	Sn-Pb Assembly
Preheat Temperature Min	$T_{s\ min}$	100 °C	100 °C
Preheat Temperature Typical	$T_{s\ typical}$	120 °C	120 °C
Preheat Temperature Max	$T_{s\ max}$	130 °C	130 °C
Preheat Time $t_s$ from $T_{s\ min}$ to $T_{s\ max}$	$t_s$	70 seconds	70 seconds
Ramp-up Rate	$\Delta T$	150 °C max.	150 °C max.
Peak Temperature	$T_p$	250 °C - 260 °C	235 °C - 260 °C
Time of actual peak temperature	$t_p$	max . 10 seconds max . 5 seconds each wave	max . 10 seconds max . 5 seconds each wave
Ramp-down Rate, Min		~ 2 K/ second	~ 2 K/ second
Ramp-down Rate, Typical		~ 3.5 K/ second	~ 3.5 K/ second
Ramp-down Rate, Max		~ 5 K/ second	~ 5 K/ second
Time 25 °C to 25 °C		4 minutes	4 minutes

Refer to IPC/ JEDEC J-STD-020E

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## Cautions and Warnings:

The following conditions apply to all goods within the product series of WE-RDCS of Würth Elektronik eiSos GmbH & Co. KG:

### General:

- This mechanical component is designed and manufactured for use in general electronic equipment.
- Würth Elektronik must be asked for written approval (following the PPAP procedure) before incorporating the components into any equipment in fields such as military, aerospace, aviation, nuclear control, submarine, transportation (automotive control, train control, ship control), transportation signal, disaster prevention, medical, public information network, etc. where higher safety and reliability are especially required and/or if there is the possibility of direct damage or human injury.
- Electronic components that will be used in safety-critical or high-reliability applications, should be pre-evaluated by the customer.
- The component is designed and manufactured to be used within the datasheet specified values. If the usage and operation conditions specified in the datasheet are not met, the component may be damaged and specially the detection function is may be not ensured.
- Do not drop or impact the components, the component may be damaged
- Würth Elektronik products are qualified according to international standards, which are listed in each product reliability report. Würth Elektronik does not warrant any customer qualified product characteristics beyond Würth Elektronik's specifications, for its validity and sustainability over time.
- The responsibility for the applicability of the customer specific products and use in a particular customer design is always within the authority of the customer. All technical specifications for standard products also apply to customer specific products.

### Product Specific:

This electronic component is designed and manufactured to build a residual detection current device (RDC-DD) to be used for mode 3 charging of electrical vehicles.

According to IEC 62955: 2018 this component is only a RDC-M-module to detect residual direct currents and provide only an electrical signal.

Follow all instructions mentioned in the datasheet.

### Soldering:

- The solder profile must comply with the technical product specifications. All other profiles will void the warranty.
- All other soldering methods are at the customers' own risk.
- Strong forces which may affect the coplanarity of the components' electrical connection with the PCB (i.e. pins), can damage the part, resulting in avoid of the warranty.
- The cross spacer for primary conductors must be assembled after wave soldering process.

### Potting and Coating:

- If the product is potted in the customer application, the potting material might shrink or expand during and after hardening. Shrinking could lead to an incomplete seal, allowing contaminants into the body, pins or termination. Expansion could damage the components. We recommend a manual inspection after potting to avoid these effects.
- Conformal coating may affect the product performance.

## Cleaning and Washing:

- Washing agents used during the production to clean the customer application might damage or change the characteristics of the component. Washing agents may have a negative effect on the long-term functionality of the product.
- Using a brush during the cleaning process may break the component. Therefore, we do not recommend using a brush during the PCB cleaning process.


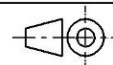

## Storage Conditions:

- A storage of Würth Elektronik products for longer than 12 months is not recommended. Within other effects, the terminals may suffer degradation, resulting in bad solderability. Therefore, all products shall be used within the period of 12 months based on the day of shipment.
- Do not expose the components to direct sunlight.
- The storage conditions in the original packaging are defined according to DIN EN 61760-2.
- For a moisture sensitive component, the storage condition in the original packaging is defined according to IPC/JEDEC-J-STD-033. It is also recommended to return the component to the original moisture proof bag and reseal the moisture proof bag again.
- ESD prevention methods need to be followed for manual handling and processing by machinery.
- The storage conditions stated in the original packaging apply to the storage time and not to the transportation time of the components.

## Handling:

- Violation of the technical product specifications such as exceeding the absolute maximum ratings will void the warranty and also the conformance to regulatory requirements.
- The applicable country regulations and specific environmental regulations must be observed.
- The PWM signal can only be used to indicate the leakage current (from 2.5mA to 30mA) and it can't be used for functional safety related purposes.
- Abnormal frequency of PWM signal (during internal residual current simulation at power-up stage), abnormal power up time sequence or an error output signal detected are considered as system abnormalities and the main circuit must be switched off in these situations.
- The error signal should be monitored permanently and the main circuit must be switched off if an error signal appears.
- Do not disassemble the component. Evidence of tampering will void the warranty.
- The temperature rise of the component must be taken into consideration. The operating temperature is comprised of ambient temperature and temperature rise of the component.
- The operating temperature of the component shall not exceed the maximum temperature specified.
- Due to physical product characteristics, the measuring accuracy of the module can be affected by strong temperature changes, therefore a self-test and calibration of the module is recommended at certain time intervals. Especially after a high self-heating of the entire application where this module is placed.
- Direct mechanical impact to the component must be prevented as the material of the body, pins or termination could flake or, in the worst case, could break. As these devices are sensitive to electrostatic discharge, proper IC Handling Procedures must be followed.
- If a component drops, it has to be sorted out as it might change its characteristics.
- Avoid touching damaged components.

These cautions and warnings comply with the state of the scientific and technical knowledge and are believed to be accurate and reliable. However, no responsibility is assumed for inaccuracies or incompleteness.

		CHECKED AllMo	REVISION 000.001	DATE (YYYY-MM-DD) 2023-07-04	GENERAL TOLERANCE DIN ISO 2768-1c	PROJECT ID N METHOD 
 <b>WÜRTH ELEKTRONIK</b> MORE THAN YOU EXPECT		DESCRIPTION <b>WE-RCDS Residual Current Detection Sensor</b>			ORDER CODE <b>791002004</b>	
Würth Elektronik eiSos GmbH & Co. KG EMC & Inductive Solutions Max-Eyth-Str. 1 74638 Waldenburg Germany Tel. +49 (0) 79 42 945 - 0 www.we-online.com eiSos@we-online.com		SIZE/TYPE Horizontal	BUSINESS UNIT eiSos	STATUS Valid	PAGE 10/11	

## Important Notes

The following conditions apply to all goods within the product range of Würth Elektronik eiSos GmbH & Co. KG:

### 1. General Customer Responsibility

Some goods within the product range of Würth Elektronik eiSos GmbH & Co. KG contain statements regarding general suitability for certain application areas. These statements about suitability are based on our knowledge and experience of typical requirements concerning the areas, serve as general guidance and cannot be estimated as binding statements about the suitability for a customer application. The responsibility for the applicability and use in a particular customer design is always solely within the authority of the customer. Due to this fact it is up to the customer to evaluate, where appropriate to investigate and decide whether the device with the specific product characteristics described in the product specification is valid and suitable for the respective customer application or not.

### 2. Customer Responsibility related to Specific, in particular Safety-Relevant Applications

It has to be clearly pointed out that the possibility of a malfunction of electronic components or failure before the end of the usual lifetime cannot be completely eliminated in the current state of the art, even if the products are operated within the range of the specifications.

In certain customer applications requiring a very high level of safety and especially in customer applications in which the malfunction or failure of an electronic component could endanger human life or health it must be ensured by most advanced technological aid of suitable design of the customer application that no injury or damage is caused to third parties in the event of malfunction or failure of an electronic component. Therefore, customer is cautioned to verify that data sheets are current before placing orders. The current data sheets can be downloaded at [www.we-online.com](http://www.we-online.com).

### 3. Best Care and Attention

Any product-specific notes, cautions and warnings must be strictly observed. Any disregard will result in the loss of warranty.

### 4. Customer Support for Product Specifications

Some products within the product range may contain substances which are subject to restrictions in certain jurisdictions in order to serve specific technical requirements. Necessary information is available on request. In this case the field sales engineer or the internal sales person in charge should be contacted who will be happy to support in this matter.

### 5. Product R&D

Due to constant product improvement product specifications may change from time to time. As a standard reporting procedure of the Product Change Notification (PCN) according to the JEDEC-Standard, we will inform about minor and major changes. In case of further queries regarding the PCN, the field sales engineer or the internal sales person in charge should be contacted. The basic responsibility of the customer as per Section 1 and 2 remains unaffected.

## 6. Product Life Cycle







Due to technical progress and economical evaluation we also reserve the right to discontinue production and delivery of products. As a standard reporting procedure of the Product Termination Notification (PTN) according to the JEDEC-Standard, we will inform at an early stage about inevitable product discontinuance. According to this we cannot guarantee that all products within our product range will always be available. Therefore it needs to be verified with the field sales engineer or the internal sales person in charge about the current product availability expectancy before or when the product for application design-in disposal is considered. The approach named above does not apply in the case of individual agreements deviating from the foregoing for customer-specific products.

## 7. Property Rights

All the rights for contractual products produced by Würth Elektronik eiSos GmbH & Co. KG on the basis of ideas, development contracts as well as models or templates that are subject to copyright, patent or commercial protection supplied to the customer will remain with Würth Elektronik eiSos GmbH & Co. KG. Würth Elektronik eiSos GmbH & Co. KG does not warrant or represent that any license, either expressed or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, application, or process in which Würth Elektronik eiSos GmbH & Co. KG components or services are used.

## 8. General Terms and Conditions

Unless otherwise agreed in individual contracts, all orders are subject to the current version of the "General Terms and Conditions of Würth Elektronik eiSos Group", last version available at [www.we-online.com](http://www.we-online.com).

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