



The D429CRS Communication Module is a multi-purpose controller with several interfaces, designed for maximal flexibility which can cover a wide range of applications.



LEADING THE EMBEDDED FUTURE

duagon Data Sheet Preamble

On having purchased products described in this data sheet, the customer acquires the right to use the products according to its specified purpose and in accordance with all operation, service and maintenance instructions. All other rights to the product, duagon's intangible assets rights in particular, belong solely to duagon and may not be deemed to have been assigned along with the sale of the products.

All product properties are fully described in the data sheet under express exclusion of any warranty for other properties. Of decisive relevance is the data sheet valid at the time of the order being placed. duagon provides a warranty that the product properties are retained during the period of warranty. Evidence that the properties of the product have been retained will be brought, always and exclusively, on duagon premises by means of a test construction pursuant to the type test.

The customer is obliged to inspect whether the products themselves are suitable for the application intended. In particular, that inspection must include the integration of the products into the intended system configuration and a check on whether the properties as per data sheet can be fulfilled once integrated into the system configuration as planned by the customer. Since the products are not certificated for operation with security applications, the customer must take appropriate measures to ensure that any malfunctions that may occur in a system configuration with other products will be absorbed by supplementary security measures.

The period of warranty for the products is 24 months and it begins on the date the products are shipped from the factory.

The warranty that duagon assumes for the products will, at duagon's discretion, be limited either to the repair of or the replacement of the products at the duagon factory. The warranty solely covers the products or parts thereof which, despite professional handling, have become defective or unusable and which arrive at the duagon factories for repair or replacement during the period of warranty. The extent of duagon's warranty is fully set out in this data sheet. duagon cannot be held liable for consequential damage caused by a defect or for indirect damage or for consequential damage of any kind. Therefore, the customer bears all and any costs that occur due to production downtime, for example, or due to the installation or dismantling of products or due to their transportation to duagon and back.

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This data sheet is to be evaluated in accordance with **Swiss law**. The court of jurisdiction is the **seat of the vendor**. The applicability of the UN agreement as to international sales of goods (also known as "Viennese Purchasing Convention") is herewith expressly excluded.

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Document history:

Rev.	Creation Date	Creator Name	Released Date	Released by	Comments	Ident-Number
1	2015-06-12	Rapka			See chapter "Document History"	d-010335-018366
2	2019-03-06	Strebel	2019-11-29	Maffioli		d-010335-047891

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1. About This Document

1.1. General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or those connected to it. To avoid potential hazards, use this product only as specified.

Safety Terms and Symbols

The following safety terms may appear in this data sheet:



WARNING. Warning statements identify conditions or practices that could result in injury or loss of life.



CAUTION. Caution statements identify conditions or practices that could result in damage to this product or other property.

NOTE. Note statements draw your attention to particularly important information relating to the product and its handling, or to part of the documentation requiring your special attention.

To Avoid Fire or Personal Injury

Connect and disconnect properly. This data sheet contains all relevant information for connecting the device.

Power On only with all connections made. All connectors on the device must be connected (unused connections should be covered with a dummy connector).

Ground the product. Ground connection is located on the device.

Observe all terminal ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult this data sheet before making connections to the product.

Avoid exposed circuitry. Do not touch exposed connections and components when power is present.

Do not operate with suspected failures. If you suspect there is a damage to this product, have it inspected by qualified service personnel, or return it to duagon AG.

Service Safety Summary

Only qualified personnel should perform installation, maintenance and service procedures

Do not service with Power On. Dangerous voltages or currents may exist in this product. Disconnect power, remove battery (if applicable), and disconnect test leads before removing protective panels, soldering, or replacing components.

To avoid electric shock, do not touch exposed connections.

1.1. Typographic Conventions

The following typographic notation is used throughout this document:

Example	Description
Bold type	Indicates that the word itself or if succeeded by a colon the sentence following are important and therefore, emphasized. For example, EN 50155:2017 or Note:
<i>Italic type</i>	Indicates folder, file and function names, for example <i>d521_conf.xml</i> , <i>target</i> or <i>ip_socket</i> .
Courier type	Courier type indicates text that must be typed exactly as shown. It is used for functions, symbols and parameters. Courier type is also used for example code.
"Subheading title"	Quotation marks indicate references to sections in a document and titles of documents referenced for further reading.
0x1F	Hexadecimal number are preceded by 0x.
0b101101	Binary numbers are preceded by 0b.
/IOR	indicate that this signal is either active low or that it becomes active at a falling edge
CCR[3:0], SD[7:0]	Numbers in brackets and separated by a colon represent either: <ul style="list-style-type: none"> • A subset of a register's named field For example, CCR[3:0] refers to bits 3-0 that are part of the host interrupt configuration of the channel configuration register. • A continuous range of individual signals of a bus For example, SD[7:0] refers to signals 7-0 of the SD bus,

Table 1: Typographic Conventions Used in this Document.

1.2. Abbreviations

Abbr.	Definition
CIP	Common Industrial Protocol
CPU	Central Processing Unit
EMC	Electromagnetic compatibility
EN	European Standard (Norm)
ESD	Electrostatic discharge
FPGA	Field Programmable Gate Array
HDC	Host-Device Communication
I/O	Input, Output
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IP	Internet Protocol
LRU	Line Replaceable Unit
MD	Message Data
MTBF	Mean Time Between Failures
NA	Not Applicable
PD	Process Data
PLD	Programmable Logic Device
REACH	Registration, Evaluation, Authorization and Restriction of Chemicals
RoHS	Restriction of the Use of Hazardous Substances
RPC	Remote Procedure Call
RT	Real-Time
TRDP	Train Real-Time Data Protocol
UID	Unique Identifier

Table 2: List of Abbreviations.

2. Introduction

2.1. Product Description

The D429CRS is a powerful CPU platform with the following communication interfaces:

- **RS485 (X1/X2 and X5)**
The D429CRS supports two independent RS485 interfaces.
- **CAN (X3)**
As an option the D429CRS supports virtually all CAN operating modes and baud rates: Version 2.0a and 2.0b, with up to 1 Mbaud.
- **RS232 (X4)**
This serial line interface is intended for service purposes.

Data can be routed between these buses according to an application specific definition of the gateway functionality.

The amount of data being transferred is mainly limited by the architectural limits of the respective bus system.

- **CPU**
A powerful ARM7 CPU runs application specific software. The D429CRS comes from duagon with a boot loader, real time operating system (eCos), and serial line support.
The user implements the application and communication driver software according to his own needs. The development environment relies on GNUC. The download of software takes place via RS232 on X4.

The D429CRS is designed for the harsh traction environment and conforms to the EN50121 / EN50155 / EN61373 standards, e.g. by:

- -40 to +70°C operating temperature
- coating against humidity
- enhanced EMI and vibration robustness

The device is integrated in a stainless-steel housing.

Other Members of the D429CRS Product Group

D429R: MVB Repeater, connect up to three MVB segments together.

D429S: RS232 on additional header, use up to four RS485 interfaces simultaneously.

D429C: MVB-to-CAN gateway.

D429X: Customer specific solution for interfaces on X3 and X5.

How to Get Started

This data sheet describes the properties and functions of the D429CRS. The D429CRS is directly powered from the vehicle battery; supporting voltages like e. g. 24V or 110V.



WARNING. When using a high voltage D429CRS device (D429CRS-HV), obey the safety precautions at the beginning of this data sheet.

Online Support

Further information about the D429CRS and all other duagon products can be found on www.duagon.com.

After ordering a duagon product, you can sign up for a login for the www.duagon.com customer area. There you will find detailed information and documentation on how to integrate your duagon product into your application. If you need any information at an earlier stage of your design process, please refer to your sales contact at duagon.

For any further technical question, you can contact our application engineering team (see www.duagon.com/contact/application-engineers):

Phone: +41 (0)44 743 73 00
Email: support@duagon.com
Skype: support.duagon

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2.2. Architecture

2.2.1. Hardware Structure+

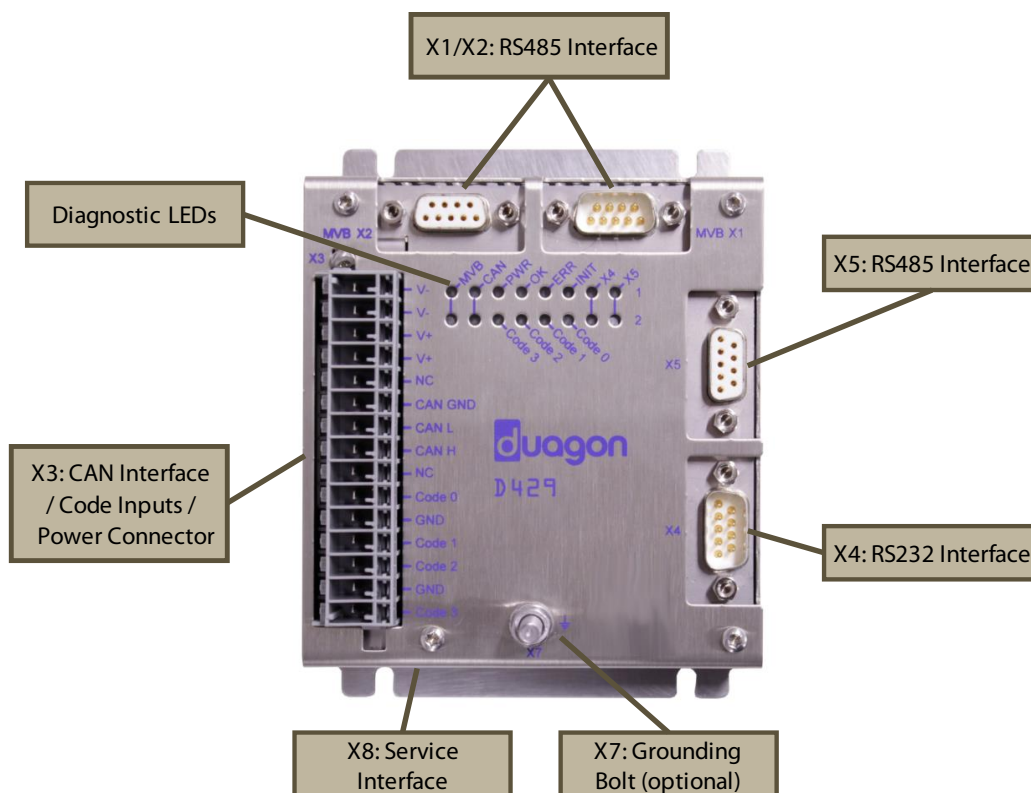


Figure 1: Hardware Structure.

2.2.2. Basic Function Blocks

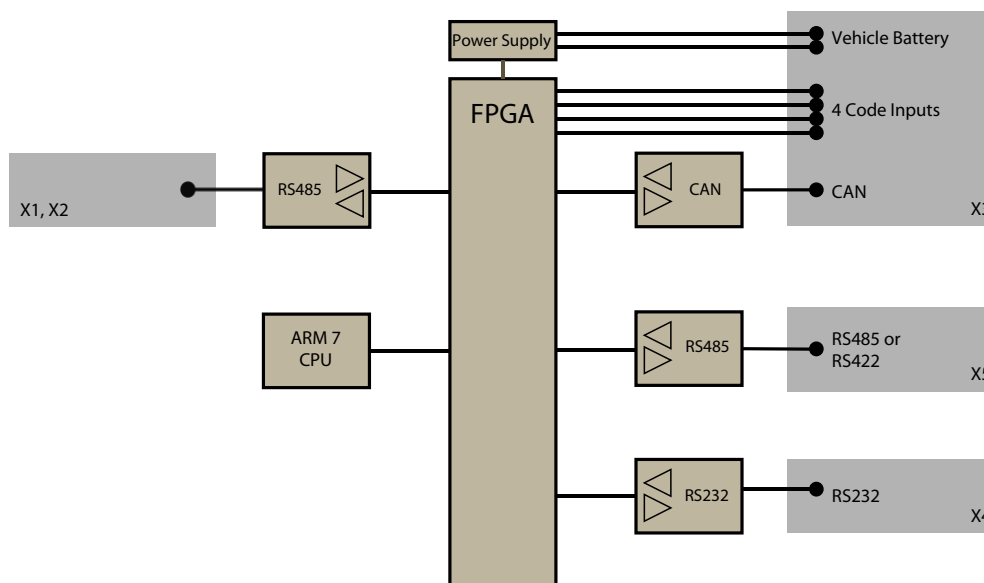


Figure 2: Basic Function Blocks.

The FPGA includes several functions like controllers for **RS485/RS232**, an interface to the **CAN** controller and several other peripheral digital functions. Depending on the application, it is compiled matching to the set of used hardware options.

The local **ARM7 microprocessor** controls the internal flow of information and can be widely adapted to application requirements. This part can be reprogrammed /redefined without hardware change. It contains 256 kByte SRAM.

Power is drawn from the vehicle battery supply. This includes the supply for the various communication transceivers as well as the internal logic.

Memory

The D429CRS local microprocessor includes the following memory spaces:

Memory Type	Size
Flash	2 MByte
SRAM general memory	256 kByte + 1 Mbyte

Table 3: Available Memory Space.

2.3. Software Structure

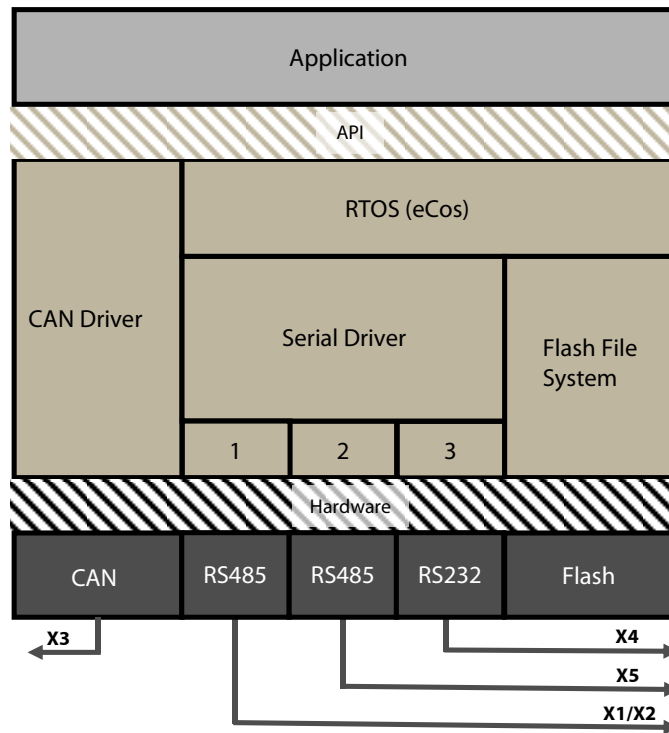


Figure 3: Software Structure.

Figure 3 shows the overall software architecture of the D429CRS as a platform. The device comes in two versions:

1. As a platform: the application is implemented on customer's side.
2. As a gateway: the device is delivered with a standard gateway application developed by duagon.

See chapter 14 "Ordering Information" on page 39 for available product ordering options.

3. Physical Interfaces

The image below shows Pin 1 and 2:

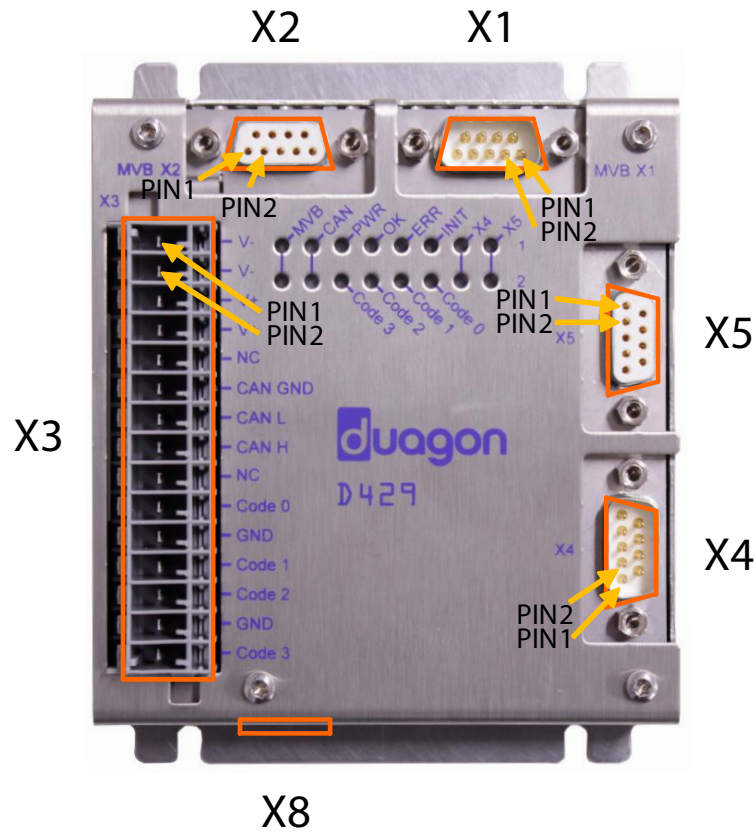


Figure 4: Interfaces of D429.

Following interfaces are available:

- X1/X2: RS485 Interface
- X3: CAN Interface, Code Inputs, Power Connector
- X4: RS232 Interface
- X5: RS485 Interface
- X7: Grounding Bolt
- X8: Programming Interface duagon

3.1. RS485 Interface (X1, X2)

On X1/X2 (two 9-pin D-Sub connector), there is a RS485 interface with the following pinout:

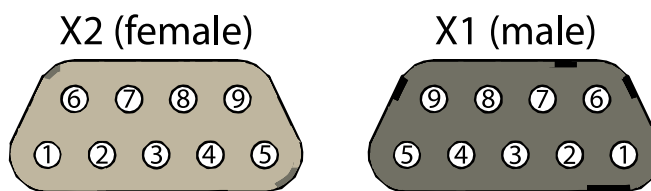


Figure 5: D-Sub Connectors of X1/X2.

Pin #	Pin shortcut	Input / Output as seen from the D429CRS	Description
1	RXTX+	Bidirectional	Non- inverted signal line, with RS485- level
2	RXTX-		Inverted signal line, with RS485- level
3	NC	-	Not connected
4	NC	-	Not connected
5	NC	-	Not connected
6	GND	Power output	Local ground of RS485 transceiver, may be used as power equalization line
7	NC	-	Not connected
8	TERM-	-	RS485 termination (see below)
9	TERM+		
shell	Shield	-	Connection to shield resp. housing.

Table 4: RS485 Interface Signal Description.

Notes:

- The RS485 interface does not provide a bias voltage.
- The RS485 interface is galvanically isolated to the digital logic.
- Pins of X1 and pins of X2 are internally connected together! (also known as pass-through or daisy chain topology).

3.1.1. Activating the internal RS485 termination

The internally RS485 termination resistance can be activated by adding a connection between pin 8 and 9. This will place a 120 Ω resistor between RXTX+ and RXTX- (i.e. pin 1 and 2).

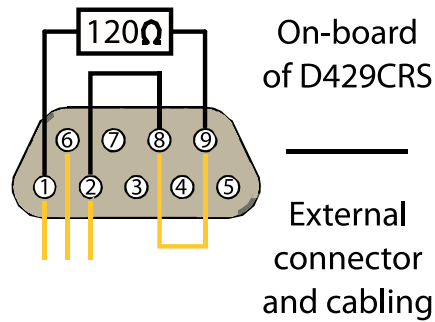


Figure 6: Cabling to Activate Termination for RS485 on X1/X2.

3.2. CAN Interface (X3)

The D429CRS provides a CAN interface on connector X3.

It supports virtually all CAN operating modes and baud rates: Version 2.0a and 2.0b, with up to 1 Mbaud. The CAN controller is compatible to the Philips SJA1000 widely used in the industry.

3.2.1. Pin Definition

The X3 connector provides a CAN interface on pin 6 to 8.

Pin #	Pin shortcut	Description
6	CAN GND	Local ground of isolated CAN interface
7	CAN L	CAN signal lines
8	CAN H	

Table 5: CAN Interface Signal Description.

Remarks:

- The pins CAN H, CAN L and CAN GND are galvanically isolated from all digital logic. However, the CAN GND pin has an RC-circuit (100 MΩ parallel to 4.7 nF) to the case surface (shield).

3.2.2. CAN Cabling

The D429CRS is by default configured to 1Mbaud operation. For this mode, shielded CAN cables are recommended to reduce trouble with emitted EMI. It is necessary to connect the shield of the CAN cable to the enclosure of device, either over the slit or the grounding bolt (if present) as shown in Figure 7.

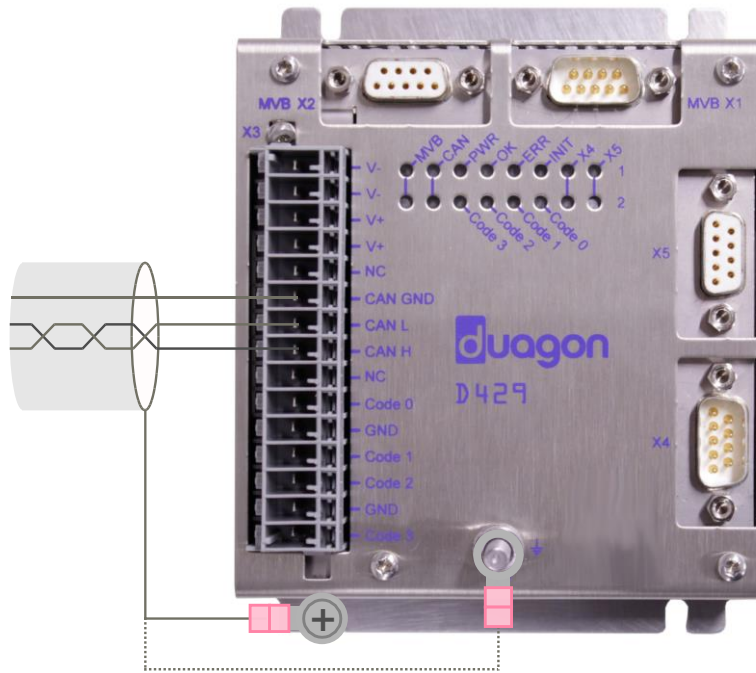


Figure 7: Connection Points for CAN Shield.

3.3. RS485-Interface (X5)

On X5 (9-pin female D-Sub connector), there is a RS485 interface with the following pinout:

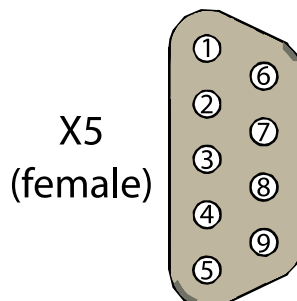


Figure 8: D-Sub Connector of X5.

Pin #	Pin shortcut	Input / Output as seen from the D429CRS	Description
1	RXTX+	Bidirectional	Non- inverted signal line, with RS485- level
2	RXTX-		Inverted signal line, with RS485- level
3	NC	-	Not connected
4	NC	-	Not connected
5	NC	-	Not connected
6	GND	Power output	Local ground of RS485 transceiver, may be used as power equalization line
7	NC	-	Not connected
8	TERM-	-	RS485 termination (see below)
9	TERM+		
shell	Shield	-	Connection to shield resp. housing.

Table 6: RS485 Interface Signal Description.

3.3.1. Activating the Internal RS485 Termination

The internally RS485 termination resistance can be activated by adding a connection between pin 8 and 9. This will place a 120 Ω resistor between RXTX+ and RXTX- (i.e. pin 1 and 2).

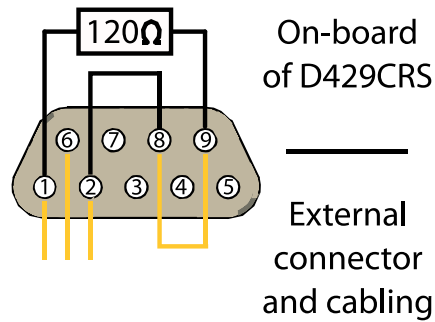


Figure 9: Cabling to Activate Termination for RS485 on X5.

3.4. Power Connector / Code Input (X3)

The D429CRS is powered directly from the vehicle battery via connector X3. In addition, connector X3 contains four Code Inputs and the CAN interface.

3.4.1. Pin Definitions

Pin #	Pin shortcut	Description
1	-V _{bat}	Negative power supply
2	-V _{bat}	
3	+V _{bat}	Positive power supply
4	+V _{bat}	
5	NC	Not connected
6	CAN GND	Local ground of isolated CAN interface
7	CAN L	CAN signal lines
8	CAN H	
9	NC	Not connected
10	Code 0	Code Input Line 0
11	GND	Power reference
12	Code 1	Code Input Line 1
13	Code 2	Code Input Line 2
14	GND	Power reference
15	Code 3	Code Input Line 3

Table 7: Power Connector / Code Input Signal Description.

Notes:

- The respective pins for the battery lines are internally connected. Since the device requires minor power, it is OK to connect only one of the V_{bat} lines, but do not connect other devices on the empty V_{bat} line.

3.4.2. Code Inputs

On X3 there are four Code Input lines. These could be read by a start-up script or an application software and used for configuration purpose (e.g. geographic addressing). The basic way to control the Code Inputs is, to strap them either to GND, or leave them open.

NOTE. Setting the code inputs "Code 1", "Code 2" and "Code 3" to GND at the same time is reserved for production purposes. This code is used during production e.g. for burn-in stress generation. Therefore, you must never use this configuration during normal operation.

Remarks:

- The recommended procedure to select code input combinations is by shortening the code pins with the GND-pins next to them. The input current on these pins is very low. Do not use long cables (no more than 0.1m) for external strapping. When a pin should be open, do not connect any cables to it.

3.5. Service Interfaces

There are two service interfaces for debugging and firmware updates: RS232 and JTAG.



CAUTION. The service interfaces are intended for service purposes only. They shall not be used for normal operation.

3.5.1. RS232 Interface (X4)

The RS232 Interface provides a Command Line Interface (CLI) and it is intended for software debugging and firmware download. It is recommended to use this serial line for no other purposes.



Figure 10 D429CRS RS232 Interface X4.

On X4 (9-pin male SUB-D), there is an RS232 interface with the following pin out:

Pin #	Pin shortcut	Input / Output as seen from the D429CRS	Description
2	RxD	Input	Receive data input
3	TxD	Output	Transmit data output
5	GND	(power line)	Reference potential.
7	RTS	Output	Request To Send or Second TxD
8	CTS	Input	Clear To Send or Second RxD

Table 8: RS232 Interface Signal Description.

All other pins are not connected.

The additional RTS, CTS pins may be used for hardware handshake or for a second pair of TxD and RxD. This can be defined by software configuration.

The RS232 interface is galvanically isolated to the digital logic.

Configuration Options RS232

This paragraph defines the user selectable options for the RS232 interface.

These firmware selectable options must be defined prior to delivery of the product.

Issue	Description	Option
Protocol	Transmission parameters	Default: UART, 115200Baud, 8N1, no hardware handshake

Table 9: RS232 Interface Configuration Options.

3.5.2. Programming Interface duagon (X8)

The 10-pin female header on the side of the D429CRS is used for service purpose at duagon. Do not connect any wire to it.



CAUTION. The service interfaces are intended for service purposes only. They shall not be used for normal operation.

4. Software

The D429CRS application is usually implemented on customer's side. duagon delivers a small demonstrator software, being an example for testing and implementation concepts.

Most of the driver and operating system software is accessible in sources. For the CAN, the simple driver may be sufficient, or it may be replaced with one of the CAN upper layer standards; according to the customer's needs.

The gateway version is delivered with a standard gateway application developed by duagon in accordance to customer specifications that can be configured via device configuration file. It is also possible that duagon implements your application according to your specification. Please call duagon for more information about software engineering projects.

See chapter 14 "Ordering Information" on page 39 for available product ordering options.

5. Electrical Specifications

5.1. Absolut Maximum Ratings

$T_A = -40$ to $+70$ °C, typical values for $T_A = 25$ °C (unless otherwise specified).

LV-Version

This paragraph applies to the LV versions only (cf. chapter 14 "Ordering Information", page 39).

Symbol	Parameter/Conditions	Min.	Typ.	Max.	Unit
V_{BAT}	Supply Voltage, with respect to V_{BAT-}	-50.4	-	50.4	V
$V_{IN,DEBUG}$	Input Voltage Serial pins, with respect to GND	-0.3	-	3.6	V

Table 10: D429CRS-LV Absolute Maximum Ratings.



CAUTION. Exceeding the absolute maximum ratings stated in Table 10 may irreversibly damage the device.

HV-Version

This paragraph applies to the HV versions only (cf. chapter 14 "Ordering Information", page 39).

Symbol	Parameter/Conditions	Min.	Typ.	Max.	Unit
V_{BAT}	Supply Voltage, with respect to V_{BAT-}	-154	-	154	V
$V_{IN,DEBUG}$	Input Voltage Serial pins, with respect to GND	-0.3	-	3.6	V

Table 11: D429CRS-HV Absolute Maximum Ratings.



CAUTION. Exceeding the absolute maximum ratings stated in Table 11 may irreversibly damage the device.

5.2. Recommended Operating Conditions

$T_A = -40^{\circ}\text{C} \dots +85^{\circ}\text{C}$, typical values for $T_A = 25^{\circ}\text{C}$ (unless otherwise specified).

Power Supply

Symbol	Parameter /Conditions	Min.	Nom. / Typ.	Max.	Unit	Norm
$V_{\text{bat}+}$	Variations, fluctuations, supply change over	0.6 ¹⁾	1	1.4 ¹⁾	* U_n	5.1.1.1 5.1.1.2 5.1.1.3 5.1.3 (Class C1)
$t_{\text{interrupt}}$	Supply interruption time	-		0	ms	5.1.1.4 (Class S1)
γ	DC ripple factor			5	%	5.1.1.6
$V_{\text{bat}+}$ Version LV	Supply voltage with respect to $V_{\text{bat}-}$ - operating -	14.4	24 36 ($\triangleq U_n$)	50.4	V	Nominal value according to 5.1.1.1; outer limits include the variations, fluctuations ¹⁾ and supply change over
	Supply voltage with respect to $V_{\text{bat}-}$ - non-operating -	-50.4		50.4	V	Survives erroneous polarity reversal.
$UVLO_{\text{LV}}$	Undervoltage-Lockout, Version LV	5.4		14.4	V	7.2.6
I^2t_{LV}	I^2t -value of the inrush current, Version LV	0.47		1.18	A ² s	7.2.8
$V_{\text{bat}+}$ Version HV	Supply voltage with respect to $V_{\text{bat}-}$ - operating -	28.8	48 72 96 110 ($\triangleq U_n$)	154	V	Nominal value according to 5.1.1.1; outer limits include the variations, fluctuations ¹⁾ and supply change over
	Supply voltage with respect to $V_{\text{bat}-}$ - non-operating -	-154		154	V	Survives erroneous polarity reversal.
$UVLO_{\text{HV}}$	Undervoltage-Lockout, Version HV	5.9		14.6	V	7.2.6
I^2t_{HV}	I^2t -value of the inrush current, Version HV	0.30		1.00	A ² s	7.2.8
P_{nom}	Power drawn from V_{bat} during normal operation	-	2.5	-	W	
P_{max}	Absolute maximum power draw from V_{bat}	-	-	5	W	

Table 12 Power Supply Operating Conditions.

Remarks:

- 1) In extension to the standard reference, there is no limitation with respect to the duration.

6. Mechanical Specifications

6.1. Dimensions and Weight

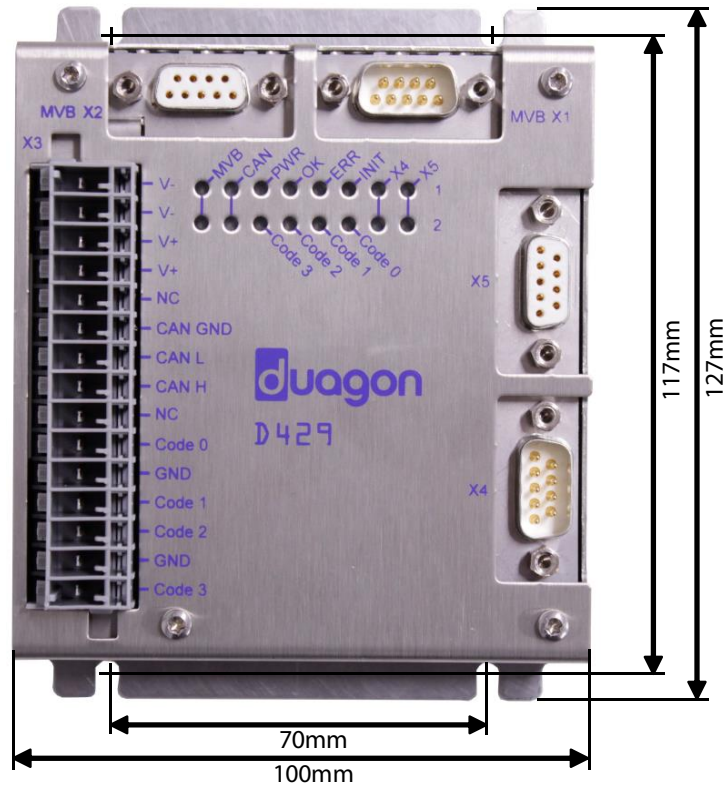


Figure 11: D429CRS Mechanical Dimensions (Top View).

The picture below shows the height of the D429CRS case without connectors.

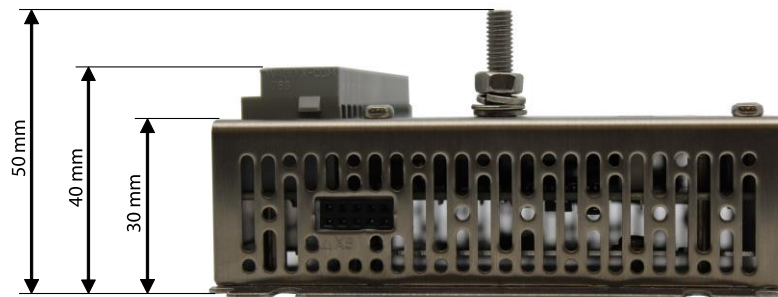


Figure 12: D429CRS Mechanical Dimensions (Side View).

Important Notes:

- When calculating the required height of the module, be aware that the cables will require space (additional 60-70mm should be sufficient).
- Add an extra 16mm if you want to plug and unplug the cable without unmounting the device.

Parameter	Value	Unit	Remarks
Housing Height	50	mm	With grounding bolt
	40	mm	Without grounding bolt
Housing Width	100	mm	
Housing Length	127	mm	
Weight of the Device	420	g	Complete assembly
Ingress protection	IP20	-	-

Table 13: Mechanical Specifications.

6.2. Mounting Instructions

6.2.1. Cabling/Cabling Locks

The connectors X1, X2, X4 and X5 use M3 thread for the cable locks. The maximum torque for the screw locks is 40cNm.



CAUTION. Be sure not to apply the UNC4-40 thread for the cable locks; it will damage the thread. A torque higher than 40cNm may destroy the thread!

For more information, see also the document "Material and Components for Wiring – Technical Note", d-000842-nnnnnn.

6.2.2. Mounting with Screws

The D429CRS is recommended to be mounted with four M4 screws. The picture above shows the dimensions for the fixture holes.

6.2.3. Mounting on Rail TH35

The mounting rail TH35 is available in two different thicknesses, the TH35-7.5 and TH35-15. We recommend the more stable TH35-15, due to the omnipresent vibrations on railway vehicles. However, the D429CRS will also fit on the lighter mounting rail.

NOTE. Be sure to have approximately 5mm headroom on both sides in addition to the 127mm in the picture above: it is required for placement on TS35 – DIN-rail.

NOTE. For good EMI (electromagnetic interference) behaviour it is essential to properly connect the device case to protective earth.

6.2.4. Convection Cooling

The D429CRS is cooled by natural convection and is designed for fan-less operation. Make sure to leave the minimum space of 5 cm around the ventilation slots marked in Figure 13 to allow for the required airflow.

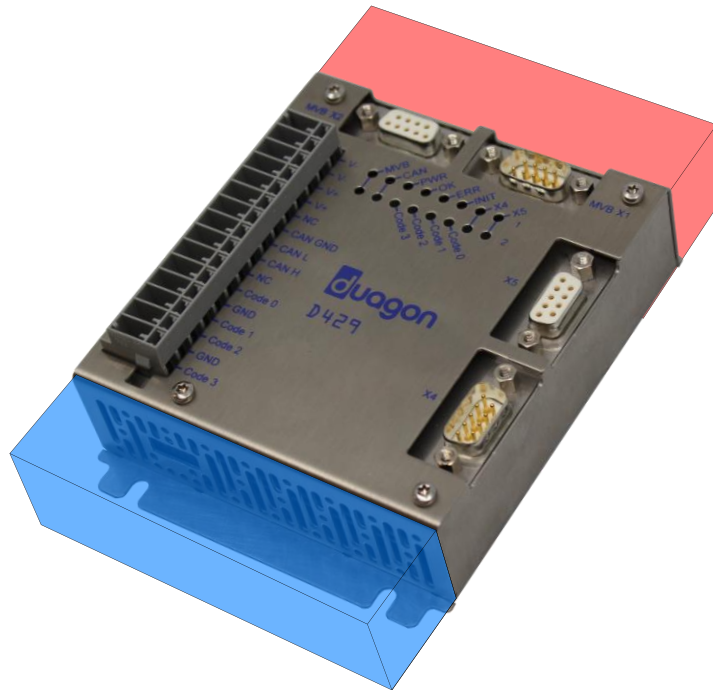


Figure 13: Required Space for Convection Cooling.

6.3. Shielding Concept

The main properties of the used shielding concept are:

- The cable shield is connected to the device housing.
- The cable shield has the same connection to the device housing in all nodes.

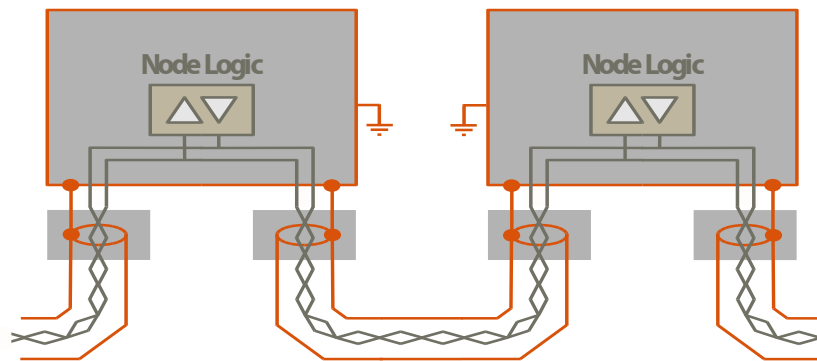


Figure 14: Shielding Concept.

As a result, all housings are connected together. Within the vehicle concept it must be ensured, that there are no ground potential differences that may harm the cable shield or the connectors.

The connection between the cable shield and the device housing is done via the cable connector housing and the fixing screw / cable lock.

6.4. Connection an Earthing Cable

This paragraph applies to the D429CRS with grounding bolt (-G) versions only (cf. chapter 14 "Ordering Information", page 39).

It is recommended to use an M5 ring cable lug for the ground connection over the grounding bolt. For the cable duagon recommends the following specifications:

- Wire cross section $> 1.5 \text{ mm}^2$

- Cable length < 30 cm
- Tightening torque ~2 Nm

To guarantee a good ground connection, two washers, a spring washer and a M5 nut are required, mounted as shown in the picture below.

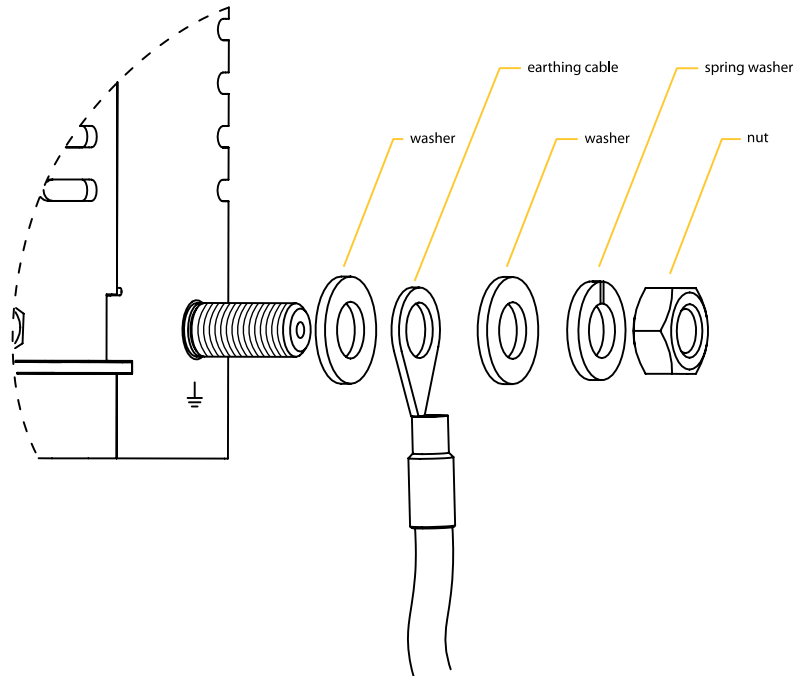


Figure 15: Mounting Instructions for Earthing Cable.

7. Environmental Specifications

Requirement	Min.	Typ.	Max.	Unit	EN 50155:2017
Operational temperature range, internal cubicle temperature.	-40	-	+70	°C	4.3.2: Class OT4.
Storage Temperature Range	-40	-	+85	°C	-
Switch-on extended Operating temperature	-	-	+85	°C	4.3.3: Class ST1.
Interruption Voltage Supply Class	-	-	-	-	5.1.1.4 S1.
Rapid temperature variations	-	-	-	-	4.3.4: Class H1.
Pollution degree	-	-	-	-	7.2.1: Pollution degree PD2.
Protective coating class	-	-	-	-	10.7: Protective coating class PC2.
Altitude above sea level	-	-	1800	m	4.3.1: according to EN 50125-1 , Table 1, class AX. ¹⁾
Relative humidity	-	<75	95	%	Typical value for yearly average, max value for 30 consecutive days per year. Short term moisture condensation without malfunction (EN 60068-2-30).
Vibration	-	-	1	m/s ²	12.2.11: according to EN 61373 class B: for 5 – 20 Hz for 20 – 150 Hz decreasing by 6 dB/oct.
Shock	-	-	50	m/s ²	12.2.11: according to EN 61373 class B: Duration 30 ms.
Fire behaviour	-	-	-	-	4.1: Class HL3 according to EN 45545-2 .
RoHS	-	-	-	-	European Directive 2011/65/EU .
REACH	-	-	-	-	European Regulation No 1907/2006 .

Table 14: Environmental Specifications.

Remarks:

- 1) For derating of maximum temperature with respect to altitude levels in excess please contact duagon.

8. RAMS Specification

8.1. Reliability

A summary of MTBF and MTTF calculations can be found in the documents "D429 MTBF calculation (IEC 62380)" (d-009201-nnnnnn).

8.2. Maintainability

In general, duagon are developed in a maintenance free manor by, where possible, not using components with limited useful life such as electrolytic capacitors. Exceptions are the usage of flash memory with limited data retention and RTC batteries, that are employed in certain devices.

Therefore, the D429CRS requires no maintenance task at maintenance levels 1 to 2. The maintenance levels are defined in accordance to **EN 13306**.

For maintenance level 4 duagon describes a single task which is a preventive maintenance task described in "Preventive Maintenance".

Useful life

The D429CRS contains following components with a limited useful life:

- Reprogrammable components (Flash Memory). These are specified from the manufacturer with 20 years data retention at 25° Celsius, which fits clause 6.2. The actual useful life may be extended by reprogramming these devices. Please refer to section "Preventive Maintenance" on page 28 for details on reprogramming devices.

The useful life of 20 years is therefore fully compliant with **EN 50155**, useful life class L4.

Remark: There are no other components with a limited useful life. Particularly, there are no electrolytic capacitors, which typically introduce a limitation to useful life.

Preventive Maintenance

Maintenance Level 4

Although the flash memory component employed by duagon products has a data retention of 20 years at 25° Celsius, duagon recommends reprogramming devices after 10 years to extend the devices useful life.

Detailed description of the programming procedure can be found in the "Programming Guide for duagon UE2G Products" (d-002247-nnnnnn).

Corrective Maintenance

Maintenance Level 3

The line replaceable units (LRU) is, in case of duagon products, the product itself. Therefore, the only corrective maintenance task performed on the vehicle is to replace the LRU.

Maintenance Level 5

Please contact the duagon support if you encounter any technical issues that require further corrective maintenance tasks.

9. Application Hints

9.1. Diagnostic by LEDs

9.1.1. General Status LEDs

Four status LEDs display the general state of the D429CRS module:



Figure 16: Status LEDs.

PWR green LED	Meaning
ON	Power is on.
OFF	No power.

Table 15: PWR LED Description.

OK green LED	Meaning
ON	Application of D429CRS is OK. Remark: Depends on application software.
OFF	Error condition: see red error LED (ERR). If the red LED is off too: Loss of power, heavy hardware error

Table 16: OK LED Description.

ERR red LED	Meaning
ON or FLASHING	Application of D429CRS has determined an error condition. Remark: Depends on application software.
OFF	No error condition in application of D429CRS. Note: LED OK should be ON.

Table 17: ERR LED Description.

INIT yellow LED	Meaning
ON	Initialization completed.
OFF	Initialization in progress.

Table 18: INIT LED Description.

9.1.2. Code LEDs

The code LEDs display the actual configured code input pins of the D429CRS module:
For more information refer to section "Code Inputs" on page 17.



Figure 17: Coding LEDs.

Code LED				Code inputs and generated index (1: Input tied to GND, 0: Input left open)			
3	2	1	0	Code 3	Code 2	Code 1	Code 0
OFF	OFF	OFF	OFF	0	0	0	0
OFF	OFF	OFF	ON	0	0	0	1
OFF	OFF	ON	OFF	0	0	1	0
OFF	OFF	ON	ON	0	0	1	1
OFF	ON	OFF	OFF	0	1	0	0
OFF	ON	OFF	ON	0	1	0	1
OFF	ON	ON	OFF	0	1	1	0
OFF	ON	ON	ON	0	1	1	1
ON	OFF	OFF	OFF	1	0	0	0
ON	OFF	OFF	ON	1	0	0	1
ON	OFF	ON	OFF	1	0	1	0
ON	OFF	ON	ON	1	0	1	1
ON	ON	OFF	OFF	1	1	0	0
ON	ON	OFF	ON	1	1	0	1
ON	ON	ON	OFF	1	1	1	0
ON	ON	ON	ON	1 ¹⁾	1 ¹⁾	1 ¹⁾	1 ¹⁾

Table 19: Coding LEDs Description.



CAUTION. 1) This state is reserved for production purposes. It is used during production e.g. for burn-in stress generation. Never use this configuration during normal operation, since this configuration may switch outputs on spontaneously.

9.1.3. Communication Interfaces

For every communication interface, a pair of LEDs is used to indicate activity on the bus:

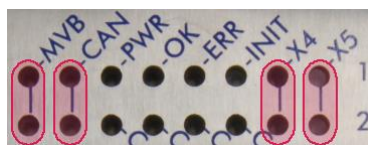


Figure 18: Communication Interface LEDs.

List of communication interfaces

Label	Communication Interface
X1X2	RS485 Interface
CAN	CAN interface
X4	RS232 interface
X5	RS485 interface

Figure 19: List of Communication Interfaces.

Meaning of LEDs per communication interface

Row "1" (TX) LEDs	Meaning
ON	The interface is transmitting data.
OFF	The interface is not transmitting data.

Table 20: Row 1 LED Description.

Row "2" (RX) LEDs	Meaning
ON	The interface is receiving data.
OFF	The interface is not receiving data.

Table 21: Row 2 LED Description.

9.2. Reset Mechanism

The device will reset itself after power-up or when the power supply voltage drops below a certain level and comes back again.

Please note: Since the D429CRS device operates also from very low voltages (-LV: far below 14V), the device may be still up and running, even if other devices have fallen out of operation already.

9.3. Power up

As with all electronic equipment, the D429CRS will need a certain time to power up. This procedure takes typically up to approx. 0.5 to 4 seconds (depending on version) and is automatically performed. However, the device is completely passive during this time, „as if nothing is plugged in.

9.4. EMI Considerations

We assume the following implementation for the D429CRS:

- The D429CRS signal lines have no connection with unshielded cables to the outside.
- The device case is properly connected to protective earth.

- Connect all power pins in a way, that the overall impedance of the power lines is reduced to a minimum.
- Connect all shielding (device housing i.e. CASE potential) in a way, that the overall impedance of the interconnection is reduced to a minimum. Keep in mind, that electromagnetic interferences are largely based on radio frequency coupling and hence, the interconnection needs to maintain a low impedance over a large frequency range.

10. Compliance Summary

10.1. Test Report Compliance Summary

Table 22 lists the type and routine tests performed on the D429CRS.

Test	Type	Routine	Reference EN 50155	Remarks
Visual inspection	yes	yes	13.4.1	Refer to "Quality Plan for duagon Products – Specification", d-000796-nnnnnnn
Burn-in test	yes	yes	-	Refer to "Quality Plan for duagon Products – Specification", d-000796-nnnnnnn
Performance test	yes	yes	13.4.2	Refer to "Quality Plan for duagon Products – Specification", d-000796-nnnnnnn
Insulation test	yes	yes	13.4.9	According to EN 50155 .
Low temperature start-up test	yes	no	13.4.4	EN 60068-2-1 , Test Ab, -40°C (2 h), Criterion A
Dry heat test	yes	no	13.4.5	EN 60068-2-2 , Test Bd, +70 °C (6 h), +85 °C (10 min.)
Cyclic damp heat test	yes	no	13.4.7	EN 60068-2-30 , Test Db, 2 cycles at 55 °C
Supply variations and interruption test.	no	no	13.4.3.2 13.4.3.3 13.4.3.4	Not applicable.
EMC test	yes	no	13.4.8	EN 50121-3-2
Shock and vibration test	yes	no	13.4.11	EN 61373 , category 1, Class B ³⁾
Enclosure protection test (IP code)	yes	no	13.4.12	IP20
Low temperature storage test	yes	no	13.4.6	EN 60068-2-1 , Test Ab, -40°C, 16 h
Salt mist test	no	no	13.4.10	-
Equipment stress screening	no	no	13.4.13	-

Table 22: Test Report Compliance Summary.

Remarks:

- **Type** tests are carried out to verify the specified requirement and are performed on a limited number of devices of a given design and manufacturing procedure.
- **Routine** tests are performed on each manufactured device and are carried out to verify that the devices meet the specified requirements and correspond to the results of the type test.

11. Normative References

The following document, in whole or in part, are normatively referenced in this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies.

Railway Applications

EN 50155:2007, Railway applications - Rolling stock - Electronic equipment.

Note: Hardware type test performed according to **EN 50155:2017**

Electromagnetic Compatibility

EN 50121-3-2:2016, Railway applications - Electromagnetic compatibility - Part 3-2: Rolling stock – Apparatus.

Environmental Conditions

EN 50125-1:2014, Railway applications - Environmental conditions for equipment - Part 1: Rolling stock and on-board equipment

TRDP

IEC 61375-2-3:2015, Electronic railway equipment - Train communication network (TCN) - Part 2-3: TCN communication profile

Fire and Smoke

EN 45545-2:2013, Railway applications - Fire protection on railway vehicles - Part 2: Requirements for fire behaviour of materials and components.

Maintenance

EN 13306:2017, Maintenance. Maintenance terminology.

Shock and Vibration

EN 61373:2010, Railway applications - Rolling stock equipment - Shock and vibration tests.

Damp Heat

EN 60068-2-30:2005, Environmental testing — Part 2-30: Tests — Test Db: Damp heat, cyclic (12 h +12 h cycle) (IEC 60068-2-30:2005).

Low Temperature

EN 60068-2-1:2007, Environmental testing — Part 2-1: Tests — Test A: Cold (IEC 60068-2-1:2007).

Dry Heat

EN 60068-2-2:2007, Environmental testing — Part 2-2: Tests — Test B: Dry heat (IEC 60068-2-2:2007).

Manufacturing

IPC-A-610 (D):2010, Acceptability of Electronic Assemblies.

RoHS

2011/65/EU, Directive of the European Parliament and of the Council on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS compliance).

REACH

1907/2006, Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH).

12. Links to other duagon Documents

In general, most of the documents are located on www.duagon.com, and may be downloaded from there in the most up to date version.

12.1. D429CRS Documentation

D429 MTBF calculation (IEC 62380), d-009201-nnnnnn

This document contains summary of MTBF and MTTF calculations for the D429CRS.

12.2. Software Documentation

CONTROLLER Driver Kit for D429, d-001211-nnnnnn

The Driver Kit provides an easy way to implement your application on the D429 controller. The Driver Kit contains the needed documents and software (e.g. real time OS, development tools, ANSI C source code of driver, driver porting guide, API interface description, as well as board specific firmware with documentation how to download).

TCN Software Architecture - Data Sheet, Software Integration Manual, d-000487-nnnnnn

This document describes the duagon TCN software architecture, which is based on the IEC 61375 (Electrical Railway Equipment – Train Communication Network). It defines interfaces for all layers and packages of the TCN software architecture. This makes it easy to port an implementation to different operating systems as well as connect all kind of busses to a device (e.g. MVB, WTB, CAN,...).

12.3. User's Guide

Programming Guide for duagon UE2G Products, d-002247-nnnnnn

This document describes how to program and update duagon UE2G products. It is also a guide on how to set up a computer to perform these actions.

12.4. General Documentation

Labelling and Packaging – Specification, d-000778-nnnnnn

This document describes all product labels (e.g. serial number label) used in relation with customers. It describes furthermore how duagon packs the products for shipment.

Quality Plan for duagon Products – Specification, d-000796-nnnnnn

This document is a specification about test procedures for series testing of duagon products. It is valid for all duagon products in general. For each specific product an applicable subset of the described tests is selected; according to the procedures specified here.

Life Cycle of duagon's Products – Technical Note, d-000526-nnnnnn

Addresses some MTBF and Life Cycle considerations. The i101 is not included in the list of devices, yet: The i101 may be added after having collected sufficient statistical data from the field. In a very general way, the Life Cycle- document may be used for planning the life time repair stock in order to ensure long support times. If further information is needed on this topic, please ask duagon for a MFTB calculation for the D429CRS.

Product Ordering Guide, d-013426-nnnnnn

General duagon product ordering guide explaining product names including the order options and the NCID number used to identify hardware and firmware revisions.

Material and Components for Wiring – Technical Note, d-000842-nnnnnn

This document is intended for engineers to help them select the right components.

13. Document History

d-010335-047891

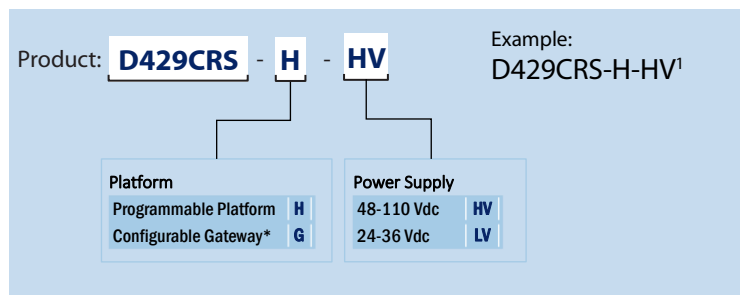
- Update to template Rev.2.0
- According to newest hardware revision
- HW Tests according to EN50155:2017.
- Error on X3 pin out table corrected
- Update on Product Ordering Table
- CAN interface: Pin 6 renamed (CAN_shd → CAN_GND); internal connection did not change.

d-010335-018366

- First release. Derived from product D429C.

14. Ordering Information

The Product Ordering Table illustrates the different order options available for the D429CRS and how the order code is built. For additional information of how the complete order code is built see "Product Ordering Guide", d-013426-nnnnnn



* contact duagon for lead times and availability

Remarks:

- 1) default ordering options

15. Document History

d-010335-047891

- Update to data sheet template 2.0.
- According to newest hardware revision.
- HW Tests according to EN50155:2017.
- Error on X3 pin out table corrected.
- Update on Product Ordering Table
- CAN interface: Pin 6 renamed (CAN_shd → CAN_GND); Internal connection did not change.

d-010335-018366

- Initial release
- Derived from product D429C.

Appendix A: Power Consumption Definitions

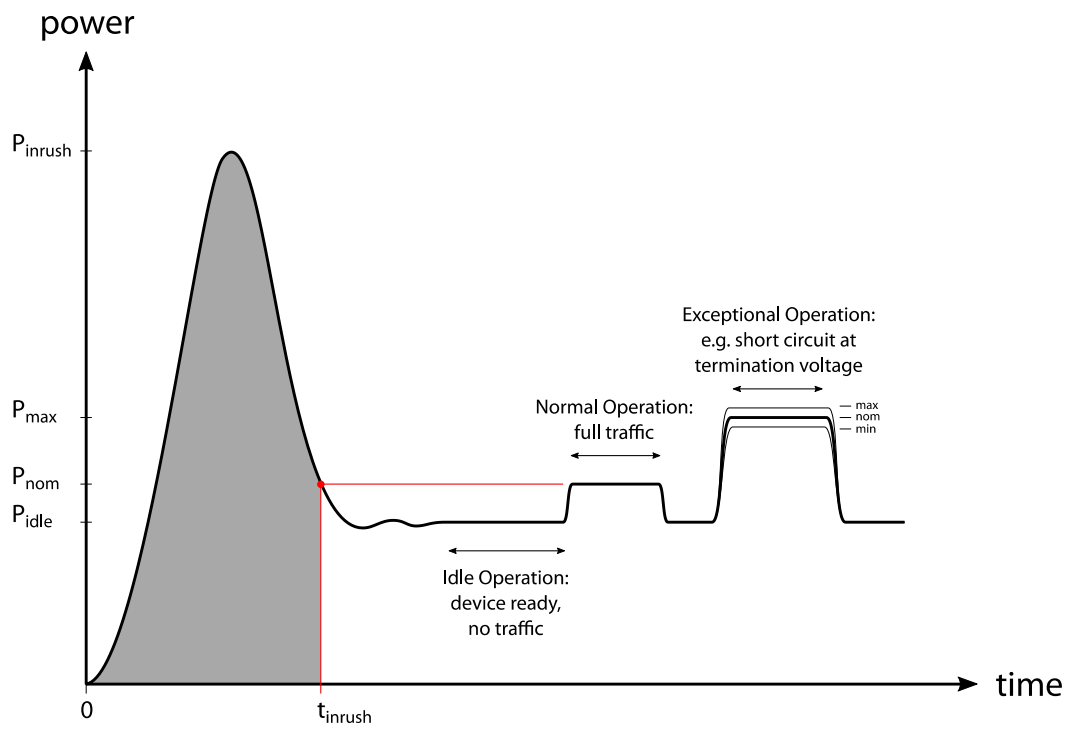


Figure 20: Power Consumption Definitions.

Appendix B: Document Numbering System

All duagon documents have a unique identification number. The identification number has a certain internal structure to ease the tracking of different documents. In general, there are two parts:

Prefix	Document number	Filing number
d	-000310	-001952
Always constant	<p>Specifies a certain purpose of a document with the intention to link several documents with different filing number.</p> <p>Please note, that the purpose of the document number is not stored for each document number, but can be derived from the document title, which is stored for each Filing number.</p> <p>The format is either 6 digits or not available.</p>	<p>Unique number, that identifies a document. Released in sequential manner as the documents are filed in the archive. A duagon- internal data base contains exactly one document title text for each filing number.</p> <p>Always 6 digits.</p>

Table 23: Explanation of the Document Numbering System at duagon AG.

Examples for identification numbers

Identification number	Document Title / Remarks
d-000310-001606 d-000310-001952	<p>"DXIO data sheet Rev 2.2"</p> <p>"DXIO data sheet Rev 2.3"</p> <p>A document, that is updated from time to time: the document number has the purpose to link several versions of the DXIO data sheet together. The filing number distinguishes between different versions.</p> <p>Please note, that the document number part is kept the same, if the basic intention of the early versions is kept, for example during revisions due to debugging or manufacturing updates.</p> <p>In case a significant change happens, another document number would be applied.</p>
d-000719	<p>Notes from prototype meeting ...</p> <p>A document, that is obviously not updated after release. The document number part is missing, and the filing number remains the only used part for identification.</p>

Table 24: Examples for the Document Numbering System at duagon AG.

Convention:

When a document is referenced by its document number, as for example "d-000584-nnnnnn", then the newest version of this specific document is meant. When a specific version of a document is intended, then the full identification number like "d-000584-002043" is specified.

Appendix C: Software Licensing

The following software components used on the duagon products are subject to specific license agreements. Modules not named in this section, are subject to the duagon software license.

Software Module	License	Copyright
eCos	eCos License Version 2.0	Red Hat, Inc.
CANpie	GPL 2	MicroControl GmbH
Firmware_load	Altera License	Altera Corporation
IPTCom	BT	Bombardier Transportation
MicroMonitor	Lucent Public License	Bell Labs
TRDP	MLP 2.0	Bombardier Transportation

Table 25: Software Components with Specific License Agreements.

Internal Altera Drivers

Altera driver and headers:

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