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TECHNICAL REPORT

colour inside

Process management for avionics – Electronics design – Part 1: Electrical signal properties, naming conventions and interface control document (ICD)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

PROCESS MANAGEMENT FOR AVIONICS – ELECTRONICS DESIGN –

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FOREWORD

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IEC TR 63238-1, which is a Technical Report, has been prepared by IEC technical committee 107: Process management for avionics.

The text of this Technical Report is based on the following documents:

Draft TR	Report on voting
107/351/DTR	107/356/RVDTR

Full information on the voting for the approval of this Technical Report can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 63238 series, published under the general title *Process management for avionics – Electronics design*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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PROCESS MANAGEMENT FOR AVIONICS – ELECTRONICS DESIGN –

Part 1: Electrical signal properties, naming conventions and interface control document (ICD)

1 Scope

This part of IEC 63238 provides information and a template to create an interface control document (ICD) for any project which includes electronic assemblies, such as electronic circuit card assemblies (CCAs) or electronic devices, connected together. This document proposes electrical signal naming conventions when interfacing electronic assemblies, and an example containing seven signal naming conventions is included. This document supports original equipment manufacturers (OEMs) in the preparation and maintenance of their electronic assemblies interfaces and integration specifications to avoid misunderstanding of signals which can cause unnecessary design and/or integration errors, and testing complications.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
interface control document
ICD
document which defines for each electronic signal its electrical properties value and naming

Note 1 to entry Typical electronic signal examples include DC voltage, 5 V, 3,3 V.

Note 2 to entry Typical electrical property values include sine wave, rectangular wave.

3.1.2
electronic assembly
electrical or electronic device that is not subject to disassembly without destruction or impairment of design use

EXAMPLE Electronic circuit cards or modules, displays, storage devices, printers, laptop computer, electro/optical devices, etc.

[SOURCE: IEC TS 62239-2:2017, 3.1.20]

3.1.3
circuit card assembly
CCA
functional electronic product based on a printed circuit board (PCB) which supports and connects electronic or electrical components

Note 1 to entry: Components are generally soldered onto the PCB to both electrically connect and mechanically fasten them to it.

Note 2 to entry A circuit card assembly can also be called printed circuit assembly (PCA) or printed circuit board assembly (PCBA).

3.1.4
electrical interface
item which allows exchanges and interactions outside of an electronic assembly

Note 1 to entry: A connector can be used to implement an electrical interface.

3.1.5
net-list
list of connections between two or several points

Note 1 to entry: The connection points are usually called "terminals" or "pins" in electronics; for example, a connector of an electric circuit card assembly (CCA) is composed of pins, also named outputs.

Note 2 to entry: An electrical connection is usually named “net” and allows the propagation of an electrical signal.

3.2 Abbreviated terms

AC	alternating current
CCA	circuit card assembly
DC	direct current
HF	high frequency
ICD	interface control document
ECMP	electronic component management plan
L	load
OEM	original equipment manufacturer
S	source

4 ICD description

4.1 General

The ICD contains, based on electrical signal or net naming conventions, the electrical parameters for connector pins or outputs of an electronic assembly (electronic CCA or electronic device for example).

Each pin can be connected to a source (S) or a load (L). Thus, the ICD defines sources and loads for each pin. Each source supplies voltage or current with a specified signal shape. Each load can be a resistor, inductor, capacitor, or impedance.

It is common for designers to use certain rules to name the net-lists, so that the signal type lies inside it. See Table 1 for examples.

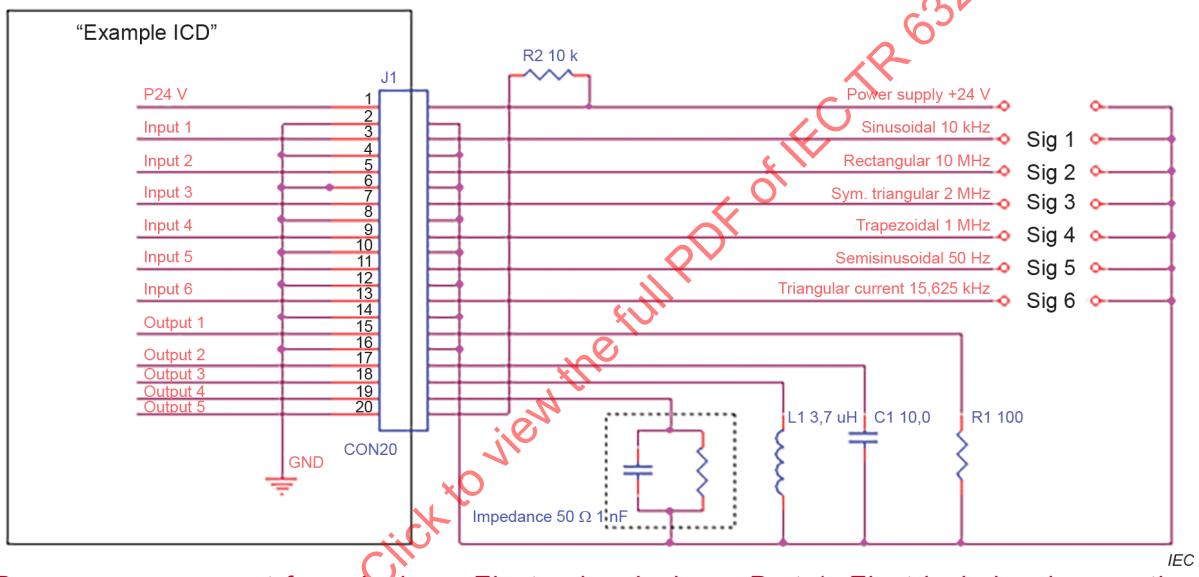
Table 1 – Examples for sources and loads

Sources	Power supply for a CCA – DC (battery) or AC; any input signal of a CCA (digital or analog).
Loads	Any output signal of a CCA (digital or analog); any module connected to a CCA that uses the CCA as a power source (for example speaker, motor, etc.)

Annex A includes an example of an ICD for the circuit described in Figure 1.

4.2 Electrical interface

For the purposes of this document and the ICD definition, Figure 1 proposes an example of a user's electronic schematic which includes an electrical interface with electrical signals.



Process management for avionics – Electronics design – Part 1: Electrical signal properties, naming conventions and interface control document (ICD)

Figure 1 – Example of an electronic schematic including an electrical interface

In Figure 1, "Sig1" to "Sig6" are signals which are defined in 4.3.3, respectively, at "Figure 2" to "Figure 7" level, and loads such as inductance "L1", capacitor "C1" and resistor "R1" are presented in Table 4.

4.3 ICD specification format

4.3.1 General

The ICD specification is typically described as explained in 4.3.2

An example of a typical user's ICD specification is shown in Table A.1.

4.3.2 Format of the ICD specification

The ICD specification tables have the typical header shown in Table 2:

Table 2 – Typical ICD specification table header

#	Param	Syntax	Units	Default	Comments

where:

- # is the order of the parameters. The parameters should be extracted in the same order that they are written, starting from the first row. This table should be used as a list of instructions.
- Param: the name of the ICD parameter that needs to be extracted;
- Syntax: this is the syntax of the field and can be one of the following:

  L – selected from a drop-down list;

  F – floating point number (for example "0,3" or "56"). Orders of magnitude can be used when entering "F" fields: p (pico), n (nano), u (micro), m (milli), k (kilo), M (mega), G (giga),T (terra) (for example "22 m" is equivalent to "0,022");

  S – string (text), set of any characters (for example "A1" or "1" or "B");
- Units: the default units of this parameter (for parameters of type F). The number that is entered in this field is interpreted in these units;
- Default: indicates if this field has a default value. A user can use the default value by entering "-" in the library:

  "D" means that if the parameter is entered as "-", this parameter will not be used for the calculation;

  a value written in this column indicates that if the parameter is entered as "-", that value is used;

  blank – no default value for this parameter, the field in mandatory;
- Comments: this column contains an explanation of the field.

4.3.3 ICD content

The typical content of an ICD file is as shown in Table 3 based on the circuit shown in Figure 1.

Table 3 – Typical ICD file

	Parameter	Syntax	Units	Default	Comment
1	Description	S			Description
	Connector type				
2	RefDes of connector	L			Reference designator of the connector. Use the drop-down menu.
3	Pin number	L			List of pins of the connector in the drop-down menu. In addition to the pins one can select “common load/source”. One should not change the pin numbers in a normal usage, because the program already populates all the connector pins into the ICD table. The usage of “common load/source” is needed when a single load or source is connected to all the pins having the same “NET-IN/NET-OUT” in a connector so that the current is divided between all the common pins. If a source is connected to many pins in a connector, all the pins can be defined with the source, or alternatively there can be one line with a “common load/source” and the rest of the lines can stay unconnected.
4	NET-IN/NET-OUT	L			Select the needed net name in the pop-up menu. This is the name of the net that is connected to the selected pin.

	Parameter	Syntax	Units	Default	Comment
5	Reference_NET	L			Select the needed net name in the drop-down menu. The source/load is connected between the nets “NET-IN/NET-OUT” and “Reference_NET”. Ground pins do not have reference nets usually, they can be omitted from the ICD or marked as “not connected”.
6	Signal type	L			Select from "-" (the connector pin is connected, the rest of the parameters need to be set) / "not connected" (the connector pin is not connected), or select signals defined in the “sources and loads definition”.
7	Polarity	L			Polarity of the signal offset. It indicates the sign of “Voffset”. Select from +/- (positive/negative). The polarity indicates the polarity of the “NET-IN/NET-OUT” (relative to the “Reference_NET”.
8	Source or load type	L1			See Table 4. Select the source or load type. The source/load is inserted between the nets “NET-IN/NET-OUT” and “Reference_NET”.
9	Shape of signal	L2			See Table 5. Select the needed shape of the signal in the drop-down menu. If a shape is selected, a graph is plotted below to specify the signal parameters. This is used only for the following "Source or load type" values: "Voltage", "Current" and "HF power".
10	Voffset [V]	F	[V]	0	Voltage offset of the signal. See for example Figure 5.
11	V~peak-to-peak [V]	F	[V]		Peak-to-peak voltage of the signal. See for example Figure 5.
12	Ioffset [A]	F	[A]	0	Current offset of the signal. See for example Figure 5.
13	I~peak-to-peak [A]	F	[A]		Peak-to-peak current value of the signal. See for example Figure 5.
14	P [dbm]	F	[dBm]		Input power. As sinusoidal voltage with Offset = 0 and A_0 = √(20 x ((P - 30)/10) x R_{load}). See for example Figure 2.
15	Freq [MHz]	F	[MHz]		Frequency of the signal. See for example Figure 5.
16	Pulse width: T0 [µs]	F	[µs]	1/(2 x Freq [MHz])	Pulse width of the signal. See for example Figure 5.
17	Initial delay time [µS]	F	[µs]	0	Initial delay of pulse referenced to the beginning of a signal period. See for example Figure 5.
18	Front width: T1 [µs]	F	[µs]	0	Front (rise) width of the pulse. See for example Figure 5.
19	R [Ohm]	F	[Ohm]		Resistive value of the load. Use only for "Source or load type": "Resistor" and "Impedance"; see “L1” at Table 4 level.
20	L [uH]	F	[uH]		Inductive value of the load. Use only for "Source or load type": "Inductive" and "Impedance"; see “L1” at Table 4 level.
21	C [uF]	F	[uF]		Capacitive value of the load. Use only for "Source or load type": "Capacitor" and "Impedance"; see “L1” at Table 4 level.

The source or load type “L1” is described in Table 4 and the shape of signal “L2” in Table 5.

Table 4 – Source or load type "L1"

	Source or load type (L1)	Description	Comment
1	Voltage	Source type	
2	Current	Source type	
3	HF power	Source type	N/A – not implemented
4	Resistor (R)	Load type	If one has the voltage (V) and the current (I) for this load, then this resistive load should have a resistance of: R = V/I. In this case it is important to take the realistic current and not some worst-case current consumption, which will not be realistic for the circuit.
5	Inductance (L)	Load type	
6	Capacitor (C)	Load type	
7	Impedance	Load type	When using this type there shall be at least one of the following parameters used: "R", "L" or "C"

Table 5 – Shape of signal "L2"

	Shape of signal (L2)	Description	See Figure
1	Sinusoidal	Sinusoidal voltage/current input signal	**Figure 2**
2	Rectangular	Rectangular voltage/current input signal	**Figure 3**
3	Symmetric triangular	Symmetric triangular voltage/current input signal	**Figure 4**
4	Trapezoidal	Trapezoidal voltage/current input signal	**Figure 5**
5	Upper half sine wave	Semi-sine voltage/current input signal	**Figure 6**
6	Triangular	Triangular voltage/current input signal	**Figure 7**
7	DC	DC voltage/current input signal	

Figures 2 to 7 describe the shape of the electrical source or load signals and their characteristics.

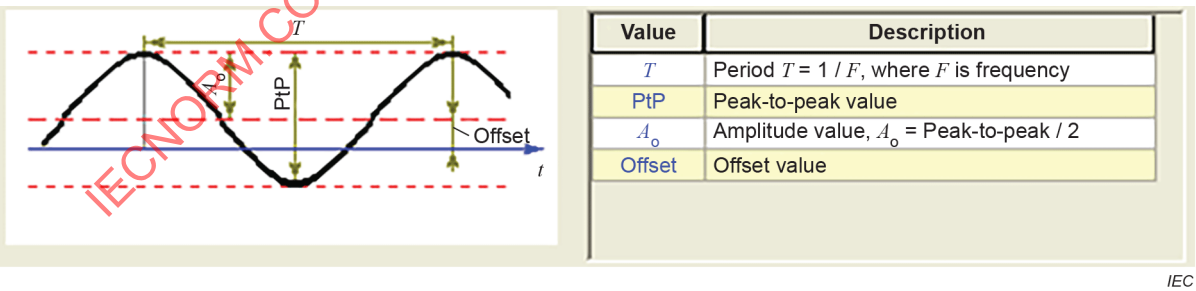
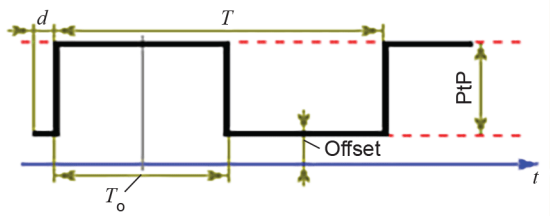


Figure 2 – Signal "Sig1": Sinusoidal wave



Value	Description
T	Period T = 1 / F, where F is frequency
T_o	Pulse width
PtP	Peak-to-peak value
Offset	Offset value
d	Initial delay time

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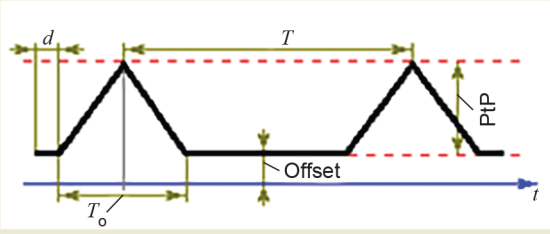
Figure 3 – Signal "Sig2": Rectangular wave



Value	Description
T	Period T = 1 / F, where F is frequency
T_o	Pulse width
PtP	Peak-to-peak value
Offset	Offset value
d	Initial delay time

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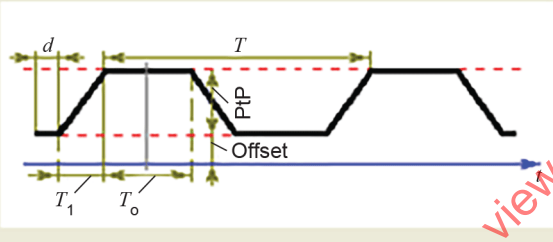
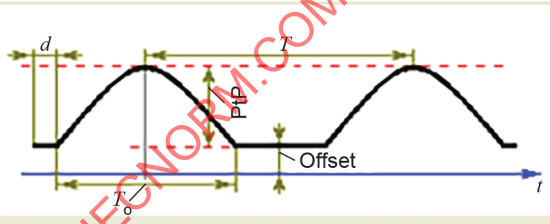
Figure 4 – Signal "Sig3": Symmetrical triangular wave



Value	Description
T	Period T = 1 / F, where F is frequency
T_o	Pulse width
T_1	Front width
PtP	Peak-to-peak value
Offset	Offset value
d	Initial delay time

IEC

Figure 5 – Signal "Sig4": Trapezoidal cut wave



Value	Description
T	Period T = 1 / F, where F is frequency
T_o	Pulse width
PtP	Peak-to-peak value
Offset	Offset value
d	Initial delay time

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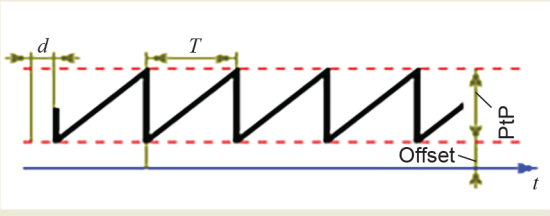
Figure 6 – Signal "Sig5": Upper half sine wave



Value	Description
T	Period T = 1 / F, where F is frequency
PtP	Peak-to-peak value
Offset	Offset value
d	Initial delay time

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Figure 7 – Signal "Sig6": Triangular align right

The characteristics of the shape of the source or load signals are identified in Table 6.

Table 6 – Columns for describing the characteristics of each signal shape

Shape of signal	Voffset [V] - Only for source or load type = "Voltage"	V~peak-to-peak [V] -Only for source or load type = "Voltage"	Ioffset [A] - Only for source or load type = "Current"	I~peak-to-peak [A] - Only for source or load type = "Current"	Freq [MHz]	Pulsewidth: To [µs]	Initial delay time [µs]	Front width: T1 [µs]
Sinusoidal	+	+	+	+	+	N/A	N/A	N/A
Rectangular	+	+	+	+	+	+	+	N/A
Symmetrical triangular	+	+	+	+	+	+	+	N/A
Trapezoidal	+	+	+	+	+	+	+	+
Upper half sine wave	+	+	+	+	+	+	+	N/A
Triangular	+	+	+	+	+	N/A	N/A	N/A
DC	+	N/A	+	N/A	N/A	N/A	N/A	N/A

Annex A
(informative)

Example of an ICD

The example in Figure 1 is a typical ICD of an electronic CCA. The columns in Table A.1 describe all fields needed for an ICD.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	Description	Connector Type	RefDes of Connector	#Pin	NET-IN/NET-OUT	Reference NET	Polarity	Source or Load Type	Shape of Signal	Voffset [V]	V~peak [V]	Ioffset [A]	I~peak [A]	P [dBm]	FREQ [MHz]	Pulse width [µs]	Initial delay time [µs]	Front width [µs]	R [Ohm]	L [µH]	C [µF]
2	-		J24	3	5V	GND1	+	Voltage	DC	5	-				-						
3	-		J25	2	REF_OUT_A	GND2	+	Voltage	DC	2.5	-				-						
4	-		J25	30	D_PORT_26	GND2	+	Voltage	DC	0.3	-				-						
5	-		P26	4	CPS_DEPLOYED	GND2	+	Voltage	DC	12	-				-						
6	-		P26	9	ALS_B_CAL_RES	ALS_B_CAL_RES_RTN	+	Voltage	DC	2	-				-						
7	-		J24	8	OPU_CP_422_SDA_L-B	GND1	+	Voltage	Rectangular	3.3	6.6				0.1	-	10				
8	-		J24	9	OPU_CP_422_SCL_L-B	GND1	+	Voltage	Rectangular	3.3	6.6				0.2	-	5				
9	-		J24	13	CP_OPU_422_SDA_H-A	GND1	+	Voltage	Rectangular	1.65	3.3				0.1	-	-				
10	-		J24	14	CP_OPU_422_SDA_L-A	GND1	+	Voltage	Rectangular	1.65	3.3				0.1	-	10				
11	-		J24	18	OPU_CP_422_SDA_L-A	GND1	+	Voltage	Rectangular	1.65	3.3				0.1	-	10				
12	-		J24	19	PWM_GEN2	GND1	+	Voltage	Rectangular	2.5	5				0.1	-	-				
13	-		J24	21	OPU_CP_422_SCL_L-A	GND1	+	Voltage	Rectangular	1.65	-				0.1	-	5				
14	-		J24	23	PWM_GEN1	GND1	+	Voltage	Rectangular	2.5	-				0.1	-	-				
15	-		J24	24	PWM_GEN3	GND1	+	Voltage	Rectangular	2.5	-				0.1	-	-				
16	-		J24	25	CP_OPU_422_SDA_H-B	GND1	+	Voltage	Rectangular	1.65	-				0.1	-	-				
17	-		J24	26	CP_OPU_422_SDA_L-B	GND1	+	Voltage	Rectangular	1.65	-				0.1	-	10				
18	-		P2	1	OPU_CP_422_SCL_H-A	GND1	+	Voltage	Rectangular	1.65	3.3				0.2	-	-				
19	-		J24	4	PWR_18V	GND1	+	Resistor											240		
20	-		J24	7	OPU_CP_422_SDA_H-B	OPU_CP_422_SDA_L-B	+	Resistor											200		
21	-		J24	10	OPU_CP_422_SCL_H-B	OPU_CP_422_SCL_L-B	+	Resistor											200		
22	-		J24	17	OPU_CP_422_SDA_H-A	OPU_CP_422_SDA_L-A	+	Resistor											200		
23	-		J24	22	OPU_CP_422_SCL_H-A	OPU_CP_422_SCL_L-A	+	Resistor											200		
24	-		P2	9	CP_OPU_422_SDA_H-A	CP_OPU_422_SDA_L-A	+	Resistor											200		
25	-		P2	24	CP_OPU_422_SDA_H-B	CP_OPU_422_SDA_L-B	+	Resistor											200		
26	-		P27	1	FILT_18V	GND1	+	Resistor											360		
27	-		P27	2	FILT_5V	GND1	+	Resistor											500		
28	-		P27	3	FILT_5V	GND1	+	Resistor											500		
29	-		P27	5	PWM_LD1	FILT_18V	+	Resistor											378		
30	-		P27	6	PWM_LD2	FILT_5V	+	Resistor											500		
31	-		P27	7	PWM_LD3	FILT_5V	+	Resistor											500		
32	-		P26	1	ALS_P_A	ALS_N_A	+	Current	DC			2.00E-05	-		-						
33	-		P26	2	ALS_P_B	ALS_N_B	+	Current	DC			2.00E-05	-		-						
34	Yes	-	J24	1	GND1	GND1		Not Connected													
35	Yes	-	J25	40	GND2	GND2		Not Connected													
36	Yes	-	P2	6	ILUMIN_RTN	GND1		Not Connected													
37	Yes	-	P2	7	OPU_GND	GND1		Not Connected													
38	Yes	-	P2	13	CP_OPU_422_SDA_L-A	GND1		Not Connected													
39	Yes	-	P2	17	CP_POWER_RTN	GND1		Not Connected													
40	Yes	-	P2	22	CP_OPU_422_SDA_L-B	GND1		Not Connected													
41	Yes	-	P2	25	OPU_On_Off_SW	GND1		Not Connected													

IEC

Figure A.1 – Example of an ICD

Table 1 provides an example for ICD data based on the signals identified in Figure A.1.

Table A.1 – Example for ICD data

Ref Des of Connector	Pin Number	NET-IN/NET-OUT	Reference NET	Signal type	Polarity	Source or load type	Shape of signal	Voffset (V)	V~peak-to-peak (V)	Ioffset (A]	I~peak-to-peak (A)	Freq (MHz)	Pulsewidth: To (µs)	Initial delay time (µs)	Front width: T1 (µs)	R (Ohm)	L (uH)	C (uF)	Comments
J1	15	Output1	GND	-	+	Resistor										100			
J1	17	Output2	GND	-	+	Capacitor												10	
J1	18	Output4	GND	-	+	Inductive											3,7		
J1	19	Output3	GND	-	+	Impedance										50	-	0,01	
J1	20	Output5	P24V	-	+	Resistor										10 000			
J1	1	P24V	GND	-	+	Voltage	DC	24											
J1	5	Input2	GND	-	+	Voltage	Rectangular	0,2	2,6			10	0,033	-					
J1	11	Input5	GND	-	-	Voltage	Upper half sine wave	-	12			5,00 E-05	10 000	0,1					
J1	3	Input1	GND	Default 1	+	Voltage	Sinusoidal	-	12			0,01							
J1	7	Input3	GND	-	+	Voltage	Symmetrical triangular	1	3			2	0,32	-					
J1	9	Input4	GND	-	+	Voltage	Trapezoidal	0,4	4,2			1	0,5	0,1	0,1				
J1	13	Input6	GND	Default 2	+	Current	Triangular			0,1	1,1	0,015625		32					