ICL16

16 A_{ac} DIN Rail Inrush Current Limiter (ICL) with control input

ICL16 product photograph

Feature summary

- Inrush current limitation to prevent erratic circuit breaker triggering
  - Designed for B16 / C16 circuit breakers
  - Zero-voltage turn-on to minimise inrush current
  - Capacitive load up to 8000 µF
- Input voltage range 85–264 V_{ac}
- Control input for relay functionality
- NTC temperature supervisor
- Non-resettable thermal fuse
- Microcontroller controlled operation
- Programmable via MCU Tracer

Product description

The ICL16 is an inrush current limiter for 85–264 V_{ac} systems rated up to 16 A. It prevents erratic circuit breaker triggering caused by the high inrush currents of switch mode power supplies or PTC loads. The device combines a softstarter and a bypass relay in a single DIN Rail housing and is switched by an external control input.

Inrush current is limited by turning on at the AC zero crossing. After a programmable softstart time the relay engages and bridges the softstart resistors. An NTC sensor supervises the resistor temperature and inhibits the softstart while the resistors are too hot. A non-resettable thermal fuse disconnects the resistors permanently if that protection fails.

Timing and protection parameters are configurable over a 3.3 V serial interface. The device operates from −40 °C to 50 °C and tolerates a limited number of load-side short circuits.

Specification overview

Description	Value
General	
Voltage range (V_{ac})	85–264
Output current (A_{ac})	16
Control input (V_{ac})	85–264
Max. capacitance	8000 µF
Delay time (typ.)	20 ms
Softstart time (typ.)	200 ms
Weight	93 g
Protection	
Temperature sensor	yes
Thermal fuse	yes
Input fuse (control)	yes

Ordering information

Order code	Output
ICL16	16 A_{ac} switched
Customisation available. Contact DPS.	

Engineering standards

Applied engineering standards	
EN 55032	EN IEC 63000
EN 61000-4-2	EN 61000-4-3
EN 61000-4-4	EN 61000-4-5
EN 61000-4-6	CISPR 32

1 Functional description

1.1 Overview

The ICL16 is an inrush current limiter for 85–264 V_{ac} systems rated up to 16 A. It prevents erratic circuit breaker triggering caused by the high inrush currents of switch mode power supplies or PTC loads. The device combines a softstarter and a bypass relay in a single DIN Rail housing and is switched by an external control input.

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Timing and protection parameters are configurable over a 3.3 V serial interface. The device operates from −40 °C to 50 °C and tolerates a limited number of load-side short circuits.

Temperature derating is required over the upper part of the operating range; see the derating note in Section 4.

Once the relay has engaged, it is held at full drive for the full-drive time given in Table 3 and then switched to a reduced holding drive, at which point the softstart path is switched off. The short second current spike visible in Figure 5 corresponds to this transition.

1.2 Load Types

The ICL16 is designed for capacitive and resistive loads only. Inductive loads are not supported.

1.3 Protections

The following protections are in place for the ICL16:

- **Control input fuse:** The internal auxiliary power supply is fused to prevent fire. The fuse is not replaceable.
- **NTC temperature protection:** An NTC supervises the temperature of the internal soft-start resistors. While an over-temperature is present the device inhibits the softstart and thereby prevents the thermal fuse from blowing. The protection is self-recovering once the resistors have cooled down. For the first turn-on after power-up the device applies a stricter temperature limit than during normal operation, because a short circuit on the load side cannot yet be ruled out at that point. A device switched on immediately after power-up may therefore delay its first softstart until the resistors are further below the normal limit.
- **Thermal fuse:** In case of a failure, for example a short-circuited IGBT, the thermal fuse permanently disconnects the softstart resistors. It is non-resettable, and the device must be replaced once it has tripped.
- **Load-side short circuit:** The device tolerates a limited number of short circuits on the load side without damage. Short circuit clearing remains the task of the upstream circuit breaker; the ICL16 is not a protective device in the sense of EN 60947-2.

1.4 Safety Information

- The ICL16 must only be installed, wired and commissioned by qualified electrical personnel.

- The device and all connected loads must be disconnected from mains and secured against reconnection before any work on the wiring.
- The device must not be opened. It contains no user-serviceable parts, and opening it exposes mains potential.
- The device provides **no galvanic isolation**. Input and output neutral are internally connected, and every terminal carries mains potential during operation.
- The device is intended for installation in a closed control cabinet or distribution board in a dry indoor environment. It must not be exposed to moisture, condensation or outdoor conditions.
- The serial interface is referenced to mains potential. It must only be accessed through an isolated converter, see Section 5.

1.5 Power Limits

The permissible number of power cycles is constrained by the power dissipation of the housing. Under frequent power cycling the device may enter the thermal protection state described above.

1.6 Ordering Information

The following ordering options are available.

Ordercode	Description	EAN	Weight	HS-Code	Origin
ICL16	16 A_{ac} DIN Rail Inrush Current Limiter (ICL) with control input	4262542250343	93 g	8536301000	Germany
Customisation available. Contact DPS.					

Table 1: Ordering information of the ICL16.

2 Pinout

The pinout of the ICL16 is depicted in Figure 1.

Figure 1: Connection diagram of the ICL16.

2.1 Pin description

Pin	Functional description
Input	
L	Line (conductor)
C	Control input. See also the application examples in Section 3. 1. Connect to L to activate. 2. Leave unconnected or connect to N to deactivate.
N	Neutral
Output	
L	Line (switched)
N	Neutral (internally connected to IN-N)
Serial interface	
Prog	Separate 4-pin connector for parameter configuration. The interface is referenced to mains potential and must only be accessed through an isolated converter; see Section 5.

Table 2: Pin description of the ICL16.

3 Application Information

3.1 Inrush Current Limiter

Figure 2 illustrates the wiring configuration for inrush current limiter operation. Fuse 1F1 must be a circuit breaker of the type recommended in the Input group of Table 3. Alternatively a breaker with a lower rating may be used.

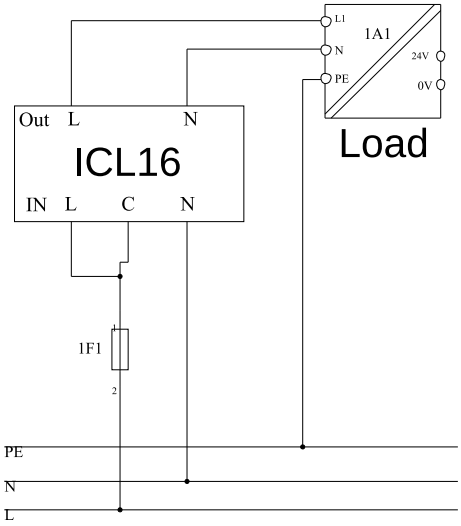

Figure 2: ICL16 operation as an inrush current limiter.

3.2 Relay

Figure 3 illustrates the wiring configuration for relay operation. Closing switch 1S1 turns on the load, releasing the switch turns it off.

The switch can be substituted with a low switching power relay.

3.3 Feed Forward Delay

To minimise inrush currents in the electrical system, multiple inrush current limiters can be configured in a feed forward arrangement as shown in Figure 4.

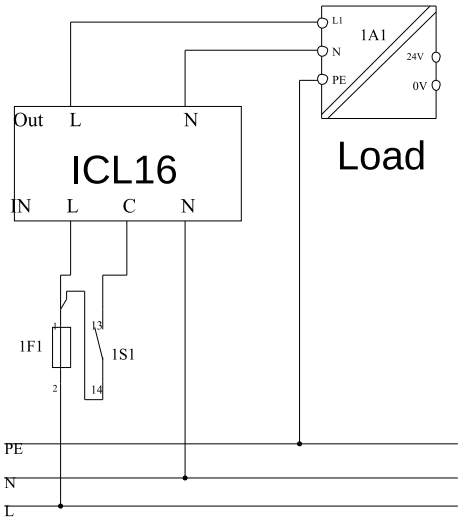

Figure 3: ICL16 operation as a relay and inrush current limiter.

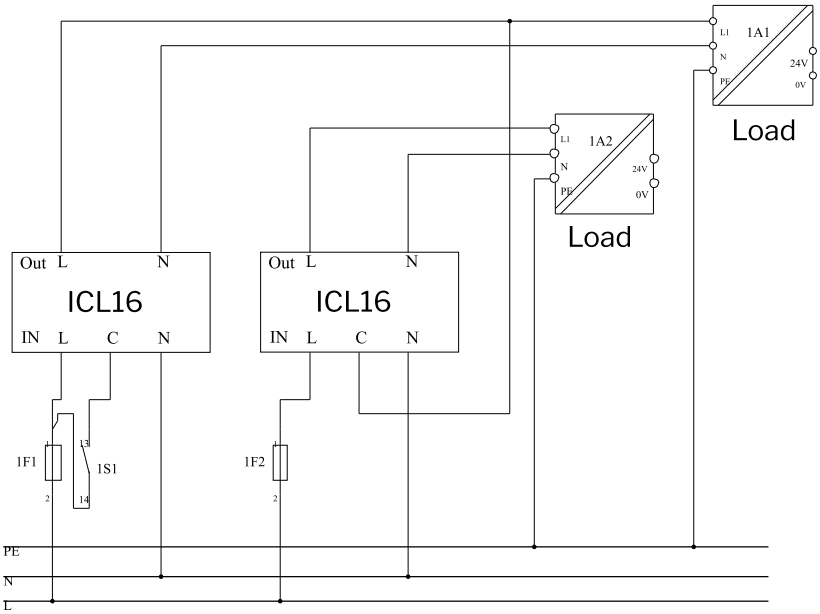

Figure 4: ICL16 in feed forward operation.

4 Specification

4.1 Specification Table

The specification for the ICL16 is shown in the following table. If not otherwise specified the following parameters have been used: T_{amb} = 25 °C and U_{in} = 230 $V_{ac,rms}$.

	Min	Typ	Max	Unit
Eingang Input				
Versorgungsspannung Supply Voltage	85		264	V_{ac}
Steuerspannung Control Voltage	85		264	V_{ac}
Empfohlene Sicherung Eingang Recommended Input Fuse		B16 / C16		
Ausgang Output				
Ausgangsstrom (Effektivwert) Current Output	0		16	A_{ac}
Lastkapazität Load Capacity	0		8000	µF
Spitzenstrom Einschalten Peak Current, Turn-On		50		A
Spitzenstrom Kurzschluss Peak Current, Short Circuit		90		A
Lasttyp Load Type		Capacitive and resistive loads only		
Zeitverhalten Timing				
Verzögerungszeit (Werkseinstellung) Delay Time (factory default)	0	20	1000	ms
Softstartzeit (Werkseinstellung) Softstart Time (factory default)	100	200	300	ms
Relaisansteuerung volle Leistung Relay Full-Drive Time		250		ms
Gehäuse Case				
Montageform Mounting Type		DIN Rail		
Baubreite Mounting Width		36.5		mm
Montagehöhe Mounting Height		117		mm
Montagetiefe Mounting Depth		58.7		mm
Gewicht Weight		93		g
Schutzart Degree of Protection		IP20		

	Min	Typ	Max	Unit
Programmierbarkeit Programmability				
Schnittstelle Interface	3.3 V RS232 with mcu_tracer protocol			
Baudrate Baud Rate	115200			Baud
Sicherheitsfeatures Safety Features				
Eingangssicherung Steuerung Input Fuse Control	yes			
Temperaturüberwachung Temperature Supervisor	yes, NTC			
Thermische Sicherung Thermal Fuse	yes, non-resettable			
Kurzschlussfestigkeit lastseitig Short Circuit Tolerance	limited number of events			
Technische Merkmale Technical Characteristics				
Temperaturbereich Temperature Range	−40		50	°C
Elektrolytkondensatoren Electrolytic Capacitors	No electrolytic capacitors			
Schutzlackierung Conformal Coating	Not coated			

Table 3: Specification of the ICL16.

4.2 Disclaimer

Wiring. Selecting the conductor cross-section for the actual installation — its routing, grouping, ambient temperature and cable length — is the responsibility of the system integrator.

Peak currents. The two peak current rows are values read from the measurements in Section 6, under the conditions stated there. They characterise the device as built; they are not guaranteed limits and must not be used to size a protective device.

Derating. The maximum output current applies up to the upper limit of the temperature range given above. Grouped installation, restricted convection or a higher ambient temperature require the output current to be reduced accordingly.

Timing. Delay time and softstart time are the factory default settings. Both are configurable over the serial interface within the ranges given in Section 5.

5 Programming

The ICL16 can be programmed in the factory or by the user with the MCU Tracer software. The MCU Tracer is an open-source tool for embedded device configuration and monitoring.

5.1 Safety Instructions

Read completely before proceeding — your safety is paramount. Improper handling may result in injury or death. Therefore, the following safety rules must always be adhered to:

1. Only qualified electrical personnel are permitted to program the device.
2. During programming, the device must always be operated on an isolated AC power supply.
3. An isolated USB-UART converter must always be used, as the signal outputs are connected to AC.

Incorrect parameters can disable a protection function. `Lowering NTCLimit` below the factory default weakens the over-temperature protection of the softstart resistors and can cause the thermal fuse to blow, which permanently disables the softstart function. Shortening `TriacOn` reduces the time available for the load to charge and increases the current step at relay engagement. Both parameters must only be changed with knowledge of the connected load.

5.2 Serial Interface

The ICL16 is programmed over the serial interface specified in Table 3. The interface is referenced to mains potential.

5.2.1 Programming connector

The programming connector is a 4-pin JST-PH-4 header. Its pin assignment is given in Table 4. All four contacts are referenced to mains potential.

Pin	Signal
1	Supply
2	RX
3	TX
4	GND

Table 4: Programming connector pin assignment of the ICL16.

5.2.2 Required tools for programming

The following components are required for programming the ICL16:

- **Isolated USB-UART cable:** Only DPS USB-UART converters should be used. The converter must be isolated, and special attention must be given to matching the converter polarity.
- **Personal computer** with USB port.
- **MCU Tracer software.**

5.3 MCU Tracer Setup

Once the MCU Tracer is installed, click on it to open. The MCU Tracer requires configuration. The setup should be done using the parameters in Table 5.

Parameter	Setting
Cable	
Type of cable	JST-PH-4
Cable for programming	Standard (non-crossover)
UART configuration	
Baud rate	115200 Baud
Parity	None
Data bits	8
Stop bits	1

Table 5: MCU Tracer setup parameters of the ICL16.

The MCU Tracer can be downloaded here:
`https://gitlab.com/greenscreenflicker/mcu_tracer2`

5.4 MCU Tracer Variables

The ICL16 exposes the variables listed in Table 6 via MCU Tracer. Read-only variables are used for monitoring, while read-write variables can be adjusted by the user to configure the device behaviour. Changed parameters can be saved to non-volatile memory using the `Save` function and restored using the `Load` function.
The temperature variables are raw readings of the 10-bit analogue-to-digital converter (ADC), not degrees Celsius. The reading **falls as the temperature of the softstart resistors rises**. The softstart is enabled while the reading is above `NTCLimit` and inhibited while it is at or below `NTCLimit` — a *higher* `NTCLimit` therefore means *stricter* protection.

Variable	Access	Type	Unit	Min	Max	Default	Description
System Status							
SysTicks	R	int	ticks	–	–	–	System tick counter. Used for timing and diagnostics.
Status	R	int	–	–	–	–	Control status register. Current operating state of the device.
CTRLDEBUG	R	int	–	–	–	–	Control debug register. Internal debug information.
Timing Configuration							
Delay2On	R/W	int	ms	0	1000	20	Delay from control input activation to softstart turn-on. Saved to flash. Attention: an additional delay, not the absolute one.

Variable	Access	Type	Unit	Min	Max	Default	Description
TriacOn	R/W	int	ms	1	1000	204	Softstart duration: how long the resistors are active before relay engagement. Saved to flash.

Variable	Access	Type	Unit	Min	Max	Default	Description
Temperature Monitoring							
NTC	R	int	ADC	0	1023	–	Raw NTC ADC reading. Falls as the resistor temperature rises.
NTCLimit	R/W	int	ADC	0	1023	400	NTC ADC threshold for over-temperature protection. Softstart inhibited at or below this value. Saved to flash.
NTC_Obsrv	R/W	int	ADC	0	1023	–	NTC temperature from an observer algorithm. Used with the measured value, whichever is lower. Not restored on power-up.
NTC_OBS_FB	R/W	int	–	0	20000	30	NTC observer feedback gain. Sets the observer response rate. Saved to flash.
Test & Debug							
TriacTest	R/W	bool	–	0	1	0	Triac test mode: triac on without relay engagement. Saved to flash.
SumDebug	R	int	ADC	0	1023	–	Debug summation value for internal diagnostics.

Table 6: MCU Tracer variables of the ICL16.

5.5 MCU Tracer Functions

The remote functions listed in Table 7 are available via MCU Tracer.

Function	Description
Save	Saves all configurable parameters to non-volatile flash memory. Parameters are retained after power-off.
Load	Loads all saved parameters from flash memory. Automatically executed on power-up.

Table 7: MCU Tracer remote functions of the ICL16.

5.6 Support

For additional support, please contact Digital Power Systems:
`support (ät) digitalpowersystems (döt) eu`

6 Measurements

6.1 Measurement Conditions

Unless stated otherwise in the individual figure caption, all measurements in this section were taken under the conditions listed in Table 8.

Parameter	Value
Input voltage U_{in}	230 $V_{ac,rms}$
Mains frequency	50 Hz
Ambient temperature T_{amb}	25 °C

Table 8: Measurement conditions of the ICL16.

Scope of these measurements. The ICL16 switches mains voltage through a triac and a bypass relay. It contains no switching converter and does not regulate its output — when switched on, the output is the input, connected through. Efficiency, output voltage stability, output voltage ripple and load transient response are therefore not defined for this device: there is no conversion ratio to be efficient at, no setpoint to be stable around, no switching edge to produce ripple and no control loop to respond to a load step. The measurements below characterise the turn-on behaviour instead, which is the property this device exists to control.

6.2 Capacitor Bank Turn on

The ICL16 is turned on with a 9000 µF capacitor bank[1]. The input and the output voltages are depicted over time in Figure 5.

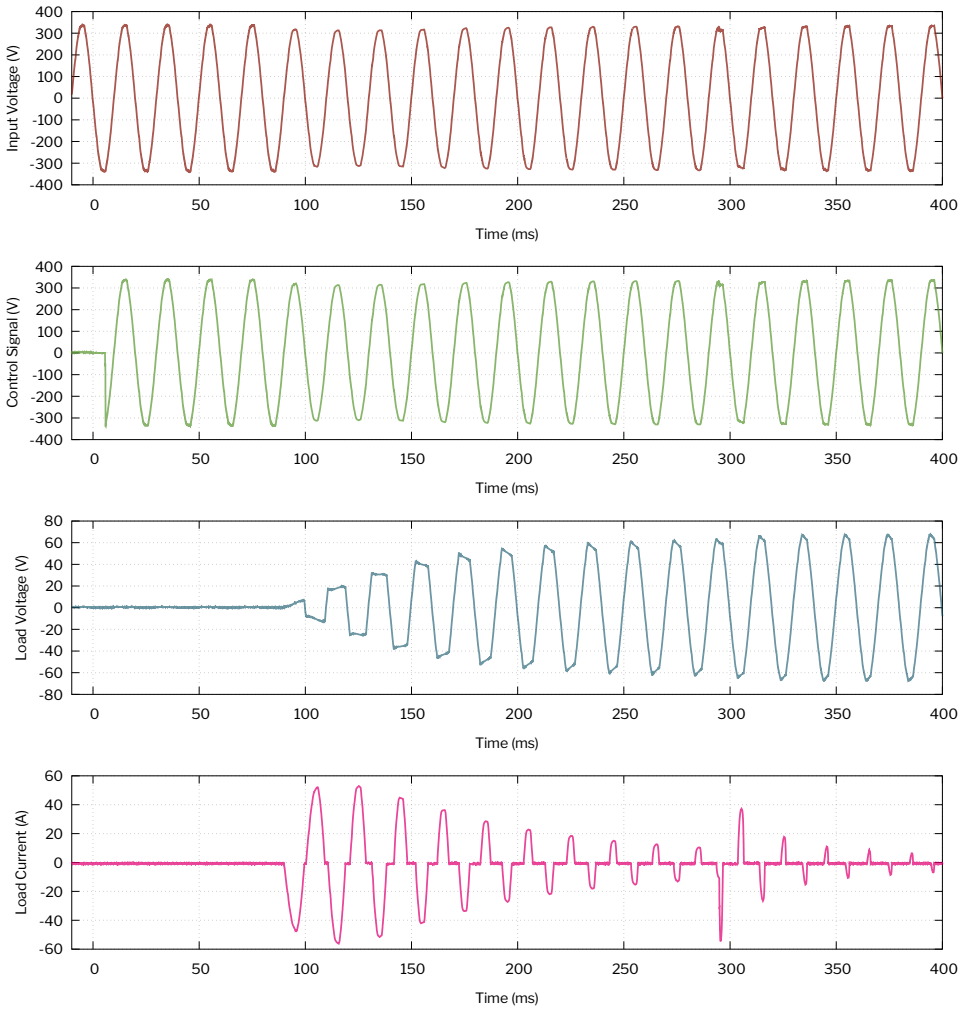

Figure 5: The ICL16 tested with a 9000 µF capacitor bank at U_{in} = 230 V_{ac}. At t = 3 ms the control input is enabled. At t = 80 ms the output voltage is enabled at a zero crossing, and at t = 280 ms the relay closes to provide full output power. A second, short output current spike can be seen.

[1]The device is specified for 8000 µF to provide tolerance margin. The 9000 µF test validates this margin.

6.3 Incandescent Lamp Turn on

The ICL16 is connected to 3200 W of incandescent lamps. The input, control and output voltages and the output current are depicted over time in Figure 6.

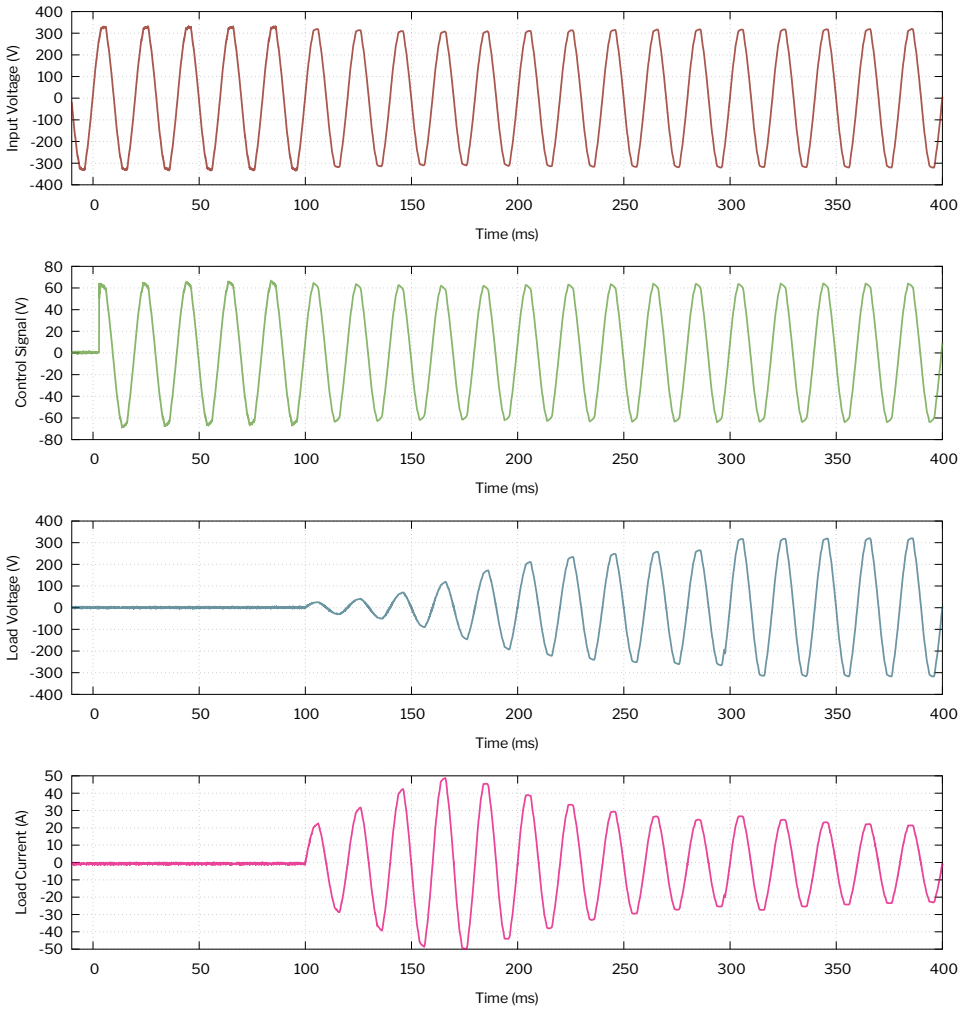

Figure 6: The ICL16 tested with a 3200 W incandescent lamp load. At t = 5 ms the control input is enabled. At t = 90 ms the output voltage is enabled at a zero crossing, and at t = 300 ms the relay closes to provide full output power.

6.4 Output short circuit

The ICL16 is tested with a 1.1 Ω short circuit on the output, see Figure 7.

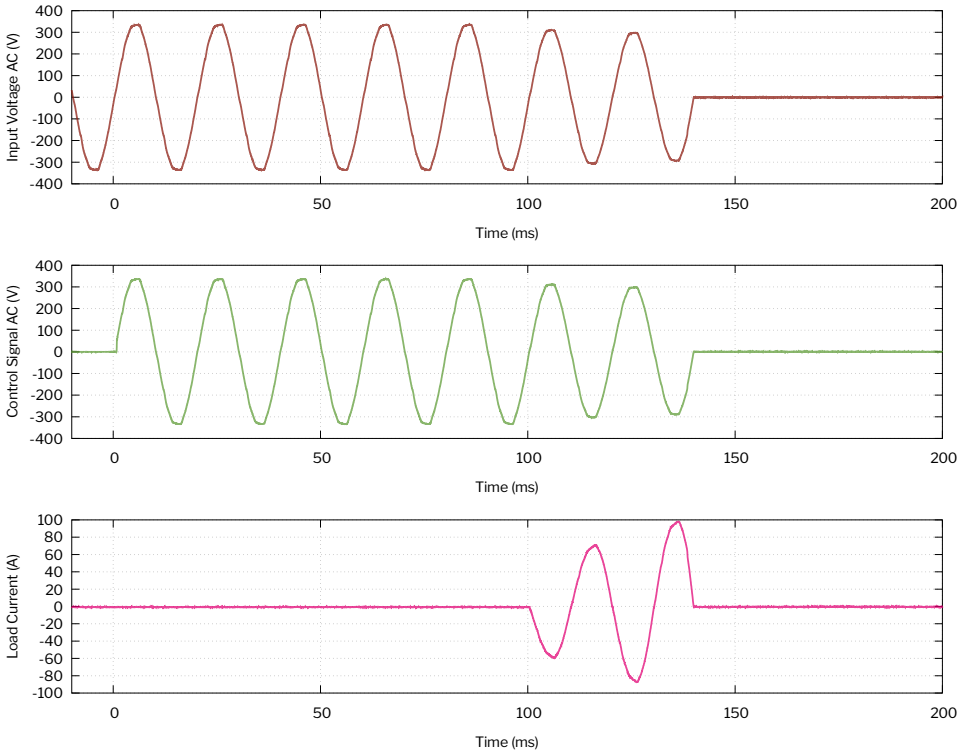

Figure 7: The ICL16 tested with a 1.1 Ω short circuit at U_{in} = 230 V_{ac}.

7 EMC Measurements

7.1 Conducted Emissions

The average conducted line emissions are depicted in Figure 8, the quasi-peak emissions in Figure 9. Both were measured at an input voltage of U_{in} = 230 $V_{ac,rms}$.
The ICL16 is classified as **Class A** equipment according to EN 55032 / CISPR 32. The measured emissions stay below the Class A limit line over the entire measured frequency range.

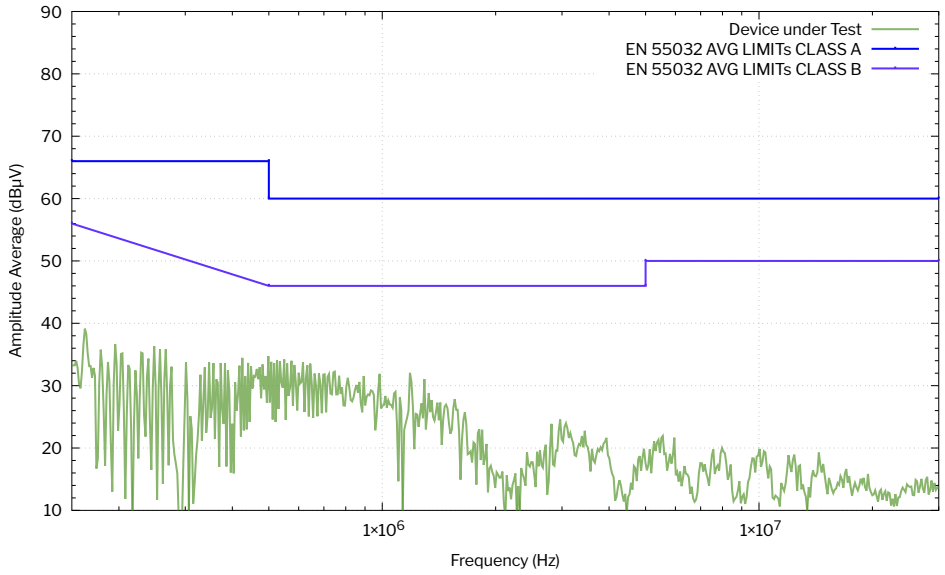

Figure 8: Average conducted emissions of the ICL16.

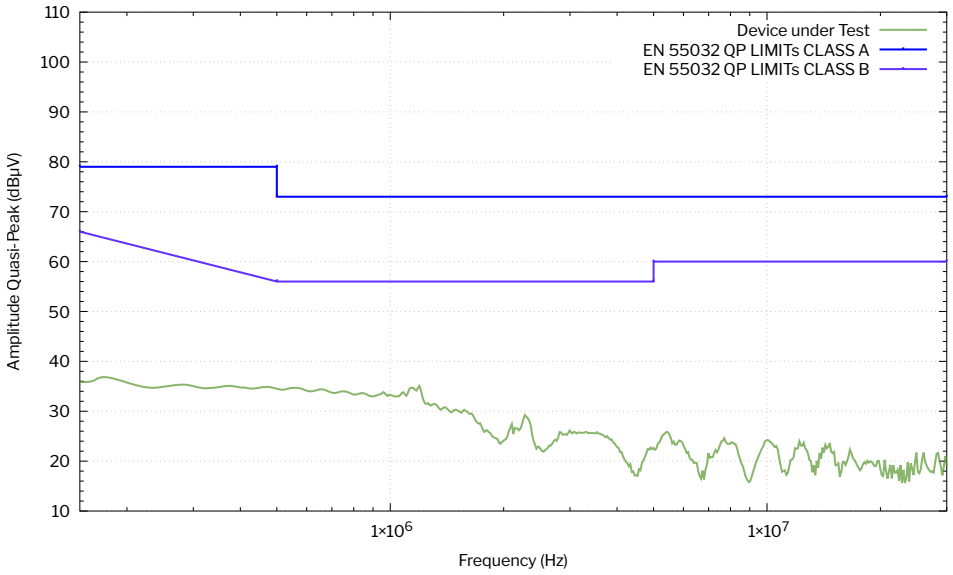

Figure 9: Quasi-peak conducted emissions of the ICL16.

7.2 Immunity

The ICL16 was assessed against the immunity standards listed in Table 9. The applied test levels are documented in the technical file.

Standard	Phenomenon
EN 61000-4-2	Electrostatic discharge
EN 61000-4-3	Radiated radio-frequency electromagnetic field
EN 61000-4-4	Electrical fast transient / burst
EN 61000-4-5	Surge
EN 61000-4-6	Conducted disturbances induced by radio-frequency fields

Table 9: Immunity standards applied to the ICL16.

7.3 Declaration of Conformity

The EU Declaration of Conformity is a separate document and is not part of this datasheet. It is published as `DPS-ICL16-CE.pdf` and lists the EU directives and the harmonized standards applied to the ICL16.

8 Case

The case drawing is shown in Figure 10, a 3D view in Figure 11.

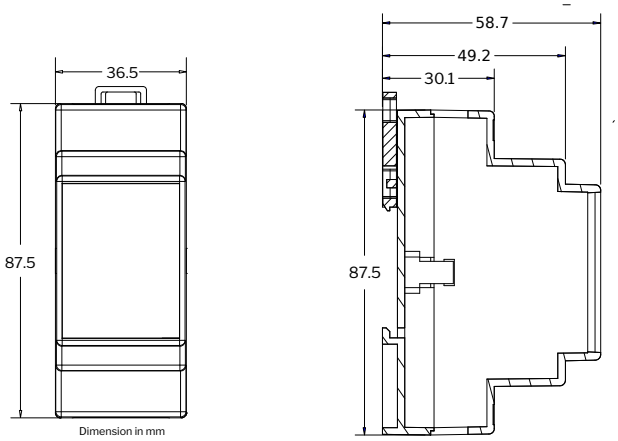

Figure 10: ICL16 case drawing. All dimensions in mm.

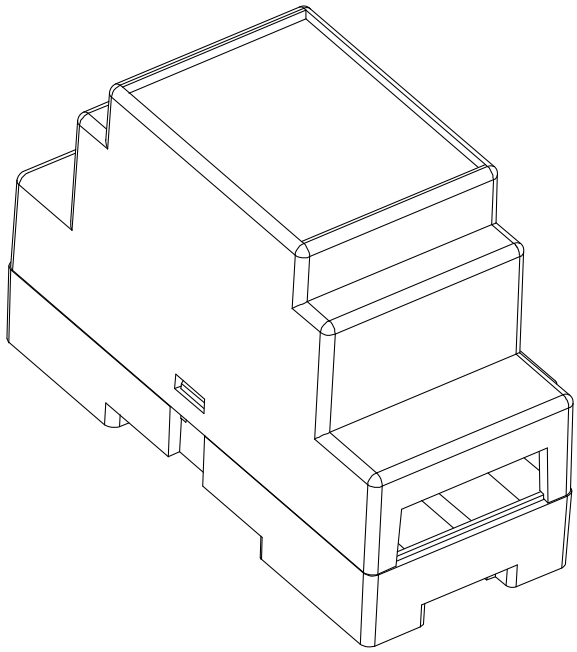

Figure 11: 3D view of the ICL16.

9 Product label

The label of the ICL16 is shown in Figure 12.

Figure 12: Product label of the ICL16.

10 Document

10.1 Latest Document Revision

The latest revision of this document can be downloaded here:
https://digitalpowersystems.eu/ICL16-linklist

10.2 Datasheet Quality

Digital Power Systems reviews its datasheets against a documented quality checklist. Feedback on this document is welcome. Please email:
`datasheet (ät) digitalpowersystems (döt) eu`

10.3 Revision History

The revision history is given in Table 10.

Date	Changes in Revision
27.07.2026	Initial release.

Table 10: Revision history of this document.

10.4 Contact Information

This is a product of Digital Power Systems GmbH (DPS).
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76131 Karlsruhe, Germany
Website: https://digitalpowersystems.eu/