WPMIH9100602S / 17791063215

MagI³C Power Module

VISM – Variable Isolated SIP Module

8V – 42V / 1W / 2kV functional isolated regulated 3.3V – 6V adjustable Output

DESCRIPTION

The VISM 17791063215 of the regulated MagI3C Power Module family is a functional isolated, fully integrated DC/DC converter and represents an Application Tailored Power Module (ATPM). Its unique feature set fulfills multiple demands of different applications. The wide input voltage range allows working with different input voltage rails from 12V to 36V. Only one external resistor is needed to adjust the output voltage from 3.3V to 6V. That gives the freedom to use one device for multiple application voltages.
The capability of 600mA dynamic power boost supports the quick charge of downstream input capacitors or a reliable tripping of fuses. The CTRL pin gives more control to the users and enables energy-efficient operation through standby/shutdown mode.

The VISM power module has an integrated protection circuit that guards against thermal overstress and electrical damage by using thermal shut-down, overcurrent, short-circuit and undervoltage protection.

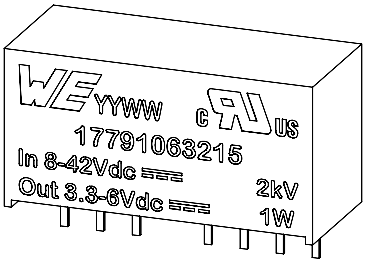
The industrial standard SIP-8 THT package (21.8 x 9.2x 11.1mm) allows for easy assembly.

FEATURES

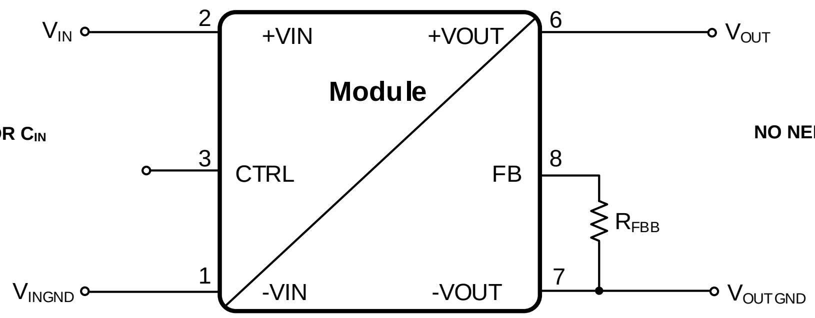
- Peak efficiency up to 82%
- 2kV DC for 60s functional isolation
- Current capability up to 0.3A
- Input voltage range: 8V to 42V
- Regulated output voltage range: 3.3V to 6V
- No minimum load required
- Continuous output power: 1W
- Integrated C_{IN}, C_{OUT} and transformer
- Dynamic power boost of 600mA
- Thermal shut down
- Short circuit protection
- Low output voltage ripple: typ. <15mV at full load
- Reference accuracy: ±0.5%.
- Operating frequency range: 300 to 600 kHz
- Operating ambient temperature range:- 40°C to 85°C
- RoHS & REACh compliant
- UL94V-0 package material
- Complies with EN55032 class B conducted and radiated emissions standard
- UL60950-1, 2nd Edition
- C22.2 No. 60950-1-07, 2nd Edition
- IEC/EN60950-1, 2nd Edition
- IEC/EN62368-1, 2nd Edition
- UL62368-1, 2nd Edition
- C22.2 No. 62368-1-14, 2nd Edition

TYPICAL APPLICATIONS

- Data acquisition
- Test and measurement systems
- Interface and microcontroller supply
- Industrial control



TYPICAL CIRCUIT DIAGRAM



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WPMIH9100602S / 17791063215

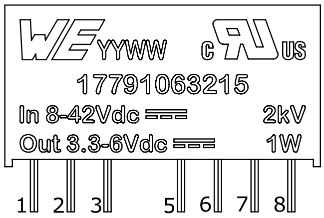
MagI³C Power Module

VISM – Variable Isolated SIP Module

MARKING DESCRIPTION

MARKING	DESCRIPTION
WE	Würth Elektronik tradename
YY	Year
WW	Calendar week
cULus	UL mark
17791063215	Ordering code
In 8-42Vdc	Input voltage range
2kV	Isolation voltage
Out 3.3-6Vdc	Output voltage range
1W	Nominal output power

PACKAGE



PIN DESCRIPTION

SYMBOL	NUMBER	TYPE	DESCRIPTION
- VIN	1	Power	Input ground
+ VIN	2	Power	Input voltage
CTRL	3	Control	ON/OFF Function. Connecting the pin3 (CTRL) with pin1 (-VIN) shuts down the module. Leaving this pin floating enables the device
NC	5		Not connected. Keep this pin floating
+VOUT	6	Power	Output voltage
-VOUT	7	Power	Output ground
FB	8	Control	The output voltage can be set between 3.3V and 6V with an external resistor connected from pin8 (FB) to pin7 (-VOUT). Do not leave this pin floating

ORDERING INFORMATION

ORDER CODE	PART DESCRIPTION	SPECIFICATIONS	PACKAGE	PACKAGING UNIT
17791063215	WPMIH9100602S	8 to 42V_{IN} / 3.3 to 6V_{OUT}	SIP-8	Tube with 23 pieces
17891063215		8 to 42V_{IN} / 3.3 to 6V_{OUT}	Eval Board	1

SALES INFORMATION

SALES CONTACTS
Würth Elektronik eiSos GmbH & Co. KG EMC & Inductive Solutions Max-Eyth-Str. 1 74638 Waldenburg Germany Tel. +49 (0) 7942 945 0 www.we-online.com powermodules@we-online.com

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WPMIH9100602S / 17791063215
MagI³C Power Module
VISM – **V**ariable **I**solated **S**IP **M**odule

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ABSOLUTE MAXIMUM RATINGS

Caution:
Exceeding the listed absolute maximum ratings may affect the device negatively and may cause permanent damage. These are stress ratings only, which do not imply functional operation of the device at these or any other condition beyond those indicated under “Operation Conditions”.

SYMBOL	PARAMETER	LIMITS		UNIT
		MIN(1)	MAX(1)	
VIN	Input pin voltage	-0.3	50	V
VOUT	Output pin voltage	0	10	V
CTRL	CTRL input voltage	-0.3	50	V
V_{ISO}	Isolation voltage input to output, 100% tested for 60 seconds(3)	-	2000	V
$T_{storage}$	Assembled, non-operating storage temperature	-55	125	°C
V_{ESD}	ESD voltage (Human Body Model), according to EN61000-4-2	-	±2000	V

All parameters are specified after 5 minutes run-in time unless otherwise noted.

WPMIH9100602S / 17791063215

MagI³C Power Module

VISM – **V**ariable **I**solated **S**IP **M**odule

OPERATING CONDITIONS

Operating conditions are conditions under which operation of the device is intended to be functional. All values are referenced to respective GND.

MIN and MAX limits are valid for the ambient temperature range of **-40°C to 85°C**.

SYMBOL	PARAMETER	MIN(1)	TYP(2)	MAX(1)	UNIT
V_{IN}	Input voltage	8.0	-	42.0	V
V_{OUT}	Regulated output voltage	3.3	-	6.0	V
I_{OUT}	Nominal output current(4)	170	-	300	mA
P_{OUT}	Nominal output power (without derating)	-	-	1	W
C_{OUTMAX}	Maximum output capacitor for default startup time (<50msec.) V_{IN}=12V V_{OUT}=5V	-	-	3900	µF
T_A	Ambient temperature range	-40	-	85	°C

All parameters are specified after 5 minutes run-in time unless otherwise noted.

THERMAL SPECIFICATIONS

SYMBOL	PARAMETER	TYP (2)	UNIT
Θ_{CA}	Case-to-ambient thermal resistance (5)	25	°C/W
$T_{case\ max}$	Maximum case temperature(5)(top side)	95	°C

PACKAGE SPECIFICATIONS

ITEM	PARAMETER	TYP (2)	UNIT
Case	UL94V-0 (Refer to UL approval E497615)		-
Potting	UL94V-0 (Refer to UL approval E497615)	-	-
φ (RH)	Operating humidity	5 - 95	%
Weight		4.2	g
Vibration	5g's for 20 minutes,12 cycles each of 3 orientations, Test from 10Hz - 2000 Hz.	MIL-STD-202G	
IP	Degree of protection according to IEC/EN 60529.	67	
Washing	Washing compatible with standard industrial water based washers.		

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WPMIH9100602S / 17791063215

MagI³C Power Module

VISM – Variable Isolated SIP Module

ELECTRICAL SPECIFICATIONS

MIN and MAX limits are valid for the ambient temperature range of **-40°C to 85°C**. Typical values represent statistically the utmost probable values at the following conditions: T_A = 25°C, unless otherwise noted.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN (1)	TYP (2)	MAX (1)	UNIT
Output Current						
I_{MOC}	Maximum overload current -static	V_{IN}=8-36V, V_{OUT}=5V T_A=-40°C to 50°C	-	250(6)	-	mA
	Maximum overload current -dynamic	0.5s, V_{IN}=8-36V, V_{OUT}=5V T_A=-40°C to 45°C	-	600(6)	-	mA
I_{CL}	Output current limit threshold	V_{IN}=12V V_{OUT}=5V	-	650	-	mA
Output Voltage						
V_{FB}	Reference voltage	T_A = 25°C	1.234	1.24	1.246	V
	Reference voltage over temperature	T_A=-40°C to 85°C	1.221	1.24	1.265	V
I_{FB}	Feedback input bias current	T_A = 25°C V_{IN}=12V V_{OUT}=5V I_{OUT}=200mA		46		µA
V_{OUT}	Line regulation	V_{IN} = 8V to 42V, V_{OUT} = 5V, I_{OUT} = 200mA	-	0.39	-	%
	Load regulation	I_{OUT} = 0mA to 200mA, V_{IN} = 12V, V_{OUT} = 5V	-	0.38	-	%
	Output voltage ripple & noise(8)	V_{IN}=12V, V_{OUT} = 5V, I_{OUT} = 200mA, T_A = 25°C, 20MHz BWL	-	15	-	mV_{pp}
Switching frequency						
f_{SW}	Switching frequency	V_{IN}=8V V_{OUT}=5V I_{OUT}=200mA	-	556	-	kHz
		V_{IN}=12V V_{OUT}=5V I_{OUT}=200mA	-	500	-	kHz
		V_{IN}=24V V_{OUT}=5V I_{OUT}=200mA	-	467	-	kHz
		V_{IN}=42V V_{OUT}=5V I_{OUT}=200mA	-	450	-	kHz
Control and undervoltage lockout						
V_{UVLO}	V_{IN} undervoltage threshold	V_{IN} decreasing V_{IN}=12V V_{OUT}=5V I_{OUT}=200mA	-	7	-	V
	V_{IN} undervoltage hysteresis		-	0.5	-	V
V_{CTRL}	CTRL threshold trip point	Shut down trip point V_{IN}=12V V_{OUT}=5V I_{OUT}=200mA	-	1.38	-	V
		Turn on trip point V_{IN}=12V V_{OUT}=5V I_{OUT}=200mA	-	1.62	-	V
		CTRL hysteresis V_{IN}=12V V_{OUT}=5V I_{OUT}=200mA	-	0.24	-	V
I_{CTRL}	CTRL pin input current	V_{IN}=12V V_{OUT}=5V I_{OUT}=200mA V_{CTRL}=0V	-	485	-	µA
Start-Up						
$t_{startup}$	Start-up time (See START-UP WITH CAPACITIVE LOAD)	V_{OUT} = 95% of $V_{OUT,nom}$ V_{IN}=12V to 24V $V_{OUT,nom}$ = 5V C_{OUT}=3900µF	-	60	-	ms

SYMBOL	PARAMETER	TEST CONDITIONS	MIN (1)	TYP (2)	MAX (1)	UNIT
Input current						
I_{IN}	No load input current (operating, switching)	V_{IN}=8V V_{OUT}=5V	-	7	-	mA
		V_{IN}=12V V_{OUT}=5V	-	7	-	mA
		V_{IN}=24V V_{OUT}=5V	-	7	-	mA
		V_{IN}=42V V_{OUT}=5V	-	7	-	mA
I_{SD}	Shutdown input current	CTRL = 0 T_A =25°C V_{IN}=12V		513		µA
I_{RRC}	Reflected ripple current(7)	V_{IN}=12V V_{OUT}=5V I_{OUT}=200mA	-	10	-	mA_{pp}
Efficiency						
η	Efficiency	V_{IN}=8V V_{OUT}=5V I_{OUT}=200mA	-	79.9	-	%
		V_{IN}=12V V_{OUT}=5V I_{OUT}=200mA	-	80.6	-	%
		V_{IN}=24V V_{OUT}=5V I_{OUT}=200mA	-	74.0	-	%
		V_{IN}=42V V_{OUT}=5V I_{OUT}=200mA	-	63.0	-	%
Isolation characteristics						
C_{ISO}	Isolation capacitance		-	-	20	pF
R_{ISO}	Isolation resistance		1	-	-	GΩ

All parameters are specified after 5 minutes run-in time unless otherwise noted.

RELIABILITY

SYMBOL	PARAMETER	TEST CONDITIONS	MIN (1)	TYP (4)	MAX (1)	UNIT
MTBF	Mean Time Between Failures	- Confidence level 60% - Test temperature: 85°C - Usage temperature: 55°C - Activation energy: 0.7eV - Test duration: 1000 hours - Sample size: 4586 - Fail: 0		$3.93 \cdot 10^8$		h

APPROVALS

SYMBOL	STANDARD	DESCRIPTION
c UR US	UL60950-1, 2nd Edition 2014-10-14	Recognized for use as Information Technology Equipment, U.S.A. (UL60950-1) and Canada (C22.2 No. 60950-1) E-File: E497615 Applicable for altitudes up to 2000m
IECEE CB SCHEME	IEC 60950-1:2005 (2nd Edition); Am1:2009 + Am2:2013 EN 60950-1:2006 + A1:2010 + A2:2013	CB Scheme, Information Technology Equipment
c RU US	UL62368-1 2nd Edition	Recognized for use as Audio/Video, Information and Communication Technology Equipment, U.S.A. (UL62368-1) and Canada (C22.2 No. 62368-1) E-File: E497615 Applicable for altitudes up to 2000m
IECEE CB SCHEME	IEC/EN 62368-1 2nd Edition	CB Scheme, Audio/Video, Information and Communication Technology Equipment

WPMIH9100602S / 17791063215
MagI³C Power Module
VISM – **V**ariable **I**solated **S**IP **M**odule

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RoHS, REACh

RoHS Directive	COMPLIANT RoHS&REACh WÜRTH ELEKTRONIK	Directive 2011/65/EU of the European Parliament and the Council of June 8th, 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
REACh Directive		Directive 1907/2006/EU of the European Parliament and the Council of June 1st, 2007 regarding the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACh)

NOTES

(1) Min and Max limits are 100% production tested at 25°C. Limits over the operating temperature range are guaranteed through correlation using Statistical Quality Control (SQC) methods.
(2) Typical numbers are valid at 25°C ambient temperature and represent statistically the utmost probable values assuming a Gaussian distribution.
(3) Test voltage as defined by the UL60950-1.
(4) Depending on temperature, see thermal derating diagram (see page 15)
(5) Measured without heatsink, still air (0 – 20LFM / 0 – 0.1m/s).
V_{IN}=24V V_{OUT}=5V I_{OUT}=200mA T_A=85°C
(6) Overload current, see overload behavior diagram (see page 16)
(7) Peak-to-peak input ripple current
(8) Measured without any external capacitor

WPMIH9100602S / 17791063215

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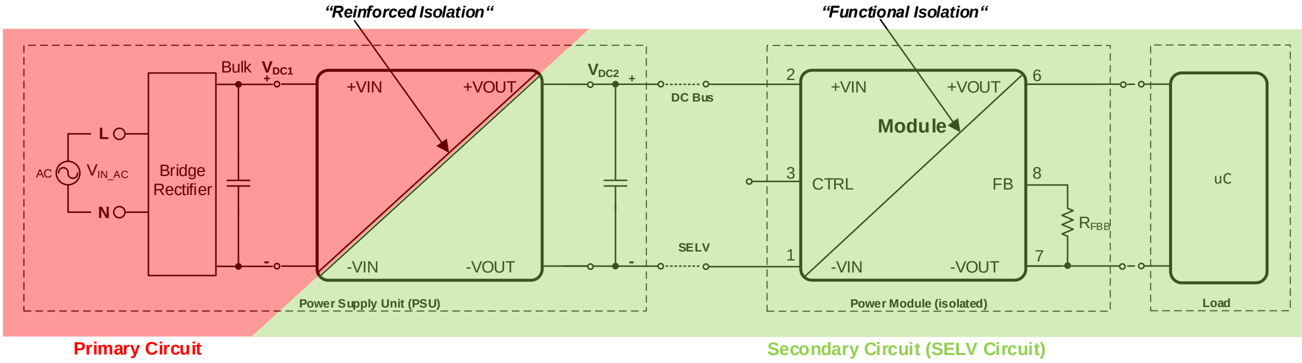
INTENDED USE – Typical Application



The 177 910 63215 MagI³C power module is only intended to be used as a CLASS III equipment according to the UL60950-1 & UL62368-1 standard. That requires that the power module is supplied by a **SELV** (safety extra low voltage) or ES1 circuit which provides protection against electric shock. There are no HAZARDOUS voltages present in CLASS III equipment.

A **SELV** circuit is a **secondary circuit** that is designed to be protected from excessive voltages (≥42 Vac or ≥ 60Vdc) during normal operating conditions and single fault conditions. A reinforced isolation is required at the boundary between the primary and the secondary circuit.

A circuit which has no direct connection to the primary circuit and derives its power from a transformer, converter or equivalently isolated device, or a battery, is defined as a **secondary circuit**.

In accordance to the safety standard UL60950-1, functional isolation (insulation) is defined as:

"1.2.9.1 Functional Insulation: insulation that is necessary only for the correct functioning of the equipment
NOTE: Functional Insulation by definition <u>*does not protect*</u> *against electric shock. It may, however, reduce the likelihood of ignition and fire."*

"1.2.9.5 Reinforced Insulation: single insulation system that provides a degree of protection against electric shock equivalent to Double Insulation under the conditions specified in this standard".
NOTE: The term "insulation system" does not imply that the insulation has to be in one homogeneous piece. It may comprise several layers that cannot be tested as Basic Insulation and Supplementary Insulation.

The above figure shows a typical application of an isolated power module. V_{DC1} is a hazardous voltage and V_{DC2} is a SELV voltage.

ISOLATION VOLTAGE

To verify the integrity of the isolation a test voltage is applied for a specified time across a component that is designed to provide electrical isolation. This test is known as a 'Hi Pot Test', 'Flash Tested', 'Withstand Voltage', 'Proof Voltage', 'Dielectric Withstand Voltage' & 'Isolation Test Voltage'.

All isolated Power Modules are 100% production tested at their stated isolation voltage. This is 2kVDC for 60 seconds.

The isolation test voltage indicated in this datasheet is for voltage transient immunity only. It does not allow this part to be used within a safety isolation system.

The part will function properly with several hundreds of volts applied continuously across the isolation barrier, however surrounding components must be individually analyzed to ensure proper insulation. Isolation measures are taken in to account to prevent any user-accessible circuitry from causing harm.

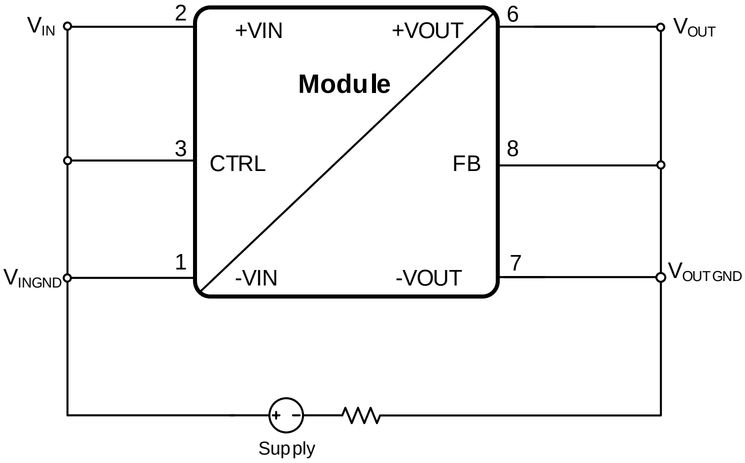
WPMIH9100602S / 17791063215

MagI³C Power Module

VISM – **V**ariable **I**solated **S**IP **M**odule

DIELECTRIC STRENGTH TEST SETUP (HIGH POT TEST)

Connect all input – and output terminals together (see figure below) before connecting the supply voltage. When testing, set the cut-off current to 500µA.



Parameters Supply Device: Current limit set 500µA, test voltage 2000Vdc, test time 60sec.

REPEATED HIGH-VOLTAGE ISOLATION TESTING

A repeated high voltage test of a barrier component degrades its isolation capabilities.

The primary and secondary windings within this transformer are enameled (coated) but do not possess additional isolation. Typically, parts can withstand multiples of their stated test voltage and still perform optimally. The magnet wire coating can degrade over time due to chemical reactions that occur at high voltages. We recommend keeping high voltage isolation testing to a minimum to better protect the isolation between the windings. If repeated high voltage isolation testing is required, consider reducing the voltage by a significant amount e.g. 20% from the test voltage stated within the datasheet.

These safety concerns are equally applicable to components that utilize functional isolation beyond wire coating (i.e. physical barriers or spacing).

WPMIH9100602S / 17791063215

MagI³C Power Module

VISM – **V**ariable **I**solated **S**IP **M**odule

TYPICAL PERFORMANCE CURVES

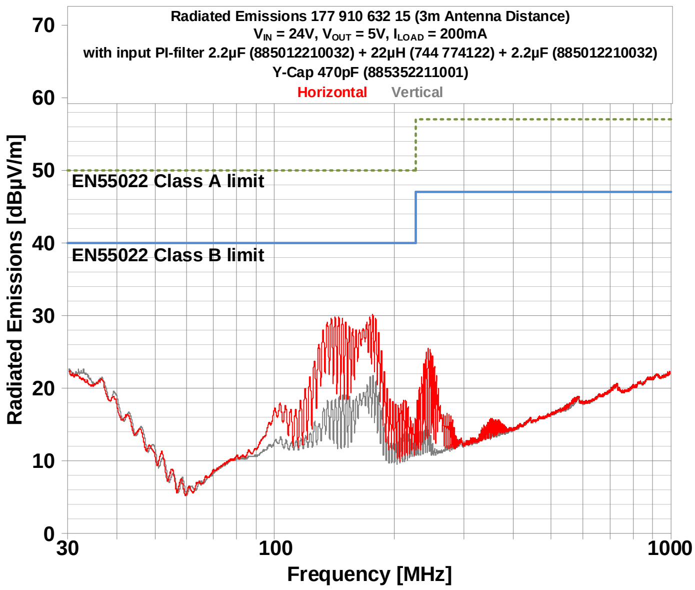
If not otherwise specified, the following conditions apply: V_{IN} = 24V, T_A = 25°C.

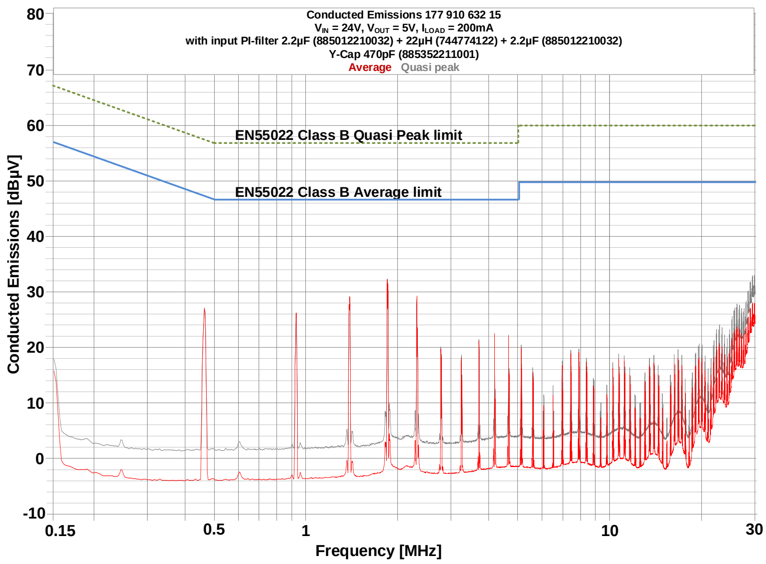
RADIATED AND CONDUCTED EMISSIONS (WITH EMI INPUT FILTER)

The 17791063215 power module is tested in several EMC configurations to give more realistic information about implementation in the applications. The test setup is based on CISPR16 with the limit values CISPR32. To give more flexibility in terms of different filter components the 17791063215 was tested with two filter setups. One classic design with MLCCs and one with Polymer capacitors.

FILTER SETUP - MLCC

1. Application specific filtering – Using an MLCC based filter
   Input wire length of 80cm, the load is connected close to the output of the power module





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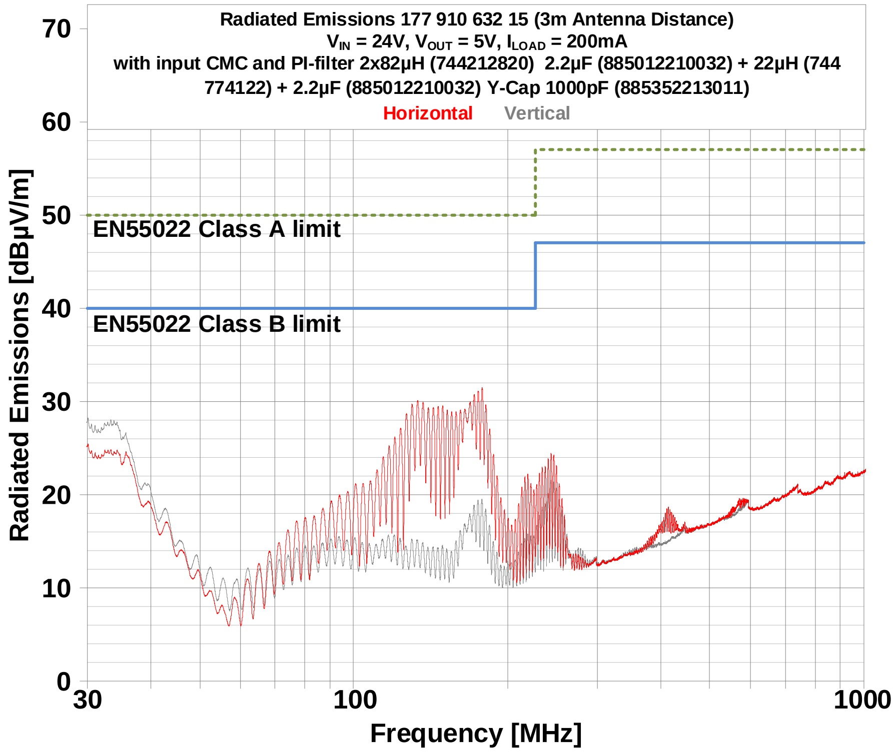
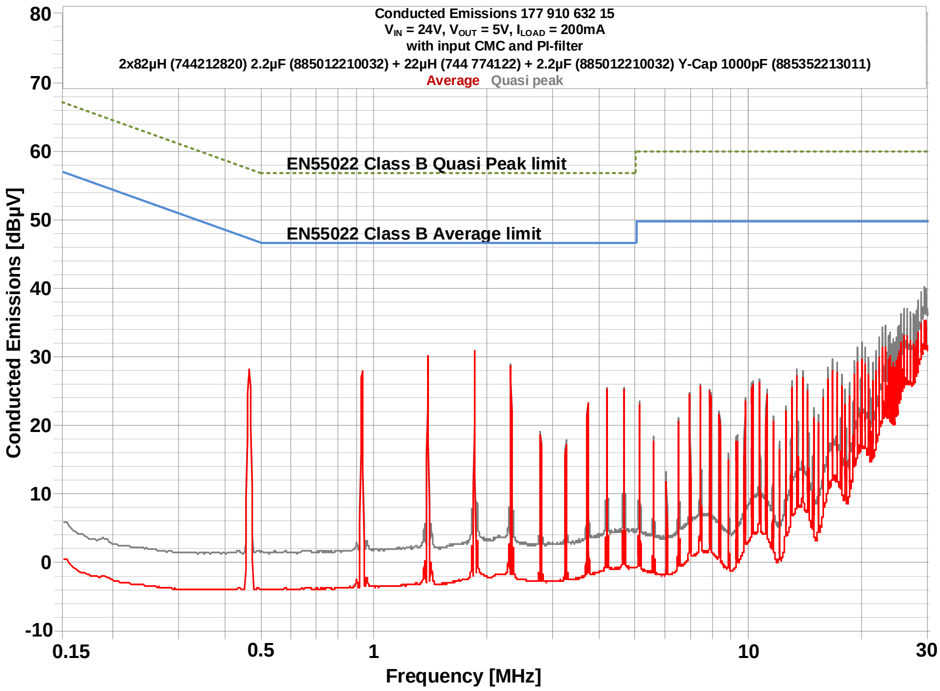
WPMIH9100602S / 17791063215
MagI³C Power Module
VISM – **V**ariable **I**solated **S**IP **M**odule

2. Using long wire filtering - Using a MLCC based filter
   Input wire length of 80cm, the load is connected with 80cm twisted wire to the output of the power module





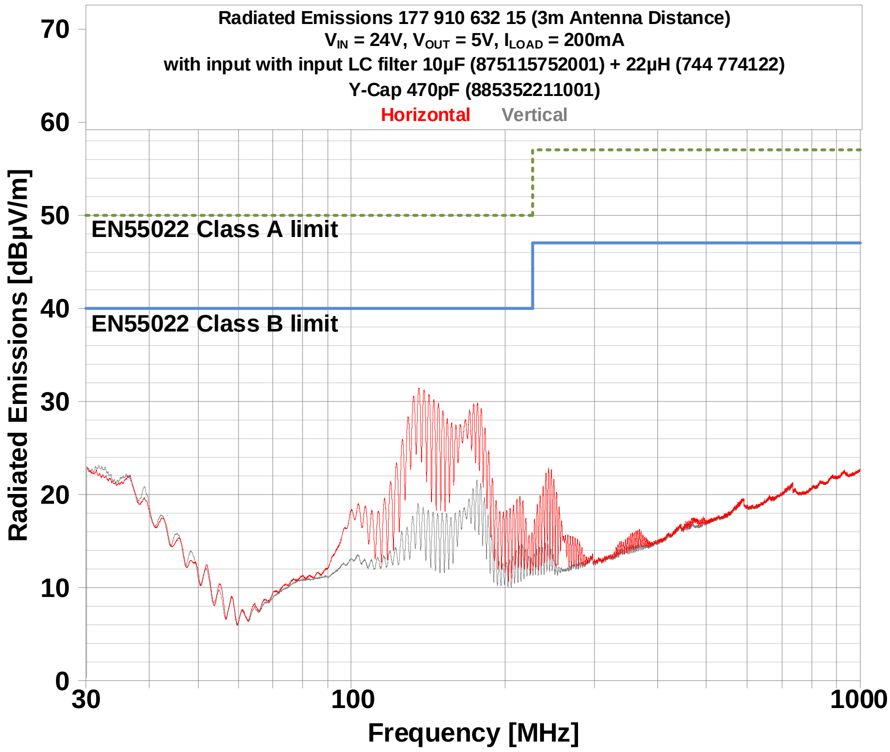
WPMIH9100602S / 17791063215

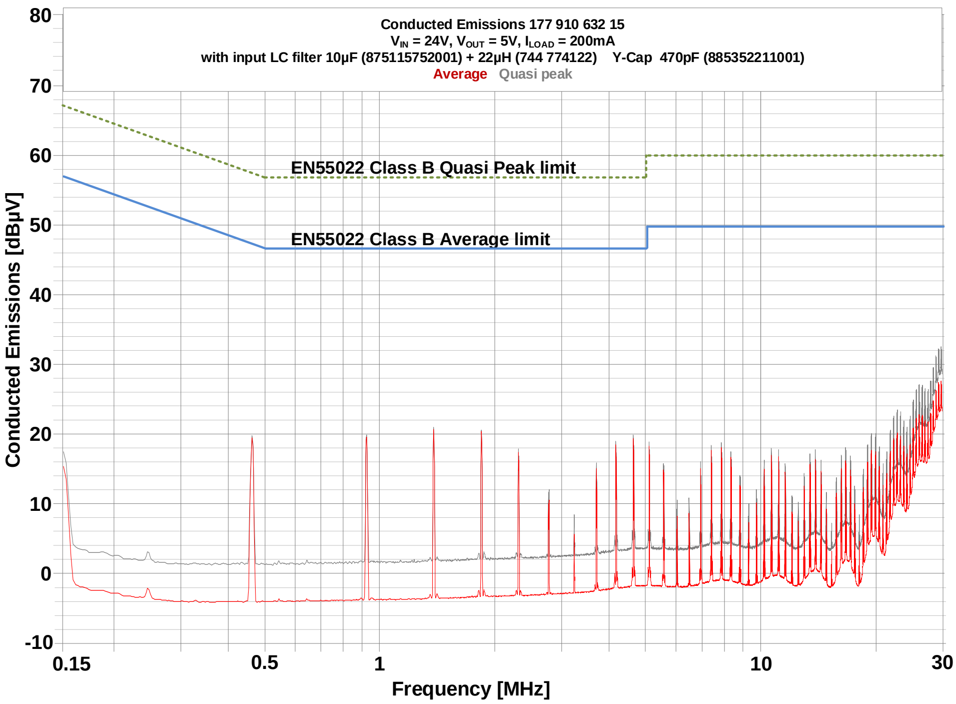
MagI³C Power Module

VISM – Variable Isolated SIP Module

FILTER SETUP – POLYMER CAP

1. Application specific filtering – Using a Polymer capacitor based filter
   Input wire length of 80cm, the load is connected close to the output of the power module



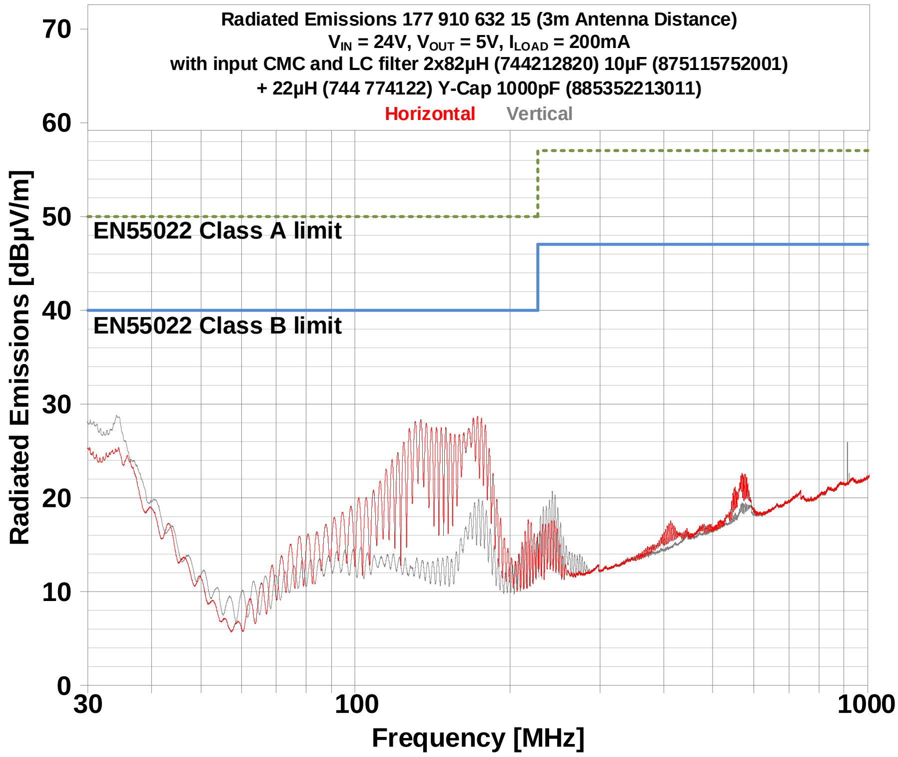


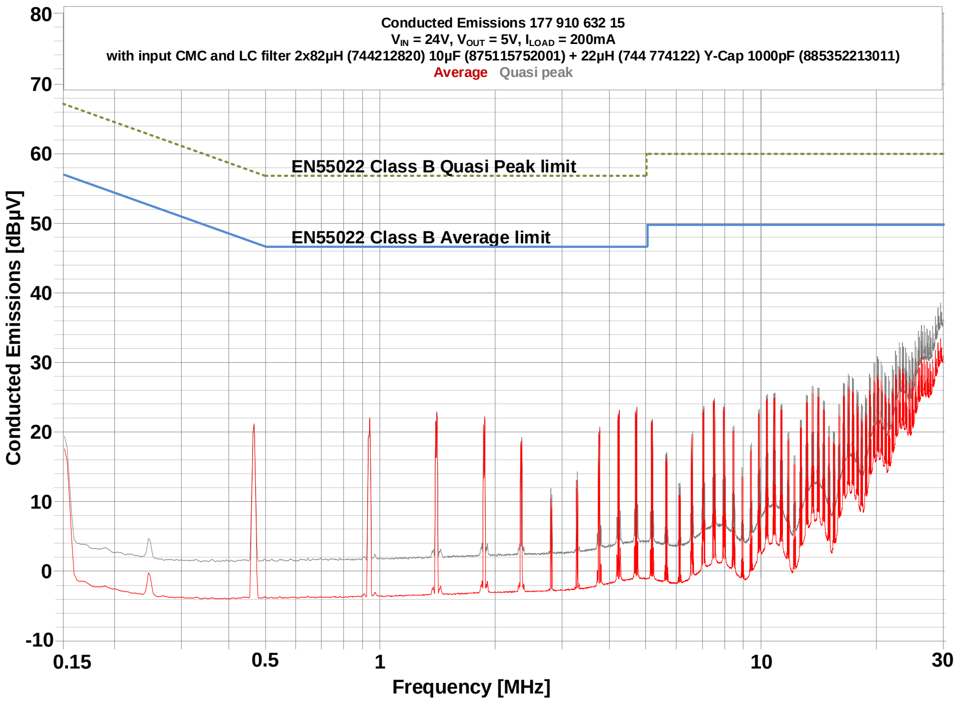
WPMIH9100602S / 17791063215

MagI³C Power Module

VISM – Variable Isolated SIP Module

2. Using long wire filtering - Using a polymer capacitor based filter
   Input wire length of 80cm, the load is connected with 80cm twisted wire to the output of the power module





WPMIH9100602S / 17791063215
MagI³C Power Module
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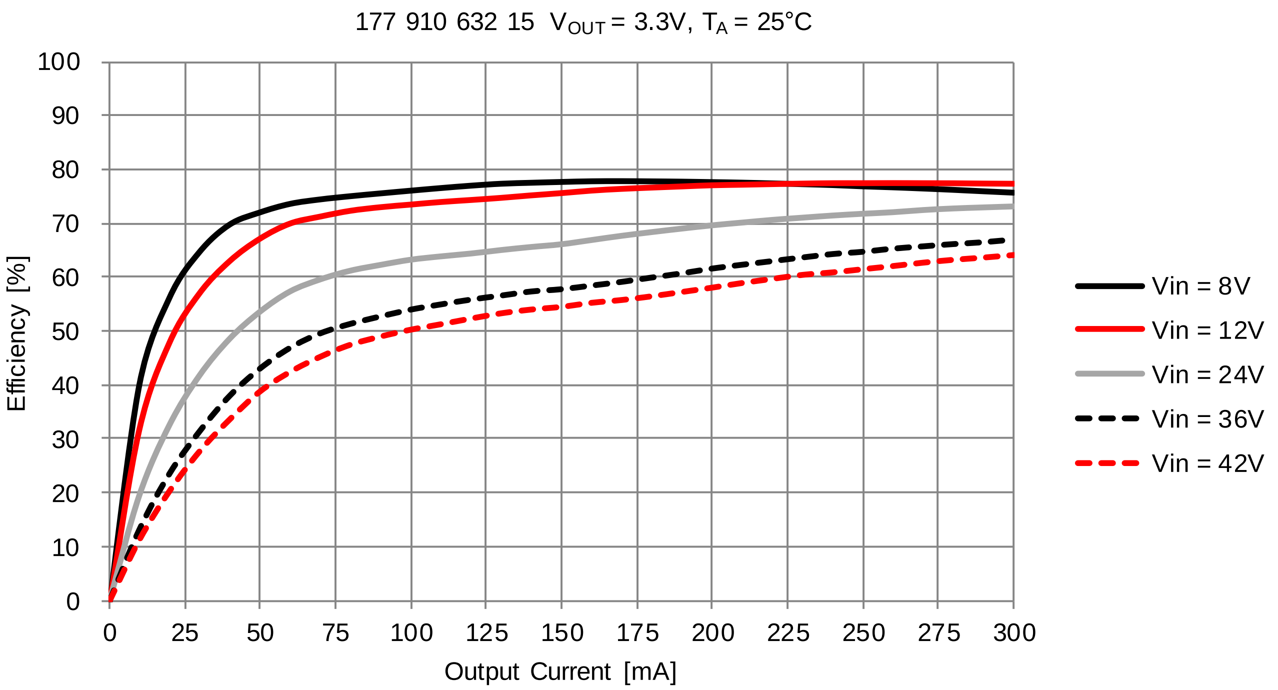
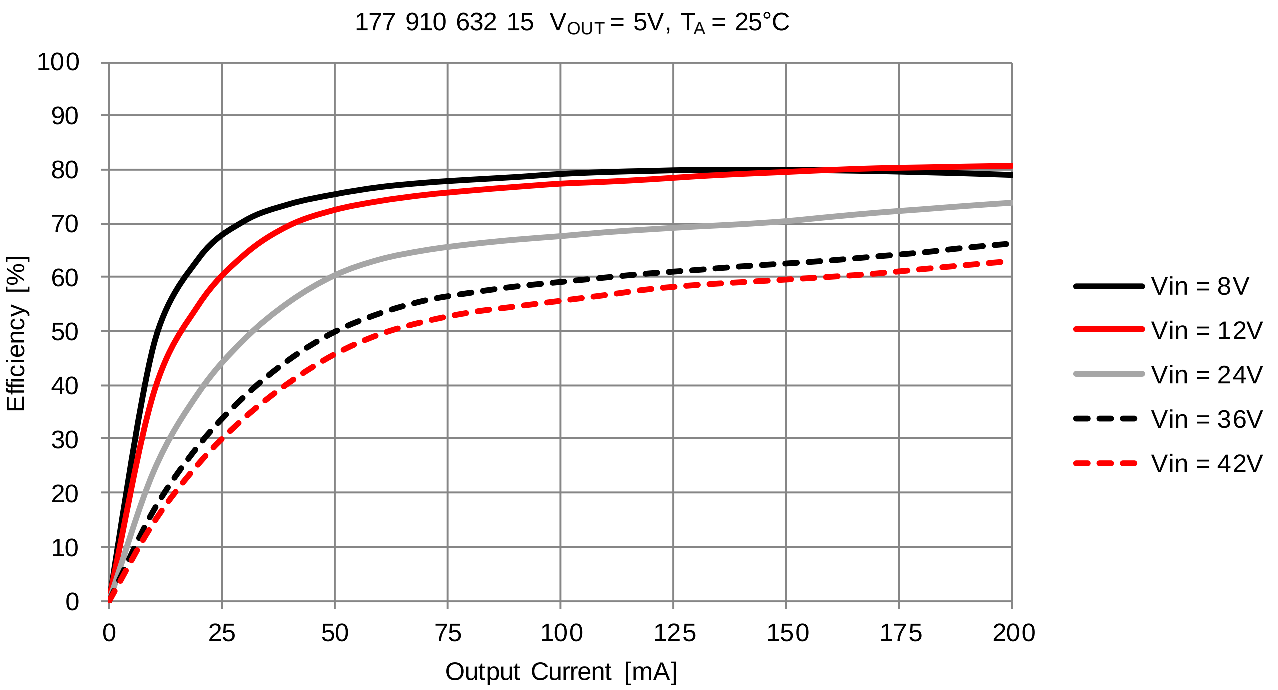
EFFICIENCY





WPMIH9100602S / 17791063215

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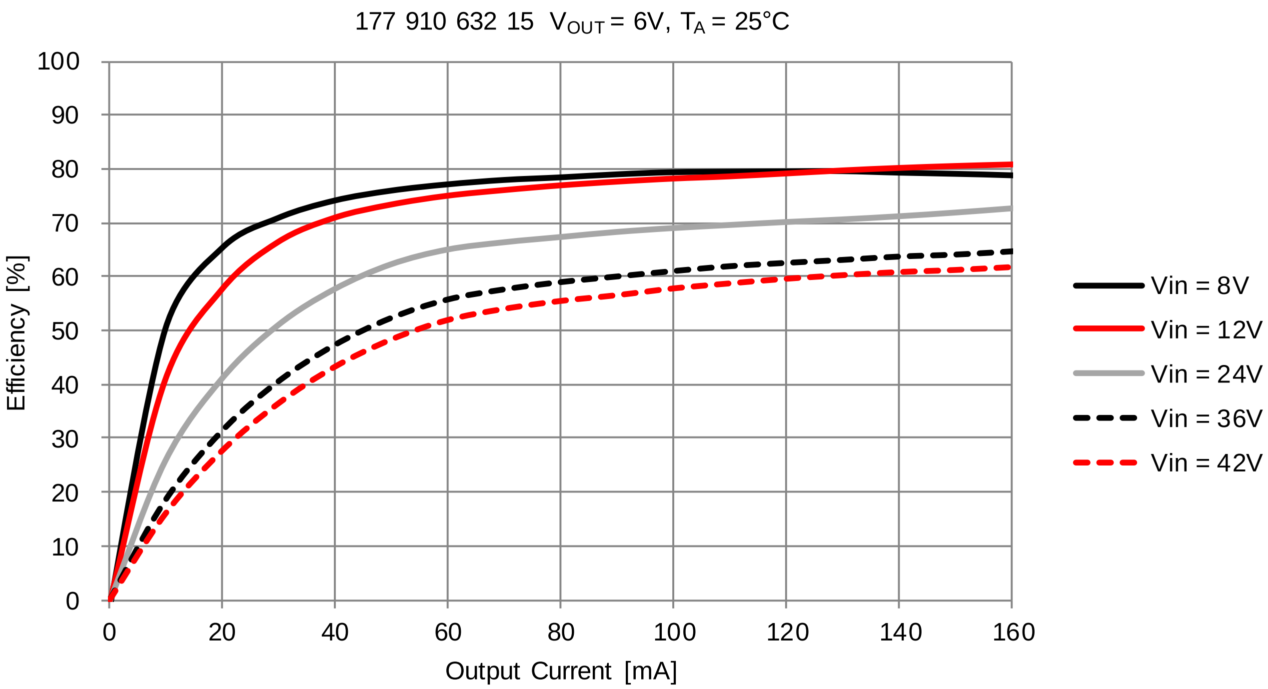
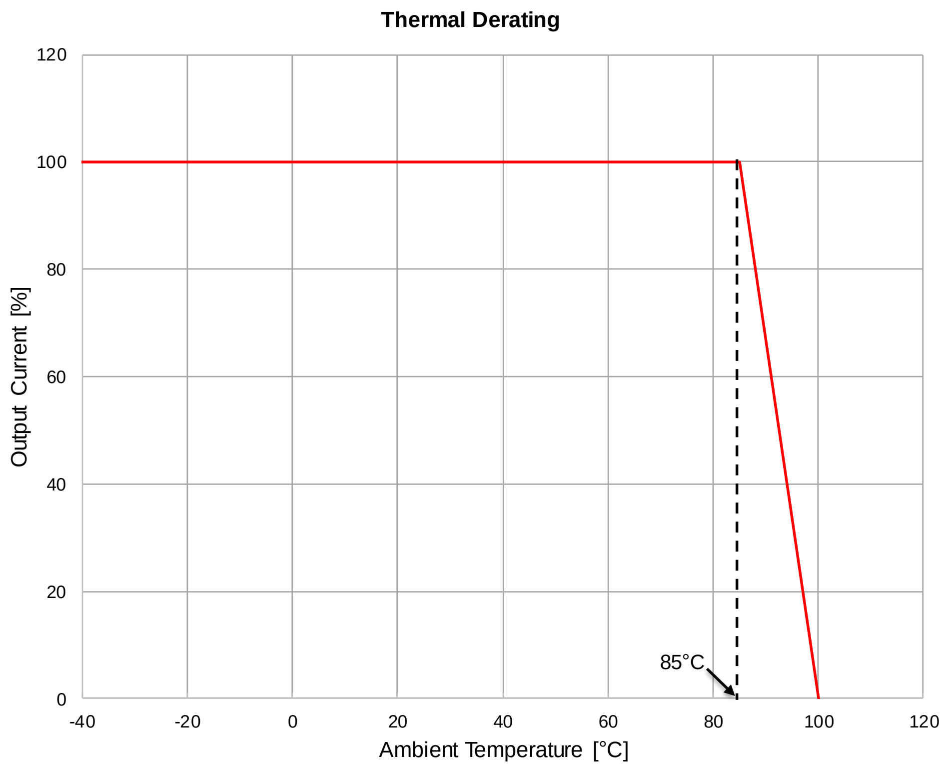
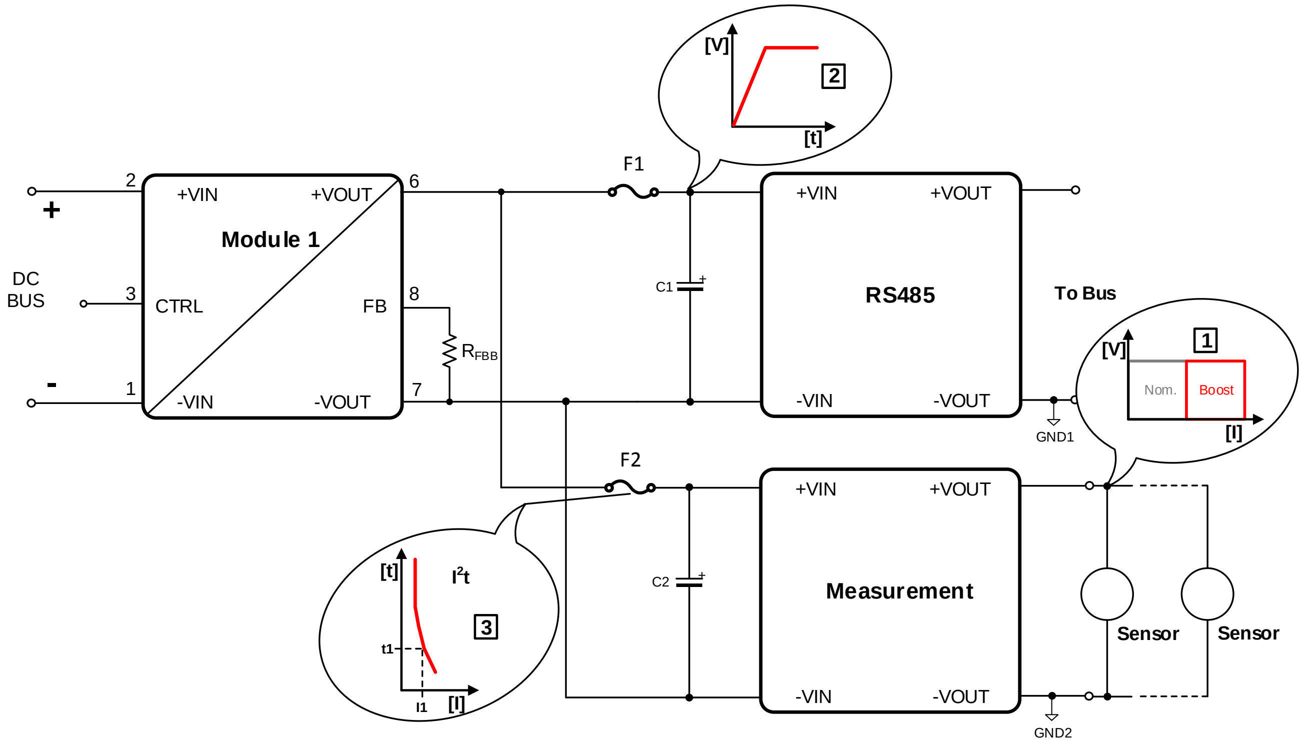


OUTPUT POWER



OVERLOAD BEHAVIOUR



The power boost feature provides additional current, allowing the module to fulfill the following demands:

- Unforcasted increases in load demands – see speech bubble 1
- Monotonic charging of capacitive loads – no voltage dips – see speech bubble 2
- Backup power for momentary higher energy demands of the application
- Tripping of input fuses of downstream applications in case of overload (ensures higher current for safe tripping) – see fuse tripping characteristic in speech bubble 3

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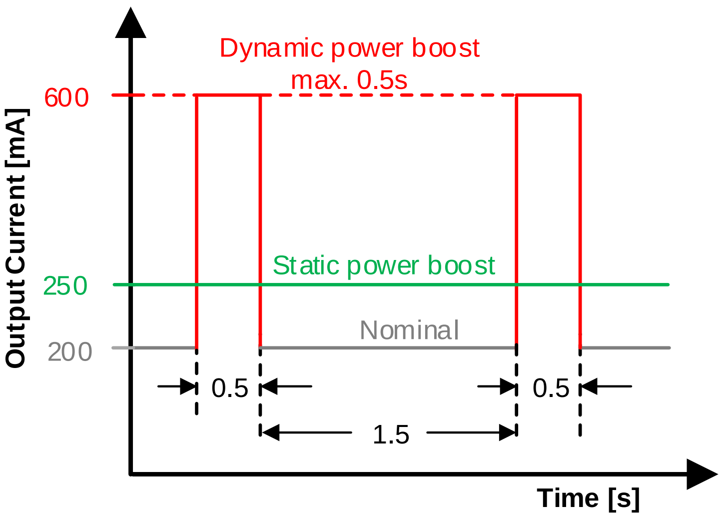
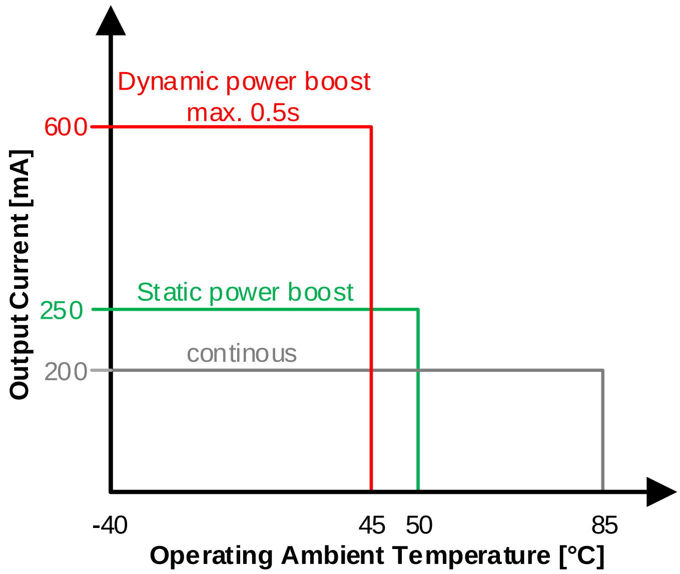
MagI³C Power Module
VISM – **V**ariable **I**solated **S**IP **M**odule

I_{MOC} DUTY CYCLE



I_{MOC} TEMPERATURE DERATING



Note: Power Boost available for V_{IN}=8V to 36V V_{OUT}=5V; still air (0 – 20LFM / 0 – 0.1m/s)

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MagI³C Power Module
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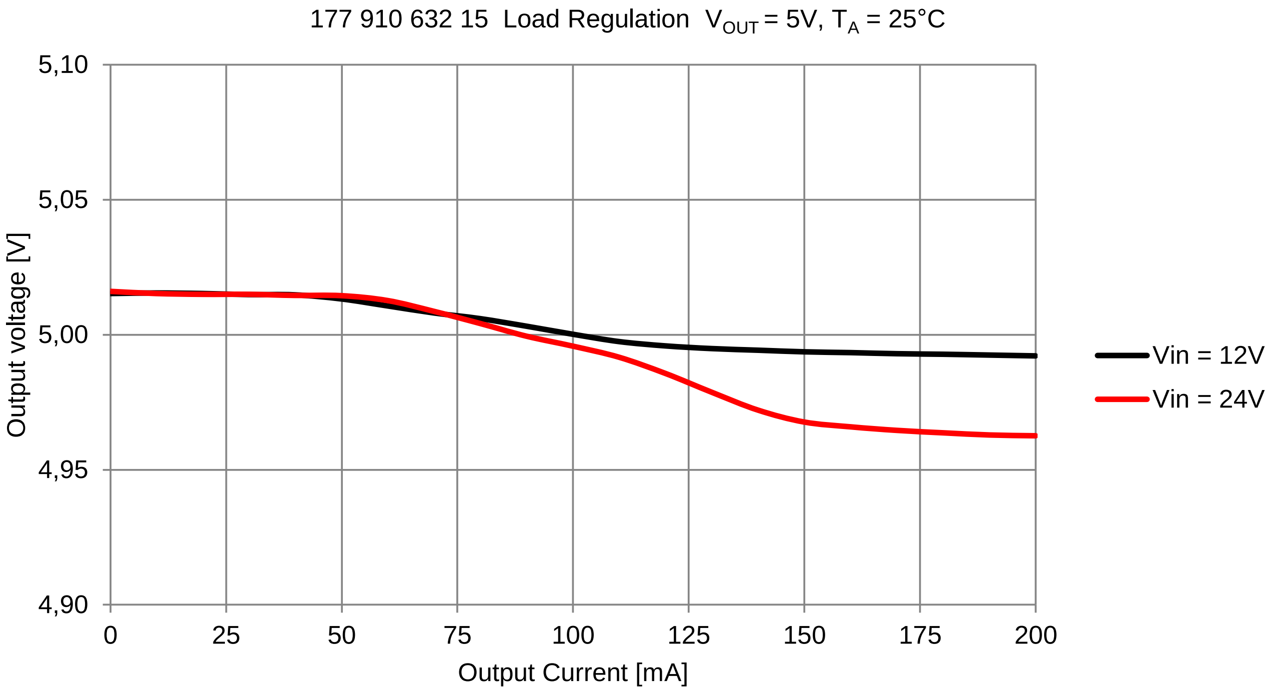
LOAD REGULATION



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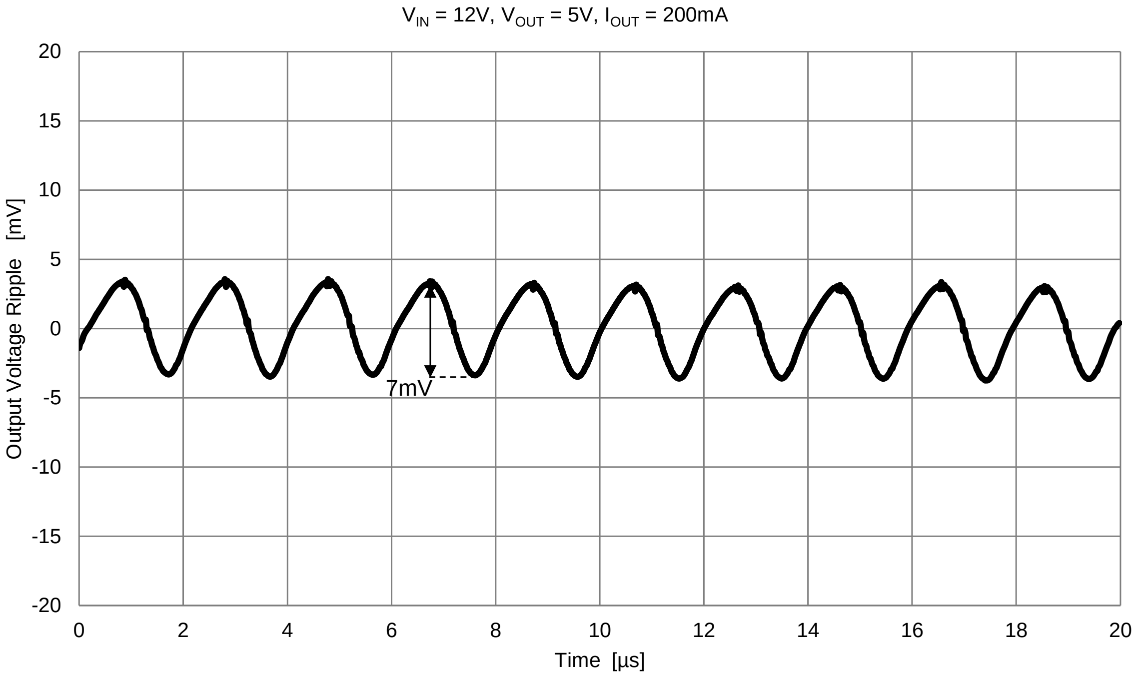
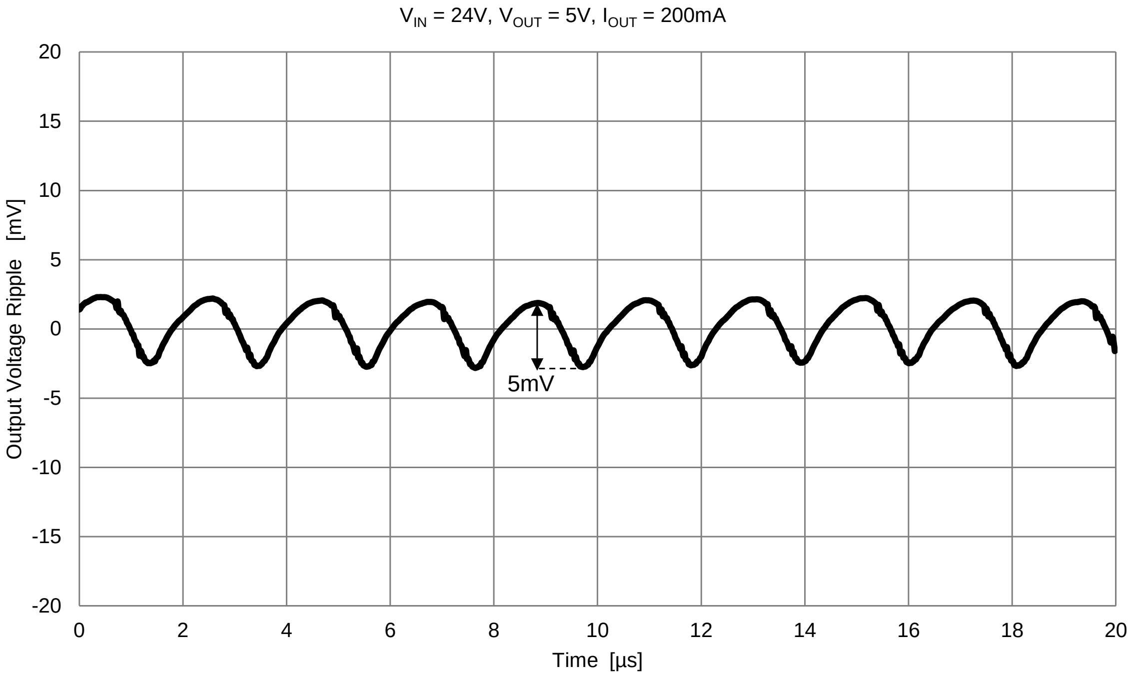
MagI³C Power Module
VISM – **V**ariable **I**solated **S**IP **M**odule

OUTPUT VOLTAGE RIPPLE

The output voltage ripple was measured under following conditions:

20MHz BWL, 1:1 oscilloscope probe, no additional MLCC or other capacitance at the output





WPMIH9100602S / 17791063215

MagI³C Power Module

VISM – **V**ariable **I**solated **S**IP **M**odule

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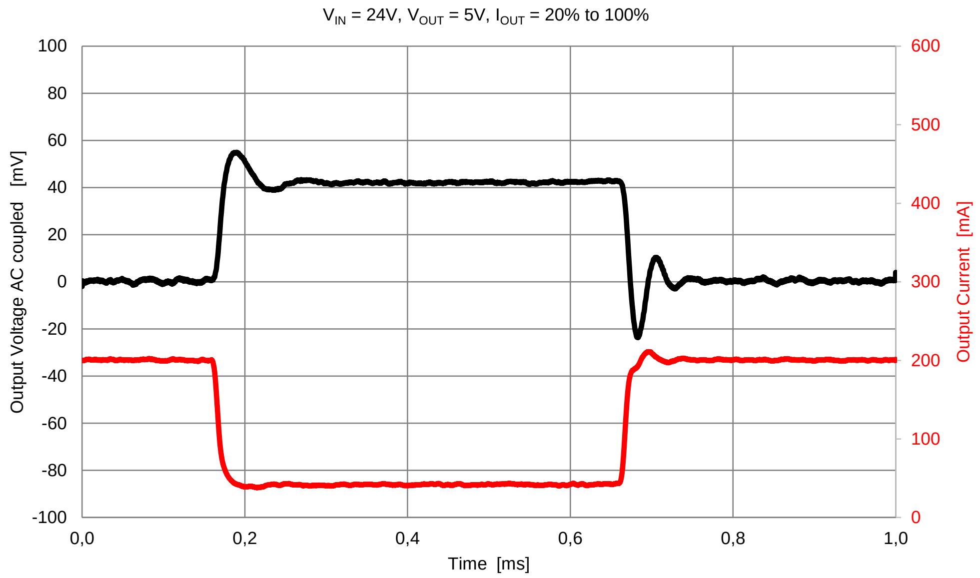
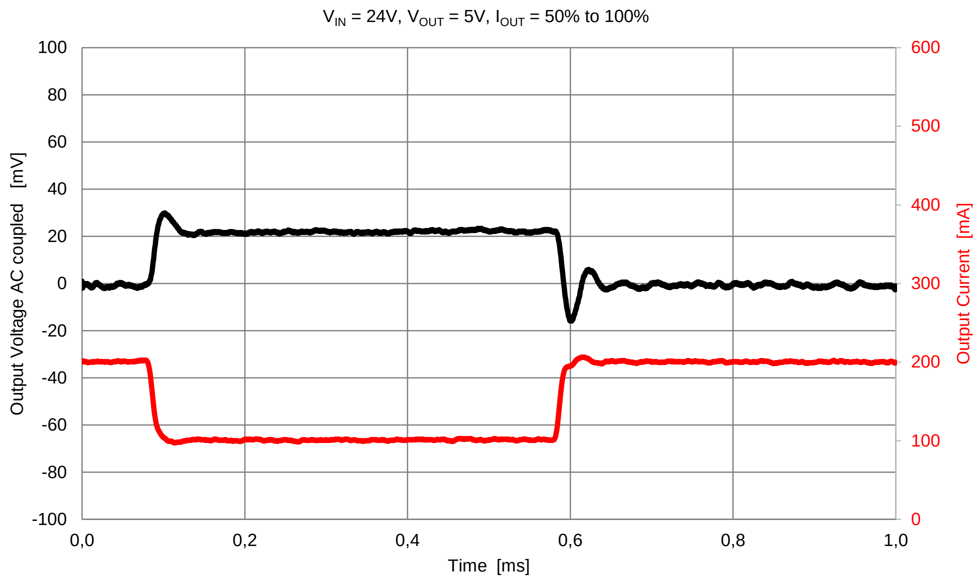
LOAD TRANSIENT RESPONSE

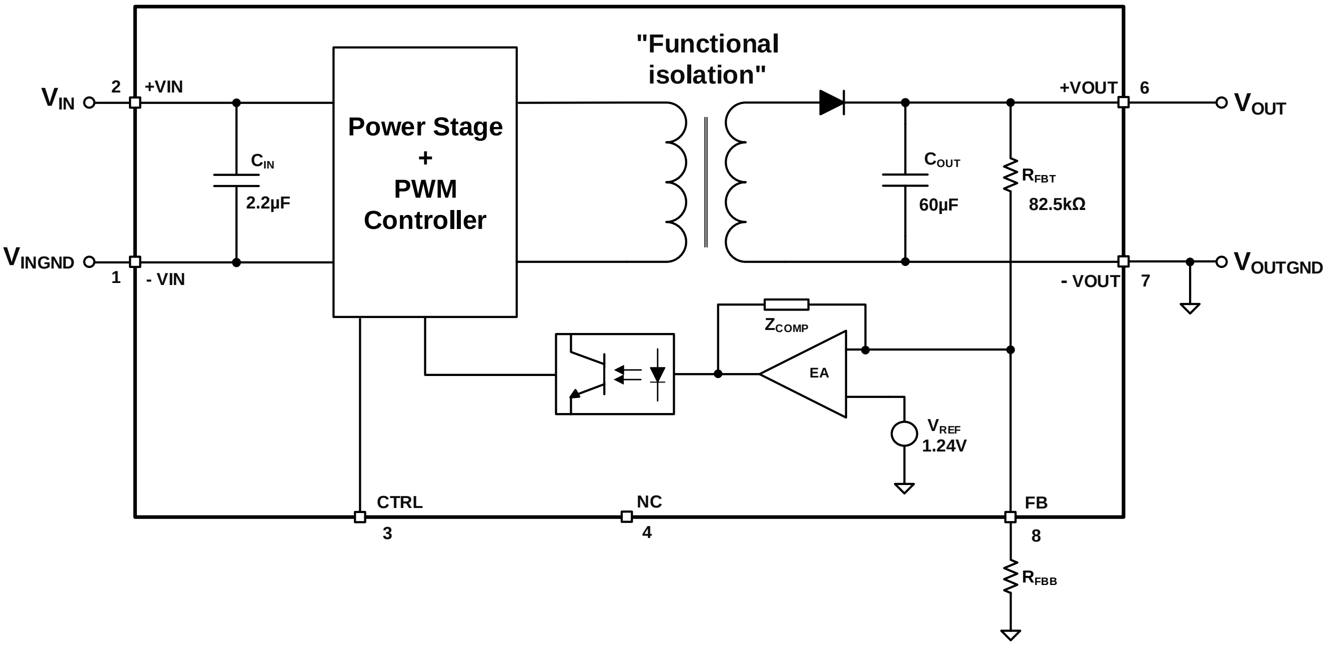
The figures below show the load transient response achieved with the integrated capacitors only.





WPMIH9100602S / 17791063215
MagI³C Power Module
VISM – **V**ariable **I**solated **S**IP **M**odule

BLOCK DIAGRAM



CIRCUIT DESCRIPTION

The MagI³C power module 17791063215 uses an isolated power stage topology. It integrates MOSFETs, power transformer, control circuit and both the input and the output capacitors.

The V_{OUT} of the regulator is divided by the feedback resistor divider and fed into the error amplifier. The error amplifier compares this signal with the internal 1.24V reference, generating an error signal. This signal is amplified and transferred through the optocoupler to the PWM stage, which drives the power MOSFETs. The high side resistor of the feedback network is integrated and the low side resistor can be externally connected for user adjustable output voltage**.**

WPMIH9100602S / 17791063215

MagI³C Power Module

VISM – **V**ariable **I**solated **S**IP **M**odule

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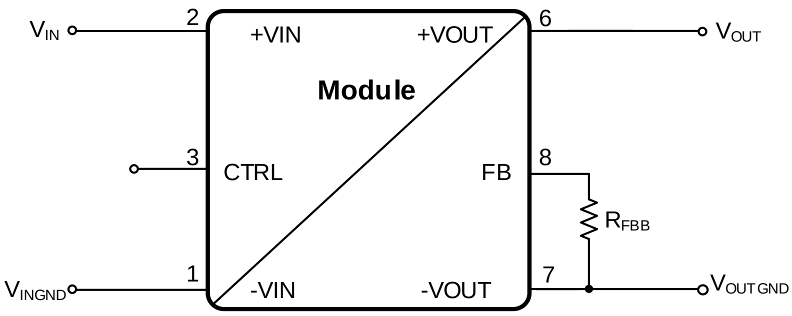
DESIGN FLOW

The design flow for 17791063215 consists of a single step: setting the output voltage trough the placement of an external resistor as the lower side of the feedback divider. External input and output capacitors are not necessary.

Essential Step

Set the output voltage



The output voltage is determined by the value of the external feedback resistor and the internal feedback resistor which create a voltage dividing network within the module. The output voltage adjustment range is from 3.3V to 6V.
The ratio of the feedback resistors for the desired output voltage is:

Equation:

$$V_{OUT} = \frac{V_{FB}(R_{FBT}+R_{FBB})}{R_{FBB}} \qquad (1)$$

Where V_{FB} = 1.24V and R_{FBT} = 82.5kΩ.

V_{OUT}	3.3V	5V	6V
R_{FBB}	48.7kΩ	26.7kΩ	21.5kΩ

PROTECTIVE FEATURES

Overcurrent protection (OCP)

Overcurrent protection is implemented by sensing the peak primary side transformer current.
When the peak current exceeds the current limit threshold (I_{CL}, see ELECTRICAL SPECIFICATIONS on page 5) the actual PWM OFF time is increased depending on the input voltage value and the feedback voltage to achieve a cycle by cycle current limit. That applies for short circuit conditions as well. After a defined time period the PWM starts with an ON cycle. Under short circuit conditions the OFF time is extended.

Overtemperature protection (OTP)

The junction temperature of the MagI³C power module should not be allowed to exceed its maximum rating. Thermal protection is implemented by an internal thermal shutdown circuit which activates at 165°C (typ.) causing the device to enter a low power standby state. Thermal protection helps to prevent catastrophic failures in case of accidental device overheating. When the junction temperature falls back below 145°C (typical hysteresis = 20°C) the soft-start is initiated, V_{OUT} rises smoothly, and normal operation resumes.

Due to the structure of the MagI³C power module the following protective features are NOT implemented:

- Input reverse polarity protection
- Input overvoltage protection
- Output overvoltage protection

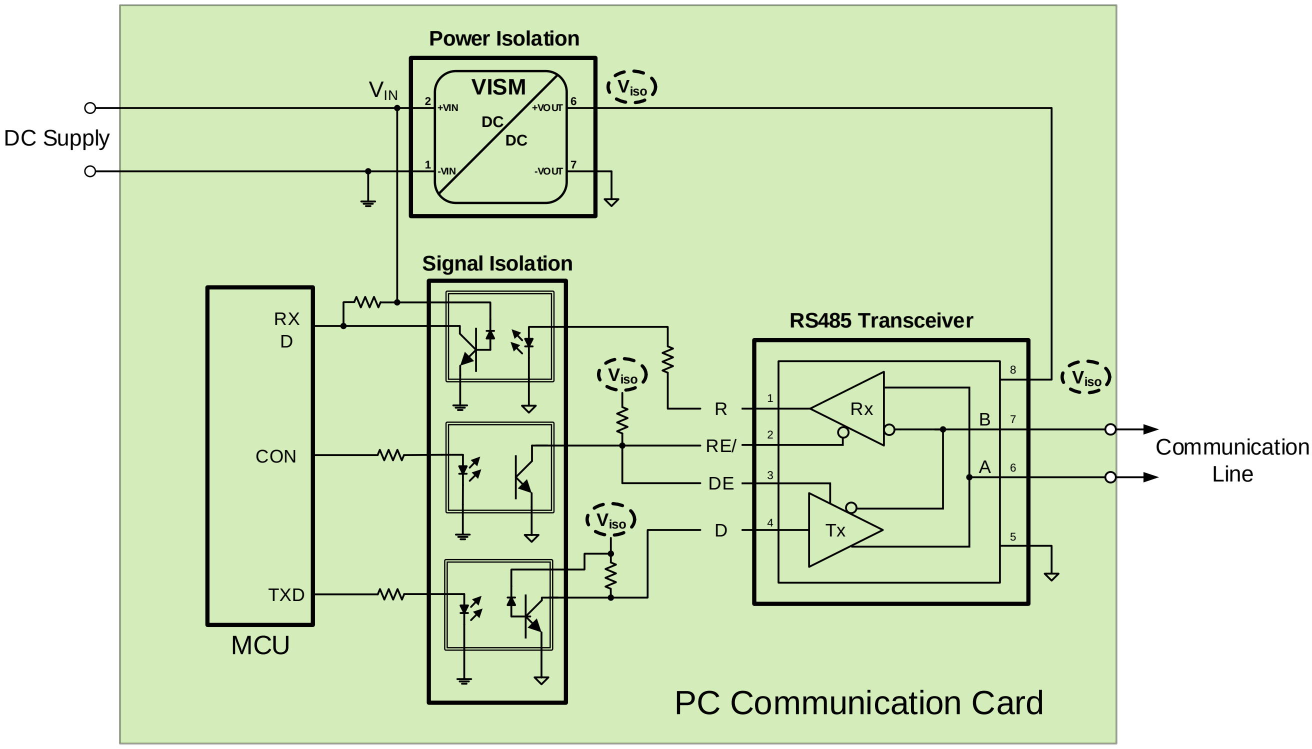
WPMIH9100602S / 17791063215

MagI³C Power Module

VISM – **V**ariable **I**solated **S**IP **M**odule

TYPICAL APPLICATION

The figure below depicts a typical application for an isolated power module setup for isolated RS485 communication with the essential functional units.



To set up an isolated communication, different functional units are required. The data for the RS485 transceiver is provided by the Micro Controller Unit (MCU), which in turn receives data from the RS485 transceiver. With the use of optocouplers the signal isolation unit can achieve galvanic isolation of the signals. A power isolation unit - a DC/DC converter power module – attains galvanic isolation of the grounds between the signal isolation unit and the transceiver unit.

The main benefit of galvanic power isolation is the prevention of faults than can propagate from the supply voltage through the bus and disturb signal lines.

WPMIH9100602S / 17791063215

MagI³C Power Module

VISM – Variable Isolated SIP Module

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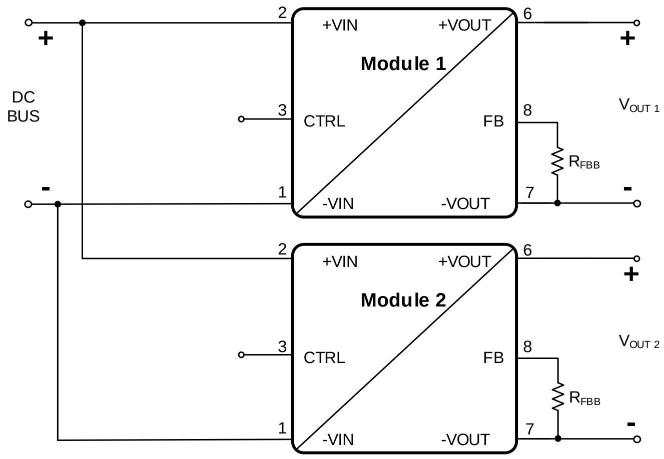
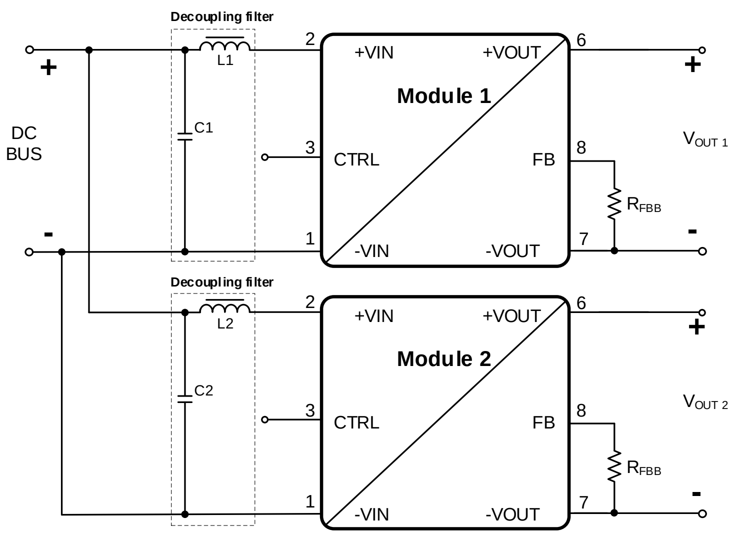
APPLICATION CONSIDERATIONS

Primary side parallel connection

A standard industrial configuration is, that the power modules are supplied by a dc bus voltage. Multiple 17791063215 can be connected to one dc bus as shown in the figure below.
The outputs do not have to be connected to each other and could have individual voltages V_{OUT1} and V_{OUT2}.



In case of using long supply lines or different wire length for each 17791063215 it is recommended to decouple each power module with an additional LC filter (see schematic below). The decoupling LC filter is also recommended if the suppling dc bus has a high impedance so that high voltage swings at the input of each power module might be present.



As a starting point for the decoupling filters, use the values of the reference filters – see also "RADIATED AND CONDUCTED EMISSIONS (WITH EMI INPUT FILTER)". The final appropriate filter for the application has then to be evaluated under operation in the target application by checking e.g. the change of the input ripple voltage.

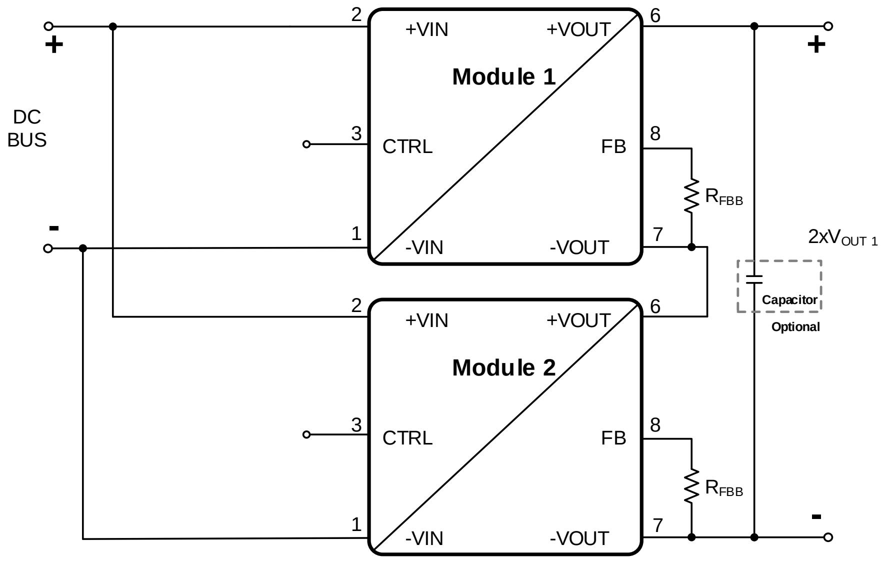
WPMIH9100602S / 17791063215

MagI³C Power Module

VISM – **V**ariable **I**solated **S**IP **M**odule

Secondary side serial connection

To generate higher output voltage/special rail voltages it is possible to put the outputs of the 17791063215 in series. It is common practice to connect an additional capacitor between the +VOUT and –VOUT.



In case of using long supply lines or different line length for each 17791063215 it is recommended to decouple each power module with an additional LC filter. The decoupling LC filter is also recommended if the suppling dc bus has a high impedance so that high voltage swings at the input of each power module could be present. See also "Primary side parallel connection" on page 25.

WPMIH9100602S / 17791063215
MagI³C Power Module
VISM – **V**ariable **I**solated **S**IP **M**odule

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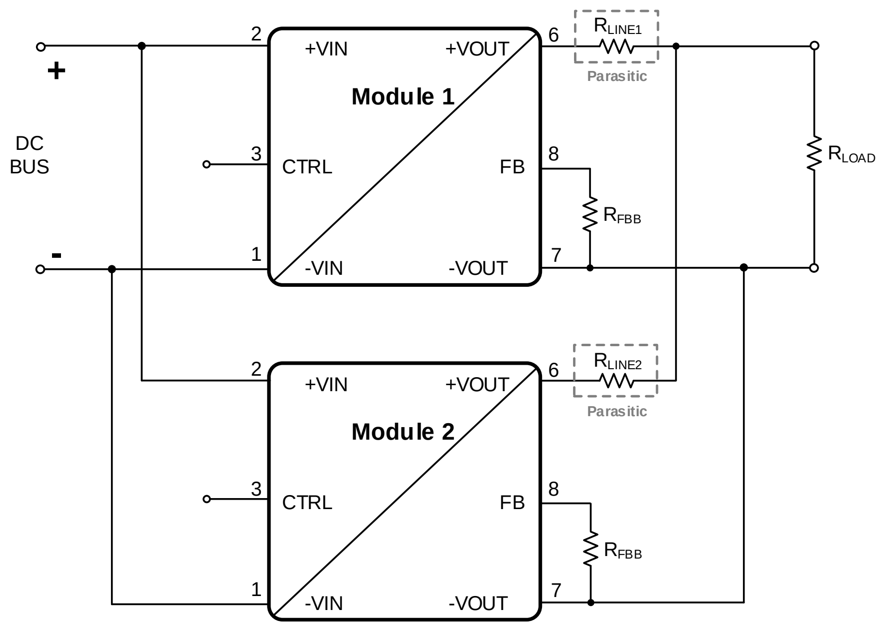
Secondary side parallel connection - increase the output power

The 17791063215 can be connected in parallel to increase the output power. The device with the highest output voltage carries the highest current. Therefore, the output voltage of each unit needs to be adjusted to the same value. V_{OUT1} &V_{OUT2} should be close as possible to be identical. The temperature of module1 & module 2 should be as close as possible to be identical. The routing on the PCB from each power module to the load needs to be symmetrical to avoid unequal parasitic line impedances (R_{LINE1}&R_{LINE2}) that leads to different current sharing. Start up all power modules at the same time to avoid the overload mode. The overload can be short circuits and the required output current is higher than the current of one unit.
Dynamic power boost is not available at secondary side parallel connection



In case of using long supply lines or different line length for each 17791063215 it is recommended to decouple each power module with an additional LC filter. The decoupling LC filter is also recommended if the suppling dc bus has a high impedance so that high voltage swings at the input of each power module could be present. . See also “Primary side parallel connection” on page 25.

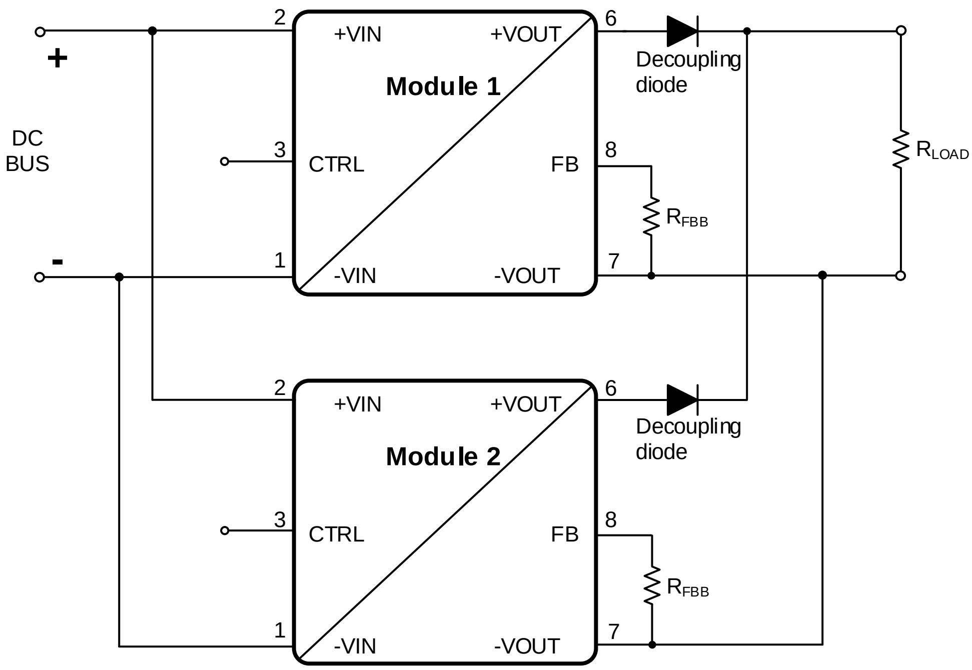
WPMIH9100602S / 17791063215

MagI³C Power Module

VISM – **V**ariable **I**solated **S**IP **M**odule

Secondary side parallel connection - generating a n+1 redundancy

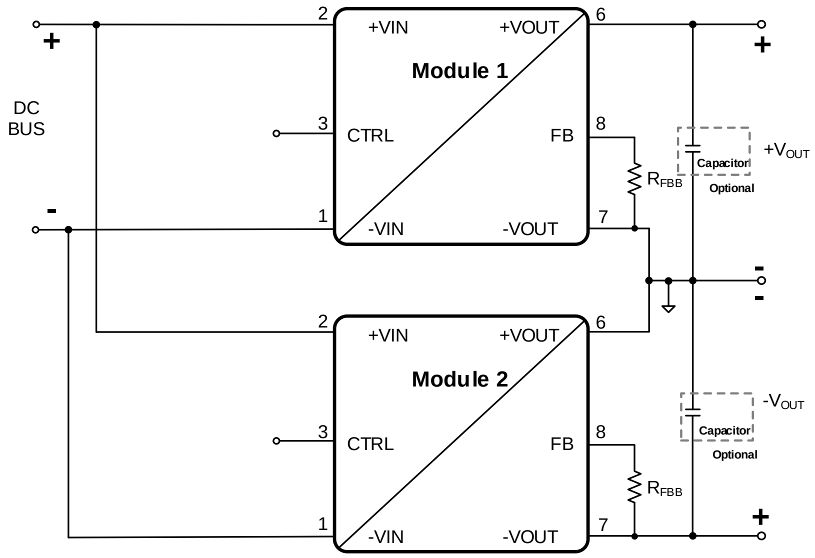
To gain higher system availability it is possible to parallel power modules.
In order to achieve redundancy in case one power module fails, a certain amount of additional power to fulfill load requirements needs to be available. Connecting two power modules in parallel (1+1 redundancy) is the simplest way to achieve this target. After a failure of one power module, the second module automatically supplies load current without any interruption. The system can be also scaled up to achieve N+1 redundancy.
This simple way of implementing a redundant system does not cover abnormal conditions such as internal body diode failure or internal short circuit in secondary side transformer winding as the failed power module acts as a load, or a short circuit, for the rest of the power modules. That situation can be avoided by using decoupling diodes.



For using long supply lines or different line length for each 17791063215 it is recommended to decouple each power module with an additional LC- filter. The decoupling LC-filter is also recommended if the suppling dc bus has a high impedance so that high voltage swings at the input of each power module could be present. . See also "Primary side parallel connection" on page 25.

Generating complementary output voltages

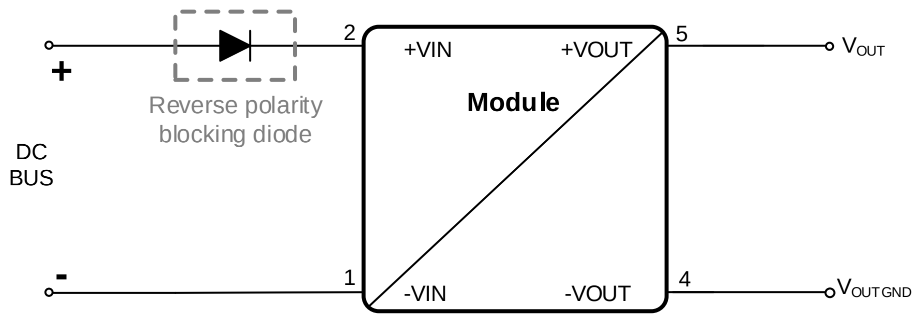
Another common requirement in industrial applications is to provide a complementary voltage (e.g. ±5V). The circuit below shows how this target can be achieved simply combining a 17791063215 used in a standard configuration (delivering a positive output voltage) with a 17791063215 in a reverse configuration. It is a common practice to connect an additional capacitor across each output voltage.



For using long supply lines or different line length for each 17791063215 it is recommended to decouple each power module with an additional LC- filter. The decoupling LC-filter is also recommended if the suppling dc bus has a high impedance so that high voltage swings at the input of each power module could be present. . See also "Primary side parallel connection" on page 25.

Reverse polarity protection

A simple way of creating an input reverse polarity protection is to place a diode in series with the plus input line. The diode blocks all negative voltages that might be applied at the plus input because of operating reverse biased. Due to the forward voltage drop of the diode the application efficiency drops.



WPMIH9100602S / 17791063215
MagI³C Power Module
VISM – **V**ariable **I**solated **S**IP **M**odule

REMOTE ON/OFF

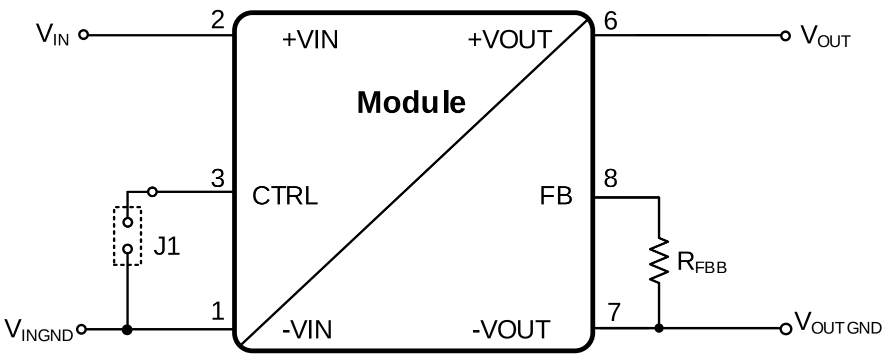
The 17791063215 power module has an implemented ON/OFF function. By pulling down pin3 (CTRL) to GND, the power module can be set to an OFF state. The output voltage then decreases from the nominal voltage to zero while the power module is still connected to the supply. The main advantages of this feature are:

- Realization of a controllable power supply
- Possibility to cascade more supplies to reduce the inrush current
- Saving energy for standby by pulling CTRL pin to ground (only 513 µA shut down current)
- Switchable supply for fast transient needs

There are two main options to set the control state of the power module:

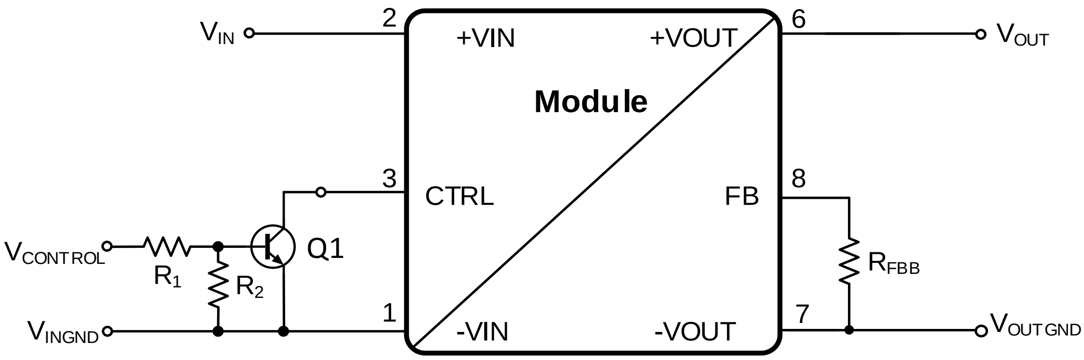
Option 1: Jumper

Connect pin3 via a hardware jumper with V_{INGND}.



Option 2: Bipolar transistor

Connect pin3 via a bipolar transistor with V_{INGND}. The ground of the control voltage of the BJT has to be referenced to V_{INGND}.



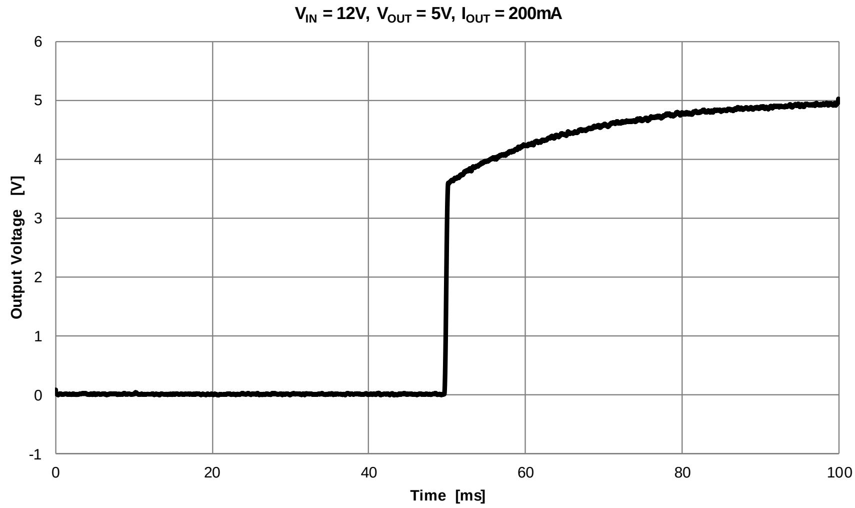
WPMIH9100602S / 17791063215

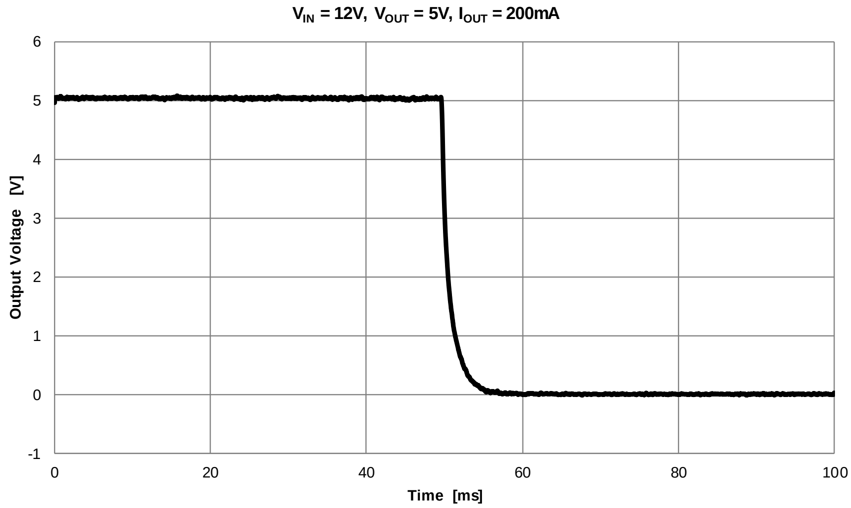
MagI³C Power Module

VISM – **V**ariable **I**solated **S**IP **M**odule

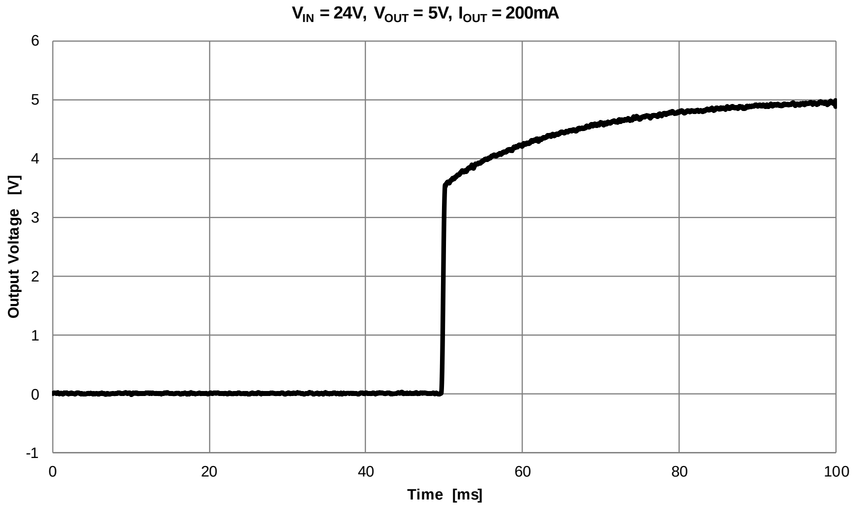
REMOTE ON / OFF

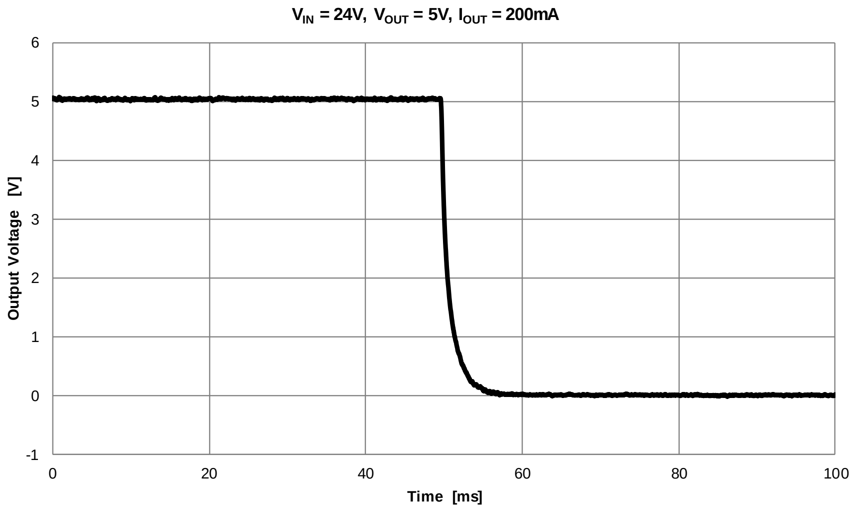
The diagrams below show the on/off behavior at different input voltages (12V and 24V).





WPMIH9100602S / 17791063215
MagI³C Power Module
VISM – **V**ariable **I**solated **S**IP **M**odule

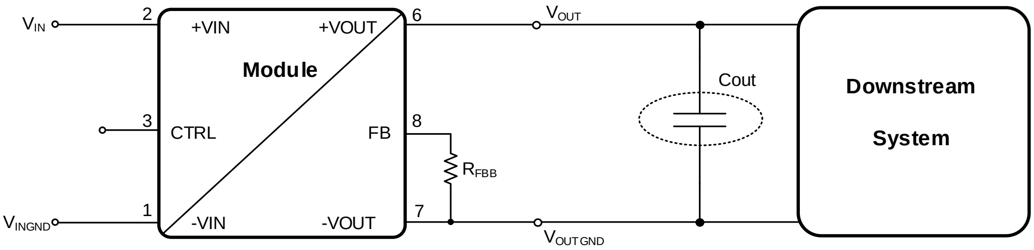




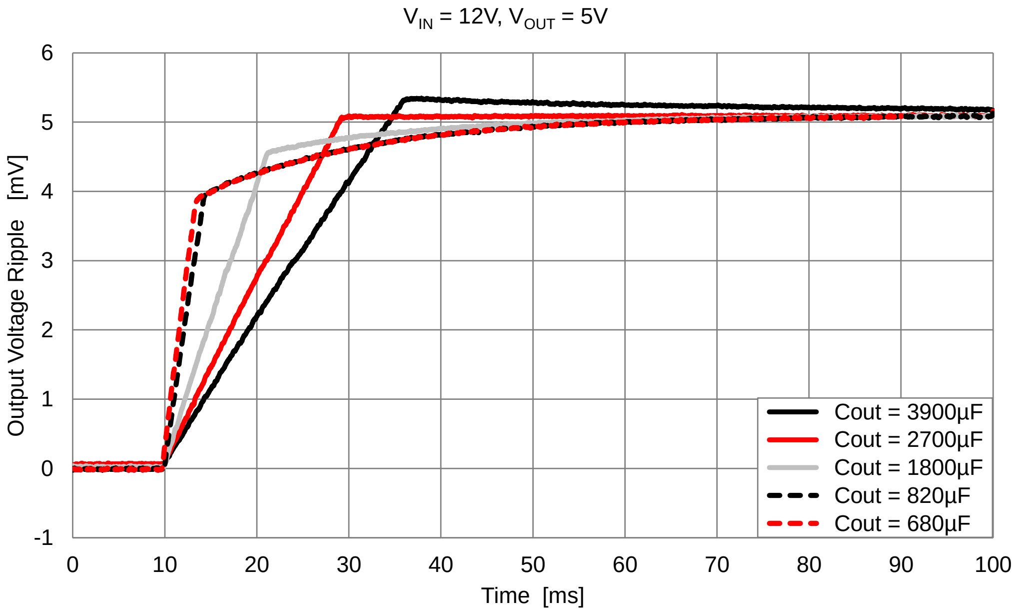
WPMIH9100602S / 17791063215
MagI³C Power Module
VISM – Variable Isolated SIP Module

START-UP WITH CAPACITIVE LOAD

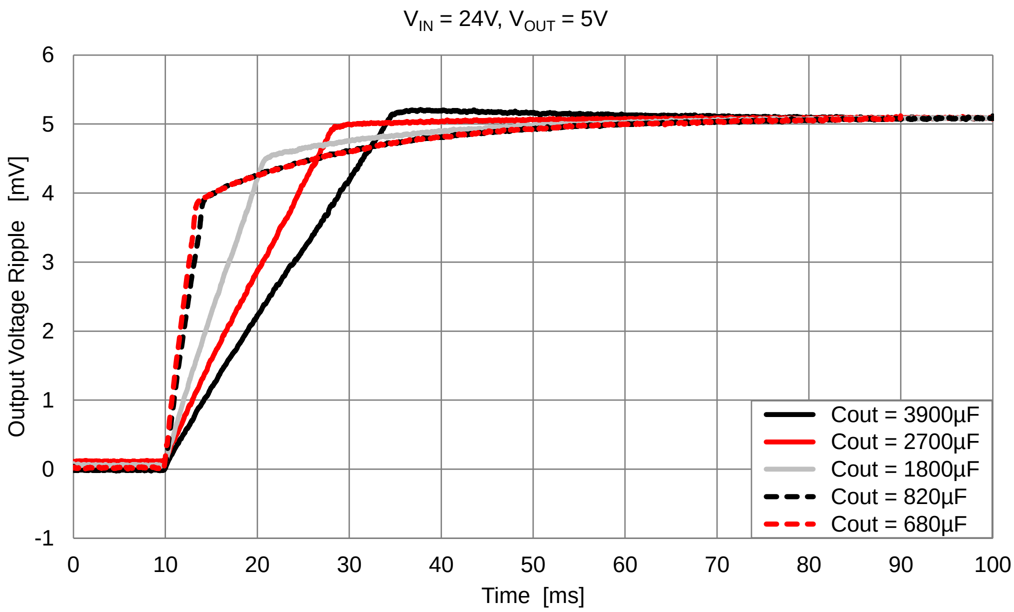
Every downstream stage connected to a DC-DC converter has its own input capacitor. This input capacitor acts as additional output capacitor for the DC-DC converter (see figure below). The output capacitance influences the start-up behavior and the slope of the output voltage. The 17791063215 can manage capacitive loads up to 3900µF (as indicated in the "OPERATING CONDITIONS" on page 4).



The diagrams below show the start-up behavior with different capacitive loads at 12V and 24V input voltage.



WPMIH9100602S / 17791063215
MagI³C Power Module
VISM – **V**ariable **I**solated **S**IP **M**odule



The table below shows the part number of the capacitors used for testing the start up behavior:

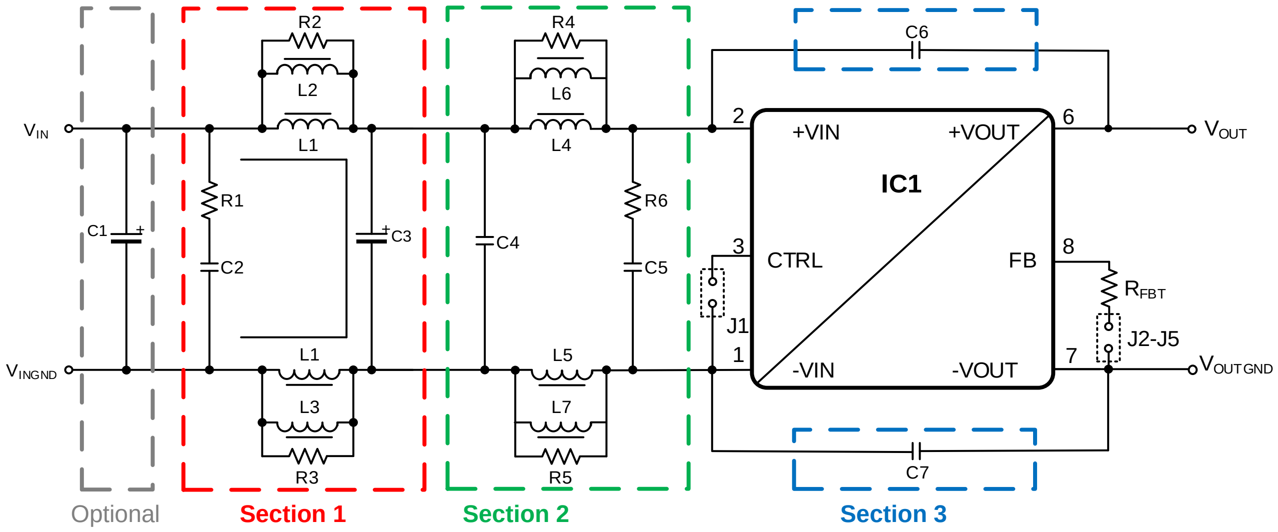
Würth Elektronik part number	Capacitance (µF]	Rated voltage [V]	ESR typ. [mΩ]
860010581024	3900	35	30
860010580022	2700	35	24
860010580020	1800	35	22
860010578016	820	35	150
860010575015	680	35	65

WPMIH9100602S / 17791063215

MagI³C Power Module

VISM – **V**ariable **I**solated **S**IP **M**odule

EVALUATION BOARD SCHEMATIC (17800VISM v.1.0)



The VISM evaluation board is a multi-functional EMI optimization tool. It offers the possibility to optimize the EMI behavior based on the application requirements by placing multiple differential (DM) and/or common mode (CM) filters.
Therefore the evaluation board consists of three different filter sections. The tables below show the main component selection possibilities:

Section 1 – red:	
Filter type	**Description**
CM	L1
CM	L2 + L3
DM	C2 + L2
DM (PI)	C2 + L2 + C3
DM	C2 + L3
DM (PI)	C2 + L3 + C3

Section 2 – green:	
Filter type	**Description**
DM	C4 + L4
DM (PI)	C4 + L4 + C5
DM	C4 + L5
DM (PI)	C4 + L5 + C5
CM	L4+L5
DM	C4 + L6
DM (PI)	C4 + L6 + C5
DM	C4 + L7
DM (PI)	C4 + L7 + C5
CM	L6+L7

Section 3 – blue:	
Filter type	**Description**
CM (Y-Cap)	C6
CM (Y-Cap)	C7
CM (Y-Cap)	C6 + C7

Beside these three basic filter topologies, mixed versions (section 1 + section 2 + section 3) are also possible with this evaluation board.

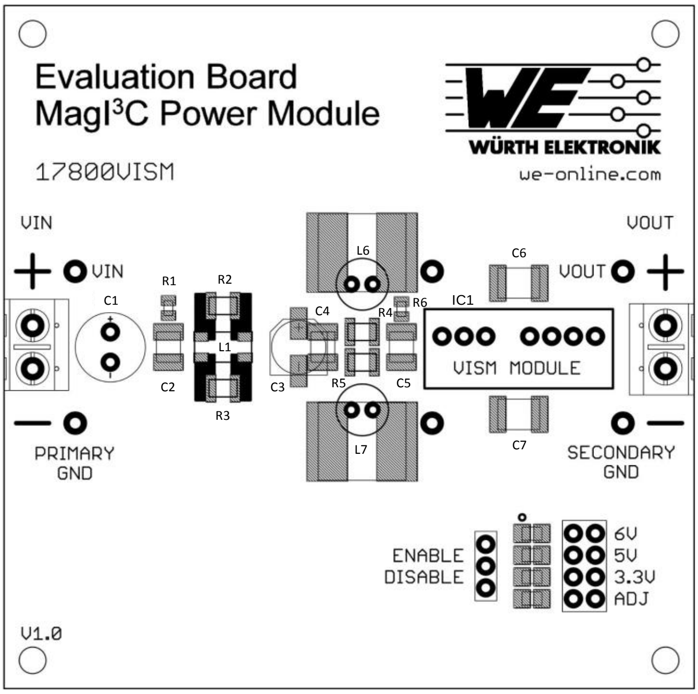
The optional additional aluminum electrolytic capacitor C1 is only for evaluation board protection purpose. It is mounted as termination of the supply line and provides a slight damping of possible oscillations of the series resonance circuit represented by the inductance of the supply line and the input capacitance.

With the resistors R1 and R6 it is possible to increase the ESR of the capacitor to establish a damping of a possible oscillation of the filter components L and C.

WPMIH9100602S / 17791063215

MagI³C Power Module

VISM – Variable Isolated SIP Module



Bill of Material

Ref. Des.	Description	Quantity	Order Code	Manufacturer
IC1	VISM MagI³C power module	1	17791063215	Würth Elektronik
C1	Aluminum electrolytic capacitor, WCAP ATG8 family, 100µF/50V	1	860010674014	Würth Elektronik
C2	Ceramic chip capacitor WCAP-CSGP 50V 1210 X7R (not mounted)	optional	8850122XXXXX	Würth Elektronik
C3	Surface mounted electrolytic e.g. WCAP-PSLP family (not mounted)	optional	875105XXXXXX	Würth Elektronik
C4	Ceramic chip capacitor WCAP-CSGP 50V 1210 X7R (not mounted)	optional	8850122XXXXX	Würth Elektronik
C5	Ceramic chip capacitor WCAP-CSGP 50V 1210 X7R (not mounted)	optional	8850122XXXXX	Würth Elektronik
C6	Ceramic chip capacitor WCAP-CSSA family 1812 (not mounted)	optional	885352XXXXXX	Würth Elektronik
C7	Ceramic chip capacitor WCAP-CSSA family 1812 (not mounted)	optional	885352XXXXXX	Würth Elektronik
L1	Common mode choke e.g. WE-SL1 (not mounted)	optional	744212XXX	Würth Elektronik
L2	Filter inductor e.g. WE-PD2 (not mounted)	optional	7447730XX	Würth Elektronik
L3	Filter inductor e.g. WE-PD2 (not mounted)	optional	7447730XX	Würth Elektronik
L4	Filter inductor e.g. WE-CBF family (not mounted)	optional	7427920XX	Würth Elektronik
L5	Filter inductor e.g. WE-CBF family (not mounted)	optional	7427920XX	Würth Elektronik
L6	Filter inductor e.g. WE-TI family (not mounted)	optional	744746XXXX	Würth Elektronik
L7	Filter inductor e.g. WE-TI family (not mounted)	optional	744746XXXX	Würth Elektronik

WPMIH9100602S / 17791063215

MagI³C Power Module

VISM – Variable Isolated SIP Module

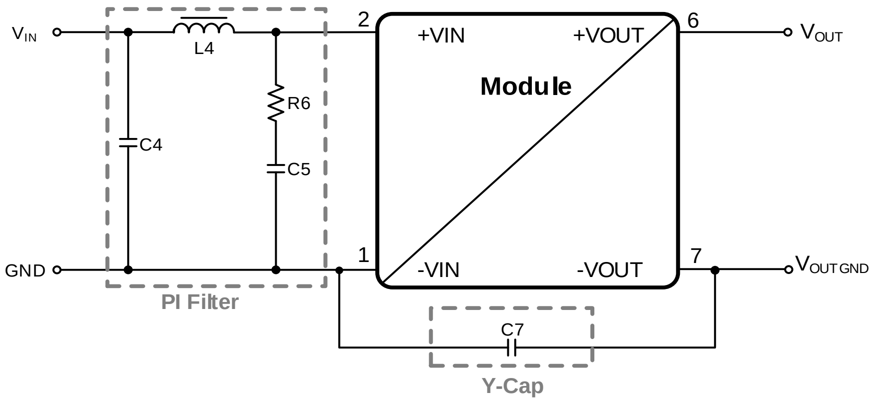
<table>
<tr><th>Ref. Des.</th><th colspan="2">Description</th><th>Quantity</th><th>Order Code</th><th>Manufacturer</th></tr>
<tr><td>R1</td><td colspan="2">SMD bridge 0Ω resistance 0603/0805</td><td>1</td><td>-</td><td>Various</td></tr>
<tr><td>R2</td><td colspan="2">SMD bridge 0Ω resistance 0805</td><td>1</td><td>-</td><td>Various</td></tr>
<tr><td>R3</td><td colspan="2">SMD bridge 0Ω resistance 0805</td><td>1</td><td>-</td><td>Various</td></tr>
<tr><td>R4</td><td colspan="2">SMD bridge 0Ω resistance 0805</td><td>1</td><td>-</td><td>Various</td></tr>
<tr><td>R5</td><td colspan="2">SMD bridge 0Ω resistance 0805</td><td>1</td><td>-</td><td>Various</td></tr>
<tr><td>R6</td><td colspan="2">SMD bridge 0Ω resistance 0603/0805</td><td>1</td><td>-</td><td>Various</td></tr>
<tr><td rowspan="4">R_{FBB}</td><td rowspan="4">Set by jumper</td><td>48.7k Ω for V_{OUT} = 3.3V</td><td>1</td><td></td><td>Various</td></tr>
<tr><td>26.7k Ω for V_{OUT} = 5V</td><td>1</td><td></td><td>Various</td></tr>
<tr><td>21.5k kΩ for V_{OUT} = 6V</td><td>1</td><td></td><td>Various</td></tr>
<tr><td>For adjustable V_{OUT}: $V_{OUT}=\frac{V_{FB}(R_{FBT}+R_{FBB})}{R_{FBB}}$</td><td>optional</td><td></td><td></td></tr>
<tr><td>J1</td><td colspan="2">Jumper for CTRL – ON/OFF of the module</td><td>1</td><td>609976302001</td><td>Würth Elektronik</td></tr>
<tr><td>J2</td><td colspan="2">Jumper for selecting the output voltage</td><td>1</td><td>609976302001</td><td>Würth Elektronik</td></tr>
</table>

The complete data of the evaluation board (Gerber files, BOM) can be downloaded from the online catalogue.

Filter Suggestion for Conducted and Radiated EMI

The input filter shown in the schematic below is recommended to achieve conducted and radiated EMI compliance according to EN55032 Class B (see results on page 10). It is a combination of filter section two and three.

PI FILTER



Bill of Material of the Input PI Filter MLCC based

Designator	Description	Filter	Order Code	Manufacturer
C4	Filter ceramic chip capacitor 2.2µF/50V, X7R, 1812	PI	885012210032	Würth Elektronik
C5	Filter ceramic chip capacitor 2.2µF/50V, X7R, 1812		885012210032	Würth Elektronik
L4	Filter inductor, 22µH, PD2 family		744774122	Würth Elektronik
R6	Resistor 0Ω.			Various
C7	Filter ceramic chip capacitor 470pF/250Vac/5000V impulse voltage 1812 X7R	Y-Cap	885352211001	Würth Elektronik

WPMIH9100602S / 17791063215
MagI³C Power Module
VISM – Variable Isolated SIP Module

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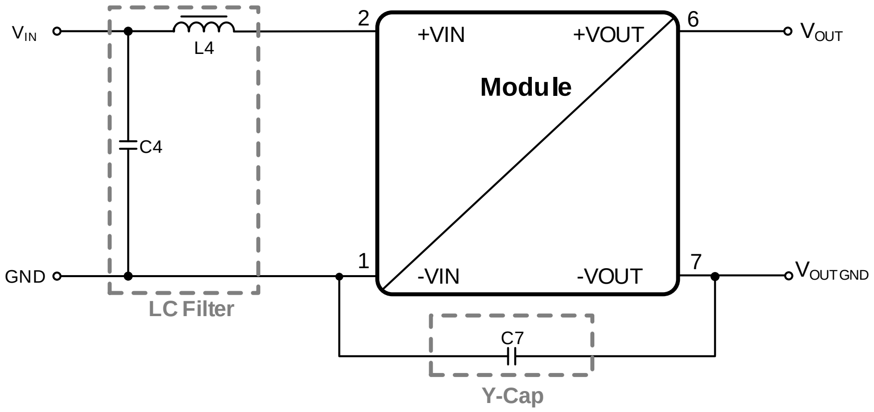
LC FILTER



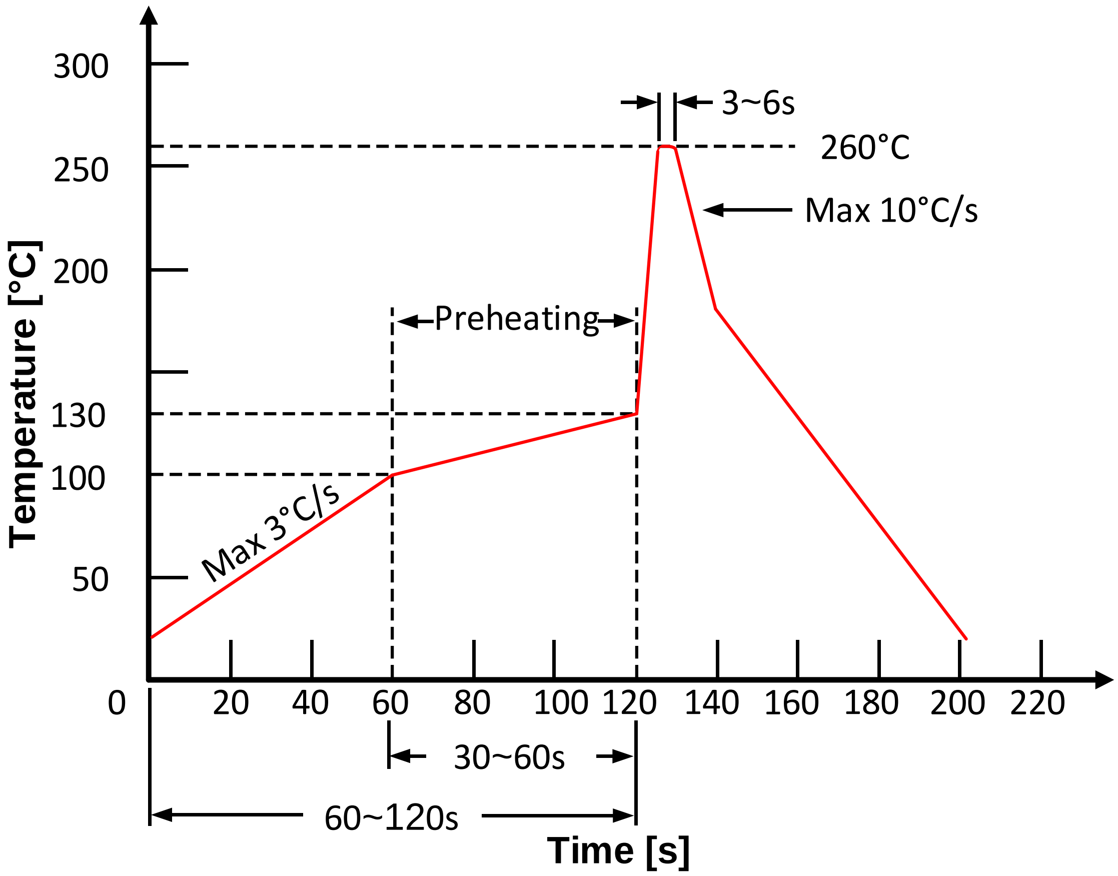
Bill of Material of the Input LC Filter Polymer capacitor based

Designator	Description	Filter	Order Code	Manufacturer
C4	Filter capacitor WCAP-PSHP 10µF/50V aluminium polymer	LC	875115752001	Würth Elektronik
L4	Filter inductor WE- PD2 family, 22µH, 5848		744774122	Würth Elektronik
C7	Filter capacitor WCAP-CSSA family 470pF/250Vac/5000V impulse voltage 1812 X7R	Y-Cap	885352211001	Würth Elektronik

WPMIH9100602S / 17791063215
MagI³C Power Module
VISM – **V**ariable **I**solated **S**IP **M**odule

SOLDER PROFILE

Automated soldering



Remarks:
Preheating temperature: 130°C
Preheating time: 30~60 seconds
Tip temperature: 260 ±5°C
Tip temperature time: 3~6 seconds
The melting point of Tin: 215 ±5°C
Max number of allowed cycles in wave soldering: 2 cycles

Manual soldering

Soldering temperature: 365 ±15°C
Soldering time: max. 3 seconds

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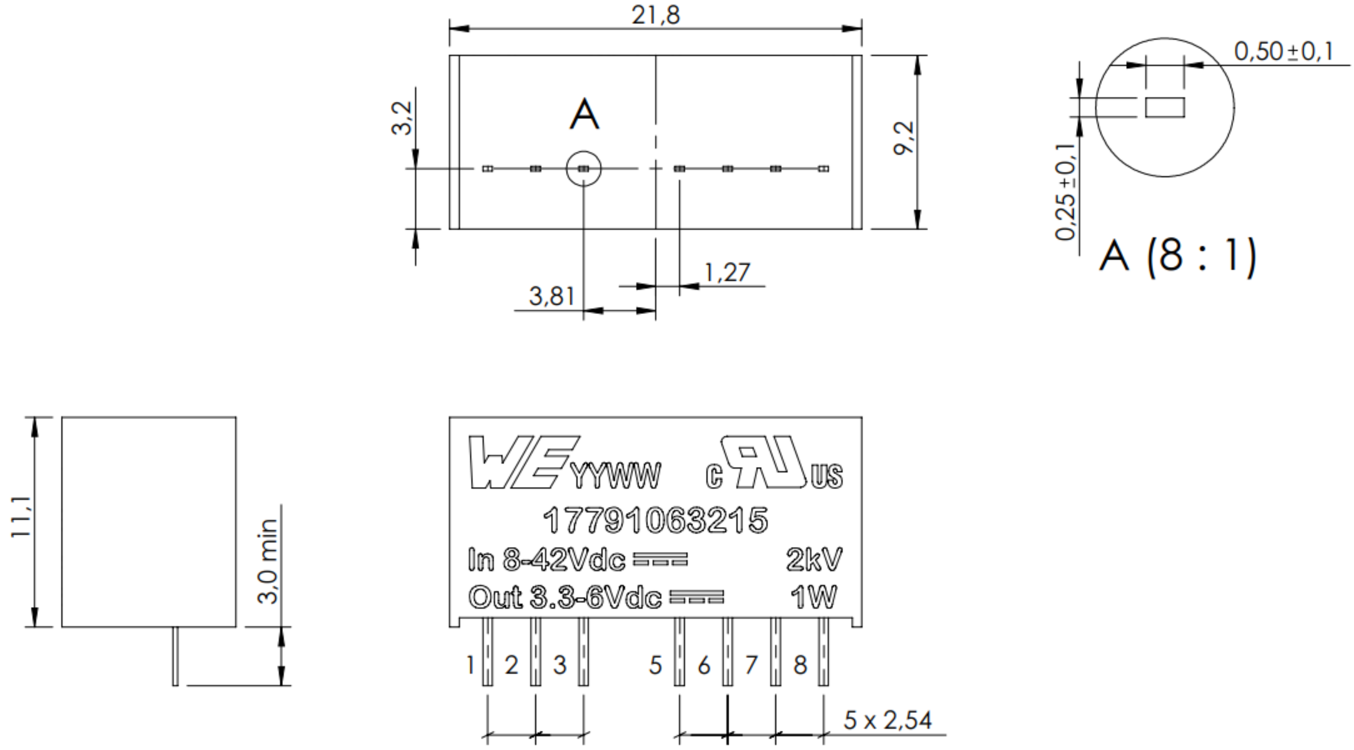
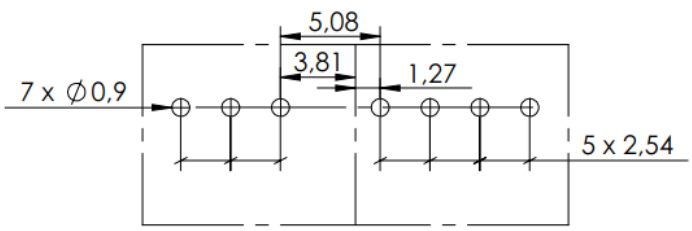
PHYSICAL DIMENSIONS



RECOMMENDED DRILL PATTERN



All dimensione are in mm

Tolerances: .xx → ±0.25mm, .x → ±0.50mm

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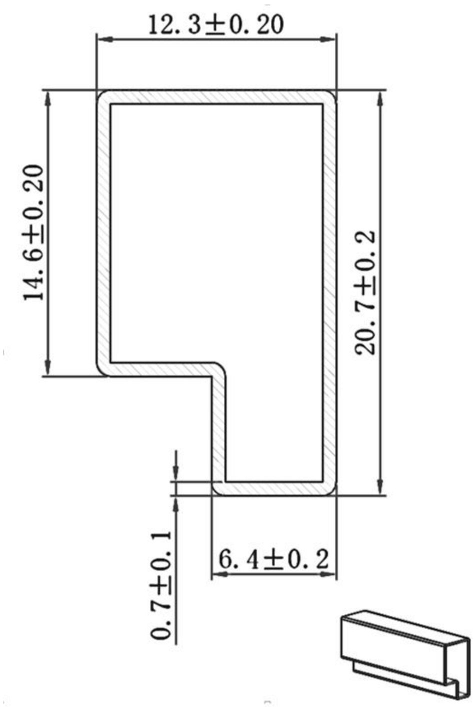
PACKAGING



All dimensions are in mm

DOCUMENT HISTORY

Revision	Date	Description	Comment
1.0	May 2018	Release of the final version	

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CAUTIONS AND WARNINGS

The following conditions apply to all goods within the product series of MagI³C of Würth Elektronik eiSos GmbH & Co. KG:

General:
All recommendations according to the general technical specifications of the data-sheet have to be complied with.

The usage and operation of the product within ambient conditions which probably alloy or harm the component surface has to be avoided.

The responsibility for the applicability of customer specific products and use in a particular customer design is always within the authority of the customer. All technical specifications for standard products do also apply for customer specific products.

Residual washing varnish agent that is used during the production to clean the application might change the characteristics of the body, pins or termination. The washing varnish agent could have a negative effect on the long term function of the product. Direct mechanical impact to the product shall be prevented as the material of the body, pins or termination could flake or in the worst case it could break. As these devices are sensitive to electrostatic discharge customer shall follow proper IC Handling Procedures.

Customer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of Würth Elektronik eiSos GmbH & Co. KG components in its applications, notwithstanding any applications-related information or support that may be provided by Würth Elektronik eiSos GmbH & Co. KG. Customer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Customer will fully indemnify Würth Elektronik eiSos and its representatives against any damages arising out of the use of any Würth Elektronik eiSos GmbH & Co. KG components in safety-critical applications.

Product specific:
Follow all instructions mentioned in the datasheet, especially:

- The solder profile has to comply with the technical reflow or wave soldering specification, otherwise this will void the warranty.
- All products are supposed to be used before the end of the period of 12 months based on the product date-code.
- Violation of the technical product specifications such as exceeding the absolute maximum ratings will void the warranty.
- It is also recommended to return the body 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.

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MagI³C Power Module

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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. Accordingly, the customer is cautioned to verify that the datasheet is current before placing orders.

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.

3. Best Care and Attention
Any product-specific notes, warnings and cautions must be strictly observed.

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 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.

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