

1769205x2, 176881212, 176861512

MagI³C Power Module FISM – Fixed Isolated SMT Module



3.3V – 12V / 1W / 2kV functional isolated
unregulated 5V / 12V / 15V Output

DESCRIPTION

The FISM series of the unregulated MagI³C power module family is a functional isolated, fully integrated DC/DC converter. The module integrates the switching power stage, control circuitry, transformer and capacitors, all in one package.

The module requires no external components for operation thus reducing design effort and complexity to a minimum.

The FISM ensures fast time to market and low development costs.

The FISM series achieves typically an efficiency of 73% to 76%.

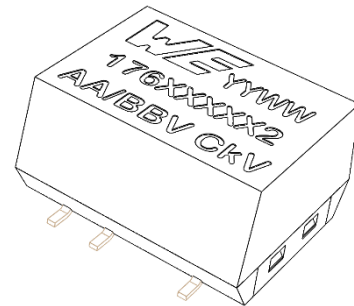
The SMT package (12.75x11.1x6.95mm) with industrial standard SMT-8 pinout allows for easy assembly.

FEATURES

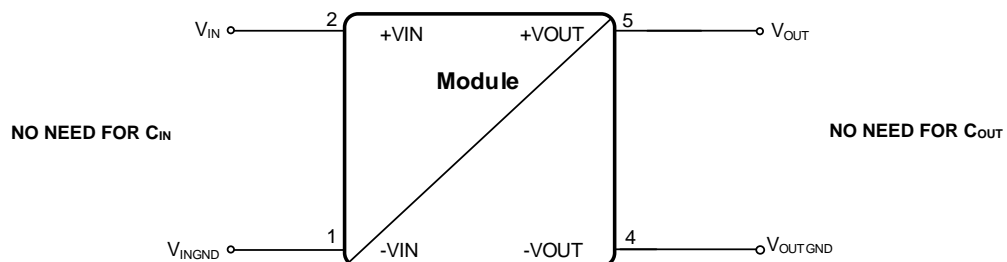
- 2kV DC functional isolation
- Current capability up to 0.2A
- Nominal input voltage rails: 3.3V / 5V / 12V
- Output voltage: 5V / 12V / 15V unregulated
- No minimum load required
- Continuous output power: 1W
- Integrated C_{IN}, C_{OUT} and transformer
- Low output voltage ripple:
typ. 65mV to 75mV at full load
- Output voltage accuracy: ±5% max.
- Operating frequency range: 50 kHz to 110 kHz
- Operating ambient temperature range:
- 40°C to 100°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

TYPICAL APPLICATIONS

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



TYPICAL CIRCUIT DIAGRAM



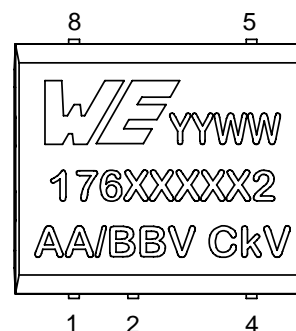
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MARKING DESCRIPTION

| MARKING | DESCRIPTION |
|-----------|----------------------------|
| WE | Würth Elektronik tradename |
| YY | Year |
| WW | Calendar week |
| 176xxxxx2 | Ordering code |
| AA | Input voltage |
| BB | Output voltage |
| C | Isolation voltage |



PIN DESCRIPTION

| SYMBOL | NUMBER | TYPE | DESCRIPTION |
|--------|--------|-------|----------------|
| - VIN | 1 | Power | Input ground |
| + VIN | 2 | Power | Input voltage |
| -VOUT | 4 | Power | Output ground |
| +VOUT | 5 | Power | Output voltage |
| N.C. | 8 | Power | Not connected |

ORDERING INFORMATION

| ORDER CODE | PART DESCRIPTION | SPECIFICATIONS | PACKAGE | PACKAGING UNIT |
|------------|------------------|----------------------------------------------------|------------|------------------|
| 176920502 | WPMIC9200502S | 3.3V _{IN} / 5V _{OUT} version | SMT-8 | Tape&Reel 500pcs |
| 176920512 | WPMIB9200502S | 5V _{IN} / 5V _{OUT} version | SMT-8 | Tape&Reel 500pcs |
| 176920522 | WPMIA9200502S | 12V _{IN} / 5V _{OUT} version | SMT-8 | Tape&Reel 500pcs |
| 176881212 | WPMIB9081202S | 5V _{IN} / 12V _{OUT} version | SMT-8 | Tape&Reel 500pcs |
| 176861512 | WPMIB9061502S | 5V _{IN} / 15V _{OUT} version | SMT-8 | Tape&Reel 500pcs |
| 17800FISM | | 3.3 to 12V _{IN} / 5 to 15V _{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 Technical support: powermodules@we-online.com |

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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 for 10s@10% Load | 3.3VIN / 5VOUT version, (176920502) | 2.64 | 3.96 | V |
| | | 5VIN / 5VOUT version, (176920512) | 4.00 | 5.75 | V |
| | | 12VIN / 5VOUT version, (176920522) | 9.60 | 13.8 | V |
| | | 5VIN / 12VOUT version, (176881212) | 4.00 | 5.75 | V |
| | | 5VIN / 15VOUT version, (176861512) | 4.00 | 5.75 | V |
| VOUT | Output pin voltage | 3.3VIN / 5VOUT version, (176920502) | 0 | 10 | V |
| | | 5VIN / 5VOUT version, (176920512) | | | V |
| | | 12VIN / 5VOUT version, (176920522) | 0 | 16 | V |
| | | 5VIN / 12VOUT version, (176881212) | | | V |
| | | 5VIN / 15VOUT version, (176861512) | | | 0 |
| V _{ISO} | Isolation voltage input to output, 100% tested for 1 second ⁽²⁾ | | - | 2000 | V |
| | Isolation voltage input to output 60 seconds ⁽⁶⁾ | | - | 1600 | V |
| | Continuous ⁽⁶⁾ | | - | 550 | V |
| T _{storage} | Assembled, non-operating storage temperature | | -55 | 125 | °C |
| V _{ESD} | ESD Voltage (Human Body Model), according to EN61000-4-2 ⁽¹²⁾ | | | ±2000 | V |

All parameters are specified after a 15 minutes run-in time unless otherwise noted.

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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 recommended ambient temperature range of **-40°C to 100°C**. Typical values represents statistically the utmost probability at following conditions: $T_A = 25^\circ\text{C}$, $V_{IN}=\text{nominal}$ $V_{OUT}=\text{nominal}$ $I_{OUT}=\text{nominal}$ unless otherwise noted.

| SYMBOL | PARAMETER | | MIN ⁽¹⁾ | TYP ⁽³⁾ | MAX ⁽¹⁾ | UNIT |
|-----------|---------------------------------------|--------------------------------------------------------------------------|--------------------|--------------------|--------------------|------|
| V_{IN} | Input voltage | 3.3 V_{IN} / 5 V_{OUT} version, (176920502) | 2.97 | 3.3 | 3.63 | V |
| | | 5 V_{IN} / 5 V_{OUT} version, (176920512) | 4.5 | 5 | 5.5 | |
| | | 5 V_{IN} / 12 V_{OUT} version, (176881212) | | | | |
| | | 5 V_{IN} / 15 V_{OUT} version, (176861512) | | | | |
| | | 12 V_{IN} / 5 V_{OUT} version, (176920522) | 10.8 | 12 | 13.2 | |
| V_{OUT} | Nominal output voltage | 3.3 V_{IN} / 5 V_{OUT} version, $I_{OUT} = 200\text{mA}$ (176920502) | 4.75 | 5 | 5.25 | V |
| | | 5 V_{IN} / 5 V_{OUT} version, $I_{OUT} = 200\text{mA}$ (176920512) | | | | |
| | | 12 V_{IN} / 5 V_{OUT} version, $I_{OUT} = 200\text{mA}$ (176920522) | | | | |
| | | 5 V_{IN} / 12 V_{OUT} version, $I_{OUT} = 84\text{mA}$ (176881212) | 11.40 | 12 | 12.60 | |
| | | 5 V_{IN} / 15 V_{OUT} version, $I_{OUT} = 66\text{mA}$ (176861512) | 14.25 | 15 | 15.75 | |
| I_{OUT} | Nominal output current ⁽⁴⁾ | 3.3 V_{IN} / 5 V_{OUT} version, (176920502) | 0 | - | 200 | mA |
| | | 5 V_{IN} / 5 V_{OUT} version, (176920512) | | | | |
| | | 12 V_{IN} / 5 V_{OUT} version, (176920522) | | | | |
| | | 5 V_{IN} / 12 V_{OUT} version, (176881212) | 0 | - | 84 | |
| | | 5 V_{IN} / 15 V_{OUT} version, (176861512) | 0 | - | 66 | |
| P_{OUT} | Nominal output power | 176xxxxx2 | - | - | 1 | W |

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| SYMBOL | PARAMETER | MIN ⁽¹⁾ | TYP ⁽³⁾ | MAX ⁽¹⁾ | UNIT |
|----------------------|-----------------------------------------------------------------------------------------|--------------------|--------------------|--------------------|------|
| C _{OUT MAX} | 3.3V _{IN} / 5V _{OUT} version, I _{OUT} = 200mA (176920502) | - | - | 1000 | μF |
| | 5V _{IN} / 5V _{OUT} version, I _{OUT} = 200mA (176920512) | | | | |
| | 12V _{IN} / 5V _{OUT} version, I _{OUT} = 200mA (176920522) | | | | |
| | 5V _{IN} / 12V _{OUT} version, I _{OUT} = 84mA (176881212) | - | - | 330 | |
| | 5V _{IN} / 15V _{OUT} version, I _{OUT} = 66mA (176861512) | - | - | 220 | |
| T _A | Ambient temperature range | -40 | - | 100 | °C |

All parameters are specified after a 15 minutes run-in time unless otherwise noted.

THERMAL SPECIFICATIONS

| SYMBOL | PARAMETER | TYP ⁽³⁾ | UNIT |
|-----------------------|-------------------------------------|--------------------|------|
| T _{case max} | Maximum Case Temperature (top side) | 110 | °C |

PACKAGE SPECIFICATIONS

| ITEM | PARAMETER | TYP ⁽²⁾ | UNIT |
|-----------|----------------------------------------------------------------------------------------|--------------------|------|
| Case | UL94V-0 (Refer to UL approval E150608) | - | - |
| φ (RH) | Operating humidity | 5 - 95 | % |
| Weight | | 1.0 | g |
| IP | Degree of protection according to IEC/EN 60529. | X0 | |
| Vibration | MIL-STD-202G: 5g's for 1 minute, 120 cycles each of 3 orientation, test from 10Hz-55Hz | | |

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ELECTRICAL SPECIFICATIONS

MIN and MAX limits are valid for the recommended ambient temperature range of **-40°C to 100°C**. Typical values represents statistically the utmost probability at following conditions: $T_A = 25^\circ\text{C}$, $V_{IN}=\text{nominal}$ $V_{OUT}=\text{nominal}$ $I_{OUT}=\text{nominal}$ unless otherwise noted.

| SYMBOL | PARAMETER | TEST CONDITIONS | MIN ⁽¹⁾ | TYP ⁽³⁾ | MAX ⁽¹⁾ | UNIT |
|----------------------------|----------------------------------------------|-----------------------------------------------------------------------------------------------------|--------------------|--------------------|--------------------|------------------|
| Output Current | | | | | | |
| I_{MOC} | Maximum Overload Current | $V_{OUT}=5\text{V}$ (1769205X2) for 5s | - | - | 300 ⁽⁷⁾ | mA |
| | | $V_{OUT}=12\text{V}$ (176881212) for 5s | - | - | 126 ⁽⁷⁾ | |
| | | $V_{OUT}=15\text{V}$ (176861512) for 5s | - | - | 99 ⁽⁷⁾ | |
| I_{CL} | Output current limit threshold | | - | - | No ⁽⁸⁾ | mA |
| Deviation | | | | | | |
| V_{OUT} | Line regulation | per 1.0% change in input voltage ⁽⁹⁾ | - | ± 1.2 | - | % |
| | Load regulation | 10% to 100% load current, 5V _{out} – see OUTPUT VOLTAGE TOLERANCE ENVELOPE | - | - | -1 +15 | % |
| | Output Voltage Accuracy | V_{in} nominal @ I_{out} nominal | - | -2% | ± 5 | % |
| | Output voltage ripple 5V _{OUT} | 20MHz BW, without external capacitor | - | 65 | - | mV _{pp} |
| | Output voltage ripple 12/15V _{OUT} | 20MHz BW, without external capacitor | - | 75 | - | mV _{pp} |
| Switching frequency | | | | | | |
| f_{sw} | Switching frequency | $V_{IN} = 3.3\text{V}$, $V_{OUT} = 5\text{V}$, $I_{OUT} = 200\text{mA}$ (176920502) | 50 | - | 110 | kHz |
| | | $V_{IN} = 5\text{V}$, $V_{OUT} = 5\text{V}$, $I_{OUT} = 200\text{mA}$ (176920512) | | | | |
| | | $V_{IN} = 12\text{V}$, $V_{OUT} = 5\text{V}$, $I_{OUT} = 200\text{mA}$ (176920522) | | | | |
| | | $V_{IN} = 5\text{V}$, $V_{OUT} = 12\text{V}$, $I_{OUT} = 84\text{mA}$ (176881212) | | | | |
| | | $V_{IN} = 5\text{V}$, $V_{OUT} = 15\text{V}$, $I_{OUT} = 66\text{mA}$ (176861512) | | | | |
| Input current | | | | | | |
| I_{IN} | No load input current (operating, switching) | $V_{IN} = 3.3\text{V}$, $V_{OUT} = 5\text{V}$, $I_{OUT} = 0\text{mA}$ (176920502) | - | 55 | - | mA |
| | | $V_{IN} = 5\text{V}$, $V_{OUT} = 5\text{V}$, $I_{OUT} = 0\text{mA}$ (176920512) | - | 33 | - | |
| | | $V_{IN} = 12\text{V}$, $V_{OUT} = 5\text{V}$, $I_{OUT} = 0\text{mA}$ (176920522) | - | 12 | - | |
| | | $V_{IN} = 5\text{V}$, $V_{OUT} = 12\text{V}$, $I_{OUT} = 0\text{mA}$ (176881212) | - | 33 | - | |
| | | $V_{IN} = 5\text{V}$, $V_{OUT} = 15\text{V}$, $I_{OUT} = 0\text{mA}$ (176861512) | - | 33 | - | |

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| SYMBOL | PARAMETER | TEST CONDITIONS | MIN ⁽¹⁾ | TYP ⁽³⁾ | MAX ⁽¹⁾ | UNIT |
|----------------------------------|------------------------------------------------|----------------------------------------------------------------------------------------|--------------------|--------------------|--------------------|------------------|
| I _{RRC} | Reflected Ripple Current ⁽¹⁰⁾ | V _{IN} = 3.3V, V _{OUT} = 5V, I _{OUT} = 200mA (176920502) | - | 75 | - | mA _{pp} |
| | | V _{IN} = 5V, V _{OUT} = 5V, I _{OUT} = 200mA (176920512) | - | 120 | - | |
| | | V _{IN} = 12V, V _{OUT} = 5V, I _{OUT} = 200mA (176920522) | - | 50 | - | |
| | | V _{IN} = 5V, V _{OUT} = 12V, I _{OUT} = 84mA (176881212) | - | 55 | - | |
| | | V _{IN} = 5V, V _{OUT} = 15V, I _{OUT} = 66mA (176861512) | - | 65 | - | |
| Efficiency | | | | | | |
| η | Efficiency | V _{IN} = 3.3V, V _{OUT} = 5V, I _{OUT} = 200mA (176920502) | - | 75 | - | % |
| | | V _{IN} = 5V, V _{OUT} = 5V, I _{OUT} = 200mA (176920512) | - | 75 | - | |
| | | V _{IN} = 12V, V _{OUT} = 5V, I _{OUT} = 200mA (176920522) | - | 73 | - | |
| | | V _{IN} = 5V, V _{OUT} = 12V, I _{OUT} = 84mA (176881212) | - | 76 | - | |
| | | V _{IN} = 5V, V _{OUT} = 15V, I _{OUT} = 66mA (176861512) | - | 76 | - | |
| Isolation characteristics | | | | | | |
| C _{ISO} | Isolation capacitance | | - | - | 75 | pF |
| R _{ISO} | Isolation resistance V _{ISO} =500V | | 10 | - | - | GΩ |

All parameters are specified after a 15 minutes run-in time unless otherwise noted.

RELIABILITY

| SYMBOL | PARAMETER | CONDITIONS | MIN ⁽¹⁾ | TYP ⁽³⁾ | MAX ⁽¹⁾ | UNIT |
|----------------------|----------------------------|-----------------------|-----------------------|--------------------|--------------------|------|
| MTBF ⁽¹¹⁾ | Mean Time Between Failures | +25°C: Ground Benign | 3000 x10 ³ | | | h |
| | | +100°C: Ground Benign | 950 x10 ³ | | | h |

APPROVALS

| SYMBOL | STANDARD | DESCRIPTION |
|-------------------------------------------------------------------------------------|---------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | UL60950-1, 2 nd Edition, 2007-03-27 | Recognized for use as Information Technology Equipment, U.S.A. (UL60950-1) and Canada (C22.2 No. 60950-1) E-File: E487909 Applicable for altitudes up to 2000m |

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**RoHS, REACH**

| | | |
|-----------------|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RoHS Directive | | 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) Test voltage as defined by the UL60950-1.
- (3) Typical numbers are valid at 25°C ambient temperature and represent statistically the utmost probability assuming the Gaussian distribution.
- (4) Depending on temperature, see thermal derating diagram ([OUTPUT POWER](#)).
- (5) Measured without heatsink, still air. (0 – 20LFM / 0 – 0.1m/s)
Test PCB 100mmx160mm horizontal orientation 105um copper on top and bottom
- (6) Not production tested. The insulation equivalence is a rated value and based on indicative nature.
- (7) Overload current, see [IMOC DUTY CYCLE](#) & [IMOC TEMPERATURE DERATING](#)
- (8) The module output is not current limited or short circuit protected. Continuous operation above the nominal output current will damage the device.
- (9) Within the complete V_{IN} tolerance range.
- (10) Peak-to-peak input ripple current
- (11) MIL-HDBK-217F; GB Ground, Benign: Non mobile, temperature and humidity controlled environments readily accessible to maintenance; includes laboratory instruments and test equipment, medical electronic equipment, business and scientific computer complexes, and missiles and support equipment in ground silos; MTBF value is referring to 176xxxxx2
- (12) The human body model is a 100pF capacitor discharged through a 1.5 kΩ resistor into each pin. Test method is per JESD-22-114.

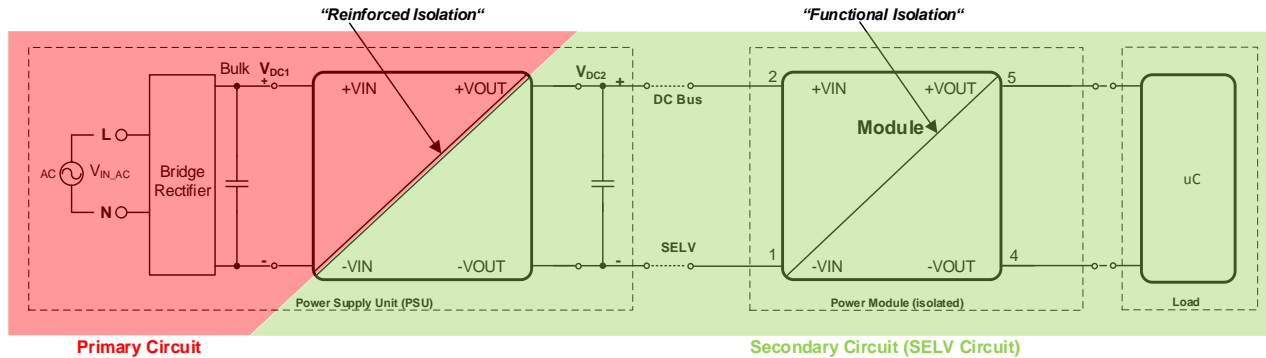
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INTENDED USE – Typical Application



The 176xxxxx2 MagI³C power modules are only intended to be used as a CLASS III equipment according to the UL60950-1 standard. That requires that the power module is supplied by a **SELV** (safe extra low voltage) 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 ≥ 60 Vdc) 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 does not protect 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 an 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 all 100% production tested at their stated isolation voltage. This is 2kVDC for 1 second.

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 to prevent any user-accessible circuitry from causing harm.

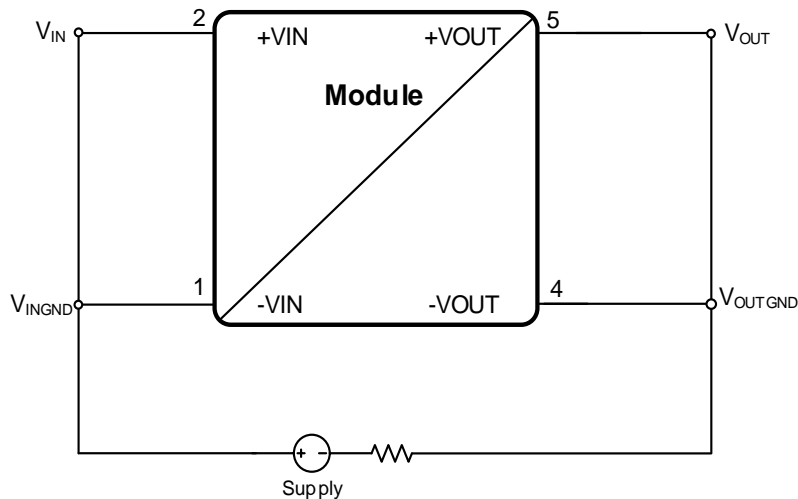
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DIELECTRIC STRENGTH TEST SETUP (HIGH POT TEST)

Connect all input – and output terminals together (see figure below) before connecting the supply voltage. When testing, set the cut-off current to 1mA.



Parameters Supply Device: Current limit set 1mA, Test voltage 2000Vdc, Test time 1sec.

REPEATED HIGH-VOLTAGE ISOLATION TESTING

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

The primary and secondary windings within this transformer are enameled (coated) but do not possess additional isolation. Typically, parts can withstand many times 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).

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TYPICAL PERFORMANCE CURVES

If not otherwise specified, the following conditions apply: T_{AMB} = 25°C.

RADIATED AND CONDUCTED EMISSIONS (WITH EMI INPUT FILTER)

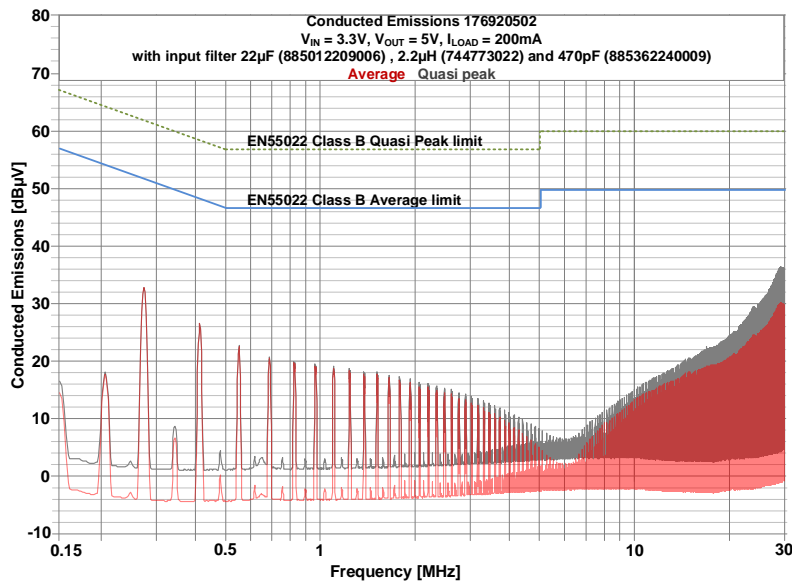
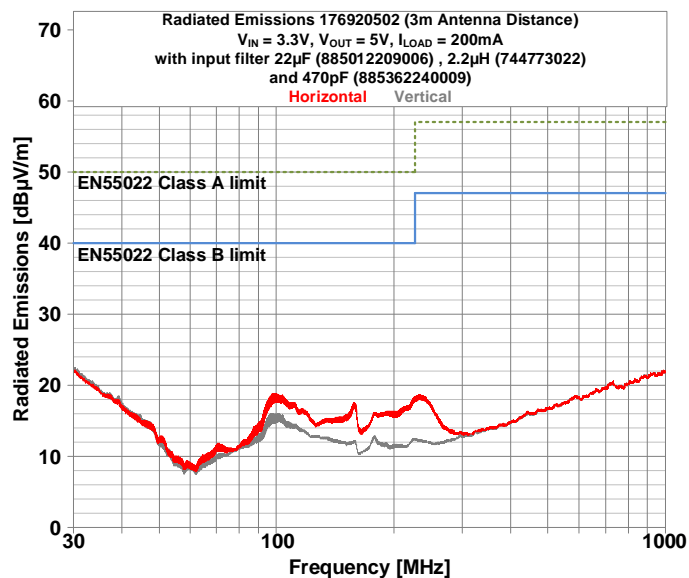
The 176xxxxx2 power module was tested in several EMC configurations to give more realistic information about implementation in the applications. The test setup is based on CISPR16 with the limit values of CISPR32

FILTER SETUP – MLCC capacitors

Application specific connection – Using an MLCC based filter

Input cable length of 80cm, the resistive load is connected close to the output of the power module

3.3V → 5V (176920502)

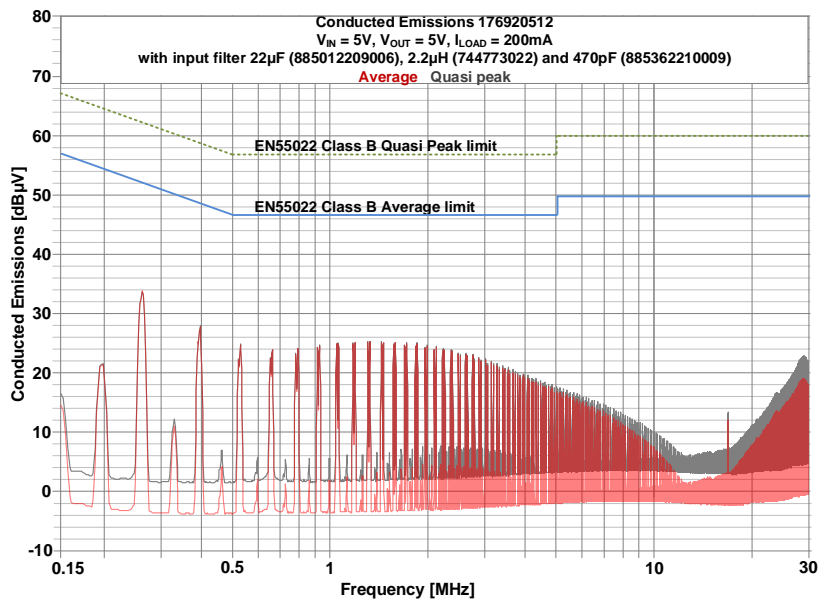
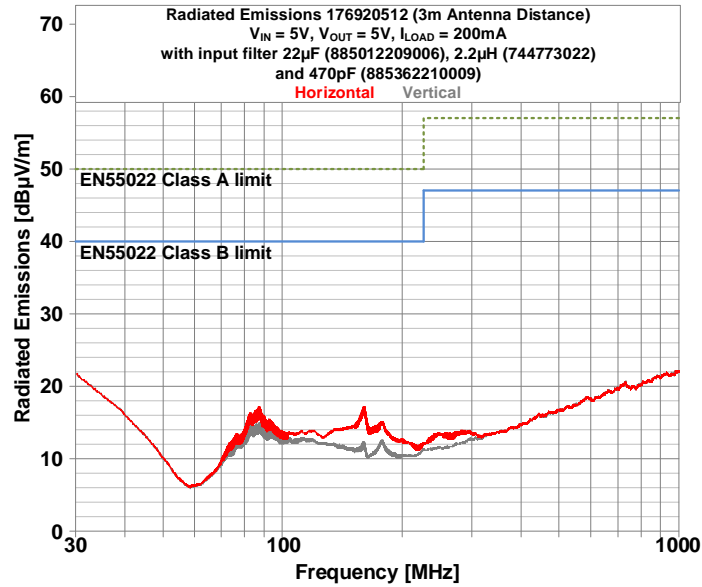


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5V → 5V (176920512)

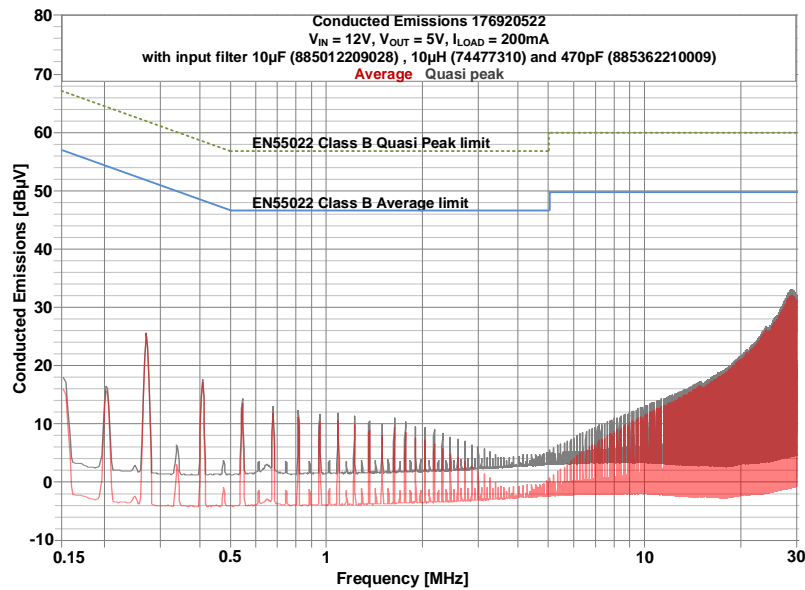
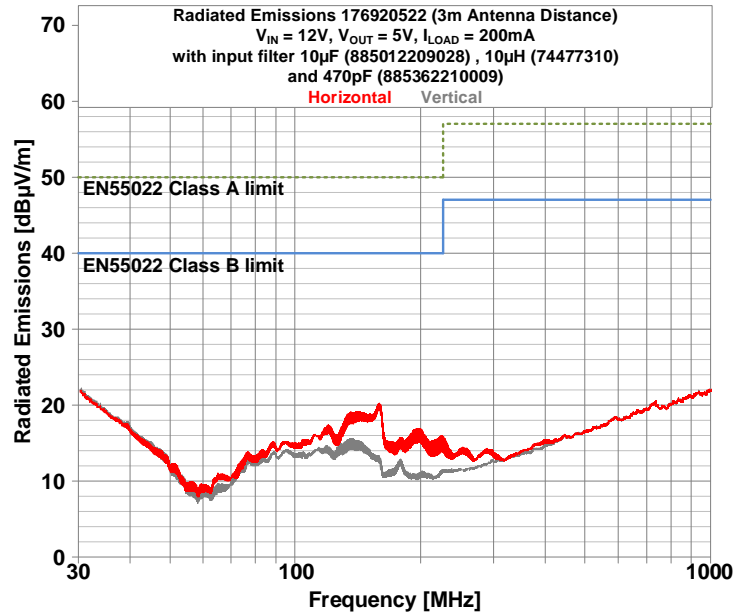


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12V → 5V (176920522)

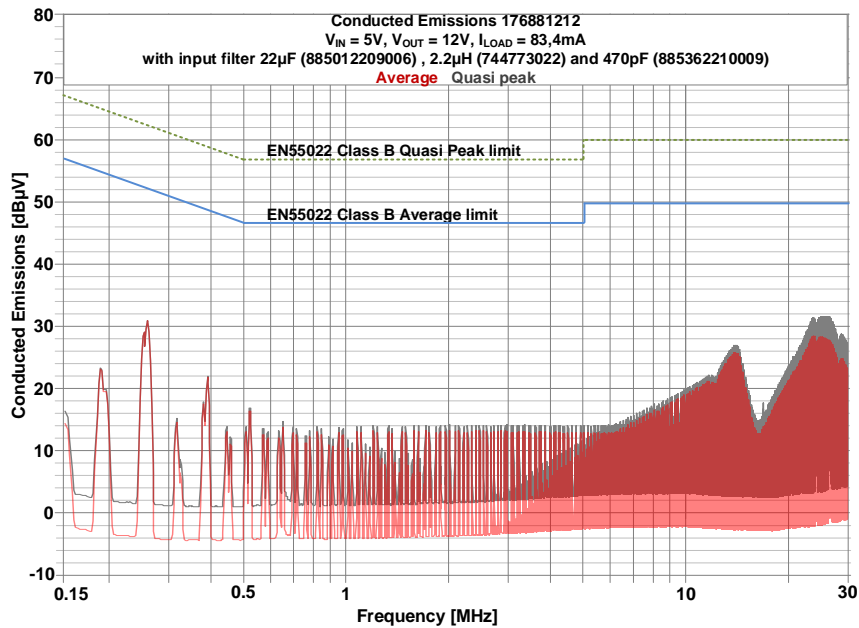
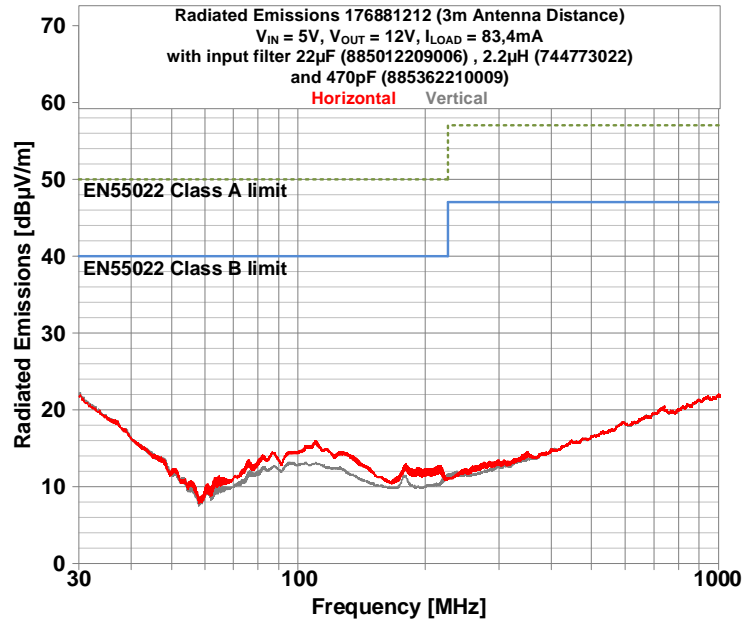


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5V → 12V (176881212)

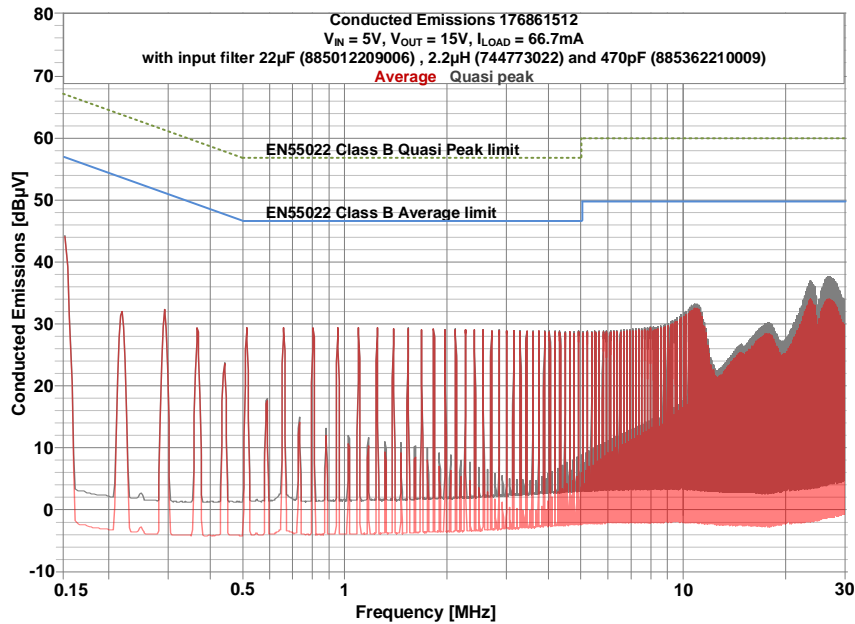
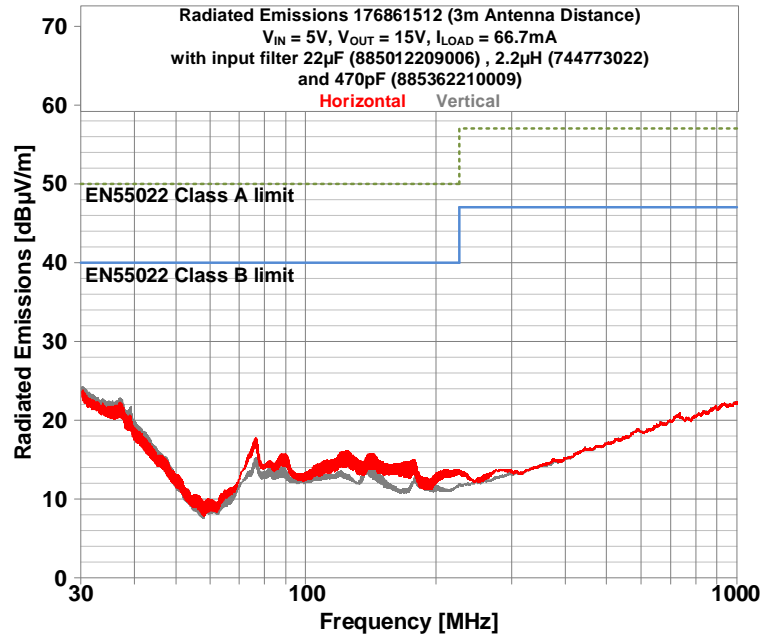


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FISM – Fixed Isolated SMT Module



5V → 15V (176861512)



1769205x2, 176881212, 176861512

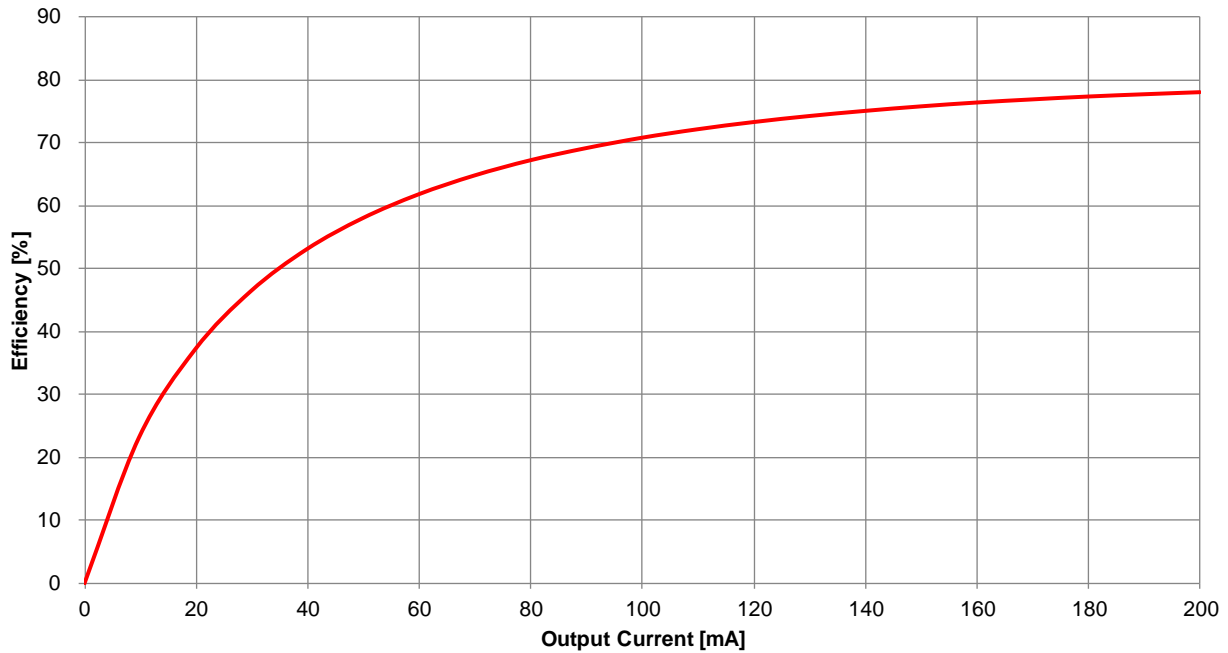
MagI³C Power Module
FISM – Fixed Isolated SMT Module



EFFICIENCY

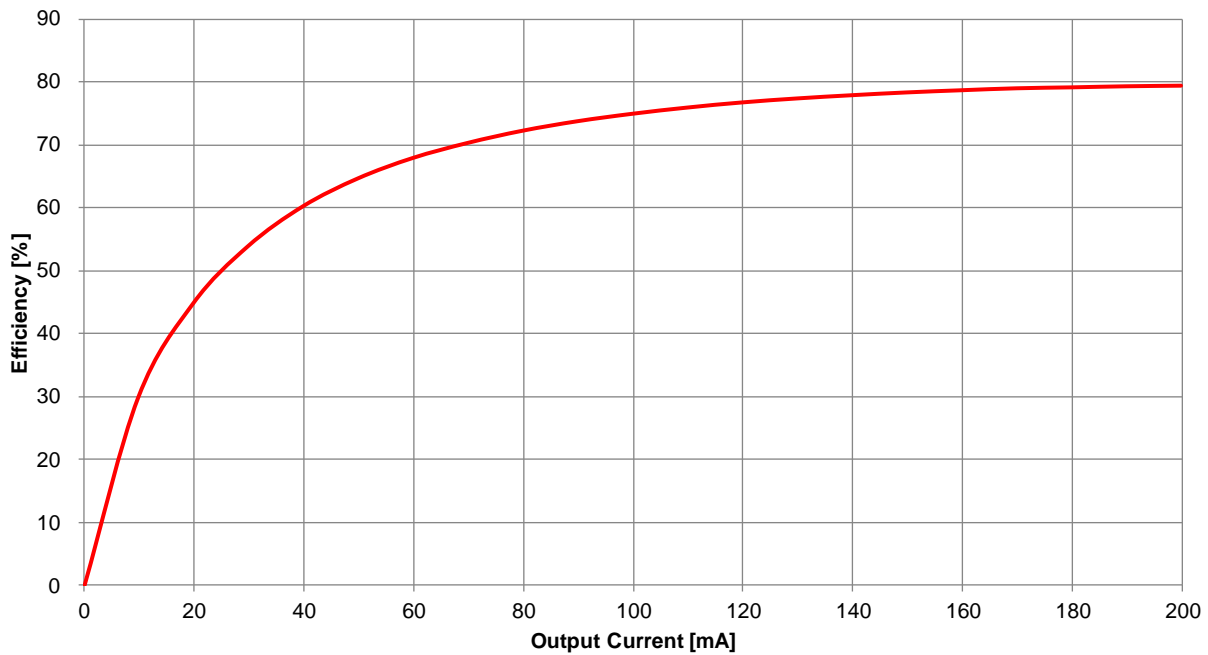
176920502 Efficiency - $V_{IN} = 3.3V$, $T_A = 25^\circ C$

— $V_{OUT} = 5V$



176920512 Efficiency - $V_{IN} = 5V$, $T_A = 25^\circ C$

— $V_{OUT} = 5V$



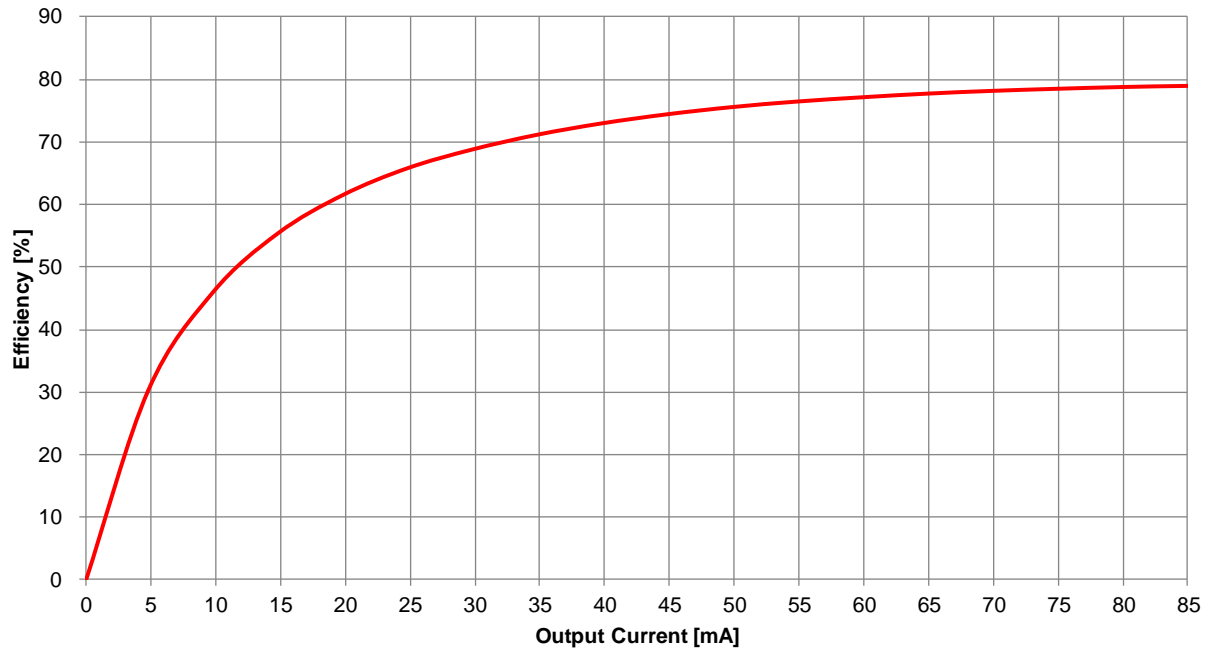
1769205x2, 176881212, 176861512

MagI³C Power Module
FISM – Fixed Isolated SMT Module



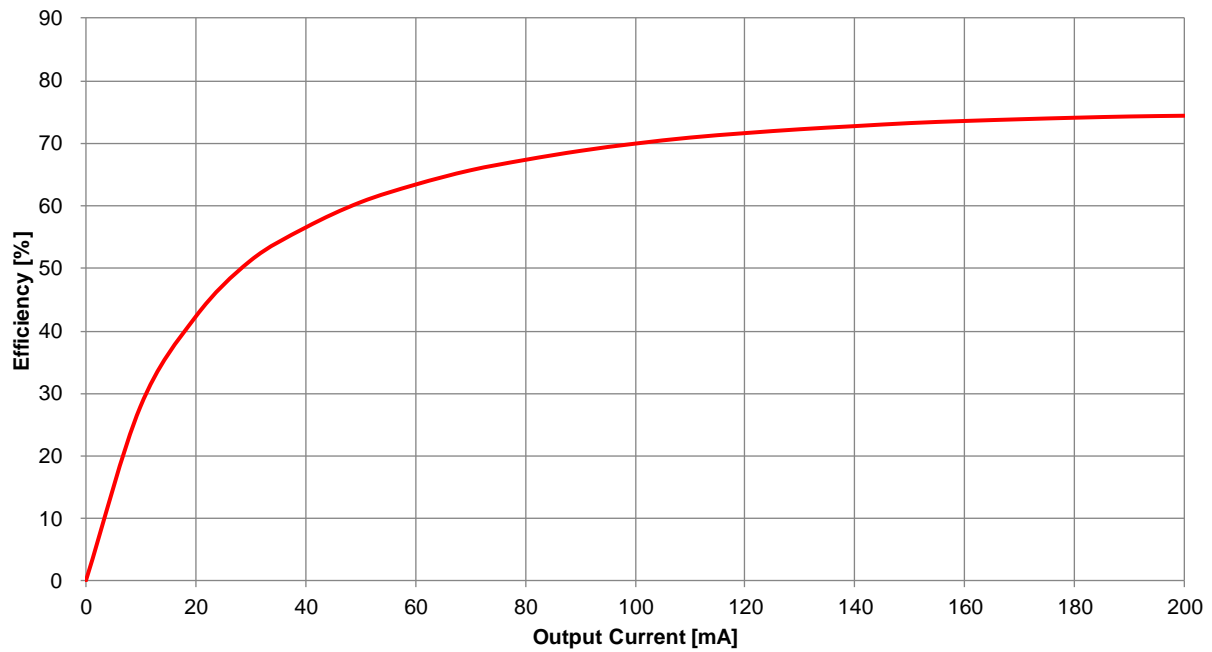
176881212 Efficiency - $V_{IN} = 5V$, $T_A = 25^\circ C$

— $V_{OUT} = 12V$



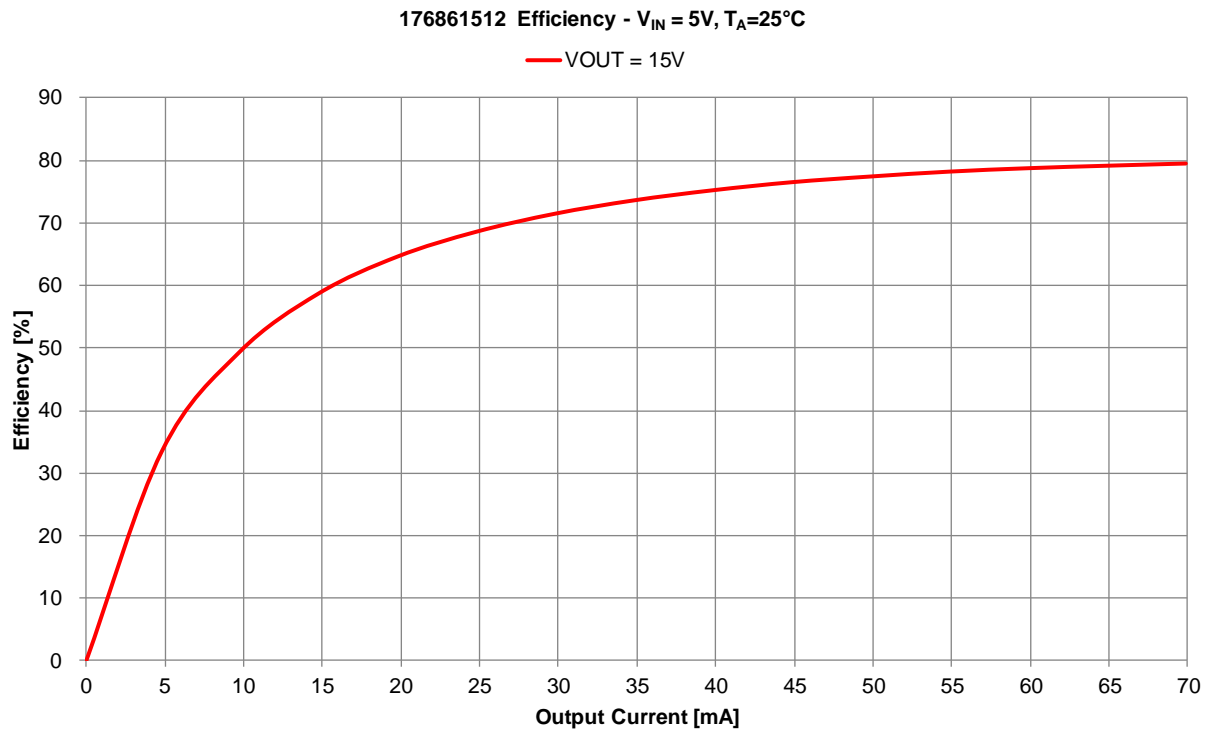
176920522 Efficiency - $V_{IN} = 12V$, $T_A = 25^\circ C$

— $V_{OUT} = 5V$



1769205x2, 176881212, 176861512

MagI³C Power Module
FISM – Fixed Isolated SMT Module

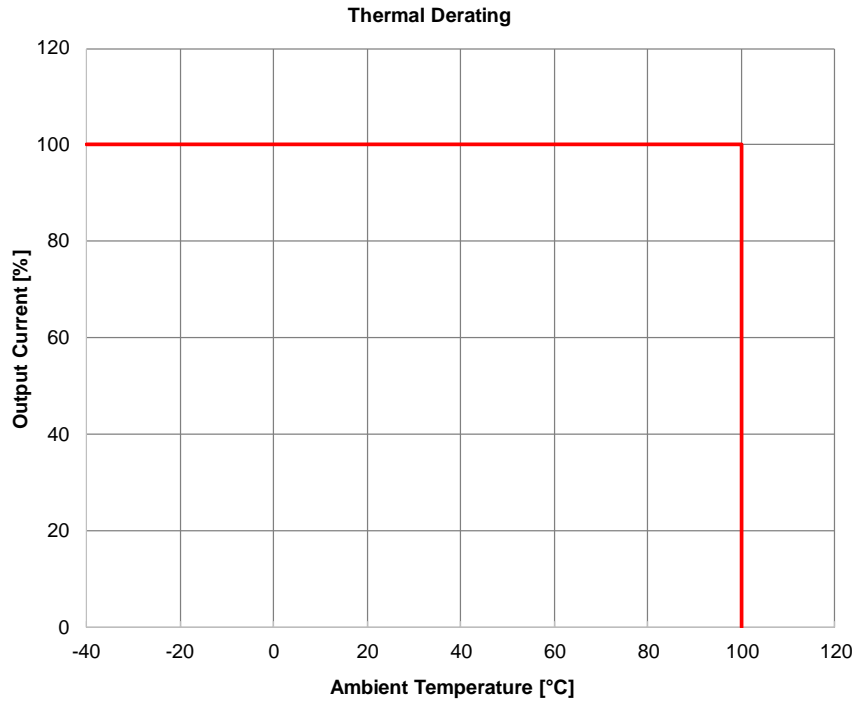


1769205x2, 176881212, 176861512

MagI³C Power Module
FISM – Fixed Isolated **SMT** Module

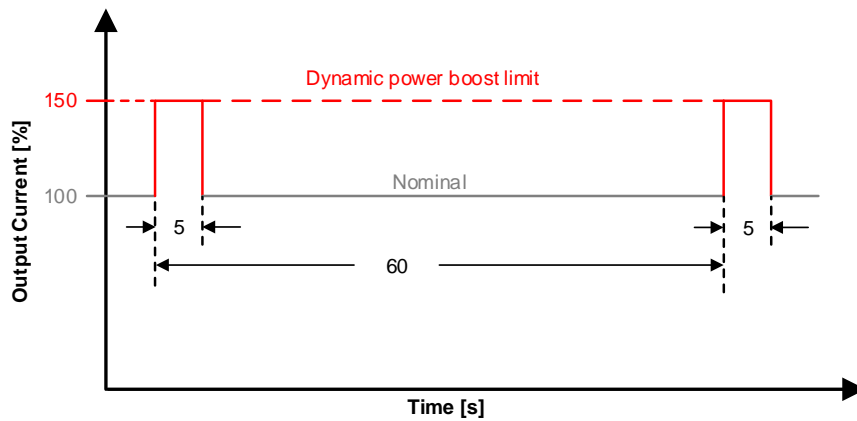


OUTPUT POWER



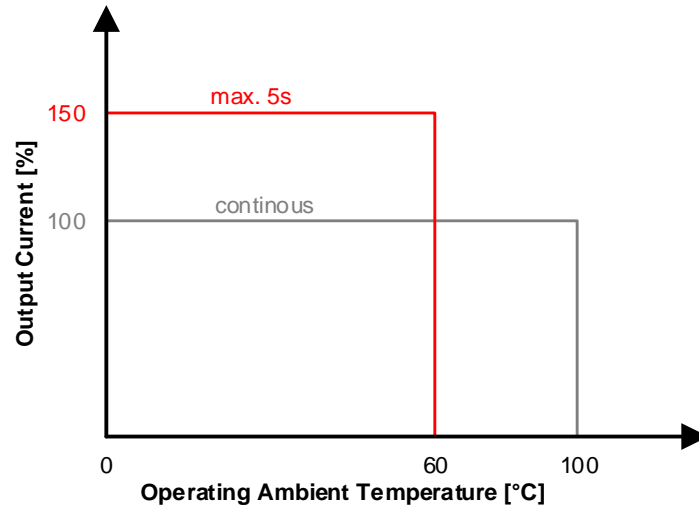
Note: Still air (0 – 20LFM / 0 – 0.1m/s)

I_{MOC} DUTY CYCLE



Note: The overload current of 150% of I_{OUT} can be supplied for maximum 5s and requires a 55s recovery time till next overload event.

1769205x2, 176881212, 176861512

MagI³C Power Module
FISM – Fixed Isolated SMT Module**I_{MOC} TEMPERATURE DERATING****Note:** Still air (0 – 20LFM / 0 – 0.1m/s)

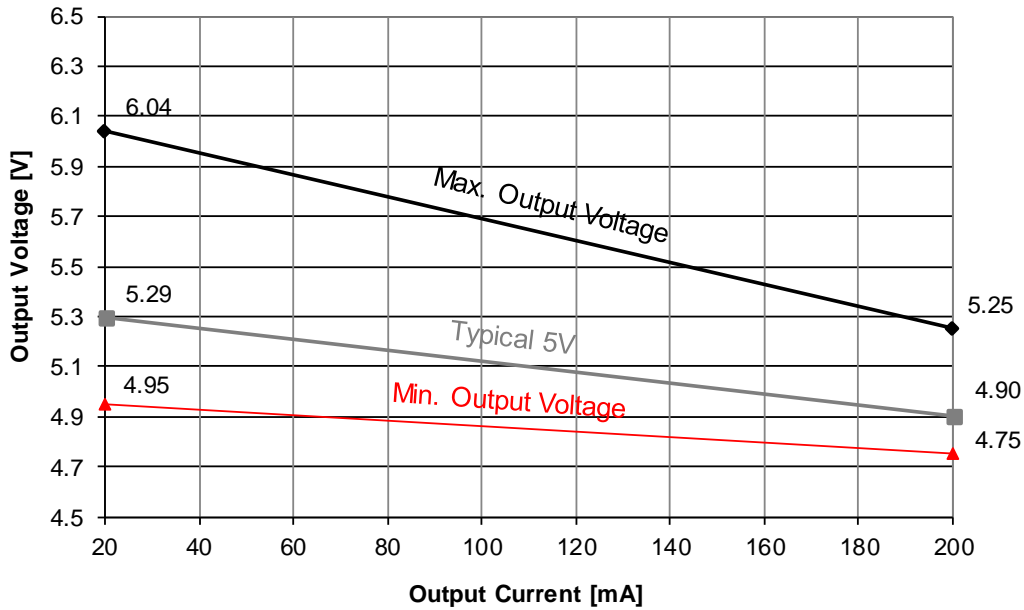
1769205x2, 176881212, 176861512

Magl³C Power Module
FISM – Fixed Isolated SMT Module

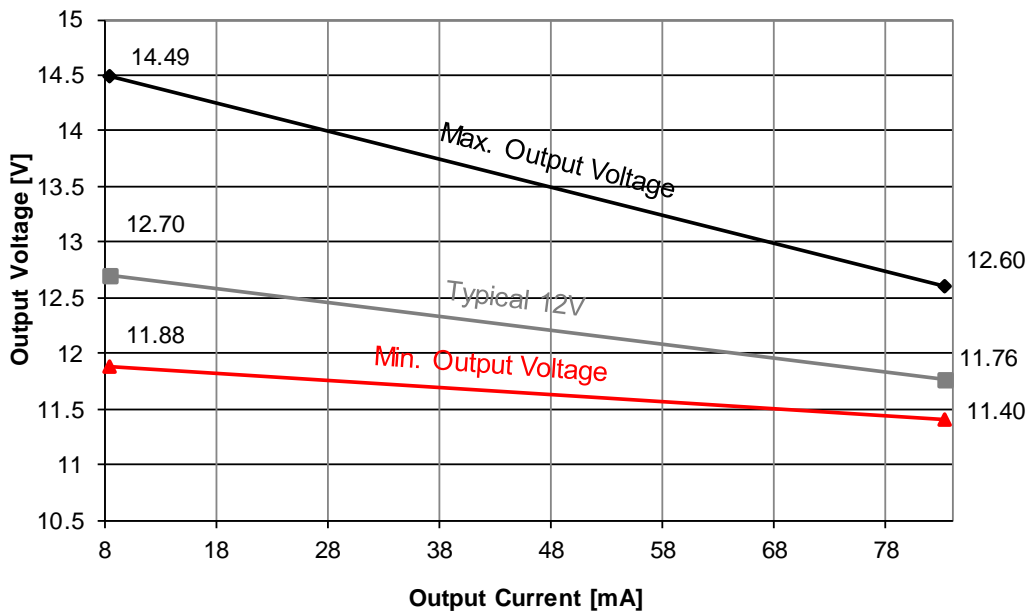


OUTPUT VOLTAGE TOLERANCE ENVELOPE

$V_{IN}=3.3V$ (176920502), $5V$ (176920512), $12V$ (176920522) $V_{OUT}=5V$



$V_{IN}=5V$ (176881212) $V_{OUT}=12V$

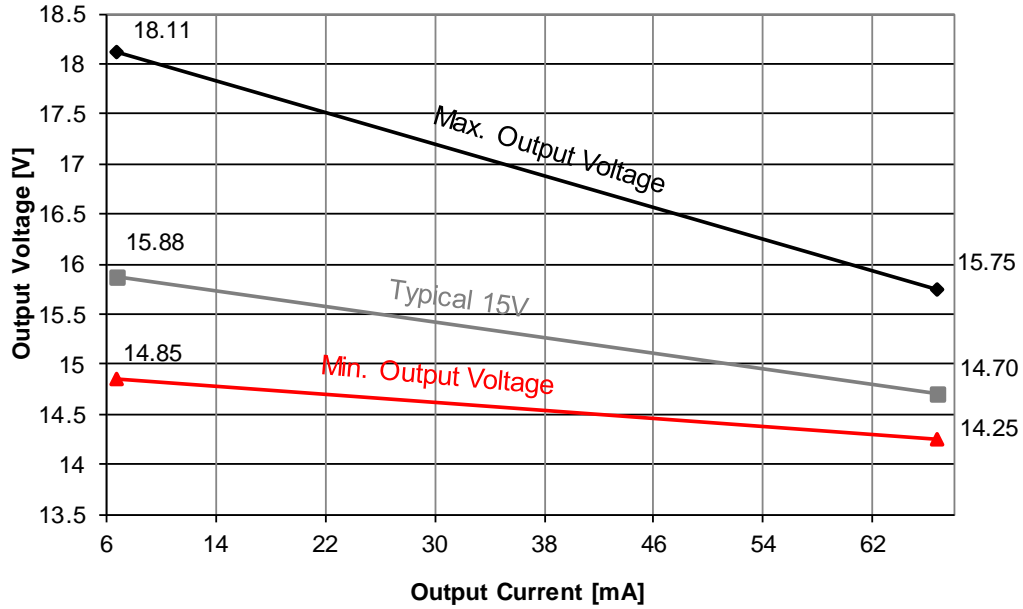


1769205x2, 176881212, 176861512

MagI³C Power Module
FISM – Fixed Isolated SMT Module



$V_{IN}=5V$ (176861512) $V_{OUT}=15V$



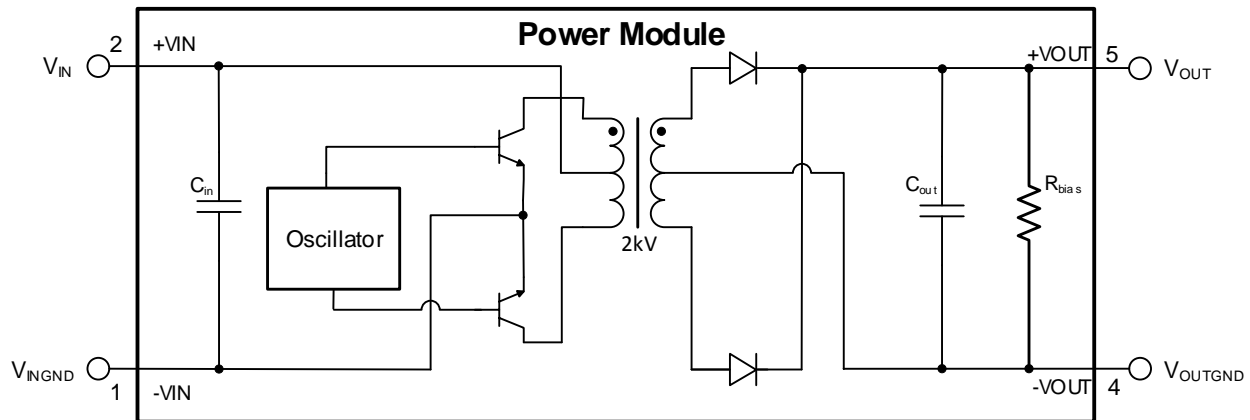
Note: Output voltage may exceed +25% of nominal output voltage at zero load

1769205x2, 176881212, 176861512

MagI³C Power Module
FISM – Fixed Isolated SMT Module



BLOCK DIAGRAM



| ORDERCODE | SPECIFICATION | C _{in} | C _{out} | R _{bias} |
|-----------|----------------------------------------|-----------------|------------------|-------------------|
| 176920502 | 3.3V _{IN} / 5V _{OUT} | 1uF | 1uF | 22k |
| 176920512 | 5V _{IN} / 5V _{OUT} | 1uF | 1uF | 22k |
| 176920522 | 12V _{IN} / 5V _{OUT} | 0.47uF | 1uF | 22k |
| 176881212 | 5V _{IN} / 12V _{OUT} | 1uF | 0.47uF | 55k |
| 176861512 | 5V _{IN} / 15V _{OUT} | 1uF | 0.22uF | 68k |

CIRCUIT DESCRIPTION

The MagI³C power modules 177XXXXX2 are based on a push–pull converter with integrated transistors, rectifying diodes, input and output capacitors and a transformer. The output voltage is unregulated.

Since there is no feedback path from the output to the input, the duty cycle is fixed at 50% and is independent of the load (zero load to full load). The output voltage is defined by the turns ratio of the transformer.

PROTECTIVE FEATURES

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

- Over temperature protection (OTP)
- Overcurrent protection (OCP)
- Output overvoltage protection (OVP)
- Input overvoltage protection
- Short circuit protection (SCP)
- Input reverse polarity protection

Note: To protect the source and the MagI³C power module in abnormal conditions (e.g. secondary side overload or short circuit) a primary side input fuse (slow blow) is recommended.

1769205x2, 176881212, 176861512

MagI³C Power Module
FISM – Fixed Isolated **SMT** Module

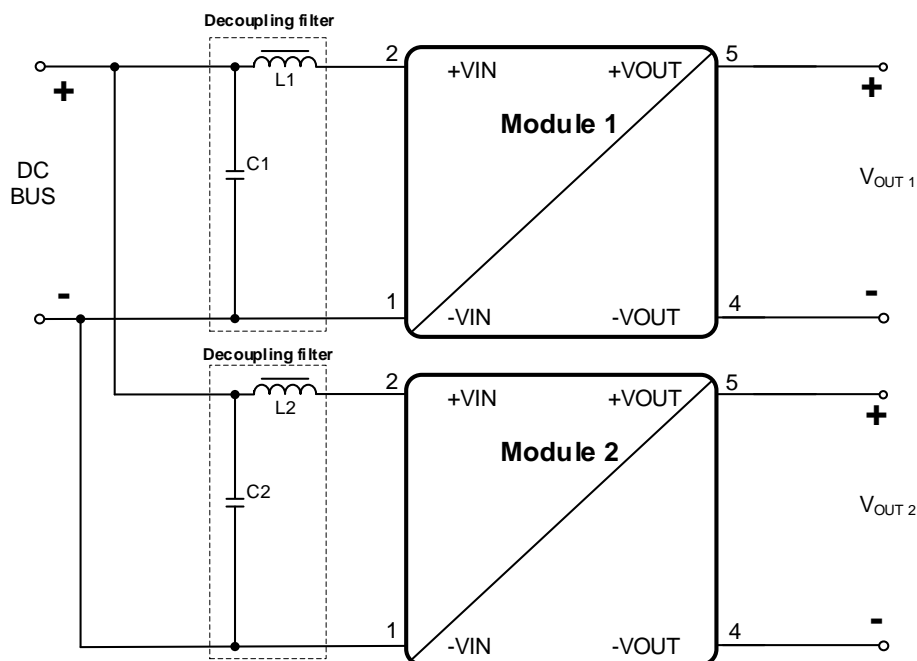


APPLICATION CONSIDERATIONS

Primary side parallel connection

A standard industrial configuration is, that the power modules are supplied by a dc bus voltage. When using multiple modules connected to a single dc bus voltage the individual module inputs have to be decoupled by LC filters. The LC filter reduces the likelihood of oscillations due to parasitics of a layout/routing. Therefore, it is not recommended to connect power modules in parallel on the primary side without an LC filter.

The outputs are not connected to each other and could have individual voltages V_{OUT1} and V_{OUT2} .



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.

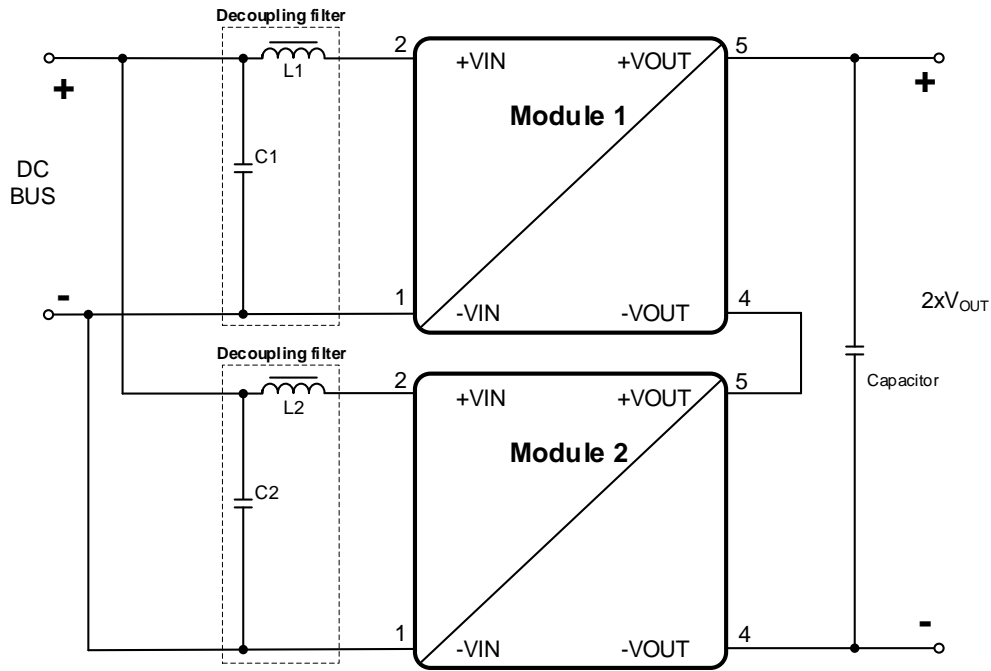
1769205x2, 176881212, 176861512

MagI³C Power Module
FISM – Fixed Isolated SMT Module



Secondary side serial connection

To generate higher output voltage/special rail voltages it is possible to put the outputs of the 176xxxxx2 in series. It is common practice to connect an additional capacitor between the +VOUT and -VOUT.



When using multiple modules connected to a single dc bus voltage the individual module inputs have to be decoupled by LC filters. The LC filter reduces the likelihood of oscillations due to parasitics of a layout/routing. Therefore, it is not recommended to connect power modules in parallel on the primary side without an LC filter. See also [Primary side parallel connection](#) on page 25.

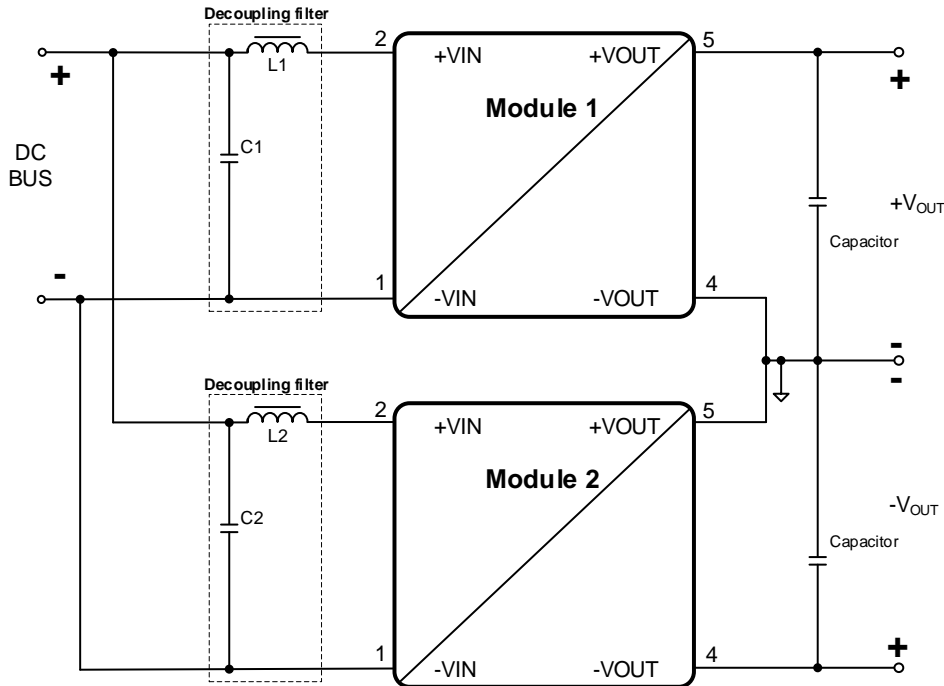
1769205x2, 176881212, 176861512

MagI³C Power Module
FISM – Fixed Isolated SMT Module



Generating Complementary Output Voltages

Another common requirement in industrial applications is to provide a complementary voltage (e.g. $\pm 5V$). The circuit below shows how this target can be achieved simply combining a 176xxxxx2 used in a standard configuration (delivering a positive output voltage) with a 176xxxxx2 in a reverse configuration. It is a common practice to connect an additional capacitor across each output voltage.

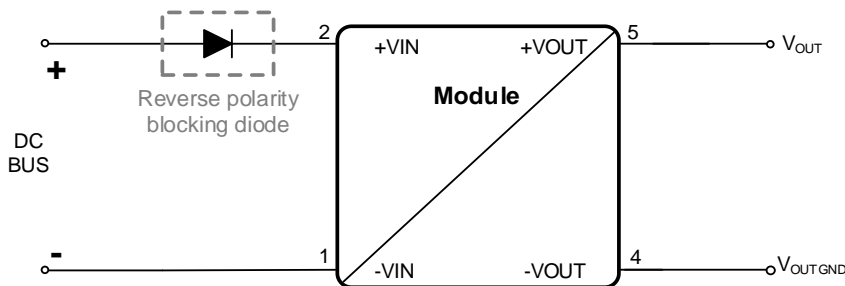


When using multiple modules connected to a single dc bus voltage the individual module inputs have to be decoupled by LC filters. The LC filter reduces the likelihood of oscillations due to parasitics of a layout/routing. Therefore, it is not recommended to connect power modules in parallel on the primary side without an LC filter. See also [Primary side parallel connection](#) on page 25.

Note: The decoupling filters are present to avoid oscillations between the two power modules. These filters don't replace the EMI input filter.

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.

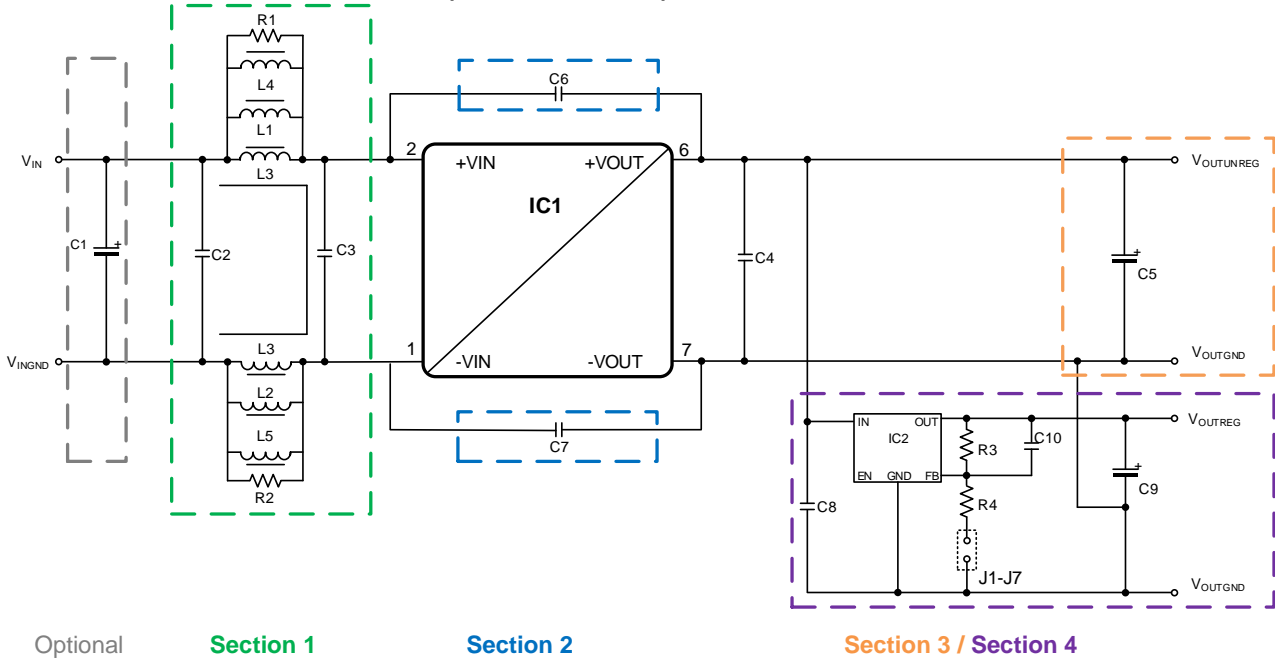


1769205x2, 176881212, 176861512

Magl³C Power Module
FISM – Fixed Isolated SMT Module



EVALUATION BOARD SCHEMATIC (17800VISM v.1.0)



EMI Section – Section 1 & Section 2

The FISM 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 – green: | |
|--------------------|--------------|
| Filter type | Description |
| DM | C2 + L1 |
| DM (PI) | C2 + L1 + C3 |
| DM | C2 + L2 |
| DM (PI) | C2 + L2 + C3 |
| CM | L1+L2 |
| CM | L3 |
| DM | C2 + L4 |
| DM (PI) | C2 + L4 + C3 |
| DM | C2 + L5 |
| DM (PI) | C2 + L5 + C3 |
| CM | L4 + L5 |

| Section 2 – blue: | |
|-------------------|-------------|
| Filter type | Description |
| CM (Y-Cap) | C6 |
| CM (Y-Cap) | C7 |
| CM (Y-Cap) | C6 + C7 |

Beside these two basic filter topologies, mixed versions (section 1 + section 2) 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.

1769205x2, 176881212, 176861512

Magl³C Power Module
FISM – Fixed Isolated SMT Module

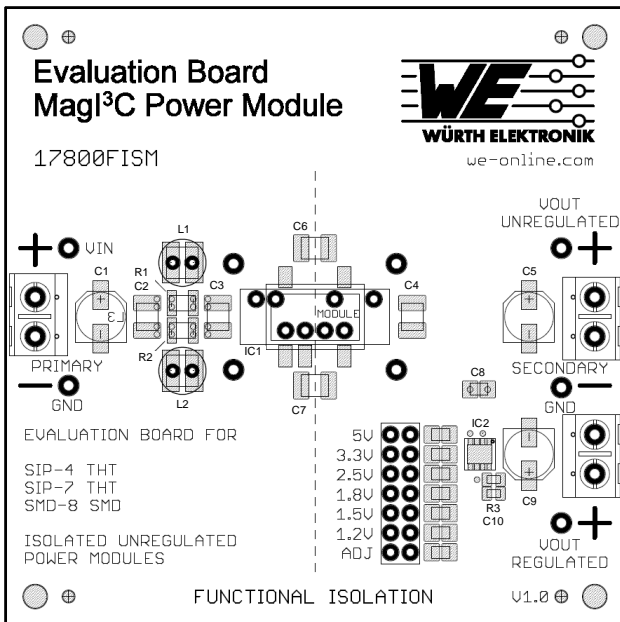


Post regulation option – Section 3 & Section 4

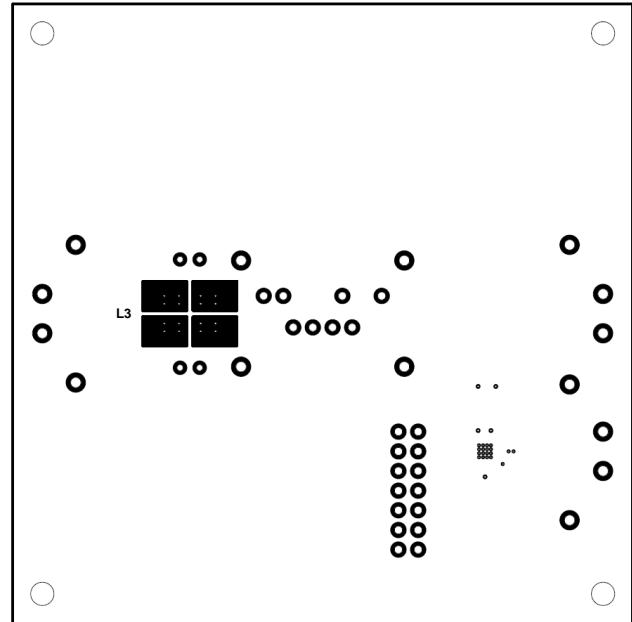
| FEATURE | DESCRIPTION |
|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Regulated output voltage | Output voltage accuracy at 100% load, V_{IN} nominal without LDO $\pm 5\%$ (max) with LDO $\pm 3\%$ (max.) Low dropout voltage: 180mV typical at 200 mA 5V out unregulated turns into 5V out regulated |
| Adjustable output voltage | 5V / 5V standard module turns into 5V / V_{OUT} adjustable |
| Continuous short circuit protection | LDO output is capable of continuous short circuit |

Note: Capacitor C10 is not necessary for operation.

TOP LAYER



BOTTOM LAYER



Bill of Material

| REF. DES. | DESCRIPTION | QUANTITY | ORDER CODE | MANUFACTURER |
|-----------|----------------------------------------------------------------------------|----------|---------------------------------------|-------------------|
| IC1 | FISM Magl ³ C power module | 1 | 176xxxxx2, 1779205x1, 1779205x4 | Würth Elektronik |
| IC2 | Micropower, 200-mA Ultra-Low-Dropout Fixed or Adjustable Voltage Regulator | 1 | LP2986 | Texas Instruments |
| C1 | Aluminum electrolytic capacitor, WCAP-ASLU family, 33 μ F/50V | 1 | 865090645012 | Würth Elektronik |
| C2 | Ceramic chip capacitor WCAP-CSGP 50V 1210 X7R (not mounted) | optional | 885012209XXX | Würth Elektronik |
| C3 | Ceramic chip capacitor WCAP-CSGP 50V 1210 X7R (not mounted) | optional | 885012209XXX | Würth Elektronik |

1769205x2, 176881212, 176861512

MagI³C Power Module
FISM – Fixed Isolated SMT Module


| REF. DES. | DESCRIPTION | QUANTITY | ORDER CODE | MANUFACTURER | |
|-----------|-------------------------------------------------------------|-----------------------------------------------------------------------------------|--------------|------------------|---------|
| C4 | Ceramic chip capacitor WCAP-CSGP 50V 1210 X7R (not mounted) | optional | 885012209XXX | Würth Elektronik | |
| C5 | Aluminum electrolytic capacitor, WCAP-ASLU family, 33µF/50V | 1 | 865090645012 | Würth Elektronik | |
| C6 | Ceramic chip capacitor WCAP-CSSA family 1808 (not mounted) | optional | 885362XXXXXX | Würth Elektronik | |
| C7 | Ceramic chip capacitor WCAP-CSSA family 1808 (not mounted) | optional | 885362XXXXXX | Würth Elektronik | |
| C8 | Ceramic chip capacitor WCAP-CSGP 16V 0805 X7R | 1 | 885012107014 | Würth Elektronik | |
| C9 | Aluminum electrolytic capacitor, WCAP-ASLU family, 33µF/50V | 1 | 865090645012 | Würth Elektronik | |
| C10 | (not mounted) | optional | | Würth Elektronik | |
| L1 | Filter inductor e.g. WE-PD2 (not mounted) | optional | 7447730XX | Würth Elektronik | |
| L2 | Filter inductor e.g. WE-PD2 (not mounted) | optional | 7447730XX | Würth Elektronik | |
| L3 | Common mode choke e.g. WE-SL1 (not mounted) | optional | 744212XXX | 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 | |
| R1 | SMD bridge 0Ω resistance 0603/0805 | 1 | - | Various | |
| R2 | SMD bridge 0Ω resistance 0805 | 1 | - | Various | |
| R3 | SMD 1kΩ resistor 0805 | 1 | - | Various | |
| R4 | Set by jumper | 4k42 Ω for V _{OUT} = 1.5V | 1 | - | Various |
| | | 2k10 Ω for V _{OUT} = 1.8V | 1 | - | Various |
| | | 953Ω for V _{OUT} = 2.5V | 1 | - | Various |
| | | 590Ω for V _{OUT} = 3.3V | 1 | - | Various |
| | | 324Ω for V _{OUT} = 5V | 1 | - | Various |
| | | For adjustable V _{OUT} : $V_{OUT} = \left(\frac{R_3}{R_4} + 1\right)$ | optional | - | Various |
| J1 | Jumper for selecting the output voltage | 1 | 609976302001 | Würth Elektronik | |

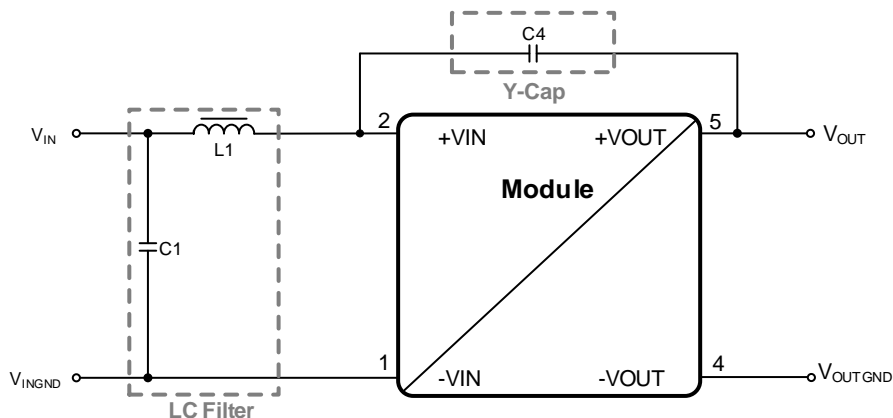
1769205x2, 176881212, 176861512

MagI³C Power Module
FISM – Fixed Isolated SMT Module



Filter Suggestions 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 pages 12 to 16 [RADIATED AND CONDUCTED EMISSIONS \(WITH EMI INPUT FILTER\)](#)).



MLCC based filter

Model: 3.3V → 5V; 5V → 5V; 5V → 12V; 5V → 15V

| DESIGNATOR | DESCRIPTION | FILTER | ORDER CODE | MANUFACTURER |
|------------|--------------------------------------------------------------------|--------|--------------|------------------|
| C1 | Ceramic chip capacitor 22μF/10V 1210 X7R | LC | 885012209006 | Würth Elektronik |
| L1 | Filter inductor, 2.2μH, PD2 family | | 744773022 | Würth Elektronik |
| C4 | Ceramic chip capacitor 470pF/250Vac/2500V Impulse Voltage 1808 X7R | Y-Cap | 885362210009 | Würth Elektronik |

Model: 12V → 5V

| DESIGNATOR | DESCRIPTION | FILTER | ORDER CODE | MANUFACTURER |
|------------|--------------------------------------------------------------------|--------|--------------|------------------|
| C1 | Ceramic chip capacitor 10μF/25V 1210 X7R | LC | 885012209028 | Würth Elektronik |
| L1 | Filter inductor, 10μH, PD2 family | | 74477310 | Würth Elektronik |
| C4 | Ceramic chip capacitor 470pF/250Vac/2500V Impulse Voltage 1808 X7R | Y-Cap | 885362210009 | Würth Elektronik |

POLYMER CAP based filter

As a replacement for C1 and L1 following parts can be used for all models (176xxxxx2)

| DESIGNATOR | DESCRIPTION | FILTER | ORDER CODE | MANUFACTURER |
|------------|--------------------------------------------------------------------|--------|--------------|------------------|
| C1 | Aluminum polymer capacitor 150μF/16V WCAP- PSLP | LC | 875105345011 | Würth Elektronik |
| L1 | Filter inductor, 3.3μH, PD2 family | | 744773033 | Würth Elektronik |
| C4 | Ceramic chip capacitor 470pF/250Vac/2500V Impulse Voltage 1808 X7R | Y-Cap | 885362210009 | Würth Elektronik |

Note: C4 has to be rated for an impulse voltage equal or greater than the isolation voltage of the power module itself.

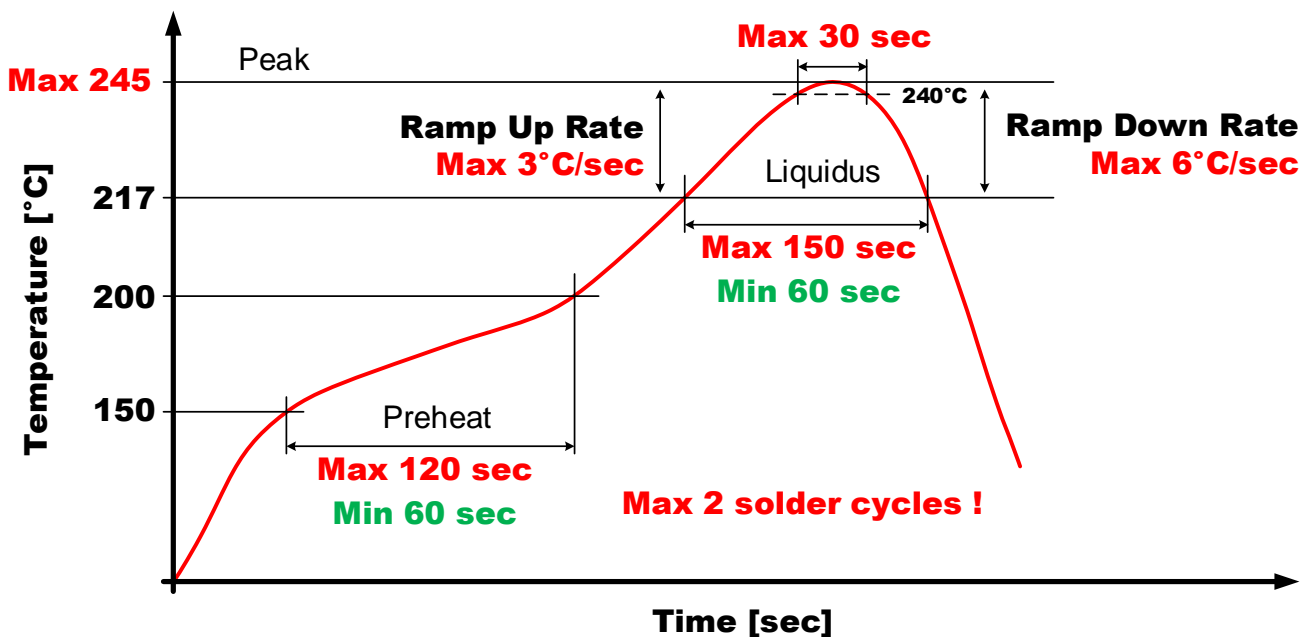
1769205x2, 176881212, 176861512

Magl³C Power Module
FISM – Fixed Isolated SMT Module



SOLDER PROFILE

1. Only Pb-Free assembly is recommended according to JEDEC J-STD020.
2. Measure the peak reflow temperature of the Magl³C power module in the middle of the top view.
3. Ensure that the peak reflow temperature does not exceed 240°C ±5°C as per JEDEC J-STD020.
4. The reflow time period during peak temperature of 240°C ±5°C must not exceed 30 seconds.
5. Reflow time above liquidus (217°C) must not exceed 150 seconds.
6. Maximum ramp up is rate 3°C per second
7. Maximum ramp down rate is 6°C per second
8. Reflow time from room (25°C) to peak must not exceed 8 minutes as per JEDEC J-STD020.
9. **Maximum number of reflow cycles is one.**
10. **For minimum risk, solder the module in the last reflow cycle of the PCB production.**
11. For soldering process please consider lead material copper (Cu) and lead finish tin (Sn).
12. For solder paste use a standard SAC Alloy such as SAC 305, type 3 or higher.
13. Below profile is valid for convection reflow only
14. Other soldering methods (e.g. vapor phase) are not verified and have to be validated by the customer on his own risk



DEFINITION OF SOLDER CYCLES

1st cycle: the module is placed on top of the PCB and reflow soldered

2nd cycle: the module remains on top and the PCB and is wave soldered from the bottom

2nd cycle: the module remains on top and the board is reflow soldered a second time, exposing the module to the reflow heating profile

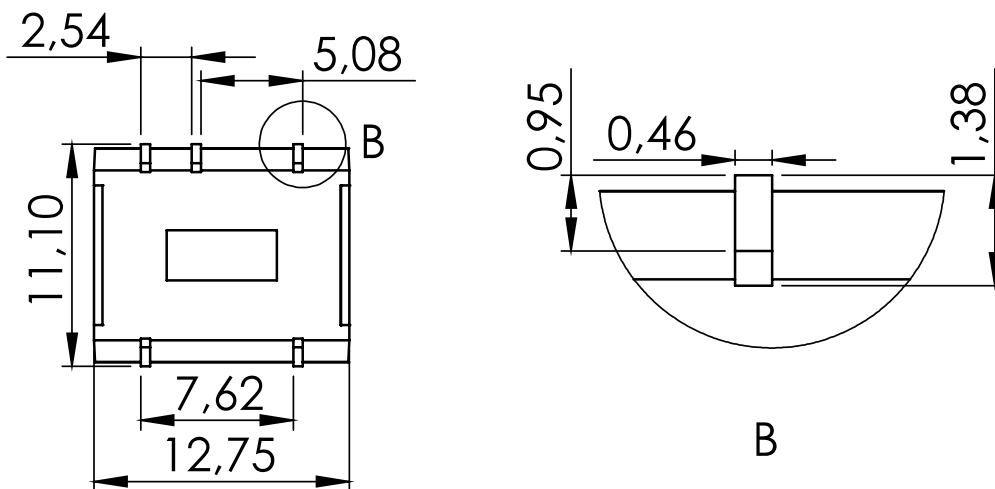
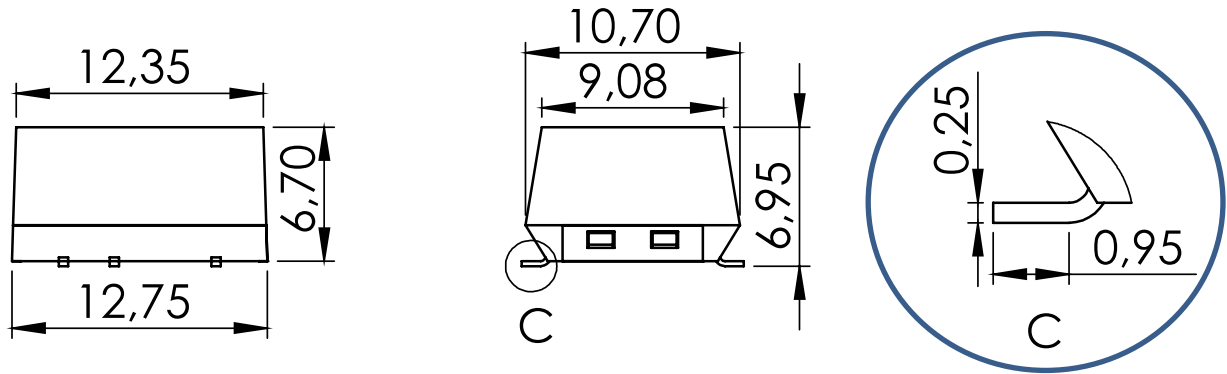
Note: Module is not allowed to be glued and soldered upside down.

1769205x2, 176881212, 176861512

MagI³C Power Module
FISM – Fixed Isolated **SMT** Module



PHYSICAL DIMENSIONS



Tolerance: xx.x = ±0.5mm ; xx.xx = ±0.25mm

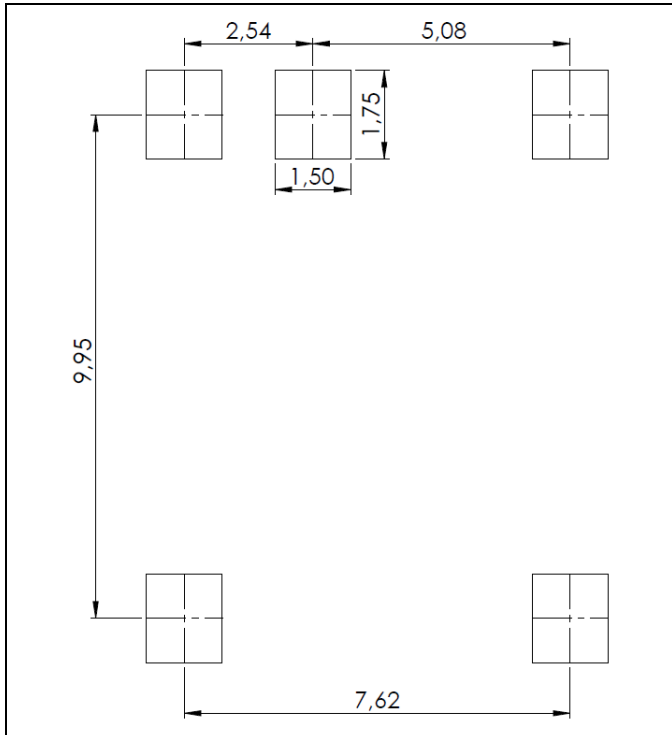
All dimensions in mm

1769205x2, 176881212, 176861512

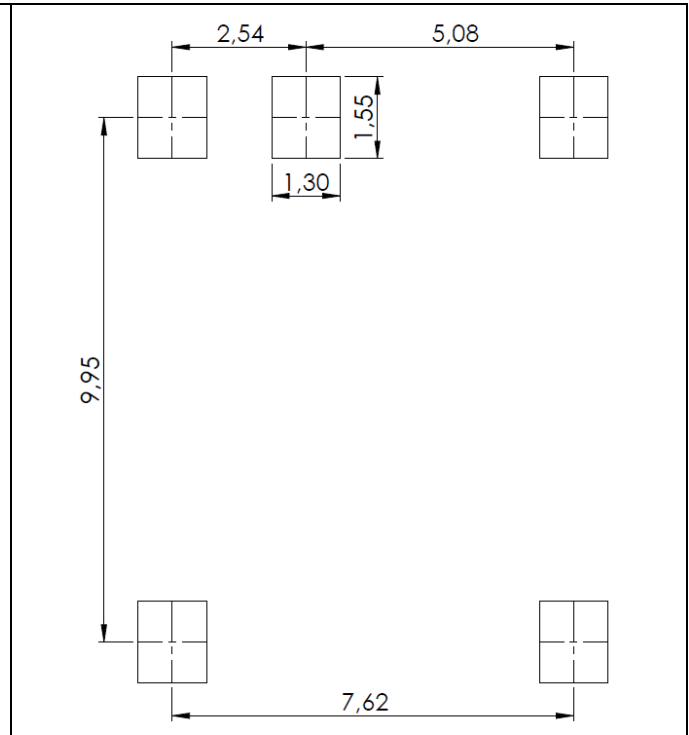
MagI³C Power Module
FISM – Fixed Isolated SMT Module



RECOMMEND LAND PATTERN



RECOMMENDED STENCIL DESIGN



all dimensions in mm

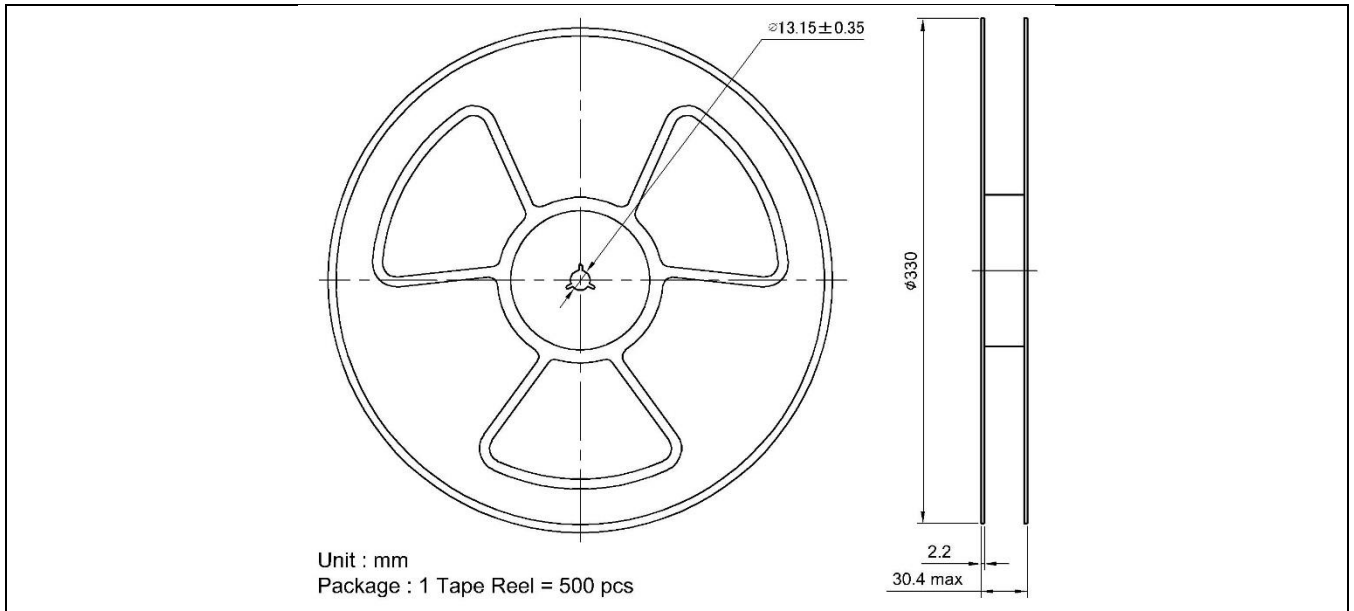
1769205x2, 176881212, 176861512

MagI³C Power Module
FISM – Fixed Isolated **SMT** Module

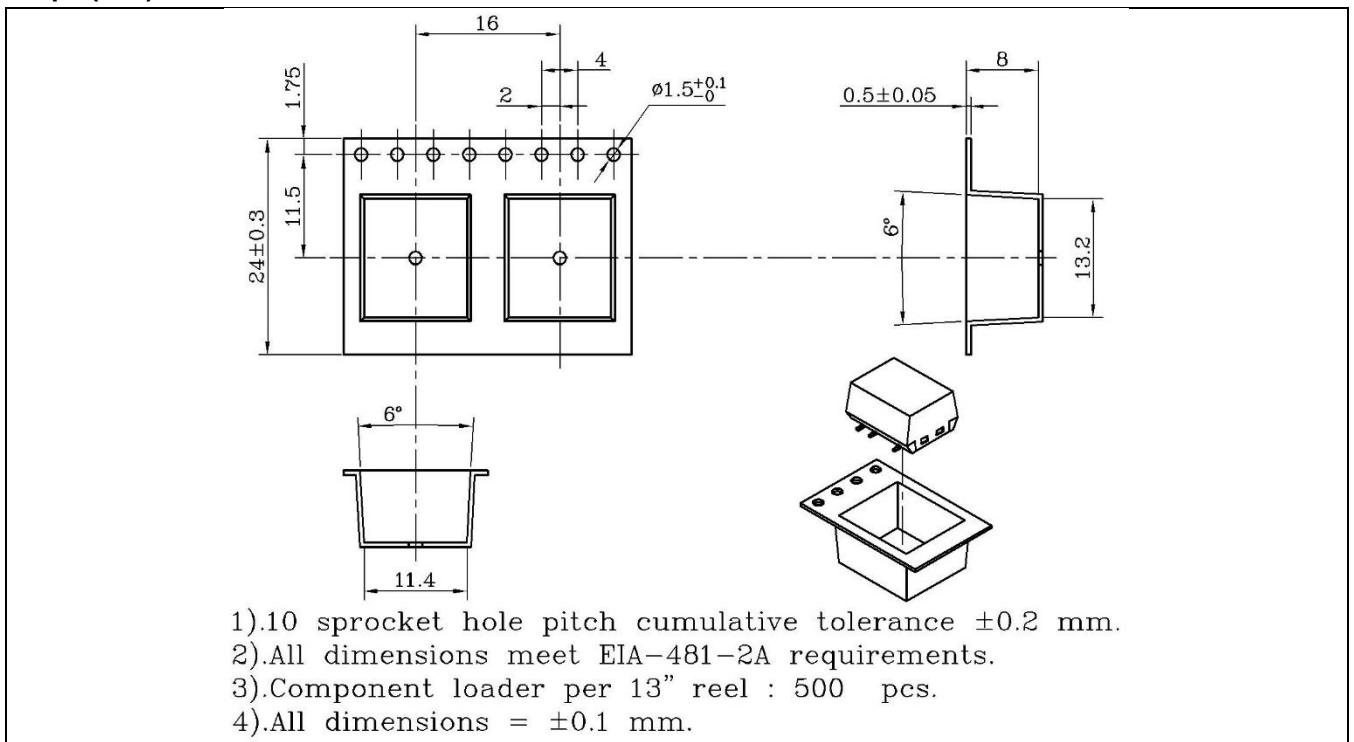


PACKAGING

Reel (mm)



Tape (mm)



1769205x2, 176881212, 176861512

MagI³C Power Module
FISM – Fixed Isolated **SMT** Module



DOCUMENT HISTORY

| Revision | Date | Description | Comment |
|----------|-----------|------------------------------|---------|
| 1.0 | July 2018 | Release of the final version | |

1769205x2, 176881212, 176861512

MagI³C Power Module
FISM – Fixed Isolated SMT Module



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 with in 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.

1769205x2, 176881212, 176861512

MagI³C Power Module
FISM – Fixed Isolated SMT Module



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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