WÜRTH ELEKTRONIK
MORE THAN YOU EXPECT

3.5V - 36V Input / 0.3A Output / 1V - 6V Output

DESCRIPTION

The VDMM 171930601 MagI³C power module provides a fully integrated DC-DC converter including the switching regulator IC with integrated MOSFETs, controller, compensation and shielded inductor in one package.

The 171930601 offers high efficiency and delivers up to 0.3A of output current. It operates with an input voltage from 3.5V to 36V and is designed for a small solution size.

The MicroModule maintains high efficiency throughout the output current range by autmoatically transitioning between operating modes based on the load demands.

The 171930601 is available in an LGA-8EP package (5 x 2.5 x 1.8mm).

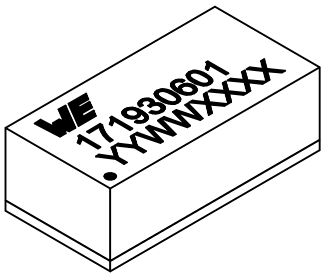
This module has integrated protection circuitry that guards against thermal overstress with thermal shutdown and protects against electrical damage using overcurrent, short-circuit and undervoltage protections.

FEATURES

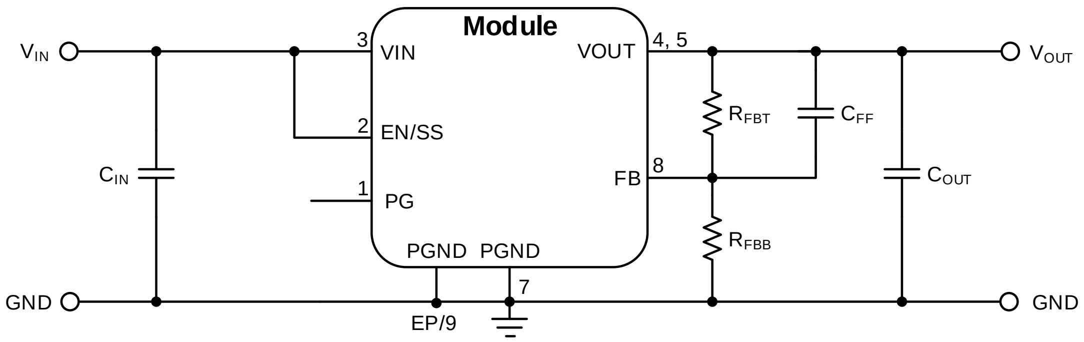
- Peak efficiency up to 87%
- Current capability up to 0.3A
- Input voltage range: 3.5V to 36V
- Output voltage range: 1V to 6V
- 12.5µA typical quiescent current
- Integrated shielded inductor
- Fixed switching frequency: 1.2MHz
- Current mode control
- Synchronous operation
- Undervoltage lockout
- Internal soft-start
- Adjustable soft-start
- Power good indicator
- Thermal shutdown
- Short-circuit protection
- Cycle-by-cycle current limit
- RoHS und REACh compliant
- Ambient temp. range: -40°C to 105°C
- No output current derating up to 85°C ambient temperature
- Operating junction temp. range: -40°C to 125°C
- Complies with EN55032 class B radiated and conducted emissions standards

TYPICAL APPLICATIONS

- Test and measurement
- Industrial control
- HVAC and building control
- Sensors



TYPICAL CIRCUIT DIAGRAM



CONTENTS

1 PINOUT

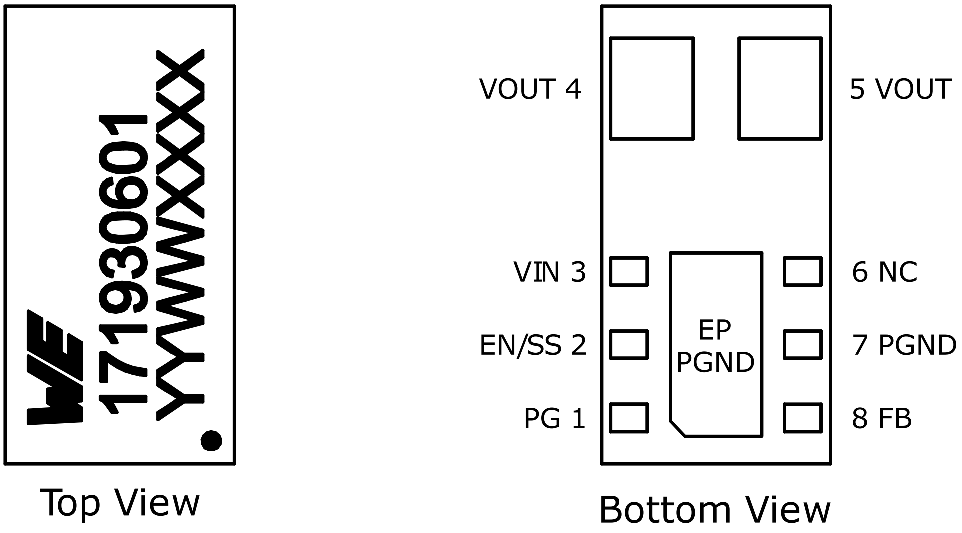


Figure 1: Pinout.

Table 1: Marking description.

MARKING	DESCRIPTION
WE	Logo
171930601	Order Code
.YYWWXXXX	Pin one indicator, year, week and lot number

Table 2: Pin description.

SYMBOL	NUMBER	TYPE	DESCRIPTION
PG	1	Output	Power good flag pin. This open drain output asserts low if the output voltage is lower than 90% or higher than 110% of the set value. A pull-up resistor of 100kΩ is recommended if this function is used.
EN/SS	2	Input	Enable pin. Setting this pin high enables the device, while setting this pin low shuts down the device. This pin must not be left floating. An internal soft-start of 2ms has already been implemented in the MicroModule. For an external soft-start function, an external resistor (R_{SS}) and capacitor (C_{SS}) should be used.
VIN	3	Power	Input voltage pin. Place the input capacitor as close as possible to VIN and PGND.
VOUT	4, 5	Power	Output voltage pin. Place output capacitors as close as possible to VOUT and PGND. For thermal performance, use copper plane(s) at this pin.
NC	6		Pin is not internally electrically connected.
PGND	7	Power	Power ground pin. This pin must be connected to the ground plane and to the exposed pad for the best thermal performance.
FB	8	Input	Feedback pin. This pin must be connected to the external resistor divider (between VOUT and PGND) to adjust the output voltage. The trace between VOUT, FB and through the external resistor divider should be kept as short and near to the module as possible.
PGND	EP	Exposed Pad	Exposed pad. This pin is electrically connected internally to PGND. It is recommended to connect this pad to the ground plane for device heat dissipation.

2 ORDERING INFORMATION

Table 3: Ordering information.

ORDER CODE	SPECIFICATIONS	PACKAGE	PACKAGING UNIT
171930601	0.3A / 1V-6V Vout version	LGA-8EP	7" Reel (1000 pieces)
178930601	0.3A / 1V-6V Vout version	Eval Board	Box with 1 piece

3 SALES INFORMATION

Table 4: Package specifications.

SALES CONTACT
Würth Elektronik eiSos GmbH & Co. KG EMC and 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

4 ABSOLUTE MAXIMUM RATINGS

Caution:
Exceeding the listed absolute maximum ratings may affect the device negatively and may cause permanent damage.

Table 5: Absolute maximum ratings.

SYMBOL	PARAMETER	LIMIT		UNIT
		MIN(1)	MAX(1)	
VIN	Input pin voltage	-0.3	40	V
VOUT	Output pin voltage	-0.3	40	V
FB	Feedback pin voltage	-0.3	6.2	V
EN	Enable pin voltage	-0.3	40	V
PG	Power good pin voltage	-0.3	6.2	V
I_{PG}	Power Good Pin Current	—	8	mA
$T_{storage}$	Assembled, non-operating storage temperature	-40	125	°C

5 OPERATING CONDITIONS

Operating conditions are conditions under which the device is intended to be functional. All values are referenced to GND. MIN and MAX limits are valid for the recommended ambient temperature range of -40°C to 105°C.

Table 6: Operating conditions.

SYMBOL	PARAMETER	MIN(1)	TYP(3)	MAX(1)	UNIT
V_{IN}	Input voltage	3.5	—	36	V
V_{OUT}	Output voltage	1	—	6	V
T_a	Ambient temperature range	-40	—	105(2)	°C
T_{jop}	Junction temperature range	-40	—	125	°C
I_{out}	Nominal output current	—	—	0.3(4)	A

6 THERMAL SPECIFICATIONS

Caution:
Typical values represent the statistically utmost probable values at the following conditions: V_{IN} = 24V, V_{OUT} = 5V, C_{IN} = 4.7µF, C_{OUT} = 47µF, T_A = 25°C unless otherwise noted.

Table 7: Thermal specifications.

SYMBOL	PARAMETER	TYP(3)	UNIT
Θ_{JA}	Junction-to-ambient thermal resistance(4)	55	K/W
Θ_{JC}	Junction-to-case (top) thermal resistance(4)	40	K/W
T_{SD}	Thermal shutdown, rising	155	°C
	Thermal shutdown, hysteresis	25	°C

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

7 ELECTRICAL SPECIFICATIONS

Caution:
MIN and MAX limits are valid for the recommended ambient temperature range of -40°C to 105°C. Typical values represents statistically the utmost probable values at the following conditions: V_{IN} = 24V, V_{OUT} = 5V, C_{IN} = 4.7µF ceramic, C_{OUT} = 47µF ceramic, T_A = 25°C unless otherwise noted.

Table 8: Electrical specifications part 1.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN(1)	TYP(3)	MAX(1)	UNIT
OUTPUT VOLTAGE						
V_{FB}	Reference voltage		0.739	0.75	0.761	V
I_{FB}	Feedback input bias current		-0.1	—	0.1	nA
V_{OUT}	Line regulation	V_{IN} = 8V to 36V, I_{OUT} = 0.3A	—	0.06	—	%
	Load regulation	0.03A ≤ I_{LOAD} ≤ 0.3A	—	1.35	—	%
	Output voltage ripple	I_{OUT} = 0.03A, 20MHz BWL	—	10	—	mV_{pp}
		I_{OUT} = 0.3A, 20MHz BWL	—	7	—	mV_{pp}
OUTPUT CURRENT						
I_{OUT}	Output current		—	—	0.3	A
I_{CL-HS}	High side switch current limit		1	1.3	—	A
SWITCHING FREQUENCY						
f_{SW}	Switching frequency		—	1.2	—	MHz
ENABLE AND UNDERVOLTAGE LOCKOUT						
V_{UVLO}	V_{IN} undervoltage threshold	V_{IN} increasing	2.7	2.8	2.9	V
		V_{IN} decreasing	2.6	2.7	2.8	V
$V_{EN/SS}$	EN/SS threshold	Enable logic high	2.5	—	36	V
		Enable logic low	—	—	0.3	V
$I_{EN/SS}$	EN/SS pin input current	V_{IN} = 36V, Enable = high	—	0.1	0.3	µA
		V_{IN} = 36V, Enable = low	-0.1	—	0.1	µA
SOFT-START						
t_{SS}	Soft-start time	T_A = 25°C (rising edge to 95% of V_{OUT})	—	2	—	ms
EFFICIENCY						
η	Efficiency	V_{IN} = 5V, V_{OUT} = 3.3V, I_{OUT} = 0.3A	—	87	—	%
		V_{IN} = 12V, V_{OUT} = 5V, I_{OUT} = 0.3A	—	87	—	%
		V_{IN} = 24V, V_{OUT} = 5V, I_{OUT} = 0.3A	—	83	—	%
INPUT QUIESCENT AND SHUTDOWN CURRENT						
I_{SD}	Shutdown current	V_{IN} = 12V, V_{EN} = low	—	1.7	—	µA
		V_{IN} = 24V, V_{EN} = low	—	2.8	—	µA
I_{IN-NL}	No load input current	V_{OUT} = 3.3V	—	15.3	—	µA
I_Q	Quiescent current	V_{IN} = 12V, Enable = high	—	12.5	—	µA
		V_{IN} = 24V, Enable = high	—	13.5	—	µA
OUTPUT CAPACITANCE						
C_{OUT_MAX}	Output capacitance	These values are absolute. Practical capacitor values need to have derating aspects considered.	20	47	150	µF

8 RoHS, REACh

Table 9: 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, Authorization and Restriction of Chemicals (REACh).

9 PACKAGE SPECIFICATIONS

Table 10: Package specifications.

ITEM	PARAMETER	TYP(3)	UNIT
Mold Compound	UL94V-0	—	—
Weight	—	0.04341	g

10 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) Depending on heat sink desing, number of PCB layers, copper thickness and air flow.

(3) Typical numbers are valid at 25 °C ambient temperature and represent statistically the utmost probable values assuming a Gaussian distribution.

(4) Measured on the 178930601 evaluation board, a 80 x 80mm two layer board with 35µm (1 ounce) copper.

11 TYPICAL PERFORMANCE CURVES

If not otherwise specified, the following conditions apply: V_{IN} = 24V, C_{IN} = 4.7µF X7R 50V ceramic, C_{OUT} = 47µF X5R ceramic, C_{FF} = 220pF, T_{AMB} = 25°C.

11.1 Radiated and Conducted Emissions EN55032 (CISPR-32) Class B Compliance

The 171930601 MicroModule is tested with a standard EMC confguration (1m wire between the module and the load) to give more realistic information about implementation in applications. The test setup is based on CISPR16 with the limit values from CISPR-32. Measured with module on an evaluation board 178930601 in a fully anechoic room (FAR) at 3m antenna distance.

11.1.1 TEST SETUP

Input wire length:

- Radiated Emission: 160cm (80cm Horizontal + 80cm Vertical)
- Conducted Emissions: 80cm

Output wire length:

- Long wire (with input filter): 1m

11.1.2 Radiated and Conducted Emissions

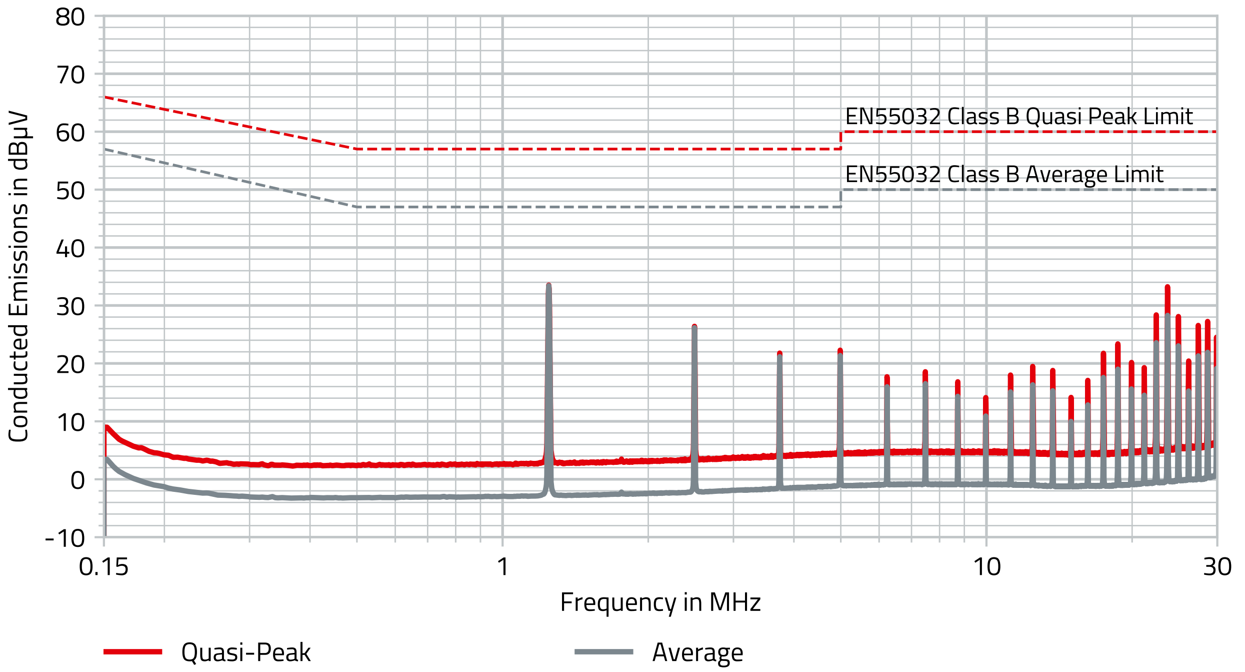


Figure 2: 171930601 conducted emissions (3m antenna distance) V_{IN} = 24V, V_{OUT} = 5V, I_{LOAD} = 0.3A with input filter C_F = 4.7µF, L_F = 1µH.

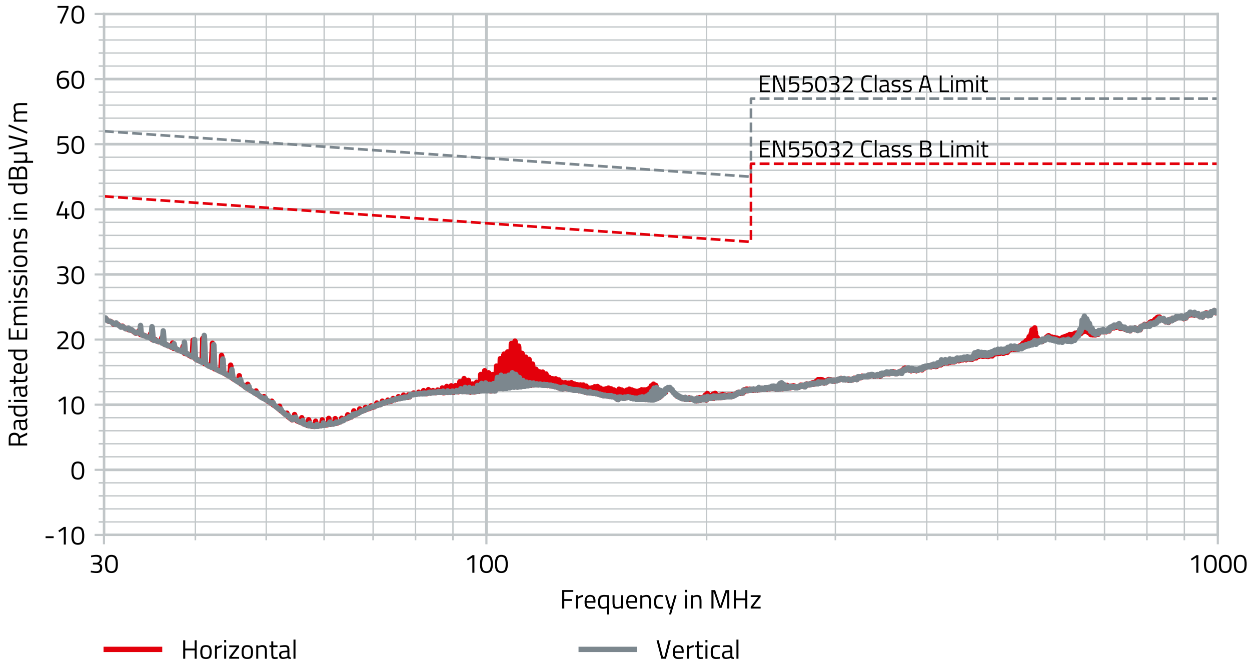


Figure 3: 171930601 radiated emissions (3m antenna distance) V_{IN} = 24V, V_{OUT} = 5V, I_{LOAD} = 0.3A with input filter C_F = 4.7µF, L_F = 1µH.

11.2 DC PERFORMANCE CURVES

11.2.1 Efficiency $12V_{IN}$

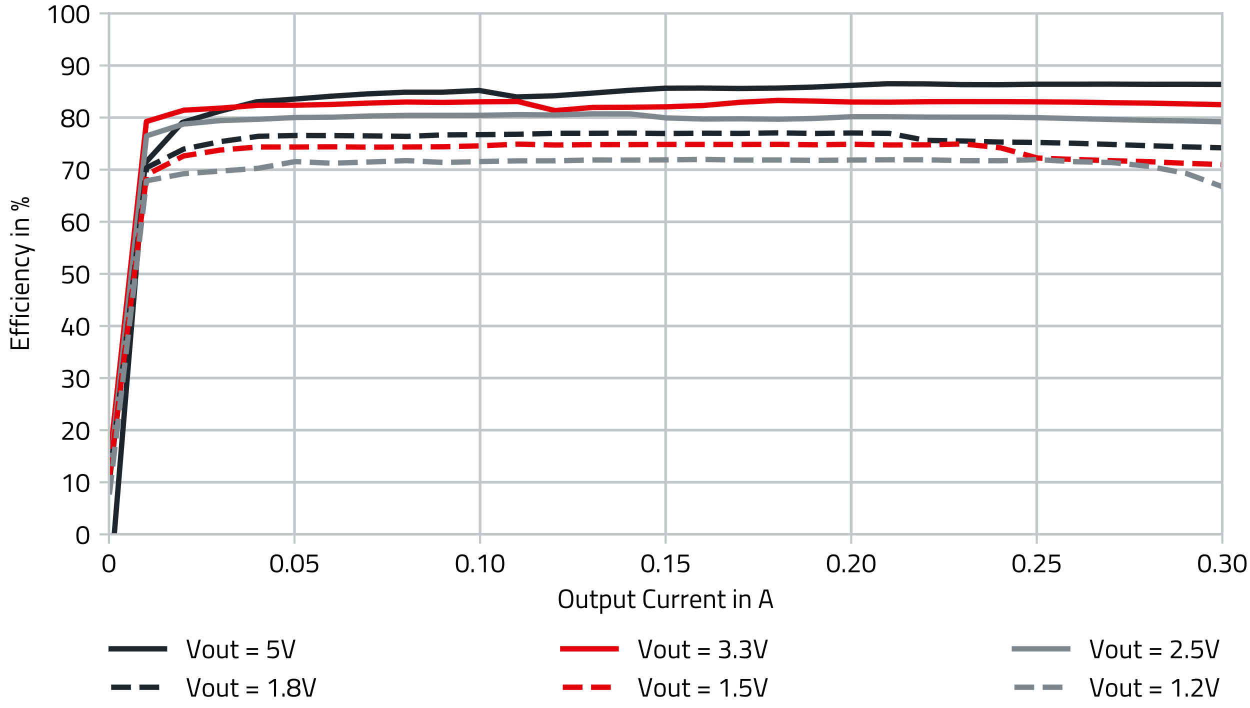


Figure 4: 171930601 efficiency V_{IN} = 12V, T_A = 25°C.

11.2.2 Efficiency $24V_{IN}$

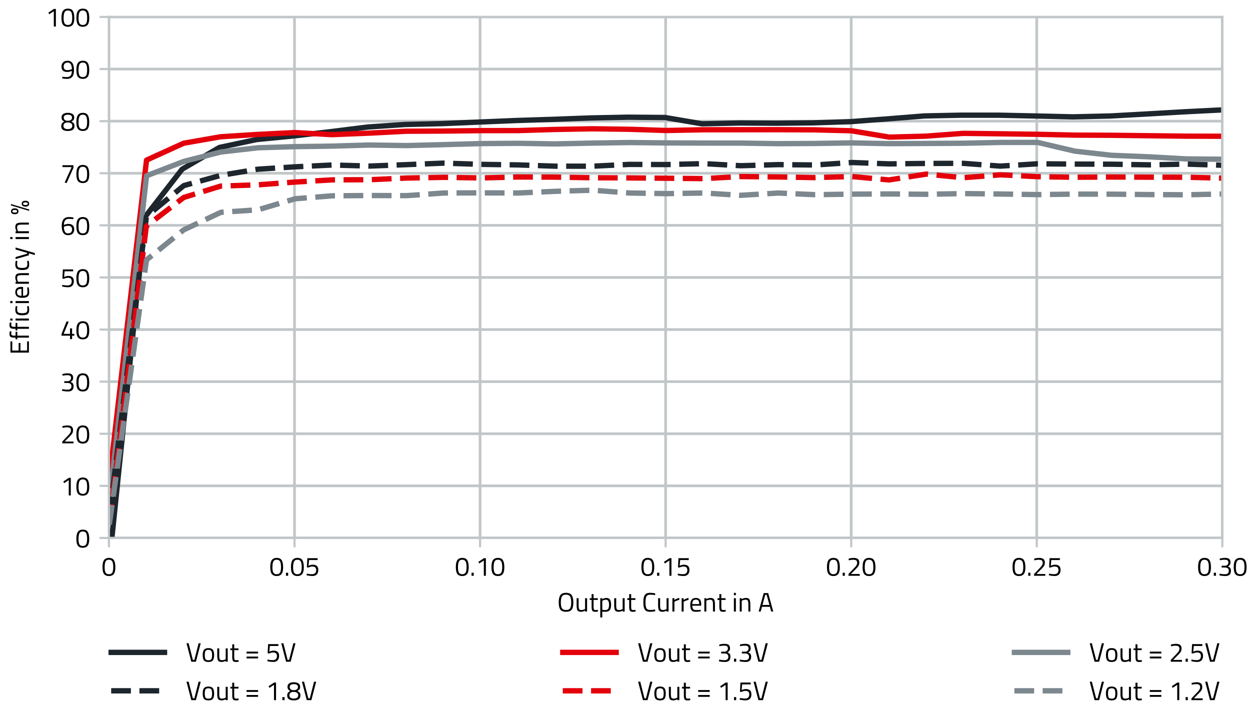


Figure 5: 171930601 efficiency V_{IN} = 24V, T_A = 25°C.

11.2.3 Thermal Derating $12V_{IN}$

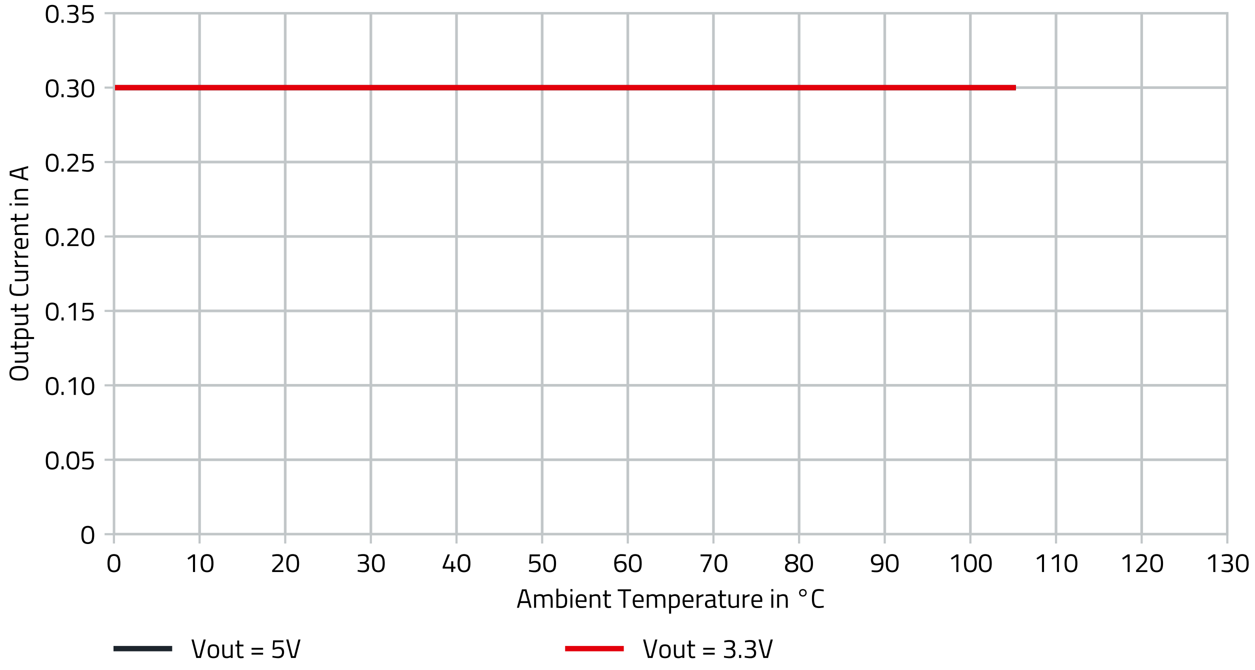


Figure 6: 171930601 output current thermal derating V_{IN} = 12V, Θ_{JA} = 55 K/W.

11.2.4 Thermal Derating $24V_{IN}$

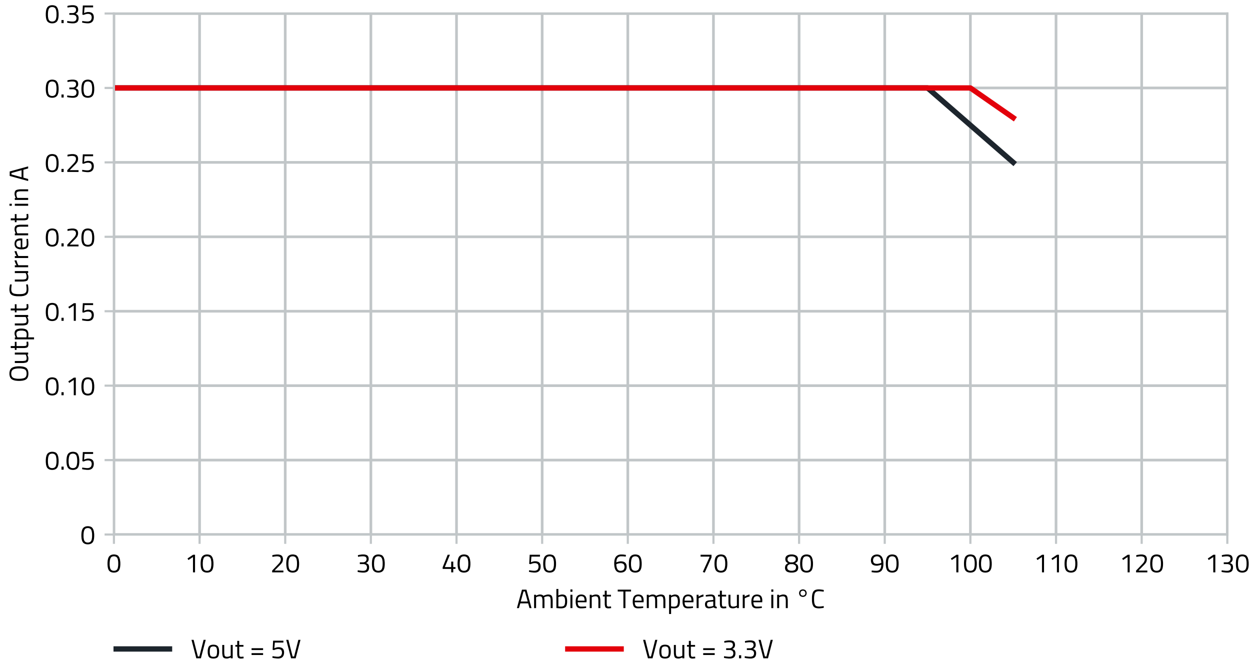


Figure 7: 171930601 output current thermal derating V_{IN} = 24V, Θ_{JA} = 55 K/W.

Note: Both thermal derating graphs were measured on the 178930601 Evaluation Board (80 x 80mm two layer board with 35µm (1 ounce) copper). Please see T_A limits in OPERATING CONDITIONS.

11.2.5 Operating Range

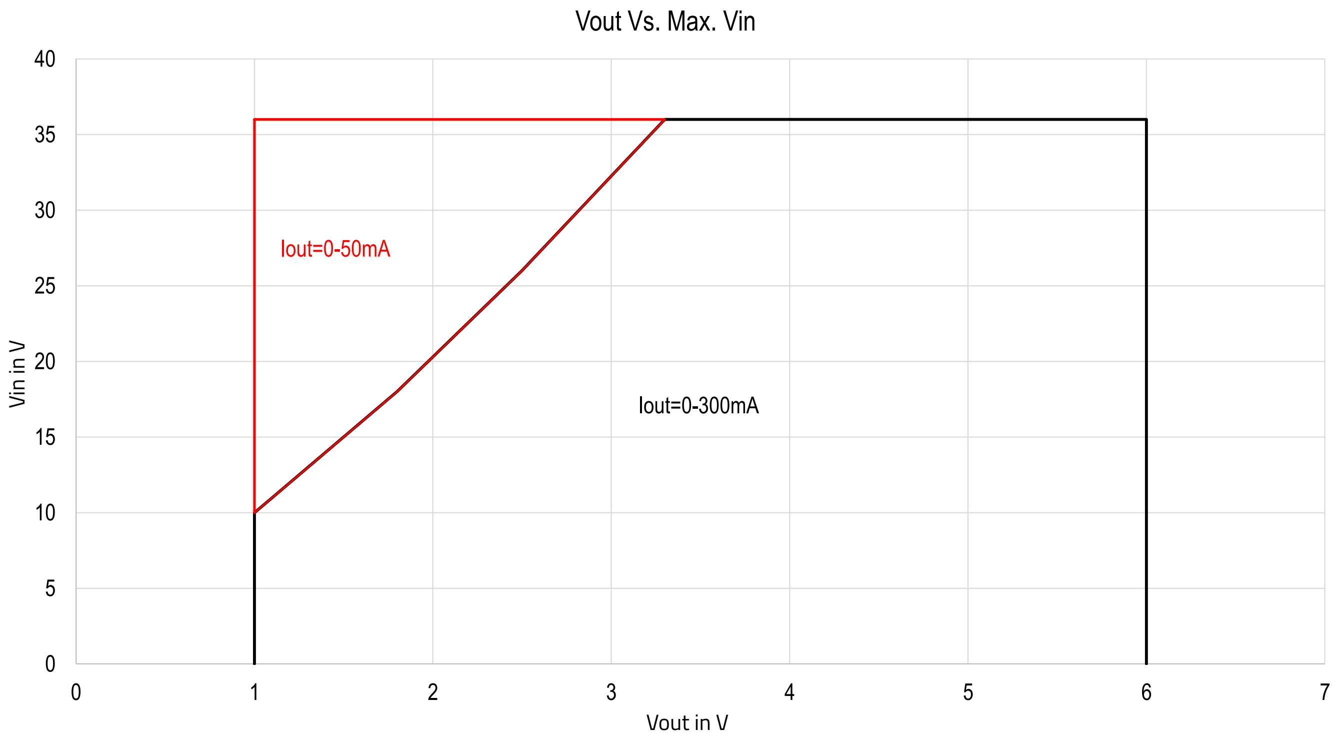


Figure 8: 171930601 output voltge vs. maximum input voltage.

11.2.6 LOAD REGULATION

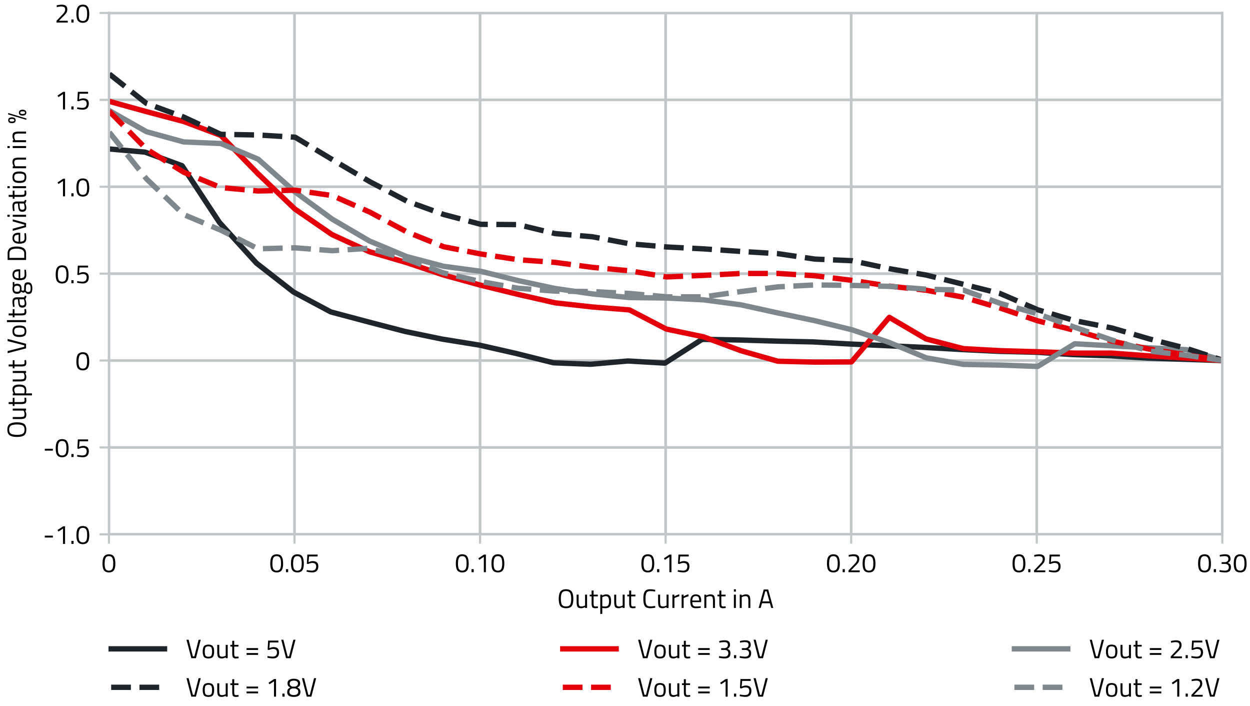


Figure 9: 171930601 load regulation V_{IN} = 24V, V_{OUT} = 3.3V, T_A = 25°C.

11.2.7 LINE REGULATION

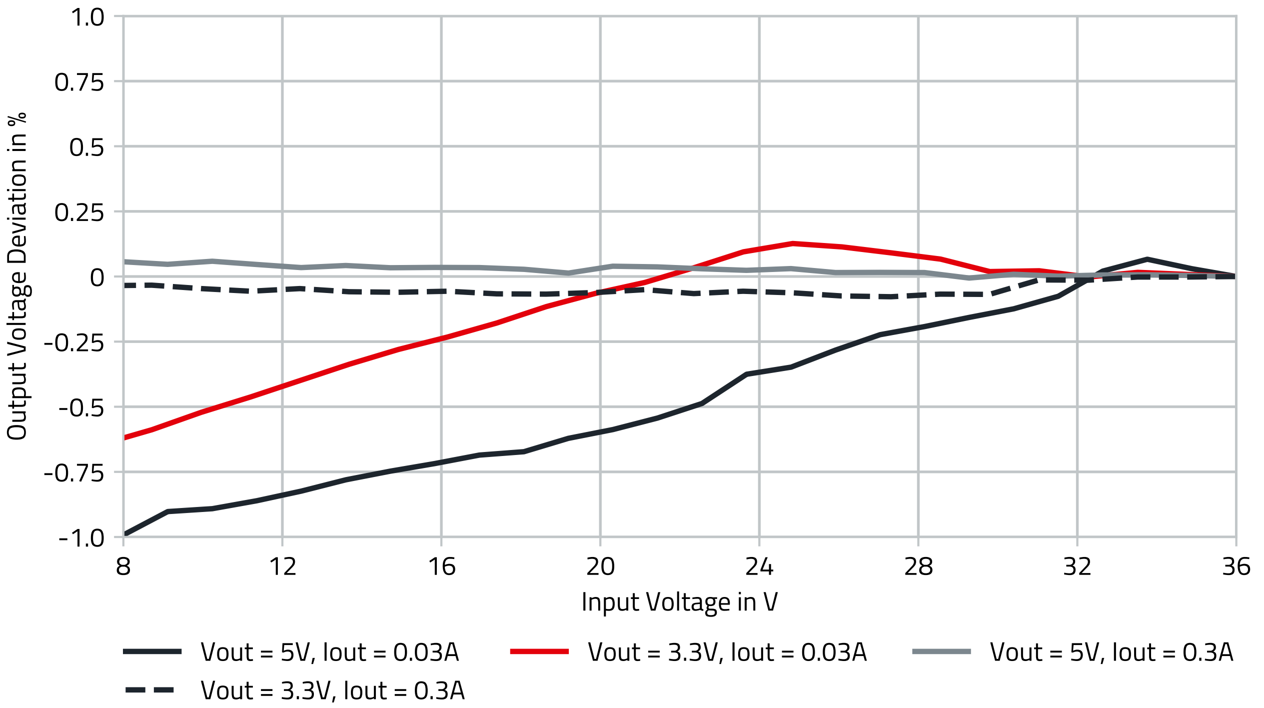


Figure 10: 171930601 line regulation V_{OUT} = 3.3V, I_{OUT} = 0.3A, T_A = 25°C.

12 BLOCK DIAGRAM

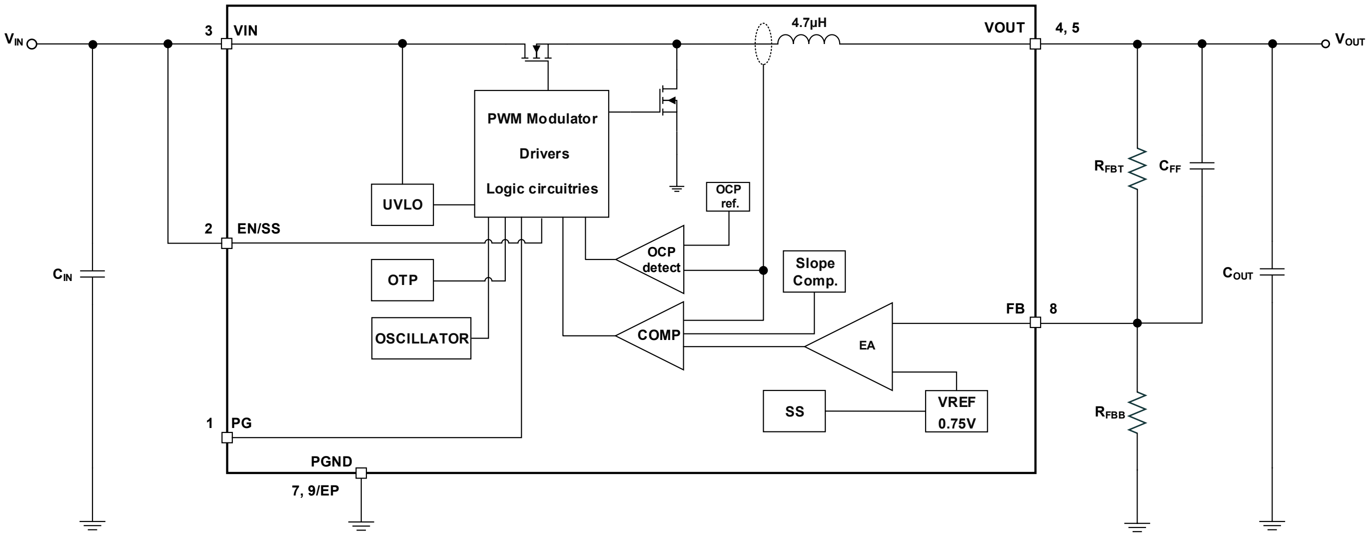


Figure 11: 171930601 block diagram.

13 CIRCUIT DESCRIPTION

The MagI³C 171930601 MicroModule is a fully integrated DC-DC power supply including the switching regulator with integrated MOSFETs, controller and compensation, as well as the shielded inductor in one package. The control scheme is based on a current mode (CM) regulation loop.

The V_{OUT} of the regulator is divided by the feedback resistor network R_{FBT} and R_{FBB} and fed into the FB pin. The error amplifier compares this signal with the internal 0.75V reference. The error signal is amplified and controls the on-time of a fixed frequency pulse width generator. This signal drives the power MOSFETs.

The current mode architecture features a constant frequency during load steps. Only the on-time is modulated. It is internally compensated and stable with low ESR output capacitors and requires no external compensation network.

This architecture supports fast transient response and very small output voltage ripples (<10mV_{p-p}) are achieved.

14 DESIGN FLOW

The next four simple steps will show how to select the external components to design the 171930601 into an application.

Essential Steps

1. Set output voltage
2. Select input capacitor
3. Select output capacitor
4. Select feed-forward capacitor

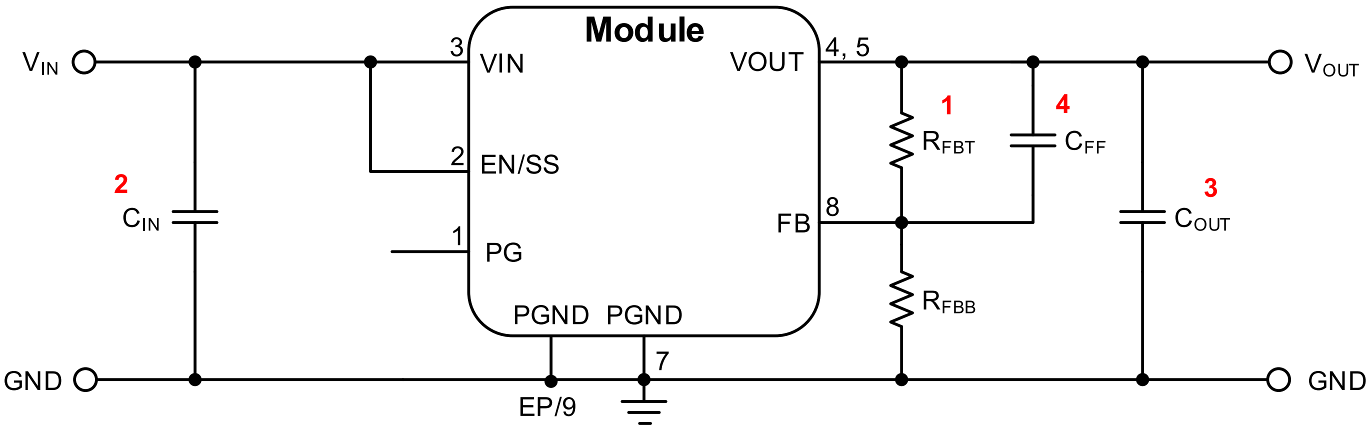


Figure 12: Design flow schematic.

14.1 STEP 1 Setting The Output Voltage (V_{OUT})

The output voltage is selected with an external resistor divider between V_{OUT} and GND (see circuit below). The voltage across the lower resistor of the divider is output voltage adjustment range is from 1V to 6V. The output voltage can be calculated according to the following formula:

$$V_{OUT} = V_{REF} \cdot \left(\frac{R_{FBT}}{R_{FBB}} + 1\right) \quad (1)$$

One resistor must be chosen and then the other resistor can be calculated. For example, if $R_{FBT} = 64.9k\Omega$ then the resistance value of the lower resistor in the feedback network is indicated in the table below for common output voltages.

Table 11: Output voltage selection with $R_{FBT} = 64.9k\Omega$.

V_{OUT} [V]	1.2	1.5	1.8	2.5	3.3	5.0	6.0
R_{FBB} (E96) [kΩ]	107	64.9	46.4	27.4	19.1	11.3	9.3

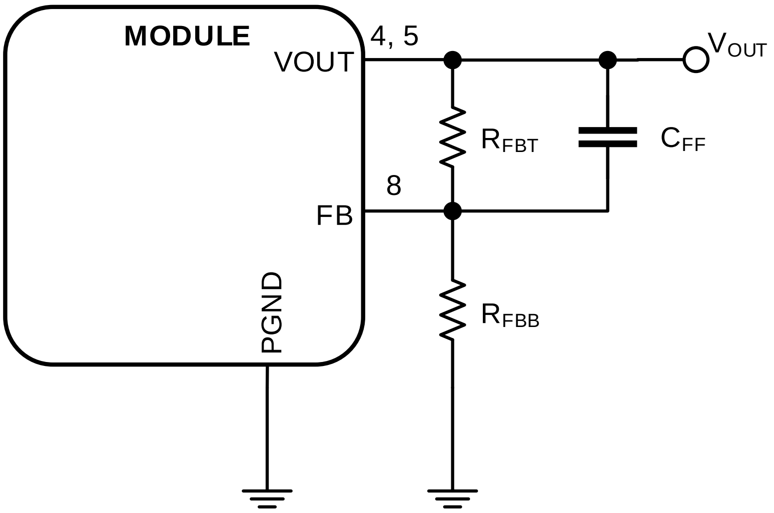


Figure 13: Output voltage schematic.

14.2 STEP 2 Select The Input Capacitor (C_{IN})

An external input capacitor is required to provide the high input pulse current. The external input capacitor must be placed as close as possible to the VIN and PGND pins. For this MagI³C MicroModule, it is recommended to use an MLCC (multi-layer ceramic capacitor) with 4.7µF. Attention must be paid to the voltage, frequency, temperature derating and thermal class of the selected capacitor.

14.3 STEP 3 Select The Output Capacitor (C_{OUT})

The output capacitor should be selected in order to minimize the output voltage ripple and to provide a stable voltage at the output. It also affects the loop stability. An external MLCC of 47µF is recommended for all application conditions. Attention must be paid to the voltage, frequency, temperature derating and thermal class of the selected capacitor.

In general, the output voltage ripple can be calculated using the following equation:

$$V_{\text{OUT ripple}} = \Delta I_{\text{L}} \cdot ESR + \Delta I_{\text{L}} \cdot \left(\frac{1}{8 \cdot f_{\text{SW}} \cdot C_{\text{OUT}}}\right) \tag{2}$$

where ΔI_L is the inductor current ripple and can be calculated with the following equation:

$$\Delta I_{\text{L}} = \frac{V_{\text{OUT}} \cdot (V_{\text{IN}} - V_{\text{OUT}})}{f_{\text{SW}} \cdot L \cdot V_{\text{IN}}} \tag{3}$$

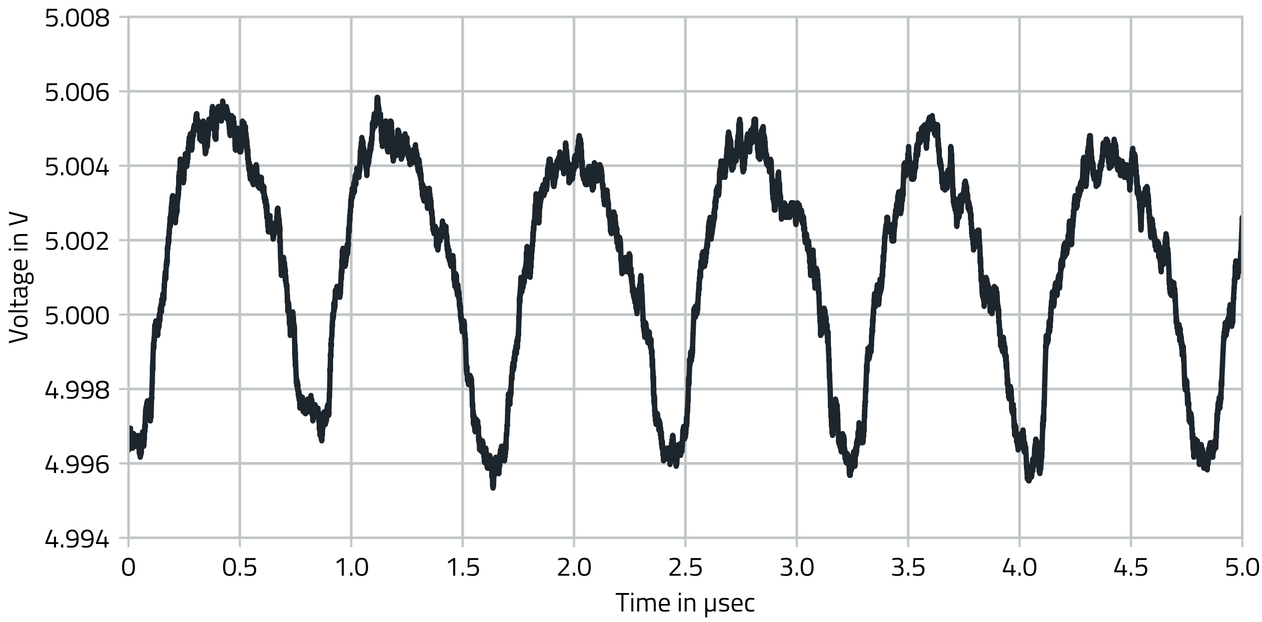


Figure 14: 171930601 output voltage ripple V_{IN} = 24V, V_{5V}, I_{OUT} = 0.3A, C_{OUT} = 33µF.

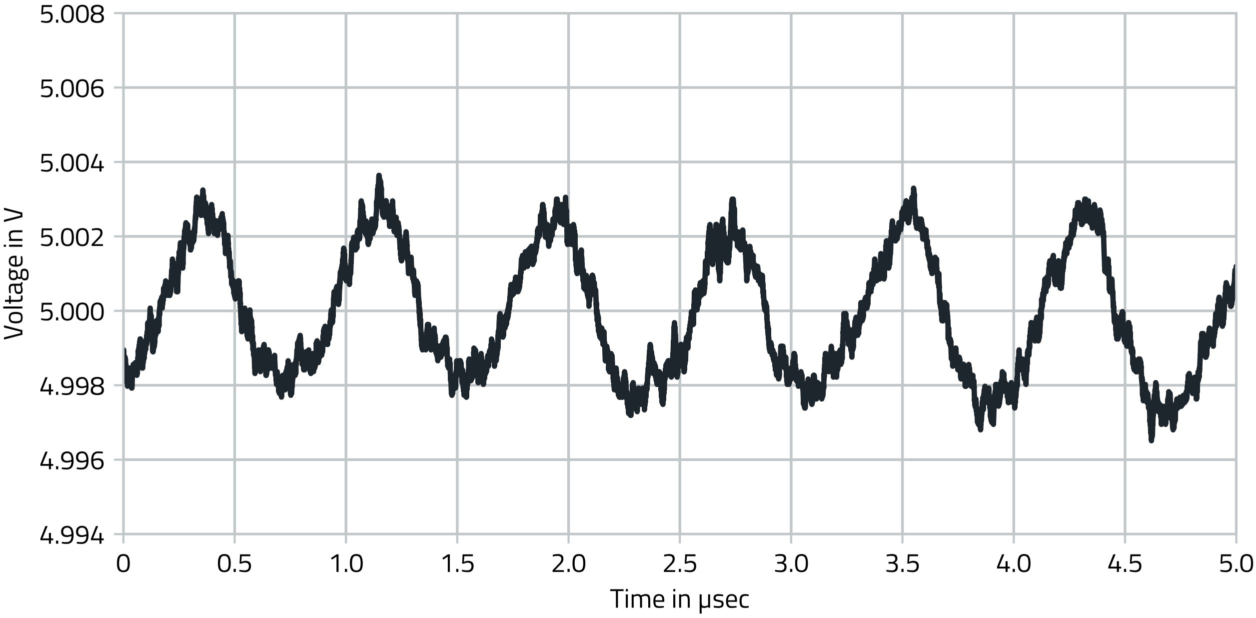


Figure 15: 171930601 output voltage ripple V_{IN} = 24V, V_{5V}, I_{OUT} = 0.3A, C_{OUT} = 68µF.

14.4 STEP 4 Select The Feed-Forward Capacitor (C_{FF})

The 171930601 MagI³C MicroModule allows for the selection of a feed forward capacitor, C_{FF}. To maintain the same transient response for different C_{FF} values, the top feedback resistor R_{FBT} should also be adjusted. The integrated inductor has a value of 4.7μH. The equation used to determine C_{FF} and R_{FBT} is as follows:

$$C_{\text{FF}} = \frac{\sqrt{C_{\text{OUT}} \cdot L}}{R_{\text{FBT}}} \tag{4}$$

A C_{FF} of 220pF has been evaluated experimentally as a value with suitable efficiency and transient characteristics for most applications.

The figures below show the transient behavior of the 171930601 in response to a load transition from 0A to 0.3A using the recommended C_{FF} = 220pF, as well as other values of C_{FF}.

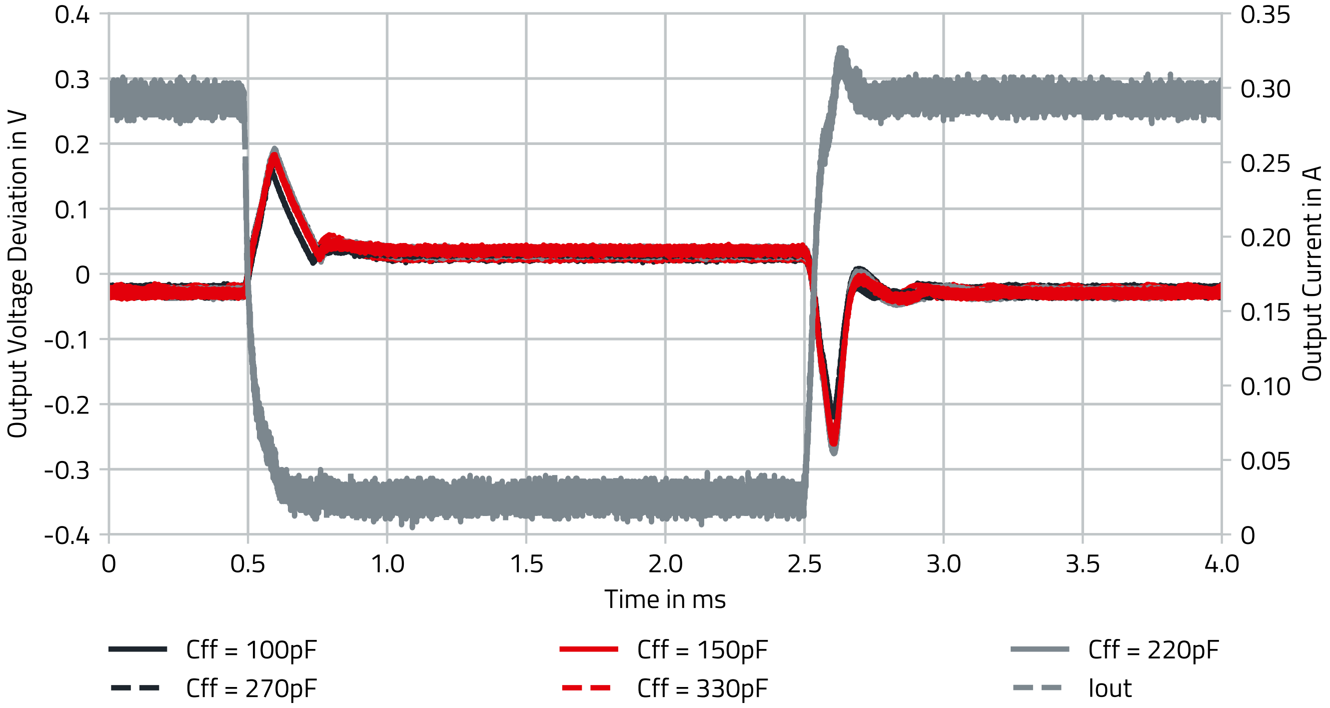


Figure 16: 171930601 load transient V_{IN} = 24V, V_{OUT} = 5V from 0.03A to 0.3A, T_A = 25°C.

This behavior is valid only for this test under the specified conditions and must be verified in the real application. The recommended C_{FF} value of 220pF will work for most applications.

15 MODES OF OPERATION

The 171930601 MicroModule has two different modes of operation and the transition takes place automatically depending on the load current value. Under light load conditions, the module operates in PFM mode where the MicroModule runs at a lower switching frequency to reduce the current consumption, which leads to achieving a higher efficiency. The PFM control is achieved by creating a single pulse to turn on the high side switch while monitoring the inductor current. The high side switch is kept on until the inductor current hits a preset value (I_{PFM}).

After reaching I_{PFM}, the high side switch is turned off and the low side switch turns on. The inductor current decreases until it reaches zero. When the inductor current reaches zero, both switches are turned off (idle time) and the output capacitor solely supplies the load with energy. While the energy is supplied to the load, the output voltage starts to drop. The MicroModule monitors the output voltage ripple value and when it hits a certain limit, while the two switches are off, another pulse is initiated and the cycle repeats. When the load current increases, the idle time decreases and the switching frequency increases until the nominal switching frequency is reached and the MicroModule goes to the PWM mode.

16 OUTPUT VOLTAGE RIPPLE

If the module is working PWM mode, the ripple is very low and it always has the same frequency as the internal oscillator (1.2). If the load current is low enough to be in the PFM mode of operation then the output voltage ripple will be higher and the frequency lower than the nominal switching frequency (see figures below).

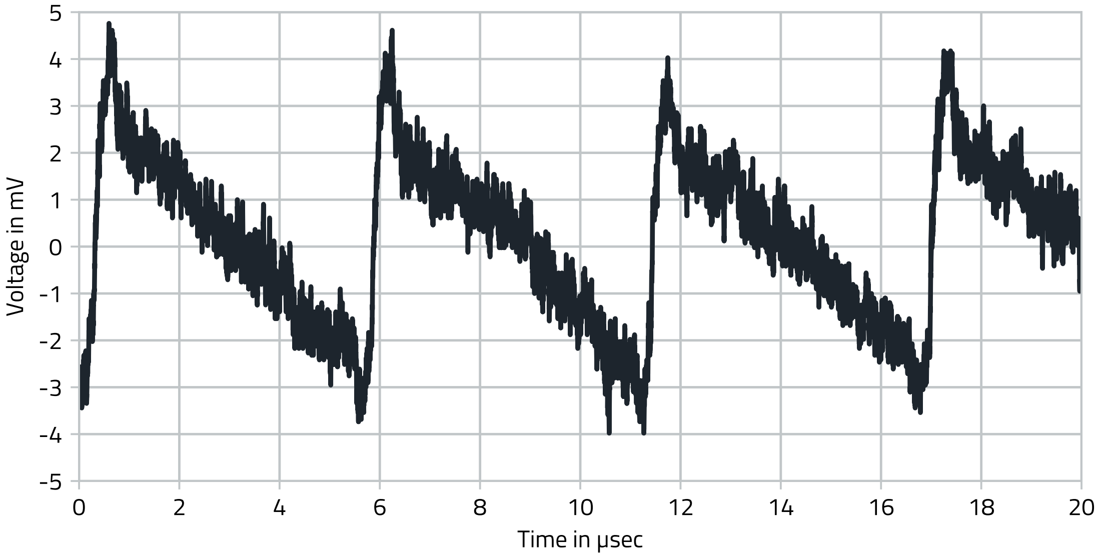


Figure 17: 171930601 output voltage ripple V_{IN} = 24V, V_{OUT} = 5V, I_{OUT} = 0.03A.

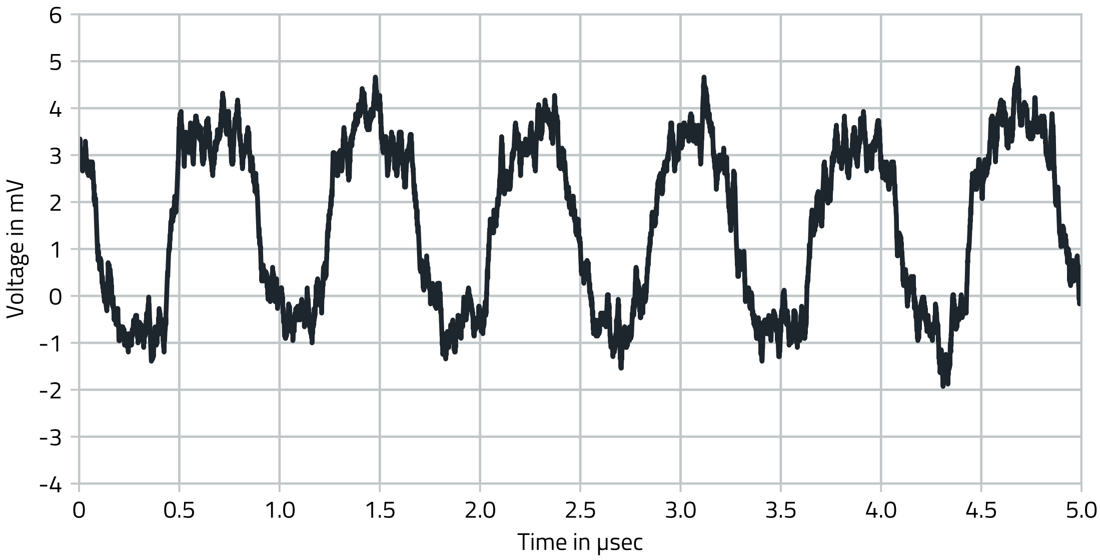


Figure 18: 171930601 output voltage ripple V_{IN} = 24V, V_{OUT} = 5V, I_{OUT} = 0.3A.

17 PROTECTION FEATURES

17.1 Over Current Protection (OCP) and Short Circuit Protection (SCP)

The overcurrent and short circuit protections are implemented using a cycle-by-cycle scheme. The high-side switch current is sensed and when the current exceeds the high side limit value (1.3A typ.), the high-side switch is turned off and the low-side switch is turned on, until the current hits the low-side switch limit value (1A typ.). When the low-side switch limit is reached, the high side switch is turned on again and the cycle repeats itself. In addition, a frequency foldback circuit is enabled to reduce the high- and low-side current limits, further reducing the rms current and heat dissipation through the MicroModule. The figures below shows the operation of the converter under OCP and SCP conditions.

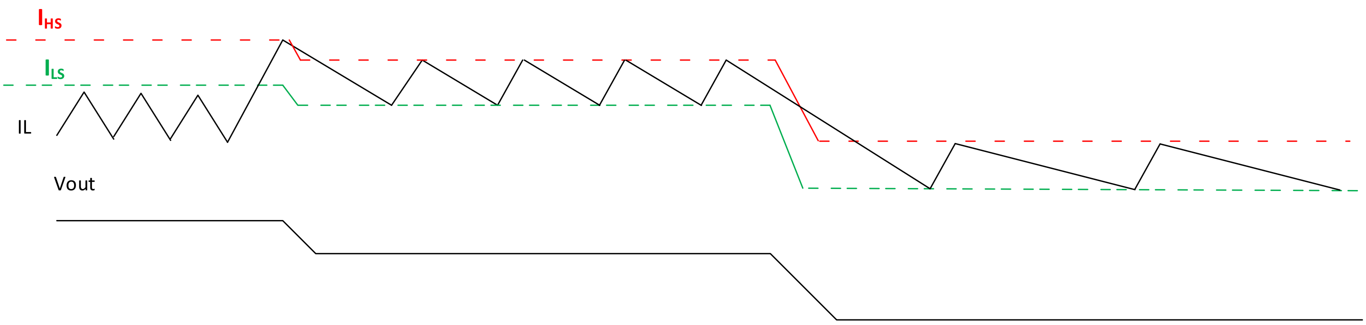


Figure 19: 171930601 inductor current and frequency foldback.

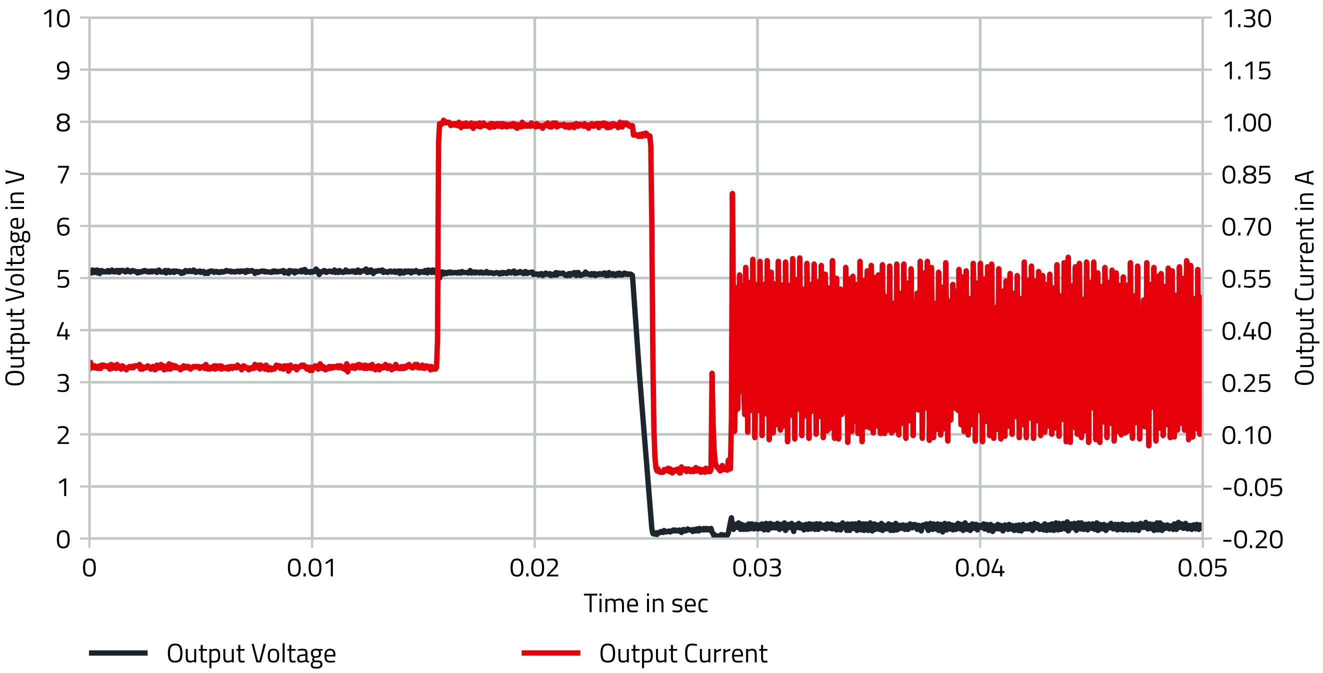


Figure 20: 171930601 OCP V_{IN} = 24V, V_{OUT} = 5V.

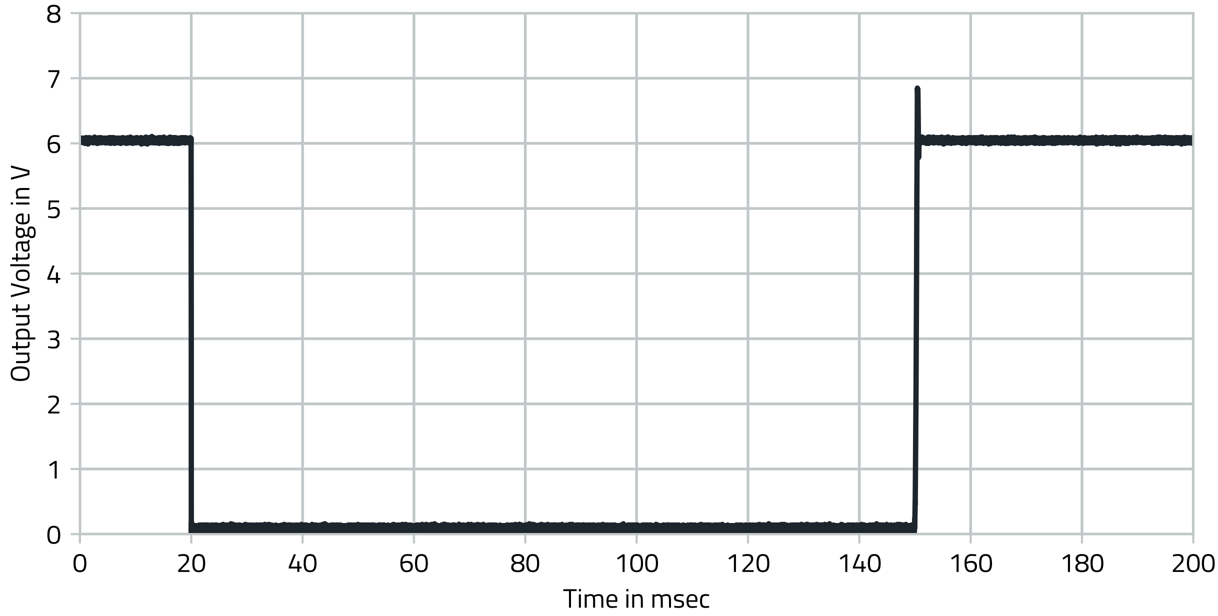


Figure 21: 171930601 SCP V_{IN} = 24V, V_{OUT} = 5V, short circuit condition.

Note that an output voltage overshoot is expected upon the return to normal operation after an overcurrent or short circuit fault. This is due to the soft-start funcitonality only activing when the module first turns on.

17.2 Over Temperature Protection (OTP)

Thermal protection helps prevent catastrophic failures due to accidental device overheating. The junction temperature of the 171930601 MagI³C MicroModule should not be allowed to exceed its maximum ratings. Thermal protection is implemented by an internal thermal shutdown circuit, which activates when the junction temperature reaches 160°C (typ). Under the thermal shutdown condition both MOSFETs remain off causing V_{OUT} to drop. When the junction temperature falls below 150°C the internal soft-start is released, V_{OUT} rises smoothly, and normal operation resumes.

17.3 Input Undervoltage Lockout (UVLO)

The device incorporates input undervoltage lockout (UVLO) to protect from unexpected behavior at input voltages below the recommended values. The thresholds of the UVLO are indicated in the ELECTRICAL SPECIFICATION.

17.4 Enable / Adjustable Soft-Start

The 171930601 MagI³C MicroModule combines the enable and soft-start functions into a single pin and is enabled by setting the pin EN/SS high. Enabling the devices achieves a 2ms soft-start time. After setting EN/SS high, the module prepares for operation. Once prepared, the module begins switching and the internal soft-start regulates the output voltage rise until the desired output voltage is met allowing normal operation to take place.
Adjustable soft-start permits the regulator to slowly ramp to its steady state operating point after being enabled, thereby reducing inrush current from the input supply and slowing the output voltage rise time to prevent overshoot. Upon turn-on, after all UVLO conditions have been passed, an internal circuit slowly ramps the EN/SS input to implement the internal soft-start. If the preset soft-start time is enough for the application, the EN/SS should be set to high. Longer soft-start periods are achieved by adding an external capacitor and a resistor to this pin as shown in the figure below:

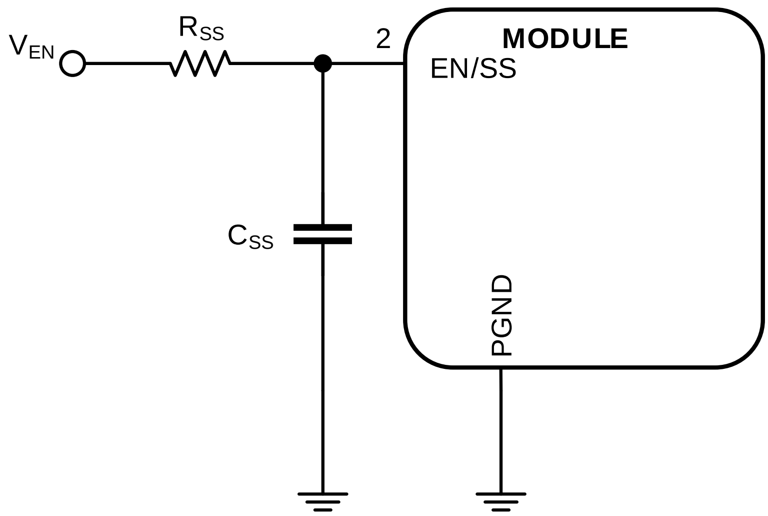


Figure 22: 171930601 external soft-start schematic.

The following equation can be used to set the soft-start time:

$$T_{\text{SS}} = C_{\text{SS}} \cdot R_{\text{SS}} \cdot \ln\left(\frac{V_{\text{EN}}}{V_{\text{EN}} - 1.45}\right) \quad (5)$$

18 DESIGN EXAMPLE

The design example shows a possible solution for 24V to 5V with a max. Iout of 0.3A. All of the necessary components to fulfill the requirements of the CISPR 32 EMI conducted- and radiated-emissions tests are included in the design example. It passes the conducted emissions class B with 0.8m input and 1m output lines and passes the radated emissions class B in a FAR at 3m measurement distance with 0.8m horizontal, 0.8m vertical input and 1m horizontal output lines. In the final application, filter components may be omitted depending on the requirements.

18.1 Layout

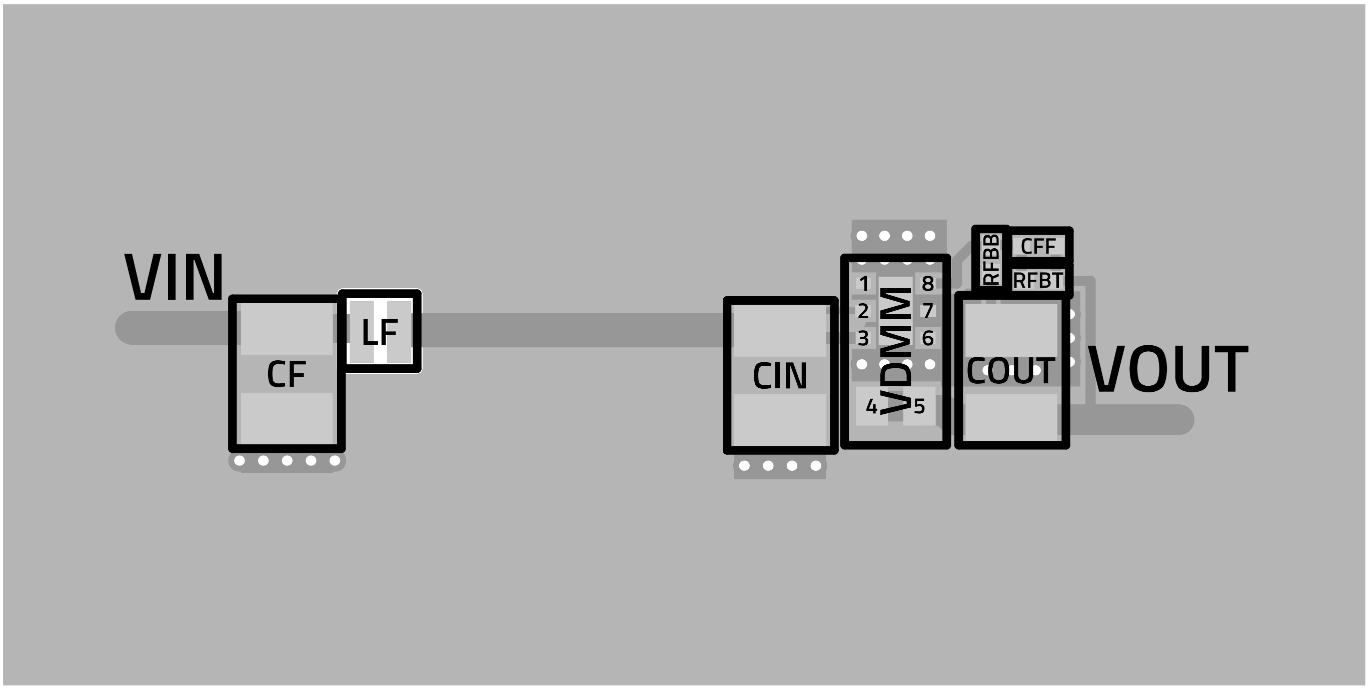


Figure 23: 171930601 layout recommendation.

The picture above shows a possible layout for the 171930601 MagI³C MicroModule. Nevertheless, some recommendations should be followed when designing the layout:

1. The input and output capacitors should be placed as close as possible to the VIN and VOUT pins of the device.
2. The feedback resistor divider should be placed as close as possible to the FB pin.
3. Avoid placing vias in any of the pads for the module the small size of the pads, significant amounts of solder can be pulled through the vias during heating, resulting in incomplete connections between the module and board.
4. The ambient temperature of this design example is limited to 85 °C due to the X5R output capacitor. For usage above 85 °C, two X7R 22µF (885012209006) capacitors are recommended to replace the single X5R capacitor.
5. To avoid direct coupling of the DC/DC converter´s E- and H-fields into connectors, filter components and cables, the module must be placed as far away from these components as possible.

18.2 Schematic

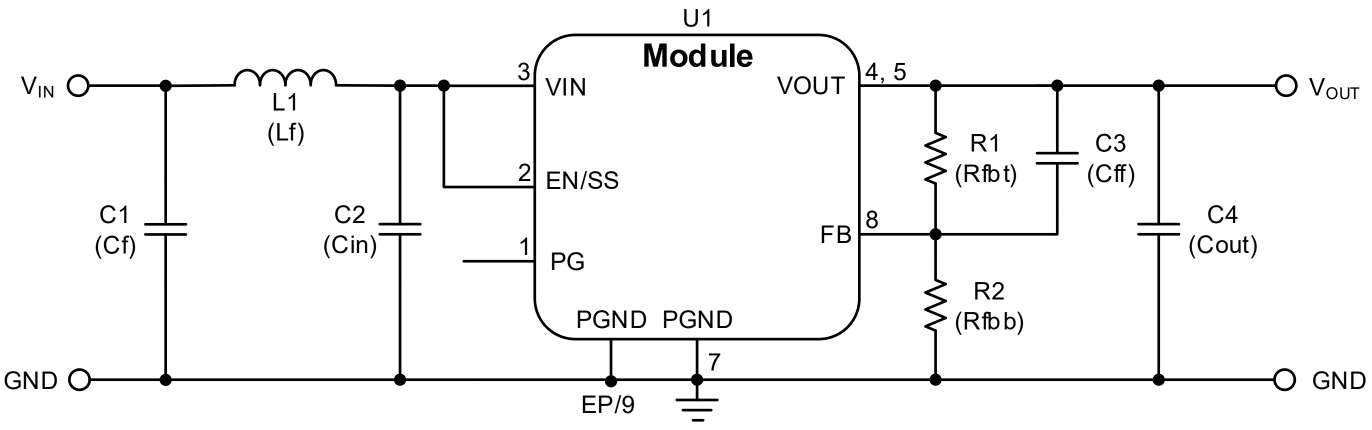


Figure 24: 171930601 design example schematic.

18.3 Bill of Materials

Table 12: 171930601 design example bill of materials.

Designator	Description	Function	Quantity	Order Code	Manufacturer
U1	MagI³C MicroModule	Power supply	1	171930601	WE
L_1	Filter inductor, 1µH, MAPI family, I_{SAT} = 3.4A, I_R = 1.4A	Input filter	1	74438313010	WE
C_1, C_2	Ceramic chip capacitor 4.7µF, 50V, X7R, 1210	Input filter	1	885012209048	WE
C_3	Ceramic chip capacitor 220pF, 10V, NP0, 0402	Eletrical performance	1	885012005015	WE
C_4	Ceramic chip capacitor 47µF, 16V, X5R, 0805	Output filter	1	885012109011	WE
R_1	64.9kΩ	Electrical performance	1	—	—
R_2	11.3kΩ for V_{OUT} = 5V	Electrical performance	1	—	—

19 HANDLING RECOMMENDATIONS

1. The power module is classified as MSL3 (JEDEC Moisture Sensitivity Level 3) and requires special handling due to moisture sensitivity (JEDEC J-STD033D).
2. The parts are delivered in a sealed bag (Moisture Barrier Bag = MBB) and should be processed within one year.
3. When opening the moisture barrier bag, check the Humidity Indicator Card (HIC) for color status. Bake parts prior to soldering in case indicator color has changed according to the notes on the card.
4. Parts must be processed after 168 hour (7 days) of floor life. Once this time has been exceeded, bake parts prior to soldering per JEDEC J-STD033D recommendation.
5. Maximum number of solder cycles is two.
6. For minimum risk, solder the module in the last solder cycle of the PCB production.
7. For soldering process please consider lead material copper (Cu) and lead finish tin (Sn).
8. It is recommended to use a standard SAC Alloy such as SAC 305, type 3 or higher.
9. The profile below is valid for convection reflow only.
10. Other soldering methods (e.g. vapor phase) are not verified and have to be validated by the customer at their own risk.

19.1 SOLDERING PROFILE

Table 13: Reflow solder profile.

Profile Feature	Symbol	Value
Preheat temperature minimum	T_{s_min}	150 °C
Preheat temperature maximum	T_{s_max}	180 °C
Preheat time from T_{s_min} to T_{s_max}	t_S	60-90 seconds
Liquidous temperature	T_L	217 °C
Time maintained above T_L	t_L	60-190 seconds
Classification temperature	T_C	260 °C
Peak package body temperature	T_P	$T_P \leq T_C$
Time within 5 °C of actual peak temperature	t_P	$t_P \leq$ 20 seconds
Ramp-up Rate (T_L to T_p)		3 °C/second maximum
Ramp-down rate (T_p to T_L)		3 °C/second maximum
Time 25 °C to peak temperature		8 minutes maximum

Please refer to JEDEC J-STD020E for further information pertaining to reflow soldering of electronic components.

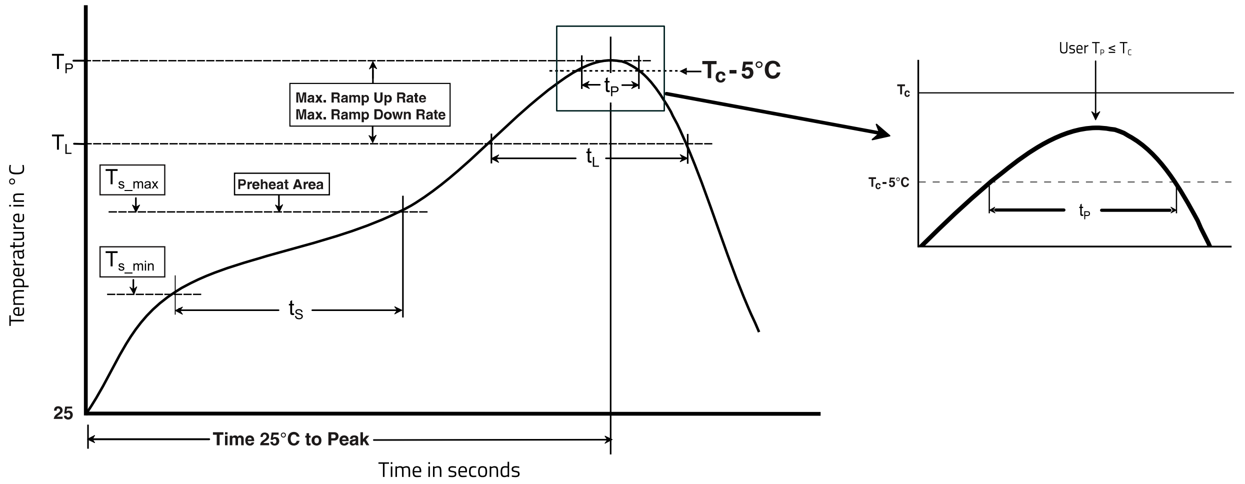
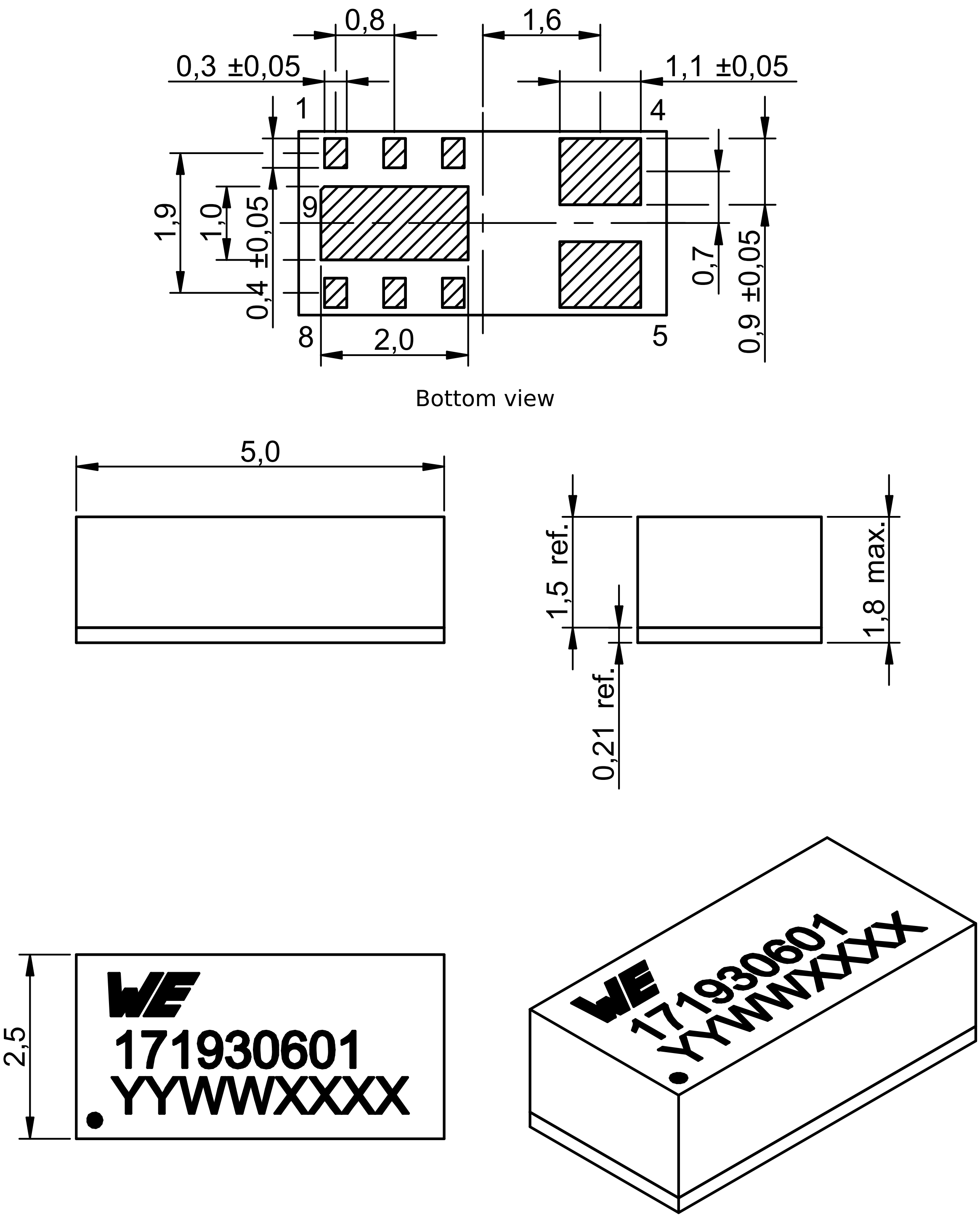


Figure 25: Solder profile.

20 PHYSICAL DIMENSIONS

20.1 COMPONENT



All dimensions in mm
Tolerances ±0.1mm unless otherwise indicated

Figure 26: 171930601 component dimensions.

20.2 EXAMPLE LANDPATTERN

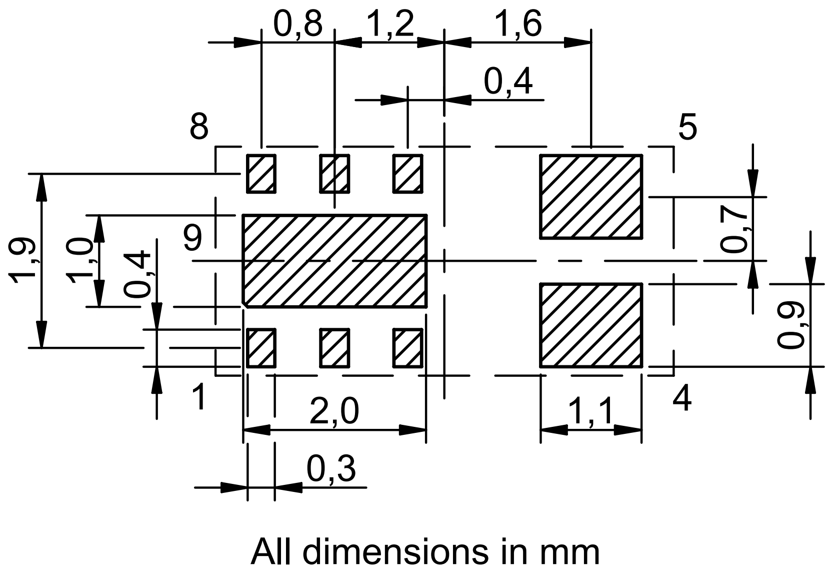
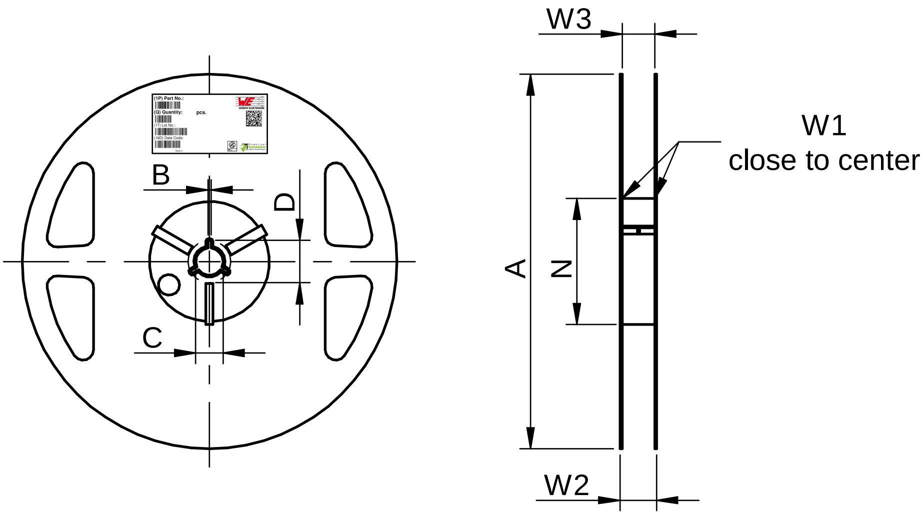


Figure 27: 171930601 landpattern dimensions.

20.3 PACKAGING

Reel in mm



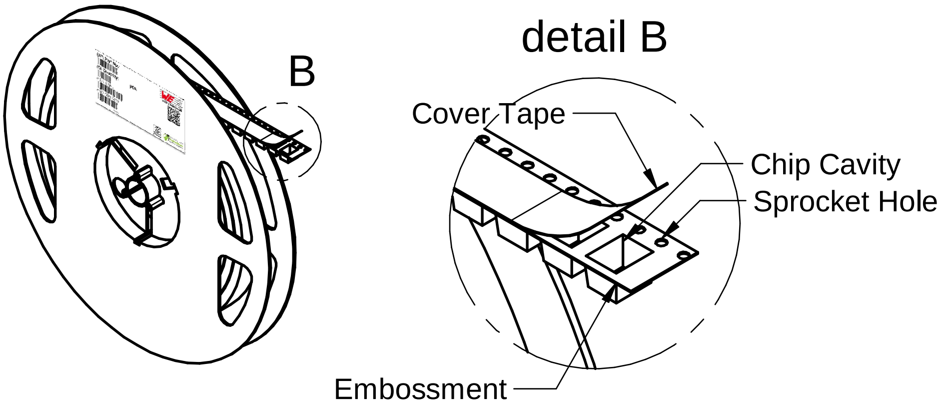


Figure 28: 171930601 reel dimensions.

Table 14: Reel dimensions.

A	B	C	D	N	W1	W2	W3	W3	Material
±1.0	±0.5	±0.5	Min.	±0.5	±1.5	±1.0	Min.	Max.	
178.00	2.50	13.00	12.50	60.00	13.2	16.00	12.20	15.00	Polystyrene

Tape in mm

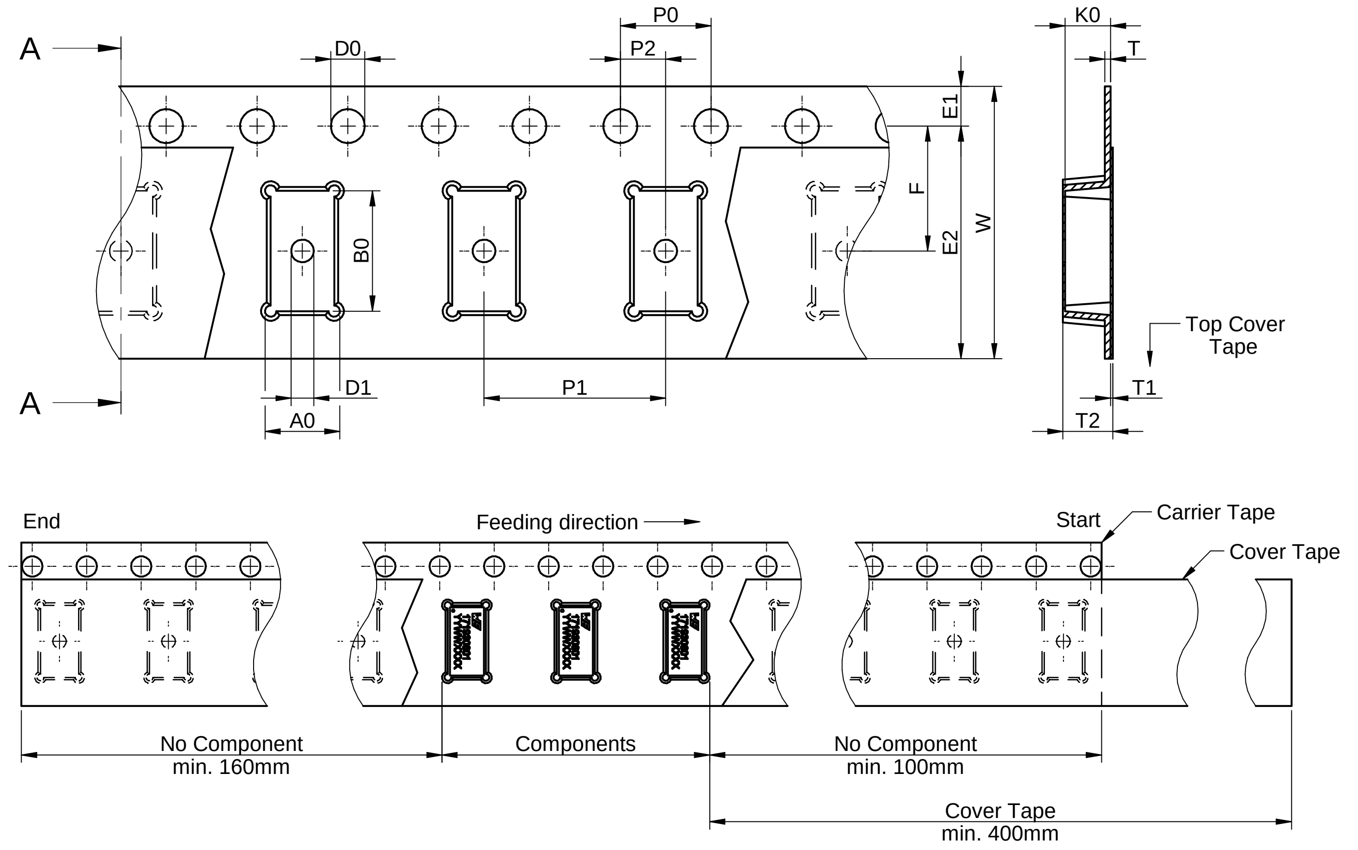


Figure 29: 171930601 tape dimensions.

Table 15: Tape dimensions.

Tape Type	A0	B0	W	T	T1	T2	K0	P0	P1	P2	D0	D1	E1	E2	F
	±0.1	±0.1	±0.3	±0.05	±0.01		±0.1	±0.1	±0.1	±0.05	Max.	Min.	±0.1	Min.	±0.05
2a	2.8	5.3	12	0.3	0.05	2.005	2.0	4	8	2	1.6	1.0	1.75	10.25	5.5

Tape material is polystyrene.

21 DOCUMENT HISTORY

Table 16: Document history.

Revision	Date	Description	Comment
1.0	November 2021	Initial data sheet release	
1.1	December 2021	Minor formatting change	Updated format and updated front page
1.2	April 2022	Minor changes	1. Updated document font style 2. Corrected output voltage values in output voltage selection table in Design Flow 3. Updated Filter Suggestion for Conducted EMI section
2.0	July 2023	PCN	The recommended reflow solder profile in the Handling Recommendations section of the data sheet has been updated. The formatting of the document has been updated.

22 LIST OF FIGURES

23 LIST OF TABLES

24 CAUTIONS AND WARNINGS

The following conditions apply to all goods within the product series of MagI^{3}C 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.

Disclaimer:

This electronic component has been designed and developed for usage in general electronic equipment only. This product is not authorized for use in equipment where a higher safety standard and reliability standard is especially required or where a failure of the product is reasonably expected to cause severe personal injury or death, unless the parties have executed an agreement specifically governing such use. Moreover Würth Elektronik eiSos GmbH & Co. KG products are neither designed nor intended for use in areas such as military, aerospace, aviation, nuclear control, submarine, transportation (automotive control, train control, ship control), transportation signal, disaster prevention, medical, public information network etc. Würth Elektronik eiSos GmbH & Co. KG must be informed about the intent of such usage before the design-in stage. In addition, sufficient reliability evaluation checks for safety must be performed on every electronic component which is used in electrical circuits that require high safety and reliability functions or performance. These cautions and warnings comply with the state of the scientific and technical knowledge and are believed to be accurate and reliable. However, no responsibility is assumed for inaccuracies or incompleteness.

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

25 IMPORTANT NOTES

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.

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.

Best Care and Attention

Any product-specific notes, warnings and cautions must be strictly observed. Any disregard will result in the loss of warranty.

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.

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.

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.

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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.

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