WPMDL1300331BD – 3.3V

MagI³C Power Module Product Family
FDRM - Fixed Step Down Regulator Module

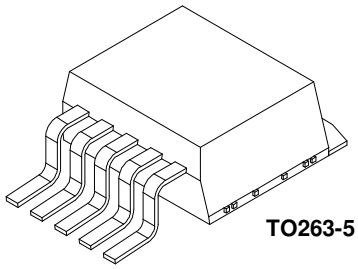
DESCRIPTION

The FDRM series of the MagI³C Power Modules Family comprise a fully integrated current mode DC/DC power supply with both the switching power stage, control circuitry and passive all in one package. The FDRM series is a stand-alone device that does not require any external components for operation. These devices also feature built-in compensation circuitry and a soft-start feature for a smooth, safe power up. The TO263-5 is an industrial high power density package with a low profile and a small outline.

The FDRM series offers high efficiency and delivers up to 3A of output current with accurate regulated output voltages. It operates from input voltage 5V to 18V.

The FDRM series provides high efficiency at light load using a PFM burst mode. It also provides a remote ON/OFF feature with current consumption less than 10µA in OFF mode. An open-drain output pin provides a Power Good signal indicating that the output voltage is in regulation.

The FDRM regulators also have on-board protection circuitry to guard against thermal and electrical damage. Thermal shut-down, over-current, over-voltage and under-voltage protections safeguard the regulator and include an auto-reset mechanism.



TO263-5

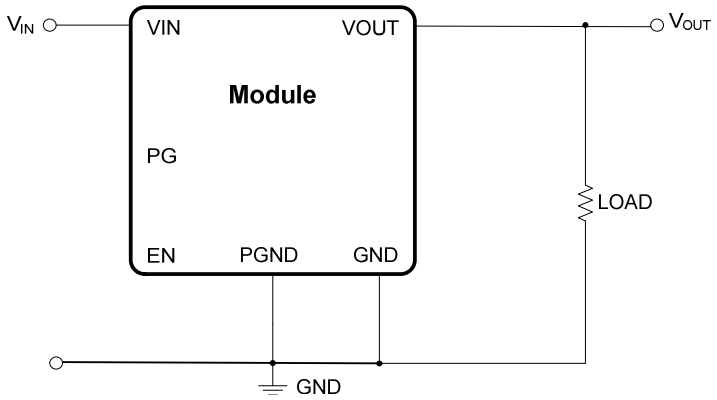
FEATURES

- Power Supply in Package (PSiP) solution
- Peak efficiency up to 95%
- Current capability up to 3A
- Wide input voltage range: 5V-18V
- Regulated output voltages: 3.3V
- Power package TO263-5
- Built-in soft-start and compensation
- Power Good signal and Remote Enable pin
- Low quiescent current <10µA
- Under voltage lockout protection (UVLO)
- Voltage overshoot and over-current protection
- Thermal shut down protection
- Junction temperature range: -40 to 125°C
- RoHS & REACh compliant

APPLICATIONS

- Point of Load DC-DC applications
- Servers, Data and Telecom
- System power supplies
- DSPs, FPGAs, MCUs and MPUs
- I/O interface

TYPICAL APPLICATION



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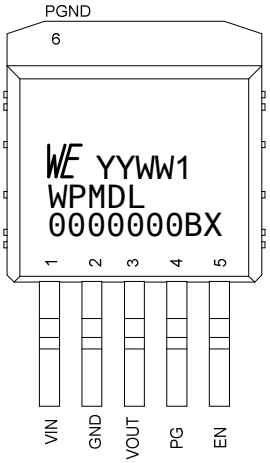
FDRM - Fixed Step Down Regulator Module

A PACKAGE MARKING



First row: Logo & Date code

Second row: Product family and type

Third row: Parameter code

Top View TO263-5

B PIN DESCRIPTION

PIN #	PIN SYMBOL	PIN DESCRIPTION
1	V_{IN}	Input power supply
2	GND	Reference ground of the device
3	V_{OUT}	Regulated output voltage
4	PG	Open-drain output, operation monitoring
5	EN	Remote ON/ OFF with internal pull-up resistor for stand-alone operation
6	PGND	Power Ground Pin - Ground for the internal low-side switch. Connected externally to GND

C ORDERING INFORMATION

ORDER NUMBER	PART DESCRIPTION	PACKAGE	PACKING UNIT
171030301	WPMDL1300331BD	TO263-5	Tape and Reel with 500 Units
178030301	WPMDL1300331BEV	box	1

D SALES INFORMATION

SALES CONTACTS
Würth Elektronik eiSos GmbH & Co. KG EMC & Inductive Solutions Max-Eyth-Str. 1 74638 Waldenburg Germany Tel. +49 (0) 79 42 945 - 0 www.we-online.com powermodules@we-online.com

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E ABSOLUTE MAXIMUM RATINGS

Preventive Caution: Exceeding the listed absolute maximum ratings below may affect the device negatively and may cause permanent damage. Therefore operating ratings are conditions under which operation of the device is intended to be functional. All values are referenced to GND and to a free ambient operating temperature of T_A=25 ± 5°C unless otherwise specified.

SYMBOL	PARAMETER	LIMITS	UNIT
V_{IN}	Input voltage V_{IN}	-0.3 to 20	V
V_{OUT}	Output voltage V_{OUT}	-0.3 to 6.0	V
EN, PG	Enable, Power Good	-0.3 to 6.0	V
PG_{SC}	PG pin sink current	10	mA
$V_{ESD-HBM}$	ESD, human body model	-2000 to 2000	V
$V_{ESD-CDM}$	ESD, charge device model	-500 to 500	V
T_J	Junction temperature	150	°C
T_{ST}	Storage temperature	-40 to 125	°C

F RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	MIN	TYP	MAX	UNIT
V_{IN}	Input voltage	5	12	18	V
EN	Enable input	0	-	5	V
PG	Power Good	0	-	5	V
PG_{SC}	PG Pin sink current	-	-	5	mA
T_A	Ambient temperature range	-40	-	85	°C
T_J	Junction temperature range	-40	-	125	°C

G THERMAL SPECIFICATIONS

SYMBOL	PARAMETER	VALUE	UNIT
θ_{JA}	Thermal resistance junction to ambient	tbd(1)	°C/W
θ_{JC}	Thermal resistance junction to case	tbd(1)	°C/W
T_{SD}	Thermal shut down, junction temperature, rising	170(2)	°C
$T_{SD-HYST}$	Thermal shut down hysteresis, falling	10	°C
T_{SOLR}	Soldering temperature reflow	245(3)	°C

H ELECTRICAL SPECIFICATIONS

Limits are valid for the recommended junction temperature range of -40°C to 125°C. Typical values represent the most likely norm at following conditions: V_{IN}=12V, T_A=25 ± 5°C, unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Specifications regarding supply voltage pin V_{IN}						
V_{IN}	Input voltage		5	12	18	V
V_{UVLO}	V_{IN} under voltage lockout threshold	V_{IN} rising, EN pin floating	4.0	-	4.5	V
$V_{UVLO-HYST}$	V_{IN} under voltage lockout hysteresis	Hysteresis	-	650	-	mV
I_{IN-NLC}	No load quiescent current	V_{IN}=12V, I_{OUT}=0A, EN floating	-	tbd	-	mA
I_{IN-OFF}	Remote OFF quiescent current	V_{IN}=12V, EN=0V	-	-	10	µA

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MagI³C Power Module Product Family
FDRM - Fixed Step Down Regulator Module

H ELECTRICAL SPECIFICATIONS

Limits are valid for the recommended junction temperature range of -40°C to 125°C. Typical values represent the most likely norm at following conditions: V_{IN}=12V, T_A=25 ± 5°C, unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Specifications regarding output voltage pin V_{OUT}						
V_{OUT}	Regulated output voltage	I_{OUT}=1.0A	V_{OUT}-2%	3.3	V_{OUT}+2%	V
V_{OUT-BM}	Regulated output voltage in burst mode	I_{OUT}=0A	V_{OUT} -1%	V_{OUT}+1%	V_{OUT}+3.5%	V
$V_{OUT-UVP}$	Under voltage protection threshold	Referring to nominal output voltage	91%·V_{OUT}	93%·V_{OUT}	95%·V_{OUT}	V
$V_{OUT-UVP-HYST}$	Under voltage protection hysteresis	Referring to nominal output voltage	-	1.5%·V_{OUT}	-	V
$V_{OUT-OVP}$	Over voltage protection threshold	Referring to nominal output voltage	-	103%·V_{OUT}	-	V
$V_{OUT-OVP-HYST}$	Over voltage protection hysteresis	Referring to nominal output voltage	-	1%·V_{OUT}	-	%
I_{OUT}	Output current				3.0	A
I_{OCP}	Over current protection		3.4	3.8	4.4	A
Specifications regarding Power Good pin PG						
t_{PG-RD}	Power Good release delay		-	10	-	ms
V_{LLV-PG}	Low level voltage PG	I_{PG}=0.3mA	-	-	10	mV
I_{PG-L}	PG pin leakage current	V_{PG}=5.0V	-	0.5	-	µA
Specifications regarding Enable pin EN						
V_{EN-LL}	Low level input voltage	Remote-OFF, V_{EN} falling	-	-	0.8	V
V_{EN-HL}	High level input voltage	Remote-ON, V_{EN} rising	-	-	2.2	
$V_{EN-HYST}$	EN input hysteresis		-	480	-	mV
I_{EN-L}	EN pin leakage current	V_{EN}=5V	-	tbd	-	µA
		V_{EN}=0V	-	tbd	-	µA
System specifications						
f_{SW}	Switching frequency		-	1.0	-	MHz
D_{max}	Duty cycle, maximum		95	97	99	%
t_{SS}	Start-up ramp time	EN transition low to high	-	4	-	ms
C_{INI}	Input capacitor, internal	Built-in capacitor	-	10	-	µF
C_{OUTI}	Output capacitor, internal	Built-in capacitor	-	44	-	µF
L_I	Inductor, internal	Built-in inductor	-	4.7	-	µH

NOTES

(1) Measured values referenced to evaluation board with 2 layer, 0.35µm copper printed circuit board and thermal via array, no airflow. Those values may vary depending on PCB design and environmental circumstances
(2) Typical value guaranteed by design. Not production tested
(3) JEDEC J-STD-020, peak package body temperature T_P

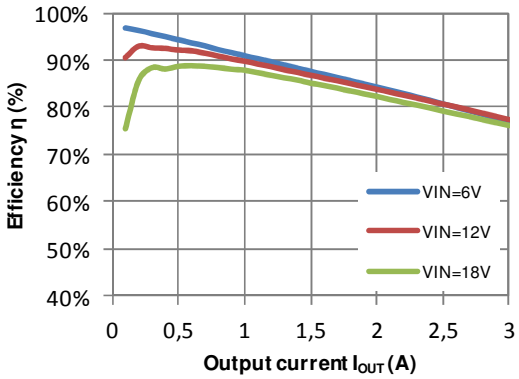
WPMDL1300331BD – 3.3V

MagI³C Power Module Product Family
FDRM - Fixed Step Down Regulator Module

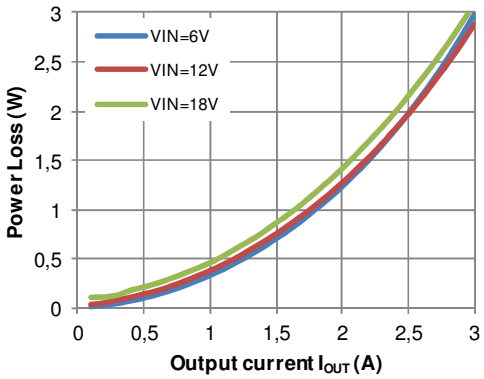
I TYPICAL PERFORMANCE CURVES

If not otherwise specified, the following conditions apply: V_{IN} = 12V; T_A=25°C ± 5°C

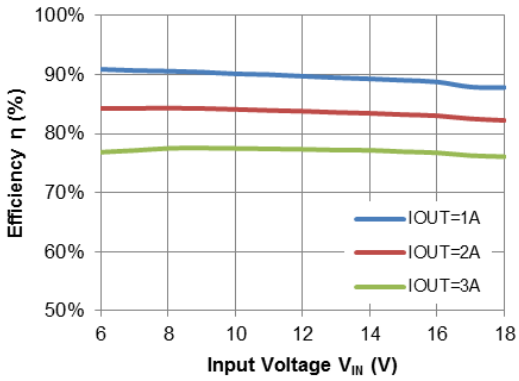
Efficiency V_{OUT}=3.3V T_A=25°C



Power Loss V_{OUT}=3.3V T_A=25°C



Efficiency V_{OUT}=3.3V T_A=25°C



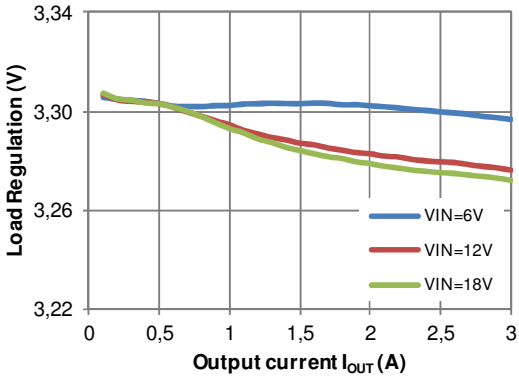
WPMDL1300331BD – 3.3V

MagI³C Power Module Product Family
FDRM - Fixed Step Down Regulator Module

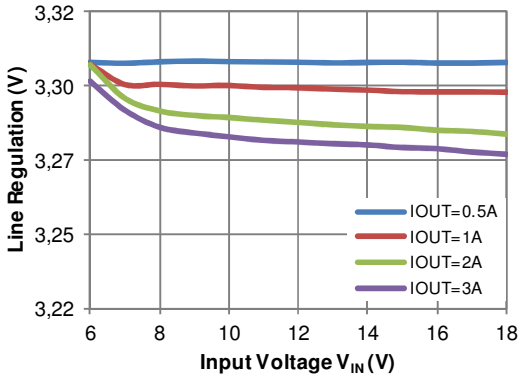
I TYPICAL PERFORMANCE CURVES

If not otherwise specified, the following conditions apply: V_{IN} = 12V; T_A=25℃ ± 5℃

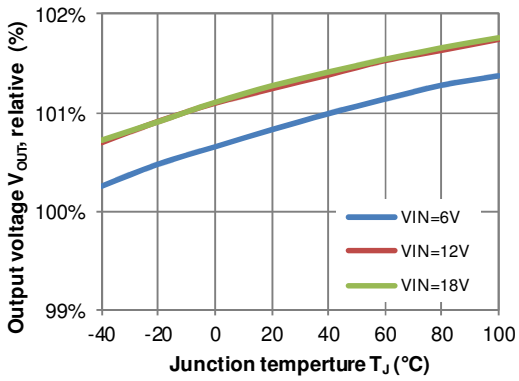
Load Regulation, $V_{OUT-NOM}$=3.3V T_A=25°C



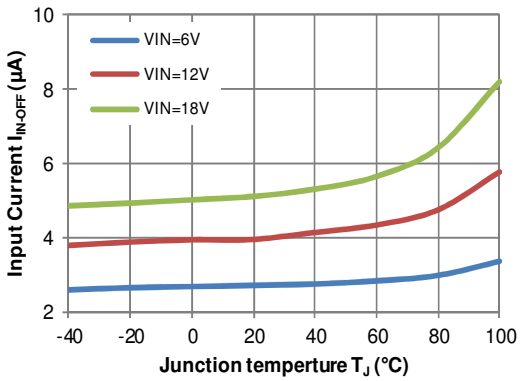
Line Regulation, $V_{OUT-NOM}$=3.3V T_A=25°C



Output voltage V_{OUT}, $V_{OUT-NOM}$=3.3V, I_{OUT}=0A



Input Current I_{IN-OFF}, V_{OUT}=0V, EN=0V

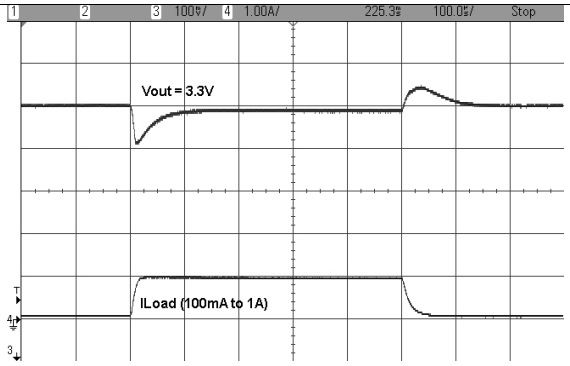


WPMDL1300331BD – 3.3V

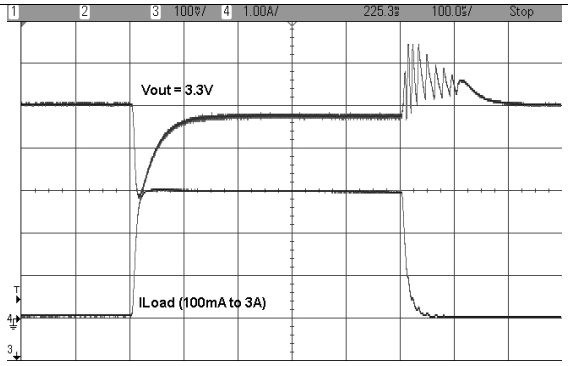
MagI³C Power Module Product Family
FDRM - Fixed Step Down Regulator Module

I TYPICAL PERFORMANCE CURVES

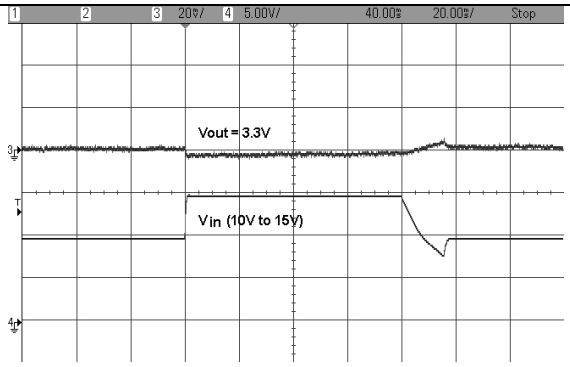
If not otherwise specified, the following conditions apply: V_{IN} = 12V; T_A=25℃ ± 5℃



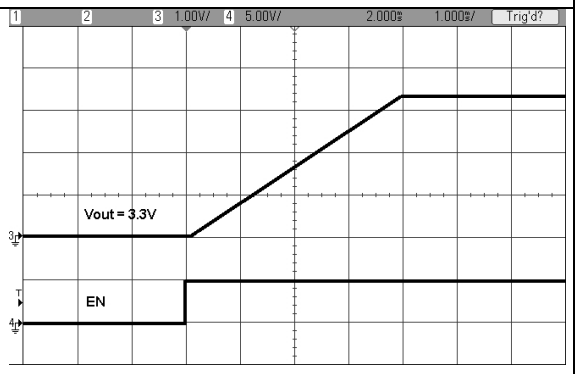
Load Transient Response, V_{IN}=12V, V_{OUT}=3.3V



Load Transient Response, V_{IN}=12V, V_{OUT}=3.3V



Line Transient Response, V_{OUT}=3.3V
Line Step from 10V to 15 V



Startup Response

WPMDL1300331BD – 3.3V

MagI³C Power Module Product Family
FDRM - Fixed Step Down Regulator Module

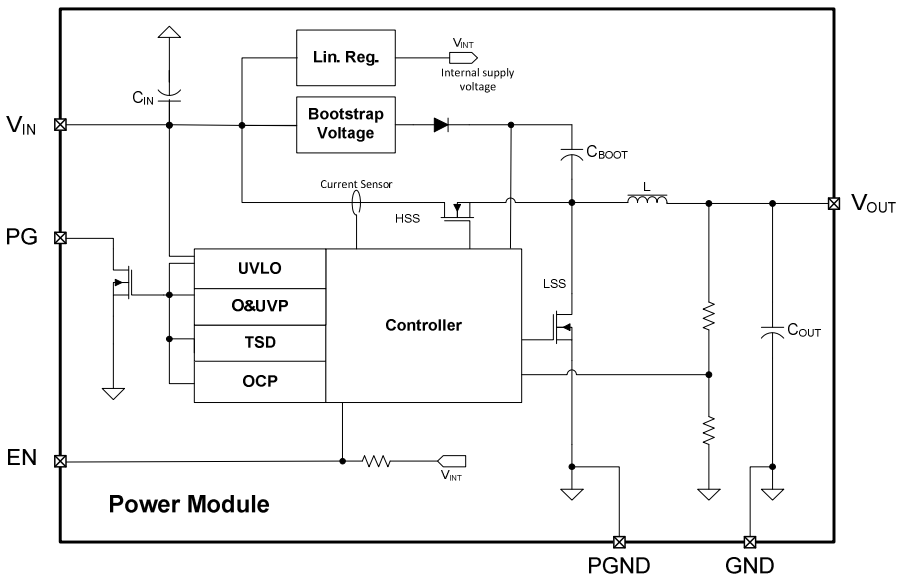
J CIRCUIT DESCRIPTION

The FDRM series of the MagI³C Power Modules Family are non-isolated switching mode DC/DC power supplies capable of supplying up to 3A of output current. These devices comprise a fully integrated current-mode control synchronous buck converter and embedded passive components. The converter switches the built-in MOSFETs with a constant frequency of 1MHz (typical) with cycle-by-cycle current limiting. Since the FDRM-Series is a power-in-package solution there is no need to route external components. The modules support two regulation modes: PWM and PFM. The device changes the modes depending on the load requirements in order to optimize power efficiency. The FDRM-Series offers fixed regulated output voltages of 3.3V and 5.0V. Its wide input voltage range of 5V to 18V (for the 3.3V output) or 7V to 18V (for the 5.0V output) meets industrial requirements as well as commercial demands.

The FDRM-Series features internal feedback loop compensation with good line and load regulation as well as good transient response. Start-up is controlled by an internal Soft-start preventing inrush current and overshoot of the output voltage. The Fixed-Power-Module series also has further protection circuitry against thermal and electrical damage on board. They are: thermal shut down, over-current, over-voltage and under-voltage protection with an auto-reset mechanism. If any of these protective functions of the module are activated the open-drain output Power Good PG is pulled down, indicating a fault.

Leaving the Enable pin EN open-circuit forces the module into standalone mode by an internal pull-up. This pin also provides a remote shut down option if it is connected to GND.

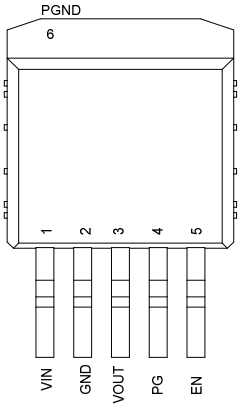
K BLOCK DIAGRAM



WPMDL1300331BD – 3.3V

MagI³C Power Module Product Family
FDRM - Fixed Step Down Regulator Module

L PIN CONFIGURATION



Top View TO263-5

M DETAILED PIN DESCRIPTION

PIN #	PIN SYMBOL	TYPE	PIN DESCRIPTION
1	V_{IN}	PWR	The supply input pin is a terminal for connection of the unregulated input voltage source. It is connected to an internal capacitor.
2	GND	PWR	The ground pin is the reference point for all stated voltages. It is internally connected to PGND.
3	V_{OUT}	O	The output voltage pin is a regulated output voltage terminal and is connected to the internal inductor and capacitor.
4	PG	O	The Power Good pin is implemented as an open drain flag That indicates the status of output voltage regulation to other devices. In the event of fault, PG is pulled to ground. It is reset automatically after the fault conditions are cleared.
5	EN	I	The EN input pin enables the device operation. The pin is internally connected to a pull-up resistor and is an active low input. Floating this pin puts the device in stand-alone mode. The user can connect this pin to a logic-high voltage of 5V maximum. A logic-low voltage of 0V disables the device.
6	PGND	PWR	The Power Ground tab is internally connected to low-side switch and GND. It is used to dissipate the heat during device operation. The soldering tab should be connected to the GND pin and a sufficiently large area of copper on the top and/or bottom of the PCB.

N PROTECTIVE FEATURES

OUTPUT OVER-VOLTAGE PROTECTION (OVP)

The output voltage is monitored by a comparator. When the output voltage rises above the OVP threshold voltage the switching cycle is immediately terminated by turning off the power transistors, protecting the device from damage. OVP releases and normal switching resumes after the condition has been cleared. OVP is indicated by the Power Good signal.

OUTPUT UNDER-VOLTAGE PROTECTION (UVP)

When the under voltage protection circuitry detects that the output voltage is lower than the defined threshold voltage, it will be pull the open-drain output of the pin PG down, indicating a fault. When the under voltage condition is over and the internal comparator detects that output voltage has risen over a set threshold then it releases the PG pin after a programmed delay time. A UVP condition can be caused by several different problems, such as output over current, input under-voltage, or thermal overload.

OVER CURRENT PROTECTION (OCP)

Output overcurrent is detected through the high side FET, and when it engages it will interrupt the switching cycle by turning off the high side switch. The module then restarts after a programmed delay, giving the current in the output inductor time to decay. Note that DC current limit varies with duty cycle, switching frequency and temperature. OCP is indicated the Power Good signal.

OVER TEMPERTURE PROTECTION (OTP)

The junction temperature of the device should not be allowed to exceed its maximum ratings. Thermal protection is implemented by an internal Thermal Shutdown circuit which activates at 170°C (typical) causing the device to enter a tri-state condition to protect against thermal damage. Once the silicon die temperature has dropped to below 160°C (typical), the module initiates an auto-restart controlled by the soft-start function. OTP is also indicated by the Power Good signal.

UNDER VOLTAGE LOCKOUT (UVLO)

A built-in UVLO hysteresis ensures a stable start-up without toggling near the threshold. The UVLO circuit enables the regulator when the input voltage reaches the upper threshold. The device is disabled when the input voltage falls below the lower threshold of the hysteresis.

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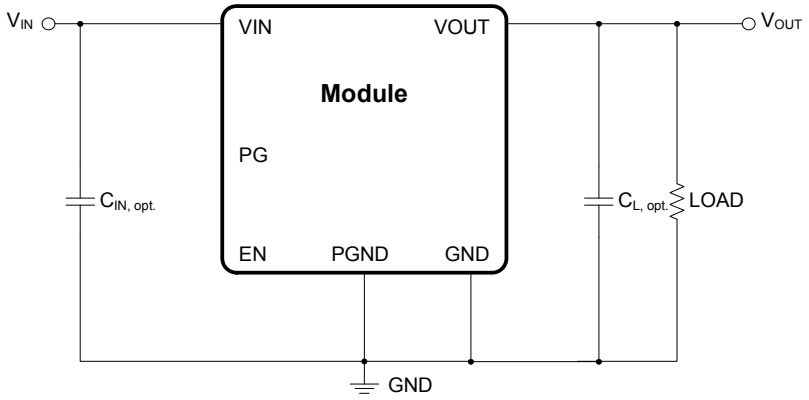
MagI³C Power Module Product Family
FDRM - Fixed Step Down Regulator Module

O APPLICATIONS

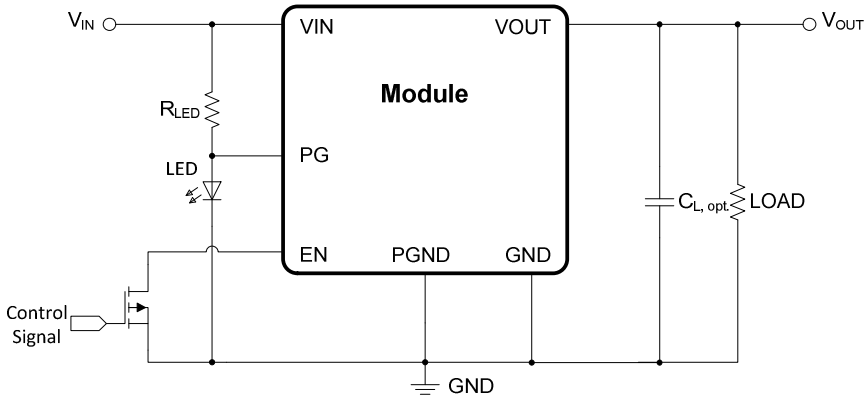
The FDRM series is a stand-alone device that does not require any external parts to function. Depending upon the load requirements, however, the system will benefit from additional filter for noise cancelation on the input and output pins. For example, adding a 10µF cap in addition to the internal cap of 10µF close to the V_{IN} pin will reduce the input voltage ripple and helps meet AC current demand of the IC. Placing the module close to the load helps to avoid a voltage drop in the wiring, but if this is not possible placing a 100µF cap close to the load will help maintain the voltage. The following application circuits show some possible operating configurations.

O1 APPLICATION CIRCUIT



Simple circuit three pin configuration. Caps C_{IN} and C_{OUT} can be connected optionally.

O2 APPLICATION CIRCUIT

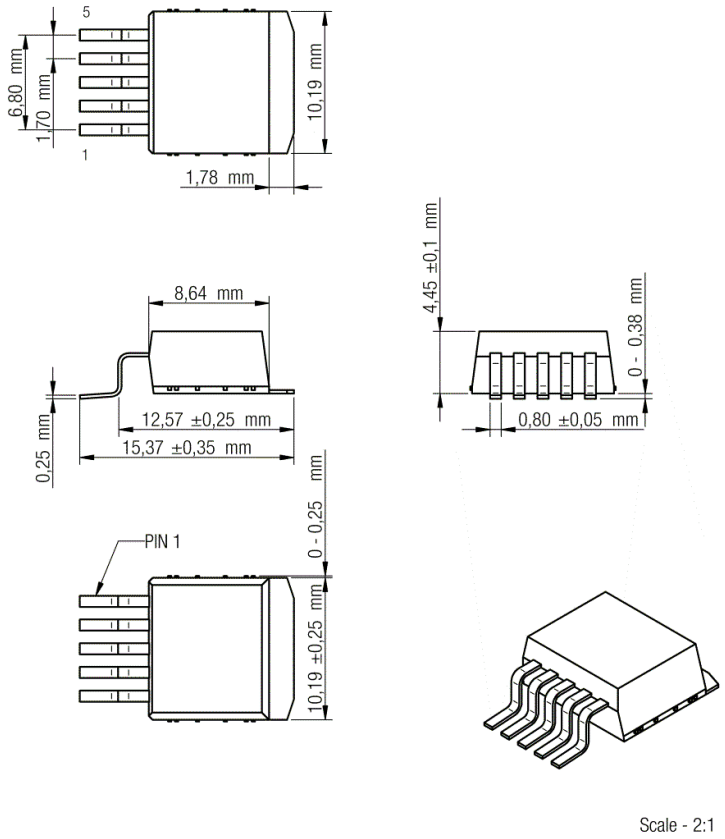


Circuit configuration with visually indication of proper regulated output voltage and remote control. The LED reduces the voltage of the pin PG to its forward voltage and protects the pin against unspecified voltages.

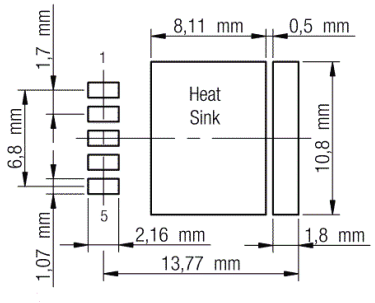
WPMDL1300331BD – 3.3V

MagI³C Power Module Product Family
FDRM - Fixed Step Down Regulator Module

P PHYSICAL DIMENSIONS



Scale - 2:1



Scale - 2:1

recommended soldering pad

WPMDL1300331BD – 3.3V

MagI³C Power Module Product Family
FDRM - Fixed Step Down Regulator Module

Q DOCUMENT HYSTORY

DOCUMENT HISTORY

Revision	Date	Description
0.10	17.04.2013	Preliminary version

WPMDL1300331BD – 3.3V

MagI³C Power Module Product Family
FDRM - Fixed Step Down Regulator 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 disposal and operation of the product within ambient conditions which probably alloy or harm the component surface has to be avoided.

If the product is potted in customer applications, the potting material might shrink during and after hardening. Accordingly to this the product is exposed to the pressure of the potting material with the effect that the body and termination is possibly damaged by this pressure and so the electrical as well as the mechanical characteristics are endanger to be affected. After the potting material is cured, the body and termination of the product have to be checked if any reduced electrical or mechanical functions or destructions have occurred.

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.

Washing varnish agent that is used during the production to clean the application might damage or change the characteristics of the body, pins or termination. The washing varnish agent could have a negative effect on the long turn 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 be complied with according to the technical reflow/ or wave soldering specification, otherwise no warranty will be sustained.
- All products are supposed to be used before the end of the period of 12 months based on the product date-code, if not a 100% solderability can´t be warranted.
- Violation of the technical product specifications such as exceeding the absolute maximum ratings will result in the loss of 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.

WPMDL1300331BD – 3.3V

MagI³C Power Module Product Family
FDRM - Fixed Step Down Regulator Module

IMPORTANT NOTES

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

0. **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 datasheet are 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 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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