SENSITEC
KÖRBER SOLUTIONS

DATA SHEET

CMS3100

Highly Dynamic MagnetoResistive Current Sensor (I_{PN} = 100 A)

The CMS3000 current sensor family is designed for highly dynamic electronic measurement of DC, AC, pulsed and mixed currents with integrated galvanic isolation. The MagnetoResistive technology enables an excellent dynamic response without the hysteresis that is present in iron core based designs.

With a **bandwidth up to 2 MHz** and a temperature range of –40°C to +105°C the CMS3000 enables new application fields for highly dynamic and compact current measurement.

The CMS3000 product family offers PCB-mountable THT current sensors in the range of 5 A up to 100 A nominal current for industrial applications.

Product discontinued.
Not to be used for new designs.

Product Overview CMS3100

Product description	Package	Delivery Type
CMS3100ABA (discontinued)	THT	Tray

Quick Reference Guide

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{CC}	Supply voltage	±12	±15	-	V
I_{PN}	Primary nominal current (RMS)	-	-	100	A
I_{PR}	Primary measuring range [1]	-400	-	+400	A
f_{co}	Frequency bandwidth (-3 dB)	1.5	2.0	-	MHz
ε_{Σ}	Accuracy [2]	-	±0.8	±1.3	% of I_{PN}

[1] For 2 s in a 60 s interval (RMS ≤ I_{PN}) and V_{CC} = ±15 V.

[2] $\varepsilon_{\Sigma} = \varepsilon_G$ & ε_{lin} with V_{CC} = ±15 V, $I_P = I_{PN}$, T_{amb} = 25 °C.

Qualification Overview

Standard	Name	Status
2002/95/EC	RoHS-conformity	Approved
EN 61800-5-1: 2007	Adjustable speed electrical power drive systems	Approved
DIN EN 50178	Electronic equipment for use in power installations	Approved
UL508 (E251279)	Industrial control equipment	Approved

Features

- Based on the AnisotropicMagnetoResistive (AMR) effect
- Measuring range up to 4 times nominal current
- Galvanic isolation between primary and measurement circuit
- Pin-compatible with CMS2000 current sensor family
- Bipolar 15 V power supply

Advantages

- Very high bandwidth > 2 MHz
- Highly dynamic step response
- High signal-to-noise ratio
- Large temperature range -40°C to +105°C
- Excellent accuracy
- Negligible hysteresis
- Compact size
- Low primary inductance

Applications

- Electrical motor control
- DC/DC converter
- Laser diode driver
- Audio amplifier
- Condition Monitoring
- Switched mode power supplies
- Sensorless BLDC motors
- Induction heating converters
- Inductive charging

ESD

RoHS-Konform 2002 | 95 | EC

Absolute Maximum Ratings Values

In accordance with the absolute maximum rating system (IEC60134).

Symbol	Parameter	Min.	Max.	Unit
V_+	Positive supply voltage	-0.3	17.0	V
V_-	Negative supply voltage	-17	0.3	V
I_{PM}	Maximum primary current [1]	-1000	+1000	A
T_{amb}	Ambient temperature	-40	+105	°C
T_{stg}	Storage temperature	-40	+125	°C
T_B	Busbar temperature	-40	+125	°C

[1] For 20 ms in a 20 s interval. (RMS ≤ I_{PN}).

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

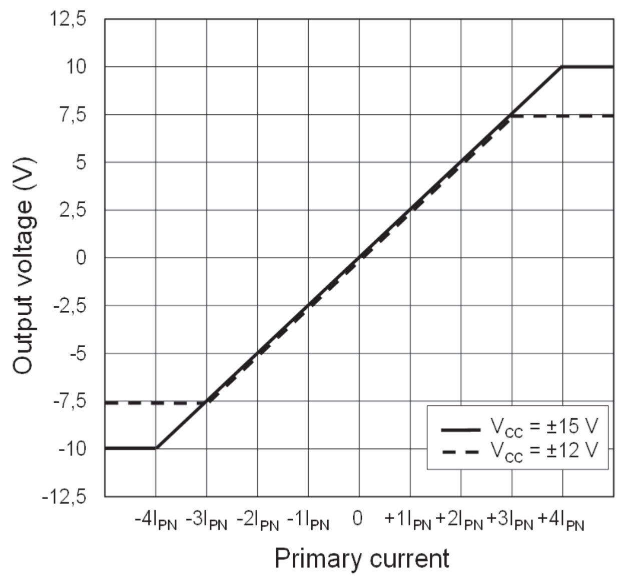

Fig. 1: Output voltage range for different supply voltages.

Electrical Data

T_{amb} = 25 °C; V_{CC} = ±15 V; unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_+	Positive supply voltage		+14.3	+15.0	+15.7	V
V_-	Negative supply voltage		-15.7	-15.0	-14.3	V
I_{PN}	Primary nominal current (RMS)		-	-	100	A
I_{PR}	Measuring range [1]		-400	-	+400	A
V_{outN}	Nominal output voltage (RMS)	$I_P = I_{PN}$, comp. Fig.1	-	2.5	-	V
R_M	Internal burden resistor for output signal		80	110	150	Ω
R_P	Resistance of primary conductor		-	0.07	0.1	mΩ
I_Q	Quiescent current	$I_P = 0$	-	21	25	mA
I_{CN}	Nominal current consumption	$I_P = I_{PN}$	-	45	50	mA
I_{CR}	Measuring range current consumption	$I_P = I_{PR}$	-	115	125	mA
I_{CM}	Maximal current consumption [2]	$I_P > I_{PR}$	-	-	135	mA

T_{amb} = 25 °C; V_{CC} = ±12 V; unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_+	Positive supply voltage		+11.4	+12.0	+12.6	V
V_-	Negative supply voltage		-12.6	-12.0	-11.4	V
I_{PN}	Primary nominal current (RMS)		-	-	100	A
I_{PR}	Measuring range [1]		-300	-	+300	A
V_{outN}	Nominal output voltage (RMS)	$I_P = I_{PN}$, comp. Fig.1	-	2.5	-	V
R_M	Internal burden resistor for output signal		80	110	150	Ω
R_P	Resistance of primary conductor		-	0.07	0.1	mΩ
I_Q	Quiescent current	$I_P = 0$	-	21	25	mA
I_{CN}	Nominal current consumption	$I_P = I_{PN}$	-	45	50	mA
I_{CR}	Measuring range current consumption	$I_P = I_{PR}$	-	90	95	mA
I_{CM}	Maximal current consumption [2]	$I_P > I_{PR}$	-	-	100	mA

[1] For 2 s in a 60 s interval (RMS ≤ I_{PN}).

[2] Limited by output driver.

Accuracy

T_{amb} = 25 °C; V_{CC} = ±15 V; unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
ε_{Σ}	Accuracy [1) 2)]	$I_P \leq I_{PN}$	-	±0.8	±1.3	% of I_{PN}
ε_G	Gain error [2)]	$I_P \leq I_{PN}$	-	±0.7	±1.2	% of I_{PN}
ε_{off}	Offset error [2)]	$I_P = 0$	-	±0.3	±0.8	% of I_{PN}
ε_{Lin}	Linearity error	$I_P \leq I_{PN}$; symmetrical current feed	-	±0.1	±0.15	% of I_{PN}
ε_{Hys}	Hysteresis	$4 \cdot I_{PN}$, Δt = 20 ms	-	-	0.04	% of I_{PN}
PSRR	Power supply rejection rate	$f_{\Delta Vcc} \leq$ 100Hz	-	-63	-	dB
PSRR	Power supply rejection rate	$f_{\Delta Vcc} \leq$ 15kHz	-	-57	-45	dB
N_{RMS}	Noise level (RMS)	f ≤ 80 kHz	-	0.25	0.3	mV
N_{pk}	Noise level (peak)	f ≤ 80 kHz	-	2.2	3.0	mV

T_{amb} = (-40…+105)°C; V_{CC} = ±15 V; unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$T\varepsilon_G$	Additional temperature induced gain error		-	-	±0.5	% of I_{PN}
$T\varepsilon_{off}$	Additional temperature induced offset error		-	-	±2.0	% of I_{PN}
$T\varepsilon_{off}$	Additional temperature induced offset error	T_{amb} = (-25…+105)°C			±1.5	% of I_{PN}
$T\varepsilon_{Lin}$	Additional temperature induced linearity error		-	-	±0.1	% of I_{PN}
$T\varepsilon_{\Sigma}$	Typical total accuracy [3)]	$I_P \leq I_{PN}$	-	±1.5	-	% of I_{PN}

1) Accuracy contains ε_G and ε_{Lin}.

2) Does not include additional error of 0.5% (I_{PN}) due to aging.

3) Typical total accuracy measured in temperature range (including error at T_{amb} = 25 °C).

General Data

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
T_{amb}	Ambient temperature 1)		-40	-	+105	°C
T_{stg}	Storage temperature		-40	-	+125	°C
T_{B}	Busbar temperature 1)		-40	-	+125	°C
T_{THT}	Solder temperature 2)	For 7 seconds	-	-	265	°C
m	Mass		-	7.5	8.0	g

General Data
T_{amb} = 25 °C; V_{CC} = ±15 V; unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
t_{reac}	Reaction time 3)	10 % I_{PN} to 10 % $I_{out,N}$	-	0.055	0.1 4)	µs
t_{rise}	Rise time 3)	10 % $I_{out,N}$ to 90 % $I_{out,N}$	-	0.05	0.25 4)	µs
t_{resp}	Response time 3)	90 % I_{PN} to 90 % $I_{out,N}$	-	-	0.15 4)	µs
f_{co}	Upper cut-off frequency	-3 dB	1.5	2.0	-	MHz
ΔV_{TR}	Transient output voltage	0 V to 530 V (3.7 kV/µs); see Fig. 3	-	0.075 4)	0.31	V
t_{recTR}	Transient recovery time	0 V to 530 V (3.7 kV/µs); see Fig. 3	-	0.7	1.8 4)	µs

Isolation Characteristics

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_{I}	Isolation test voltage (RMS)	50/60 Hz, 60 s	4.4	-	-	kV
V_{imp}	Impulse withstand voltage	1.2/50 µs	8.0	-	-	kV
d_{cp}	Creepage distance		6.1	-	-	mm
d_{cl}	Clearance distance 5)		6.1	-	-	mm
V_{B}	System voltage (RMS) 6)	Reinforced isolation PD2, CAT III	300	-	-	V
V_{B}'	System voltage (RMS) 6)	Basic isolation PD2, CAT III	600	-	-	V
ESD	Electro static test voltage	HBM, contact discharge method	-	8.0	-	kV

1) Operating condition.

2) Depending on the size of the primary conductor, variation of pre-heating parameters (temperature, duration) might be necessary in order to ensure sufficient soldering results.

3) $I_{P} = I_{PN}$, di/dt of 500 A/µs.

4) With recommended RC output filter values according to page 8.

5) If mounted on a PCB, the minimal clearance distance might be reduced according to the PCB layout (e.g. diameter of drilling holes and annular rings).

6) According to DIN EN 50178, DIN EN 61800-5-1.

Typical Performance Characteristics

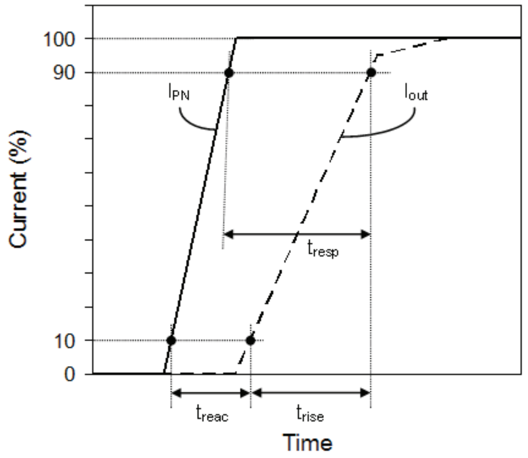

Fig. 2: Definition of reaction time (t_{reac}), rise time (t_{rise}) and response time (t_{resp}).

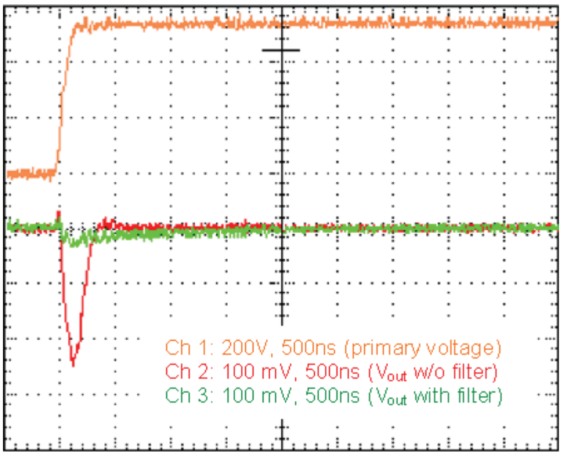

Fig. 3: dV/dt (3.7 kV/µs; 530 V voltage on primary conductor; filter configuration acc. to Tab. 1).

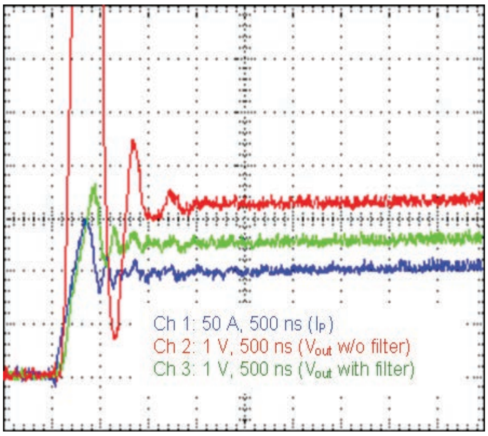

Fig. 4: Step response (I_P = 100 A; di/dt ≈ 500A/µs; filter configuration acc. to Tab. 1).

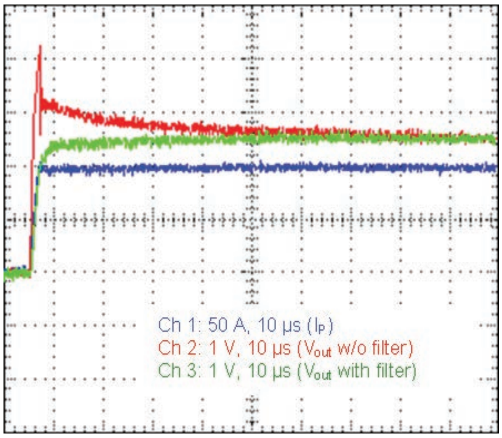

Fig. 5: Step response (IP = 100 A; di/dt ≈ 60 A/µs; filter configuration acc. to Tab. 1).

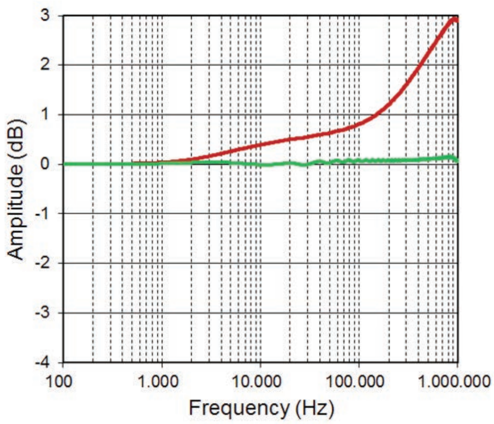

Fig. 6: Typical frequency response with RC-filter (green) and without (red). Filter configuration acc. to Tab. 1.

Pinning

Pad	Symbol	Parameter
1	V_+	Positive supply voltage
2	V_-	Negative supply voltage
3	GND	Ground
4	SGND	Signal ground
5	V_{out}	Signal output
6	I_{in}	Primary current input
7	I_{out}	Primary current output

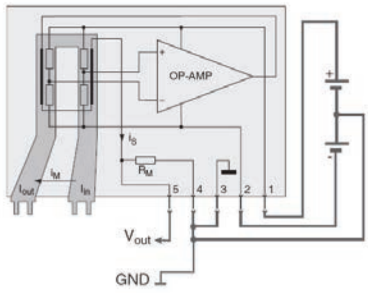

Fig. 7: Pinning of CMS3100.

Dimensions

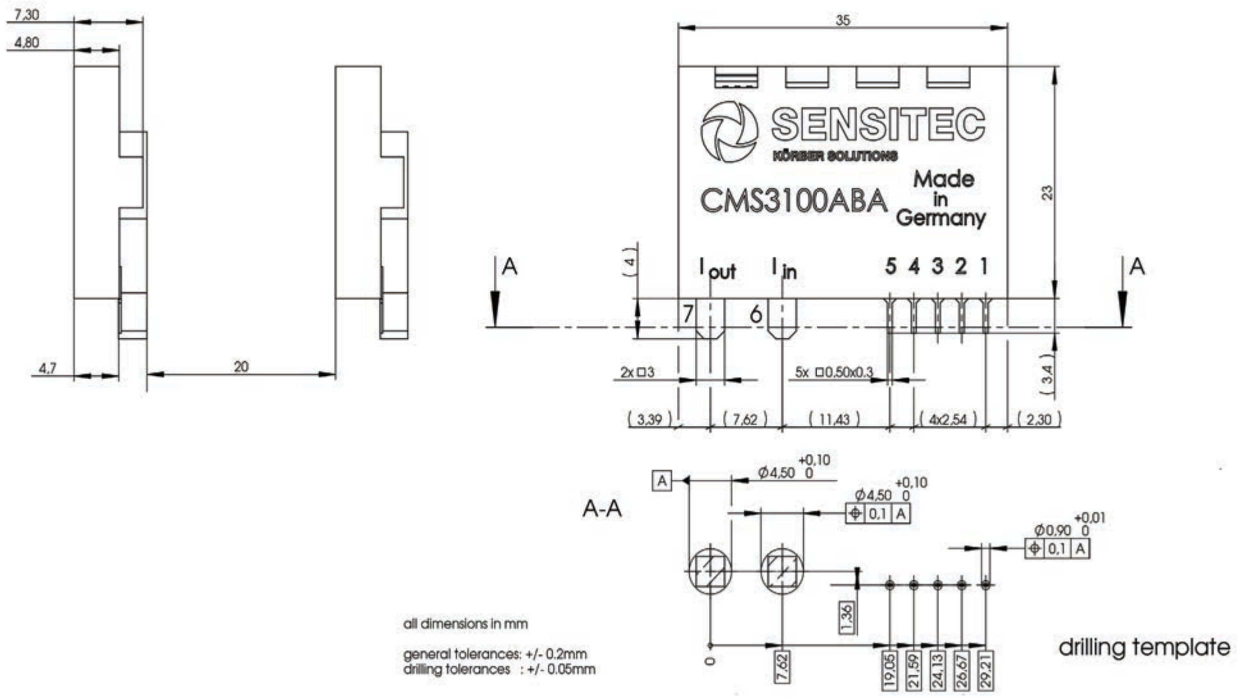

Fig. 8: Package outline.

Application Circuit

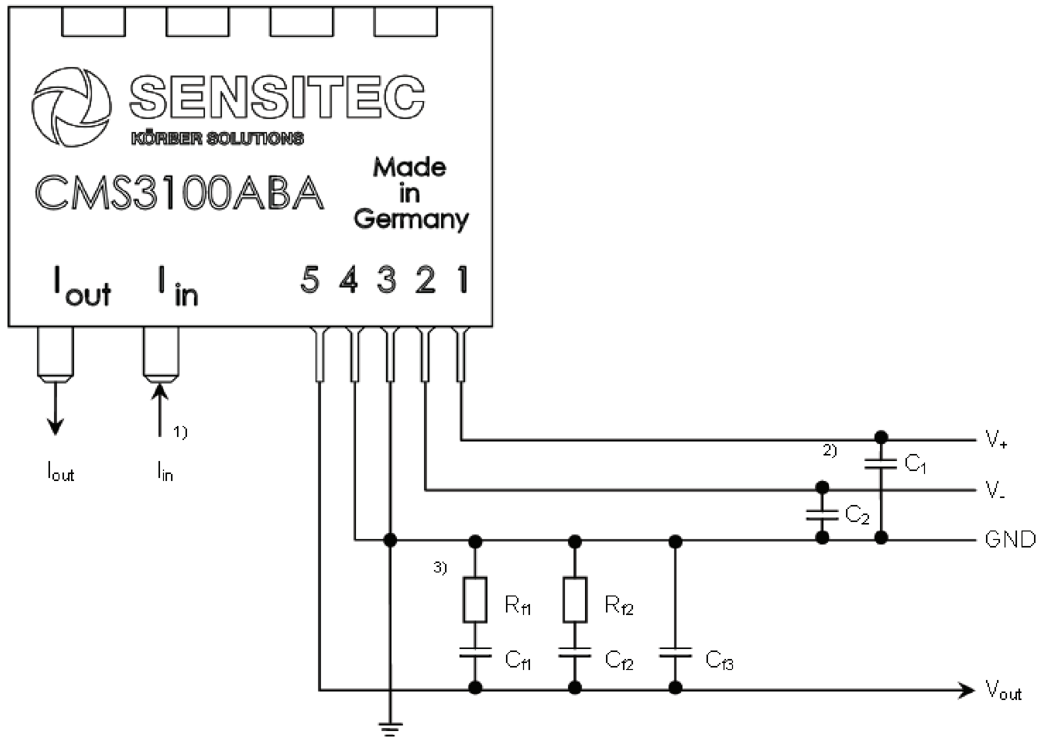

Fig. 9: Typical circuit to improve frequency response using a RC-filter network.

Filter Configuration

Recommended RC-filter values for di/dt ≈ 500 A/µs:

Type	R_{f1}	C_{f1}	R_{f2}	C_{f2}	C_{f3}
CMS3100ABA	330 Ω	68 nF	10 Ω	10 nF	3.3 nF

[1] V_{out} is positive, if I_P flows from pin "I_{in}" to pin "I_{out}".

[2] The power supply should always be buffered by 47 µF electrolytic capacitor C_1 and C_2.

[3] To improve the frequency response, a RC-filter is recommended according to Tab.1. Depending on the application, further optimization is possible.

PCB Layout

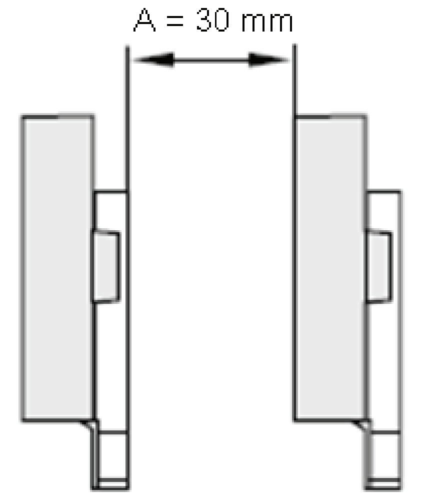

Fig. 10: Recommended clearance A among each other.

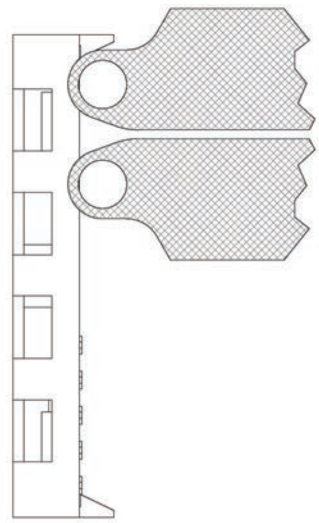

Fig. 11: Recommended current feed layout.

Additional Notes for the Designer

To operate the sensor within the specified accuracy, the following recommendations should be taken into account:

- The Accuracy of the CMS3100 depends strongly on a symmetrical current feed layout. The recommended current feeds should be routed straight and parallel as shown in Fig. 11. If a change of direction (e.g. rectangular routing) is necessary in such a case, e.g. at a distance of 10 mm, an additional gain error of 0.7% (IPN) occurs, decreasing with increasing distance.
- If a closer distance needs to be used or if the forward and return current feeds need to be connected from opposite direction or both in parallel from the sensor's frontside, the gain and linearity error may be significantly larger than specified.
- In order to limit self-heating of the sensor and hence to not exceed the maximal allowed busbar temperature of 125°C, it is recommended to maximise the area of the current feeds on the PCB to provide a heat sink for the busbar. The required clearance and creepage distances need to be observed.
- The minimum clearance to other sources of magnetic fields (e.g. relays, motors, current conductors or permanent magnets depends on the strength of the magnetic field. In order to keep the influence of magnetic stray fields on the current sensor signal below 1% (of IPN), both homogeneous magnetic fields and magnetic field gradients at the position of the sensor chip (located at the centre of the primary conductor) should be below 1 kA/m and 15 (A/m)/mm (18.7 µT/mm), respectively. Generally, shieding is possible to avoid influence of magnetic stray fields.

  Example: A conductor carrying 1 A generates a magnetic field of 20 A/m and a magnetic field gradient of 2.5 (A/m)/mm at a distance of 8 mm.
- For multiple sensor arrangements, it is recommended to place the sensors including their current feeds with a clearance (A) of at least 30 mm to each other as shown in Fig. 10. A smaller distance may cause cross talk to adjacent sensors. The primary current feeds in the PCB may not to be routed underneath a sensor.
- Parts made of electrically conductive material (e.g. housing parts made of aluminium) placed in close proximity to the sensor may affect the dynamic sensor behaviour due to the induced eddy currents in these parts.
- Parts made of ferromagnetic material (e.g. housing parts made of steel) placed in close proximity to the sensor may affect the sensor's accuracy as the magnetic field generated by the sensor's primary conductor may be disturbed.

The CMS3000 Product Family

The CMS3100 is a member of the CMS3000 product family offering PCB-mountable THT current sensors from 5 A up to 100 A nominal current with a typical bandwidth of 2 MHz for various industrial applications.

	CMS3005ABA	CMS3015ABA	CMS3025ABA	CMS3050ABA	CMS3100ABA
					
I_{PN} [1]	5 A	15 A	25 A	50 A	100 A
I_{PR} [2]	20 A	60 A	100 A	200 A	400 A

The CMK3000 demoboard offers the opportunity to learn the features and benefits of the CMS3000 current sensors in a quick a simple manner.

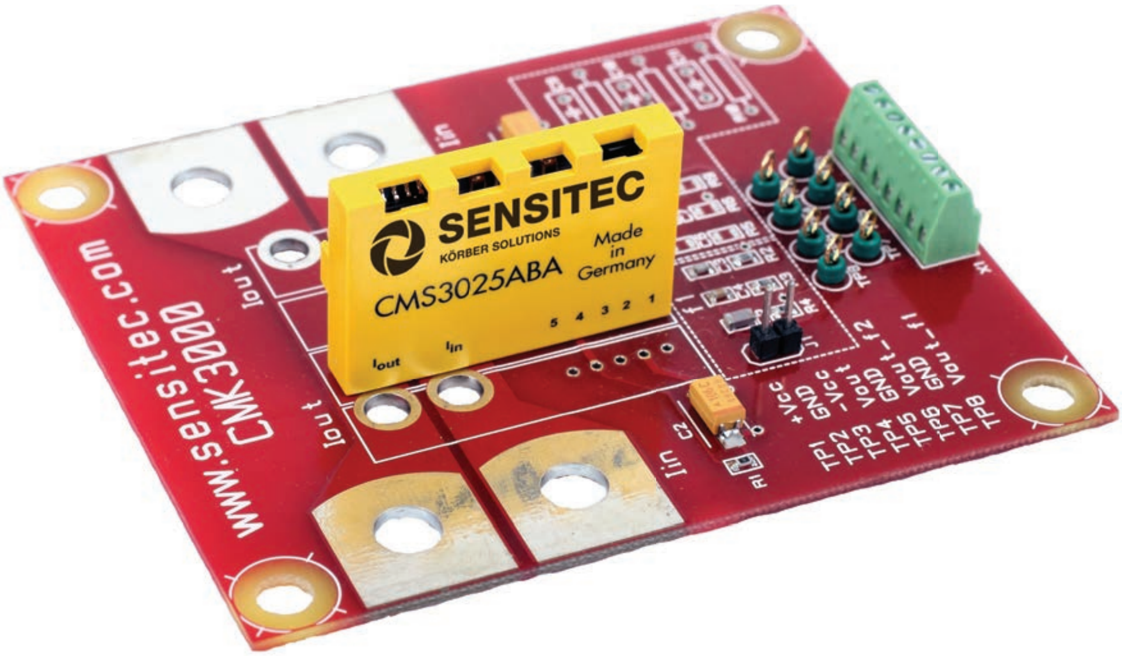

Fig. 12: The CMK3000 demoboards are available for different current ranges.

1) Nominal primary current (RMS).

2) Measurement range.

Safety Notes

⚠	**Warning!** This sensor shall be used in electric and electronic devices according to applicable standards and safety requirements. Sensitec's datasheet and handling instructions must be complied with. Handling instructions for current sensors are available at www.sensitec.com.
⚡	**Caution! Risk of electric shock!** When operating the sensor, certain parts, e. g. the primary busbar or the power supply, may carry hazardous voltage. Ignoring this warning may lead to serious injuries! Conducting parts of the sensor shall not be accessible after installation.

General Information

Product Status

Article	Status
CMS3100	The product is in series production.
Note	The status of the product may have changed since this data sheet was published. The latest information is available on the internet at www.sensitec.com.

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Sensitec GmbH
Georg-Ohm-Str. 11 · 35633 Lahnau · Germany
Tel. +49 6441 9788-0 · Fax +49 6441 9788-17
www.sensitec.com · sensitec@sensitec.com

General Information

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Sensitec GmbH
Georg-Ohm-Str. 11 · 35633 Lahnau · Germany
Tel. +49 6441 9788-0 · Fax +49 6441 9788-17
www.sensitec.com · sensitec@sensitec.com