

# CMS3050

## Highly Dynamic MagnetoResistive Current Sensor ( $I_{PN} = 50\text{ A}$ )

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  $-40^{\circ}\text{C}$  to  $+105^{\circ}\text{C}$  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 CMS3050

Product description	Package	Delivery Type
CMS3050ABA (discontinued)	THT	Tray

### Quick Reference Guide

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{CC}$	Supply voltage	$\pm 12$	$\pm 15$	-	V
$I_{PN}$	Primary nominal current (RMS)	-	-	50	A
$I_{PR}$	Primary measuring range <sup>1)</sup>	-200	-	+200	A
$f_{co}$	Frequency bandwidth (-3 dB)	2	-	-	MHz
$\epsilon_z$	Accuracy <sup>2)</sup>	-	$\pm 0.6$	$\pm 0.8$	% of $I_{PN}$

<sup>1)</sup> For 3 s in a 60 s interval ( $RMS \leq I_{PN}$ ) and  $V_{CC} = \pm 15\text{ V}$ .

<sup>2)</sup>  $\epsilon_z = \epsilon_G$  &  $\epsilon_{lin}$  with  $V_{CC} = \pm 15\text{ V}$ ,  $I_P = I_{PN}$ ,  $T_{amb} = 25^{\circ}\text{C}$ .

### 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	Pending

### Features

- Based on the Anisotropic MagnetoResistive (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  $> 2\text{ MHz}$
- Highly dynamic step response
- High signal-to-noise ratio
- Large temperature range  $-40^{\circ}\text{C}$  to  $+105^{\circ}\text{C}$
- 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



## 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	0.3	V
$I_{PM}$	Maximum primary current <sup>1)</sup>	-500	+500	A
$T_{amb}$	Ambient temperature	-40	+105	°C
$T_{stg}$	Storage temperature	-40	+125	°C
$T_B$	Busbar temperature	-40	+125	°C

<sup>1)</sup> For 20 ms in a 20 s interval. ( $RMS \leq I_{PN}$ ).

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.

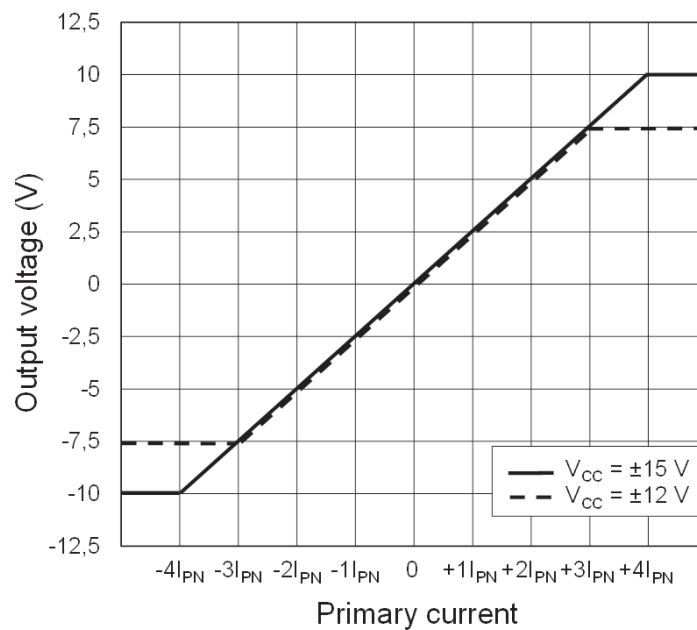


Fig. 1: Output voltage range for different supply voltages.

## Electrical Data

$T_{amb} = 25\text{ °C}$ ;  $V_{CC} = \pm 15\text{ V}$ ; 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		-14.3	-15.0	-15.7	V
$I_{PN}$	Primary nominal current (RMS)		-	-	50	A
$I_{PR}$	Measuring range <sup>1)</sup>		-200	-	+200	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	126	150	$\Omega$
$R_P$	Resistance of primary conductor		-	0.1	0.15	m $\Omega$
$I_Q$	Quiescent current	$I_P = 0$	-	21	25	mA
$I_{CN}$	Nominal current consumption	$I_P = I_{PN}$	-	40	50	mA
$I_{CR}$	Measuring range current consumption	$I_P = I_{PR}$	-	105	110	mA
$I_{CM}$	Maximal current consumption <sup>2)</sup>	$I_P > I_{PR}$	-	-	130	mA

$T_{amb} = 25\text{ °C}$ ;  $V_{CC} = \pm 12\text{ V}$ ; 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		-11.4	-12.0	-12.6	V
$I_{PN}$	Primary nominal current (RMS)		-	-	50	A
$I_{PR}$	Measuring range <sup>1)</sup>		-150	-	+150	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	126	150	$\Omega$
$R_P$	Resistance of primary conductor		-	0.1	0.15	m $\Omega$
$I_Q$	Quiescent current	$I_P = 0$	-	21	25	mA
$I_{CN}$	Nominal current consumption	$I_P = I_{PN}$	-	40	50	mA
$I_{CR}$	Measuring range current consumption	$I_P = I_{PR}$	-	80	95	mA
$I_{CM}$	Maximal current consumption <sup>2)</sup>	$I_P > I_{PR}$	-	-	100	mA

<sup>1)</sup> For 3 s in a 60 s interval ( $RMS \leq I_{PN}$ ).

<sup>2)</sup> Limited by output driver.

## Accuracy

$T_{amb} = 25\text{ °C}$ ;  $V_{CC} = \pm 15\text{ V}$ ; unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$\epsilon_z$	Accuracy <sup>1) 2)</sup>	$I_P \leq I_{PN}$	-	$\pm 0.6$	$\pm 0.8$	% of $I_{PN}$
$\epsilon_G$	Gain error <sup>2)</sup>	$I_P \leq I_{PN}$	-	$\pm 0.5$	$\pm 0.7$	% of $I_{PN}$
$\epsilon_{off}$	Offset error <sup>2)</sup>	$I_P = 0$	-	$\pm 0.3$	$\pm 0.8$	% of $I_{PN}$
$\epsilon_{Lin}$	Linearity error	$I_P \leq I_{PN}$ ; symmetrical current feed	-	$\pm 0.1$	$\pm 0.15$	% of $I_{PN}$
$\epsilon_{Hys}$	Hysteresis	$4 \cdot I_{PN}$ , $\Delta t = 20\text{ ms}$	-	-	0.04	% of $I_{PN}$
PSRR	Power supply rejection rate	$f_{\Delta V_{CC}} \leq 100\text{ Hz}$	-	-63	-	dB
PSRR	Power supply rejection rate	$f_{\Delta V_{CC}} \leq 15\text{ kHz}$	-	-55	-45	dB
$N_{RMS}$	Noise level (RMS)	$f \leq 80\text{ kHz}$	-	0.25	0.3	mV
$N_{pk}$	Noise level (peak)	$f \leq 80\text{ kHz}$	-	2.2	3.0	mV

$T_{amb} = (-40...+105)\text{ °C}$ ;  $V_{CC} = \pm 15\text{ V}$ ; unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$T\epsilon_G$	Additional temperature induced gain error		-	-	$\pm 0.5$	% of $I_{PN}$
$T\epsilon_{off}$	Additional temperature induced offset error		-	-	$\pm 2.0$	% of $I_{PN}$
$T\epsilon_{off}$	Additional temperature induced offset error	$T_{amb} = (-25...+105)\text{ °C}$	-	-	$\pm 1.5$	% of $I_{PN}$
$T\epsilon_{Lin}$	Additional temperature induced linearity error		-	-	$\pm 0.1$	% of $I_{PN}$
$T\epsilon_z$	Typical total accuracy <sup>3)</sup>	$I_P \leq I_{PN}$	-	$\pm 1.5$	-	% of $I_{PN}$

<sup>1)</sup> Accuracy contains  $\epsilon_G$  and  $\epsilon_{Lin}$ .

<sup>2)</sup> Does not include additional error of 0.5% ( $I_{PN}$ ) due to aging.

<sup>3)</sup> Typical total accuracy measured in temperature range (including error at  $T_{amb} = 25\text{ °C}$ ).

## General Data

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$T_{amb}$	Ambient temperature <sup>1)</sup>		-40	-	+105	°C
$T_{stg}$	Storage temperature		-40	-	+125	°C
$T_B$	Busbar temperature <sup>1)</sup>		-40	-	+125	°C
$T_{THT}$	Solder temperature <sup>2)</sup>	For 7 seconds	-	-	265	°C
m	Mass		-	6.5	6.7	g

## Dynamic Data

$T_{amb} = 25 \text{ °C}$ ;  $V_{CC} = \pm 15 \text{ V}$ ; unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$t_{reac}$	Reaction time <sup>3)</sup>	10 % $I_{PN}$ to 10 % $I_{out,N}$	-	0.025	0.08 <sup>4)</sup>	µs
$t_{rise}$	Rise time <sup>3)</sup>	10 % $I_{out,N}$ to 90 % $I_{out,N}$	-	0.05	0.09 <sup>4)</sup>	µs
$t_{resp}$	Response time <sup>3)</sup>	90 % $I_{PN}$ to 90 % $I_{out,N}$	-	-	0.04 <sup>4)</sup>	µs
$f_{co}$	Upper cut-off frequency	-3 dB	2.0	-	-	MHz
$\Delta V_{TR}$	Transient output voltage	0 V to 530 V (3.7 kV/µs); see Fig. 3	-	0.06 <sup>4)</sup>	0.23	V
$t_{recTR}$	Transient recovery time	0 V to 530 V (3.7 kV/µs); see Fig. 3	-	0.8	2.0 <sup>4)</sup>	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		6.4	-	-	mm
$d_{cl}$	Clearance distance <sup>5)</sup>		6.4	-	-	mm
$V_B$	System voltage (RMS) <sup>6)</sup>	Reinforced isolation PD2, CAT III	300	-	-	V
$V_B'$	System voltage (RMS) <sup>6)</sup>	Basic isolation PD2, CAT III	600	-	-	V
ESD	Electro static test voltage	HBM, contact discharge method	-	8.0	-	kV

<sup>1)</sup> Operating condition.

<sup>2)</sup> 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.

<sup>3)</sup>  $I_p = I_{PN}$ , di/dt of 400 A/µs.

<sup>4)</sup> With recommended RC output filter values according to page 8.

<sup>5)</sup> 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).

<sup>6)</sup> According to DIN EN 50178, DIN EN 61800-5-1.

## Typical Performance Characteristics

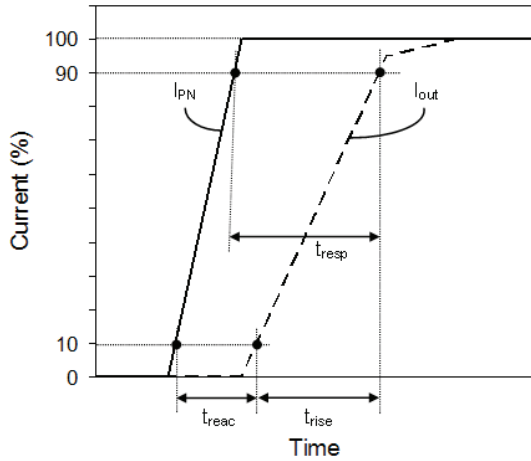


Fig. 2: Definition of reaction time ( $t_{reac}$ ), rise time ( $t_{rise}$ ) and response time ( $t_{resp}$ ).

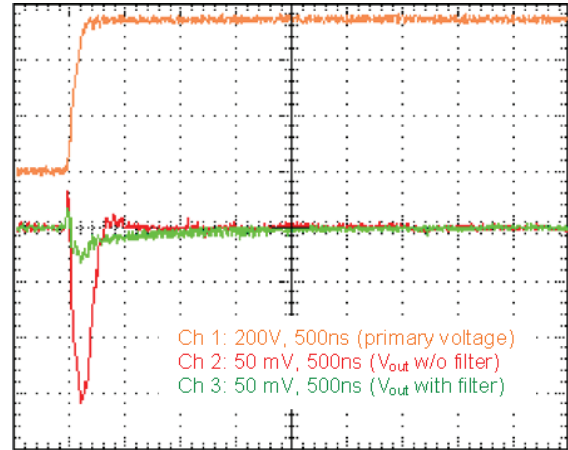


Fig. 3: dV/dt (3.7 kV/μs; 530 V voltage on primary conductor; filter configuration acc. to Tab. 1).

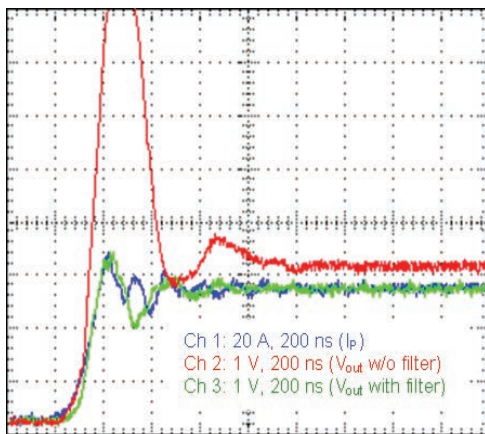


Fig. 4: Step response ( $I_p = 50\text{ A}$ ;  $di/dt \approx 400\text{ A}/\mu\text{s}$ ; filter configuration acc. to Tab. 1).

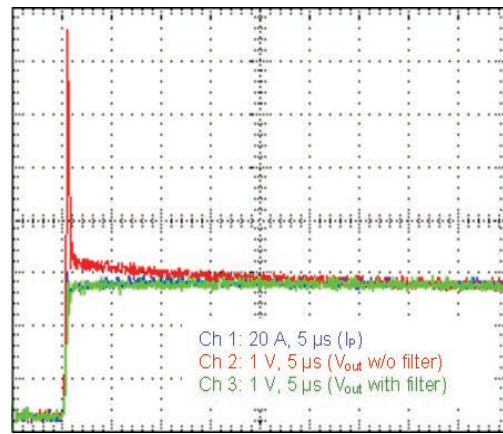


Fig. 5: Step response ( $I_p = 50\text{ A}$ ;  $di/dt \approx 170\text{ A}/\mu\text{s}$ ; filter configuration acc. to Tab. 1).

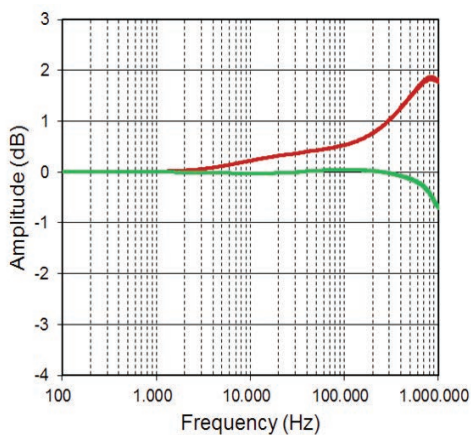
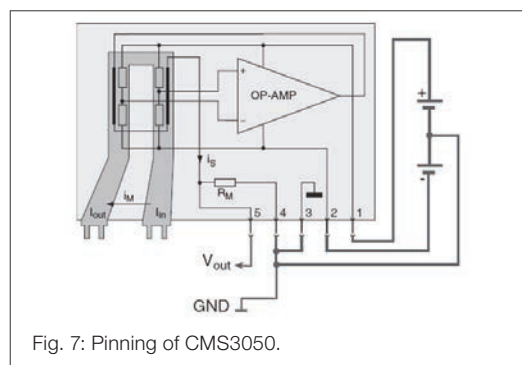


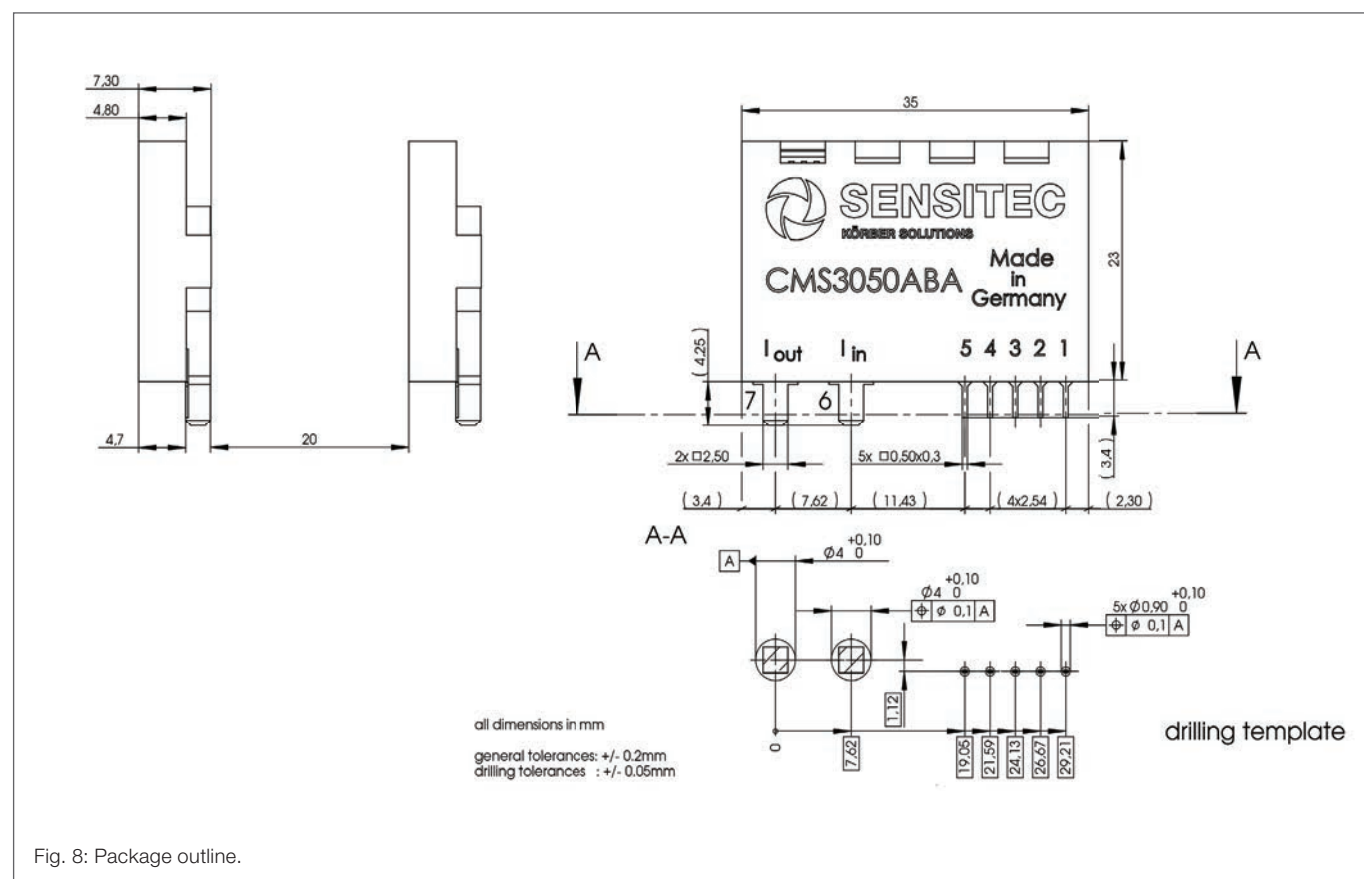
Fig. 6: Typical frequency response with RC-filter (green) and without (red). Filter configuration acc. to Tab. 1.

## 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



## Dimensions



## Application Circuit

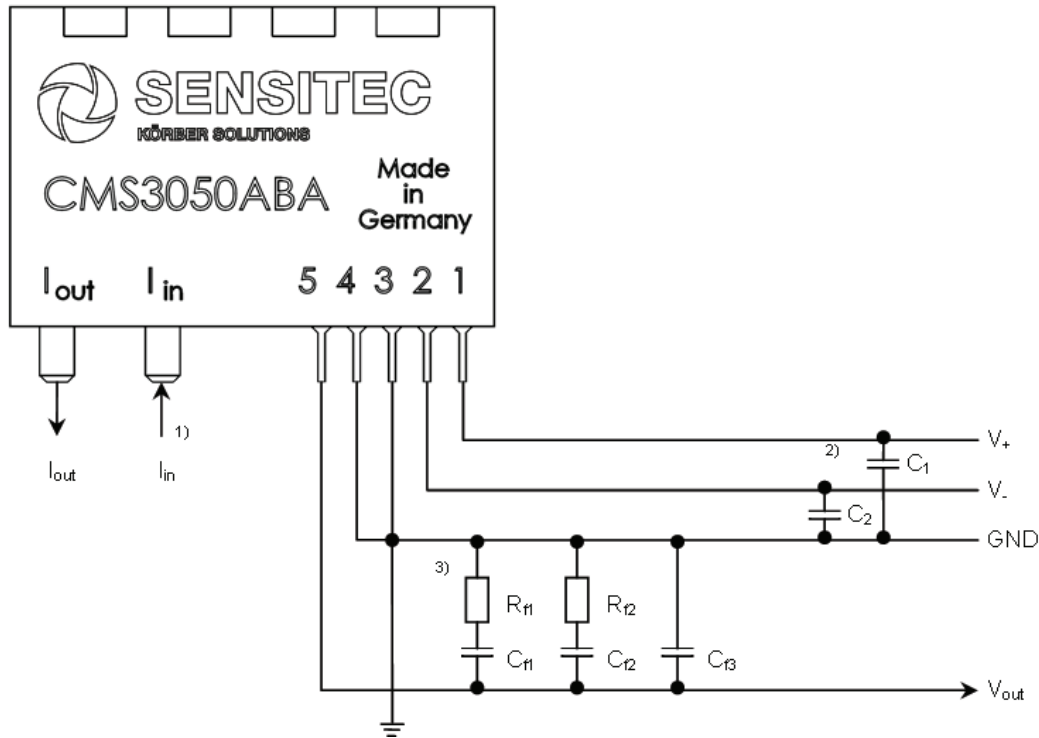


Fig. 9: Typical circuit to improve frequency response using a RC-filter network.

## Filter Configuration

Recommended RC-filter values for  $di/dt \approx 500\text{ A}/\mu\text{s}$ :

Type	$R_{f1}$	$C_{f1}$	$R_{f2}$	$C_{f2}$	$C_{f3}$
CMS3050ABA	620 $\Omega$	22.0 nF	22 $\Omega$	6.8 nF	-

<sup>1)</sup>  $V_{out}$  is positive, if  $I_p$  flows from pin " $I_{in}$ " to pin " $I_{out}$ ".

<sup>2)</sup> The power supply should always be buffered by 47  $\mu\text{F}$  electrolytic capacitor  $C_1$  and  $C_2$ .

<sup>3)</sup> To improve the frequency response, an RC-filter is recommended according to Tab.1. Depending on the application, further optimization is possible.



## PCB Layout

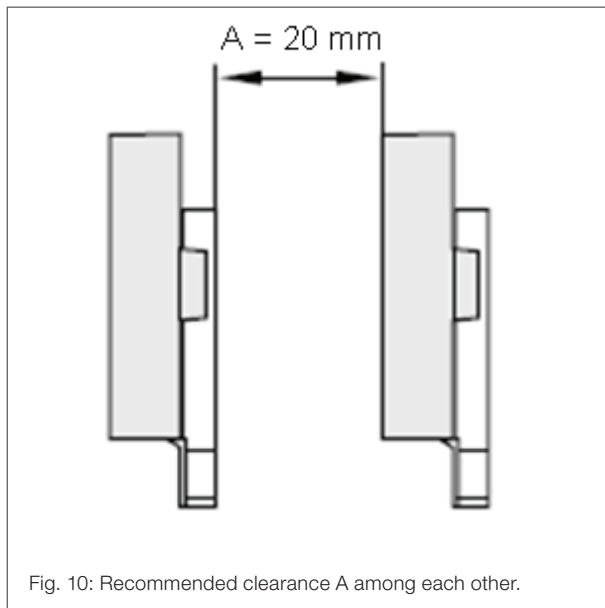


Fig. 10: Recommended clearance A among each other.

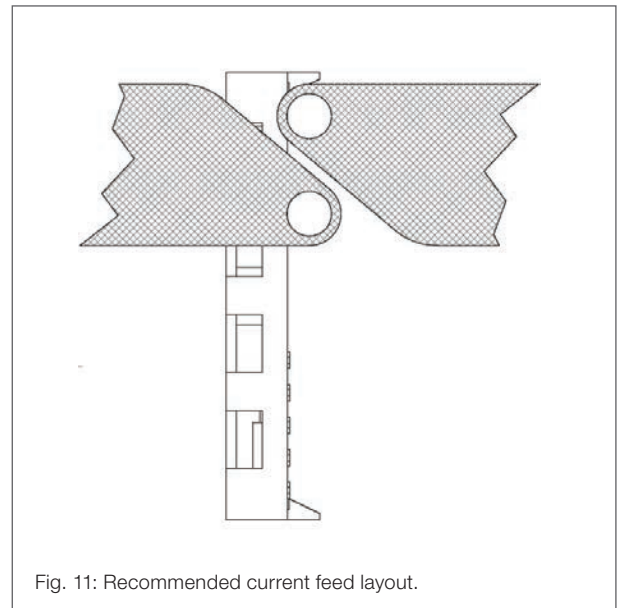


Fig. 11: Recommended current feed layout.

## Additional Notes for the Designer

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






- In order to limit self-heating of the sensor and hence to not exceed the maximal allowed busbar temperature of  $125^{\circ}\text{C}$ , 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  $I_{PN}$ ), 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  $1\text{ kA/m}$  and  $15\text{ (A/m)/mm}$  ( $18.7\text{ }\mu\text{T/mm}$ ), respectively. Generally, shielding is possible to avoid influence of magnetic stray fields.

Example: A conductor carrying  $1\text{ A}$  generates a magnetic field of  $20\text{ A/m}$  and a magnetic field gradient of  $2.5\text{ (A/m)/mm}$  at a distance of  $8\text{ mm}$ .

- For multiple sensor arrangements, it is recommended to place the sensors including their current feeds with a clearance (A) of at least  $20\text{ mm}$  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 CMS3050 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.

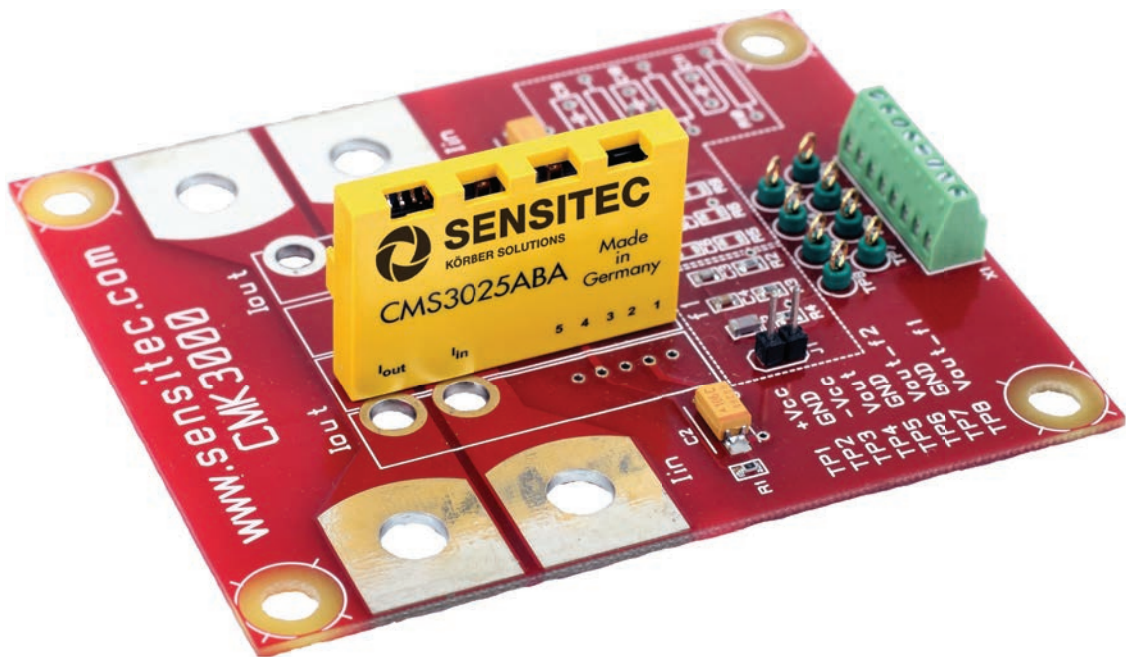




Fig. 12: The CMK3000 demoboards are available for different current ranges.

<sup>1)</sup> Nominal primary current (RMS).

<sup>2)</sup> Measurement range.

## Safety Notes

	<p><b>Warning!</b></p> <p>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 <a href="http://www.sensitec.com">www.sensitec.com</a>.</p>
	<p><b>Caution! Risk of electric shock!</b></p> <p>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.</p>

## General Information

### Product Status

Article	Status
CMS3050	The product is in series production.
<b>Note</b>	The status of the product may have changed since this data sheet was published. The latest information is available on the internet at <a href="http://www.sensitec.com">www.sensitec.com</a> .

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## General Information

### Application Information

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