Model CDS4006

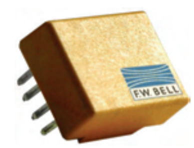
Current Sensors

MagnetoResistive Current Sensor (I_{PN} = 6A)

preliminary data sheet

Description

The CDS4000 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. The system accuracy can be improved by using either the internal or an external reference voltage. This further reduces temperature drift and several sensors can share the same reference voltage. The adjustable overcurrent detection enables a fast response in overload situations to prevent damage to the power units. The CDS4000 product family offers PCB-mountable THT current sensors from 3 A up to 150 A nominal current for industrial applications.



CDS4006ABA

Current Sensors

Product overview

Product description	Package	Delivery Type
CDS4006ABA	THT	Tray
CDK4006ABA	Demoboard	Pocketbox

Quick reference guide

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{CC}	Supply voltage	4.75	5	5.25	V
I_{PN}	Primary nominal current (RMS)	-	-	6	A
I_{PR}	Primary measuring range 1)	-18	-	+18	A
ε_{Σ}	Overall accuracy 2)	-	0.8	1.3	% of I_{PN}
f_{co}	Upper cut-off frequency (-1 dB)	100	150	200	kHz
T_{amb}	Ambient temperature 3)	-25	-	+85	°C
T_B	Busbar temperature 3)	-25	-	+100	°C

1) For 1 s in a 60 s interval; R_M = 300 Ω.
2) $\varepsilon_{\Sigma} = \varepsilon_G + \varepsilon_{off} + \varepsilon_{lin}$ with V_{CC} = 5 V and T_{amb} = 25 °C.
3) Operating condition.

Qualification overview

Standard	Name	Status
EN 61800-5-1: 2003	Adjustable speed electrical power drive systems	Approved
IEC 62103	Electronic equipment for use in power installations	Approved
DIN EN 50178	Electronic equipment for use in power installations	Approved
UL508C	Power conversion equipment	Pending

Features

- Based on the Anisotropic Magneto Resistive (AMR) effect
- Galvanic isolation between primary and measurement circuit
- Single 5V power supply
- Adjustable overcurrent detection

Advantages

- Excellent accuracy
- Low temperature drift
- Very small size
- Highly dynamic response
- External reference possible
- Low primary inductance
- Negligible hysteresis

Applications

- Solar power converters
- AC variable speed drives
- Converters for DC motor drives
- Uninterruptible power supplies
- Switched mode power supplies
- Power supplies for welding applications

VDE REG.-Nr. C571

RoHS-conform 2002/95/EC

Electrical data

T_{amb} = 25 °C; V_{CC} = 5 V; unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
I_{PN}	Primary nominal current (RMS)		-	-	6	A
I_{PR}	Measuring range [1)]		-18	-	+18	A
I_{PM}	Maximum primary peak current (abs) [2)]		-	-	60	A
I_{outN}	Nominal output current (RMS)	$I_P = I_{PN}$	-	2	-	mA
I_{outM}	Maximum output current (abs) [1)]	$I_P = 3 \cdot I_{PN}$	-	-	6	mA
R_M	Burden resistor for output signal [3)]		100	300	1000	Ω
R_P	Resistance of primary conductor		6	8	10	mΩ
V_{CC}	Supply voltage		4.75	5	5.25	V
I_Q	Quiescent current	$I_P = 0$	-	25	30	mA
I_{CN}	Nominal current consumption	$I_P = I_{PN}$	-	50	60	mA
I_{CM}	Maximum current consumption		-	105	150	mA
V_{out}	Maximum output voltage range [4)]		0.625	-	4.375	V
V_{refout}	Reference voltage output	V_{refin} connected to GND	2.49	2.5	2.51	V
V_{refin}	Reference voltage input		1.5	2.5	2.6	V
G_V	Voltage gain	R_M = 300 Ω	-	100	-	mV/A
G_I	Current gain		-	1/3	-	mA/A
I_L	Maximum additional load V_{refout}	$\Delta V_{refout} \leq 10$ mV	-	-	1	mA

1) For 1 s in a 60 s interval; R_M = 300 Ω.
2) For 3 ms in a 100 ms interval.
3) R_M > 300 Ω: reduces I_{PR} but increases G_V.
4) Output voltage is scaled by changing R_M but not beyond these limits.

Absolute maximum ratings

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

Symbol	Parameter	Min.	Max.	Unit
V_{CC}	Supply voltage	-0.3	+7	V
I_{PM}	Maximum primary current [5)]	-	60	A
T_{amb}	Ambient temperature	-40	+130	°C
T_{stg}	Storage temperature	Tbd.	Tbd.	°C
T_B	Busbar temperature	Tbd.	Tbd.	°C

5) For 3 ms in a 100 ms interval.

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.

Qualifications

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_I	Isolation test voltage (RMS)	50/60 Hz, 60 s	-	3	-	kV
V_{imp}	Impulse withstand voltage	1.2/50 µs	-	6	-	kV
V_{pde}	Partial discharge extinction voltage		1	-	-	kV
d_{cp}	Creepage distance		-	15	-	mm
d_{cl}	Clearance distance		-	15	-	mm
CTI	Comparative Tracking Index		-	600	-	-

Accuracy

T_{amb} = 25 °C; V_{CC} = 5 V; unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
ε_Σ	Overall accuracy [1]	$I_P \le I_{PN}$	-	0.8	1.3	% of I_{PN}
ε_G	Gain error	$I_P \le I_{PN}$	-	0.3	0.5	% of I_{PN}
ε_{off}	Offset error	$I_P = 0$	-	0.3	0.5	% of I_{PN}
ε_{Lin}	Linearity error	$I_P \le I_{PN}$	-	0.2	0.3	% of $2 \cdot I_{PN}$
$\varepsilon_{Vrefint}$	Internal reference error		-10	0	+10	mV
$\varepsilon_{Vrefext}$	External reference error [2]	V_{refin} = 1.5 to 2.6 V	-3	0	+3	mV
ε_{Hys}	Hysteresis [3]		-	-	-	% of I_{PN}
$T\varepsilon_G$	Maximum temperature induced gain error	T_B = (-25…+85)°C	-1	0	+1	% of I_{PN}
$T\varepsilon_{off}$	Maximum temperature induced offset error	T_B = (-25…+85)°C	-1	0	+1	% of I_{PN}
$T\varepsilon_{Lin}$	Maximum temperature induced linearity error	T_B = (-25…+85)°C	-	0	0.1	% of $2 \cdot I_{PN}$
$T\varepsilon_{Vrefint}$	Maximum temperature induced error of internal reference	T_B = (-25…+85)°C	-0.6	0	+0.6	% of V_{refout}
$T\varepsilon_{Vrefext}$	Maximum temperature induced error of external reference	T_B = (-25…+85)°C	-0.1	0	+0.1	% of V_{refout}
PSRR	Power supply rejection rate		-	40	30	dB
N	Noise level (RMS)	f < 300 kHz	-	1.7	-	µA

Dynamical data

T_{amb} = 25 °C; V_{CC} = 5 V; unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
t_{ra}	Reaction time [4]	10% I_{PN} to 10% I_{out}	-	650	-	ns
t_r	Response time [4]	90% I_{PN} to 90% I_{out}	-	850	-	ns
f_{co}	Upper cut-off frequency	-1 dB	100	150	200	kHz

Notes

1) $\varepsilon_\Sigma = \varepsilon_G + \varepsilon_{off} + \varepsilon_{Lin}$

2) $\varepsilon_{Vrefext} = V_{refin} - V_{refout}$

3) Residual voltage after $3 \cdot I_{PN}$ DC.
Hysteresis is smaller than noise level N.

4) $I_P = I_{PN}$ with di/dt of 6 A/µs. See Fig.1.

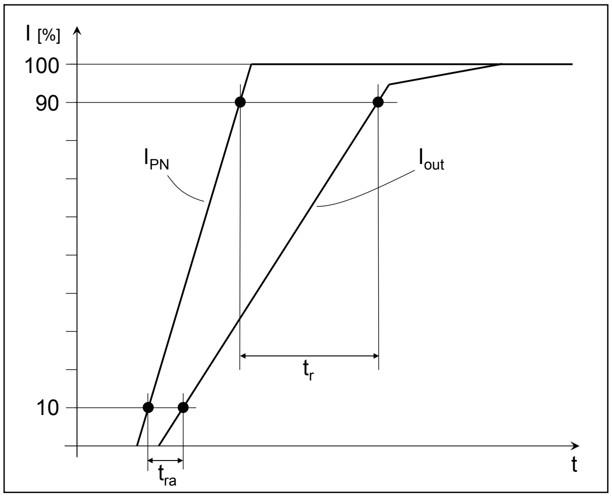


Fig.1: Definition of reaction (t_{ra}) and response time (t_r).

General data

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
T_{amb}	Ambient temperature		-25	-	+85	°C
T_{stg}	Storage temperature		Tbd.	-	Tbd.	°C
T_B	Busbar temperature		-25	-	+100	°C
T_{THT}	Solder temperature for THT version		Tbd.	Tbd.	Tbd.	°C
m	Mass		Tbd.	Tbd.	Tbd.	g

Overcurrent detection (OVC) related data

The CDS4006 current sensor offers with OVC a digital comparator output to signal primary current overloads. The output is pulled low when a user defined critical current value is exceeded. The overcurrent detection is adjustable for both threshold voltage and delay time. The OVC output is an open collector output with internal 10 kΩ pull up resistor. A maximum of 3 CDS (for 3-Phase-detection) can be connected in parallel as a wired-or signal.

T_{amb} = 25 °C; V_{CC} = 5 V; unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_{OVCH}	Overcurrent output high level		4.5	-	5	V
V_{OVCL}	Overcurrent output low level		0	-	0.7	V
V_{set}	Threshold input		0.625	-	2.5	V
$\varepsilon_{OVCVset}$	Error of OVC Threshold	R_M = 300 Ω, I_P = I_{PN}	-3	-	+3	% of $V_{out,N}$
ε_{OVCHys}	Switching Hysteresis		7	10	13	mV
R_D	Internal pull up resistance		7	10	13	kΩ
I_S	Maximum current sink at OVC output		-	-	2	mA

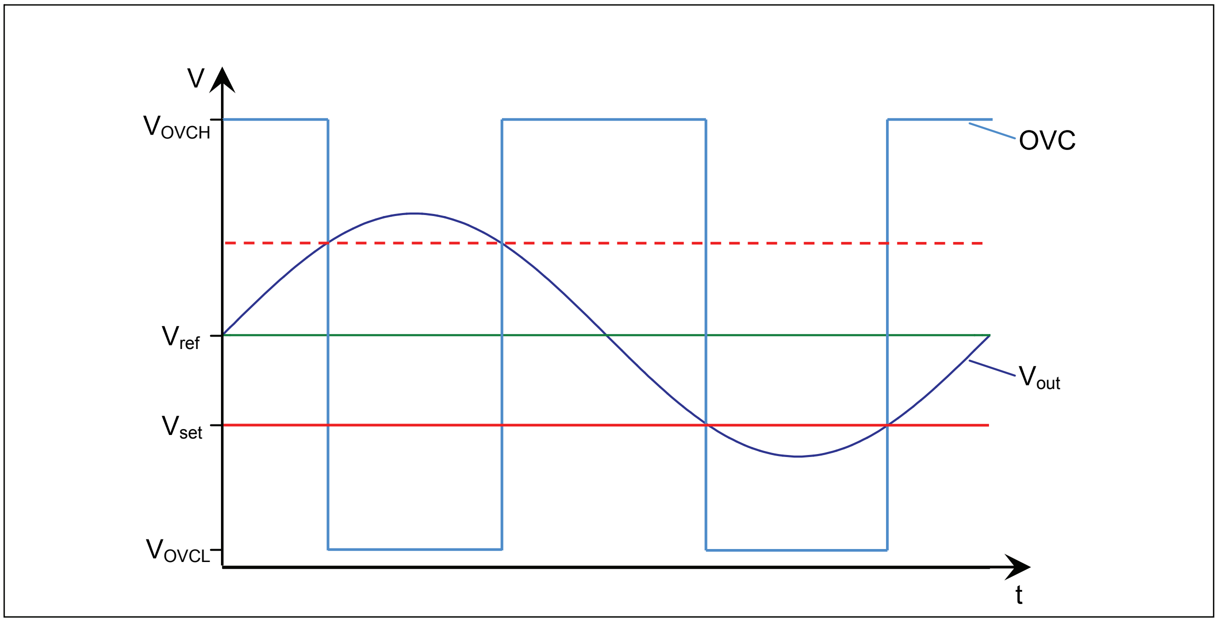


Fig. 2: Response of the overcurrent detection. Positive and negative overcurrents will be detected.

CDS4006 in THT-housing

Pinning

Pin	Symbol	Parameter
1	V_{refout}	Reference voltage output
2	Out	Signal output
3	GND	Ground
4	V_{cc}	Supply voltage
5	V_{refin}	External reference voltage input
6	C_d	Overcurrent delay capacitor input
7	OVC	Overcurrent detection output
8	V_{set}	Threshold voltage for overcurrent detection
9	I_{in}	Primary current input
10	I_{out}	Primary current output

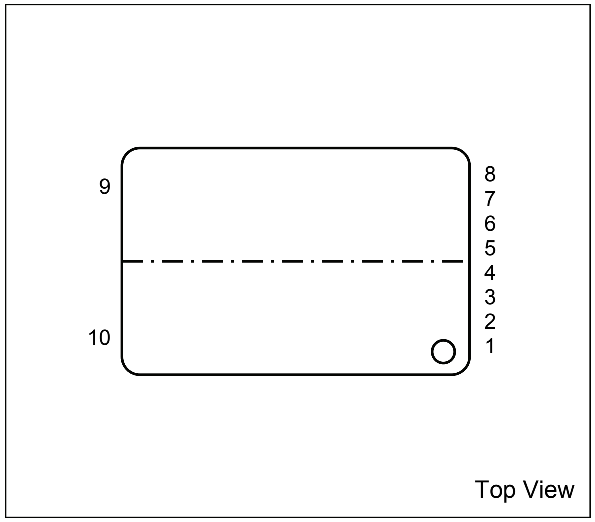


Fig.3: Pinning of CDS4006ABA-IA.

Dimensions

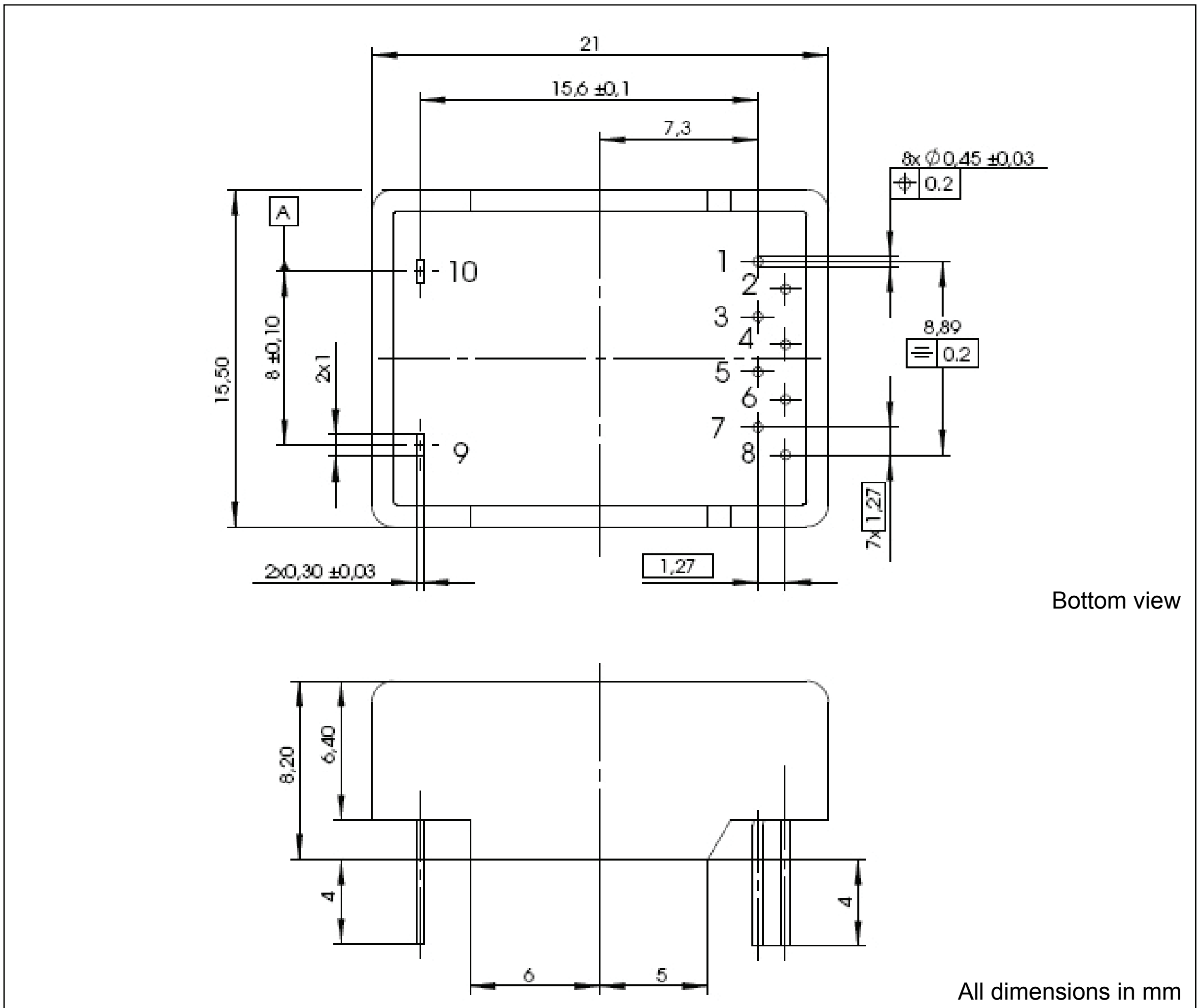


Fig.4: Package outline of THT-housing. Tolerance ± 0.2 mm unless otherwise specified.

Application circuit

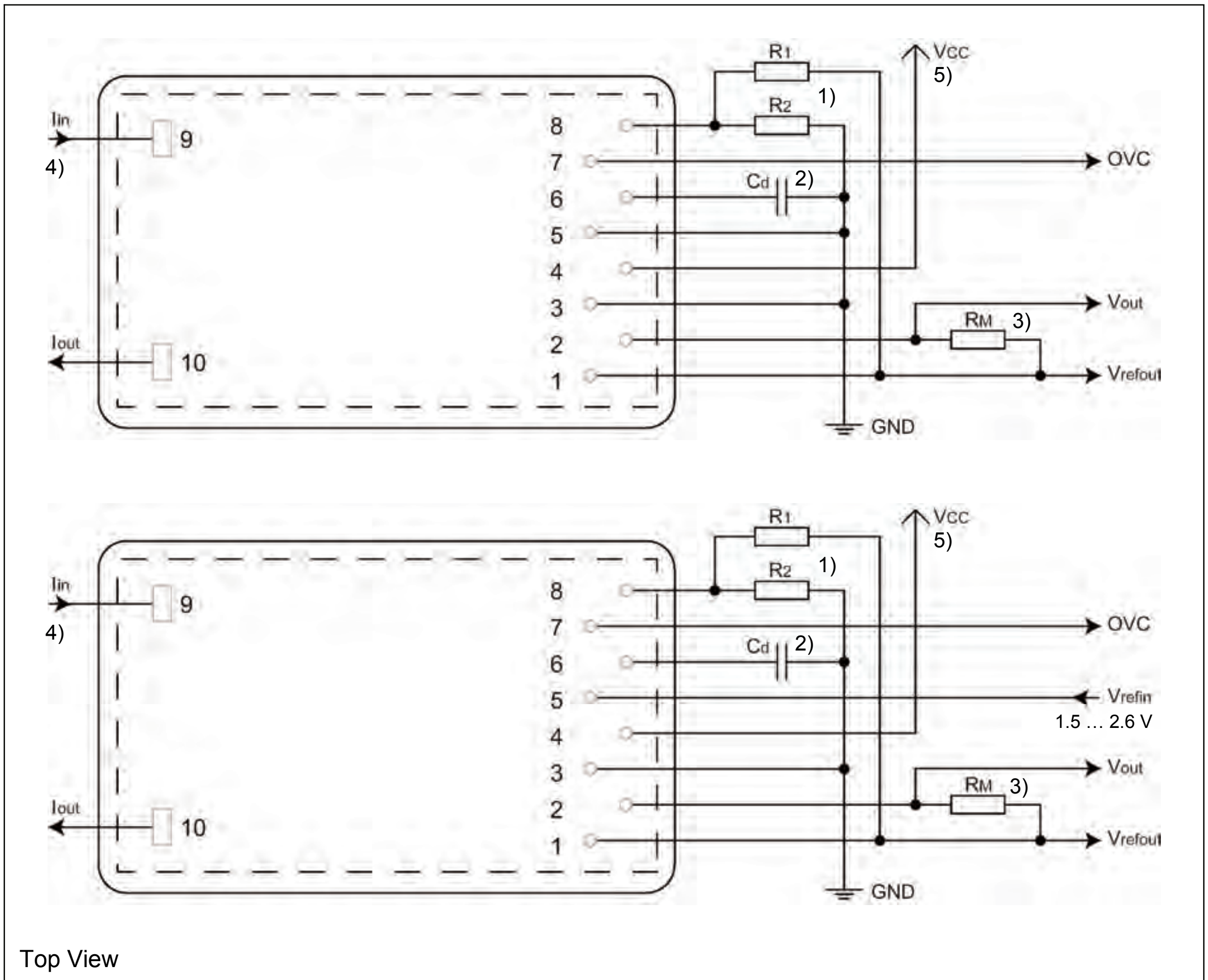


Fig.5: *Top:* Example of how to use the internal reference voltage.
Bottom: Circuit with external reference voltage at V_{refin} (Pin 5).

Notes

1) The overcurrent threshold is set by applying a voltage to pin 8 (V_{set}) according to the formula:

$$I_{OC} = \frac{V_{refout} - V_{set}}{R_M \cdot G_I}$$ Example: V_{refout} = 2.5 V; R_M = 300 Ω; I_{OC} = 12 A → V_{set} = <u>1.3 V</u>

In the above Fig.7 the potential divider with R_1 and R_2 on Pin 8 (V_{set}) is used to adjust the threshold for the overcurrent detection.

$$I_{OC} \approx \left(1 - \frac{R_2}{R_1 + R_2}\right) \cdot \frac{V_{refout}}{R_M \cdot G_I}$$ with 2.5 kΩ < (R_1 + R_2) < 25 kΩ.

2) The overcurrent delay time is adjustable with the capacitor C_d on Pin 6. Without C_d the delay time has its minimum value. The minimum delay time is achieved by not using a capacity C_d (not connected on ground).

$$t_d \leq 0.5\ \mu s + \frac{C_d\ (pF)}{50\ pF}\ \mu s$$

3) R_M > 300 Ω: reduces I_{PR} but increases G_V.

4) V_{out} is positive, if I_P flows from Pin 9 "I_{in}" to Pin10 "I_{out}".

5) V_{CC} should always be buffered with a capacity of at least 100 nF.

Application circuit

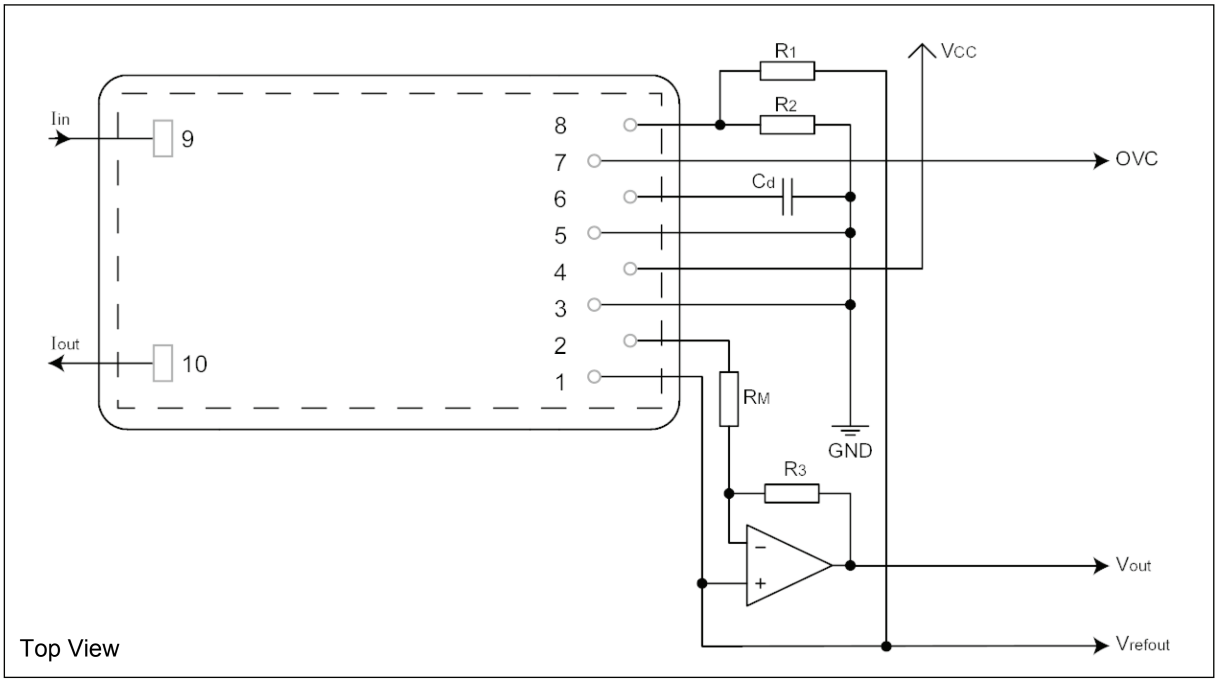


Fig.6: Example of how to use an operational amplifier to adjust the output signal to an A/D converter. With R_M = 300 Ω and R_3 = 410 Ω, the output signal is amplified to a full scale output of 4.92 V.

PCB Layout

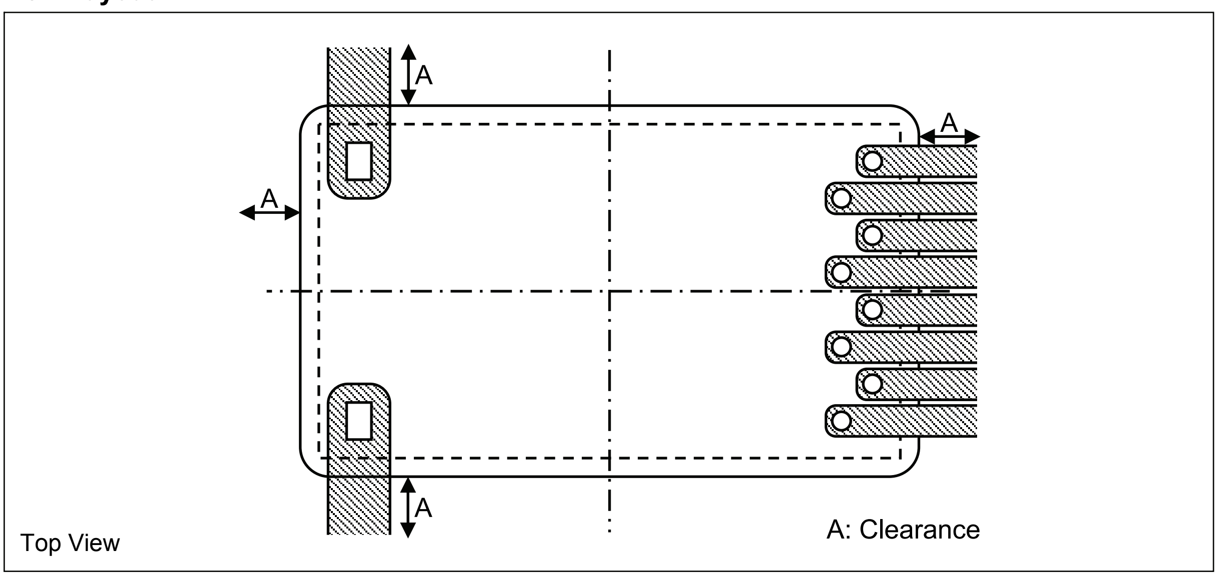


Fig.7: Recommended PCB Layout for the CDS4006 sensor.

Additional notes for the designer

- The minimum clearance to other magnetic devices (for example: relay, current conductors and permanent magnets) depends on the strength of their magnetic field. Homogeneous fields should be below 1 kA/m and magnetic field gradients should be lower then 4 kA/m². A conductor carrying 1 A produces a magnetic field of 20 A/m and a magnetic field gradient of 2.5 kA/m² at a distance of 8 mm.
- The maximum operating temperature is primarily limited by the busbar temperature. Care must be taken to keep the busbar temperature below 100 °C.
- It is recommended to place multiple CDS4006 sensors with a clearance (A) of at least 10 mm. A smaller distance will only influence the offset. Cross-talk is not relevant. The current paths in the PCB however may not be routed underneath a CDS4000 sensor.

Typical performance graphs

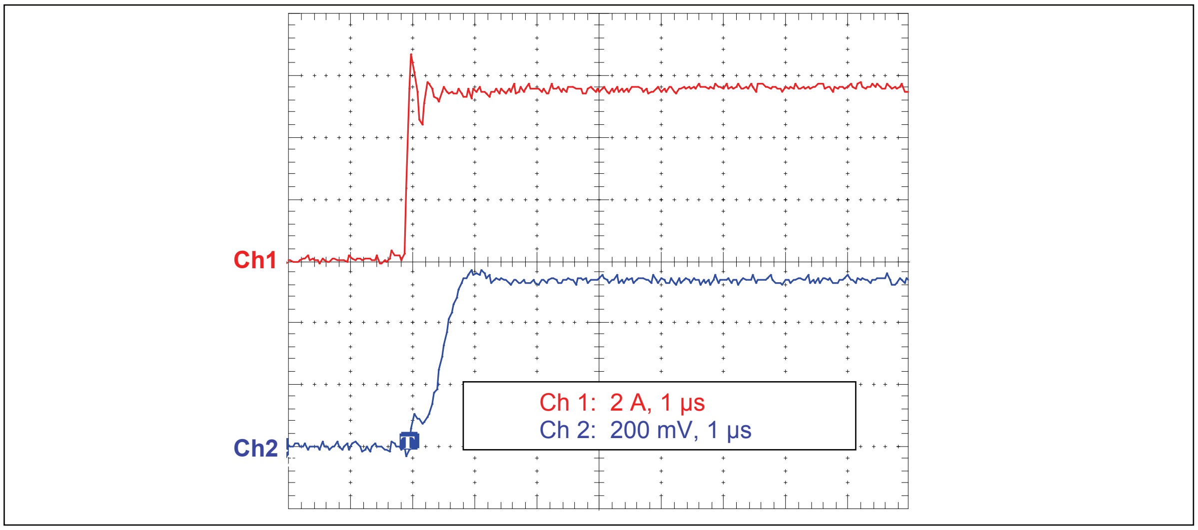


Fig.8: Typical output characteristic due to a current jump from 0 to I_{PN}. Input di/dt ≈ 60 A/µs.

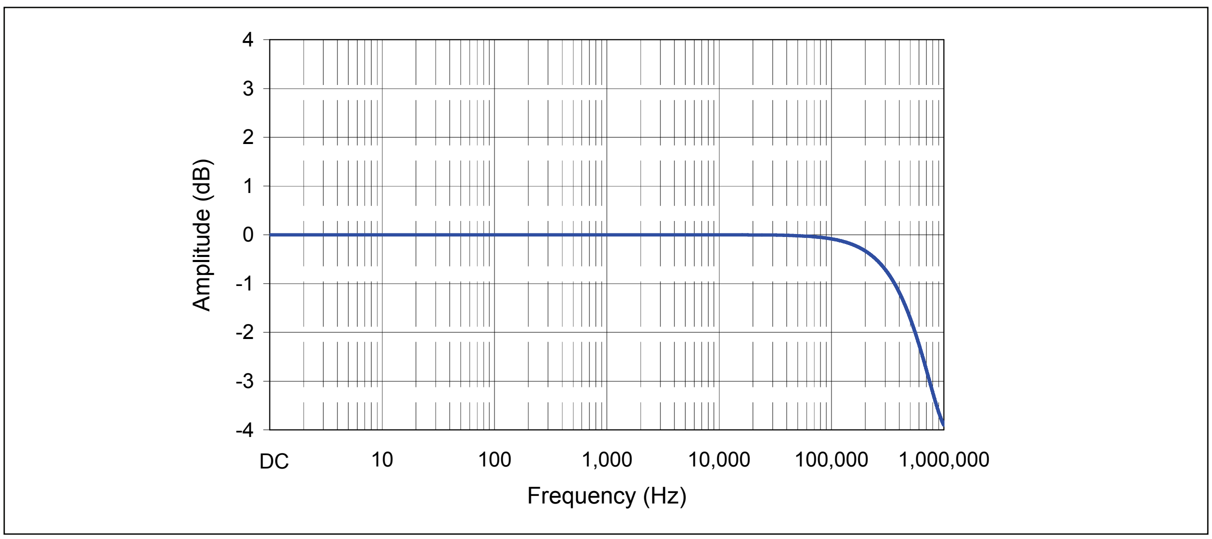
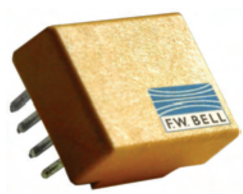


Fig.9: Typical frequency response.

The CDS4000 product family

The CDS4006 is a member of the CDS4000 product family offering PCB-mountable THT current sensors from 3 A up to 150 A nominal current for various industrial applications.

Product	I_{PN} (A)	I_{PR} (A)	Package
CDS4003ABA-Ix	3	9	
CDS4006ABA-Ix	6	18	
CDS4010ABA-Ix	10	30	
CDS4015ABA-Ix	15	45	
CDS4025ABA-Ix	25	75	
CDS4050ABA-Ix	50	150	
CDS4050ACA-Ix	50	150	
CDS4100ACA-Ix	100	300	
CDS4125ACA-Ix	125	375	
CDS4150ACA-Ix	150	450	

I_{PN}: Nominal primary current (RMS).
I_{PR}: Measurement range (For 1 s in a 60 s interval; R_M = 300 Ω).

General information

Product status

The product is undergoing qualification tests. Deliverables have a sample status at this time. The data-sheet is preliminary. **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.sypris.com.**

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Sypris Test & Measurement
6120 Hanging Moss Road
Orlando, FL 32807

Phone (407) 678-6900
Fax (407) 677-5765
Toll Free (800) 778-6117

www.sypris.com

E-Mail sales.stm@sypris.com

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