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data

preliminary!

product data thermopile gas module

TPMG CO2 3000 / V2.0 engineering sample + TPMG development kit

OEM CO_2 gas detector module + microcontroller and software

- **Features:**
  - **Measures atmospheric CO_2 by IR absorption,**
  - **Measurement range 0...3000 ppm,**
  - **Calibrated at 0 and 1000 ppm dry CO_2 with accuracy ±100 ppm.**

- **Applications:**
  - **Air quality control,**
  - **Heating ventilation and air conditioning.**

Connection diagram of module PCB:

1: Input VCC 5 V
2: Ground
3: Input lamp switching (TTL-level)
4: Output thermistor signal (ambient temperature)
5: Output difference signal
6: Output CO_2 signal
7: Output reference signal
8: EEPROM SCL (t.b.d.)
9: EEPROM SDA (t.b.d.)

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1 General product description

1.1 Introduction

1.1.1 TPMG CO2 3000 thermopile-based gas detector module

The PerkinElmer OEM gas module TPMG CO2 3000 is a sub-unit which contains a thermopile-based infrared (IR) absorption cell. An IR-source sends broadband radiation through the cell, which incidences on a dual channel thermopile detector. One of the thermopile channels is equipped with an IR bandpass that senses radiation in a band around 4.26 μm, i.e. the absorption band of carbon dioxide (CO_2). The output of this channel is therefore a function of the CO_2 content. The other thermopile channel carries a bandpass centered at 4 μm, acting as reference.

1.1.2 Development kit for TPMG CO2 3000

For evaluation and demonstration purpose, a development kit is available for the OEM PCB. This kit consists of a microcontroller running a software that controls the IR-source, performs the necessary data acquisition, and does the evaluation of the CO_2 concentration. The microcontroller sends all relevant data via a RS232 interface to a PC. An additional visualization software on the PC makes the recording and plotting possible.

The product, i.e. the OEM module PCB and the development kit are still under development. Therefore the specifications given here in the paper are so far preliminary. Please feel free to discuss with the engineers at PerkinElmer for any questions or comments.

1.2 Name of the product; device marking

PerkinElmer TPMG CO2 3000 thermopile-based gas detector module:

TP = thermopile, M = module, G = gas, CO2 = type of gas (here: CO_2), 3000 = measurement range (here: 0...3000 ppm).

Identification: no device number (PerkinElmer Bau No.) assigned so far. Engineering sample device No. 9538 2031 is used.

Development kit for TPMG CO2 3000:

Consisting of Microcontroller with software, power supply 5 V, RS232 cable, 2 installation disks for PC-based visualization software.

Identification: no device number (PerkinElmer Bau No.) assigned so far. Engineering sample device No. 9538 2031 is used.

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2 Technical data

2.1 Design characteristics of TPMG CO2 3000 module

Parameter	Type
Supply voltage	5 (-0.25 +0.5) V.
PCB	approximately 20 x 66 mm^2.
Connections	9 wires.
Housing	For demonstration purpose housed in transparent tube with aluminium caps.
Thermopile	PerkinElmer TPS 2534 G2 G20 / 9638 3197 with 30 kΩ thermistor.
IR souce	PerkinElmer IRL 715 / 9538 2047.
Measurement cell	Preliminary aluminium with two diffusion holes and about 22 mm absorption path; the final version will have elaborate aluminium coated plastic IR optics.
Signal conditioning	Low noise analog circuit.

2.2 Electrical connection diagram of PCB

The below drawing shows the electrical circuit of the TPMG CO2 3000 / V2.0. The shown EEPROM is not included. This will be done in a later version.

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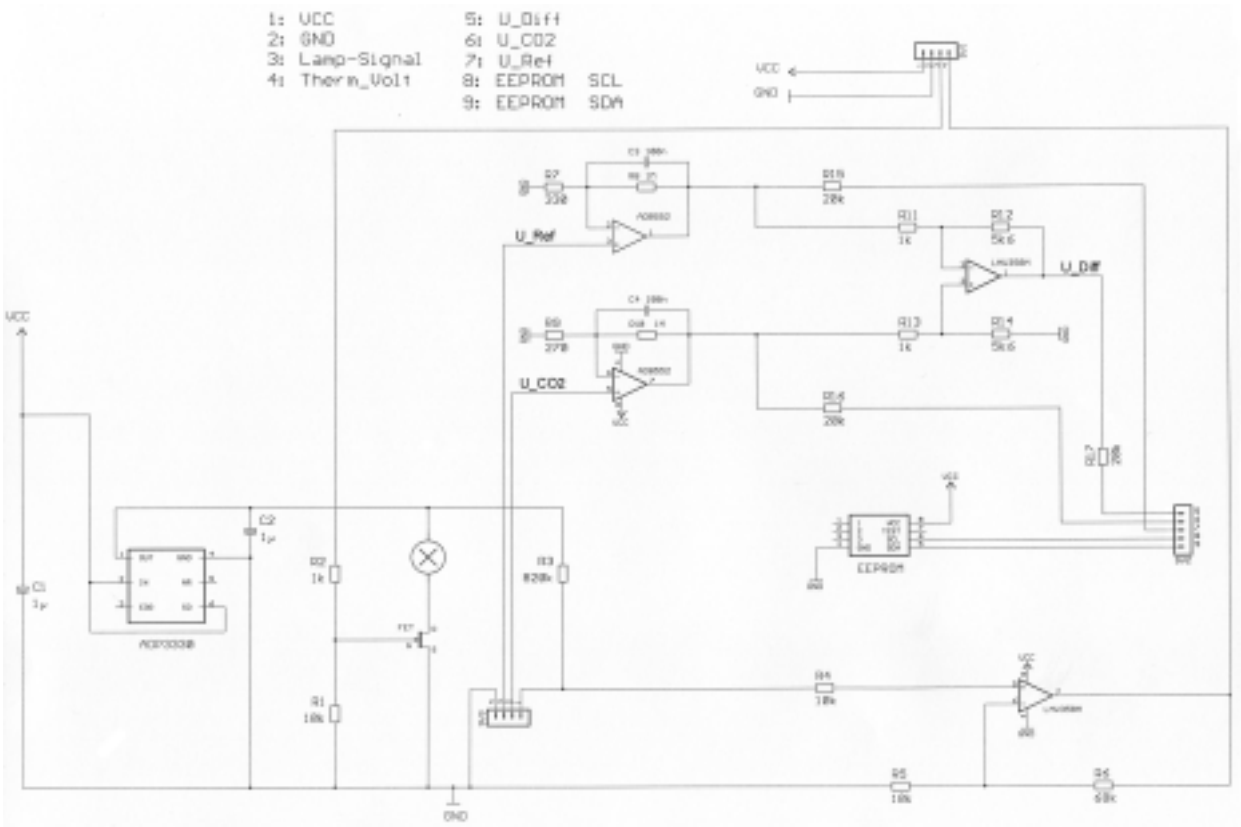

Figure 1: Circuit diagram of TPMG CO2 3000, version 2.0 (01/2001).

2.3 Performance data

It has to be noted that the module TPMG CO2 3000 alone does not provide values for gas concentration data. The signals at the output leads have to be interpreted accordingly and a calculation has to be performed. In the case of an evaluation algorithms, that is defined in section 3, the following data are applicable:

Parameter	**Limits**			**Units**	**Conditions**
	Min	*Typ*	*Max*		
Measurement range	0	1000	3000	ppm CO_2	
Accuracy		50	100	ppm CO_2	at calibration points 0 and 1000 ppm dry CO_2, temperature range 10...50°C
Repeatability		20	50	ppm CO_2	constant environment conditions
Response time		30	60	seconds	governed by gas diffusion

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The above data are dependent on the individual evaluation algorithm.

2.4 Optical data

For the optical properties of the employed thermopile, please refer to the datasheets of the Perkin-Elmer thermopile sensor TPS 2534 G2 G20.

2.5 Characteristics of input/output data

2.5.1 Input: Lamp control

Minimum 4.5 V input required to ignite lamp.

2.5.2 Output: Thermopile signals

The output voltage of the two thermopile channels, U_{CO2} and U_{ref}, reacts on the lamp radiation. A typical output pattern is seen in the following graph. There is also a difference amplifier included which generates the Signal U_{Diff} ($U_{Diff} = U_{CO2} - U_{ref}$).

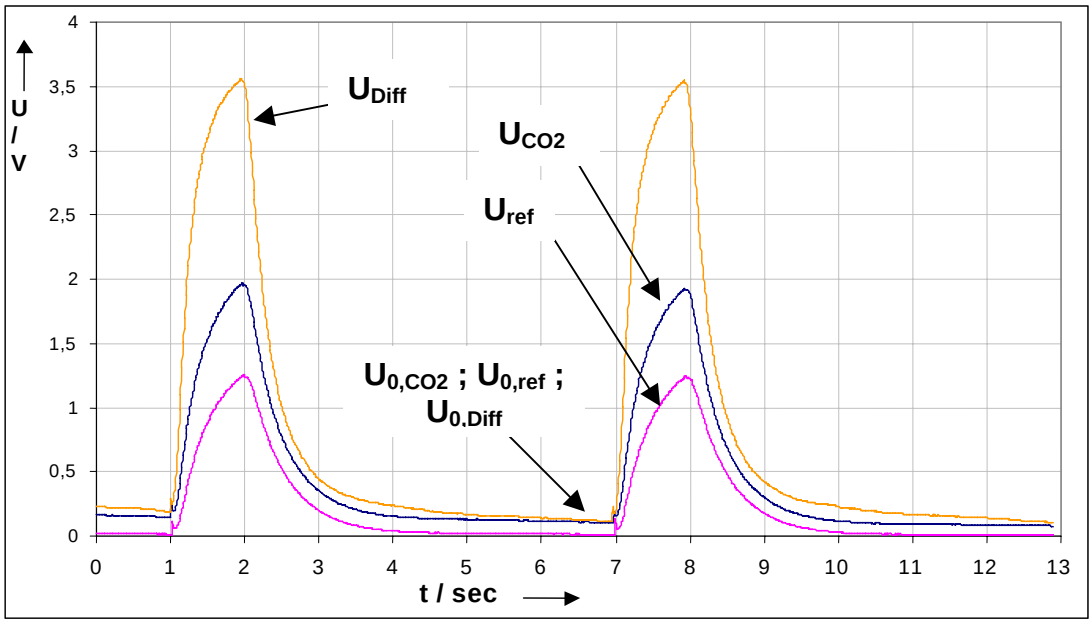

Figure 2: Voltage pattern as a function of time at the amplified outputs U_{CO2} , U_{ref} and U_{Diff}. $U_{0,CO2}$, $U_{0,ref}$ and $U_{0,Diff}$ are the offset values for the CO_2 ,the reference channel and the difference output, respectively.

2.5.3 Output: Temperature reference signal

The thermistor in the thermopile detector TPS 2534 is read out by a current less than 10 µA. Since the readout circuit is not defined yet, no detailed data are given. These will be added at the new version.

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For the specifications of the employed thermistor, please refer to the datasheets of the PerkinElmer thermopile sensor TPS 2534 G2 G20.

2.6 Absolute maximum ratings; handling requirements

Parameter	Symbol	Limits			Units	Conditions
		Min	*Typ*	*Max*		
Ambient Temperature Range		-40 10		100 50	°C	Storage Operation

Stresses above the absolute maximum ratings may cause damages to the device.

The module can be damaged by electrostatic discharges. Please take appropriate precautions for the handling.

3 Evaluation algorithm

The signals generated by the PCB-based OEM gas module TPMG CO2 3000 have to be further processed by a suitable circuit – preferably a microcontroller unit – which the customer will add by himself.

For demonstration and evaluation purposes, PerkinElmer offers a microcontroller with software, that employs the following evaluation algorithm:

- The lamp is pulsed at 1 sec on-time followed by 5 sec off time = 6 seconds measurement cycle. This is the pattern seen in figure 2.
- Before switching on the lamp, the thermal offset data of $U_{0,CO2}$, $U_{0,ref}$ and $_{U0,}$Diff are read by the microcontroller (several data points with averaging). (cf. figure 2.)
- Ambient temperature is recorded by reading the thermistor signal voltage and calculating the temperature.
- Before the lamp is switched off after 1 sec on-time, 5 data points of the peak values, $U_{peak,CO2}$, $U_{peak,ref}$ and $U_{peak,Diff}$ are recorded and averaged. The thermal offset is subtracted.
- The relevant data are then $U_{CO2} = U_{peak,CO2} - U_{0,CO2}$, $U_{ref} = U_{peak,ref} - U_{0,ref}$ and $U_{Diff} = U_{peak,Diff} - U_{0,Diff}$.
- Only U_{CO2} is dependent on the gas concentration. U_{ref} is used to compensate for temperature dependence and intensity changes of the IR-light source.
- Good measures for gas concentration are therefore the quotient $\Delta U = U_{CO2}/U_{ref}$ and the difference $U_{diff} = U_{CO2} - U_{ref}$. However, ΔU is the only Signal which garanties reproducibility right now.
- Both measures have, however, still a temperature dependence left, which has to be corrected by software calculation.

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A typical resulting functional dependency of the CO_2 concentration and $\Delta U = U_{CO2}/U_{ref}$ is shown in figure 3:

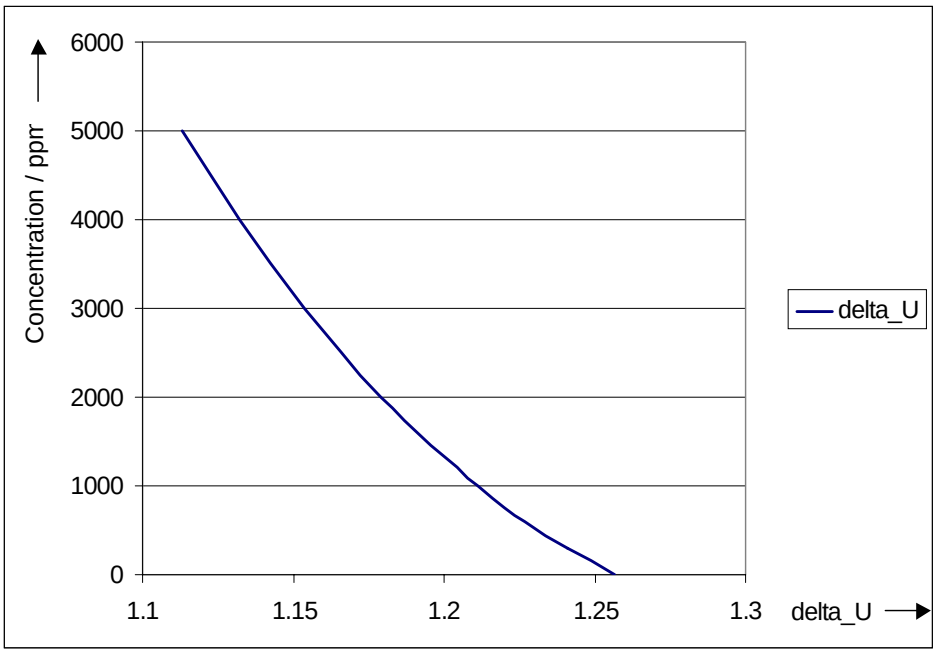

Figure 3: The change in $\Delta U = U_{CO2}/U_{ref}$ when the CO_2 gas concentration is varied between 0 and 5000 ppm. The absorption length in this case is 22 mm.

This curve is further a function of the ambient temperature. A typical result is shown in figure 4:

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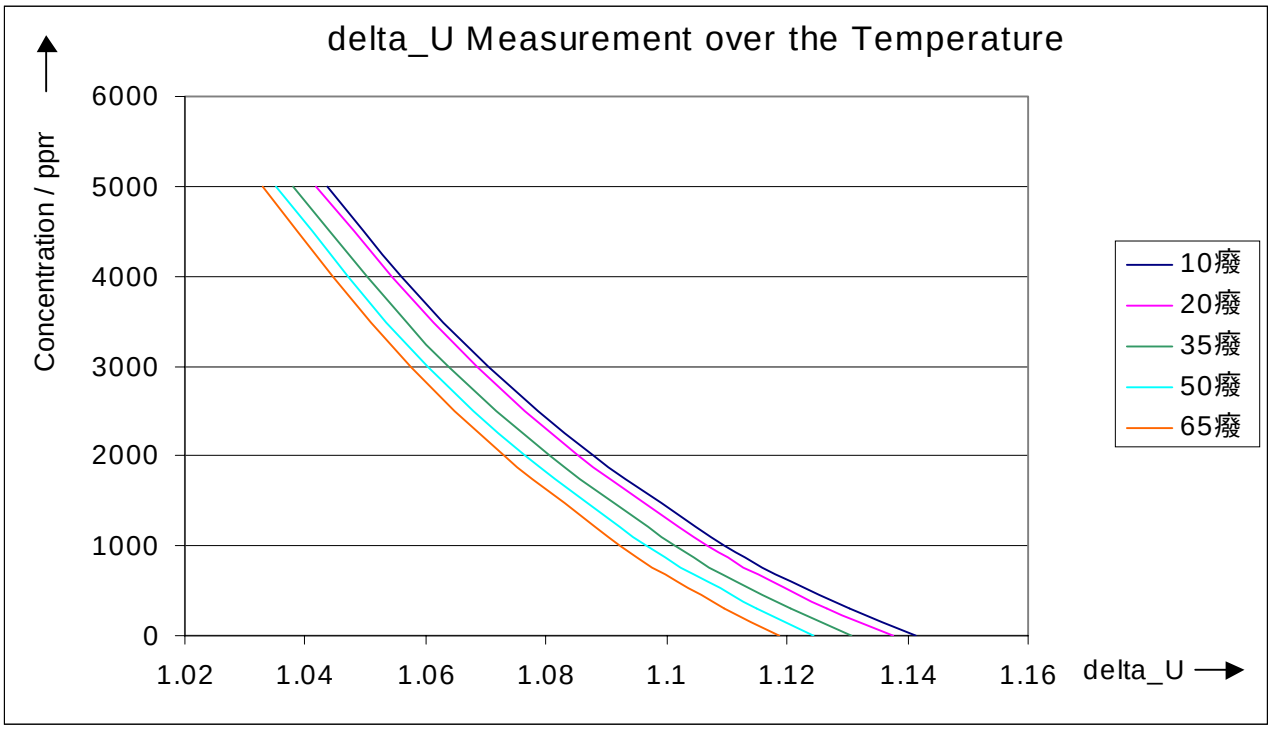

Figure 4: The parameter field of the CO_2 gas sensor, when evaluating the quotient $\Delta U = U_{CO2}/U_{ref}$ as a function of CO_2 gas concentration and ambient temperature.

The final evaluation algorithm to be made by the system integrator (customer) has to take the ambient temperature dependency into account.

4 Quality statement

PerkinElmer Optoelectronics is an ISO 9001 certified manufacturer with established SPC and TQM. All materials are checked according to specifications and final goods meet the specified tests.

All devices employing PCB assemblies are manufactured according IPC-A-610C class 3 guidelines.

5 Contact PerkinElmer Optoelectronics

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The contents of this document are subject to change without notice. Customers are advised to consult with PerkinElmer Optoelectronics sales representatives before ordering.

Customers considering the use of PerkinElmer Optoelectronics thermopile devices in special applications where failure or abnormal operation may directly affect human lives or cause physical injury or property damage, or where extremely high levels of reliability are demanded, are requested to consult with PerkinElmer Optoelectronics sales representatives before such use. The company will not be responsible for damage arising from such use without prior approval.

As any semiconductor device, thermopile sensors or modules have inherently a certain rate of failure. It is therefore necessary to protect against injury, damage or loss from such failures by incorporating safety design measures into the equipment.

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