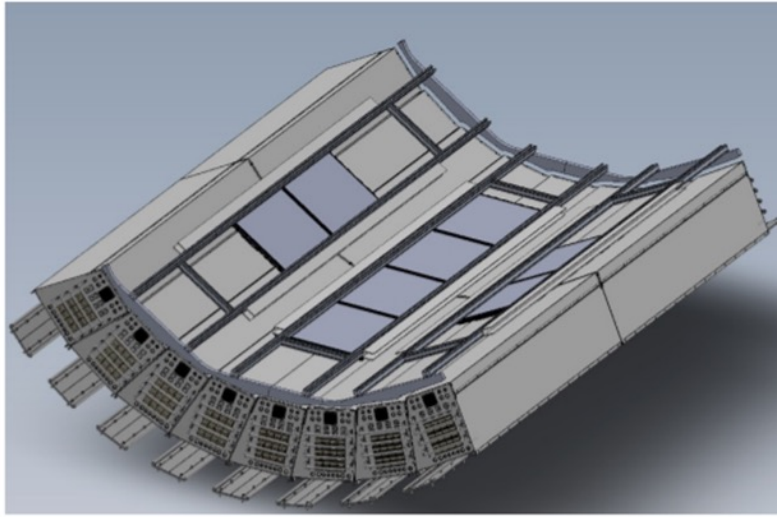
TPOT Safety Considerations

John Haggerty

Detector configuration

- There are a total of 8 modules
  - Arranged in three adjacent sectors
  - 16 detectors
  - 32 TPC FEE boards
- Structure supported by the inner HCAL
- Bottom-most sector has 4 modules to have full longitudinal coverage
- Immediate neighbor sectors have 2 modules each



ES&H considerations

- TPOT has the usual safety issues (fusing, flammability of components, shock hazards from HV and LV)
  - Uses TPC Front End Electronics (FEE)
  - Uses TPC LV distribution and cabling
  - Cooling a small variation on TPC FEE card cooling
  - HV mainframe identical to that used by MVTX
  - See presentation in backup shared with Mike Sivertz (ESRC chair) and Joe Levesque for details
- However, this is the first detector in sPHENIX using a gas with a small flammable component

Gas

- Gas is Argon-isobutane 95/5
  - Gas volume 8 modules · 1.4L = 11.2L
  - Flow 3L/h/module
- There is a lot of gas infrastructure intact from PHENIX in the Gas Mixing House (GMH) which we plan to repurpose
  - We plan to reuse the PHENIX TOF.W rack
- Rob Pisani will present details of the design
- Flammable gas detection in GMH will be necessary

Isobutane equipment

Discussion with ESRC

While a component of the gas will be flammable (5% isobutane), when diluted in air to increase the oxygen content to above 12% (the normal oxygen level needed to sustain ignition of a gas), the flammable component goes below the lower flammable limit for isobutane (1.8%).

From the US Bureau of Mines Bulletin 627, it is shown in this chart. It means the blended gas is inert. The safety concern will be ensuring the blend is 95%/5%. If it is purchased from a vendor, it will need QA measures to ensure it is the right mix. If it is blended in house, check precautions will need to be designed into the blending operations to ensure reliable 95%/5% mix.

So, happens I was preparing a document describing protections of physic experiments (passing down the institutional knowledge). I attached a current draft for your info, and feel free to comment.

One item to note, if you use flammable gas detection, it is highly recommended you do not use catalytic bead detection. The technology is subject to poisoning by chemicals, it drifts quickly as it ages and has a poor history of false alarms and high maintenance. IR technology is more expensive but has nowhere near the problems of the catalytic beads.

Sincerely,
Joe [Levesque]

From your analysis it sounds like there is no need for a flammable gas detection system in the IR.
What is needed is a reliable gas analyser for the gas mixing house.
Is that your understanding?
With some planning, we should be able to come up with a baseline gas design for sPHENIX that meets all our needs..

Mike Sivertz

Yes, a reliable gas monitor, that is calibrated periodically as per the manufacturer, would be a solution.

Thank you for the correction.

Sincerely,
Joe

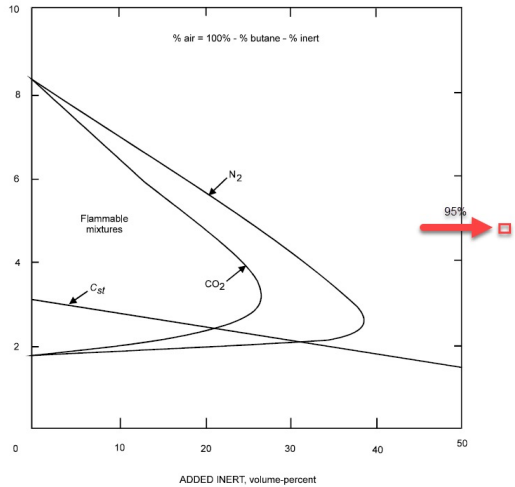


Figure 31—Limits of Flammability of Butane-Carbon Dioxide-Air and Butane-Nitrogen-Air Mixtures at 25°C and Atmospheric Pressure.

Flammable gas detection

- PHENIX had an extensive system of flammable gas detection, but it needs to be replaced in the sPHENIX era for this detector
- Joel Vasquez (sPHENIX Infrastructure Engineering team lead) has quotes for new gas detectors
  - Detection in Gas Mixing House can easily be integrated with safety system PLC

Summary

- The hazards associated with the TPOT have had a preliminary evaluation by ESRC members
- We will make a presentation to the full ESRC in the coming weeks to finalize our plans

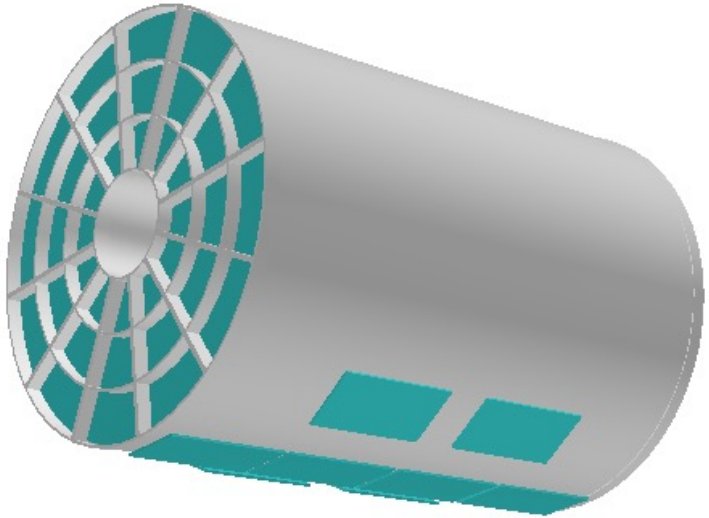
Presentation shared with ESRC 2021-11-24

TPOT Safety Considerations

The TPOT Team

Detector configuration

- The TPC Outer Tracker are Micromegas detectors located at the bottom of the TPC between the TPC and EMCAL used for calibration of tracking distortions in the TPC
- There are a total of 8 modules
  - Arranged in three adjacent sectors
  - 16 detectors
  - 32 TPC FEE boards
- Structure supported by the inner HCAL
- Bottom-most sector has 4 modules to have full longitudinal coverage
- Immediate neighbor sectors have 2 modules each to validate extrapolation procedure to sectors which do not have Micromegas modules



ES&H considerations

- TPOT has the usual safety issues (fusing, flammability of components, shock hazards from HV and LV)
  - Uses TPC Front End Electronics
  - Uses TPC LV distribution and cabling
  - New HV system
- This is the first detector in sPHENIX using a gas with a small flammable component, so we think we need to have flammable gas detection inside the solenoid and in the Gas Mixing House

Gas

- Gas is Argon-isobutane 95/5
  - Gas volume 8 modules · 1.4L = 11.2L
  - Flow 3L/h/module
- There is a lot of gas infrastructure intact from PHENIX in the Gas Mixing House which we plan to repurpose
  - We plan to reuse the PHENIX TOF.W rack
- Piping from GMH to detector has to be installed
- Control and monitoring for TPC is being moved from custom computing to PLC; this will be a small increase of that scope

Isobutane equipment

Flammable gas detection

- New catalytic bead sensor with low zero drift specs
  - Addresses issue of setting alarms at 5% LEL
- In the solenoid
  - Two aspirating flammable gas detector channels
- In the GMH
  - Four sensors as in PHENIX

Dräger

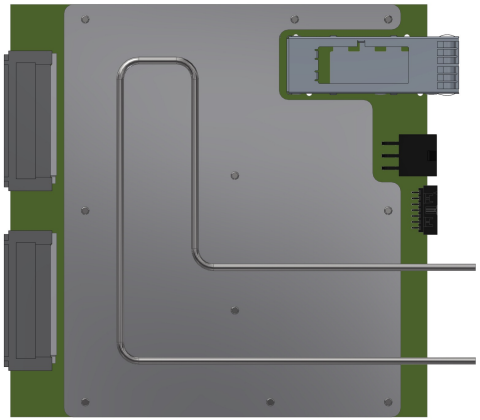
Dräger Polytron® 8200 CAT
Detection of flammable gases and vapors

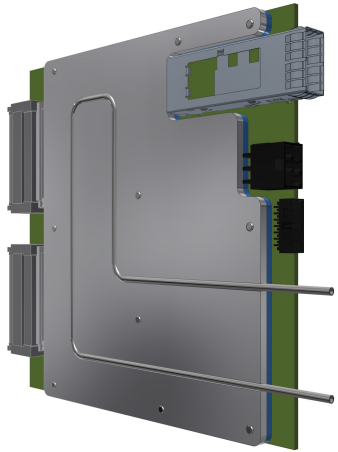
The Dräger Polytron® 8200 CAT is an advanced explosion proof transmitter for the detection of flammable gases in the lower explosion limit (LEL). It uses a catalytic bead DrägerSensor® Ex ... DD, which will detect most flammable gases and vapors. Besides a 3 wire 4 to 20 mA analog output with relays, it also offers Modbus and Fieldbus protocols making it compatible with most control systems.

Dräger. Technology for Life®

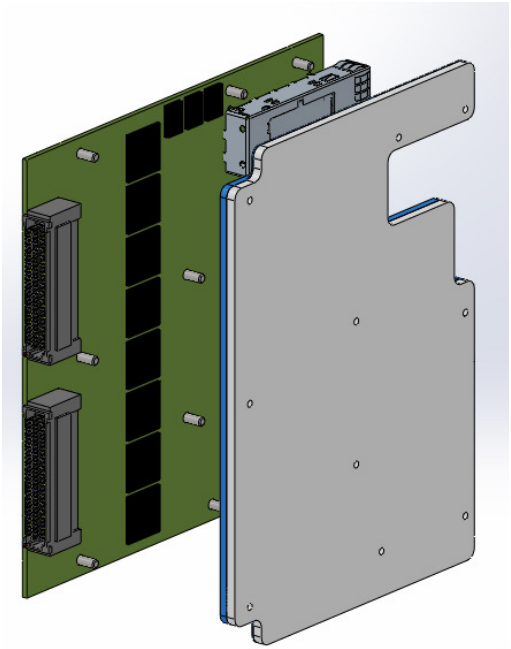
Cooling

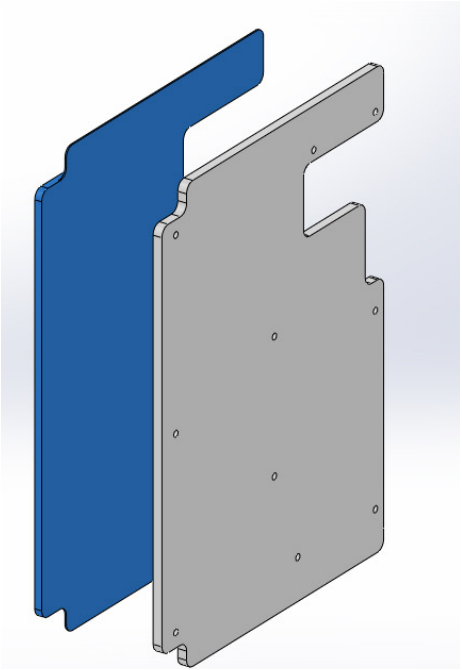
- 2 FEE cards/module have to be cooled
  - Equivalent to 2 additional sectors of TPC (24→26)
  - Cooling must remove 20W/FEE
  - We want to avoid heating up the TPC
- We can't just copy the cooling design from the TPC, which relies on cooling plates in thermal contact with a "slot," but it's easy to imagine a variation where the cooling plate is cooled directly
- We need to do some modeling or testing, and then route cooling lines to the outside
- Enough headroom in TPC chillers to add some additional cooling to each TPC sector
- Relatively small addition to scope
  - Need some thermal and mechanical engineering; cooling plates made outside, possibly





FEE cooling





Cooling plate will use similar concept as for TPC, but needs tube to cool the plate directly

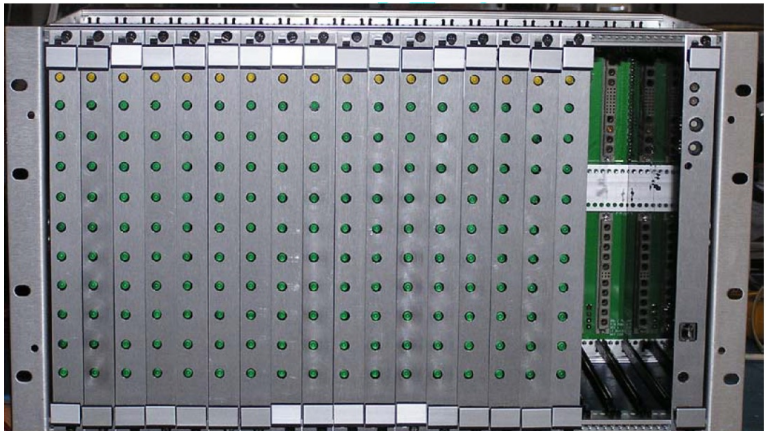
Cooling water at negative pressure tapped off the TPC cooling

Will require careful flow balancing

Eric Renner

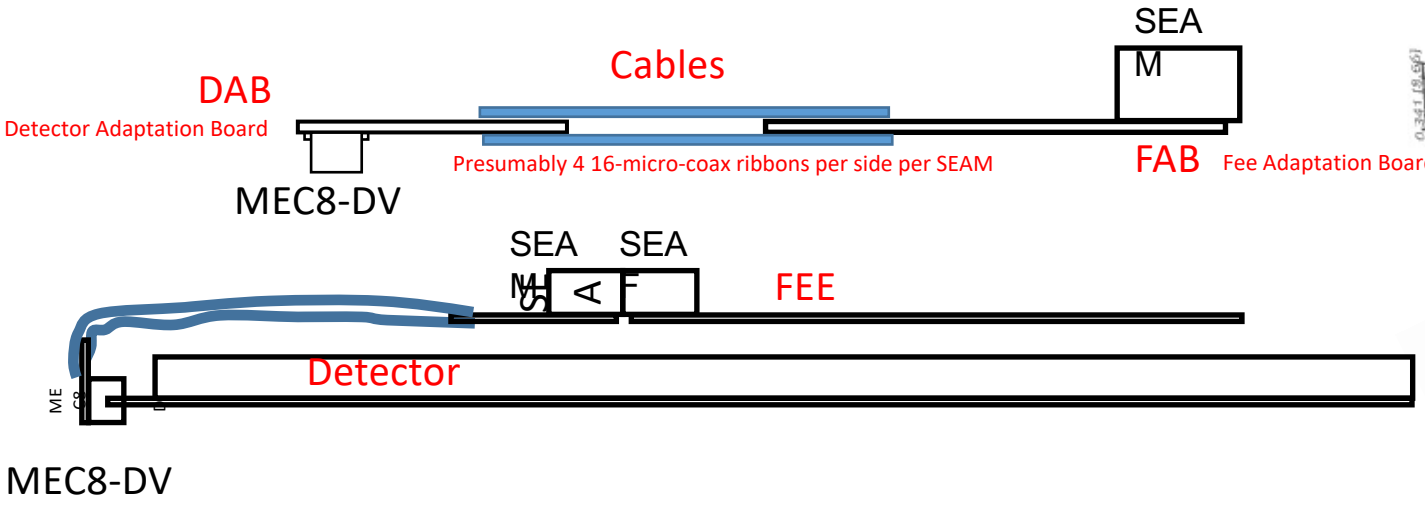
Low voltage

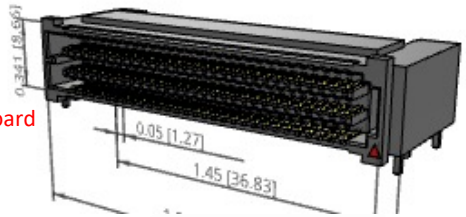
- Add channels to TPC LV power distribution
  - 3 voltages/FEE
- 5 modules to feed 16 FEE
- Distribution crate and Megapak for TPOT

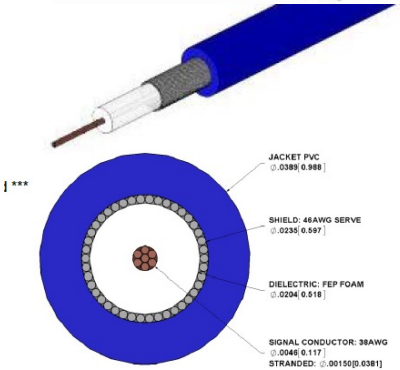


Switching module fed by Megapak

FEE-to-detector connector







Proposal from Saclay - Irakli Mandjavidze
Takao and Irakli are following up with SAMTEC

Cables detector to patch panel

https://docs.google.com/spreadsheets/d/1JeDJg8PGkYo8F-KefOTvAWrGPMYPmzk7bsciS6LPC00/edit?usp=sharing

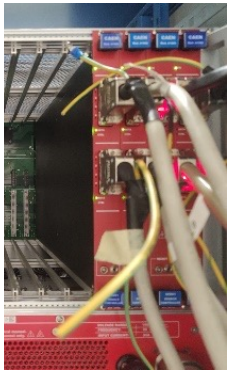
Type	Count/module	Reference	Diameter	Comments	
HV	10	**HTC-50-1-1, 0.5Lz/1.5, CEH50 Dakra https://www.prysmiangroup.com/sites/default/files/business_markets/markets/downloads/datasheets/hf41e_0.pdf**	3mm	Maxence/Stephan	based on picture sent by Maxence
LV	0.5	8671806CY SL005 https://www.mouser.com/ProductDetail/Alpha-Wire/8671806CY-SL005?qs=y6ZabgHbY%252BxMmewweWgroQ%3D%3D	0.458in = 12mm	Takao	I think one set of 12AWG+18AWG per sector per side
Fiber	2			Takao	
Gas	2		6mm	Maxence/Stephan	could also be 6mm, based on picture sent by Maxence
FEE cooling pipe	2			Eric ?	plastic
Ground	1		6mm (CLAS)		John. Will need to ground the frame to the detector
gas aspiration	1		12mm tbc (PHENIX)		

Needed to define cable trays and cable routing on support structure, patch panels at end of support structures

Chris Vidal

HV power supply and distribution

Each plane has 5 independent HV lines
1 DRIFT up to 2kV (negative)
4 Strips HV for segmentation* (positive)
<u>10 HV lines per module</u> (8+ 2-)
8 Modules : 64 negative, 8 positive
(2 neg. cards + 1. positive)



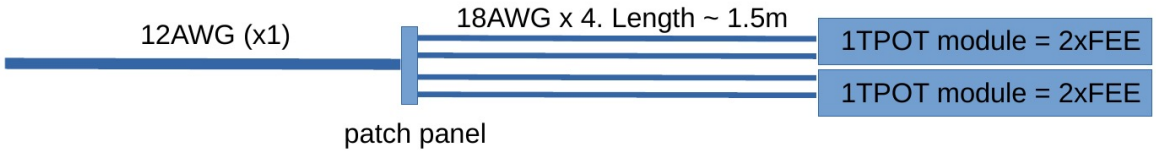
Recommended HV power supply :
CAEN SY4527 Mainframe (20k) - Also used by MVTX
+ 48 channels CAEN A7030 (8k per card)
+ positive card for drift (8k per card)
(used for ATLAS NSW)

https://www.caen.it/products/a7030/

Maxence Vandenbroucke

LV power supply and distribution

One TPC side of the 4 TPOT modules sector



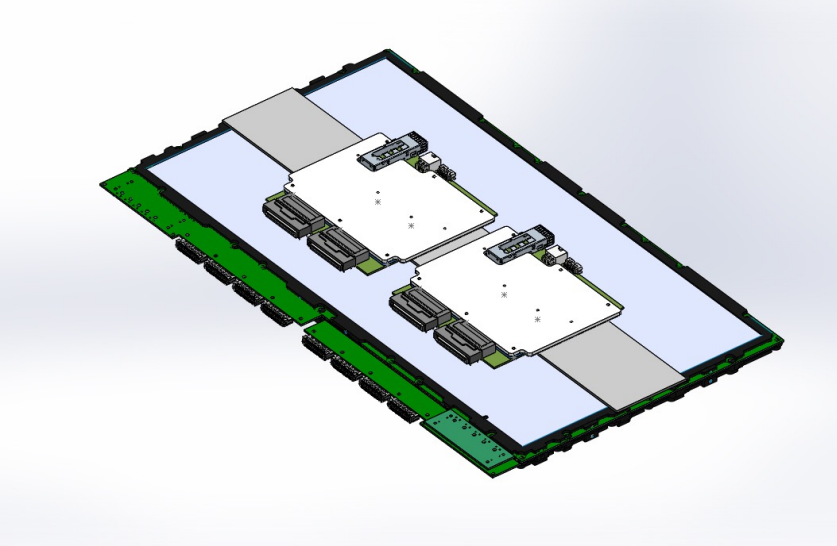
One TPC side of the 2 TPOT modules sector

Will use same Power Supply and cable types as TPC
One 12AWG/18AWG per sector and per side (6 cable pairs total)
Connection between 12AWG and 18AWG at patch panel

Takao Sakagushi

FEE mounting on detector, FEE housing

For now we have an aluminium plate off the TPOT 3D-Printed frame on which FEE boards are attached.
Need to define type of housing needed around FEE boards



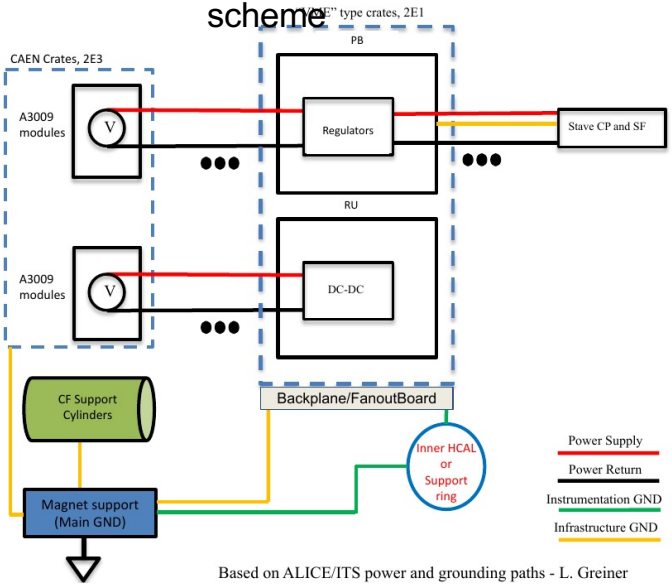
Chris Vidal

Grounding

Will need input on:

- Infrastructure ground vs instrumentation ground
- How to ground Micromegas detectors,
- How to ground the SAMPA FEE

MVTX grounding scheme



Based on ALICE/ITS power and grounding paths - L. Greiner

https://indico.bnl.gov/event/10927/contributions/57115/attachments/38277/63251/MVTX_ESRC_review_slides.pdf

Dräger Polytron® 8200 CAT
Detection of flammable gases and vapors

The Dräger Polytron® 8200 CAT is an advanced explosion proof transmitter for the detection of flammable gases in the lower explosion limit (LEL). It uses a catalytic bead DrägerSensor® Ex ... DD, which will detect most flammable gases and vapors. Besides a 3 wire 4 to 20 mA analog output with relays, it also offers Modbus and Fieldbus protocols making it compatible with most control systems.

Benefits

Fast and stable – the DrägerSensor® Ex ... DD

The latest generation type DD gas sensor is based on the proven catalytic bead principle. Innovative dual active elements result in very good long-term zero stability. Dräger has raised the bar yet again for poison resistance. The resulting long service life provides you with low ownership costs. Measuring performance has also been improved. The innovative gas inlet allows the sensor to respond to gas within a matter of seconds.

Easy device management via digital communication

The Dräger Polytron 8200 is equiped with digital interfaces allowing for quick and easy remote interrogation of the transmitter's state. Integration with existing asset management systems such as PACTware™ is possible via DTM.

In addition to the common HART® communication system, the fieldbus interfaces PROFIBUS® PA, FOUNDATION fieldbus™ H1, and Modbus RTU are also available.

Same design, same operating principle

The Dräger Polytron 8200 belongs to the Polytron 8000 series. All transmitters in this series have the same design and user interface. This allows for uniform operation with reduced training and maintenance requirements.

The large graphic backlit display shows status information clearly and in an easy to use format. The measured gas concentration, selected gas type, and measuring unit are displayed during normal operation. Colored LEDs (green, yellow and red) provide additional alarm and status information.

The Polytron 8200 is operated by means of a magnetic wand over contact surfaces.

Three relays for controlling external equipment

Upon request, the Dräger Polytron 8200 can also be supplied with three integrated relays. This enables you to use it as an independent gas detection system with two arbitrarily adjustable concentration alarms and one fault alarm. Audio alarms, signal lights, or similar devices can thus be controlled locally without an additional cable between the transmitter and central controller.

Safe, robust housing for every application

Polytron 8200 features a Class I, Div. 1 rated explosion proof enclosure made from aluminum or stainless steel, making it suitable for a wide range of environmental conditions. A protection type "e" version includes a convenient docking station which allows installation in hazardous atmospheres without running conduit (where approved).

Benefits

Make the impossible possible with the remote sensor

An available remote sensor condulet housing allows the sensor to be installed up to 30 meters (100 feet) away from the Polytron transmitter. The sensor splash guard with integrated tubing nipple permits one person to perform a full calibration of a remote mounted sensor from the transmitter.

Data logger

The Polytron 8200 has a data logger, which records measuring and event data from prior years.

System Components

D-9717.2009

Dräger REGARD® 3900

The Dräger REGARD® 3900 is a standalone control system for the detection of toxic gases, oxygen levels, and Ex hazards. The control system is fully configurable between 1 and 16 channels, depending upon the type and quantity of input/output boards installed.

IST-0265-2004

Dräger REGARD®-1

The Dräger REGARD®-1 is a standalone single-channel control system for the detection of toxic and Ex hazards and oxygen levels. The control system is fully configurable for a single input from either a 4 to 20 mA transmitter or a Dräger Polytron® SE Ex measuring head.

Technical Data

Dräger Polytron® 8200 CAT

Type	Explosion proof / flameproof enclosed transmitter ("d") or combined with increased safety ("d/e")		
Gases	Flammable gases and vapors		
Measuring ranges	DD	0 to 100% LEL	
	LC	0 to 10% LEL	
Display	Backlit graphic LCD; 3 Status LEDs (green/yellow/red)		
Electrical data	Signal output analog	Normal operation	4 to 20 mA
		Maintenance	Constant 3.4 mA or 4 mA ±1 mA 1 Hz modulation; (adjustable)
		Fault	< 1.2 mA
	Signal output digital	HART®, PROFIBUS® PA, FOUNDATION fieldbus™ H1 and Modbus RTU	
	Power supply	10 to 30 V DC, 3-wire	
	Power consumption (max.)	DrägerSensor® Ex ... DD, w/o relay, non-remote	105 mA at 24 V
		DrägerSensor® Ex ... DD, w/ relay, remote	145 mA at 24 V
		DrägerSensor® Ex LC, w/o relay, non-remote	130 mA at 24 V
		DrägerSensor® Ex LC, w/ relay, remote	165 mA at 24 V
	Relay specification (option)	2 alarm relays and 1 fault relay, single-pole two-way contact 5 A @ 230 VAC, 5 A @ 30 VDC, resistance-bound	
Environmental conditions (see sensor data sheet)	Temperature	-40 to 80°C (-40 to 176°F) without relay -40 to 70°C (-40 to 158°F) with relay	
	Pressure	20.7 to 38.4 inch Hg / 700 to 1,300 mbar	
	Humidity	0 to 100% r. h., non-condensing	
Housing	Transmitter housing	Epoxy coated copper-free aluminum or stainless steel SS316 L	
	Sensor housing	Stainless steel 303	
	Enclosure protection type	NEMA 4X & 7, IP65/66/67	
	Cable entry point	3/4" NPT threaded holes or M20 cable gland	
	Dimensions (H x W x D), approx.	w/o docking station	11.0" x 5.9" x 5.1" / 280 x 150 x 130 mm
		w/ docking station	11.0" x 7.1" x 7.5" / 280 x 180 x 190 mm
	Weight, approx.	w/o docking station Aluminum	4.9 lbs / 2.2 kg
		w/o docking station SS316 L	8.8 lbs / 4.0 kg
		w/ docking station Aluminum	7.7 lbs / 3.5 kg
		w/ docking station SS316 L	11.9 lbs / 5.4 kg

Approvals*

UL		Class I, Div 1, Groups A, B, C, D; Class II, Div 1, Groups E, F, G; Class I, Zone 1, Group IIC; T-Code T6/T4
CSA		Class I, Div 1, Groups A, B, C, D; Class I, Zone 1, Group IIC; T-Code T6/T4 CSA C22.2 No. 152
IECEx	4-20-mA HART®	Ex db IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; "d" version

Technical Data

		Ex db e IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; "e" version; Ex tb IIIC T80/130°C Db
	PROFIBUS® & FF	Ex db ia IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; "d" version Ex db e ia IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; "e" version; Ex tb IIIC T80/130°C Db
ATEX	4-20-mA HART®	II 2G Ex db IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; "d" version II 2G Ex db e IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; "e" version II 2D Ex tb IIIC T80/130°C Db
	PROFIBUS® & FF	II 2G Ex db ia IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; "d" version II 2G Ex db e ia IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; "e" version II 2D Ex tb IIIC T80/130°C Db
CE markings		ATEX (Directive 2014/34/EU) Electromagnetic Compatibility (Directive 2014/30/EU) Low Voltage (Directive 2014/35/EU)
Shipping approvals (for DD sensor only)		DNV GL, ABS
MED approval B (for DD sensor only)		Certificate no. 61549/ 50 – 13 HH
MED approval D (for DD sensor only)		Certificate no. 12031 – 10 HH
Performance approval (for DD sensor only)		Certificate no. BVS 13 ATEX G 001 X
SIL 2 certified by TUEV Sued		Certificate no. Z10 1207 53474 013
* All docking station versions are only ATEX/IECEx approved		

Ordering Information

Dräger Polytron® 8200 CAT	
Dräger Polytron® 8200 CAT DD d A 4-20/HART®	83 44 439
Dräger Polytron® 8200 CAT DD d A 4-20/HART® relay	83 44 440
Dräger Polytron® 8200 CAT DD e A 4-20/HART® (incl. Docking Station)	83 44 457
Dräger Polytron® 8200 CAT DD e A 4-20/HART® relay (incl. Docking Station)	83 44 458
Dräger Polytron® 8200 CAT DD d S 4-20/HART® Relay	83 44 449
Dräger Polytron® 8x0 Kit (Custom configuration e. g. stainless steel housing)	83 44 800

Accessories	
Magnetic wand	45 44 101
Pipe mount bracket	45 44 198
Duct mount kit	68 12 725
IR Connection Kit Polytron® 5000/8000	45 44 197
PolySoft	83 23 405
PolySoft premium	83 23 411
Splash guard	68 12 510

Ordering Information

Gassing adapder	PE incl. tubing	45 09 314
Calibration adapter Viton®		68 10 536
Process adapter (Stainless steel) for DD		68 12 470
Prozess adapter (Stainless steel) for LC		68 12 465

HART® is a registered trademark of the HART Communication Foundation.
FOUNDATION fieldbus™ is a registered trademark of the Fieldbus Foundation™.
PROFIBUS® is a registered trademark of PROFIBUS and PROFINET International (PI).
PACTware™ is a registered trademark of Pepperl+Fuchs GmbH.
Viton® is a registered trademark of the DuPont company.

Dräger PSD 3000
Sampling unit for Gas Detection Systems

The Dräger PSD 3000 is a sampling unit for continuous sampling of gas and air mixtures. Combined with Dräger Gas Detectors, the Dräger PSD 3000 serves as a sampling system for gas monitoring purposes. The internal vibrating diaphragm pump has a superior life expectancy, due to the lack of rotating parts.

The Dräger PSD 3000 can be used for most industrial gases. An electronic circuit monitors the flow rate internally and advises if the flow rate in the input line falls below a predefined minimum threshold. The device offers a flexible programmable messaging of the low-flow signal to the control system.

FAST AND EASY INSTALLATION

The sampling unit can be placed either before or behind a gas transmitter depending on application requirements. Two instant tube fittings allow a fast and easy connection of stiff sample lines without tools or manual force. Electrically the sampling unit is installed between the gas transmitter and the central control system. There are cable glands and terminals provided for the respective connections. The 4 to 20 mA signal from the transmitter as well as a separate 24 V wire can be passed through the sampling unit.

OPERATION

A multicoloured LED indicates the operational status of the device. The LED indicates conditions such as normal operation, a blocked sampling line or a broken supply voltage connection. The flow rate of the sampling line can be adjusted internally to adapt to special needs in certain circumstances. A dust filter protects the sampling pump from dust and aerosols.

LOW-FLOW MONITOR

The Dräger PSD 3000 generates a signal in case the flow in the inlet line drops below a predefined value. This signal can alternatively be transmitted via the 4 to 20 mA line to the control system or by a separate switching contact. The latter option is useful if a digital communication between the transmitter and the controller should be maintained during a low-flow condition. In addition the operation LED indicates with a red colour that the low-flow condition has been triggered.

Dräger PSD 3000
Sampling unit for remote gas sampling.

TECHNICAL DATA

Type	Electronic sampling unit with vibrating diaphragm pump	
Voltage	(DC) 24 V ± 2.4 V	
Power	< 6.5 W	
Flow rate	Adjustable 0.3 l/min up to approx. 1.0 l/min	
	Factory default approx. 0.75 l/min	
Low-flow alarm	0.3 l/min	
Switching contact rating	Ohmic loads only U_{max} = 30 V DC, I_{max} = 2 A, Pmax = 60 W	
Ambient condition	Operation 0 °C to 50 °C; 32 °F to 120 °F	
	0 %rh to 95 %rh, non condensing	
	During storage – 40 °C to 70 °C; – 40 °F to 160 °F	
Materials used in the gas path	Hose connection	Metal, NBR
	Hoses	Viton, PTFE
	Hose connection	PP
	Dust filter	PE, PP
	Internal restrictor	Glass
	Pump	PP, EPDM, silicone
Enclosure	IP 54; ABS	
Dimensions	Approx. 123 x 147 x 83 mm (W x H x D)	
Weight	Approx. 0.65 kg	
CE markings	Electromagnetic Compatibility (89/336/EEC)	
Certificate	RoHS (2002/95/EG) (Restriction of the use of certain hazardous substances in electrical and electronic equipment)	
Cable glands (2x)	M 20; cross section 6 to 12 mm	
Wire cross section	0.5 to 1.5 mm^2	
Hose connection	Inside diameter 4 mm, outside diameter 6 mm	

ORDER INFORMATION

Dräger PSD 3000	83 19 270
Sampling point filter (glassfibre/cellulose)	68 06 743
Filter insert	67 37 352
Gassing adapter DrägerSensor	68 06 978
Gassing adapter DrägerSensor AC	68 09 380

HEADQUARTERS:
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