H2Sense-

Cost-effective and reliable hydrogen sensors

for facilitating the safe use of hydrogen

FCH JU Grant agreement no.: 325326

Report

in fulfilling Task 1.1

„Market survey of COTS hydrogen sensors”

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Berlin, 29 November 2013

I. Objectives & Motivation

The H2Sense Project is promoting the identification and application of cost-effective and reliable hydrogen sensors in order to facilitate the safe use of hydrogen. In accordance with the project objectives an extensive market survey to identify hydrogen sensor manufacturers and existing commercial-off-the-shelf (COTS) hydrogen sensors has been carried out. The findings of the survey are compiled in the present report. The core of the report is a comprehensive database comprising the hydrogen sensors currently available on the market. For each sensor the database includes the technology which the sensor is based on as well as the relevant and anticipated sensor applications recommended by the supplier. It should be noted that the database identifies all hydrogen sensor manufacturers that have come to our knowledge during the survey. The database may be used by scientists, engineers and end-users as a tool to assist sourcing suitable hydrogen sensors for their specific application and as a technical reference for choosing the most suitable one.

II. Approach

The starting point for the hydrogen sensor market survey was a list "Suppliers of Hydrogen Sensors" provided by BAM and a "Commercial Sensors Database" provided by JRC. These databases were updated, complemented and combined into a new "H2Sense Hydrogen Sensor Database". Updates and complementing data were acquired by internet-based research.

The present new database lists the hydrogen sensor manufacturers in alphabetical order. For the current survey we focused on sensor manufacturers that provide their own and original products, distributors or companies acting as sales agencies were mostly not considered. The database includes the city and country where the hydrogen sensor manufacturer is based and separately lists the product names of each hydrogen sensor offered by the manufacturer. For each listed sensor we indicate the applied sensor technology, and we give additional descriptions or remarks related to the sensor specification or the sensor performance, if appropriate. Additionally, for the first time, the recommended application by the manufacturer, if available, is included into a database. A link to the manufacturer's website is offered.

It should be made clear that we consider the present H2Sense Hydrogen Sensor Database a dynamic document; entries will be updated and complemented regularly, at least for the duration of the current project.

III. Data Analysis

The result of the hydrogen sensor market survey is compiled in the "H2Sense Hydrogen Sensor Database" as the core of this report.

There are 89 sensor manufacturers listed in the "H2Sense Hydrogen Sensor Database". The number of products provided by these manufacturers and listed in the database is 395. This number includes hydrogen-specific sensors as well as sensors that can be used to detect hydrogen but also to detect other gases, such as flammable gas or combustible gas sensors. The term "sensor" comprises sensor

elements, transmitters and transducers as well as gas detection and analyzer systems and devices. Single gas and multi-gas sensors are considered.

In this context, we denote the device that actually acquires the desired physical or chemical property by reacting directly to the measurement parameter as the sensor element. Transmitters or transducers include additional electronics to deliver an electrical signal which can be processed. A gas detection or analyzer system finally is a complete and independent measurement instrument or apparatus that delivers a processed data output. These systems may be used in portable/ transportable or fixed versions and as single gas or multi-gas devices.

It may occur that the actual sensor element used in gas transmitters and detection or analyzing devices are among the sensor elements that are listed separately in the database. Sensor elements may be provided by the same or a different manufacturer. If knowledge about the sensor elements used in transmitters and measurement instruments has become available this is mentioned in the Description/Remarks part of the database.

Sensor Manufacturers

Ninety-one hydrogen sensor manufacturers have come to our knowledge during the market survey. Considering the distribution of their locations we found that most of them are based in the United States (32%). The second largest amount of manufacturers are located in Germany (30%), Japan (9%) and the UK (8%) ranging third and forth. A notable amount of hydrogen sensor manufacturers has been identified in Switzerland, China, Canada and other EU countries such as The Netherlands or Italy. Figure 1 shows the distribution of the hydrogen sensor manufacturers' location as found in our market survey.

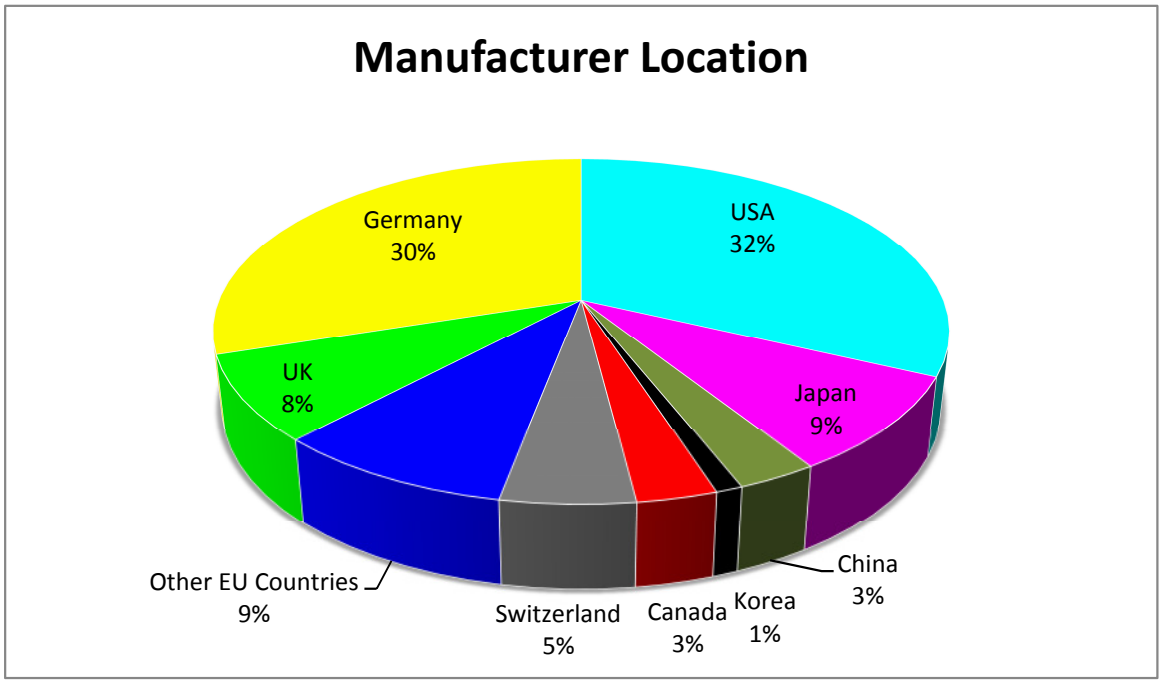

Fig. 1. Location of hydrogen sensor manufacturers listed in the "H2Sense Hydrogen Sensor Database".

The companies listed in the database are quite diverse. There are global players with a large and diversified portfolio, such as ABB Process Automation, Honeywell Analytics, Dräger Safety or Riken Keiki, companies specifying on gas sensor or even hydrogen sensor technology like H2Scan, innovative small and medium sized enterprises, which make up the largest amount, and even start-ups. It should be noted that a considerable number of companies offer hydrogen sensor technology as part of their combustible or flammable gas sensor portfolios.

The sensor market presented itself as quite dynamic, several takeovers and mergers between manufacturers have taken place in recent times. Well-known sensor manufacturers such as Zellweger Analytics, Capteur, MST Measurement Systems or First Technology have been integrated into Honeywell. Others such as Sixth Sense or Sensoric are part of City Technology now, and, thus, are also part of Honeywell. RAE Systems has been acquired by Honeywell in 2013. Transducer Technology now is a division of KWJ Engineering. E2V's sensor business has been acquired by SGX Sensortech.

Sensor Technologies

We categorized the sensor technology according to the classification suggested by T. Hübert et al. in Sensors and Actuators B 157, 329-352 (2011), where eight different sensor technologies are described and reviewed:

1. Catalytic
2. Thermal conductivity
3. Electrochemical
4. Resistive
5. Work function based
6. Mechanical
7. Optical
8. Acoustic

Sensors in the database that do not fit in this classification (e.g. sensors based on new technologies such as nanotechnologies) are summarized in a category "Others/New".

The most wide-spread sensor technology in our survey turned out to be catalytic. In 33% of the products in our database catalytic sensor technology is used. Most catalytic sensors use pellistors, i.e. catalytic beads where hydrogen is oxidized on the activated catalytic surface, thus generating heat and a change in resistivity that can be measured. Sensors based on electrochemical cells or solid-state electrolytes represent the second largest group in our survey (29%), thermal conductivity based (16%) and resistance-based (13%) sensors ranging third and forth. The four remaining categories are considerably less represented, optical technologies are used in 4% of the sensors, work function based technologies in 2%, mechanical and acoustic technologies make up only 1% of the sensors each. Also 1% of the sensors use a new sensor technology, e.g. based on Pd-nanoparticles. Figure 2 gives an overview of the distribution of the technologies used in the sensors listed in our "H2Sense Hydrogen Sensor Database".

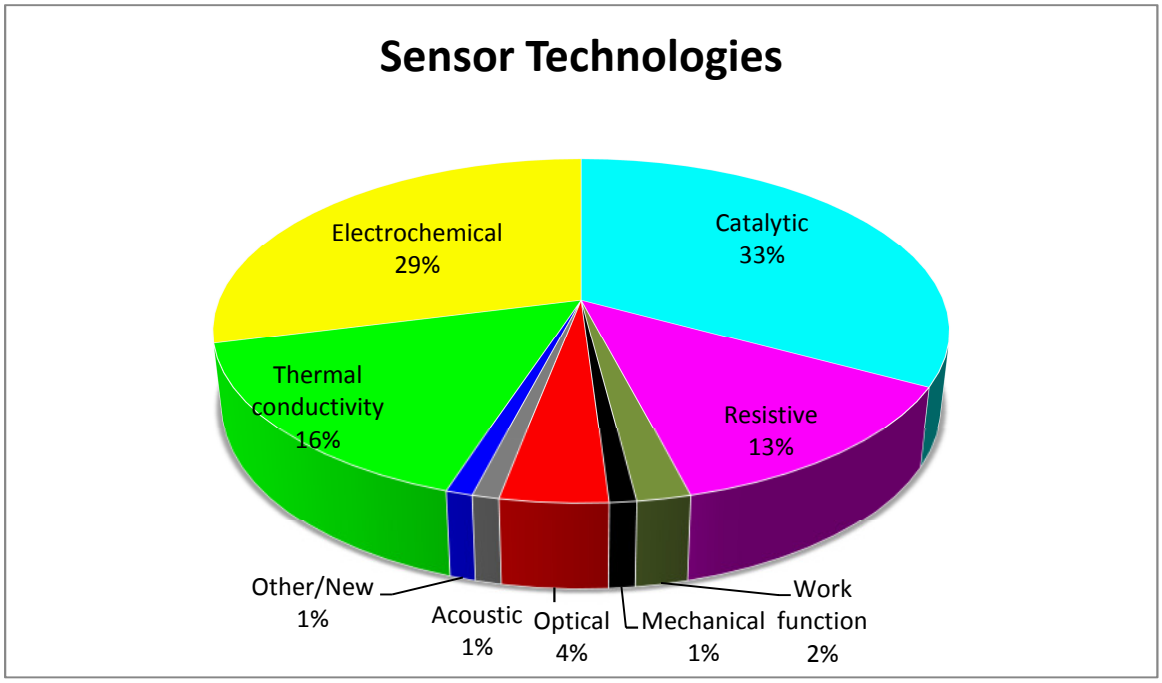

Fig. 2. Sensor technologies applied in the products listed in the "H2Sense Hydrogen Sensor Database"

The terms used by sensor manufacturers to describe their technologies did not always correspond to our classification categories as described above. In cases where it was not possible to classify the sensors unambiguously, the entry on the technology utilized is given in brackets. These sensors were not considered for the analysis of the survey (Figs. 1 and 2). Some manufacturers did not provide any information about the sensing technology, in these cases the technology field in the database was left blank.

Several manufacturers use a combination of technologies in their sensors to improve their performance. Detection range, sensitivity or accuracy can be increased this way. AppliedSensor GmbH, for instance, uses a combination of work function based and thermal conductivity technologies in their hydrogen sensors, UST Umweltsensortechnik GmbH combines resistive and thermal conductivity technologies. H2Scan Corp. offers a sensor element that includes the two different work function based and resistive sensor technologies. In our survey, these sensors were considered in both categories.

Sensor Applications

Most portable and fixed sensor systems are used for industrial or residential safety in general. A wide variety of gas detection, warning and alarm systems are offered for that purpose, leak detection or emission control, used for instance with power generators and in battery rooms, are among the most common applications. Also, systems for continuous gas analysis and monitoring are offered for various industries, e.g. the electric power or nuclear power industries, refining and petrochemical industries.

Since the H2Sense project is promoting the effective deployment and safe use of reliable hydrogen sensors primarily, even if not exclusively, for application of hydrogen as an alternative fuel we were particularly interested in applications related to that field. Such applications include hydrogen-

powered vehicles, hydrogen gas fueling facilities, vehicle maintenance facilities, fuel cells or hydrogen storage. Several manufacturers indicate these applications for their products, sometimes even exclusively, sometimes as specific OEM solutions. Among these manufacturers are:

- AirTest Technologies
- Applied Nanotech
- AppliedSensor
- AST American Sensor Technologies
- Element One
- Escube
- Figaro
- FIS
- Gassonic
- H2Scan
- Makel Engineering
- Neodym Systems
- NTM Sensors
- UST Umweltsensortechnik
- Xensor Integration

IV. The "H2Sense Hydrogen Sensor Database"

The H2Sense Hydrogen Sensor Database is a compilation of available data from internet on hydrogen sensor supplier, sensors and their performance characteristics.

The entries of the "H2Sense Hydrogen Sensor Database" include in detail:

Column 1: Serial number of sensor manufacturer ("No. M")

Column 2: Serial number of sensor ("No. S")

Column 3: Sensor manufacturer location, city and country ("City, Country")

Column 4: Hydrogen sensor product name or product number and link to the manufacturer's website, homepage or product page ("Sensor Model")

Column 5: Sensor technology ("Technology")

Column 6: Description or remark related to sensor type, sensor specification and/or sensor performance ("Description/Remark")

Column 7: Sensor application as recommended by sensor manufacturer ("Application")

Column 8: Additional Information ("Detection Range")

Column 9: Additional Information "Certificates / Approvals / Tests / Classification"

The H2Sense Hydrogen Sensor Database in its current version is available from internet:

http://www.h2sense.bam.de/en/data_sheet/index.htm

and added as an appendix to this report.

No. M	No. S	Manufacturer City, Country	Sensor Model	Technology	Description / Remark	Application	Detection Range (H_2)	Certificates / Approvals / Tests / Classification
1	1	ABB Limited Process Automation Stonehouse, UK	AK 100 Series	**Thermal conductivity** Katharometer	H_2 Purity & Purge Gas Monitor; ATEX compliant gas analyzer system	Hydrogen purity and purge gas measurement in hydrogen-cooled turbo-generators and alternators	Hydrogen purity analysis: 85 to 100% H_2 80 to 100% H_2 user selectable Purge gas analysis: 0 to 100% hydrogen in purge gas 0 to 100% air in purge gas	ATEX II (1)G CENELEC Eex ia IIC T4
	2		EL3000 Series	**Thermal conductivity**	Continuous Gas Analyzer System; uses ABB gas analyzer Caldos27 for hydrogen measurements	Continuous gas analysis, measurement of H_2 in air and various gases and also various gases in H_2	Smallest Measurement Ranges: 0 - 11 vol.% H_2 in air, Ar, CH_4, CO CO_2, N_2 0 - 10 vol.% H_2 in NH_3 0 - 13 vol.% air, Ar, CO, CO_2, N_2 in H_2 0 - 14 vol.% CH_4 in H_2 0-10 vol.% NH_3 in H_2	EN 61010-1:2001 (=> Low Voltage Directive 2006/95/EC) EN 61326-1:2006, EN 61000-3-2:2006, EN 61000-3-3:1995 + A1:2001 + A2:2005 (=> EMC Directive 2004/108/EC) EN 60079-15:2005 (=> ATEX Directive 94/9/EC) CAN/CSA-C22.2 No. 61010-1-04 UL 61010-1 (2nd ed.) & further certifications for Russia and China
	3		EL3060 Series	**Thermal conductivity**	Continuous Gas Analyzer System; uses ABB gas analyzer Caldos27 for hydrogen measurements	Continuous gas analysis, measurement of H_2 in air and various gases and also various gases in H_2; Special version for monitoring hydrogen-cooled turbo generators	Smallest Measurement Ranges: 0 - 1 vol.% H_2 in air, Ar, CH_4, CO CO_2, N_2 0 - 10 vol.% H_2 in NH_3 0 - 3 vol.% air, Ar, CH_4, CO, CO_2, N_2 in H_2 0 - 14 vol.% CH_4 in H_2 0-10 vol.% NH_3 in H_2 Special Version: 100 - 0 vol.% H_2 in CO_2 100 - 80/90 vol.% H_2 in air	EN 61010-1:2001 (Low Voltage Directive 2006/95/EC) EN 61326-1:2006, EN 61000-3-2:2006, EN 61000-3-3:1995 + A1:2001 + A2:2005 (EMC Directive 2004/108/EC) EN 60079-0, EN 60079-1, EN 60079-7 (ATEX Directive 94/9/EC)
2	4	AirTest Technologies Corp. Delta, Canada	TR5200 CG	**Catalytic**	Gas sensor/transmitter for all combustible gases, target gas to be specified	Battery charging rooms, vehicle maintenance facilities, hydrogen gas fueling facilities, below ground facilities, etc.	Standard Range: 0 - 100% LEL Combustible Gas Minimum Detectable: 2% LEL	CSA/NRTL
	5		TR5500 CG	**Catalytic**	Gas sensor/transmitter for all combustible gases, target gas to be specified; explosion-proof enclosure	Battery charging rooms, vehicle maintenance facilities, hydrogen gas fueling facilities, below ground facilities, etc.	Standard Range: 0 - 100% LEL Combustible Gas Minimum Detectable: 2% LEL	CSA/UL Cl. 1, Div. 1

No. M	No. S	Manufacturer City, Country	Sensor Model	Technology	Description / Remark	Application	Detection Range (H_2)	Certificates / Approvals / Tests / Classification
3	6	Alphasense Ltd. Great Notley, UK	H2 AF	**Electrochemical**	Hydrogen-specific sensor element; Part of toxic/exotic gas sensors portfolio; "very low sensitivity to CO makes this one of the most selective hydrogen sensors on the market"	Emissions monitoring, process safety, environmental monitoring, volatile organic compounds (VOCs)	Limit of performance warranty: 2000 ppm	n/a
	7		CH-A3	**Catalytic** Pellistor	Flammable gas sensor, not hydrogen-specific; small size (Model A)	fixed or portable application	0 - 100% LEL methane	Sira 07ATEX 1088X II 2 G Ex d IIC T4 IECEx SIR07.0031X Ex d IIC T4 UL913 091007-E253708 Cl. I, II, III, Div. 1 CSA 22.2 1906313 Cl. 4828 31
	8		CH-D3	**Catalytic** Pellistor	Flammable gas sensor, not hydrogen-specific; miniature size (Model D)	portable application	0 - 100% LEL methane	Sira 07ATEX 1088X II 2 G Ex d IIC T4 IECEx SIR07.0031X Ex d IIC T4 UL913 091007-E253708 Cl. I, II, III, Div. 1 CSA 22.2 1906313 Cl. 4828 31
4	9	Analox Stokesley, UK	3003 SI	**Electrochemical** Galvanic Fuel Cell	Gas sensor transmitter, modular design; Hydrogen Gas Monitoring at ppm level, models for 0-1000 ppm, 0-2000 ppm	Industrial Safety	0 - 1000 ppm 0 - 2000 ppm	Ga Ex ia IIC T4 ATEX II1G
5	10	Applied Nanotech Inc. Austin, TX, USA	MNPS-B	**Other/New** Nanotechnology / Resistive	Hydrogen sensor; effective surface area of Pd-nanoparticles increase on reaction with hydrogen, Phase transition of Pd-based nanoparticles resulting in decrease in sensor resistivity	Fuel cells, hydrogen storage, automotive, back-up power systems, portable gas detectors and monitors, power transformers	0 - 10000 ppm Lowest detection limit: 10 ppm	n/a
6	11	AppliedSensor GmbH Reutlingen, Germany	HLS-440	Combination of **Work function** Field effect transistor & **Thermal conductivity**	Hydrogen Leak Sensor; catalytic metal gate stack as gas-sensing layer, thermal conductivity sensor element improves sensor performance and increases measuring range	Hydrogen gas leak detection in hydrogen-powered vehicles (sensor locations at cabin ceiling, under the hood of the engine compartment, beneath the trunk lid); leak detection at hydrogen fueling stations	0 - 4.4% H_2 in air	EMC: Automotive Shock: Automotive Vibration: Automotive ATEX: Zone 2 Self test/Error handling: Developed in accordance to IEC 61508 (SIL2)
	12		HLS-440P	**Thermal conductivity**	Hydrogen Leak Sensor for installation in harsh environments; catalytic metal gate stack as gas-sensing layer, thermal conductivity sensor element improves sensor performance and increases measuring range	Hydrogen gas leak detection in fuel cell systems (e.g. exhausts) and other in-process application	0 - 10% H_2 in air or N_2	EMC: Automotive Shock: Automotive Vibration: Automotive Designed for ATEX 100a Zone 2 Self test/Error handling: Developed in accordance to IEC 61508 (SIL2)
	13		HPS-100	**Thermal conductivity**	Hydrogen Process Sensor for installation in harsh environments; catalytic metal gate stack as gas-sensing layer, thermal conductivity sensor element improves sensor performance and increases measuring range	Hydrogen gas measurement in fuel cell systems (e.g. exhausts) and other in-process application	0 - 100% H_2 in N_2	EMC: Automotive Shock: Automotive Vibration: Automotive Designed for ATEX 100a Zone 2 Self test/Error handling: Developed in accordance to IEC 61508 (SIL2)
7	14	Arrgh!! Manufacturing Co. Inc. Novato, CA, USA	H2 - Hydrogen Gas Detector	**Resistive** Semiconductor	Wall-mount Hydrogen Detector	Lead-acid battery charging rooms and other areas	n/a	n/a

No. M	No. S	Manufacturer City, Country	Sensor Model	Technology	Description / Remark	Application	Detection Range (H_2)	Certificates / Approvals / Tests / Classification
8	15	Asensor Technologies Co. Ltd. Shenzhen, China	DH4-H2-500	**Electrochemical**	Three-electrode hydrogen sensor element, 0-500 ppm	Hydrogen gas detection and monitoring for Industrial Safety, Mining, Residential Safety, Emissions, Environmental Monitoring	0 - 500 ppm	n/a
	16		DH4-H2-1000	**Electrochemical**	Three-electrode hydrogen sensor element, 0-1000 ppm	Hydrogen gas detection and monitoring for Industrial Safety, Mining, Residential Safety, Emissions, Environmental Monitoring	0 - 1000 ppm	n/a
	17		DH4-H2-10000	**Electrochemical**	Three-electrode hydrogen sensor element, 0-10000 ppm	Hydrogen gas detection and monitoring for Industrial Safety, Mining, Residential Safety, Emissions, Environmental Monitoring	0 - 10000 ppm	n/a
	18		DH7-H2-500	**Electrochemical** Amperometric	Three-electrode hydrogen sensor element, 0-500 ppm	Hydrogen gas detection and monitoring for Industrial Safety, Mining, Residential Safety, Emissions, Environmental Monitoring	0 - 500 ppm	n/a
	19		DH7-H2-1000	**Electrochemical** Amperometric	Three-electrode hydrogen sensor element, 0-1000 ppm	Hydrogen gas detection and monitoring for Industrial Safety, Mining, Residential Safety, Emissions, Environmental Monitoring	0 - 1000 ppm	n/a
	20		DH7-H2-10000	**Electrochemical** Amperometric	Three-electrode hydrogen sensor element, 0-10000 ppm	Hydrogen gas detection and monitoring for Industrial Safety, Mining, Residential Safety, Emissions, Environmental Monitoring	0 - 10000 ppm	n/a
	21		KG100A	**Electrochemical**	Fuel cell sensor, composite readings of H_2, CO, C_2H_2, C_2H_4	Monitoring of the concentration of a specific gas in a target environment Application fields: energy, electric power, petrochemical, nuclear power, etc.	0 - 5000 µL/L	n/a
	22		KG100B	**Electrochemical**	Fuel cell sensor, selective H_2	Monitoring of the concentration of a specific gas in a target environment Application fields: energy, electric power, petrochemical, nuclear power, etc.	0 - 5000 µL/L	n/a
	23		KG2100A	**Electrochemical**	Fuel cell sensor, composite readings of H_2, CO, C_2H_2, C_2H_4	Determination of gases in different fields, e.g. electric power, nuclear power, etc.	0 - 5000 µL/L	n/a
	24		KG2100B	**Electrochemical**	Fuel cell sensor, selective H_2	Determination of gases in different fields, e.g. electric power, nuclear power, etc.	0 - 5000 µL/L	n/a
9	25	AST American Sensor Technologies Inc. Mount Olive, NJ, USA	AST 2000 H2	**Mechanical** Piezoresistive	Hydrogen pressure sensor / transducer applying Krystal Bond™ Technology (MEMS pressure sensor technology using MEMS strain gages on the surface of a single piece metal diaphragm)	PEM fuel cells, hydrogen storage, hydrogen filling stations, back-up power, test stands, e.g. control of hydrogen flow to fuel cell stack	Available Pressure Ranges: 20 bar, 448 bar, 500 bar, 700 bar, 900 bar	EC 79 (20 bar, 350 bar, 700 bar) CE EN 61326 EU 406/2010 Annex IV Part 3 Sects. 2, 3, 4.1.1, 4.1.2, 4.2.1, 4.2.2, 4.2.3, 4.2.5 ECE R110 Rev.1
	26		AST 4000	**Mechanical** Piezoresistive	Pressure sensor / transducer adaptable to hydrogen sensing applying Krystal Bond™ Technology ; AST 4000 for flexibility in mechanical and electrical interfaces	PEM Fuel Cells, Hydrogen Filling Stations, Back Up Power, Hydrogen Storage, etc. used, for instance, at outlet valve of fuel storage vessels	All pressures between 0 - 25 PSI and 0 - 10000 PSI	UL/cUL 508
	27		AST 4300	**Mechanical** Piezoresistive	Pressure transducer adaptable to hydrogen sensing applying Krystal Bond™ Technology; AST 4300 for high accuracy, approved for use in hazardous location areas	Hydrogen fuel, gas compression and storage	All pressures between 0 - 25 PSI and 0 - 10000 PSI	UL/cUL Class 1, Div. 2, Groups A, B, C, D EN 60068-2-27 (Shock) EN 60068-2-6, 60068 -2-64, IEC 68-2-32 (Vibration)

No. M	No. S	Manufacturer City, Country	Sensor Model	Technology	Description / Remark	Application	Detection Range (H_2)	Certificates / Approvals / Tests / Classification
	28		AST 4600	**Mechanical** Piezoresistive	Pressure sensor / transducer adaptable to hydrogen sensing applying Krystal Bond™ Technology; AST 4600 explosion proof, to withstand high vibration and temperature extremes	Industrial OEM & Hydrogen Equipment	0 - 100, 200, 500, 1000, 1500, 2500, 3000, 5000, 7500, 10000, 15000, 20000 PSI	CSA 30 (UL 1203/FM3615) Class 1, Zone 1, Group IIC; CSA 30 Class 1, Div. 1, Groups A, B, C, D CSA 30 Class 2, Div. 1, Groups E, F, G EN 60068-2-27 (Shock) EN 60068-2-6, 60068 -2-64, IEC 68-2-32 (Vibration)
10	29	**Bacharach Inc. New Kensington, PA, USA**	Leakator® 10	(Solid state / Semiconductor; patented)	Combustible gas leak detector, hand-held, gases detected: hydrogen, etc.	Leak detection	20 ppm Sensitivity, methane-based	UL 913 Class 1, Div. 1, Groups A, B, C, D
11	30	**BERNT Messtechnik Düsseldorf, Germany**	GP2000HL	(Semiconductor) **Electrochemical**	Gas warning system for hydrogen gas; hydrogen-specific device based on devices for toxic and combustible gases; Different technologies for different measurement ranges	Monitoring of areas with restricted or no acceibility, gas withdrawel from machines and exhaust pipes	min. 0 - 100 ppm max. 0 - 2000 ppm	n/a
12	31	**Bieler + Lang GmbH Achern, Germany**	Exmonitor / Gasmonitor H2 1000	**Electrochemical**	Detects toxic gases, e.g. hydrogen, and oxygen, depending on specific sensor	Industrial safety equipment, monitoring of gas concentration and warning	0 - 1000 ppm (standard range; 0 - 2000 ppm available)	EC Directive 94/9/EC (ExMonitor): II 2 G Ex ia IIC T4 Gb BVS 03 ATEX E 384
	32		ExDetector HC-100	**Catalytic**	Detection of combustible gases and vapors; Certificate (BAM) for examined gases available	Industrial safety equipment, monitoring of gas concentration and warning	0 - 100% LEL	EC Directive 94/9/EC Housing/Electronics: II 2 G Ex de [ib] IIC T6 / Ex de IIC T6 (PTB certified) Measuring head: II 2 G Ex e IIC T4 / T6 (PTB certified) BAM Performance Certification Instrument safety: EN 50270
	33		ExDetector HC-150	**Catalytic**	Detection of combustible gases and vapors; Certificate of conformity (PTB) available	Industrial safety equipment, monitoring of gas concentration and warning	0 - 100% LEL	ATEX: II 3 G Ex nA de IIC T4 Certificate of conformity (PTB)
	34		ExDetector HC-200	**Catalytic**	Detection of combustible gases and vapors	Industrial safety equipment, monitoring of gas concentration and warning	0 - 100% LEL	EC Directive 94/9/EC: II 3(2) G Ex nA de [ib] IIC T4 (PTB Certified) Ex-Zone 2 Use: EMC Directive 2004/108/EC ATEX Directive 2004/108/EC
	35		ExDetector SC-220	(Semiconductor)	Detection of combustible gases and vapors, Type P sensor for hydrogen detection	Industrial safety equipment, monitoring of gas concentration and warning	0 - 50% LEL	ATEX: II 3(2) G Ex nA de [ib] IIC T4 (PTB Certified) Zone 2 Satefy Standards: EN 50270, EN 61000-6-3, EN 60079-15
13	36	**Bionics Instrument Co. Tokyo, Japan**	GS-1550DP GS-1551DP	**Electrochemical**	Explorer Series Gas Detector, hydrogen sensors for different ranges; Gas detection method: Diffusion	Continuous monitoring of target gas in hazardous areas	0 - 4000 ppm (Standard) 0 - 1000 ppm (Low)	ATEX II 2G EEx d[ia] IIC T6 EN 50014, EN 50018, EN 50020 CE, EN IEC 61000-6-2, EN IEC 61000-6-3

No. M	No. S	Manufacturer City, Country	Sensor Model	Technology	Description / Remark	Application	Detection Range (H_2)	Certificates / Approvals / Tests / Classification
	37		GS-1550HT GS-1551HT	**Electrochemical**	Explorer Series Gas Detectors, hydrogen sensors for different ranges; Gas detection method: Suction	Continuous monitoring of target gas in hazardous areas	0 - 4000 ppm (Standard) 0 - 1000 ppm (Low)	ATEX II 2G EEx d IIC T6 EN 50014, EN 50018 CE, EN IEC 61000-6-2, EN IEC 61000-6-3
	38		GS-1550DS GS-1551DS	**Electrochemical**	Observer Series Gas Detectors, hydrogen sensors for different ranges; WAD-line Gas Detectors (TX-WAD); Gas detection method: Diffusion	Target gas detection; Production facilities and research centers	0 - 4000 ppm (Standard) 0 - 2000 ppm (Low)	n/a
	39		GS-1550HS GS-1551HS	**Electrochemical**	Observer Series Gas Detectors, hydrogen sensors for different ranges; WAD-line Gas Detectors (SH-WAD); Multi-point gas sampler/Multi gas sampler; Gas detection method: Suction	Target gas detection; Production facilities and research centers	0 - 4000 ppm (Standard) 0 - 2000 ppm (Low)	n/a
14	40	**BlueSens gas sensor GmbH Herten, Germany**	BCP-H2	**Thermal conductivity**	Hydrogen sensor for in-situ measuring	Chemical industry, biogas production, agriculture, algal hydrogen production	0 - 10 vol.%, 0 - 50 vol.% 0 - 100 vol.%	n/a
15	41	**Brechbühler AG Schlieren, CH**	H2 Sensor Series 9000	(Thermostated flow-through semiconductor type)	Thermostated flow-through sensor; alarm system, adjustable threshold level; Model for all GC's; H_2 Sensor Series 9100 for TRACE 1200/1310 Series GC available	Continuous monitoring of the hydrogen concentration in the GC oven	0.5 vol.% - 4 vol.%	n/a
16	42	**Buveco Gasdetection B.V. Bleiswijk, NL**	BUCOM ST400EC	**Electrochemical**	Gas sensor for the detection of hydrogen, P/N 1217513 (0-1000 ppm) P/N 1217521 (0-100% LEL)		0 - 1000 ppm	CE 0344 ATEX II 1G EEx ia IIC T6 KEMA 02 ATEX 1296
	43		BUCOM ST650EX	**Catalytic**	Gas sensor for the detection of flammable gases		0 - 100% LEL	ATEX II 2G EEx d IIC T6 KEMA 02 ATEX 2043
17	44	**CEA Instruments Inc. Westwood, NJ, USA**	TRIPLE PLUS +	**Electrochemical**	Portable, multi-gas unit, one to four gases; hydrogen-specific sensor heads: S01250 (0-2000 ppm), S011971 (0-4%)		0 - 2000 ppm (S01250) 0 - 4% (S011971)	UL / CSA Class 1, Div. 1, Groups A, B, C, D + other not specified intrinsic safety approvals
	45		TETRA		Portable, multi-gas unit, different gas sensor configurations, monitoring of one to four gases; hydrogen-specific sensor head: S011429 (0-2000 ppm)		0 - 2000 ppm	UL / CSA Class 1, Div. 1, Groups A, B, C, D + other not specified intrinsic safety approvals
	46		GASMAN H2		Personal mini gas detector, single-gas unit; hydrogen-specific sensor heads: S011429/M (0-2000 ppm Hydrogen) S011460/M (0-100% LEL Flammable Gases)		0 - 2000 ppm, 0 - 100% LEL Flammable Gases	ATEX II 2G EEx iad IIC T4 (Flammable) Class 1 Groups A, B, C, D Safety Standards: EN 50014, EN 50020, EN 50018, 94/9/EC UL 913, CSA 22.2, 152 Operation Standards: EN50270, EN50271, IEC61508, EN61779 Software designed to meet IEC61508

No. M	No. S	Manufacturer City, Country	Sensor Model	Technology	Description / Remark	Application	Detection Range (H_2)	Certificates / Approvals / Tests / Classification
	47		SERIES U	(Solid state diffusion type)	Gas leak detector; single wall mount, multi-point wall mount, single, 4 and 8 channel, portable; Hydrogen detection unit: H-7200		0 - 1000 ppm, 0 - 5000 ppm, 0 - 20000 ppm (50% LEL), 0 - 100% LEL	n/a
	48		CEA 427	(Solid state diffusion type adsorption - desorption type catalyst surface)	Two-wire remote sensor/transmitter; detection based on gas adsorption on active catalyst surface causing a resistance change, solid-state diffusion type sensor Available ranges: 0-1000 ppm, 0-5000 ppm, 0-20,000 (50% LEL), 0-100% LEL		0 - 1000 ppm, 0 - 5000 ppm, 0 - 20000 ppm (50% LEL), 0 - 100% LEL	n/a
	49		XGARD Type 1	**Electrochemical**	Remote gas sensor, wall-mounted unit; specific sensor for hydrogen detection		0 - 200 ppm, 0 - 500 ppm, 0 - 2000 ppm 0 - 2 vol.%, 0 - 4 vol.%	ATEX II 1 G EEx ia IIC T4 UL Class 1, Div. 1, Groups A, B, C, D EN 50270 (EMC Compliance)
	50		XGARD Type 2	**Electrochemical**	Remote gas sensor, wall-mounted unit; specific sensor for hydrogen detection, sensors available in flameproof, intrinsically safe or safe area formats for use in all environments		0 - 200 ppm, 0 - 500 ppm, 0 - 2000 ppm 0 - 2 vol.%, 0 - 4 vol.%	ATEX II 2 G EEx d IIC T6 UL Class 1, Div. 1, Groups B, C, D EN 50270 (EMC Compliance)
	51		XGARD Type 3	**Catalytic**	Remote gas sensor, wall-mounted unit; specific sensor for hydrogen detection, sensors available in flameproof, intrinsically safe or safe area formats for use in all environments		0 - 100% LEL	ATEX II 2 G EEx d IIC T4 / EEx d IIC T6 UL Class 1, Div. 1, Groups B, C, D EN 50270 (EMC Compliance)
	52		XGARD Type 4	**Catalytic**	Remote gas sensor, wall-mounted unit; specific sensor for hydrogen detection, sensors available in flameproof, intrinsically safe or safe area formats for use in all environments		0 - 100% LEL	ATEX II 2 G EEx d IIC T3 UL Class 1, Div. 1, Groups B, C, D EN 50270 (EMC Compliance)
	53		XGARD Type 5	**Catalytic**	Remote gas sensor, wall-mounted unit; specific sensor for hydrogen detection, sensors available in flameproof, intrinsically safe or safe area formats for use in all environments		0 - 100% LEL	ATEX II 2 G EEx d IIC T6 / EEx d IIC T4 UL Class 1, Div. 1, Groups B, C, D EN 50270 (EMC Compliance)
	54		XGARD Type 6	**Thermal conductivity**	Remote gas sensor, wall-mounted unit; specific sensor for hydrogen detection, sensors available in flameproof, intrinsically safe or safe area formats for use in all environments		0 - 5 vol.%, 0 - 10 vol.%, 0 - 50 vol. % (in air) 0 - 20 vol.%, 0 - 25 vol.%, 0 - 30 vol.% (in N_2)	ATEX II 2 G EEx d IIC T6 / EEx d IIC T4 UL Class 1, Div. 1, Groups B, C, D EN 50270 (EMC Compliance)
	55		TXGARD-IS+	**Electrochemical**	Remote gas sensor, wall-mounted unit; hydrogen-specific sensor heads/ranges: S01176 (0-2000 ppm) S01177 (0-20000 ppm, 50% LEL)		2000, 20000 ppm (50% LEL)	Ex II 1 GD EEx ia IIC T6 UL Class 1, Div. 1, Groups A, B, C, D
	56		FLAMGARD PLUS	**Catalytic**	Remote gas sensor, wall-mounted unit; ranges available: 0-100% LEL		0 - 100% LEL	Ex II 2 G Eex d IIC T6 UL Class 1, Div. 1, Groups B, C, D

No. M	No. S	Manufacturer City, Country	Sensor Model	Technology	Description / Remark	Application	Detection Range (H_2)	Certificates / Approvals / Tests / Classification
18	57	Citizen Finetech Miyota Co. Ltd. Miyota, Japan	CGA-1210	**Catalytic**	Sensor element on circuit board	Leakage monitoring of hydrogen fuel cell	200 ppm - 4%	n/a
19	58	City Technology Ltd. Portsmouth, UK	3HYE	**Electrochemical**	3 Series CiTiceL® Hydrogen Sensor Element	Industrial Safety	0 - 10000 ppm nominal 20000 ppm max. overload	n/a
	59		3HYT	**Electrochemical**	3 Series CiTiceL® Hydrogen Sensor Element	Industrial Safety	0 - 1000 ppm nominal 2000 ppm max. overload	n/a
	60		3MHYE	**Electrochemical**	Hydrogen sensor with mV output 3 Series, Sensor type used: 3HYE	Industrial Safety	0 - 20000 ppm max.	n/a
	61		3MHYT	**Electrochemical**	Hydrogen sensor with mV output 3 Series, Sensor type used: 3HYT	Industrial Safety	0 - 2000 ppm max.	n/a
	62		EZT3HYE	**Electrochemical**	Hydrogen sensor with EasyCal transmitter 3 Series, Sensor typr used: 3HYE	Industrial Safety	0 - 20000 ppm precalibrated Recalibration to intermediate ranges available	n/a
	63		EZT3HYT	**Electrochemical**	Hydrogen sensor with EasyCal transmitter 3 Series, Sensor type used: 3HYT	Industrial Safety	0 - 200 ppm, 0 - 300 ppm 0 - 500 ppm, 0 - 1000 ppm, 0 - 2000 ppm precalibrated, Recalibration to intermediate ranges available	n/a
	64		4HYT	**Electrochemical**	4 Series CiTiceL® Hydrogen Sensor Element	Industrial Safety	0 - 1000 ppm nominal 2000 ppm max. overload	n/a
	65		7HYE	**Electrochemical**	7 Series CiTiceL® Hydrogen Sensor Element	Industrial Safety	0 - 10000 ppm nominal 20000 ppm max. overload	n/a
	66		7HYT	**Electrochemical**	7 Series CiTiceL® Hydrogen Sensor Element	Industrial Safety	0 - 1000 ppm nominal 2000 ppm max. overload	n/a
	67		H2 3E 1%	**Electrochemical**	Sensoric Hydrogen Sensor Element, designed and manufactured at Sensoric Branch, Bonn	Industrial Safety	0 - 10000 ppm	n/a
	68		H2 3E 4%	**Electrochemical**	Sensoric Hydrogen Sensor Element, designed and manufactured at Sensoric Branch, Bonn	Industrial Safety	0 - 4% (100% LEL)	n/a
	69		T3H	**Electrochemical**	3 Series, Sensor type used: 3H Specified as H_2S gas detector in data sheet with H_2 cross sensitivity; search result für H_2 sensor	Automotive	0 - 300 ppm; eight precalibrated ranges and recalibration to intermediate ranges available	n/a
	70		T3HYE	**Electrochemical**	Hydrogen sensor with transmitter 3 Series, Sensor type used: 3HYE	Automotive	0 - 20000 ppm, 0 - 50000 ppm precalibrated, Recalibration to intermediate ranges available	n/a

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	71		T3HYT	**Electrochemical**	Hydrogen sensor with transmitter 3 Series, Sensor type used: 3HYT	Automotive	0 - 2000 ppm; five precalibrated ranges and recalibration to intermediate ranges available	n/a
	72		4P50M	**Catalytic** Pellistor	CiTipeL®, portable, combustible gas sensor Gases detected: methane and hydrogen		0- 100% LEL	CSA C22.2 No 30-M1986 Class 1, Div. 1, Groups A, B, C, D UL 913 Class 1, Groups A, B, C, D EN 60079-0:2006, EN 60079-1:2007 ATEX II 2 G Ex d IIC T6 Gb CE 518
	73		4P75M	**Catalytic** Pellistor	CiTipeL®, portable, combustible gas sensor Gases detected: methane and hydrogen		0 - 100% LEL	CSA C22.2 No 30-M1986 Class 1, Div. 1, Groups A, B, C, D UL 913 Class 1, Groups A, B, C, D EN 60079-0:2006, EN 60079-1:2007 ATEX II 2 G Ex d IIC T6 Gb CE 518
	74		4P90M	**Catalytic** Pellistor	CiTipeL®, portable, Search engine result, not hydrogen-specific	Combustible gas sensor	0 - 100% LEL	CSA C22.2 No 30-M1986 Class 1, Div. 1, Groups A, B, C, D UL 913 Class 1, Groups A, B, C, D EN 60079-0:2006, EN 60079-1:2007 ATEX II 2 G Ex d IIC T6 Gb CE 518
20	75	Compur Monitors GmbH & Co. KG München, Germany	Statox 501		Gas detection system for combustible gases, system comprising sensor head and controller modules; Specific hydrogen sensor heads available for 0 - 150 / 300 / 1000 ppm measuring range Compur 5803 163 (HRC / ARE) E2V VQ 641TS (LRC)	Stationary Gas Warning System	0 - 150 / 300 / 1000 ppm	ATEX II 2 G EEx de IIC T6 (HRC/ARE sensor head) ATEX II 2 G EEx de IIC T5 (LRC sensor head)
	76		Statox 505	**Electrochemical**	Transmitter according to SIL2 Standard; hydrogen sensor head with measuring range 0-300 ppm	Stationary Gas Warning System	300 ppm, 1000 ppm	EMC Compliance: EN 50270; ATEX II 2 G Ex ib IIC T4 (EN 60079-0, EN 60079-11) BVS Certificate; SIL 2 (Functional safety)
21	77	Control Instruments Corporation Fairfield, NJ, USA	SNR476	**Electrochemical** Micro fuel cell	Hydrogen Sensor for SmartMaxII stand-alone controller	Monitoring of hydrogen gas	0 - 1000 ppm (standard range; 0 - 2000 ppm available)	n/a
22	78	COSA Xentaur Yaphank, NY, USA	CHA Continuous Hydrogen Analyzer	**Electrochemical** Potentiometric proton conducting polymer membrane	Unique, patented electrochemical sensor; direct and specific measurement of hydrogen, continuous signal outout corresponding to hydrogen concentration	Refining, petrochemical, electric power applications; Hydrogen production, hydrogen-cooled power generation; Hydrogen/hydrocarbon ratio, isomerization	0.04 - 100 vol.%	Ex

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23	79	Crowcon Detection Instruments Ltd. Abingdon, UK	TETRA		Personal multigas monitor, detection of flammable gases, oxygen and a wide range of toxic gases		0 - 1000 ppm (typ.)	ATEX II 2G Ex ia d IIC T3 Gb IECEX Ex ia d IIC T3 Gb CSA UL/cUL Class 1, Div. 1, Groups A, B, C, D, T3C Safety standards: EN60079-0, EN60079-11, EN60079-1, 94/9/EC UL913, CSA22.2, 152 EN50270, EN50271, IEC61508, EN61779, EN45544
	80	Note: Same product names as CEA Instruments	TRIPLE PLUS +	**Electrochemical**	Portable multigas monitor, detection of flammable gases, oxygen and toxic gases; specific hydrogen sensor available		0 - 100% LEL	ATEX II 2G Ex ib d IIC T4 Gb Class 1, Div. 1, Groups A, B, C, D Safety standards: EN50014, EN50020, 94/9/EC, EN50081-2, EN50270, EN50082-2 UL 913, CSA 22.2 No.157 SFA3009
	81		FLAMGARD PLUS	**Catalytic** Pellistor	Flameproof flammable gas detector, detection of explosive levels of hydrocarbons, hydrogen and other flammable gases and vapours.		0 - 100% LEL	ATEX II 2 G Ex d IIC T6 UL Class 1, Zone 1 EN 50270, FCC, ICES-003 (EMC Compliance)
	82		TXGARD-IS+	**Electrochemical**	Intrinsically safe toxic gas detector suitable for hydrogen detection		2000 ppm, 50% LEL, 100% LEL	ATEX, IECEx II 1 G Ex ia IIC T4 Ga UL, cUL Class 1, Groups A, B, C, D EN 50270, FCC. ICES-003 (EMC Compliance)
	83		40/40 Series Flame Detector	**Optical** IR based	Detector for detecting flames at a distance, including gas and fuel fires from hydrocarbons, hydrogen, etc. Manufacturer: Spectrex Inc.		n/a	
24	84	C-Sqared Inc. Anaheim, CA, USA	Hycision 10M	**Thermal conductivity**	Hydrogen sensing module		0 - 10 vol.%	n/a
	85		Hycision 100M	**Thermal conductivity**	Hydrogen sensing module		0 - 100 vol.%	n/a
	86		Hycision 10	**Thermal conductivity**	Hydrogen Analyzer, hand-held unit; uses hydrogen sensing module 10M		0 - 10 vol.%	n/a
	87		Hycision 100	**Thermal conductivity**	Hydrogen Analyzer, hand-held unit; uses hydrogen sensing module 100M		0 - 100 vol.%	n/a

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25	88	DET-TRONICS Minneapolis, MN, USA	GT3000	**Electrochemical**	Fixed-point toxic Gas Detector for continuous monitoring; sensor includes Transmitter (GTX) and Sensor Module (GTS); Different sensors for detection of a list of gases, including hydrogen, are available.	Gas leak detection, continuous monitoring of atmosphere	0 - 1000 ppm	Explosion-Proof Model FM/CSA: Class I, Div. 1, Groups A, B, C, D (T4) Class I, Div. 2, Groups A, B, C, D (T4) Class I, Zone 1, AEx d mb [ia Ga] IIC T4 IP66 ATEX: CE 0539 II 2(1)G Ex d mb [ia Ga] IIC T4 Gb IP66 IECEx: Ex d mb [ia Ga] IIC T4 Gb IP66 Intrinsically Safe Model FM: IS Class I, Div. 1, Groups A, B, C, D (T4) Class I, Zone 0, AEx ia IIC (T4), IP66 CSA: Class I, Div. 1 & 2, Groups A, B, C,D (T4) IP66. ATEX: CE 0539 II 1 G Ex ia IIC T4, IP66. IECEx: Ga Ex ia IIC T4, IP66
	89		X3302	**Optical** IR Spectroscopy	Hydrogen Flame Detector; Sensor uses multispectrum infrared (MIR) technology focusing on the water-band IR emissions of the hydrogen flame (H_2O vapor)	Hydrogen fire/flame detection in e.g. refineries, chemical loading, battery rooms, compressor areas, generators, refrigerants, gas plants.	n/a	n/a
26	90	Dextens SA Geneva, Switzerland	H2 52201	**Thermal conductivity**	for H_2, CO_2 and N_2 measurements	also for hydrogen solved in liquids	0-2 ppm, 0-10 ppm	IP65
27	91	Dräger Safety AG & Co. KGaA Lübeck, Germany	DrägerSensor® DD	**Catalytic** Pellistor	Sensor element; Versions available: HT M DD, PR M/NPT DD, LC M/NPT DD; HT: high temperature; PR: poison resistant; M/NPT: metric/NPT thread; LC: low concentration; Sensors for use in: Dräger Polytron SE Ex Fixed Gas Detectors	Detection of combustible gases: hydrogen, etc.	n/a	n/a
	92		DrägerSensor® Smart Cat Ex	**Catalytic**	Sensor element	Measurement of combustible gases and vapours in air, multiple gas detection	n/a	n/a
	93		DrägerSensor® XS P/N 68 09 185	**Electrochemical**	Toxic gas and vapour sensor element for use in portable gas detectors	Detection of toxic gases and vapours, P/N for hydrogen-specific sensor head	0 - 2000 ppm	n/a
	94		DrägerSensor® XS P/N 68 11 365	**Electrochemical**	Toxic gas and vapour sensor element for use in portable gas detectors	Detection of toxic gases and vapours, P/N for hydrogen-specific sensor head	0 - 4.0 vol.%	n/a
	95		Polytron SE Ex PR ... DD	**Catalytic** Pellistor	Fixed gas detector, four housing options (M1, M2, M3, NPT1)	Continuous monitoring of combustible gases and vapours in ambient air;	n/a	94/9/EG: EN 60079-29-1

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	96		Polytron SE Ex LC ... DD	**Catalytic** Pellistor	Fixed gas detector, four housing options (M1, M2, M3, NPT1)	Continuous monitoring of combustible gases and vapours in ambient air; Target gases: hydrogen, etc.	n/a	94/9/EG: II 2 G Ex de IIC T6/T5/T4 Gb (M1 - M3) II 2 G Ex d IIC T6/T5/T4 Gb (NPT1) II 2 D Ex tD A21 IP 6x T130°C IECEx: Ex de IIC T6/T5/T4 Gb (M1 - M3)
	97		Polytron SE Ex HT M DD	**Catalytic** Pellistor	Fixed gas detector, high temperature housing	Continuous monitoring of combustible gases and vapours in ambient air; Target gases: hydrogen, etc.	n/a	94/9/EG: EN 60079-29-1 II 2 G Ex d IIC T3 II 2 D Ex tD A21 IP 6x T195°C (valid for sensor; slightly different for housing and cable fitting)
	98		Polytron 3000	**Catalytic** Pellistor	Fixed gas detector	Continuous monitoring of toxic gases in ambient air; gases: hydrogen etc.	various, not specified	ATEX II 1G EEx ia IIC T6/T4 II 3G EEx nL IIC T6/T4 II 3D IP6x T65 °C
28	99	**Element One Inc. Boulder, CO, USA**	Under development	**Optical** Chemochromic	Hydrogen indicating sensor, color change of metal oxide film on subtrate in the presence of gaseous hydrogen	Leak detection applications: Storage Tanks, Connectors, Fuel Cells, Fuel Reformers, Connection Hardware, Grounding Connections, Hoses, and anywhere hydrogen is used.	n/a	n/a
29	100	**ENMET Corp. Ann Arbor, MI, USA**	EX 5100	**Catalytic** Pellistor	Combustible Gas Sensor/Transmitter, Fixed gas monitoring system		0 - 100% LEL	Sensor Head: ATEX Enclosure: Class I, Groups B, C, D Class II, Groups E, F, G CENELEC: EEx d IIC, IP66 FM 3615; CSA C22.2 No. 30; UL 1203 CENELEC EN 50014, 50018
	101		EX 5175 P/N 10014-1500	**Electrochemical**	Explosion-proof sensor/transmitter for specific target gas; Hydrogen: P/N 10014-1500; Fixed gas monitoring system		24 ppm (LDL) - 2000 ppm	Class I, Div. 1, Groups B, C, D UL 916 (3rd ed.), UL 1203 (4th ed.) CSA 22.2, No. 0-M91, 30-M1986, 142-M1987
	102		SDS-1500-97D	**Electrochemical**	Sensor/Transmitter for specific target gas, including a wide range of toxic gases, hydrogen, oxygen; Hydrogen: P/N 10022-1500		24 ppm (LDL) - 2000 ppm	n/a
	103		ProAir 2200	**Electrochemical**	Gas monitor für process compressed air lines, specific target gas; Hydrogen configuration option available		0 - 2000 ppm	UL 60601-1 IEC 60601-1 CSA 22.2, No. 601.1
	104		GSM 60	**Electrochemical**	Gas sampling monitor with internal pump, sensors for up to four specific target gases; Hydrogen configuration option available		0 - 2000 ppm	n/a
	105		PGD2	**Catalytic**	4-Gas Portable Detector, sensor for flammable gas, not hydrogen-specific		n/a	ATEX II 2 G EEx ia IIC T3 CE; EN 50081-2, EN 50082-1, EN 550022

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30	106	Environment One Corporation Niskayuna, NY, USA	GGA	**Thermal conductivity**	Generator Gas Analyzer	Hydrogen-cooled generators, continuous monitoring of gas purity during all phases of generator operation	70 - 100% H_2 in air 0 - 100% H_2 in CO_2	Class I, Zone 2, Group IIB + H_2
	107		PGA	**Thermal conductivity**	Portable Hydrogen Gas Analyzer	non-hazardous environments	70 - 100% H_2 in air 0 - 100% H_2 in CO_2	n/a
31	108	ESCUBE GmbH & Co. KG Stuttgart, Germany	HydroSEN	**Electrochemical**	solid-state electrolyte (ZrO_2)	Safety and leak monitoring applications, e.g. of fuel cells or electrolysers	0 - 1000 ppm / 0 - 10000 ppm (max. 50% LEL)	n/a
32	109	ExTox Gasmess-Systeme GmbH Unna, Germany	H2-2-EC	**Electrochemical**	Hydrogen Transmitter; 0…2 Vol%; explosion-proof version available	Industrial	0 - 2 vol.%	Sens Series: 2004/108/EG (EMV) 94/9/EG (ATEX) CE Ex II 3 G Ex nA IIC T6 X EN 60079-29-1 ExSens Series: 2004/108/EG (EMV) 94/9/EG (ATEX) CE 0158 Ex II 2 G EN 60079-1, EN 60079-29-1 Ex d IIC T5 Gb, Ex d IIC T4 Gb
	110		H2-30-EC	**Electrochemical**	Hydrogen Transmitter; 0…30 Vol%	Industrial; main application: gas analysis in combination with gas withdrawal system	0 - 30 vol.%	Sens Series only: 2004/108/EG (EMV) 94/9/EG (ATEX) CE Ex II 3 G Ex nA IIC T6 X EN 60079-29-1
	111		H2-1000-EC	**Electrochemical**	Hydrogen Transmitter; 0…1000 ppm; explosion-proof version available, version including activated carbon filter for biogas analysis available	Bio gas analysis	0 - 1000 ppm	Sens Series: 2004/108/EG (EMV) 94/9/EG (ATEX) CE Ex II 3 G Ex nA IIC T6 X EN 60079-29-1 ExSens Series: 2004/108/EG (EMV) 94/9/EG (ATEX) CE 0158 Ex II 2 G EN 60079-1, EN 60079-29-1 Ex d IIC T5 Gb, Ex d IIC T4 Gb
	112		BG-HL	(Metal oxide semiconductor)	Flammable Gas Transmitter; 0…100% LEL; Target gases: Hydrogen, etc. explosion-proof version available	Ambient air monitoring, etc.	0 - 100% LEL	Sens Series: 2004/108/EG (EMV) EN 60079-29-1 ExSens Series: 2004/108/EG (EMV) 94/9/EG (ATEX) CE 0158 Ex II 2 G EN 60079-1, EN 60079-29-1 Ex d IIC T4 Gb

No. M	No. S	Manufacturer City, Country	Sensor Model	Technology	Description / Remark	Application	Detection Range (H_2)	Certificates / Approvals / Tests / Classification
	113		BG-5000-HL	(Metal oxide semiconductor)	Flammable Gas Transmitter, 0…5000 ppm; Target Gases: Hydrogen, etc. explosion-proof version available	Leakage and trace analysis, etc.	0 - 5000 ppm	Sens Series: 2004/108/EG (EMV) EN 60079-29-1 ExSens Series: 2004/108/EG (EMV) 94/9/EG (ATEX) CE 0158 Ex II 2 G EN 60079-1, EN 60079-29-1 Ex d IIC T4 Gb
	114		BG-WT	**Thermal conductivity**	Flammable Gas Transmitter, 0…100% LEL; Target Gases: all flammable gases; explosion-proof version available	Explosion protection	0 - 100% LEL	Sens Series: 2004/108/EG (EMV) EN 60079-29-1 ExSens Series: 2004/108/EG (EMV) 94/9/EG (ATEX) CE 0158 Ex II 2 G EN 60079-1, EN 60079-29-1 Ex d IIC T4 Gb
	115		H2-100-WLD H2-30-WLD H2-10-WLD	**Thermal conductivity**	Transmitter for basic device	gas analysis, using with sampler ExTox IMC	0 … 100 vol.% H_2 0 … 30 vol.% H_2 0 … 10 vol.% H_2	
33	116	Figaro USA Inc. Glenview, IL, USA	TGS821	**Resistive** Semiconductor (SnO_2)	Sensor element; high sensitivity and selectivity to hydrogen gas; conductivity increase with gas concentration	Hydrogen gas detection for transformer maintenance, batteries, steel industry usage, etc.	50 - 1000 ppm	n/a
	117		TGS813	**Resistive** Semiconductor (SnO_2)	Sensor element; detection of combustible gases, not hydrogen-specific, ideal for monitoring natural gas and LPG	Domestic gas leak detectors and alarms, portable gas detectors	n/a	n/a
	118		TGS6812	**Catalytic**	Sensor element; sensitive to hydrogen, methane and LP gas, high accuracy, good durability and stability, quick response, low sensitivity to alcohol, compact size	Hydrogen and combustible gas leak detector for fuel cells/stationary fuel cell systems; Detection of hydrogen, methane and LP gas	0 - 100% LEL	n/a
34	119	FIS Inc. Hyogo, Japan	SB-19-00	**Resistive** Semiconductor (SnO_2)	Sensor element; excellent sensitivity and selectivity to hydrogen	hydrogen detection	n/a	n/a
	120		SP-19-01	**Resistive** Semiconductor (SnO_2)	Sensor element; high sensitivity and selectivity to hydrogen	hydrogen detection	n/a	n/a
	121		SB-42A-11		no specification available	Hydrogen detection in fuel cells / automotive	n/a	n/a
35	122	General Monitors Lake Forest, CA, USA	45186-12	**Electrochemical**	Electrochemical sensor element for hydrogen detection	Hydrogen detection	0 - 500 ppm	CSA, FM, ATEX, CE, SIL
	123	Note: Website very similar to MSA	10164-1	**Catalytic**	Hydrogen specific catalytic bead sensor element	Hydrogen detection	0 - 100% LEL	CSA approved Class 1, Div. 1, Groups B, C, D

No. M	No. S	Manufacturer City, Country	Sensor Model	Technology	Description / Remark	Application	Detection Range (H_2)	Certificates / Approvals / Tests / Classification
	124		TS4000H	**Electrochemical**	Toxic Gas Detector, measured gases includes hydrogen		0 - 500 ppm	Base Unit: CSA: Class I, Div. 1 & 2, Groups B, C, D; Class II, Div. 1 & 2, Groups E, F, G; Class III, Type 4X ATEX/IECEx: Ex d IIB + H_2 T5 Gb Interface Module: CSA: Ex d ia IIB + H_2 T5 ATEX/IECEx: Ex d mb ib IIC Gb Approvals: CSA, ATEX, GOST, IECEx and CE Marking. HART registered. SIL 2 suitable (FM). EMC: EN 50081-2, EN 50270
	125		S4000CH	**Catalytic**	Combustible Gas Detector		0 - 100% LEL	Electrical Classification: CSA/FM Class I, Div. 1, Groups B, C, D Class I, Zone 1, IIB + H_2, T6, Type 4X ATEX II 2 G EEx d Iib + H_2 T5, IP66 Approvals: CE, CSA, FM, ATEX, IECEx Compliance with ANSI/ISA 12.13.01-2000, EN 61779-1, -4 HART registered, SIL 2 / 3 suitable RFI/EMI Protection: Compliance with EN 50270, EN 61000-6-4
	126		S4100C	**Catalytic**	Combustible Gas Addressable Transmitter		0 - 100% LEL	Approvals: ATEX II 2 G EEx em II T5 & T4, IP 66/67 Compliance with EN 61779-1, -4 EMI/RFI: EN 50082-2, EN 50081-1/2
	127		GASSONIC Surveyor	**Acoustic** Ultrasonic	Non-concentration based gas detector for leak detection from high-pressure systems, detector responds to ultrasound generated from gas releases	hydrogen storage facilities gas compressor and metering stations	25 - 70 kHz 44 - 104 dB (dynamic range)	Electrical Classification: ATEX: II 2G EEx ia IIC T4 IECEx: EEx ia IIC T4 Approvals: ATEX, IECEx, IEC 61508 certified to SIL 1 & 2
	128		GASSONIC Observer-H	**Acoustic** Ultrasonic	non-concentration based gas detector for leak detection from high-pressure systems, detector responds to ultrasound generated from gas releases	hydrogen storage facilities gas compressor and metering stations	25 - 70 kHz 58 - 104 dB (dynamic range)	Electrical Classification: CSA/FM: Class I, Div 1 & 2, Groups B, C, D; Class II/III, Div 1 & 2, Groups E, F, & G; Type 4X ATEX/IECEx: Ex d ia IIB + H_2 T6 Gb Ex tb IIIC T85°C Db; IP66 Approvals: FM, CSA, ATEX, IECEx, FM certified to IEC 61508, SIL 3 suitable, HART registered. RFI/EMI Protection: Complies with EN61000-6-2 and EN61000-6-4

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36	129	GFG Dortmund, Germany	GMA36 Pro	**Electrochemical**	Complete transmitter and controller in one unit, wall-mounted, sensor according to target gas: Hydrogen, etc. Three detection ranges for Hydrogen available: 0-2000 ppm, 0-1% vol., 0-4% vol.	Continuous surveillance of toxic gases, oxygen and hydrogen	0 - 2000 ppm 0 - 1 vol.% 0 - 4 vol.%	EMC: EN 61000-6-3, EN 61000-6-4, EN 50270 Type 1 and Type 2
	130		Micro IV	**Electrochemical**	Single gas detector, sensor according to target gas: Hydrogen, etc.	Single gas detection of toxic gases, oxygen and hydrogen	2000 ppm 4 vol.%	Approval: ATEX II 2 G EEx ib IIC T4/T3
	131		Microtector II G460	**Electrochemical**	7-Gas Detector, 5 sensor positions, sensors according to target gas: Hydrogen, etc.	Continuous and selective measurement of seven gases simultaneously	0 - 2000 ppm 0 - 1 vol.% 0 - 4 vol.%	ATEX II 2 G Ex ia de IIC T4/T3 EN 60079-29-1 EN 50270:1999
37	132	H2Scan Corp. Valencia, CA, USA	HY-ALERTA 500	Two sensor elements: **Work function** MOS capacitor & **Resistive** Pd/Ni thin film resistor	Handheld hydrogen leak detector; Hydrogen Sensitivity Range: 15 ppm to 100% hydrogen by volume, No peripheral equipment needed	Portable hydrogen leak detector; locating source of hydrogen leak where hydrogen gas is produced, used, transported, or stored	15 ppm - 100 vol.%	cUL, CE
	133		HY-ALERTA 600	**Resistive** Pd/Ni thin film resistor	Fixed area hydrogen safety monitor; Hydrogen Sensitivity Range: 0.4% to 5.0% hydrogen by volume,	Hydrogen-specific leak detection and measurement	0.4 - 5 vol.% 10 - 125% LFL	cUL, CE
	134		HY-ALERTA 1600	**Resistive** Pd/Ni thin film resistor	Fixed area hydrogen safety monitor, intrinsically safe. Hydrogen Sensitivity Range: 0.4% to 5.0% hydrogen by volume,	Hydrogen-specific leak detection and measurement	0.4 - 5 vol.% 10 - 125% LFL	Certification: CE 0359, ATEX II 1 G, Ex ia II H_2, d+d IIB T3 II 2 G, Ex ib II H_2, ib d IIB T3
	135		HY-ALERTA 2600	**Resistive** Pd/Ni thin film resistor	Fixed area hydrogen safety monitor, explosion-proof. Hydrogen Sensitivity Range: 0.4% to 5.0% hydrogen by volume,	Hydrogen-specific leak detection and measurement	0.4 - 5 vol.% 10 - 125% LFL	cUL, FM Class I Group B, C, D; Class II Group E, F, G; Class III Type 4X Class I Zone 1 AEx d IIC
	136		HY-OPTIMA 2700AS	**Resistive** Pd/Ni thin film resistor	Process Hydrogen Analyzing System, complete solution. Hydrogen Sensitivity Range: 0.5% to 100% hydrogen by volume at 1 ATM	Process hydrogen measurement in refineries, chemical plants, air separation units and industrial gas manufacturing plants	0.5 - 100 vol.% (@ 1 ATM)	UL Class I, Div. 1 Groups B, C, D ATEX Ex Proof Ex d IIB + H_2 T4 Gb
	137		HY-OPTIMA 2700	**Resistive** Pd/Ni thin film resistor	Real time hydrogen-specific in-line process analyzer, operation in process gas streams, explosion-proof. Hydrogen Sensitivity Range: 0.5% to 100% hydrogen by volume at 1 ATM	Ideal for hydrogen production and petrochemical applications (where real-time measurements of hydrogen can enhance process plant efficiencies, diagnostics and maintenance management)	0.5 - 100 vol.% (@ 1 ATM)	Certifications UL, CE 0359 UL 508, 1203 USC Class I, Div. 1, Groups B, C, D Hazardous (Classified) II 2 G Ex d IIB + H_2 T4 Gb Remote: UL 913, CAN/CSA C22.2 No. 157-92 Ex ia IIC T4 Ga
	138		HY-OPTIMA 2720	**Resistive** Pd/Ni thin film resistor	Real time hydrogen-specific in-line process analyzer, operation in air & nitrogen background gas streams, explosion-proof. Hydrogen Sensitivity Range: 0.4% to 5% hydrogen by volume at 1 ATM	Ideal for hydrogen processes (where real-time measurements of hydrogen can ensure safety in application, increase process efficiencies, improve diagnostics and enhance maintenance management)	0.4 - 5 vol.% (@ 1ATM)	Certifications UL, CE 0359 UL 508, 1203 USC Class I, Div. 1, Groups B, C, D Hazardous (Classified) II 2 G Ex d IIB + H_2 T4 Gb Remote: UL 913, CAN/CSA C22.2 No. 157-92 Ex ia IIC T4 Ga

No. M	No. S	Manufacturer City, Country	Sensor Model	Technology	Description / Remark	Application	Detection Range (H_2)	Certificates / Approvals / Tests / Classification
	139		HY-OPTIMA 2730	**Resistive** Pd/Ni thin film resistor	Real time hydrogen-specific in-line process analyzer, operation in background gas streams having CO concentrations up to 100 ppm, H_2S concentrations up to 1000 ppm, explosion-proof. Hydrogen Sensitivity Range: 0.5% to 100% hydrogen at 1 ATM on a volume basis in a single or multicomponent gas background	Ideal for hydrogen production and petrochemical applications (where real-time measurements of hydrogen can increase process plant efficiencies, improve diagnostics and enhance maintenance management)	0.5 - 100 vol.% (@ 1 ATM)	UL Class I, Div. 1, Groups B, C, D ATEX II 2 G Ex d IIB + H_2 T4 Gb
	140		HY-OPTIMA 2740	**Resistive** Pd/Ni thin film resistor	Real time hydrogen-specific in-line process analyzer, operation in background gas streams having CO concentrations up to 20% by volume, H_2S concentrations up to 10% by volume, explosion-proof. Hydrogen Sensitivity Range: 0.5% to 100% hydrogen at 1 ATM on a volume basis in a single or multicomponent gas background	Ideal for hydrogen production and petrochemical applications (where real-time measurements of hydrogen can increase process plant efficiencies, improve diagnostics and enhance maintenance management)	0.5 - 100 vol.% (@ 1 ATM)	UL Class I, Div. 1, Groups B, C, D ATEX II 2 G Ex d IIB + H_2 T4 Gb
	141		HY-OPTIMA 1700AS	**Resistive** Pd/Ni thin film resistor	Process Hydrogen Analyzing System; complete solution. Hydrogen Sensitivity Range: 0.5% to 100% hydrogen by volume at 1 ATM	Process hydrogen measurement in refineries, chemical plants, air separation units and industrial gas manufacturing plants	0.5 - 100 vol.% (@ 1 ATM)	n/a
	142		HY-OPTIMA 1700	**Resistive** Pd/Ni thin film resistor	Real time hydrogen-specific in-line process analyzer, operation in background gas streams, intrinsically safe. Hydrogen Sensitivity Range: 0.5% to 100% hydrogen by volume at 1 ATM	Ideal for process gas streams containing virtually no contaminants (where real time continuous measurements of hydrogen can increase process plant efficiencies, improve diagnostics and enhance maintenance management)	0.5 - 100 vol.% (@ 1 ATM)	Certifications CE 0359, ATEX II 1 G, Ex ia II H_2, d+d IIB T3 II 2 G, Ex ib II H_2, ib d IIB T3
	143		HY-OPTIMA 1720	**Resistive** Pd/Ni thin film resistor	Real time hydrogen-specific in-line process analyzer, operation in air and Nitrogen background gas streams, intrinsically safe. Hydrogen Sensitivity Range: 0.4% to 5% hydrogen by volume at 1 ATM	Ideal for the detection of hydrogen within processes (where real-time monitoring can increase plant safety, improve process diagnostics and enhance maintenance management)	0.4 - 5 vol.% (@ 1ATM)	Certifications CE 0359, ATEX II 1 G, Ex ia II H_2, d+d IIB T3 II 2 G, Ex ib II H_2, ib d IIB T3

No. M	No. S	Manufacturer City, Country	Sensor Model	Technology	Description / Remark	Application	Detection Range (H_2)	Certificates / Approvals / Tests / Classification
	144		HY-OPTIMA 1730	**Resistive** Pd/Ni thin film resistor	Real time hydrogen-specific in-line process analyzer, operation in background gas streams having CO concentrations up to 100 ppm, H_2S concentrations up to 1000 ppm, intrinsically safe. Hydrogen Sensitivity Range: 0.5% to 100% hydrogen at 1 ATM	Ideal for hydrogen gas production, petroleum refining and petrochemical applications (where continuous real time measurements of hydrogen can increase process plant efficiencies, improve diagnostics and enhance maintenance management)	0.5 - 100 vol.% (@ 1 ATM)	Certifications CE 0359, ATEX II 1 G, Ex ia II H_2, d+d IIB T3 II 2 G, Ex ib II H_2, ib d IIB T3
	145		HY-OPTIMA 1740	**Resistive** Pd/Ni thin film resistor	Real time hydrogen-specific in-line process analyzer, operation in background gas streams having CO concentrations up to 20% by volume, H_2S concentrations up to 10% by volume, intrinsically safe. Hydrogen Sensitivity Range: 0.5% to 100% hydrogen by volume at 1 ATM	Ideal for hydrogen gas production, petroleum refining and petrochemical applications (where real-time measurements can enhance process plant efficiencies, diagnostics and maintenance management	0.5 - 100 vol.% (@ 1 ATM)	Certifications CE 0359, ATEX II 1 G, Ex ia II H_2, d+d IIB T3 II 2 G, Ex ib II H_2, ib d IIB T3
	146		HY-OPTIMA 700	**Resistive** Pd/Ni thin film resistor	Real time hydrogen-specific in-line process analyzer, operation in process gas streams. Hydrogen Sensitivity Range: 0.5% to 100% hydrogen by volume at 1 ATM	Ideal for hydrogen production and petrochemical applications (where real-time measurements can enhance process plant efficiencies, diagnostics and maintenance management)	0.5 - 100 vol.% (@ 1 ATM)	cUL, CE
	147		HY-OPTIMA 720AS-GC	**Resistive** Pd/Ni thin film resistor	In-Line Hydrogen Analyzing System for Gas Chromatography Systems. Hydrogen Sensitivity Range: 0.5% to 5% hydrogen at 1 ATM on a volume basis in a single or multi-component gas background	Hydrogen Analyzing System to detect, measure and respond to hydrogen leaks in gas chromatography (GC) systems.	0.5 - 5 vol.% (@ 1 ATM)	n/a
	148		HY-OPTIMA 720	**Resistive** Pd/Ni thin film resistor	Real time hydrogen-specific in-line process analyzer, operation in air and nitrogen background gas streams. Hydrogen Sensitivity Range: 0.4% to 5% hydrogen by volume at 1 ATM	Ideal for monitoring of hydrogen processes (where real-time measurements can ensure safety in application, increase process efficiencies, improve diagnostics and enhance maintenance management)	0.4 - 5 vol.% (@ 1ATM)	cUL, CE
	149		HY-OPTIMA 730	**Resistive** Pd/Ni thin film resistor	Real time hydrogen-specific in-line process analyzer, operation in background gas streams having CO concentrations up to 100 ppm, H_2S concentrations up to 1000 ppm. Hydrogen Sensitivity Range: 0.5% to 100% hydrogen at 1 ATM on a	Ideal for hydrogen production and petrochemical applications (where real-time measurements can enhance process plant efficiencies, diagnostics and maintenance management)	0.5 - 100 vol.% (@ 1 ATM)	cUL, CE

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	150		HY-OPTIMA 740	**Resistive** Pd/Ni alloy thin film resistor	Real time hydrogen-specific in-line process analyzer, operation in background gas streams having CO concentrations up to 20% by volume, H_2S concentrations up to 10% by volume. Hydrogen Sensitivity Range: 0.5% to 100% hydrogen at 1 ATM on a	Ideal for hydrogen production and petrochemical applications (where real-time measurements can enhance process plant efficiencies, diagnostics and maintenance management)	0.5 - 100 vol.% (@ 1 ATM)	cUL, CE
	151		OEM Sub-system	**Resistive** Pd/Ni thin film resistor	Hydrogen sensing technology is available for integration into customer product as an OEM assembly.	Applications suitable for custom configuration: Fuel Cell, stationary, vehicle, fuel cell bus garages Battery rooms Process control Nuclear, waste and plants Transformer monitoring etc.		
38	152	Henan Hanwei Electronics Co. Zhengzhou, China	MQ-2	**Resistive** Semiconductor (SnO_2)	Combustible gas sensor element, not hydrogen specific, detects LPG, Propane, Hydrogen etc. conductivity increase with detectable gas concentration cf. Winsen Electronics, same product!	Combustible gas sensor	300 - 5000 ppm	n/a
	153		MQ-8	(Semiconductor)	no specification available	Hydrogen gas sensor	n/a	n/a
39	154	Honeywell Analytics Uster, CH	MIDAS	**Electrochemical**	Extractive transmitter with sensor, gas monitoring system. Hydrogen detection cartridge MIDAS-S-H_2X / MIDAS-E-H_2X or MIDAS-S-LEL is used for hydrogen detection	Typical industrial process environment; for gases used or generated in the semiconductor and other industrial manufacturing applications	0 - 100% LEL 0 - 1000 ppm	CE marked; EN 50270:1999 (Type2), EN 55011:2000 ETL approved UL 61010B, CSA-C22.2 No. 1010.1-92 Designed to meet with UL 2075 Electrical: IEEE 802.3af-2003
	155		Apex	**Electrochemical**	Transmitter with sensor, sensor mounted directly on transmitter or remotely up to 100m away. Large choice of toxic gas ranges and wide range of detectable flammable gases; Hydrogen detection cartridge is used for hydrogen detection	Petrochemical: exploration drilling rigs, ... Heavy industrial: Steel manufacture, ... Manufacturing: Automotive, ... Pharmaceutical: research labs, ...	0 - 1000 ppm	CE Approved to all applicable European directives. EMC EN 50270:2006 Performance Standards Exam (DMT) EN50054 / 50057 / 50271. CSA C22.2 No.152 Certification ATEX II 2 G D Ex d ia IIC Ex tD A21 IP67 UL: Class I, Div. 1, Groups B, C, D, T4 / T5 CSA: Class I, Div. 1, Groups B, C, D C22.2 No. 152, T4 / T5
	156		Sensepoint Combustible	**Catalytic** Poison resistant bead	Combustible Gas Sensor, suitable for hydrogen detection	Indoor, outdoor, potentially explosive environments	0 - 100% LEL 0 - 10% LEL	ATEX / IECEx II 2 GD Ex d IIC Gb tb IIIC A21 Db IP67 Compliance with CE standards including EN 50270 (EMC), EN 60079-29-1
	157		Sensepoint Toxic	**Electrochemical**	Toxic Gas Sensor; suitable for hydrogen detection with hydrogen-specific sensor	Indoor, outdoor, potentially explosive environments	0 - 1000 ppm 0 - 10000 ppm	ATEX / IECEx II 2 GD Ex d ia IIC T4 Gb tb IIIC A21 IP67 Compliance with CE standards including EN 50270 (EMC)

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	158		Satellite XT	**Electrochemical**	Gas detection transmitter with sensor to detect toxic, corrosive and combustible gases; Hydrogen detection sensors: MST 9602-5100 (0...1.0% vol.) MST 9602-5101 (0...4.0% vol.) Manufactured by: MST Technology, München, Germany	Typical installation: gas cabinet exhaust ducting, equipment enclosures, …	0 - 1.0 vol.% 0 - 4.0 vol.%	RFI / EMC: EN 550011/550022, EN 50082-2
	159		E3Point	**Catalytic**	Stand alone remote sensor platform; Remote hydrogen sensor E3SRMH2 includes hydrogen sensor cartridge E3H2	Gas monitoring	0 - 100% LEL	CSA C22.2 No. 61010-1, UL 61010-1; FCC part 15; ICES-003 issue 4; ISO 9001-2008
40	160	**Industrial Scientific Oakdale, PA, USA**	iBrid MX6	**Catalytic** **Electrochemical**	Portable multi-gas detector, sensor selection according to target gas, hydrogen-specific sensor available P/N 17124975-C		0 - 100% LEL (Combustible gas sensor) 0 - 2000 ppm (Hydrogen sensor)	UL, ATEX, IECEx, CSA, ANZEx, INMETRO, KOSHA, MSHA, China Ex, China CPC, GOST-R
	161		Ventis MX4	**Catalytic**	Portable multi-gas detector, sensor selection according to target gas, combustible gas sensor available, not hydrogen-specific, P/N 17134495	Chemical, Construction, Electrical / Gas Utilities, Fire Service, Oil and Gas, Public Works, Steel Production, Water / Waste Water Treatment Industries	0 - 100% LEL (Combustible gas sensor)	UL, ATEX, IECEx, CSA, ANZEx, INMETRO, KOSHA, MSHA, PA-DEP, China Ex, China CMC, China MA, GOST-K, GOST-R
	162		BM 25	**Catalytic** **Electrochemical**	area monitoring, sensor selection according to target gas, hydrogen-specific sensor available P/N 6313803	Area montoring	0 - 100% LEL (Combustible gas sensor) 0 - 2000 ppm (Hydrogen sensor)	ATEX, IECEx, CSA
	163		GasBadge Pro		portable single gas detector, sensor selection according to target gas, hydrogen-specific sensor available P/N 17124983-C	Single gas monitoring	0 - 2000 ppm	UL/cUL, CSA, ATEX, IECEx, ANZEx, INMETRO, China Ex, KOSHA
	164		MX4 iQuad	**Catalytic**	Portable four-gas detector, sensor selection according to target gas, combustible gas sensor available, not hydrogen specific, P/N 17134495	Personal gas monitor	0 - 100% LEL (Combustible gas sensor)	UL, ATEX, IECEx, CSA, MSHA, China Ex, China MA, GOST-R, ANZEx KOSHA, VIET NAM
	165		iTX	**Catalytic** **Electrochemical**	Portable multi-gas monitor, sensor selection according to target gas, hydrogen-specific toxic gas sensor available P/N 17100967	Monitoring of one to six gases	0 - 100% LEL (Combustible gas sensor) 0 - 1000 ppm (Hydrogen sensor)	UL, CSA, MSHA, ATEX, Australia
41	166	**INFICON Bad Ragaz, Schweiz**	Sensistor-ILS500	**(Thermal conductivity)**	portable device	Leak detection		IP30
	167		Sensistror-XRS9012	**(Thermal conductivity)**	handheld device	Leak detection		IP55
	168		Extrima	**(Thermal conductivity)**	portable device	Leak detection		Ex ia IIC T3
	169		Sensistor-ISH2000	**(Thermal conductivity)**	portable device	Leak detection	0.5 ppm H_2 ; 5x10-7 mbarl/s or cc/s with 5% H_2	
	170		Sensistor-Sentrac	**(Thermal conductivity)**	destop or portable device	Leak detection	0.5 ppm H_2 ; 5x10-7 mbarl/s	
42	171	**International Gas Detectors Ltd. Stockport, UK**	MK III DCP	(Pellistor)	Flammable gas detector, not hydrogen-specific		0 - 100% LEL	ATEX, Exd

No. M	No. S	Manufacturer City, Country	Sensor Model	Technology	Description / Remark	Application	Detection Range (H_2)	Certificates / Approvals / Tests / Classification
	172	Note: formerly known as Oliver IGD Ltd.	MK VI		Flammable gas detector, used in detector series, no specification available			
	173		Tocsin 102		Gas detector series, available sensor types include IR, EC, PID devices, type depending on detectable gas. Hydrogen sensor: P/N 5106901		0 - 200 ppm (min.) 0 - 2000 ppm (max.)	ATEX, EExd
	174		Tocsin 103		Gas detector series, available sensor types include MK III, MK VI, Type B pellistors, IR, EC devices type depending on detectable gas. Sensor for ll flammable gases: P/N 5137001 (MK VI sensor) Hydrogen sensor: P/N 5224601		0 - 100% LEL (Flammable gas sensor) 0 - 100 ppm (min.) 0 - 2000 ppm (max.) (Hydrogen sensor)	n/a
43	175	INRAG AG Birsfelden, CH	I-GRAPH XS	**Thermal conductivity**	Micro Gas Chromatography System; mobile	Analysis of gaseous substances, gas chromatographic monitoring; Custom application: hydrogen and oxygen measurement for hydrogen generation	n/a	n/a
	176		I-GRAPH XC	**Thermal conductivity**	Micro Gas Chromatography System; mobile, harsh field conditions, all-in-one device	Analysis of gaseous substances, gas chromatographic monitoring	n/a	n/a
	177		I-GRAPH XPR	**Thermal conductivity**	Micro Gas Chromatography System; 19" rack version, fully integrated in the control cabinet	Analysis of gaseous substances, gas chromatographic monitoring; Custom application: hydrogen and oxygen measurement in nuclear power plants	n/a	n/a
	178		I-GRAPH XPX	**Thermal conductivity**	Micro Gas Chromatography System; continuous plant monitoring, potentially explosive atmospheres	Analysis of gaseous substances, gas chromatographic monitoring	n/a	ATEX
	179		I-GRAPH OEM	**Thermal conductivity**	Micro Gas Chromatography System; box for plant integration	Analysis of gaseous substances, gas chromatographic monitoring	> 0.1 ppm	IP 44
44	180	Intelligent Optical Systems Inc. Torrance, CA, USA	Hydrogen Sensor	**Optical**	Hydrogen Gas Leak Detector in Air, hand-held or wall-mount Prototype	Hydrogen Fuel Cells Storage Facilities and Tanks Vehicles	100 ppm - 10%	n/a
45	181	J. Dittrich Elektronic GmbH & Co. KG Baden-Baden, Germany	MF420-P	**Catalytic** Pellistor	Gas measurement system for explosible gases and vapors; target gases: hydrogen, etc.	Analysis of gases and vapors	0 - 100% LEL	n/a
	182		MF420-H	**Resistive** Semiconductor, metal oxide based (SnO_2), on substrate	Gas measurement system for explosible gases and vapors; target gases: hydrogen, etc.	Analysis of gases and vapors	0 - 50% LEL	n/a
	183		MF420-C-H2	**Electrochemical** Solid state electrolyte	Hydrogen-specific gas measurement system	Hydrogen analysis	0.01 - 4 vol.%	n/a
46	184	Kebaili Corp. Irvine, CA, USA	KHS-100	**Resistive** Silicon-based MEMS-sensor	Hydrogen gas sensor element, 0-100% LEL		0 - 100% LEL	n/a
	185		KHS-200	**Catalytic** MEMS-based micro pellistor	Hydrogen gas sensor element, 0-100% LEL; sensor on Kebaili KHS-EVAL evaluation boards		0 - 100% LEL	n/a

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	186		KHS-EVAL-L-LEL	**Catalytic**	Evaluation board based on KHS-200 hydrogen sensor element		0 - 100% LEL (0 - 40000 ppm)	n/a
	187		KHS-EVAL-L-PPM	**Catalytic**	Evaluation board based on KHS-200 hydrogen sensor element		0 - 10% LEL (0 - 4000 ppm)	n/a
	188		KHS-EVAL-S-LEL	**Catalytic**	Evaluation board based on KHS-200 hydrogen sensor element		0 - 100% LEL (0 - 40000 ppm)	n/a
47	189	Komyo Rikagaku Kogyo K. K. Kawasaki, Japan	RD-4	**Catalytic**	Hydrogen gas detector head; more detector heads for combustible gases are available	For use in Fixed Type Gas Detector Alarm Systems (e.g. FA-480, FA-490)		n/a
	190		FA-480 / FA-490	(Hot wire semiconductor)	Gas detector alarm units for single point monitoring, different versions available: Detection of hydrogen in air, etc.	Single point gas leak detection	0 - 2000 ppm	n/a
	191		KTS-526	**Electrochemical** amperometric	Hydrogen gas sensor element, more sensors for combustible gases using different technologies (catalytic combustion, hot wire semiconductor) are available		0 - 4 vol.%	n/a
	192		137U	**Optical** Color change	KITAGAWA gas detector tube system, hydrogen gas detector tub, color change of chemical reagent in detector tube		0.05 - 0.8%	n/a
48	193	KWJ Engineering Inc. Newark, CA, USA	A285		Four Gas Analyzer: H_2, CO, CO_2, O_2; Portable monitor for spot measurement; Custom solution for KWJ customer	Bio gas analysis, Custom solution for KWJ Customer	n/a	n/a
	194		A355		Transformer tester, portable monitor for spot measurement; detection of combustible gases; Modification of RKI	Oil-filled high-powered electrical transformers	n/a	n/a
	195		626 Pipeline Special	(MOX)	Gas leak detector, dual sensor H_2 and CH_4; Portable monitor for spot measurement	Gas pipeline leak surveys, above and below ground	0 - 10000 ppm	n/a
	196		634 Pro Surveyor	(MOX)	Gas leak detector, dual sensor H_2 and CH_4; Portable monitor for spot measurement	Gas pipeline leak surveys, above and below ground	0 - 10000 ppm	n/a
	197		555	(MOX)	Hydrogen leak detector, Dual sensor hydrogen gas leak detector; Portable monitor for spot measurement	Hydrogen leak surveys in conventional and nuclear power plants	n/a	n/a
49	198	Kyushu University, Kato-Lab / Orii&Mec Corporation Fukuoka, Japan	H2 Sensor	**Acoustic** Ultrasonic	Single product direcly from university lab	Portable, installation and large area multipoint	100 ppm - 100%	n/a
50	199	LAMTEC GmbH & Co KG Walldorf, Germany	CarboSen	**Electrochemical** Solid state electrolyte	Detection of flammable gases, CO, H_2, etc.		n/a	n/a

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	200		HydroSen	**Electrochemical** Solid state electrolyte	Detection of hydrogen; Note: identical product is offered by Escube GmbH & Co. KG	Leakage and safety monitoring particularly of fuel cells and electrolysis equipment	0 - 1000 ppm, 0 - 10000 ppm (max. 50% LEL)	n/a
51	201	LFE GmbH & Co. KG Bruchköbel, Germany	CONTHOS 3	**Thermal conductivity**	Hydrogen gas analyzer	industrial processes;	Lowest: 0 - 0.5% H_2 in N_2 or 99.5 - 100% H_2 in N_2 Largest: 0 - 100% H_2	n/a
52	202	Makel Engineering, Inc. Chico, CA, USA	"Smart Hydrogen Sensors"	(MEMS-based, thin-film microsensor)	Hydrogen microsensor, MEMS-based device; no datasheets or specifications for sensors available, just text.	Fuel cell safety, Facility monitoring, Assembly leak checking, Industrial gas detection, Chemical process monitoring; Also, space applications and missions, Ford Model U Hydrogen Prototype are mentioned on website.	n/a	n/a
53	203	Materion GmbH Wismar, Germany	MOHS 2.1	**Optical**	Modular hydrogen gas sensor; change in thin film properties	Room air monitoring, process control, control of industrial applications	0.1 - 4.0 vol.%	n/a
	204		MOHS 2.2	**Optical**	Modular Hydrogen gas sensor; change in thin film properties	Room air monitoring, process control, control of industrial applications	0.1 - 4.0 vol.%	n/a
	205		MOHS 3	**Optical**	Modular hydrogen gas sensor; change in thin film properties	Room air monitoring, process control, control of industrial applications	0.1 - 100 vol.%	n/a
	206		MOHS 3.Z	**Optical**	Modular hydrogen gas sensor; change in thin film properties	Room air monitoring, process control, control of industrial applications	0.1 - 100 vol.%	n/a
	207		MOHS 4	**Optical**	Modular hydrogen gas sensor; change in thin film properties	Room air monitoring, process control, control of industrial applications	0.1 - 100 vol.%	n/a
54	208	Membrapor Wallisellen, CH	H2/M-1000	**Electrochemical**	Hydrogen gas sensor element; miniature size	Safety and Environmental Control For Portable Gas Detectors	0 - 1000 ppm	n/a
	209		H2/M-4000	**Electrochemical**	Hydrogen gas sensor element; miniature size	Safety and Environmental Control For Portable Gas Detectors	0 - 4000 ppm	n/a
	210		H2/CA-1000	**Electrochemical**	Hydrogen gas sensor element; compact size H_2 Detection in H_2/CO-Mixtures	Medical Applications Safety and Environmental Control	0 - 1000 ppm	n/a
	211		H2/CB-1000	**Electrochemical**	Hydrogen gas sensor element; compact size H_2 Detection in H_2/CO-Mixtures	Medical Applications Safety and Environmental Control	0 - 1000 ppm	n/a
	212		H2/C-2000	**Electrochemical**	Hydrogen gas sensor element; compact size	Safety and Environmental Control	0 - 2000 ppm	n/a
	213		H2/C-5000	**Electrochemical**	Hydrogen gas sensor element; compact size	Safety and Environmental Control	0 - 5000 ppm	n/a
	214		H2/C-20000	**Electrochemical**	Hydrogen gas sensor element; compact size	Safety and Environmental Control	0 - 20000 ppm	n/a
	215		H2/CT-40000	**Electrochemical**	Hydrogen gas sensor element; compact size	Safety and Environmental Control	0 - 40000 ppm	n/a
	216		H2/SA-1000	**Electrochemical**	Hydrogen gas sensor element; compact size H_2 Detection in H_2/CO-Mixtures	Safety and Environmental Control	0 - 1000 ppm	n/a
	217		H2/S-2000	**Electrochemical**	Hydrogen gas sensor element; standard size	Safety and Environmental Control	0 - 2000 ppm	n/a
	218		H2/SA-1000-S	**Electrochemical**	Hydrogen gas sensor element; slim size H_2 Detection in H_2/CO-Mixtures	Medical Applications Safety and Environmental Control	0 - 1000 ppm	n/a

No. M	No. S	Manufacturer City, Country	Sensor Model	Technology	Description / Remark	Application	Detection Range (H_2)	Certificates / Approvals / Tests / Classification
	219		H2/S-2000-S	**Electrochemical**	Hydrogen gas sensor element; slim size	Safety and Environmental Control	0 - 2000 ppm	n/a
	220		H2/S-10000-S	**Electrochemical**	Hydrogen gas sensor element; slim size	Safety and Process Control	0 - 10000 ppm	n/a
55	221	Micronas GmbH Freiburg, Germany	GAS 8616B	**Work function** Capacity-coupled field effect transistor / MOSFET	Multi-parametric sensor platform, target gas H_2 + NO_2, two independent gas sensor units	Detection of concentration changes of ambient trace gases, trace gas / gas leakage detection	100 ppb - 1% gas concentration approx.	n/a
56	222	Microsens S.A. Neuchâtel, CH	MCGS	**Catalytic**	Datasheet available only for MCGS-2102 methane gas sensor (CH_4); Measurement of the temperature change induced by exothermic reaction with combustible gases.	Security (explosive gases, solvents), industrial process monitoring	0 - 100% LEL	n/a
	223		MSGS 3000	**Resistive** Semiconducting metal oxide layer	Monosensor; semiconductor surface conductivity modification with reducing or oxidizing gas interaction; sensitive layer: SnO_2 - Nb_2O_5, doped and undoped	Security (explosive gases, solvents), industrial process monitoring, indoor air quality, combustion control, environment, exhaust gases	1 - 10000 ppm	n/a
	224		MSGS 4000	**Resistive** Semiconducting metal oxide layer	Multisensor (4-sensor array & 6-sensor array) semiconductor surface conductivity modification with reducing or oxidizing gas	Security (explosive gases, solvents), industrial process monitoring, indoor air quality, combustion control, environment, exhaust gases	1 - 10000 ppm	n/a
	225		MGSM 3000	**Resistive** Semiconducting metal oxide layer	Gas sensing module with two MSGS 3000 gas sensors	Pre-calibrated module for portable systems, Indoor air monitoring, Environment monitoring, Security, industrial process control	1 - 10000 ppm	n/a
57	226	Monicon Technology Ltd. Galway, Ireland	T100	**Electrochemical**	Toxic Gas Detector, 3 electrode / micro fuel cell technology Electrode material is desigend specifically for the gas to be sensed (catalysed reactions), target gases: H_2, etc.		500 ppm (min.) 4% (max.)	ATEX EMC Compliance: EN 50081, EN 50082
	227		CGS500	**Catalytic**	Combustible Gas Detector; active & reference thermocatalytic element	Combustible gas concentration measurements	0 - 100% LEL	ATEX EMC Compliance: EN 50081, EN 50082
58	228	MSA Cranberry Township, PA, USA MSA Auer GmbH Berlin, Germany	ULTIMA® XE Hydrogen	**Electrochemical**	Gas Monitor; electrochemical principle for hydrogen specific sensor, 0-1000 ppm	Continuous detection and monitoring of combustible gases, industrial environment Hydrogen monitoring in Data Centers, Refineries, Chemical/Petrochemical	0 - 1000 ppm	ATEX, EMC, Low Voltage Directives Performance approval: EN 60079-29-1:2007, EN 50104:2002 EN 50271:2002
	229		ULTIMA® XE Combustible gas	**Catalytic**	Gas Monitor; catalytic bead principle for general combustible gas sensor, including hydrogen, 0-100% LEL	Continuous detection and monitoring of combustible gases, industrial environment Hydrogen monitoring in Data Centers, Refineries, Chemical/Petrochemical	0 - 100% LEL	ATEX, EMC, Low Voltage Directives Performance approval: EN 60079-29-1:2007, EN 50104:2002 EN 50271:2002
	230		TRIGARD®	**Catalytic**	Gas Monitoring System	Detection of combustible gases, including hydrogen	n/a	n/a
	231		GasGard® XL		Contoller/Monitor for up to eight remote gas sensors	Combustible, Oxygen, Toxic Detection	n/a	UL/CSA, CE, FTZU, CMC, GOST, cCSAus ATEX, EMC (EN 50270), Low Voltage (EN 61010-1) Directives EN 61779-1 / -4; EN 50402

No. M	No. S	Manufacturer City, Country	Sensor Model	Technology	Description / Remark	Application	Detection Range (H_2)	Certificates / Approvals / Tests / Classification
	232		Ultrasonic IS-5 / EX	**Acoustic** Ultrasound	cf. General Monitors product, seems identical	Gas leak detection; gas pipelines, hydrogen storage	25 kHz to 70 kHz (Frequency range) 58 dB to 104 dB (Ultrasonic dynamic range)	FM, CSA, ATEX, IECEx, GOST-R, SIL 3 suitable
59	233	MST Intertrade GmbH München, Germany	SECS H2 20000	**Electrochemical**	Hydrogen sensor, three-electrode, amperometric, 20000 ppm, 2% vol.	Hydrogen detection	0 - 20000 ppm	n/a
	234		Hydrogen-H2-2E-5%	**Electrochemical**	Hydrogen sensor, two-electrode, amperometric; 5% vol. H_2 in air or N_2	Hydrogen detection	0 - 5 vol.% in air or N_2	n/a
	235		H2 Sensor 4 Se 6-24	**Electrochemical**	Hydrogen sensor, three-electrode, amperometric; 20000 ppm, 2% vol.	Hydrogen detection	0 - 20000 ppm	n/a
60	236	Nano Environmental Technology (N.E.T.) S.r.l. Cornaredo, Italy	NP-17SMM	**Catalytic**	Flammable gas sensor element, not hydrogen-specific;	Flammable gas detection	0 - 100% LEL	n/a
	237		NP-17SM	**Catalytic** Pellistor	Flammable gas sensor element, not hydrogen-specific; matched pair of pellistor elements mounted on single header	Flammable gas detection	0 - 100% LEL	n/a
	238		NP-17SHM NP-17SHP	**Catalytic**	Flammable gas sensor element, not hydrogen-specific; Single header, metal or plastic housing	Flammable gas detection	0 - 100% LEL (linear to 60% LEL)	n/a
	239		NP-18SMM	**Catalytic**	Flammable gas sensor element, not hydrogen-specific;	Flammable gas detection	0 - 100% LEL	n/a
	240		NP-18SHM NP-18SHP	**Catalytic**	Flammable gas sensor element, not hydrogen-specific; Single header, metal or plastic housing	Flammable gas detection	0 - 100% LEL (linear to 60% LEL)	n/a
	241		NP-30SMM	**Catalytic**	Flammable gas sensor element, not hydrogen-specific;	Flammable gas detection	0 - 100% LEL	n/a
	242		NP-30SHM NP-30SHP	**Catalytic**	Flammable gas sensor element, not hydrogen-specific, Single header, metal or plastic housing	Flammable gas detection	0 - 100% LEL	n/a
	243		NP-21TSMM	**Catalytic**	Flammable gas sensor element, not hydrogen-specific;	Flammable gas detection	0 - 100% LEL	n/a
	244		NT-H2-SR	**Electrochemical** Solid state electrolyte	Hydrogen sensor for gas detection	Hydrogen, car park, building, residential	0 - 50% LEL	n/a
	245		NT-H2-SF	**Electrochemical** Solid state electrolyte	Hydrogen sensor for gas detection	Hydrogen, car park, building, residential	0 - 50% LEL	n/a
	246		Genius	Two sensor elements: **Optical** IR & **Catalytic**	Dual Tech Sensor Family, detection of two gases, composed of NDIR sensor (IRNET-P-20) and hydrogen pellistor for H_2 %LEL detection	Hydrocarbon and hydrogen detection 0-100% LEL	0 - 100% LEL (hydrogen)	n/a
61	247	NEMOTO Sensor Engineering Co. Ltd. Tokyo, Japan	NC-170 (NCP-170)	(Pellistor)	General combustible gas sensor element matched pair type	Industrial sensor	Less than 100% LEL	n/a
	248		NC-170S (NCP-170S)	(Pellistor)	General combustible gas sensor element single header type	Industrial sensor	Less than 100% LEL	n/a

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	249		NC-300 (NCP-300)	(Pellistor)	General combustible gas sensor element matched pair type	Industrial sensor	Less than 100% LEL	n/a
	250		NC-300S (NCP-300S)	(Pellistor)	General combustible gas sensor element single header type	Industrial sensor	Less than 100% LEL	n/a
	251		NC-180 (NCP-180)	(Pellistor)	General combustible gas sensor element matched pair type	Industrial sensor	Less than 100% LEL	n/a
	252		NC-180S-H (NCP-180S-H)	(Pellistor)	hydrogen-specific sensor element single header type	Industrial sensor	Less than 100% LEL	n/a
	253		NC-180-H (NCP-180-H)	(Pellistor)	hydrogen-specific sensor element matched pair type	Industrial sensor	Less than 100% LEL	n/a
	254		NC-50S (NCP-50S)	(Pellistor)	General combustible gas sensor element single header type	Industrial sensor	Less than 100% LEL	n/a
	255		NC-70S (NCP-70S)	(Pellistor)	General combustible gas sensor element single header type	Industrial sensor	Less than 100% LEL	n/a
	256		NAP-2A	**Catalytic**	General combustible gases; universal type	Residential sensor; Gas detectors, gas densitometers	Hydrogen: 0.05 - 4%, 0.05 - 1.5% (high accuracy)	n/a
	257		NAP-55A	**Catalytic**	General combustible gases; small sized, lower power consumption	Residential sensor; Gas detectors, leak testers	Hydrogen: 0.05 - 4%, 0.05 - 1.5% (high accuracy)	n/a
	258		NAP-56A	**Catalytic**	General combustible gases; small sized, lower power consumption	Residential sensor	Hydrogen: 0.05 - 4%, 0.05 - 1.5% (high accuracy)	n/a
	259		NAP-50A	**Catalytic**	General combustible gases; low sensitivity to ethanol	Residential sensor; Gas detectors	Hydrogen: 0.05 - 4%, 0.05 - 1.5% (high accuracy)	n/a
	260		NAP-50AF	**Catalytic**	General combustible gases; with charcoal filter	Residential sensor	Hydrogen: 0.05 - 4%, 0.05 - 1.5% (high accuracy)	n/a
	261		NAP-3A	**Catalytic**	LPG, hydrogen, and organic solvent vapor; universal type	Residential sensor; LP Gas detectors, leakage tester, gas denistometers	Hydrogen: 0.05 - 4%, 0.05 - 1.5% (high accuracy)	n/a
	262		NAP-66A	**Catalytic**	LPG, hydrogen, and organic solvent vapor; small sized, lower power consumption	Residential sensor; Gas detectors, leak testers	Hydrogen: 0.05 - 4%, 0.05 - 1.5% (high accuracy)	n/a
	263		NAP-67A	**Catalytic**	LPG, hydrogen, and organic solvent vapor; small sized, lower power consumption	Residential sensor	Hydrogen: 0.05 - 4%, 0.05 - 1.5% (high accuracy)	n/a
	264		NAP-100AM	**Catalytic**	Target: Flammable/combustible gases for commercial use; high performance	Industrial	1 - 50% LEL	n/a
	265		NAP-100AC	**Catalytic**	Target: Flammable/combustible gases for commercial use; high performance	Industrial	3 - 100% LEL	n/a
	266		NAP-100AD	**Catalytic**	Target: Flammable/combustible gases for commercial use; high performance	Industrial	1 - 50% LEL	n/a
	267		NAP-100AH	**Catalytic**	Target: Hydrogen, CO; commercial use, high performance	Industrial	1 - 50% LEL (Hydrogen)	n/a
	268		NSU-131A	**Catalytic**	General combustible gases, hydrogen	Residential sensor, for hydrogen fuel cell, pre-set alarm calibration	Calibrated Alarm Concentration: 3600 - 4000 ppm Calibration Range: 5 - 25% LEL (Hydrogen)	n/a

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	269		NSU-131AF	**Catalytic**	General combustible gases, hydrogen	Residential sensor, for hydrogen fuel cell, pre-set alarm calibration	Calibrated Alarm Concentration: 3600 - 4000 ppm Calibration Range: 5 - 25% LEL (Hydrogen)	n/a
62	270	Neodym Systems Inc. Vancouver, Canada	HydroKnowz®	**Catalytic**	Hydrogen gas monitor	Power generation equipment	0 - 25000 ppm	n/a
	271		ProtiSen®	**Catalytic**	Hydrogen gas sensor module	Power generation equipment	0 - 40000 ppm	n/a
	272		PowerKnowz®	(Metal Oxide Semiconductor / MOS Tin dioxide)	Combustible gas detector, Hydrogen-specific option: Model PK-GH	Specifically designed for safety applications in fuel cells and gas-burning power generators	0 - 20000 ppm	n/a
	273		MiniKnowz®	(Metal Oxide Semiconductor / MOS Tin dioxide)	Combustible gas sensor module, Hydrogen-specific option: Model MN-GH	Specifically designed for safety applications in fuel cells and gas-burning power generators	0 - 20000 ppm	n/a
63	274	Net Safety Monitoring Inc. Calgary, Canada	SC310	**Catalytic**	Combustible gas detector, hydrogen detection range is given in data sheet; For control and communication: Millenium II fixed gas detection transmitters in single / basic single channel, dual channel versions	Combustible gas detection	0 - 100% LEL	US/CDN: Class I, Div. 1, Groups B, C, D; Class I, Zone 1, Group IIB + H_2, Type 4X, IP64 FM 6310/6320, ANSI/ISA 12.13.01, CSA-C22.2 No152 ATEX - II 2 G Exd IIB + H_2 T5 IP64 IEC 61779-1, IEC 61779-4 IECEx (pending) INMETRO - Ex d IIB + H_2 T4 Gb IP66/67 GOST-R
64	275	New Cosmos Electric Co. Ltd. Osaka, Japan		(Hot wire semiconductor)	Target gas: Combustible / Toxic Sampling method: Diffusion type; Also distributed by Bionics Instrument	Gas detector head, industrial use	n/a	n/a
	276		KD-12B	**Catalytic**	Target gas: Combustible / Toxic Sampling method: Diffusion type; Also distributed by Bionics Instrument	Gas detector head, industrial use	n/a	n/a
	277		KD-12C	**Thermal conductivity**	Target gas: Hydrogen, Helium, CO_2 Sampling method: Diffusion type; Also distributed by Bionics Instrument	Gas detector head, industrial use	n/a	n/a
	278		XP-3110	**Catalytic**	Portable detector; Target: Combustible gases and vapors, gas to be detected must be specified	Monitoring a risk of explosion	0 - 100% LEL	Ex ibd II BT3
	279		XP-3118	**Catalytic**	Portable detector; Target: simultaneous detection of combustible gas and oxygen concentration, gas to be detected must be specified	Compliance work, safety and environmental monitoring	0 - 100% LEL	Ex ibd II BT3
	280		XP-3140	**Thermal conductivity**	Combustible gas detectors; portable; gas to be detected has to be specified	Inspecting the amount of gas remaining in tanks	0 - 100 vol.%	Ex ibd II BT3
	281		XP-3160	**Catalytic**	Portable detector; Target: Combustible gases and vapors, gas to be detected must be specified	Measuring toxic and combustible gases in the ppm range	0 - 5000 ppm 0 - 10000 ppm	Ex ibd II BT3

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	282		XP-702 II Z	(Hot wire semiconductor)	Combustible gas leak detector; allows simultaneous detection of two types of gas	Detecting small gas leaks, detection of one or two types of gas simultaneously	10 ppm (min.)	n/a
	283		XP-703 D	(Hot wire semiconductor)	Portable detector; Target gases: semiconductor manufacturing gases including hydrogen Also distributed by Bionics Instrument	Gas leak and trace detection in semiconductor manufacturing	1.0 ppm (min.)	n/a
65	284	Nolek Norsborg, Sweden	SniffIT X1	(Novel patented SniffIT technology®)	Helium and hydrogen leak detector, hand-held	Leak test in various application areas	n/a	n/a
66	285	Nova Analytical Systems Niagara Falls, NY, USA	335 Series	**Thermal conductivity**	Portable Process Hydrogen Analyzer	Analysis of hydrogen in a binary gas mixture in process gases such as H_2 in air, H_2 in N_2, H_2 in CO_2, H_2 in Ar, H_2 in O_2, etc.	0 - 100% H_2 in a binary gas mixture	n/a
	286		340 Series	**Thermal conductivity**	Portable Analyzer for Oxygen and Hydrogen; Oxygen detection: electrochemical sensor	Analysis of O_2/H_2 in exothermic furnace atmospheres for copper, brass, or steel annealing, neutral heating, sintering, glass metal beds, or oxide coating of steel.	0 - 25.0% O_2, 0 - 40.0% H_2 (Model 340) 0 - 2.0% and 0 - 25.0% O_2, 0 - 40.0 % H_2 (Model 340) 0 - 100 to 0 - 9999 ppm O_2, 0 - 40% H_2 (Model 340L)	n/a
	287		380 Series	**Thermal conductivity**	Portable Tri-gas Analyzer, Hydrogen Purity Analyzer	Gas analyzer for power generators: Analysis of atmosphere inside hydrogen-cooled power generator during purity and purge modes.	0 - 100% H_2 in Air 0 - 100% H_2 in CO_2	n/a
	288		430 Series	**Thermal conductivity**	Process Hydrogen Analyzer	Continuous analysis of up to 100% hydrogen in process gas streams. Also recommended for: H_2 cooled generators, electrolysis units, refinery gas, heat treating atmospheres, etc.	Any between 0 - 2.0% and 0 - 100.0% H_2	Class 1, Div. 1, Groups A, B, C, D Hazardous Area Rating (Models 430N7MC & 430PMN7) Class 1, Div. 2, Hazardous Area Rating (Model 430D2)
	289		436 Series	**Thermal conductivity**	Continuous tri-gas purity and purging monitor of hydrogen cooled power generators	Power generation industry	0 - 100% H_2 in Air 0 - 100% H_2 in CO_2	Class 1, Div. 1, Groups A, B, C, D Hazardous Area Rating (Models 436N7MC & 436PMN7) Class 1, Div. 2, Hazardous Area Rating (Model 436D2)
	290		870 Series	**Thermal conductivity**	Continuous gas analyzer; Analysis of any combination of CH_4, CO_2, CO, H_2, O_2. O_2: electrochemical detection CO, CO_2, CH_4: NDIR infrared detector	Steel-making and metals industries; Monitoring of atmospheres accociated with steel-making and metal working or other industrial processes.	0 - 5.0%, 0 - 50.0%, 0 - 100.0% H_2	n/a
	291		970 Series	**Thermal conductivity**	Syngas / gasification analyzer; Analysis of any combination of CH_4, CO_2, CO, H_2, O_2. O_2: paramagnetic detection, CO, CO_2, CH_4: NDIR infrared detector	Continuous monitoring of syngas and gasification atmospheres or other industrial processes.	0 - 5.0%, 0 - 50.0%, 0 - 100.0% H_2	n/a
	292		7200-5	**Catalytic**	Continuous flue gas analyzer, combination of analyzed gases includes combustible gases, e.g. H_2	Continuous analysis of flue gas for different combinations and ranges of gases including combustible gases	0 - 2%, 0 - 5%, 0 - 10% Combustibles	n/a

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	293		7900P Series	**Thermal conductivity**	Portable industrial analyzers; Analysis of any combination of CO, CO_2, CH_4, H_2, O_2. O_2: electrochemical detection, CO, CO_2, CH_4: infrared detector	Monitoring heat treating atmosphere or process gases.	0 - 2.0%, 0 - 50.0% H_2	n/a
	294		7900 Series	**Thermal conductivity**	Single and multi-gas industrial process gas analyzer; Continuous monitoring of any combination of gases such as O_2, CH_4, CO_2, CO, H_2. O_2: electrochemical detection, CO, CO_2, CH_4: NDIR infrared detector	Industrial processes including heat treating atmospheres	0 - 2.0%, 0 - 50.0% H_2	n/a
67	295	NTM Sensors Lewis Center, OH, USA	NTM SenseH2®	**Other/New** Chemi-resistive ceramic	patent-pending technology; Alarm box and calibration kit available	Hydrogen fuelled back-up power systems, battery based UPS or cabinet system monitoring, hydrogen refuelling stations and hydrogen generation (electrolyzer) systems, fuel cell power devices including forklift trucks, any hydrogen monitoring requiring high sensitivity and quick response	0.25 - 4.0% (in air)	UL, ATEX, CE (hazardous locations)
68	296	ODB-Tec GmbH & Co. KG Neuss, Germany	ODB-Schottky-Diode Hydrogen Sensor	**Work function** Schottky Diode	Might be still under development. Public funding and cooperation with university is highlighted.	Fuel cell / automotive low-cost consumer product	n/a	n/a
69	297	Oldham Arras, France Industrial Scientific Pittsburgh, PA, USA	CTX 300	**Electrochemical**	Fixed Gas Detector, allows for hydrogen-specific sensor	Detection of toxic gases or lack of oxygen	2000 ppm (Model WC3 H2A / Hydrogen) 2 % (Model WC3 H2B / Hydrogen)	US/CDN: CSA EMC: EN 50270:06
	298		iTrans	**Electrochemical**	Fixed-point Monitor, allows for hydrogen-specific sensor		0 - 999 ppm (Hydrogen)	NRTL/c & CSA, ATEX (pending), IEC (pending), China
	299		iTrans 2	**Electrochemical**	Fixed Gas Detector, allows for hydrogen-specific sensor, detection and display of up to two gases	Oil and Gas Industry, Offshore Drilling, Utilities and Power, Petrochemical Industry, Municipal Water and Waste Treatment, Food and Beverage Production	0 - 999 ppm (Hydrogen)	NRTL/c & CSA, ATEX (pending), IEC (pending), China
	300		OLC 10	**Catalytic** Pellistor	Combustible/flammable gas and vapor monitor/transmitter; OLCT 10 version for toxic gases available	Designed for the use in boiler rooms and parking garages	0 - 100% LEL	EMC: EN 50270 ATEX Approved
	301		OLC 20	**Electrochemical** **Thermal conductivity** Catharometer	Detector/transmitter for fixed gas detection with choice of two different hydrogen-specific sensors; general flammable gas catalytic sensor also available	Designed for indoor or outdoor facility monitoring	2000 ppm (electrochemical) 0 - 100 vol.% (catharometer)	EMC: EN 50270 ATEX Certified
	302		OLC 50	**Electrochemical** **Thermal conductivity** Catharometer	Detector/transmitter for fixed gas detection with choice of two different hydrogen-specific sensors; general flammable gas catalytic sensor also available	Designed for manufacturers, refineries and other industries	2000 ppm (electrochemical) 0 - 100 vol.% (catharometer)	EMC: EN 50270 ATEX Certified

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	303		OLCT 60	**Electrochemical**	Detector/transmitter for fixed gas detection, hydrogen-specific sensor; general explosive gas catalytic sensor also available	Gas detection	2000 ppm	ATEX SIL 2 (EN 50271) EMC (EN 50270)
	304		OLCT 80	**Electrochemical** **Thermal conductivity** Catharometre	Detector/transmitter for fixed gas detection with choice of two different hydrogen-specific sensors; general flammable gas catalytic sensor also available	Gas detection	2000 ppm (electrochemical) 0 - 100 vol.% (catharometer)	EN 50054, EN 45544, EN 50104 EN 50270, EN 60529, EN 51271
	305		OLCT 100	**Electrochemical**	Detector/transmitter for fixed gas detection, hydrogen-specific sensor; general explosive gas catalytic sensor also available	Steel mills, Petrochemical facilities, Chemical industry, Pharmaceutical industry, Food industry, Refrigeration industry, Water treatment	2000 ppm	ATEX, IECEx SIL 2 (EN 50402 / EN 61508) EN IEC 60079-29-1 (Metrological performance) EN 50270 (EMC)
70	306	Pronova GmbH Berlin, Germany	MGA45	**Electrochemical**	MonoGas® Analyzer with EC-Module: Detection of H_2 and other gases	Emission monitoring, leakage monitoring; portable and fixed	50, 100, 300 ppm	n/a
	307		MGA22	**Thermal conductivity**	MonoGas® Analyzer with WLD-Module: Detection of H_2 in N_2 or air, other gases in N_2 or air	Leakage monitoring, petrochemical, monitoring of H_2-containing gas mixtures; portable and fixed	1, 5, 10, 20, 30, 50, 80, 100 vol.% H_2 in N_2	n/a
	308		ACS Sensor	**Electrochemical**	Gas sensor including electronics, various gases, including hydrogen	Gas detection, various gases	0 - 200 ppm (min.) 0 - 500 ppm (max.)	n/a
71	309	RAE Systems Inc. San Jose, CA, USA	RAEGuard LEL	**Catalytic**	Fixed combustible gas transmitter; hydrogen not explicitely mentioned in data sheet (product search result)	Industries: refineries, oil production, chemical plants, industrial safety, power plants, steel mills	0 - 100% LEL (combustible gas)	UL Class I, Div. 1, Groups B, C, D T6
	310		ToxiRAE Pro LEL	**Catalytic**	Personal wireless monitor for combustible gases and vapors, hydrogen not explicitely mentioned in data sheet (product search result)	construction, foundries, oil and gas, …	0 - 100% LEL (combustible gas)	CSA, ATEX, IECEx, China Ex; CE Compliance: EMC 2004/108/EC, R&TTE 1999/5/EC, ATEX 94/9/EC; Performance Test Compliance: C22.2 No. 152, ANSI/ISA-12.13.01
72	311	Riken Keiki Co. Ltd. Tokyo, Japan	GX-2003	**Catalytic**	Personal four gas monitor; combustible gas detection, not hydrogen specific	Gas detection & monitoring	0 - 100% LEL	CSA (CDN/US)
	312		GX-2009	**Catalytic**	Personal four gas monitor; combustible gas detection, not hydrogen specific	Confined spaces, Refineries/Petrochemical, Waste water treatment, Utilities, Chemical plants, Hazardous materials, Fire services, Mining, Pharmaceuticals	0 - 100% LEL	ATEX, IECEx, CSA, CE, JML
	313		GX-2012	**Catalytic**	Personal four gas monitor; combustible gas detection, not hydrogen specific	Personal monitoring, Confined spaces, Refineries/Petrochemical, Waste water treatment, Utilities, Chemical plants, Hazardous materials, Fire services, Mining	0 - 100% LEL	ATEX, IECEx, TIIS, CE
	314		GX-8000 LEL	**Catalytic**	Portable single gas monitor; combustible gas detection in air, H_2 detection in air	Single gas monitoring	0 - 100% LEL (hydrogen in air)	IECEx, ATEX, TIIS, MED, HK, CE Compliance with IEC 60079-29-1
	315		GX-8000	**Catalytic** **Thermal conductivity**	Portable multi gas monitor general combustible gases including H_2	Confined spaces, Refineries/Petrochemical, Waste water treatment, Utilities, Chemical plants, Hazardous materials, Fire services, Mining, Pharmaceuticals, Fuel Cell Facilities	0 - 100% LEL (catalytic) 0 - 100 vol.% (TC)	IECEx, ATEX, TIIS, MED, HK, CE Compliance with IEC 60079-29-1

No. M	No. S	Manufacturer City, Country	Sensor Model	Technology	Description / Remark	Application	Detection Range (H_2)	Certificates / Approvals / Tests / Classification
	316		GD-A8 series	**Catalytic**	Gas detector head, fixed gas detector; hydrogen in air, etc.	Various industries, oil and gas, petrochemical, ships, iron steel, automobile, etc.	0 - 100% LEL	TIIS, CE, NK, KR, CCS, GOST, CEC, KIMM Exd II C T4 CE approved
	317		GD-D8 series	**Catalytic**	Gas detector head, fixed gas detector; general combustible gases in air	Various industries, oil and gas, petrochemical, ships, iron steel, automobile, etc.	0 - 100% LEL	TIIS, CE, NK, GOST d2G4 / Exd II B T6 CE approved
	318		GD-V77D	(Semiconductor cell)	Fixed gas detector Combustible gases & Hydrogen	Semiconductor processing gases	0 - 2000 ppm (Hydrogen)	CE
	319		SD-1 GP	**Catalytic**	Smart transmitter / gas detector; fixed gas detector; combustible gases, H_2, etc.	Measuring gas: Combustible gas in the presence of hydrogen Petroluem refining plant	0 - 100% LEL	ATEX, TIIS, CE Exd II C T5
	320		FI-21	**Optical** Interferometric	Optical gas indicator, portable, single gas, gas purity: H_2 in air, etc.	Gas purity measurement	0 - 100 vol.% (Hydrogen in Air, N_2, CO_2)	n/a
	321		FI-800	**Optical** Interferometric	Gas analyzer, fixed gas detector, combustible gases and vapours, H_2, etc.	Gas concentration in drying facilities, purity control of several gases, etc.	0 - 100 vol.% (Hydrogen)	Exd II B + H2 T4 TIIS, GOST, KOSHA
	322		GP-01	**Catalytic**	Personal combustible gas monitor, combustible gas in air	Hazardous material, Refineries/Petrochemical, Utilities, Mining, Water/Waste water treatment, Chemical Plants, Pharmaceuticals, Fire services	0 - 100% LEL	CSA, ATEX, JML
	323		GP-88A	**Catalytic**	Portable combustible single gas monitor, general combustible gas; dual range	Gas detection & monitoring	0 - 10% LEL (low) 0 - 100% LEL (high)	TIIS Ex iad II B T3
	324		GP-88AS	**Catalytic**	Portable combustible single gas monitor, general combustible gas, toxic gas & solvent, including hydogen; dual range	Gas detection & monitoring	0 - 500 ppm (low) 0 - 5000 ppm (high)	TIIS Ex iad II B T3
73	325	**RKI Analytical Instruments GmbH Bad Homburg, Germany**	SP-205-ASC	Combination of **Catalytic** & (Semiconductor)	Portable gas detector	Gas detector for leakage monitoring in semiconductor industry	1.0 ppm (min.)	n/a
	326	(A Riken Keiki company)	GC-70D NCU	**Catalytic**	Fixed; hydrogen gas detection, other gas detectors available		0 - 100% LEL	CE
	327		GC-70D SGU	(Semiconductor)	Fixed; hydrogen gas detection, other gas detectors available		0 - 500 / 1000 / 2000 ppm 0 - 2.0 vol.%	CE
74	328	**RKI Instruments Inc. Union City, CA, USA**	H2 Specific LEL 65-2450RK	**Catalytic** coated with molecular sieve	Hydrogen-specific sensor/transmitter	Semiconductor, power plants, fuel cell industry, R&D applications, gas plants	0 - 100% LEL	n/a
	329	(A Riken Keiki company)	H2 Specific ppm 65-2440RK	(Metal oxide semiconductor, with molecular sieve)	Hydrogen-specific sensor/transmitter	Semiconductor, power plants, fuel cell industry, R&D applications, gas plants	0 - 2000 ppm	n/a
	330		PS-2	(Metal Oxide Semiconductor / MOS)	Single point stand alone monitor, LEL or ppm detection ranges available for many gases	Hydrogen detection in battery rooms / battery storage locations petrochemicla plants, refineries, automotive, etc.	LEL / ppm	n/a
75	331	**Scott Safety Monroe, NY, USA**	Freedom 6000	**Electrochemical** **Catalytic**	Universal transmitter for toxic (EC) and combustible (CAT) gases for incorporation into a fixed gas detection system; various gas sensors are available, including hydrogen (as toxic gas)	Wide variety of industries: refineries, oil and gas production, gas storage and distribution facilities, etc.	n/a	Combustible Transmitter: Class I, Div. 1, Groups A, B, C, D or Class I, Div. 1, Groups B, C, D ATEX, IECEx (pending) Toxic Transmitter: Class I, Div. 2, Groups B, C, D Class I, Div. 1, Groups B, C, D (pending) ATEX (pending), IECEx (pending)

No. M	No. S	Manufacturer City, Country	Sensor Model	Technology	Description / Remark	Application	Detection Range (H_2)	Certificates / Approvals / Tests / Classification
76	332	SENKO Co. Ltd. Korea	Hydrogen Gas Sensor (P/N SS1178)	**Electrochemical**	Hydrogen sensor, analog & digital transmitter board available	Portable & fixed gas detector, industrial safety (petrochemical, refining) waste water, sewage treatment plant, mine, etc.	0 - 1000 ppm	n/a
	333		Portable Gas Detector (P/N SP2277)	**Electrochemical**	Portable Gas Detector, specific target gas: hydrogen	Gas detection	0 - 500 ppm 0 - 1000 ppm	EEx ia IIC T4
77	334	Sensitron S.r.l. Cornaredo, Italy	SMART 3G-D2	**Catalytic** Pellistor type	SMART 3G series, with hydrogen sensor (P/N S2157H2; N.E.T. product line)	Industrial safety, industrial applications with tougher industrial requirements	% LEL	ATEX Certified, Group II 2G SIL2 HW (TUV) EN 502070:2011, EN 61000 (EMC)
	335		SMART 3G-C2	**Catalytic** Pellistor type	SMART 3G series, with hydrogen sensor (P/N S2097H2; N.E.T. product line)	Industrial safety, industrial applications, high performance products	% LEL	ATEX Certified, Group II 2G SIL2 HW (TUV) EN 502070:2011, EN 61000 (EMC)
	336		SMART S-SS	**Catalytic** Pellistor type	SMART S Single sensor, Hydrogen sensor availbale (N.E.T. product line)	For toughest industrial requirements, monitoring of toxic and flammable gases in	n/a	ATEX II 2G SIL 2 (3) certified (EN 50402)
78	337	Z.B.P. Sensor Gaz Tychy, Poland	EKP-1/N/H2	**Catalytic**	Explosimetric Hydrogen sensor head, concentration up to 100% LEL, uses sensor head PC-31xx	Measurement of hydrogen concentration	0 - 100% LEL H_2	ATEX II 2G Ex d ia IIC T5
	338		EKP-1/W/H2	**Catalytic**	Explosimetric Hydrogen sensor head, concentration in range 0-100% V/V, uses sensor head PC-62	Measurement of hydrogen concentration	0 - 100 vol.% H_2	ATEX II 2G Ex d ia IIC T5
	339		EKP-1/NW/H2	**Catalytic**	Explosimetric Hydrogen sensor head, concentration in range 0-100% V/V in two subranges, uses sensor heads PC-31xx & PC-62	Measurement of hydrogen concentration	Two subranges: 0 - 100% LEL H_2 0 - 100% vol.% H_2	ATEX II 2G Ex d ia IIC T5
	340		PC-31xx	**Catalytic**	Pellistor head for use in EKP-1/N/H_2 and EKP-1/NW/H_2	Measurement of hydrogen concentration and most combustible gases and vapors	0 - 100% LEL CH_4	ATEX I M1 EEx ia I ATEX II 2G EEx ia II
	341		PC-32xx	**Thermal Conductivity**	sensing element	Measurement of hydrogen concentration and most combustible gases and vapors	0 ... 100 vol% CH_4	ATEX I M1 EEx ia I ATEX II 2G EEx ia II
79	342	Sensors Europe GmbH Erkrath, Germany	AGM 22	**Thermal conductivity**	OEM Gas Transmitter for H_2, He, Xe, SF6 and other gases	Industrial applications, Gas Warning, Process Control, Gas Quality	0 - 5, 10, 50, 80, 100 vol.%	optional
80	343	Hermann Sewerin GmbH Gütersloh, Germany	Snooper mini		Handheld hydrogen leak detector, specific hydrogen sensor in use, no sensor specification	Gas leak detection indoors; leaks in pipes, valves, and other industrial products	0 - 100 ppm, > 100 - 2000 ppm, > 2000 - 10000 ppm (H_2)	n/a
	344		EX-TEC PM 4	(Semiconductor) (ppm) **Catalytic** (% LEL) **Thermal Conductivity** (vol.%)	Flammable gas detection, detection, warning, concentration measuring instrument; Operator selectable flammable gas menu, including hydrogen; no sensor specification	Gas leak detection indoors; % LEL (warning), ppm (detecting), vol.% (measuring) sensors available. Instrument available for warning application, in all combinations of two applications and for all three applications	% LEL (warning): 0 - 4.4 vol.% ppm (detecting): 0 - 22000 ppm vol.% (measuring): 0 - 100 vol.%	ATEX Certificate (94/9/EG) II 2 G Ex d e ib IIB T4
	345		EX-TEC GM 4	**Electrochemical**	Gas detection, gas warning and gas concentration measuring instrument for toxic and flammable gases, Target gas: Hydrogen etc.	Pipe leak detection Environmental air monitoring Monitoring of chamical or biological processes	0 - 10000 ppm (H_2)	ATEX Certificate (94/9/EG) II 2 G Ex e ib IIC T4

No. M	No. S	Manufacturer City, Country	Sensor Model	Technology	Description / Remark	Application	Detection Range (H_2)	Certificates / Approvals / Tests / Classification
81	346	SGX Sensortech Chelmsford, UK	EC4-1000-H2	**Electrochemical**	Hydrogen sensor element	Industrial safety: Mining, oils & gas, confined space entry, indoor air quality, industrial area protection, leak detection	0 - 1000 ppm	n/a
	347		VQ10 SB	**Catalytic** Standard pellistor pair	combustible gas sensor element, hydrogen (pinhole) compensator		0 - 100% LEL	n/a
	348		VQ1 B	**Catalytic** Standard pellistor pair	Combustible gas sensor element, detection of combustible gases, particularly methane in air mixtures		10% max. methane concentration	n/a
	349		VQ2	**Catalytic** Standard pellistor pair	Combustible gas sensor element, detection of combustible gases, particularly methane in air mixtures		5% max. methane concentration	n/a
	350		VQ21T B	**Catalytic** Poison-resitant pellistor pair	Combustible gas sensor element, detection of most flammable gases and vapors	poison resistant detectors for general purpose applications, particularly for fixed point systems where the consideration of power consumption is not an overriding factor	100% LEL max.	n/a
	351		VQ21T BJ	**Catalytic** Poison-resitant pellistor pair	Combustible gas sensor element, detection of most flammable gases and vapors	poison resistant detectors for general purpose applications, particularly for fixed point systems where the consideration of power consumption is not an overriding factor	100% LEL max.	n/a
	352		VQ21T SB	**Catalytic** Poison-resitant pellistor pair	Combustible gas sensor element, detection of most flammable gases and vapors; Modification for superior performance in the presence of hydrogen	poison resistant detectors for general purpose applications, particularly for fixed point systems where the consideration of power consumption is not an overriding factor	100% LEL max.	n/a
	353		VQ22B	**Catalytic** Poison-resitant pellistor pair	combustible gas sensor element		0 - 100% LEL methane	n/a
	354		VQ23B	**Catalytic** Poison-resitant pellistor pair	combustible gas sensor element		0 - 100% LEL methane	n/a
	355		VQ23TB	**Catalytic** Poison-resitant pellistor pair	combustible gas sensor element		0 - 100% LEL methane	n/a
	356		VQ24SB	**Catalytic** Standard pellistor pair	combustible gas sensor element, hydrogen (pinhole) compensator		0 - 100% LEL methane	n/a
	357		VQ25B	**Catalytic** Poison-resitant pellistor pair	combustible gas sensor element		0 - 100% LEL methane	n/a
	358		VQ3	**Catalytic** Standard pellistor pair	combustible gas sensor element		0 - 100% LEL methane	n/a
	359		VQ31MB	**Thermal conductivity** Pellistor pair	combustible gas sensor element		0 - 100 vol.%	n/a
	360		VQ35MB	**Thermal conductivity** Pellistor pair	combustible gas sensor element		0 - 100 vol.%	n/a
	361		VQ41TSB	**Catalytic** Poison-resitant pellistor pair	ammonia/combustible gas sensor element hydrogen (pinhole) compensator		Ammonia 0 - 10% LEL, 0 - 1.5 vol.%	n/a
	362		VQ546M	**Thermal conductivity** Pellistor pair	Combustible gas sensor element	Ideally suited for use in portable instruments	vol.%	ATEX, IECEx, CSA certified, UL recognised II 2G Ex d IIC Gb, I M2 Ex d I Mb

No. M	No. S	Manufacturer City, Country	Sensor Model	Technology	Description / Remark	Application	Detection Range (H_2)	Certificates / Approvals / Tests / Classification
	363		VQ546MR	**Thermal conductivity** Pellistor pair	Combustible gas sensor element	Ideally suited for use in portable instruments	vol.%	ATEX, IECEx, CSA certified, UL recognised II 2G Ex d IIC Gb, I M2 Ex d I Mb
	364		VQ547TS	**Catalytic** Poison-resitant pellistor pair	Combustible gas sensor element	Ideally suited for use in portable instruments	LEL level	ATEX, IECEx, CSA certified, UL recognised II 2G Ex d IIC Gb, I M2 Ex d I Mb
	365		VQ548ZD	**Catalytic** Poison-resitant pellistor pair	Combustible gas sensor element	Ideally suited for use in portable instruments	LEL level	ATEX, IECEx, CSA certified, UL recognised II 2G Ex d IIC Gb, I M2 Ex d I Mb
	366		VQ548ZD/W	**Catalytic** Poison-resitant pellistor pair	Combustible gas sensor element, improved version of VQ548ZD	Optimised performance gas sensing head for mining type applications	0 - 100% LEL methane	ATEX, IECEx, CSA certified, UL recognised II 2G Ex d IIC Gb, I M2 Ex d I Mb
	367		VQ549ZD	**Catalytic** Poison-resitant pellistor pair	Combustible gas sensor element	Ideally suited for use in portable instruments	LEL level	ATEX, IECEx, CSA certified, UL recognised II 2G Ex d IIC Gb, I M2 Ex d I Mb
	368		VQ549ZD/W	**Catalytic** Poison-resitant pellistor pair	Combustible gas sensor element, improved version of VQ549ZD	Optimised performance gas sensing head for mining type applications	0 - 100% LEL methane	ATEX, IECEx, CSA certified, UL recognised II 2G Ex d IIC Gb, I M2 Ex d I Mb
	369		VQ5MB	**Thermal conductivity** Pellistor pair	combustible gas sensor element		0 - 100 vol.%	n/a
	370		VQ61	**Catalytic** Standard & poison-resitant pellistor pair	combustible gas sensor element		0 - 100% LEL methane	n/a
	371		VQ621T/1	**Catalytic** Poison-resitant pellistor pair	combustible gas sensor element		0 - 100% LEL methane	ATEX, CSA certified II 2G Ex d IIC T5
	372		VQ621T/3	**Catalytic** Poison-resitant pellistor pair	combustible gas sensor element		0 - 100% LEL methane	ATEX, CSA certified II 2G Ex d IIC T5
	373		VQ631M/2	**Thermal conductivity** Pellistor pair	combustible gas sensor element		0 - 100 vol.%	ATEX, CSA certified II 2G Ex d IIC T5
	374		VQ641TS/1	**Catalytic** Poison-resitant pellistor pair	combustible gas sensor element, hydrogen (pinhole) compensator		0 - 100% LEL methane	ATEX, CSA certified II 2G Ex d IIC T5
82	375	SIM GmbH Oberhausen, Germany	HS 2000 10 00	**Catalytic** Pellistor	Hydrogen sensor integrated in Agilent Gas Chromatography Systems, Alarm and switch to inert gas at concentration limits	Continuous detection of the hydrogen proportion of the GC oven air	0 - 25% LEL (0 - 1.0 vol.%) H_2	n/a
	376		HS 1000 10 00	**Catalytic** Pellistor	External Hydrogen Sensor System for Gas Chromatography	Continuous detection of the hydrogen proportion of the GC oven air	0 - 25% LEL (0 - 1.0 vol.%) H_2	n/a
83	377	Solidsense GmbH Krailling, Germany	SEC H2 20000 4 SE 5 V	**Electrochemical** Solid-state electrolyte amperometric	Hydrogen gas sensor element	Hydrogen detection	0 - 20000 ppm	n/a
	378		SEC H2 20000 4 S	**Electrochemical** Solid-state electrolyte amperometric	Hydrogen gas sensor element	Hydrogen detection	0 - 20000 ppm	n/a
	379		SEC H2 20000 Micro	**Electrochemical** Solid-state electrolyte amperometric	Hydrogen gas sensor element	Hydrogen detection	0 - 20000 ppm	n/a
	380		SEC H2 20000 Micro +	**Electrochemical** Solid-state electrolyte amperometric	Hydrogen gas sensor element	Hydrogen detection	0 - 20000 ppm	n/a

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	381		SEC H2 20000 SS1	**Electrochemical** Solid-state electrolyte amperometric	Hydrogen gas sensor element	Hydrogen detection	0 - 20000 ppm	n/a
84	382	Synkera Technologies Inc. Longmont, CO, USA	P/N 701	**Resistive** Metal oxide semiconductor / MOS	ProKera™ Product Line Trace Hydrogen Sensor	Chemical sensing, security and defense, etc.	n/a	n/a
	383		P/N 703	**Resistive** Metal oxide semiconductor / MOS	ProKera™ Product Line LEL Hydrogen Sensor	Chemical sensing, security and defense, etc.	1000 ppm - 2% (low power operation LEL hydrogen detection) 50 - 1000 ppm (ppm hydrogen detection)	n/a
	384		P/N 724	**Resistive** Metal oxide semiconductor / MOS	MicroKera™ 4L Product Line; Hydrogen Sensor Low-power MOS microsensor	Chemical sensing, security and defense, etc.	n/a	n/a
85	385	TAD Gesellschaft für Elektronik-Systemtechnik mbH Unna, Germany	GMS-K2	**Thermal conductivity**	Stationary Gas Measuring System	H_2 / O_2 Measuring system for metallurgic annealing processes	n/a	n/a
	386		GMS.H-H2.wl	**Thermal conductivity**	Stationary Gas Measuring System	Hydrogen measuring system for tightness tests, determination of hydrogen concentration	n/a	n/a
	387		GME.84-K4	**Thermal conductivity**	Stationary Gas Measuring System	Process gas analyzing system for simultaneous measurement of CO, CO_2, CH_4, H_2; determination of hydrogen concentration in multi-component gas	n/a	n/a
	388		EGM	**Thermal conductivity**	Single Gas Measuring Module	Measurement of single gas component, gas specific sensor, including hydrogen	n/a	n/a
86	389	Teckso GmbH Neukirche-Vlyn, Germany	DVLS3	**Catalytic**	Portable device	hydrogen leackage in GC		
87	390	Teledyne Analytical Instruments City of Industry, CA, USA	2000A / 2000B	**Thermal conductivity**	Therma Conductivity Gas analyzer; typically H_2, Ar or N_2 detection	Air separation, petrochemical and refinery, turbine generators, nuclear power generation, steel/heat trating: H_2 purity monitoring and analysis	Three ranges, application dependent	Optional FM approval: Class I, Div. 2
	391		2000XTC	**Thermal conductivity**	Thermal conductivity transmitter; no sensor specification	H2 purity analysis; detection of H_2, He, N_2, Ar, CO_2 or a number of other gases in binary or multi-component sample gas mixtures; Power plant, petrochemical plant, fuel cell development, Electrolysis, etc.	Customer specified	Class I, Div 1, Groups A, B, C, D CENELEC / ATEX as per EEx ib IIC T3 (EN 50020)
	392		2010A / 2010B	**Thermal conductivity**	Thermal Conductivity Gas analyzer	Air separation, petrochemical and refinery, turbine generators, nuclear power generation, steel/heat trating: H_2 purity monitoring and analysis	Three ranges, application dependent	Analysis Unit: Class I, Div. 1, Groups B, C, D Explosion-proof
	393		2020	**Thermal conductivity**	Thermal Conducitivty Gas analyzer	Air separation, petrochemical and refinery, turbine generators, nuclear power generation, steel/heat trating: H_2 purity monitoring and analysis	Three ranges, application dependent	FM approved: Class I, Div. 1, Groups B, C, D CENELEC versions available

No. M	No. S	Manufacturer City, Country	Sensor Model	Technology	Description / Remark	Application	Detection Range (H_2)	Certificates / Approvals / Tests / Classification
	394		212R	**Thermal conductivity**	Most sensitive process thermal conductivity analyzer commercially available	Detection of specific impurity in a binary gas mixture, monitoring of one component in more complex mixtures; Trace analyzer Specific binary configuration: e.g. H_2 in AR, H_2 in N_2 or O_2; Air separation plants, H_2 and He purification plants, Synthetic gas plants, Specialty chemical plants, R&D labs	0 - 25 ppm H_2 in Ar, N_2 or O_2	n/a
	395		2750	**Thermal conductivity**	Portable analyzer	Design for turbine generator applications, H_2 in air measurement	0 - 100% H_2 in CO_2 0 - 100% Air in CO_2 80 - 100% H_2 in Air	n/a
88	396	Union Instruments GmbH Karlsruhe, Germany	INCA series		Multisensor analyzing system, flexible configuration, wide range of measurement techniques, sensor systems depending on gas types and concentrations to be measured Single channel/multi channel available	Determination of gas composition Process gas analyzer for the measurement of biogas, biomethane, landfill gas and sewage gas	4000 ppm (H_2)	ATEX G IIC
	397		SIRA 8000		Explosion-proof multi-gas analyzer	Analysis of gas composition	4000 ppm (H_2)	ATEX G IIC
		TROTEC Heinsberg, Germany	-	(Gas sensor)	handheld detector head or device for soil inspection	leak detection	10 ppm to 2 vol% H_2	IP 55
			LD 6000, LD 6000H2	**sonic (acoustic)**	amplification 120 dB, hand helt	leak detection, handheld device, also combination of acoustic and gas sensor available		
89	398	Unitronic AG Düsseldorf, Germany	USM VGSA		Multi-functional gas sensor array	Detection of many different gases, e.g. hydrogen	n/a	n/a
	399		USM 5.1-400	**Resistive** Semiconductor (SnO_2)	Gas sensor module for hydrogen detection, uses sensor TGS821 (Figaro), module for other gases available	Gas detection & warning system	Switching value: > 200 ppm	n/a
90	400	UST Umweltsensortechnik GmbH Geschwenda, Germany	GGS 1000 T series	**Resistive** Semiconductor	Flammable gases, broadband	Leak detection of combustible gases	n/a	n/a
	401		GGS 2000 T series	**Resistive** Semiconductor	High sensitivity for H_2, CO, C_2H_5OH	Stationary observation of LEL	n/a	n/a
	402		GGS 6000 T series	**Resistive** Semiconductor	H2 detection	Hydrogen detection	n/a	n/a
	403		Peaker	**Resistive** Semiconductor	Gas leak detector, portable device, uses GGS 1000 broadband sensor, calibrated for CH_4, C_3H_8, H_2	Fast and selective detection of gases	Indicators: 1 Operational / ppm 2 ≥ 10 ppm 3 ≥ 100 ppm 4 ≥ 0.1 vol.% 5 ≥ 1 vol.%	n/a

No. M	No. S	Manufacturer City, Country	Sensor Model	Technology	Description / Remark	Application	Detection Range (H_2)	Certificates / Approvals / Tests / Classification
	404		Hydrogen-Power	**Resistive** Semiconductor	Gas leak detector, portable device, uses GGS 6000 hydrogen sensitive sensor; (optional: alternative use of CCG 1000 broadband sensor)	Fast and selective detection of hydrogen	Indicators: 1 Operational 2 ≥ 10 ppm 3 ≥ 100 ppm 4 ≥ 999...0.1 vol.% 5 ≥ 1 vol.%	n/a
	405		Sniffer-HT	(Two sensor technology)	HT-Model for hydrogen-specific leak detection, mobile device	Fast and selective detection of hydrogen, hydrogen gas leak detection from underground pipes and other areas; detection on waste disposal sites, detection of leaks on flat roofs, etc.	< 10 ppm 10 - 100 ppm 100 - 1000 ppm 1000 ppm - 1 vol.%	n/a
	406		H2-Semicon®-Sensor-System	Combination of **Resistive** Semiconductor (SnO_2) & **Thermal conductivity**	Highly selective gas sensor system for hydrogen	Leakage monitoring in fuel cell systems, monitoring and control of chemical processes, fixed and mobile gas leak detection	0 - 40000 ppm H_2	RoHS Directive: 2002/95/EC
	407		H2-Semicon®-Sensor-System pi	Combination of **Resistive** Semiconductor (SnO_2) & **Thermal conductivity**	Highly selective gas sensor system for hydrogen	Leakage monitoring in fuel cell systems, monitoring and control of chemical processes, fixed and mobile gas leak detection	0 - 40000 ppm H_2	RoHS Directive: 2002/95/EC
91	408	**Weidmann Diagnostic Solutions Inc. St. Johnsbury, VT, USA**	InsuLogix® H Hydrogen Monitor	(Patented micro-chip and coating technologies, Pd/Ni sensor)	Monitor uses H_2Scan technology based on Supply Agreement	Monitoring of fluid filled electrical equipment; Measuring hydrogen in oil or gas phases, esp. in the oil of power transformers as indicator of fault condition	25 - 5000 ppm	EMI/EMC: IEEE STD C37.90.1, EN 55022/FCC PART 15 & EN 55024/EN 610004; IEC 60068-2-6; IP67 (IEC 60529), NEMA 6; CE Mark (IEC 61000)
92	409	**Xensor Integration B.V. Delft, NL**	XEN-5310	**Thermal conductivity**	Hydrogen Sensor, uses Xensor Thermal Conductivity Gauge XEN-TCG3880 for gas type and vacuum measurement	Leak detection, e.g. in fuel cells, filling stations	H_2: - 0.8 ... + 4.0 vol.%	ATEX Conformity Option available soon
	410		XEN-TCG3880	**Thermal conductivity**	Thermal conductivity gauge based on silicon technology	Gas type measurement: Measurement of thermal conductivity, Measurement of concentration of Helium, CO_2, etc, in air, Measurement of binary gas-mixture composition	n/a	n/a
93	411	**Zhengzhou Winsen Electronic Technology Co. Ltd. Zhengzhou, China**	MQ-2	**Resistive** Semiconductor (SnO_2)	Combustible gas sensor element, not hydrogen specific, detects LPG, Propane, Hydrogen etc. conductivity increase with detectable gas concentration	Gas sensor for use in domestic gas leakage detector, portable gas detector, industrial combustible gas detector	300 - 10000 ppm	n/a
	412		MC114	**Catalytic**	Combustible gas sensor element, not hydrogen specific	Gas concentration detection in industrial applications, such as natural gas, LPG, etc. combustible gas, gasoline, ... Combustible gas leaking alarm or detectors; Gas concentration meter.	0 - 100% LEL	n/a
	413		MC115	**Catalytic**	Combustible gas sensor element, not hydrogen specific	Gas concentration detection in industrial applications, such as natural gas, LPG, etc. combustible gas, gasoline, ... Combustible gas leaking alarm or detectors; Gas concentration meter.	0 - 100% LEL	n/a

No. M	No. S	Manufacturer City, Country	Sensor Model	Technology	Description / Remark	Application	Detection Range (H_2)	Certificates / Approvals / Tests / Classification
	414		MC116	**Catalytic**	Combustible gas sensor element, not hydrogen specific	Gas concentration detection in industrial applications, such as natural gas, LPG, etc. combustible gas, gasoline, ... Combustible gas leaking alarm or detectors; Gas concentration meter.	0 - 100% LEL	n/a
	415		MC119	**Catalytic**	Combustible gas sensor element, not hydrogen specific	Gas concentration detection in industrial applications, such as natural gas, LPG, etc. combustible gas, gasoline, ... Combustible gas leaking alarm or detectors; Gas concentration meter.	0 - 100% LEL	n/a
94	416	Zirox GmbH Greifswald, Germany	TCS	**Thermal conductivity**	Hydrogen Measuring Device; Note: Company specializes in O_2 sensors based on solid state electrolyte (ZrO_2)	Hydrogen concentration monitoring	0 - 100 vol.%	n/a