Gas Detection for Industrial Manufacturing

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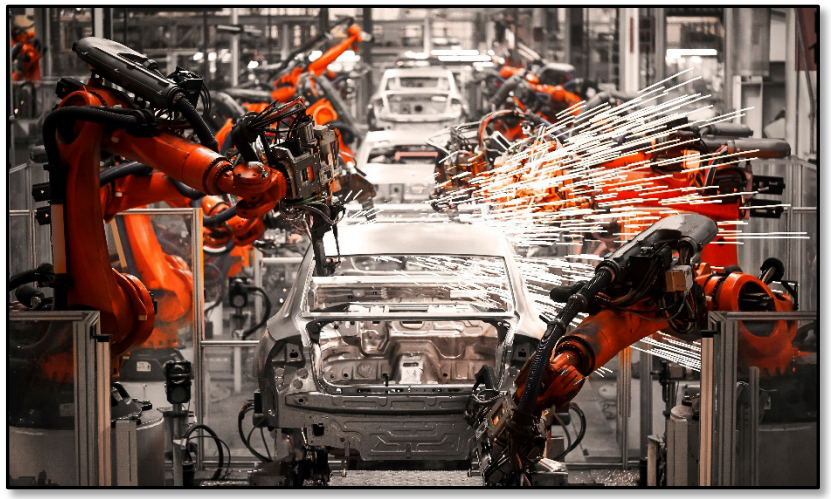
The best instrument for the application is a function of sensing technology and manufacturer Porpoise.

Industrial Manufacturing Gas Detection Self Assessment Questions

- "Manufacturing" is a very broad category!
- Manufacturing safety managers deal with an extremely wide range of atmospheric hazards, monitoring applications and activities.
- Atmospheric hazards can be generally present or associated with specific activities (like CS entry).
- Each facility needs to be individually evaluated.
  - Hazard assessment is critical!



What are your most urgent concerns and problems?

- Start with a detailed assessment of activities and risks that involve atmospheric hazards.
- Drill down to make sure you understand what is most important.
- Are you currently meeting all requirements?
- Are the instruments you are currently using fit for purpose?
- Where do you need to make improvements?
- Gas detection issues are not necessarily limited to safety!
- Gas detection solutions are definitely not limited to portable instruments!

Manufacturing managers are involved with many types of safety and hygiene gas detection

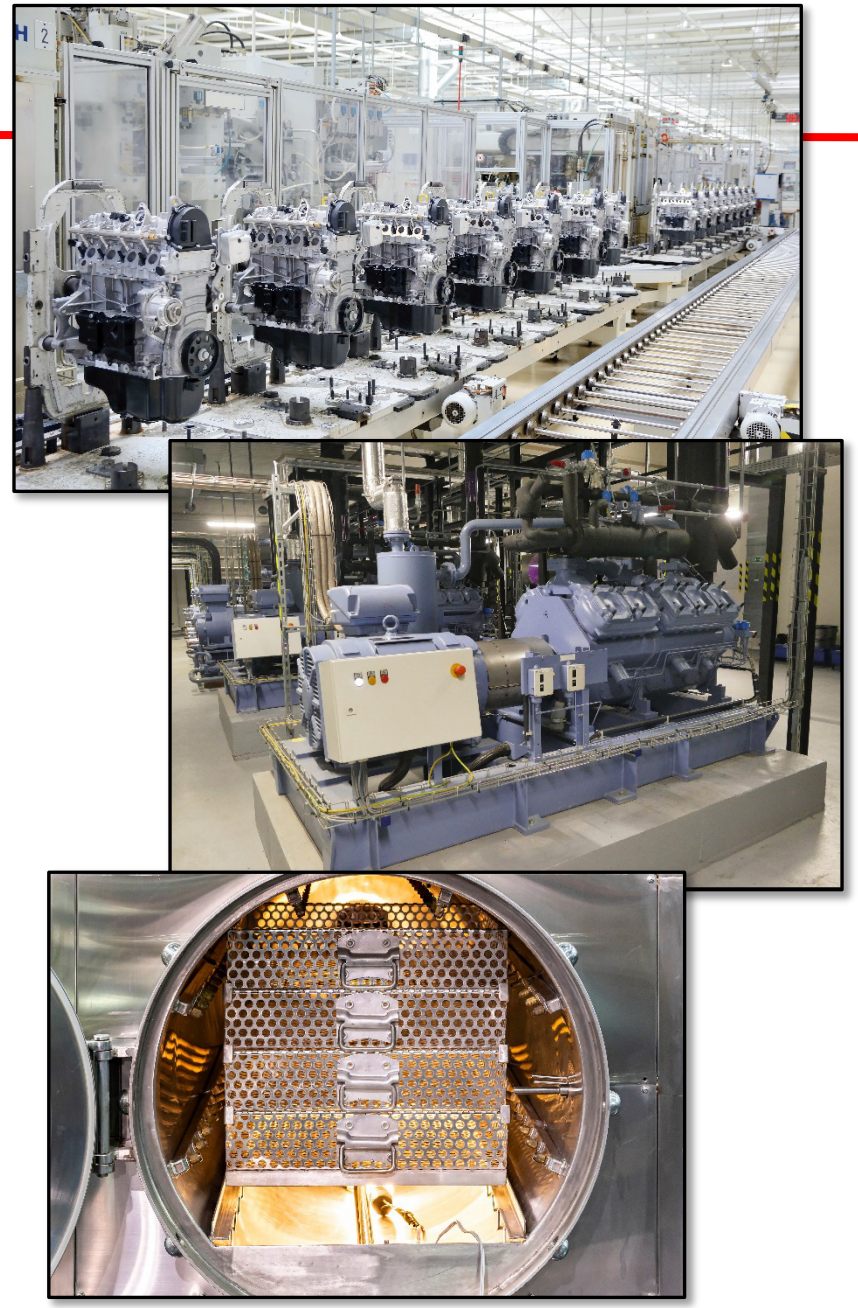
- Personal exposure monitoring
- Confined space
- Construction
- Hazmat and emergency response
- Hot work
- Manufacturing activities

Manufacturing gas detection requirements include

- Production
- Process
- Facilities
- Industrial hygiene
- Community (such as fence line or nuisance odor)
- Regulatory (EPA)
- Disaster response (floods, leaks, spills, accidents, etc.)
- Construction

Presence of dangerous atmospheric conditions may be due to:

- Materials used in production
  - Resins
  - Sealants
  - Polymers
  - Solvents
  - Degreasers
  - Industrial gases (natural gas, nitrogen, argon, sulfur dioxide, chlorine, hydrogen, hydrides like arsine)
- Refrigeration gases
  - Ammonia
  - Propane
  - Freons and halocarbons
  - Nitrogen
- Process(es) used to transform raw materials into finished goods
  - Chemical reactions
  - Curing / drying



The presence of dangerous atmospheric conditions may be due to (continued):

- Chemical reactions
  - Synthesis
  - Electrolysis
  - Sulfurization
  - Hydrogenation
  - Doping
- Natural process(es)
  - Fermentation (CO_2 as well as O_2 deficiency)
  - Decomposition
  - Oxidation
- Confined space entry activities
  - Hot work
  - Scraping
  - Mucking
  - Paints and sealants

The presence of dangerous atmospheric conditions may be due to (continued):

- Facilities
  - Battery charging (generation of hydrogen)
  - Combustible liquid cabinets
  - Gas storage areas
  - Spills
  - Leaks
  - Fueling stations (hydrogen or propane)
- Combustion
  - Stack gas (SO_2, acid gas, NO_2, NO, CO, CO_2)
  - Engine exhaust (CO, NO_2, NO, CO_2)
- Deliberate creation of potentially dangerous atmospheric conditions
  - Nitrogen purging
  - Curing ovens
  - Inert gas actuation
  - Shielding (hydrogen used to shield dynamos and generators)

*Make sure you understand and define the objectives for use of your instruments**

- **Step 1** – Statement of Purpose.

  The first step should be a brief but complete decription of the goals for detecting the hazards or condition.

- **Step 2** – Selection of objectives.
  - Confined space hazards and entry requirements are specified in various OSHA standards such as:
    - 29 CFR 1910.146 “Permit-Required Confined Spaces”
    - 29 CFR 1926 Subpart AA “Confined Spaces in Construction”

* Useful AIHA documents posted with support materials on SND Digital Asset Management (DAM) Platform:

- AIHA Technical Framework – *“Guidance on Use of Direct-Reading Instruments”* (Standardized Equipment Specification Fact Sheet).
- AIHA White Paper: *“Establishing a Process for the Setting of Real Time Detection System Alarms White Paper”* (Determining Fitness for Use).

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Step 3: Selection and determination of fitness for purpose

1. **Monitoring target:** What are the hazards or conditions that must be recognized, qualitatively or quantitatively by the sensor(s)?
2. **Operability of the instrument in the environment where it will be installed or deployed:** Communication of the condition and expected actions by those receiving the information must work seamlessly. Requires training and demonstrated proficiency to those expected to respond to an alarm.
3. **Knowledge of the environmental conditions to be encountered in the field:** Will the sensors work in all conditions of temperature and humidity encountered once deployed?
4. **Human factor (HF) considerations need to be explored and documented.** The readings and alarms are used to alert the user to potentially hazardous conditions, as well as to possibly direct further assessment (investigation) or action (vacate a confined space).
5. **Alarm information must be timely:** Alarms must allow sufficient time for execution of a defined response; and consideration must be given to the human capabilities and limitations that will be in place when the alarm occurs (consideration of limitations of the response).
6. **Verify instrument meets certification requirements:** These may include safety performance certifications (devices acceptable for explosive atmospheres as an example), as well as response performance certifications (devices acceptable for specific sites of use such as mining).

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Fixed or Portable solution?

- Gas detection requirements are <u>definitely</u> <u>not</u> limited to portable instruments!
- When hazards are generally present or associated with specific activities (like CS entry) gas detection solutions focus more on portable instruments.
- When hazards are chronically present, or present in specific areas, fixed gas detection should be considered as well.
  - Optimal solution often includes both fixed and portable instruments!
- For industrial manufacturers it's often "Same place same thing."
  - For certain locations, activities, or a specific process, the same atmospheric hazards are often present on a repeating basis.

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Don't be afraid of considering fixed system solutions!

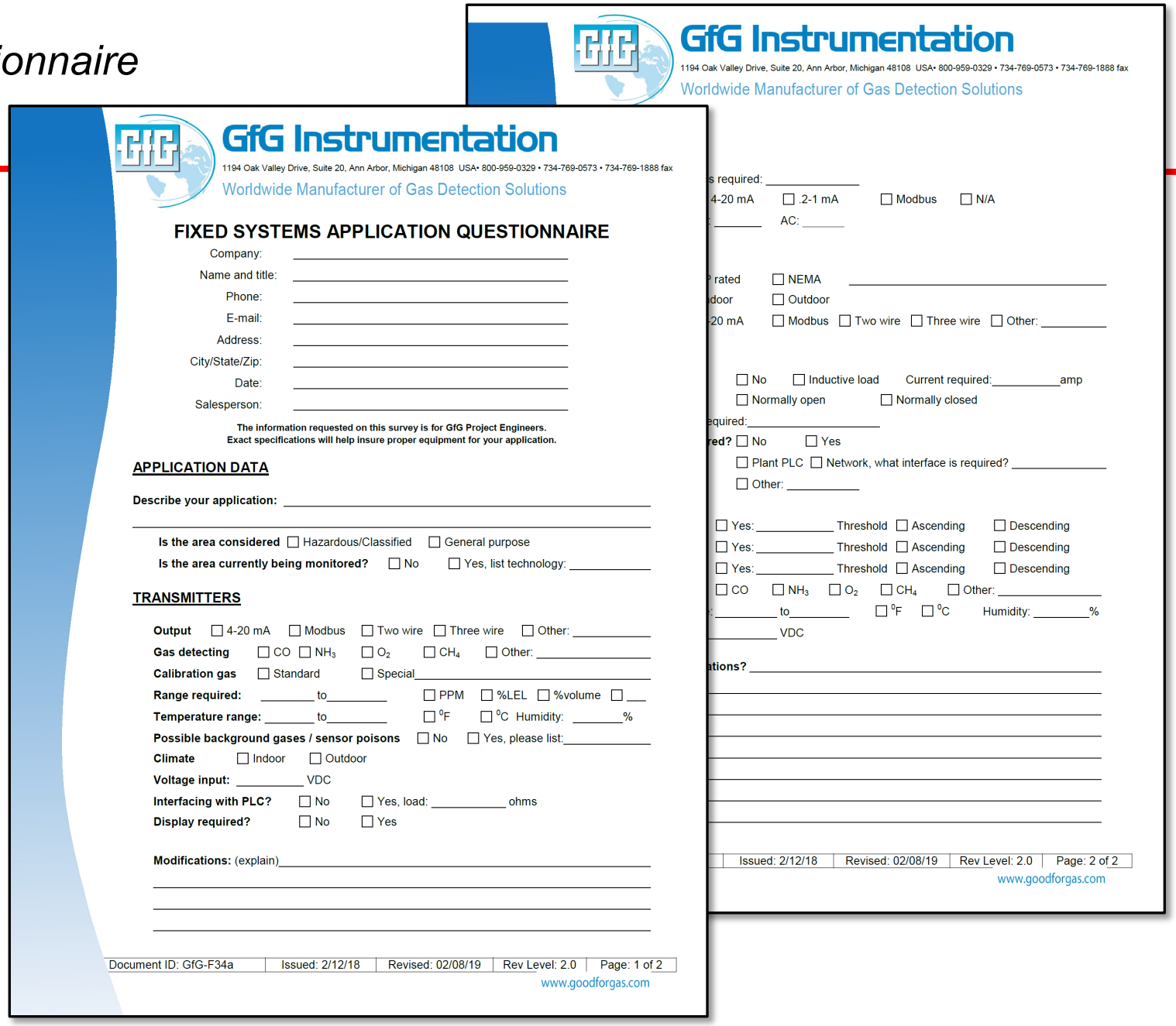
- Many common solutions based on small standalone single point systems, or small systems with 1 to 4 points of detection.
- Larger systems can be complicated, but your manufacturer partners are there to help you through the specification process.
- Make sure to include everyone with a stake in the outcome in the discussion and selection process!

Make sure you understand company policies and procedures for fixed systems

- Specification and purchase of fixed gas detection systems can be complicated
- Are fixed system decisions made by a third-party design firm or contractor?
- Are fixed system decisions made by managers at your facility?
- Are there any open projects?
- Who is involved in the specification and evaluation process?
- Who is responsible for calibration and routine maintenance?

Example Fixed System Questionnaire

- Simple information but <u>critical</u> to know!
- The questionnaire will help you to ask the right questions.
- Vital to provide the best solution!



GfG Instrumentation
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Worldwide Manufacturer of Gas Detection Solutions

FIXED SYSTEMS APPLICATION QUESTIONNAIRE

Company: _____
Name and title: _____
Phone: _____
E-mail: _____
Address: _____
City/State/Zip: _____
Date: _____
Salesperson: _____

The information requested on this survey is for GfG Project Engineers.
Exact specifications will help insure proper equipment for your application.

APPLICATION DATA

Describe your application: _____

Is the area considered ☐ Hazardous/Classified ☐ General purpose
Is the area currently being monitored? ☐ No ☐ Yes, list technology: _____

TRANSMITTERS

Output ☐ 4-20 mA ☐ Modbus ☐ Two wire ☐ Three wire ☐ Other: _____
Gas detecting ☐ CO ☐ NH_3 ☐ O_2 ☐ CH_4 ☐ Other: _____
Calibration gas ☐ Standard ☐ Special _____
Range required: _____ to _____ ☐ PPM ☐ %LEL ☐ %volume ☐ ___
Temperature range: _____ to _____ ☐ °F ☐ °C Humidity: _____%
Possible background gases / sensor poisons ☐ No ☐ Yes, please list: _____
Climate ☐ Indoor ☐ Outdoor
Voltage input: _____ VDC
Interfacing with PLC? ☐ No ☐ Yes, load: _____ ohms
Display required? ☐ No ☐ Yes

Modifications: (explain) _____

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s required: _____
4-20 mA ☐ .2-1 mA ☐ Modbus ☐ N/A
_____ AC: _____

? rated ☐ NEMA _____
door ☐ Outdoor
-20 mA ☐ Modbus ☐ Two wire ☐ Three wire ☐ Other: _____

☐ No ☐ Inductive load Current required: _____amp
☐ Normally open ☐ Normally closed
equired: _____
red? ☐ No ☐ Yes
☐ Plant PLC ☐ Network, what interface is required? _____
☐ Other: _____

☐ Yes: _____ Threshold ☐ Ascending ☐ Descending
☐ Yes: _____ Threshold ☐ Ascending ☐ Descending
☐ Yes: _____ Threshold ☐ Ascending ☐ Descending
☐ CO ☐ NH_3 ☐ O_2 ☐ CH_4 ☐ Other: _____
_____ to _____ ☐ °F ☐ °C Humidity: _____%
_____ VDC

ations? _____

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Fixed gas detection systems

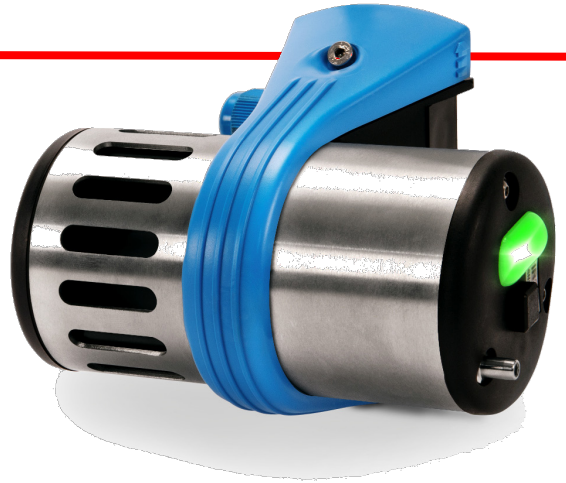
- Controllers
- Transmitters
- Stand-alone systems

What is a fixed system gas transmitter?

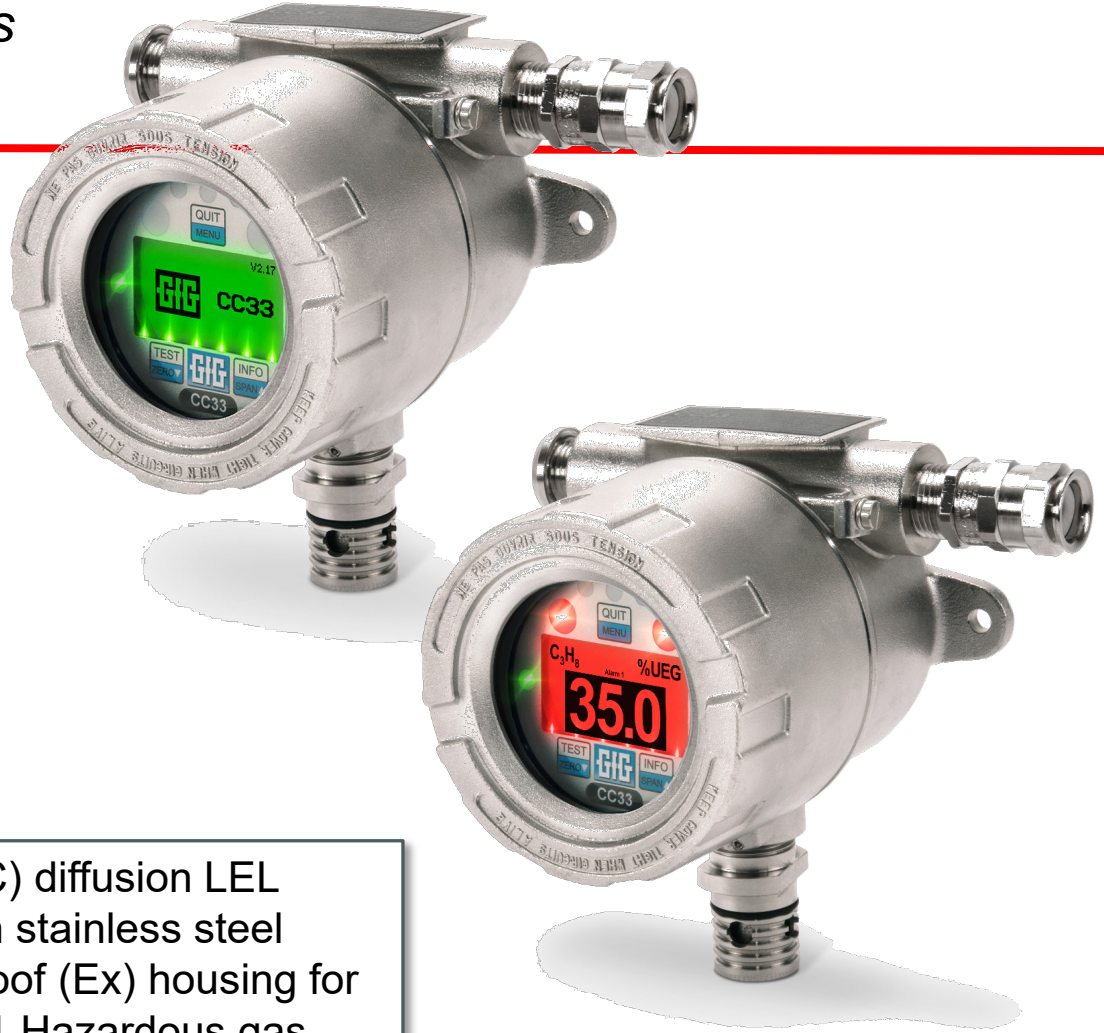
- Assembly that includes the actual sensor as well as the local electronics installed locally with the sensor.
- Transmitter can be diffusion design, pumped design or the sensor can be located on the end of a cable.
- Transmitter can have a local display and pushbutton or magnetic control interface; or can be a “Blind” transmitter without display or controls.
- Transmitter can be Intrinsically Safe, Explosion Proof, or can be designed for installation in “ordinary” (non-hazardous) locations.

Examples of diffusion transmitters for ordinary (non HAZLOC) areas.

Examples of transmitters for use in hazardous locations



Intrinsically Safe Infrared (IR) diffusion LEL transmitter for Zone 0 Hazardous gas locations



Catalytic (CC) diffusion LEL transmitter in stainless steel explosion proof (Ex) housing for Class I, Div 1 Hazardous gas locations.

Examples of extractive (pumped), diffusion, and remoted diffusion sensor cassette on cable

- D-ReX family of fixed system gas measurement transmitters was developed as an advanced monitoring system a wide diversity of applications.
- Configurations include:
  - Built-in diffusion sensor for “Point of Use” operation.
  - Remotely located sensor for “Point of Sampling” operation.
  - Motorized pump for sample-draw operation.
  - Over 25 currently available sensors.
  - Pyrolyzer option to extend range of measurable analytes.

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Examples of transmitters for use in hazardous locations

EC-28 family of Intrinsically Safe O_2 and toxic gas transmitters for Class I Div 1 and Div 2 Hazardous gas locations

Examples of types of gas meqasurement transmitters include:

- *Fuel cell O_2*
- *Lead free O_2*
- *Zirconium dioxide (ZD) O_2*
- *Electrochemical (EC) toxic*
- *Charge Carrier Injection (CI) toxic*
- *Chemosorption (CS) toxic and LEL*
- *Infrared (IR) CO2 and LEL*
- *Photoionization Detector (PID) toxic VOC*
- *Catalytic (CC) LEL*

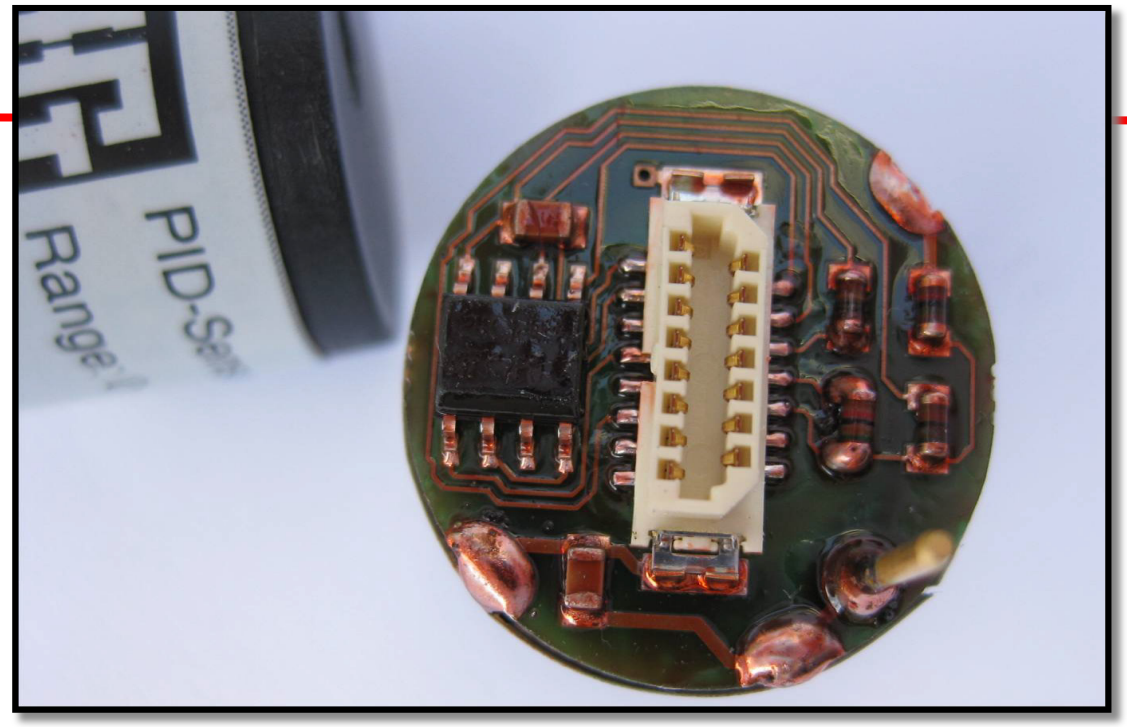
Detection technology available for hundreds of different toxic and explosive gases

Gasart (Stoffe)	Chemische Formel	GG Code	TRGS 900 Ausgabe 2003		Gasdichte	Zündtemp.	Flammpunkt	Molgewicht	Explosionsgrenzen in Luft 20°C/1013 mbar		Messverfahren und kleinste Messbereiche				
									Gestis Datenb.		WT	WL	EC	CS	IR
			ppm	mg/m³	Luft = 1	°C	°C		UEG	OEG	%UEG	Vol%	ppm	ppm	Vol%
Aceton	CH_3-CO-CH_3	1	500	1200	2,00	435	<-20	58,08	2,5	13,0	0.. 50			20.. 300	0..0,5
Acetonitril	CH_3-C≡N	2	20	34	1,42	525	6	41,05	3,0	16,0	0..100			20..1000	
Acetylen (= Ethin)	HC≡CH	3			0,91	305		26,04	2,3	100	0..100			20..1000	
Ammoniak	NH_3	6	50	35	0,60	630		17,03	15,4	33,6	0.. 50		0..50	20.. 300	
Arsin (= Arsenwasserstoff)	AsH_3	111	0,05	0,2	2,69	285		77,95	3,9	100			0.. 1		
Benzin (Ottokraftstoff)	Gemisch	10		250			-21		0,6	7,6	0..100			20..1000	
Benzol	C_6H_6	11	1	3,25	2,7	498	-11	78,11	1,2	8,0	0..100			20.. 300	
Bortrichlorid (HCl Messung)	BCl_3	134			4,06			117,17	–	–			0.. 3		
Bortrifluorid (HF Messung)	BF_3	135	1	3	2,37			67,81	–	–			0.. 3		
Brommethan (R40 B1)	CH_3Br	136	(5)	(20)	3,07	535	194	94,94	8,6	20,0				20.. 300	
Bromtrifluormethan (Halon 1301)	$CBrF_3$	13	1000	6200	5,24			148,91	–	–		0..10			
Butadien	CH_2=CH-CH=CH_2	14	5	11	1,92	415	-85	54,03	1,4	16,3	0..100			20.. 300	
n-Butan	C_4H_{10}	15	1000	2400	2,11	365	-60	58,12	1,4	9,3	0.. 50	0.. 5		30..2000	0..0,1
iso-Butan	$(CH_3)_3CH$	16	1000	2350	2,11	460	-83	58,12	1,5**	9,4**	0.. 50	0.. 5		30..2000	0..0,2
1-Butanol	C_4H_9OH	17	100	300	2,55	359	29	74,12	1,7	12,0	0..100			20..1000	0..0,2
2-Butanol	C_2H_5-CHOH-CH_3	137	100	300	2,56	405	24	74,12	1,7	9,8	0..100			20..1000	0..0,2
Isobutanol (= 2-Methyl-1-Propanol)	$(CH_3)_2CH$-CH_2OH	70	100	300	2,56	415	28	74,12	1,7	10,9	0..100			20..1000	0..0,2
2-Butanon (= Methylethylketon)	CH_3-CO-C_2H_5	18	200	600	2,49	404	-9	72,11	1,8	11,5	0..100			20..1000	0..0,2
1-Buten (= 1-Butylen)	CH_2=CH-CH_2-CH_3	22			2,00	440	-112	56,11	1,6	10,0	0..100			20..1000	0..0,2
n-Butylacetat	CH_3-CO-O-C_4H_9	19	100	480	4,01	425	22	116,16	1,2	7,5	0..100			20..1000	0..0,2
iso-Butylacetat	CH_3-CO-O-CH_2-$CH(CH_3)_2$	20	100	480	4,01	421	18	116,16	1,6	10,5	0..100			20..1000	0..0,1
Chlor	Cl_2	23	0,5	1,5	2,49			70,91	–	–			0.. 5		
Chlordifluormethan (R22)	$CHClF_2$	48	1000	3600	2,99			86,47	–	–		0..10		30..1000	
Chlordioxid	ClO_2	112	0,1	0,28	2,33			67,45	–	–			0.. 1		
Chlormethan (= Methylchlorid)	CH_3Cl	24	50	100	1,78	625		50,49	7,6	19,0				20.. 300	
Chlorwasserstoff (= Salzsäure)	HCl	25	5	8	1,27			36,46	–	–			0.. 10		
Cyanwasserstoff (= Blausäure)	HC≡N	26	10	11	0,95	538	-18	27,03	5,4	46,6			0.. 20		
Cyclohexan	C_6H_{12} (6-Ring)	27	200	700	2,91	245	-20	84,16	1,0**	9,3**	0..100			20.. 500	0..0,1
Cyclopentan	C_5H_{10} (5-Ring)	28			2,42	361	<-17	70,13	1,4	8,0	0..100			20..1000	0..0,2
Deponiegas	CH_4 + CO_2	138			Gemisch – Werte variabel							0..50			0..50
Diboran	B_2H_6	113	0,1	0,1	0,97	ca.40	-90	27,67	(0,8)	100			0.. 4		
Dichlordifluormethan (R 12)	CCl_2F_2	30	1000	5000	4,26			120,91	–	–		0.. 5		30..2000	
1,1-Dichlorethan	$CHCl_2$-CH_3	31	100	410	3,42	660	-17	98,96	5,6	16,0				20.. 500	
Dichlormethan (= Methylenchlorid)	CH_2Cl_2	33	100	350	2,93	556		84,93	13,0	22,0				20.. 300	
Diethylether	C_2H_5-O-C_2H_5	115	400	1200	2,55	175	-20	74,12	1,7	36,0	0..100			30..2000	
Difluorethan (152 a)	CHF_2-CH_3	139			2,28	455		66,05	3,7	20,2				30..1000	
Dimethylether	CH_3-O-CH_3	36	1000	1910	1,63	235	-42,2	46,07	2,7	32,0	0..100			30..2000	0..0,1
1,4-Dioxan	$(C_2H_4$-O-$C_2H_4)O$ (6 Ring)	140	20	73	3,04	300	12	88,11	1,9	22,5	0..100			30..2000	
Ethan	C_2H_6	39			1,05	515	-135	30,07	2,4**	14,3**	0.. 50			50..5000	0..5
Ethanol	C_2H_5OH	40	500	960	1,59	363	12	46,07	3,1**	27,7**	0.. 50			30..2000	0..0,2
Ethylacetat	CH_3-CO-O-C_2H_5	41	400	1500	3,04	426	-4	88,11	2,0**	12,8**	0..100			20.. 500	0..0,2
Ethylen (Ethen)	CH_2=CH_2	43			0,98	425		28,05	2,4**	32,6**	0.. 50			20..1000	0..5
Ethylenoxid	$(CH_2$-$CH_2)O$	44	1	2	1,52	440	-30	44,05	2,6	100	0..100		0.. 10	20.. 300	0..0,2
Fluor	F_2	118	0,1	0,16	1,31			38,00	–	–			0.. 10		
Fluorwasserstoff (= Flussäure)	HF	119	3	2,5	(0,71)			20,01	–	–			0.. 10		
Formaldehyd	H_2C=O	47	0,5	0,62	1,04	424		30,03	7,0	73,0			0.. 20		
German (= Germaniumwasserstoff)	GeH_4	120	0,2	0,6	2,65	<85		76,62	(1,0)	100			0..10		

Interchangeable “Smart Sensors”

Flexible “smart sensor” approach allows use of widest range of available sensors from multiple sensor manufacturers

GfG proprietary sensors offer unrivalled accuracy, stability and longevity



Proprietary Electrochemical sensor designs

SensoriX gas sensors:

- Proprietary high tech toxic sensor designs.
- Longest operational life span.
- Long life ionic electrolyte.
- Wide range of available sensors.
- Sister Division to GfG:

  Ionic Liquids (IL) are organic salts that remain liquid within a wide temperature range, at or below room temperature.

  Very low vapor pressure and high thermostability make them ideal for use as electrolytes in gas sensors.

  Sensor lifetime is always at least 18 months – usually longer – even in harsh conditions.

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Difficult to detect gases are a company specialty!

AsH_3	Arsine	H_2S	Hydrogen sulphide	PH_3	Phosphine
$B2H_6$	Diborane	HBr	Hydrogen bromine	SeH_2	Hydrogen selenide
Br_2	Bromine	HCl	Hydrogen chloride	SiH_4	Silane
Cl2	Chlorine	HCN	Hydrogen cyanide	SO_2	Sulphur dioxide
ClF_3	Chlorine trifluoride	HF	Hydrogen fluoride	TEOS	Tetraethyl orthosilicate
ClO_2	Chlorine dioxide	HMDS	Hexamethyldisilazane	TMB	Trimethyl borate
CO	Carbon monoxide	N_2H_4	Hydrazine	LEL	Combustible gases and vapors
CO_2	Carbon dioxide	N_2O	Nitrous oxide	C_4F_6*	Hexafluorobutadiene
$COCl_2$	Phosgene	NH_3	Ammonia	C_5F_8*	Octafluorocyclopentene
ETO	Ethylene oxide	NO	Nitric oxide	CH_3F*	Methyl fluoride
F_2	Fluorine	NO_2	Nitrogen dioxide	NF_3*	Nitrogen trifluoride
GeH_4	Germanium	O_2	Oxygen	SF_6*	Sulfur hexafluoride
H_2	Hydrogen	O_3	Ozone	VOC	Volatile Organic Chemicals detectible by 10.6 PID

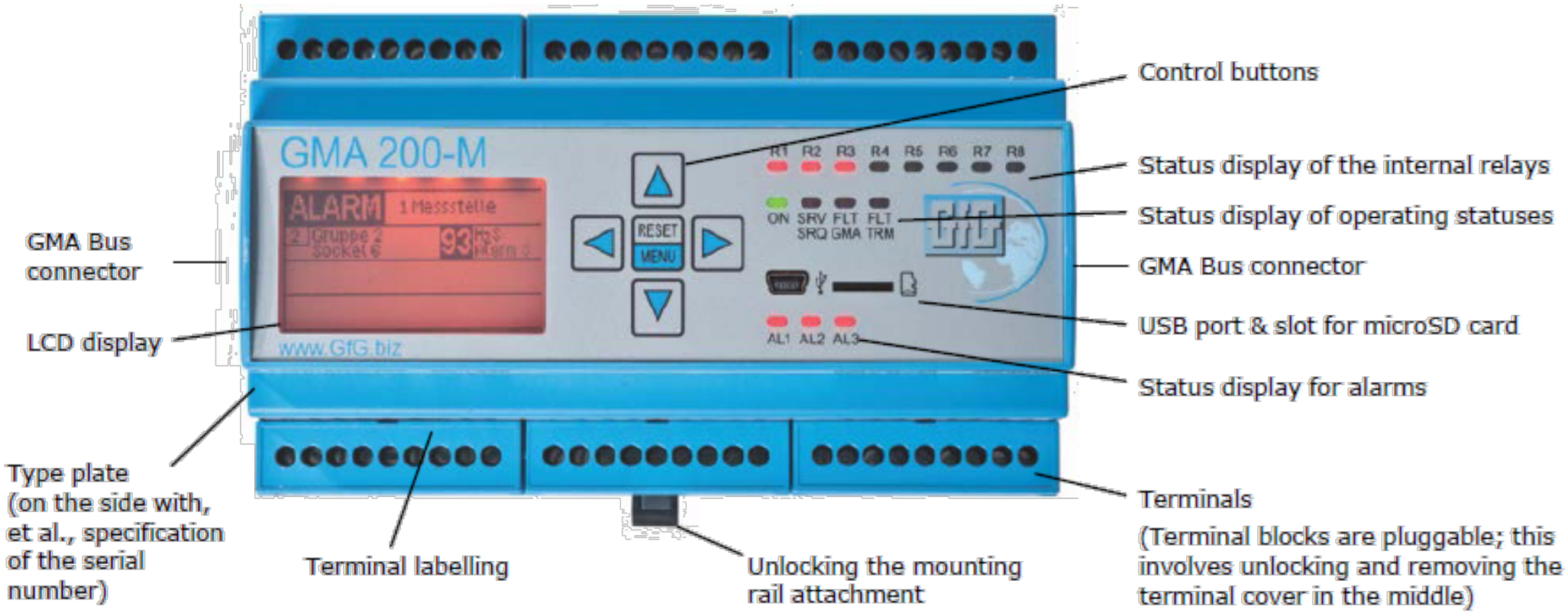
D-ReX Family of Sensors, Transmitters, Pyrolyzers and Accessories

Fixed system controllers

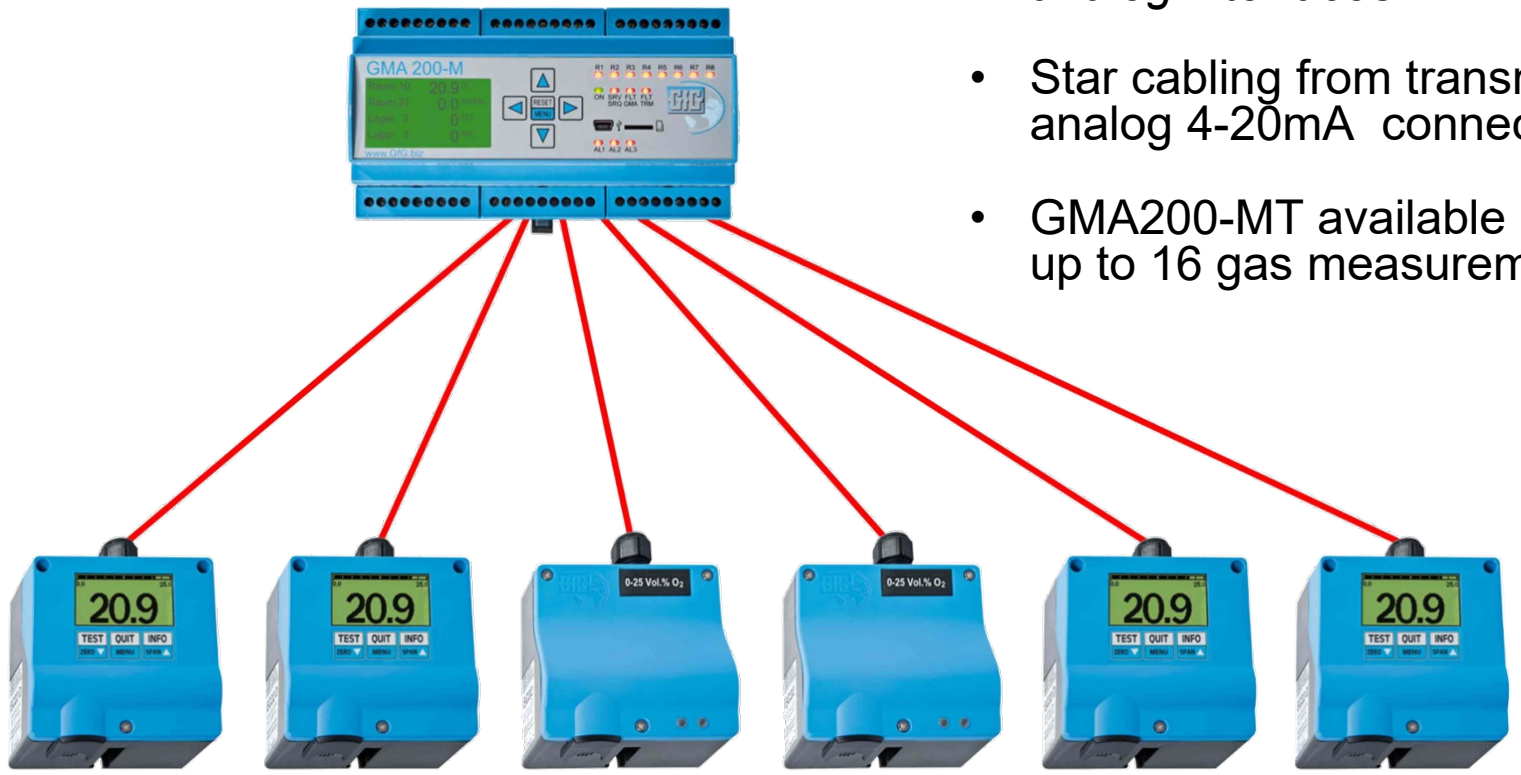
- Fixed system controllers are the brains of the system.
- Used to display readings, activate alarms, and control peripheral equipment like fans.
- Transmitters can be connected to the controller by analog 4-20 mA or digital connection.
- Controllers can be used for single or multi-point detection systems.
- Controllers can be connected to another controller or PLC (Programmable Logic Controller).
- Easily able to scale up the system for whatever number of detection points are needed.

GMA MW-4 Controller for 1 to 4 transmitters. Includes integrated display for readings and messages, and high intensity horn and strobe.

GMA 200 MT Programmable Logic Controller

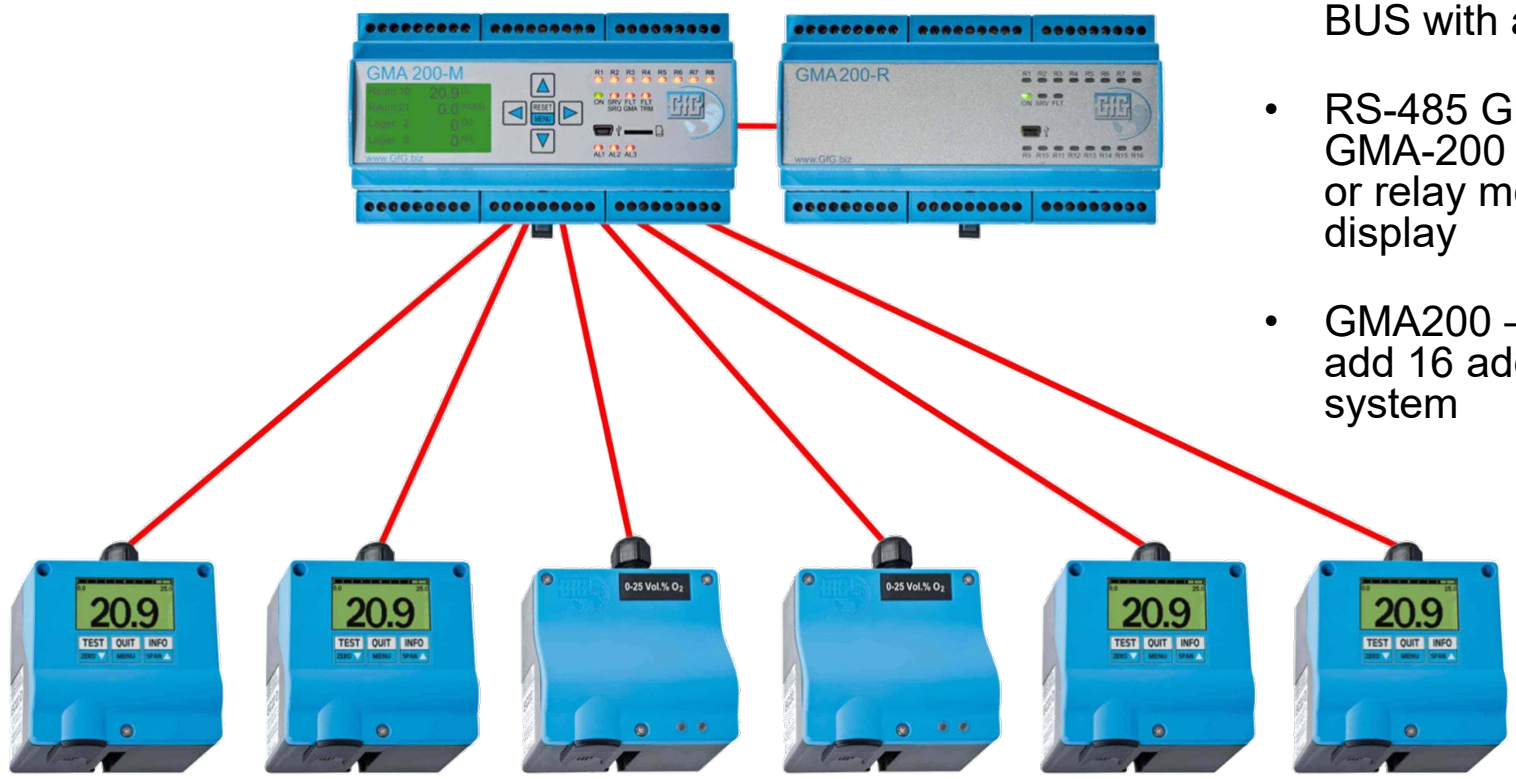


GMA200-MT/16 DIN Rail Mounted Controller



- *Connection of up to 16 transmitters with analog interfaces*
- Star cabling from transmitter to controller via analog 4-20mA connection
- GMA200-MT available in versions to control up to 16 gas measurement transmitters

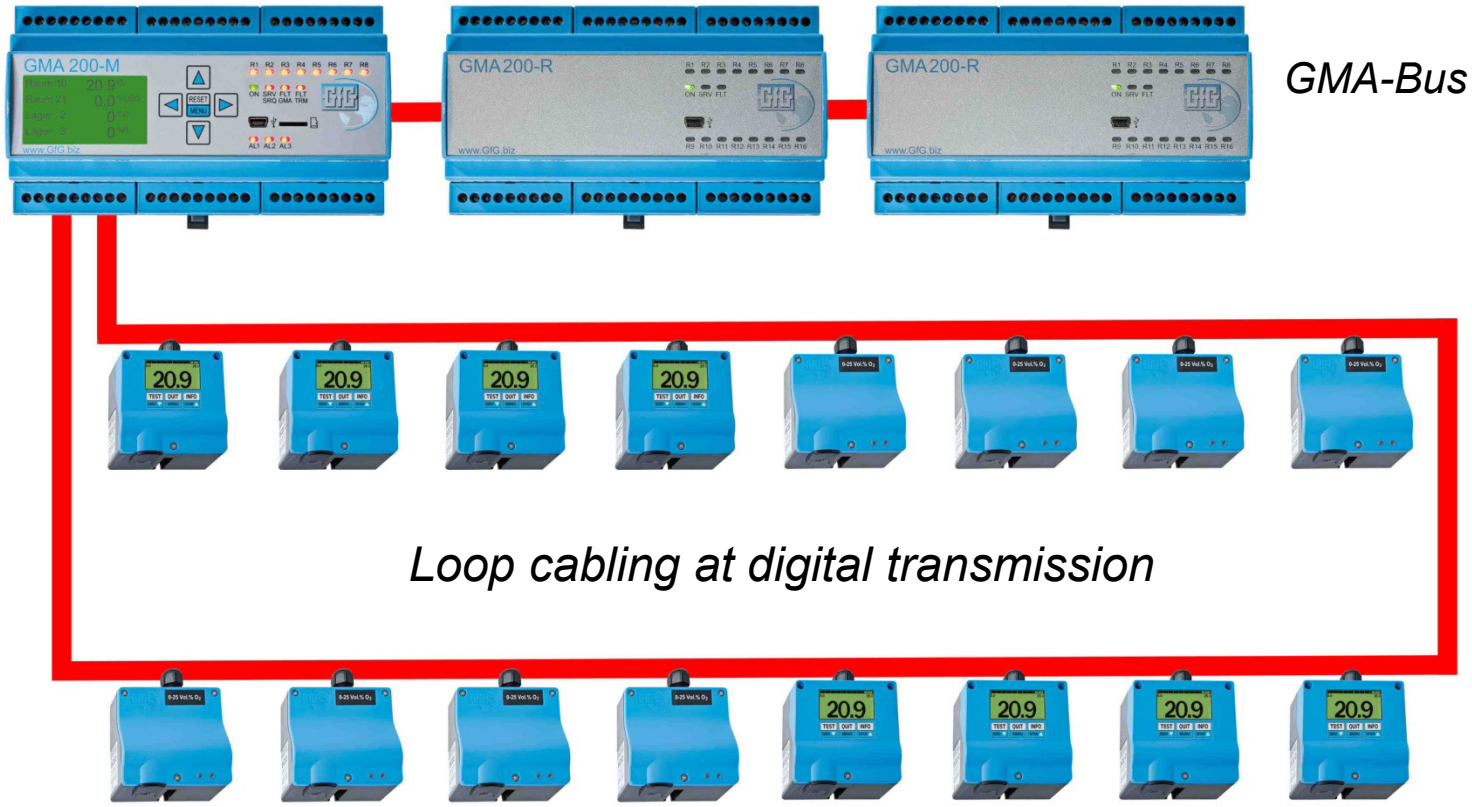
GMA200-MT/16 DIN Rail Mounted Controller



- Connect controller via 4-20mA or RS-485 BUS with additional modules
- RS-485 GMA-Bus can be used to connect GMA-200 controller with additional control or relay modules, or with a remote terminal display
- GMA200 –RT relay module can be used to add 16 additional programmable relays to system

GMA200-MT/16 DIN Rail Mounted Controller

Connection via digital interfaces

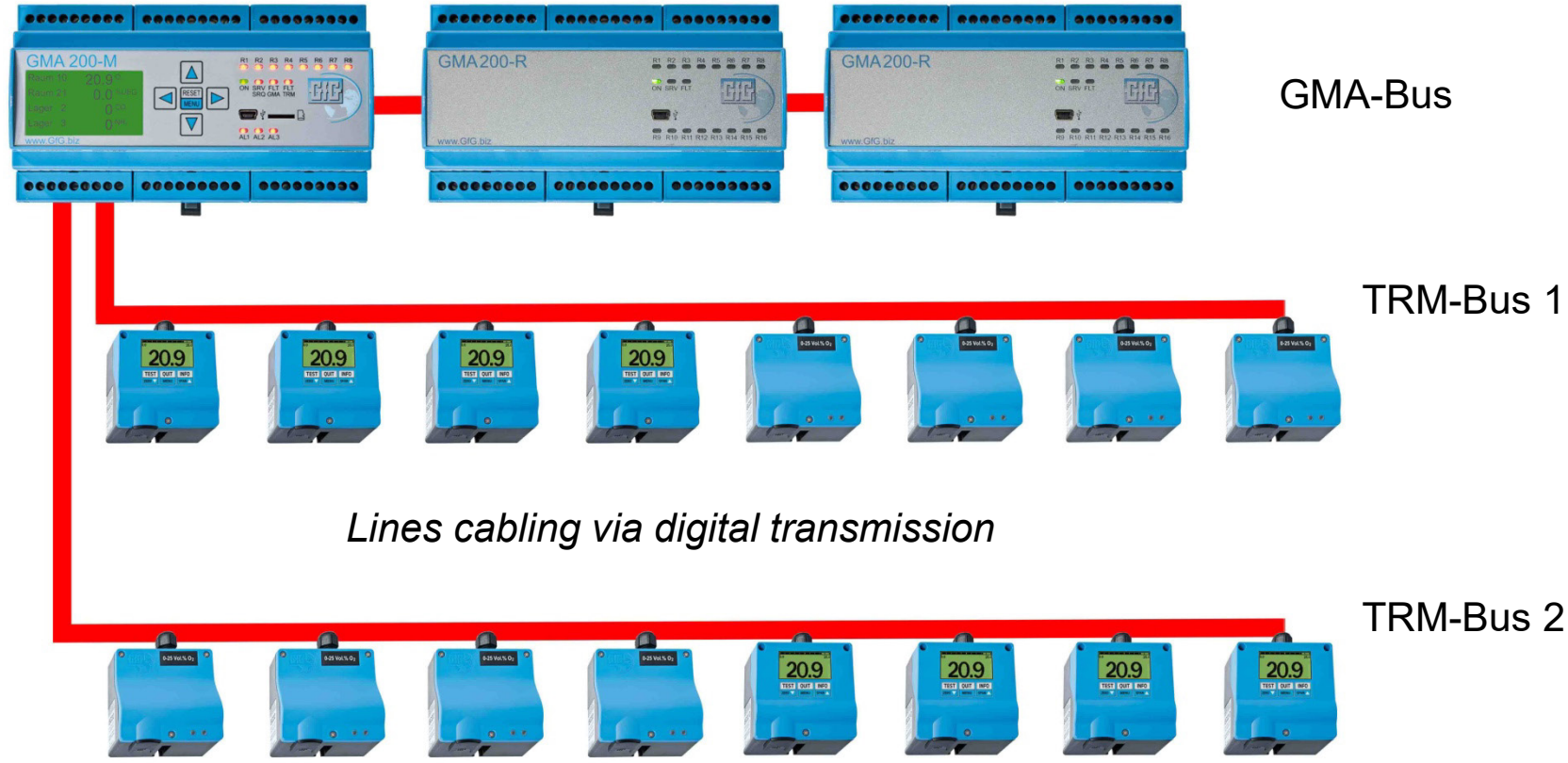


GMA-Bus

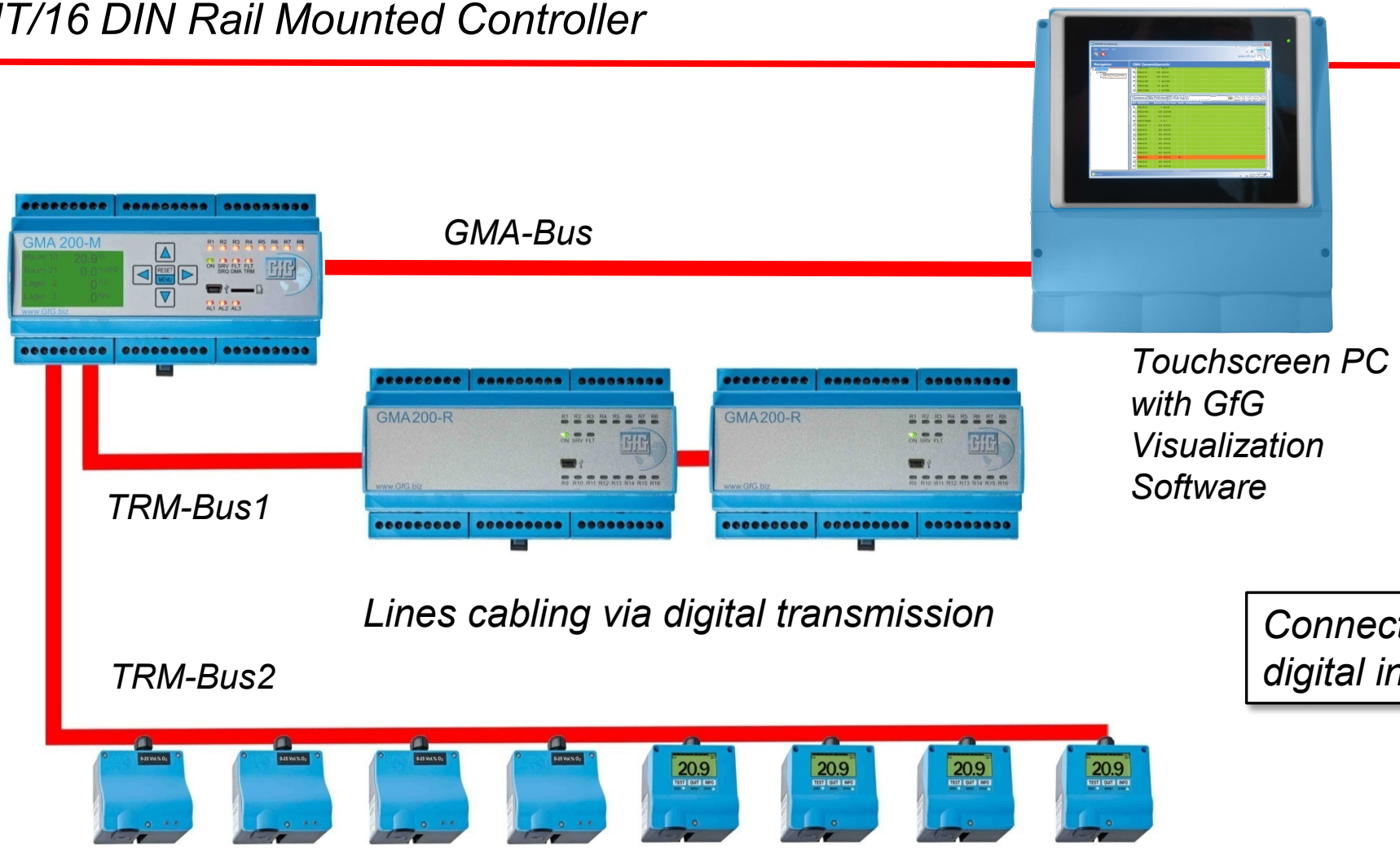
TRM-Loop-Bus (Bus1+2)

GMA200-MT/16 DIN Rail Mounted Controller

Connection via digital interfaces



GMA200-MT/16 DIN Rail Mounted Controller

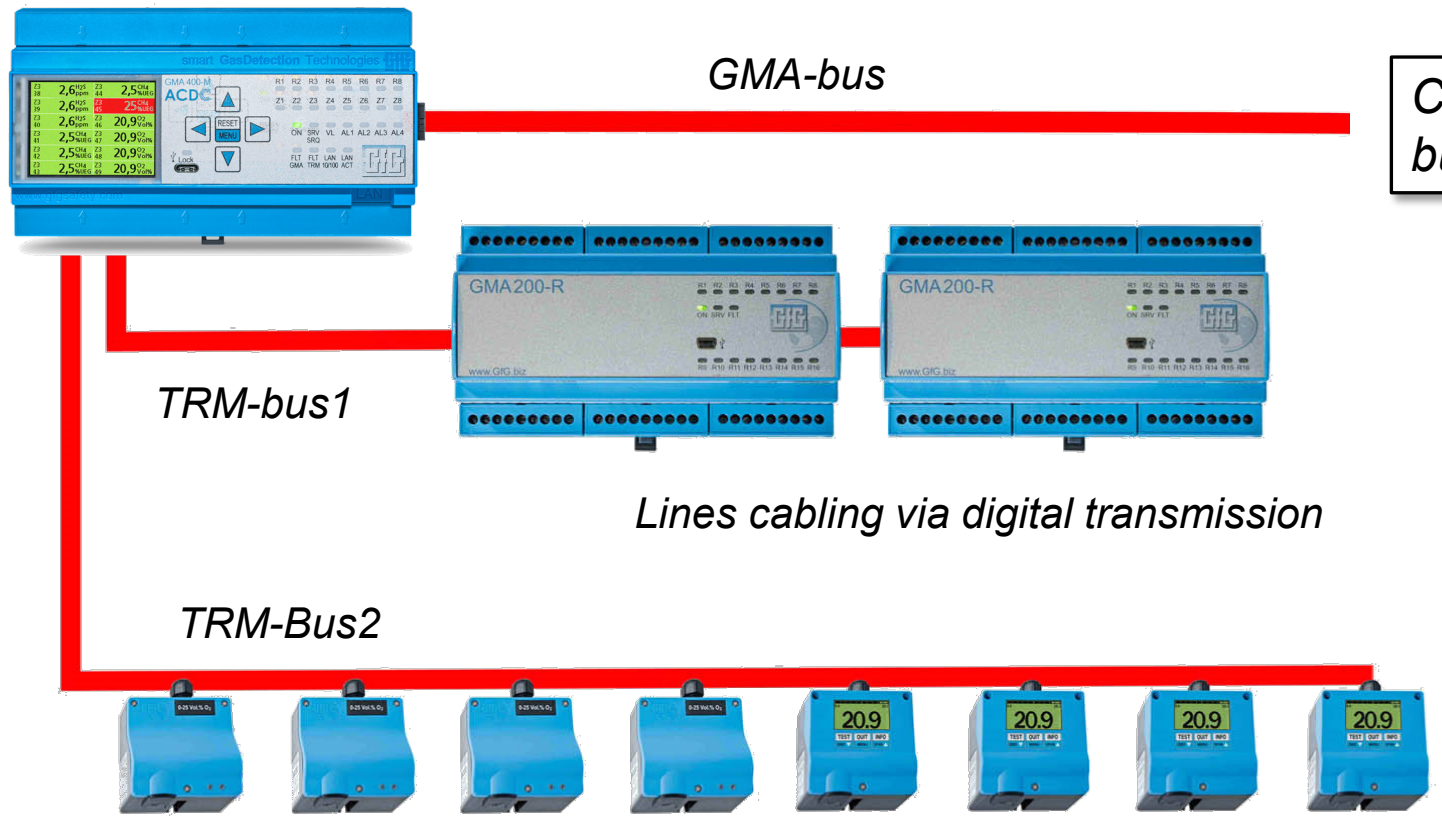


Touchscreen PC with GfG Visualization Software

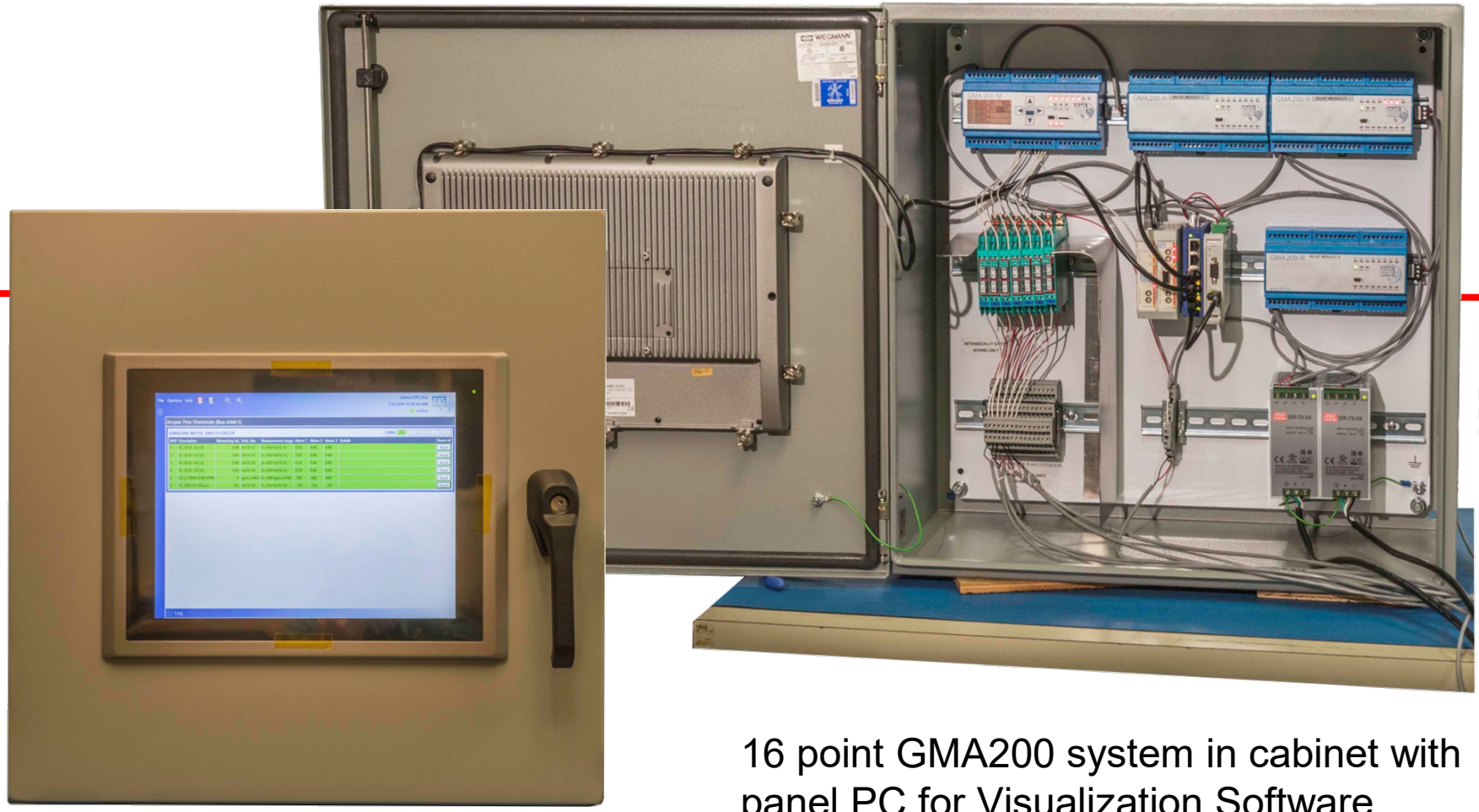
Lines cabling via digital transmission

Connection via digital interfaces

GMA400-MT controller for up to 128 points of detection



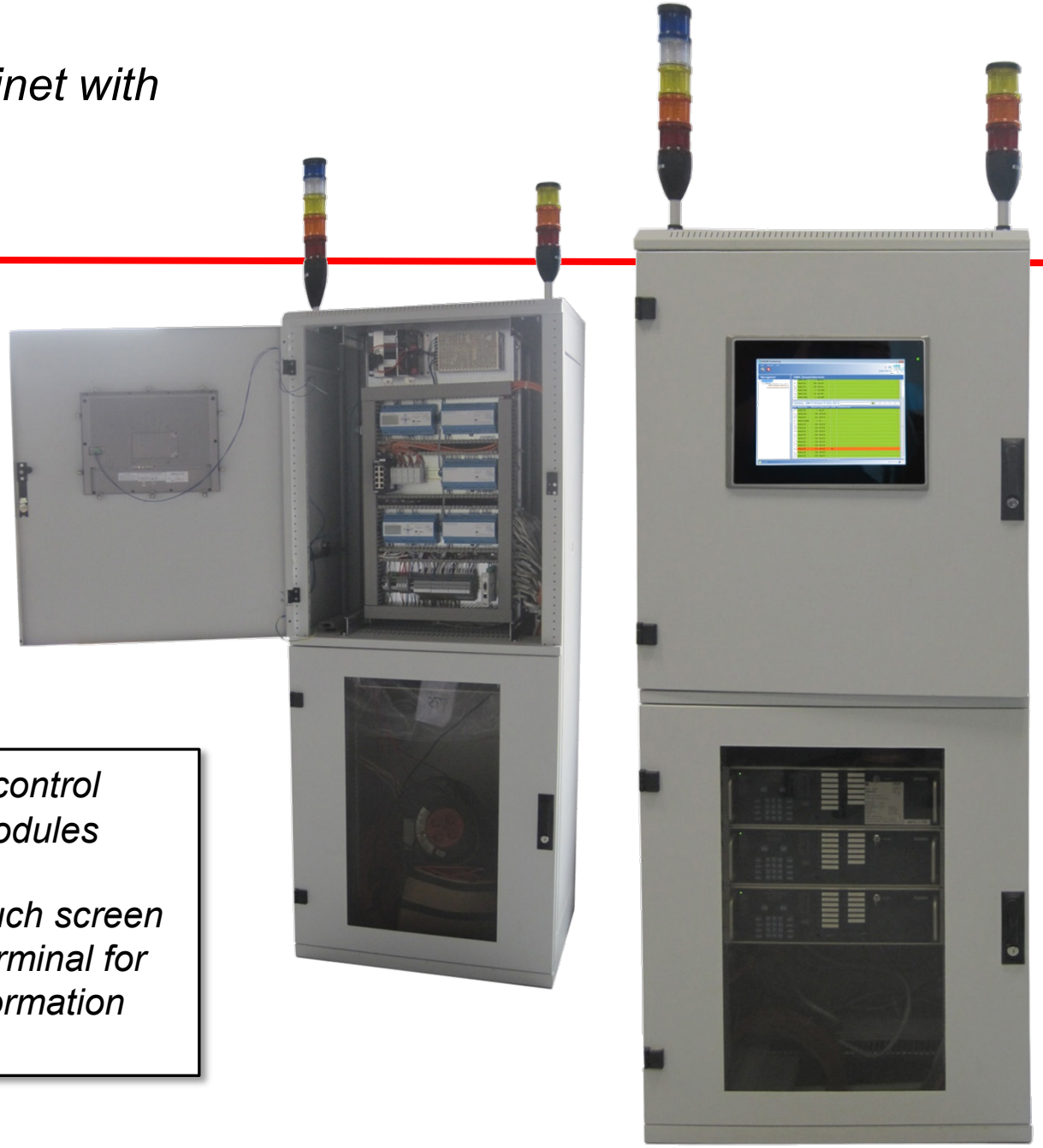
Connection via GMA-bus to built-in Ethernet gateway



16 point GMA200 system in cabinet with panel PC for Visualization Software

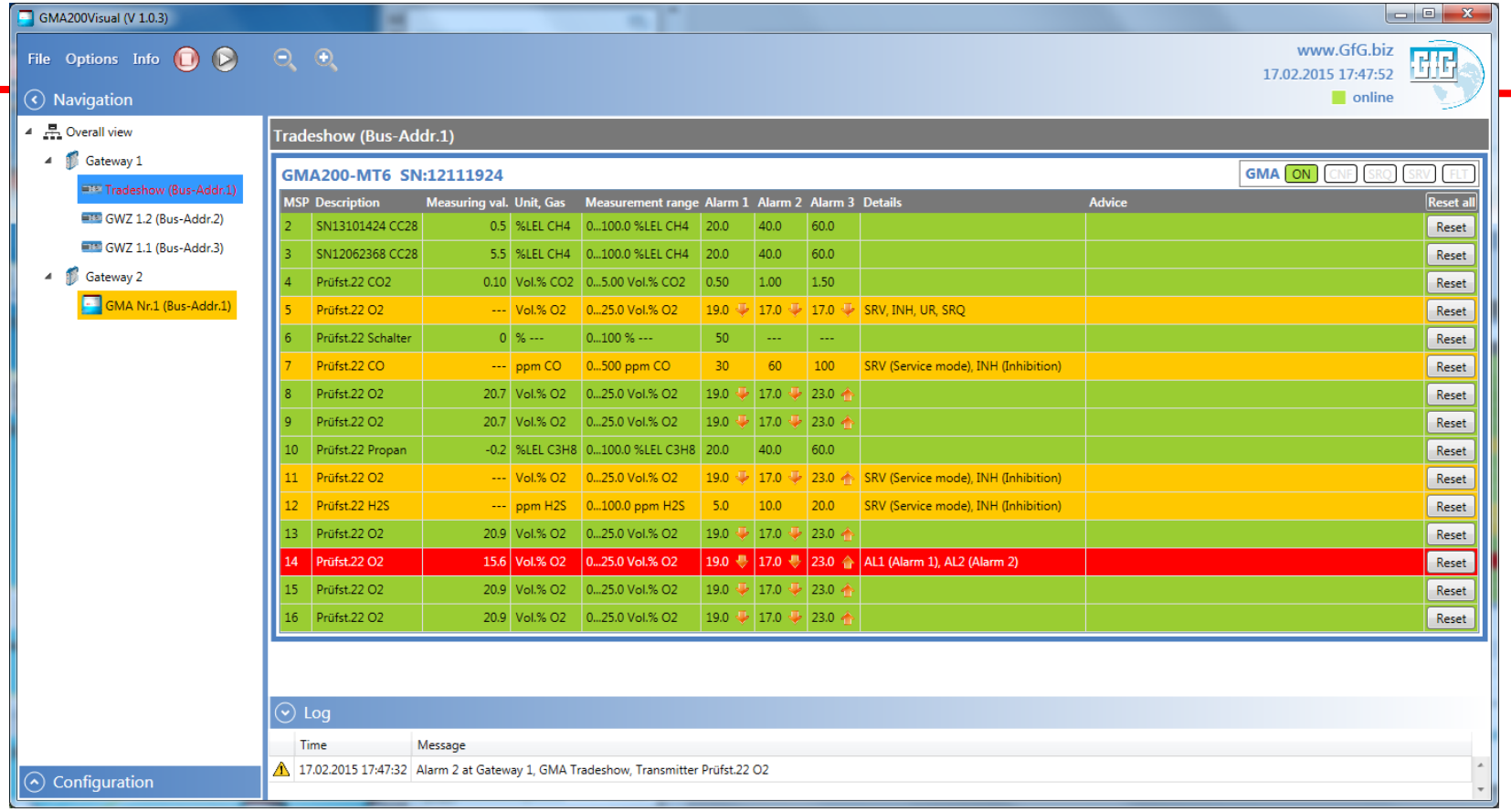
System includes 1 GMA200-MT/16 control module and 3 GMA200-RT relay modules, as well as Ethernet and Profinet Gateways for RS-485 MODBUS communication with customer's facility wide DCS (Distributed Control System)

32 point GMA200 system in cabinet with touch screen terminal display



- *System includes 2 GMA200-MT/16 control modules, and 2 GMA200-RT relay modules*
- *GfG Visualization Software allows touch screen PC or laptop to be used as remote terminal for display of comprehensive system information*

GMA200 Visualization Software



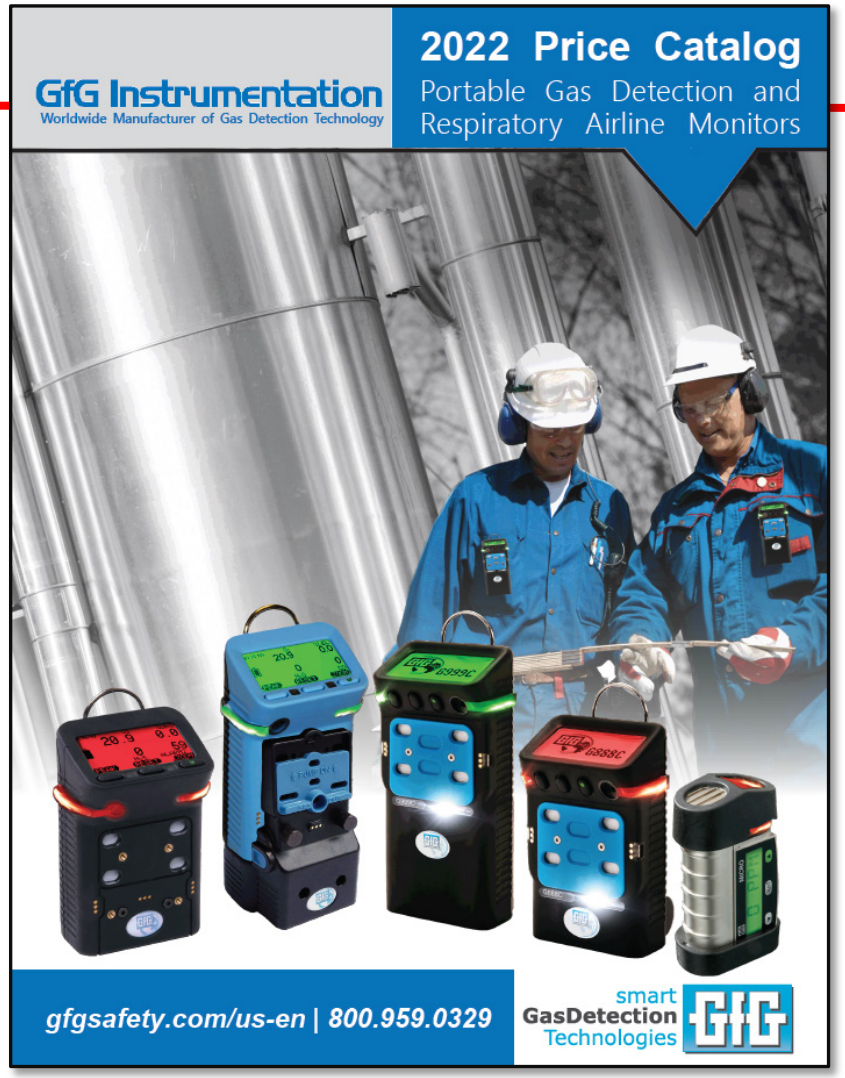
GMA with high alarm (alarm 2) condition

50 point GMA200 system in cabinet with 2 touch screen terminal displays

- *System includes 4 GMA200-MT control modules, and 5 GMA200-RT relay modules*
- *GfG Visualization Software allows splitting information for convenience between two PC terminal displays*

Avoid being overly focused on price!

- Eventually, the decision of whether to proceed involves price and affordability.
  - It's better to bring price into the conversation later, not at the beginning of the process.
  - There is a difference between the purchase price and the true cost of ownership.
- The questioning process is designed to uncover how your solution can benefit and reduce the pain the customer is feeling because of issues with his current products.
  - Once you fully identify the problems and how the new product is going to help, it's easier to understand the costs.
  - When you do a good job of identifying the problems, and how your product is going to help, price will not be nearly as important.



Identify “cost of ownership” issues!

- Are you spending a fortune keeping your current equipment in service?
- Are you being charged a monthly fee for reports and factory support?
- Do you have many sensor failures?
  - If so, what kinds of sensors are failing?
- Do you have battery problems?
  - Do the instruments run long enough on a single charge or set of batteries?
- How often do you test and calibrate your instruments?
  - Do you do it yourself or use a service?
- Are there any special conditions or contaminants that are causing problems?
- Do you trust your gas detectors?
- <u>Do you feel you are currently getting a good deal?</u>

Who is currently looking after your instruments?

- Do you do it yourself, use a third-party service, or work directly with the factory?
- If you like your current instruments, and want to keep them in service, you might want to talk about maintenance agreements or refurbishment programs.
- Ask your local distributor whether they offer calibration or repair services.
- Ask your current manufacturer whether they have factory maintenance programs, or a loaner or replacement instrument policy.
- You should expect excellent after the sale support!

Do you have any plans to update, expand, replace or change the equipment you are currently using?

- If you have relationships with gas detection manufacturers and distributors you trust, get them involved!
  - Gas detection manufacturers are happy to discuss issues directly with end-user customers.
  - The Internet and social media are terrific tools for finding out what's new, and what customers have to say.
  - You have multiple sources of information!
- Gas detection decisions are typically made by a group of individuals who have different roles in the decision process, including process or facilities management, safety, hygiene, purchasing, and (often) union representatives.
  - Make sure you don't leave anyone out!
  - The same issue often looks considerably different to a manager with different responsibilities.

What sensor configurations do you currently use?

- How many / what kinds of sensors are installed in your instruments?
  - Traditional 4-gas (LEL / O_2 / CO / H_2S)?
  - 5-gas with PID?
  - Some other sensor configuration?
- What type of sensor are you using (or interested in using) for LEL?
  - Traditional CC LEL?
  - IR LEL?
- What type of O_2 sensor are you using?
  - Fuel cell?
  - Lead free?
  - How long does it last?
- Do you use different multi-sensor instruments for different activities?
  - Do you deal with VOC vapors?
  - CS entry into inerted vessels?

Multi-gas portable instrument considerations

- Do you have other gases of concern beyond the basic four most common atmospheric hazards (O_2, LEL, CO and H_2S)?
  - SO_2?
  - VOCs?
  - Benzene?
  - Hydrogen?
  - CO_2?
  - NO_2?
  - Other gases?
- Do you use pump equipped or diffusion type instruments?
  - Do your instruments have an internal pump?
  - Is it possible to equip your instruments with an attachable pump?

How do you sample the atmosphere from within the confined space?

- Is the instrument a diffusion only design?
- Does the instrument have an attachable sample pump?
- Does the instrument have a built-in pump?
- Does the instrument have the option of switching from diffusion to sampling by means of the built-in pump?

What types of battery and charging technology are available?

- Does the instrument have an internal or interchangeable battery packs?
- Alkaline option?
- What type of rechargeable battery?
  - Li Ion?
  - NiMH?
- Cold temperature performance?
- Charging options
  - Cradle?
  - Wall power / USB adapter?

What about periodic testing and calibration?

- How often do you perform a bump test?
  - Before each day's use?
  - Do you keep bump test kits (with gas) with the instruments?
  - How do you prove your instruments have been bumped?
  - What do you do if you fail a bump test?
- How often do you perform a full calibration?
  - Do you use a docking station for bump tests and calibrations?
  - How do you prove your instruments are properly maintained and calibrated?
  - How do you retain maintenance and calibration records?
- Is your current strategy working?
  - Is it easy?

Are your gas detectors wirelessly enabled (or are you considering this option)?

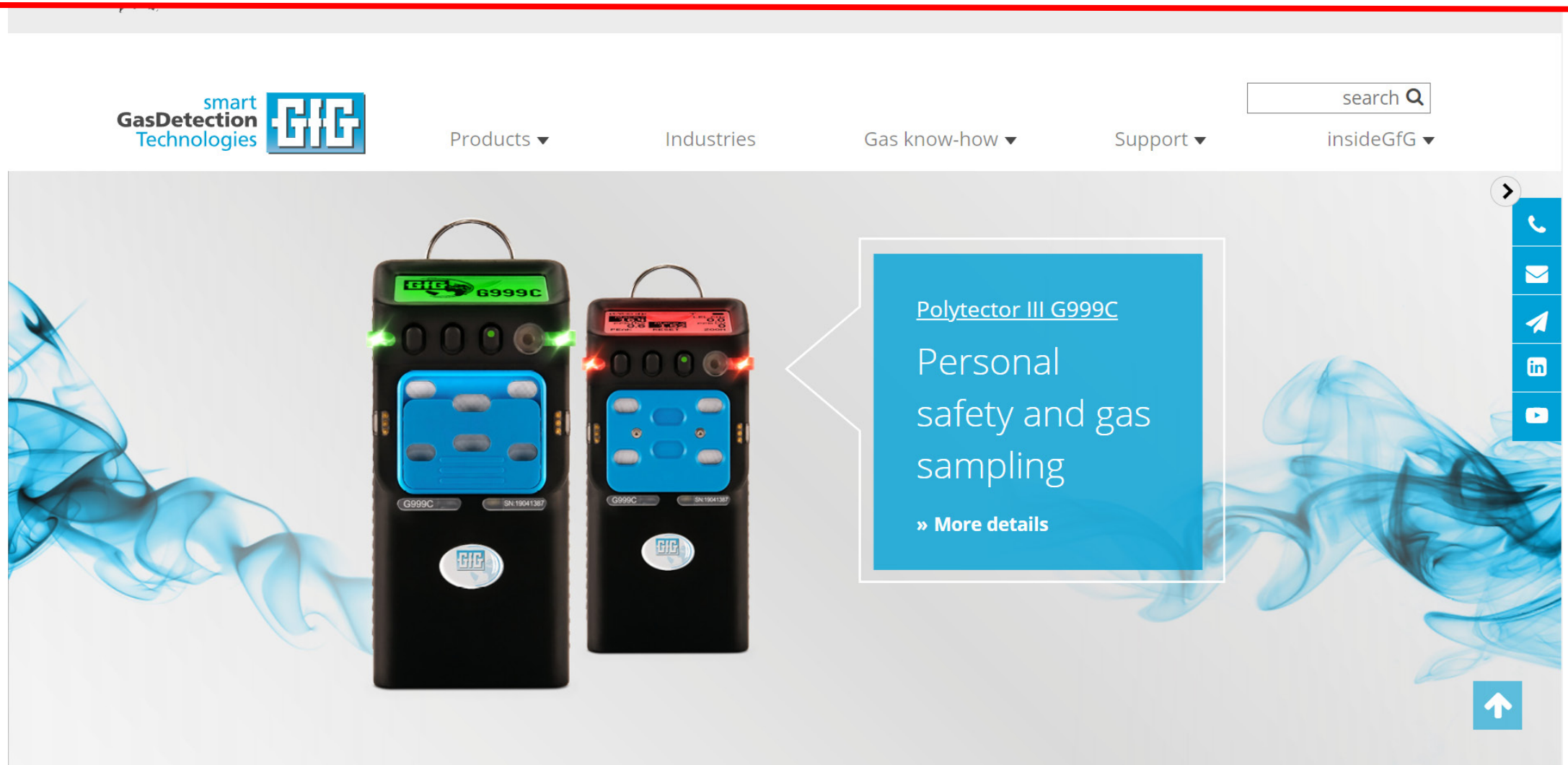
- Most manufacturers now offer a “wireless” communication option.
  - Each manufacturer has its own strategy, with its own benefits and limitations.
  - Make sure you understand the wireless options and competitive benefits!
- Common communication methods:
  - Blue Tooth
  - Cellular
  - ISM RF
- Do you intend to use wireless communication during CS entry?
  - How do you get the information out of the space?

What about after the sale support?

- Satisfaction is a function of ongoing support.
  - Atmospheric monitors and systems are life critical safety equipment.
  - Customers should expect excellent after the sale support.
- Don’t forget to consider:
  - Warranty
    - Sensors
    - Instrument
- Technical support
  - Is your vendor there to provide help?
- Training
  - Videos?
  - In person?
  - Internet resources?

Please visit the GfG Instrumentation website

- GfG Instrumentation website:
  www.gfgsafety.com/us-en



Questions?

Thank you!

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For additional information or gas detection help:

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