

XTC601 for Monitoring Hydrogen Cooled Generators

Thermal Conductivity Technology

A robust, linear and stable thermal conductivity analyzer for measuring the binary gas mixes present during the operation and maintenance of hydrogen cooled electricity generators. The primary measurement is hydrogen (H₂) purity to monitor air leaking into the system. The second measurement is monitoring hydrogen in carbon dioxide (CO₂) during system purging, and finally CO₂/air during maintenance. The sensor and HMI are in one compact case that is under 10kg. The analyzer is suitable for hazardous areas and uses non-depleting sensor technology for minimal cost of ownership.



Highlights

- Suitable for use in ATEX, IECEx, TC TR Ex & cCSAus
- Monitors all three phases of hydrogen cooled generators - normal running, purging and maintenance
- Remotely change the measurement phase to match your maintenance schedule
- Phase indication via 4-20 mA output
- Touch-screen display allows calibration or adjustment without the need for a hot works permit
- Compact and rugged design with an EExd enclosure
- IP66 rated enclosure so no chance of water or dust ingress
- Low cost of ownership due to minimal maintenance

Other applications for the XTC601

- Product quality in air separation plants
- Syngas production
- Helium recovery
- Fuel cell research
- Product quality such as air in argon for double glazing



Michell XTC601 for hydrogen cooled generators

The XTC601 for Hydrogen Cooled Generators is a binary gas analyzer which has been designed specifically for monitoring the purity and scheduled maintenance processes of hydrogen cooled generators. Using thermal conductivity with high quality thermistors, the sensor is reliable and highly stable. The analyzer is housed in an explosion-proof case and is rated for use in hazardous areas.

Features

Non-Depleting Technology

The non-depleting sensor technology with no moving parts means that there is no regular replacement of cells, this greatly reducing maintenance time and the cost of ownership.

Easy Installation with Local Display

The XTC601 for Hydrogen Cooled Generators is housed in a robust casing, allowing the analyzer to be placed at the point of measurement.

The closer the analyzer can be installed to the sample point, the better. The benefit of this include, faster overall speed of response (for safety), less sample line or cabling (saves costs), and greater choice of installations points (flexibility). Having a local display allows for maintenance and diagnostics to be performed directly rather than in a control room.

Internal or External Phase Control

There are two methods of choosing the phase. The first is internally via the HMI of the instruments, and the second is through the 4-20 mA input.

The second mA output is utilised as a phase indication.

External Sensor Input

The unit has the facility to accept a 4-20 mA signal from an external source such as dew-point sensor, temperature probe or user-defined sensor, and display it on the screen. This saves the cost of buying and installing an external display for another parameter that only requires occasional visual inspection.

Technology

Thermal Conductivity Sensor

Thermal conductivity is a property of all gases. Hydrogen is used as a cooling agent in electricity generators because it has a very high thermal conductivity, and is able to quickly draw off the heat created by the power load of the coils and windings in the generator.

The sensor in the XTC601 for Hydrogen Cooled Generators utilizes thermal conductivity technology to accurately determine the purity of the hydrogen in the cooling loop.

Measurement Principle

The measuring principle is via matched thermistors in a Wheatstone Bridge configuration. One thermistor is in the sample cell and the other is either in a sealed or flowing reference chamber. The whole assembly is heated to +50°C to ensure an iso-thermal environment. This provides an accurate and stable platform for measuring the target gas concentration.

Phase functions

The diagram below summarises how the different phases are normally used in hydrogen cooled generator applications so that maintenance can be carried out.

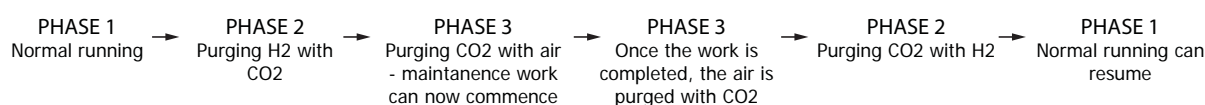


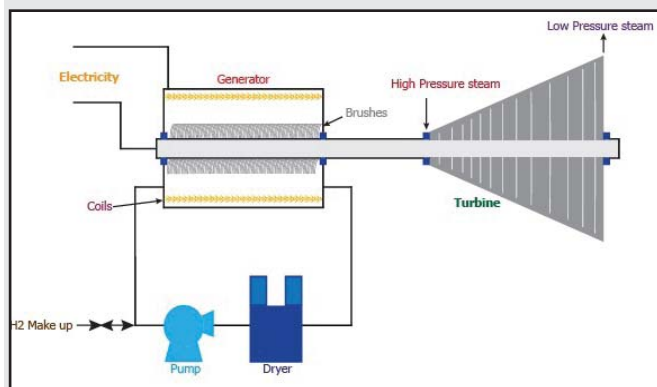


Image courtesy of Siemens AG

The three phases of hydrogen cooled generator applications

Hydrogen cooled generator applications

Most conventional power plants use steam from process boilers that are heated by the combustion of coal, natural or synthetic gas or biomass to run generators to create electricity. High pressure steam is injected into a turbine causing the turbine shaft to spin at a high rate creating mechanical energy. The shaft is connected to an electric generator, which converts the mechanical energy into electricity via metal brushes (on the shaft) passing over stationary coils. This process also generates considerable heat. Hydrogen is used as a coolant, as it has two properties that are beneficial in this process it has very high thermal conductivity (to draw the heat away) and very low viscosity (to reduce the wind resistance on the brushes). If a 900MW generator has a reduction in hydrogen purity from 98% to 95%, it can result in losses from cooling friction and windage of an additional 0.7MW (or power for up to 1,000 households).



Typical schematic of a hydrogen cooled generator

Phase 1 - General running H₂ in Air

During normal operation the analyzer is monitoring air in hydrogen (80/90-100% H₂) for safety and efficiency.

Back. Gas: Air	CONTROL	INTERNAL
98.70 % H ₂	PHASE	H ₂ /AIR
H ₂ in Air phase		

Phase 2 - Purging H₂ in CO₂

CONTROL	EXTERNAL
PHASE	H ₂ /CO ₂

Hydrogen is very flammable and is explosive in concentrations from 4% to 75% in air, so when routine maintenance is carried out, the plant can't simply turn off the hydrogen and open the turbine due to the explosive potential of the hydrogen/air mixture that would result.

Instead, the turbine is purged with carbon dioxide to remove the hydrogen. When the carbon dioxide is at 100% (and therefore 0% hydrogen), it is safe to allow air into the turbines.

Phase 3 - Purging CO₂ in Air

CONTROL	EXTERNAL
PHASE	CO ₂ /AIR

Before the units can be opened the carbon dioxide, which is an asphyxiant, must be purged with air. Once the unit reads 100% air, it is safe to break the seals and commence maintenance.

After maintenance is complete, the purging cycles are reversed to end up with pure hydrogen in the system and the turbine can be started back up.

The XTC601 for Hydrogen Cooled Generators can monitor all of the phases in a compact analyzer with an integrated HMI.

Technical Specifications

Performance			
Phase	Phase 1 - H ₂ in Air	Phase 2 - H ₂ in CO ₂	Phase 3 - CO ₂ in Air
Measurement Range	80-100% or 90-100%	0-100%	0-100%
Display resolution	0.01%	0.1%	1%
Response time (T90)	< 20 seconds	< 20 seconds	< 50 seconds
Recommended calibration	Monthly	Prior to use	Annually
Measurement technology	Thermal Conductivity sensor		
Gas requirements	Non-condensing sample with particles <3µm		
Display type	Backlit LCD		
Repeatability	±0.2% of span		
Linearity	±1% span		
Sample flow rate	100 to 600 ml/min		
Sample flow effect (calibrated at 300 ml/min)	< 1% of span for flows: 100 to 600 ml/min		
Sample pressure	0 to 3 barg with atmospheric vent		
Sample temperature	0 to +45°C max		
Sample cell temperature	+50°C		
Electrical Specifications			
Analog inputs	2 off 4–20 mA inputs One to control phase selection One for an external sensor that can be displayed on the screen		
Analog outputs	2 off 4–20 mA outputs: mA 1 = Concentration mA 2 = Phase indication		
Alarms	2 off single pole changeover (SPCO) relays for concentration (250 V, 5 A max)		
Digital communications	Modbus RTU over RS485 Protocol		
Power supply	24 V DC, 1.5 A max		

Operating Conditions

Ambient temperature -15 to +55°C

Mechanical Specifications

Warm up & stabilization time < 30 minutes

Dimensions 234 x 234 x 172mm (w x d x h)

Weight 9.7 kg

Wetted materials 316 stainless steel, borosilicate glass, platinum, (plus O-ring)

O-Ring materials Viton

Gas connection 1/4" NPT to 1/4" tube (standard)
1/4" NPT to 6mm tube (optional)

Ingress protection IP66, NEMA 4

Hazardous Area Classification

ATEX II 2GD Ex d IIB +H2 T3 Gb
Ex tb IIIC T137°C Db IP66

IECEx Ex d IIB +H2 T3 Gb
Ex tb IIIC T137°C Db IP66

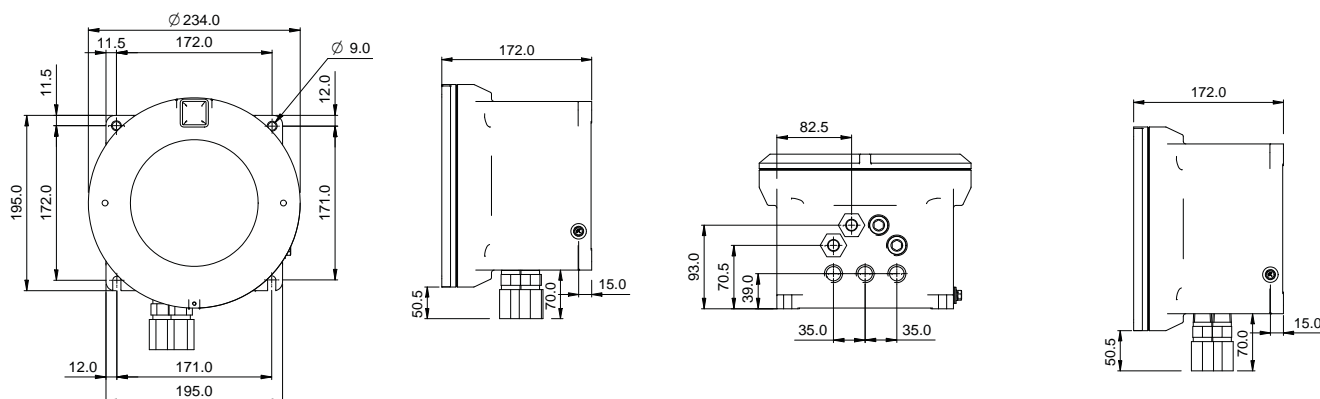
Temperature ranges for ATEX and IECEx as per O-ring type
Viton: Ta = -15°C to +55°C

cCSAus Class I, Division 1, Groups B,C,D T3C

TC TR 1Exd IIB+H2 T3 Gb

Note: Please see the main XTC601 Datasheet for other gases and applications.

Dimensions



Michell Instruments, Inc 319 Newburyport Turnpike, Suite 207, Rowley, MA 01969

Tel: 978 484 0005, Fax: 978 843 7669, Email: us.info@michell.com, Web: www.michell.com/us

Michell Instruments adopts a continuous development programme which sometimes necessitates specification changes without notice.

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XTC601 Binary Gas Analyzer

Order Codes

The XTC601 Binary Gas analyzer comes in four main configurations; General Purpose (GP1) for safe area use, General Purpose (GP2) also for safe areas, but supplied with flame arrestors for flammable samples and finally a model certified for Hazardous Areas (EX). Transmitters are available for users who have a local control system and do not require a HMI to interact with the units (GP3) & (EX3). Finally, the HCG that is designed to monitor the purity of gases in the cooling loop of hydrogen cooled generators.

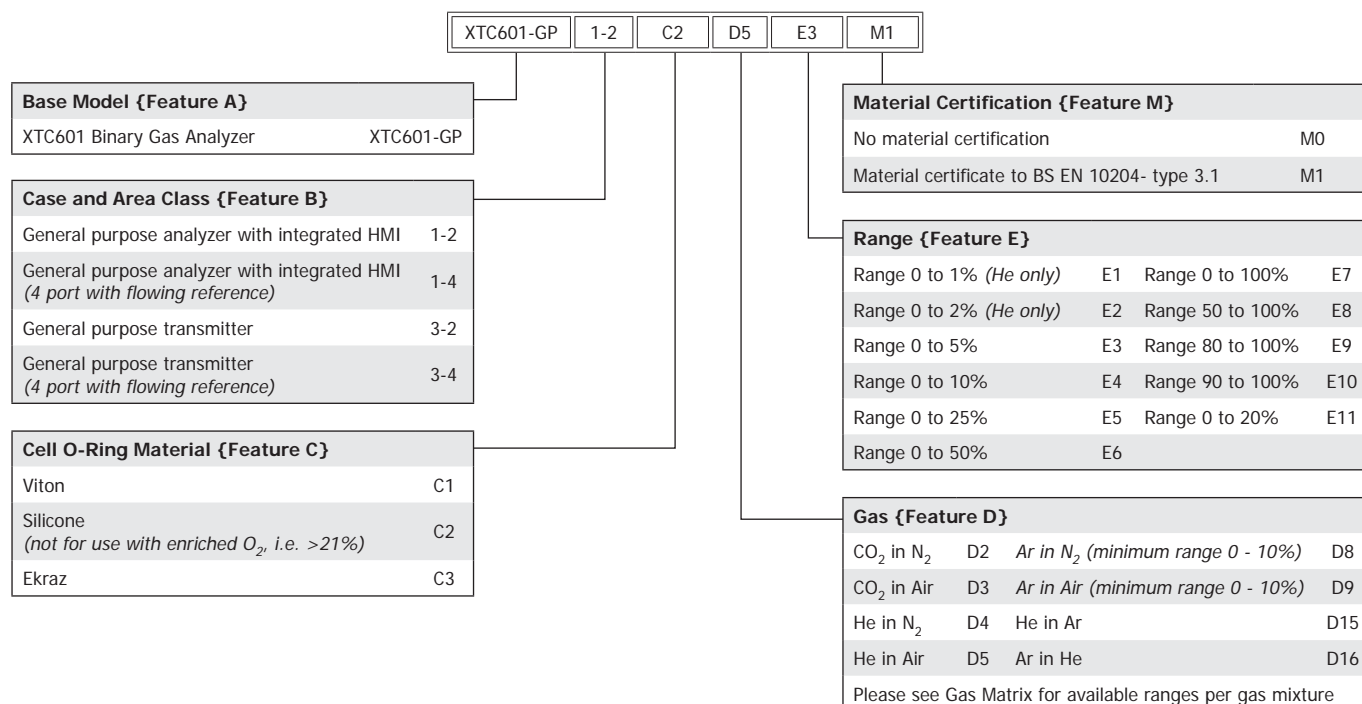
XTC601-GP

XCT601-GP for measuring binary mixtures of non-flammable gases. Sealed or flowing reference versions of both analyzer and transmitter available. Sealed reference will suit most applications, four port flowing reference only required for measuring range 90-100% helium.

To construct the order code, select the relevant feature from the tables below, starting with the base model, which is {Feature A} and then add on options to create a string: {Feature A} - {Feature B} + {Feature C} + {Feature D} + {Feature E} + {Feature M}

Ordering Example: XTC601-GP + 1-2 + C2 + D5 + E3 + M1

XTC601 with Integrated HMI, Silicone Cell O-Ring, 0 to 5% He in Air, Material Certificates



Accessories and Spare Parts for XTC601 GP models

Item	Product / Description	Item	Product / Description
PTFE-TAPE-02	Unsintered PTFE tape for use with enriched oxygen samples	XTC601-M20COMPRESS	M20 cable gland (nickel plated brass 20S - compression) (GP only)
XTC601-EW24	Extended warranty 24 months from invoice date	XTC601-M20CONDUIT	M20 Conduit Entry 3/4" NPT (nickel plated brass)
XTC601-EW36	Extended warranty 36 months from invoice date	XTC601-LIGHTGUIDE	Light Guide (only one available per unit)
XTC601-RC	Ribbon cable assembly	XTP601-26149	Fuse for main PCB
XTC601-1/4"	1/4" tube adapter fitting	XTC601-6MM	6mm tube adapter fitting
XTC601-BLANKPLUG	Blanking plug	XTC601-GP-HMI	Display assembly for GP model

XTC601 order codes continued overleaf.

XTC601 Binary Gas Analyzer

Order Codes

XTC601-GP2

Safe Area analyzer with the added protection of flame arrestors when analyzing flammable samples.

To construct the order code, select the relevant feature from the tables below, starting with the base model, which is {Feature A} and then add on options to create a string: {Feature A} - {Feature B} + {Feature C} + {Feature D} + {Feature E} + {Feature M} + {Feature X (only if required)}

Ordering Example: XTC601-GP + 2-2 + C2 + D6 + E3 + M1

XTC601 with Integrated HMI, Silicone Cell O-Ring, 0 to 5% H₂ in CO₂ background gas, Material Certificates.

XTC601-GP		2-2	C2	D6	E3	M1
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Base Model {Feature A}	
XTC601 Binary Gas Analyzer	XTC601-GP

Case and Area Class {Feature B}	
General Purpose Analyzer with Flame Arrestors	2-2
General Purpose Analyzer with Flame Arrestors (4 Gas Port)	2-4

Cell O-Ring Material {Feature C}	
Viton	C1
Silicone (not for use with enriched O ₂ , i.e. >21%)	C2
Ekraz	C3

Gas {Feature D}			
H ₂ in N ₂	D1	H ₂ in CH ₄	D13
H ₂ in CO ₂	D6	H ₂ in NMHC (Calibrated using C ₂ H ₆)	D14
CO ₂ in H ₂	D7	CH ₄ in CO ₂	D17
N ₂ in C ₃ H ₆ (Surrogate Calibraton using CO ₂)	D10	H ₂ in O ₂	D18
CH ₄ in N ₂	D11	H ₂ in Ar	D19
CO ₂ in CH ₄	D12		
Please see Gas Matrix for available ranges per gas mixture			

Material Certification {Feature M}	
No material certification	M0
Material certificate to BS EN 10204- type 3.1	M1

Range {Feature E}			
Range 0 to 1% (H ₂ only)	E1	Range 0 to 100%	E7
Range 0 to 2% (H ₂ only)	E2	Range 50 to 100%	E8
Range 0 to 5%	E3	Range 80 to 100%	E9
Range 0 to 10%	E4	Range 90 to 100%	E10
Range 0 to 25%	E5	Range 0 to 20%	E11
Range 0 to 50%	E6		

Special Cleaning Procedure {Feature X}	
Cleaned for oxygen service	X3

Accessories and Spare Parts for XTC601 GP models

Item			Product / Description
PTFE-TAPE-02	Unsintered PTFE tape for use with enriched oxygen samples	XTC601-M20COMPRESS	M20 cable gland (nickel plated brass 20S - compression) (GP only)
XTC601-EW24	Extended warranty 24 months from invoice date	XTC601-M20CONDUIT	M20 Conduit Entry 3/4" NPT (nickel plated brass)
XTC601-EW36	Extended warranty 36 months from invoice date	XTC601-LIGHTGUIDE	Light Guide (only one available per unit)
XTC601-RC	Ribbon cable assembly	XTP601-26149	Fuse for main PCB
XTC601-BLANKPLUG	Blanking plug	XTC601-GP-HMI	Display assembly for GP model
XTC601-1/4"	1/4" tube adapter fitting	XTC601-6MM	6mm tube adapter fitting
XTC601-1/4"-SC11	1/4" tube adapter fitting (Oxygen cleaned)	XTC601-6MM-SC11	6mm Tube Adapter Fitting (Oxygen cleaned)

XTC601 Binary Gas Analyzer

Order Codes

XTC601-EX

To construct the order code, select the relevant feature from the tables below, starting with the base model, which is {Feature A} and then add on options to create a string: {Feature A} - {Feature B} + {Feature C} + {Feature D} + {Feature E} + {Feature M} + {Feature X (only if required)}

Ordering Example: XTC601-EX+ 1-2 + C2 + D6 + E3 + M1 + X1

XTC601 with Integrated HMI, Silicone Cell O-Ring, 0 to 5% H₂ in CO₂ background gas, Material Certificates and ATEX-IECEX certification

XTC601-EX		1-2		C2		D6		E3		M1		X1			
Base Model {Feature A}															
XTC601 Binary Gas Analyzer				XTC601-EX											
Case and Area Class {Feature B}															
Hazardous Area Analyzer with integrated HMI				1-2											
Hazardous Area Analyzer with integrated HMI (4 Port with flowing reference)				1-4											
Hazardous Area Transmitter				3-2											
Hazardous Area Analyzer (4 Port with flowing reference)				3-4											
Cell O-Ring Material {Feature C}															
Viton				C1											
Silicone (not for use with enriched O ₂ , i.e. >21%)				C2											
Ekraz				C3											
Gas {Feature D}															
H ₂ in N ₂				D1		CH ₄ in N ₂		D11							
CO ₂ in N ₂				D2		CO ₂ in CH ₄		D12							
CO ₂ in Air				D3		H ₂ in CH ₄		D13							
He in N ₂				D4		H ₂ in NMHC (Calibrated using C ₂ H ₆)		D14							
He in Air				D5		He in Ar		D15							
H ₂ in CO ₂				D6		Ar in He		D16							
CO ₂ in H ₂				D7		CH ₄ in CO ₂		D17							
Ar in N ₂ (minimum range 0 - 10%)				D8		H ₂ in O ₂		D18							
Ar in Air (minimum range 0 - 10%)				D9		H ₂ in Ar		D19							
N ₂ in C ₃ H ₈ (Surrogate Calibraton using CO ₂)				D10											
Please see Gas Matrix for available ranges per gas mixture															
Certification {Feature X}															
ATEX, IECEx												X1			
cCSAus												X2			
Material Certification {Feature M}															
No material certification												M0			
Material certificate to BS EN 10204-3.1												M1			
Range {Feature E}															
Range 0 to 1% (H ₂ or He only)												E1			
Range 0 to 2% (H ₂ or He only)												E2			
Range 0 to 5%												E3			
Range 0 to 10%												E4			
Range 0 to 25%												E5			
Range 0 to 50%												E6			
Range 0 to 100%												E7			
Range 50 to 100%												E8			
Range 80 to 100%												E9			
Range 90 to 100%												E10			
Range 0 to 20%												E11			

Accessories and Spare Parts for the XTC601 EX models

Item	Product / Description	Item	Product / Description
PTFE-TAPE-02	Unsintered PTFE tape for use with enriched oxygen samples	XTC601-LIGHTGUIDE	Light Guide (only one available per unit)
XTC601-EW24	Extended warranty 24 months from invoice date	XTC601-1/4"	1/4" tube adapter fitting
XTC601-EW36	Extended warranty 36 months from invoice date	XTC601-6MM	6mm tube adapter fitting
XTC601-RC	Ribbon cable assembly	XTP601-26149	Fuse for main PCB
XTC601-BLANKPLUG	Blanking plug	XTC601-1/4"-SC11	1/4" tube adapter fitting (Oxygen cleaned)
XTC601-M20BARRIER	M20 cable gland (nickel plated brass 20S — barrier)	XTC601-6MM-SC11	6mm Tube Adapter Fitting (Oxygen cleaned)
XTC601-M20CONDUIT	M20 Conduit Entry 3/4" NPT (nickel plated brass)		

XTC601 Binary Gas Analyzer

Order Codes

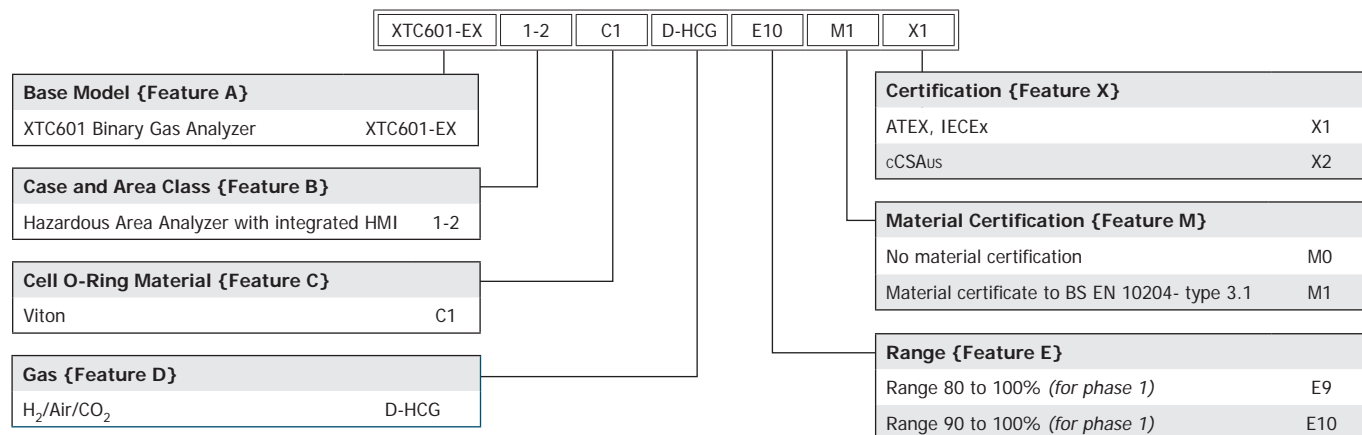
XTC601-EX for hydrogen cooled generators

Multi-map analyzer for measuring the three phases of a hydrogen cooled generator. Hydrogen Purity (Phase 1) with air as the contaminant, H₂ in CO₂ for purging (Phase 2) and CO₂ in Air for second purge type (Phase 3).

To construct the order code, select the relevant feature from the tables below, starting with the base model, which is {Feature A} and then add on options to create a string: {Feature A} - {Feature B} + {Feature C} + {Feature D} + {Feature E} + {Feature M} + {Feature X (only if required)}

Ordering Example: XTC601-EX+ 1-2 + C1 + D-HCT + E10 + M1 + X1

XTC601 with Integrated HMI, Viton Cell O-Ring, Hydrogen in Air Phase (90 to 100%), material certificates and ATEX-IECEX certification.



Accessories and Spare Parts for the XTC601 EX models

Item	Product / Description	Item	Product / Description
PTFE-TAPE-02	Unsintered PTFE tape for use with enriched oxygen samples	XTC601-M20CONDUIT	M20 Conduit Entry 3/4" NPT (<i>nickel plated brass</i>)
XTC601-EW24	Extended warranty 24 months from invoice date	XTC601-LIGHTGUIDE	Light Guide (<i>only one available per unit</i>)
XTC601-EW36	Extended warranty 36 months from invoice date	XTC601-1/4"	1/4" tube adapter fitting
XTC601-RC	Ribbon cable assembly	XTC601-6MM	6mm tube adapter fitting
XTC601-BLANKPLUG	Blanking plug	XTP601-26149	Fuse for main PCB
XTC601-M20BARRIER	M20 cable gland (<i>nickel plated brass 20S — barrier</i>)		

Background gas Matrix

Target Gas	Background Gas							
	H2	He	CH4	Air	N2	CO2	Ar	NMHC
H2			0-1%	0-1%	0-1%	0-1%	0-1%	0-1%
He				0-1%	0-1%	0-1%	0-1%	
CH4				0-20%	0-20%	0-10%		0-10%
Air	0-1%	0-1%	0-20%			0-10%	0-10%	
N2	0-1%	0-1%	0-10%			0-10%	0-10%	
CO2	0-1%	0-1%	0-5%	0-10%	0-10%			
Ar				0-10%	0-10%			
NMHC			0-10%	0-20%	0-20%			

Key	
	Minimum range available
	Minimum range with flowing reference
	Not tested
	Unlikely or impossible measurements

Michell Instruments Ltd 48 Lancaster Way Business Park, Ely, Cambridgeshire, CB6 3NW

Tel: +44 (0) 1353 658000, Fax: +44 (0) 1353 658199, Email: uk.info@michell.com, Web: www.michell.com/uk

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