QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PLAN

FOR

ADIRONDACK FARMS LLC ANAEROBIC DIGESTER GAS (ADG) SYSTEM

Agreement # 29203

September 9, 2016

Submitted to:

New York State Energy Research and Development Authority
17 Columbia Circle
Albany, NY 12203-6399

and

Adirondack Farms LLC
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Submitted by:

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Introduction

This plan describes the approach that will be used to monitor the performance of the anaerobic digester gas (ADG) system that is currently being installed at Adirondack Farms LLC (the farm) in Peru, NY, to produce biogas and electricity. Biogas will be used to fuel one engine-generator set to produce power that will be consumed on site and/or exported back to the local utility. A monitoring system will be installed to measure and collect the data necessary to quantify the electric power produced and amount of biogas used by the engine-generator. The data will serve as the basis for payment of ten (10) years of performance incentive payments, which the farm has applied for under a Standard Performance Contract with NYSERDA based on a Total Contracted Capacity of 633 kW.

ADG System Description

The digester system at the farm was designed by Envitec Biogas. The engine-generator equipment will be provided by Martin Machinery while the gas conditioning equipment will be supplied by Envitec Biogas. Gas and power metering are provided by Sage Metering Inc. and Electro Industries GaugeTech Inc, respectively. The site will operate one 633 kW genset. Gas conditioning equipment, piping, and controls will be located next to the engine skid in a nearby building. The electrical system includes controls to synchronize the generator to the grid as well as a Beckwith M-3410A protective relay and a grid monitoring device to automatically isolate the units from the utility grid in the event of a utility power outage. The farm expects to utilize most available biogas for power generation with some biogas directed to heat recovery.

Figure 1: Aerial View of Adirondack Farm LLC (left) and Digester Construction Progress (right)

Figure 2: Manure Piping From Manure Pit

Table 1 - Biogas Systems at Adirondack Farms

Digester	Completely mixed, flexible supported cover, heated, 1.9 million gallon capacity, 27 day retention time
Feedstock	Dairy Manure, approximately 2,800 animals (lactating cows)
Engine	Jenbacher JGS 312, 1,800 RPM, 633 kW on biogas
Generator	Emerson Leroy Somers Model LSA 49.1 – 440 VAC, 3 Phase.
Biogas Conditioning	Air is introduced from a compressor to reduce H_2S levels in the internal layer of the digester. Biogas flows through 200 feet of horizontal underground piping which reduces temperature and removes excess moisture before introduction to the CHP system.
Engine Backup/startup Fuel	Biogas Only for Engine Start-up
Heat Recovery Use	Digester and Farm Areas

Figure 3 and Figure 4 show the farm layout and general site plan. Cows are currently bedded with sand but will switch over to solids. Manure is collected from five freestall barns via scrape systems. Manure from four of the five barns (upper row of barns) and the milking parlor is scraped into a flume pipe and flows into a 500,000 gallon capacity sand settling lane where most sand is deposited. Manure from the fifth barn (heifer barn; lower freestall barn) is scraped into a

concrete reception pit and pumped into tankers for either land application or discharge into the sand settling lane. Effluent from the settling lane flows into a concrete pump tank and is pumped in series to the three manure storage ponds. There are three cells with a total storage capacity of 12.4 million gallons. A mechanical solids separation step is performed if needed. Liquid from the final manure storage pond is recycled through the flume to flush manure to the sand settling lane.

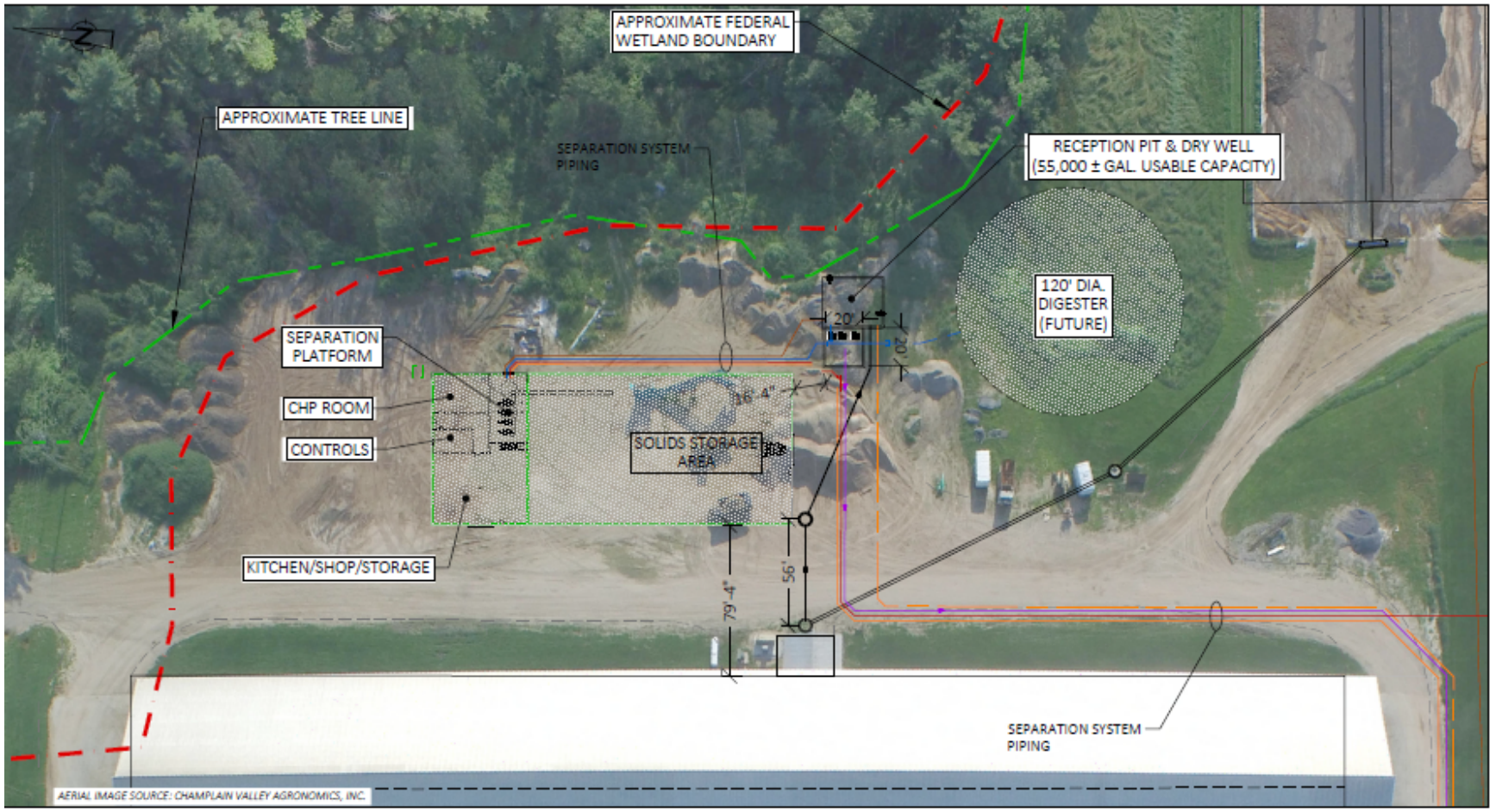


Figure 3: Site Plan 1 of 2

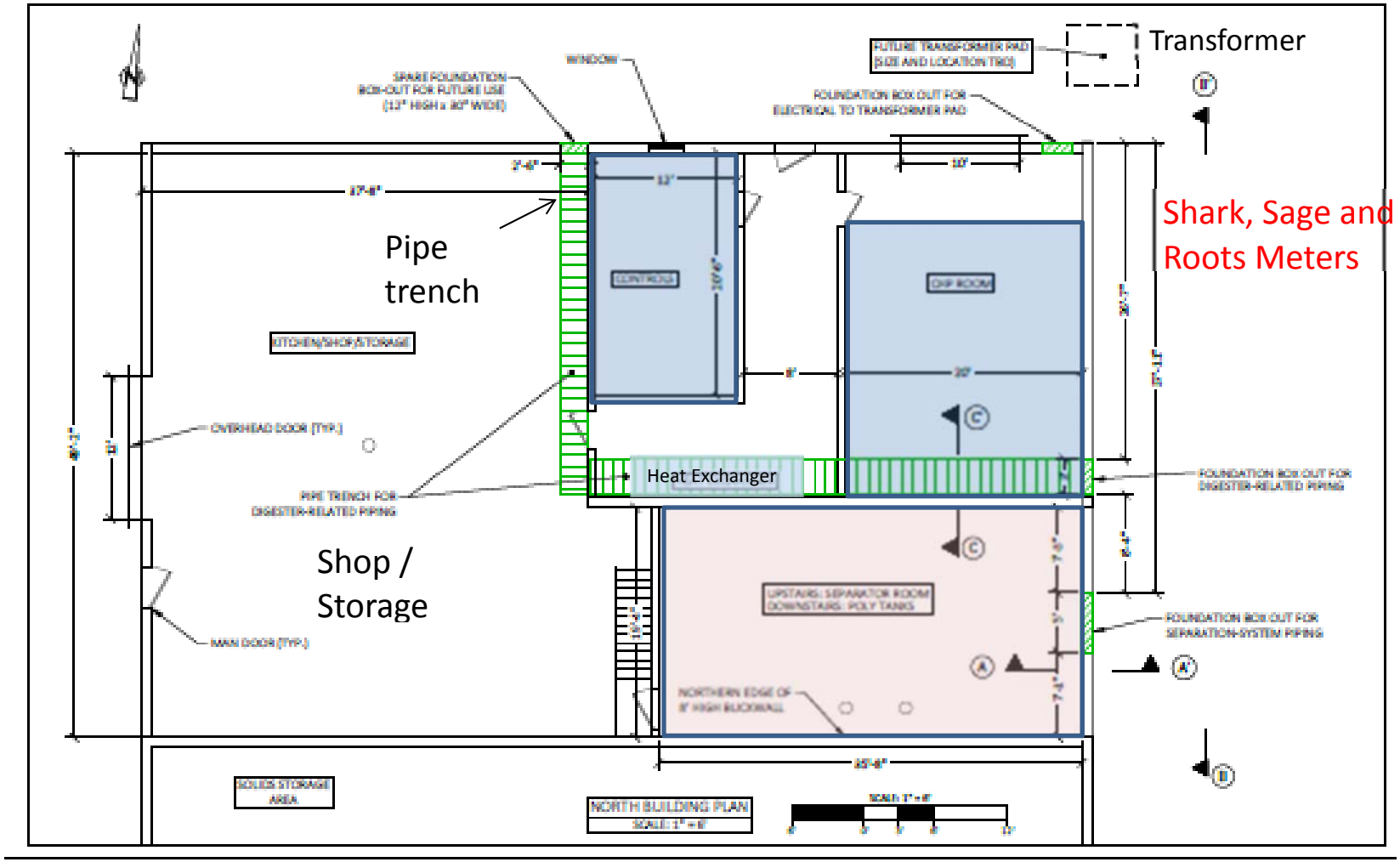


Figure 4: Site Plan 2 of 2

Figure 5 shows the process diagram for the digester and engine system. Manure and bedding from the barns will be scraped into the existing flume pipe, which will terminate in a reception pit at the eastern edge of the rows of barns. Manure will be pumped from the reception pit into a single 1.9 million gallon completely mixed above ground digester vessel supplied by Envitec Biogas USA. The digester is approximately 120 feet in diameter and 24 feet tall with a flexible, supported cover. The digester will be continuously agitated by five 13kW (17.5 hp) mixers. Effluent from the digester will flow by gravity to holding tanks and then to solids separators (screw presses) for bedding recovery. Bedding will be returned to the barns, while the liquid effluent will flow to the existing manure storage ponds for eventual land application in compliance with the existing nutrient management plan or to the flume pit to be used as flume water.

Biological removal of hydrogen sulfide from the biogas will occur inside the digester headspace, supported by oxygen injection. A Mapro MCF 500 blower will be used to remove the biogas from the digester via an intake in the headspace of the vessel. Moisture will removed from the biogas with a passive condensation field consisting of 200 feet of horizontal, underground pipe and a moisture trap. The engine-generator set is conservatively expected to operate at a capacity factor of approximately 90% after accounting for biogas production rates and expected maintenance intervals. The planned biogas distribution will be used completely for power generation with potential excess biogas flared as needed for backup.

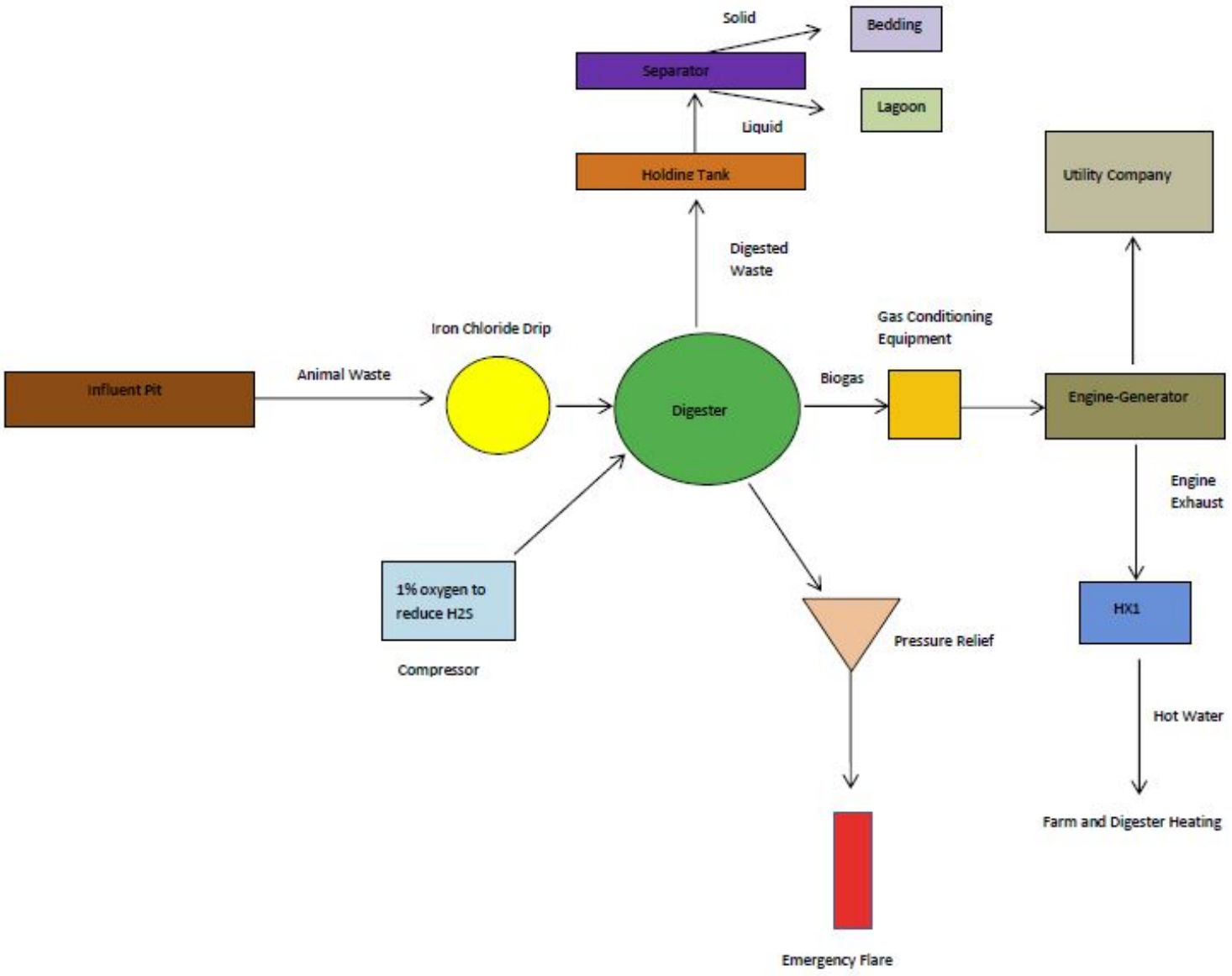


Figure 5: Proposed Digester Process Diagram

Sage Metering Inc. devices will measure gas flow to the engine-generator (**G1**). A Shark 200 Revenue grade meter (**S1**) will measure the energy output and power data of the engine-generator to determine the Annual Performance Incentive. A small amount of air will be injected directly into the digester head space to help reduce H_2S in the biogas prior to the carbon removal system. This limit is to protect the engine from damage or overheating due to concentrations of H_2S. Measurement of H_2S is not included in the QA/QC plan with respect to the gas clean up performance incentive, but Envitec Biogas will voluntarily supply H_2S data to provide insight on the effectiveness of their gas cleaning techniques.

Heat is recovered from the engine exhaust in the form of hot water. This hot water is circulated through the heat exchanger where it provides heat to the digester contents, pumped by the recirculation pump. A similar system is used to offset the hot water requirements in the milking parlor and calving area.

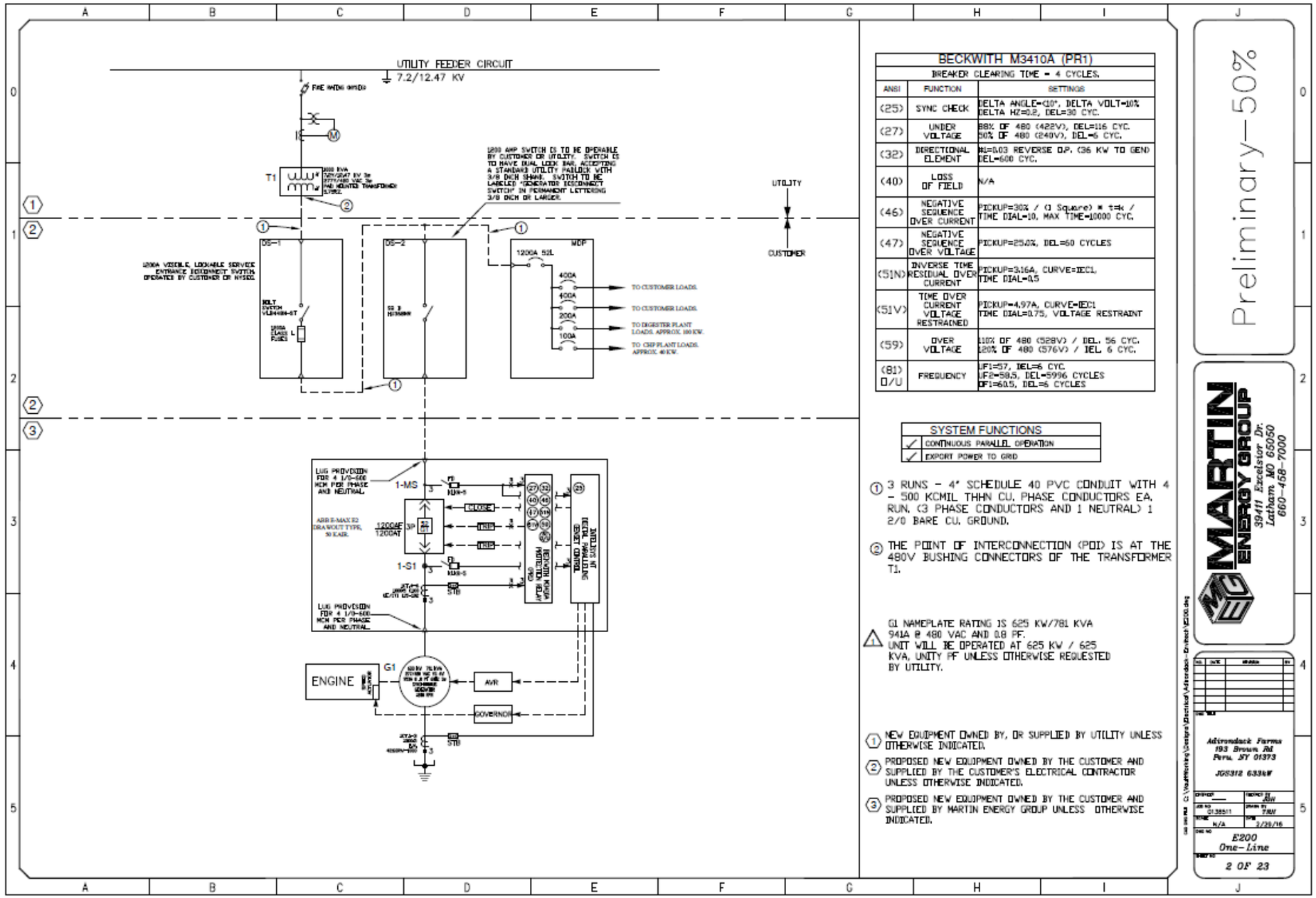


Figure 6: One Line Electrical Diagram

ADG System Capacity Payment Descriptions

This Section describes the Capacity Incentive Payments included in the Agreement, the payment milestones to be achieved in order to receive payment, and the deliverables to be provided in achieving these milestones.

Capacity Payment #1: Up to 15% of the Total Capacity Incentive.

Payment Milestones: Initial payments made for major equipment and other work, such as the engine generator system, the anaerobic digester system, the gas scrubbing equipment, and other major components and fees for system design, engineering, CESIR study and other "soft costs".

Deliverables: Documentation that initial payments have been made to suppliers or service providers for major project components.

Capacity Payment #2: Up to 45% of the Anaerobic Digester component of Total Capacity Incentive.

Payment Milestones: NYSERDA's designated technical consultant has verified that construction/installation/upgrade of the anaerobic digestion system has been completed.

Deliverables: (a) A QA/QC Plan approved by NYSERDA and (b) Site inspection and verification by the NYSERDA technical consultant that the installation is complete and operational in accordance with the approved QA/QC Plan. The digester can be considered complete and operational if the digester structures, piping, controls and equipment are all installed for the feeding mixing, heating and unloading of digester feedstocks and for gas treatment and flaring. The completed installation may be documented with (1) a listing of the digester structures, piping, controls and equipment for feeding, mixing, heating and unloading and gas treatment and flaring and other major equipment to be installed in the design and (2) provision of as-built drawings, photos, verification by on-site inspection by the NYSERDA technical consultant, and/or other means satisfactory to NYSERDA documenting that these have been installed and are ready to operate to produce and manage the design biogas power generation rate of approximately 12,026 scf/hr identified in the project Application Package to PON 2828 Appendix B Section B as a total of 105,340,764 scf/yr. *(If the installed equipment deviates from that listed in the Application Package, an explanation of the deviation must be provided for determination by NYSERDA whether the installed equipment adequately meets the terms of the Agreement.)*

Capacity Payment #3: Up to 45% of the Power Generation component of Total Capacity Incentive.

Payment Milestones: The Contractor has provided sufficient documentation to NYSERDA verifying that the power generation system has been delivered to the site (e.g., delivery receipt).

Deliverables*:* Delivery receipts, photos or other documentation acceptable to NYSERDA of delivery of the engine and generator equipment as described in the Agreement and adequate explanation of any deviations. *(If the installed equipment deviates from that listed in the*

Application Package, an explanation of the deviation must be provided for determination by NYSERDA whether the installed equipment adequately meets the terms of the Agreement.)

Capacity Payment #4: Up to 45% of the Project Enhancement component of Total Capacity Incentive.

Payment Milestones: NYSERDA's designated technical consultant has verified that construction/installation of the Project Enhancement has been completed or the required documentation for the Project Enhancement, according to applicable sections of *Using the Incentive Calculation Tool* of Exhibit D has been submitted to NYSERDA. The Contractor may request payment at this time for any Project Enhancements that have been completed and verified. Payment for Project Enhancements completed and verified after the 4th Capacity payment request has been made may be requested with the 6th Capacity payment.

Deliverables: Documentation that the project enhancement for the system designed to accept greater than 20% food waste has been completed, including pretreatment equipment, all meeting the requirement of Enhancements Section 3 of the Using Incentive Calculation portion of Exhibit D.

Capacity Payment #5: Up to 20% of the Total Capacity Incentive.

Payment Milestones: Documentation has been provided to NYSERDA that sufficiently verifies successful operation of the newly installed system, full payment of the interconnection implementation cost; confirmation from the utility that the interconnection will be completed; and a schedule for completion from the utility.

Deliverables: Documentation that (a) the interconnection implementation cost has been paid in full; confirmation that the utility is moving forward with the interconnection; a schedule for completion; and (b) the new power generation equipment is complete and operational in accordance with the approved QA/QC Plan. The New Power Generation Capacity can be considered complete and operational if it has produced electricity at a minimum average of 75% capacity factor or 474.75 kWh/h for at least one hour.

Capacity Payment # 6: Up to 100% of the Total Capacity Incentive.

Payment Milestones: The newly installed system is successfully commissioned. Commissioning includes operating the ADG - fueled energy generation system at a minimum of 75% average capacity factor over seven (7) consecutive days, and demonstrating the ability to upload data generated by the system to NYSERDA's CHP website, if applicable. Any Project Enhancements payments that were not made with the 4th Capacity payment may be requested with this payment.

Deliverables: A Project Commissioning Report documenting the completion of all elements of the Commissioning process required by the QA/QC Plan and successful uploading of data to the website that is adequately consistent to NYSERDA's satisfaction with the data recorded on site. The Project Commissioning Report shall consist of the compilation of the following deliverables

is provided to NYSERDA's satisfaction as meeting the requirements for the 6th Capacity Incentive Payment.

1. Documentation that construction of the ADG-to Electricity System is complete;

2. Documentation that the System's New Equipment has satisfactorily operated for at least seven consecutive days, which is defined as operation with a minimum average 75% Capacity Factor of the Total Contracted Capacity or 474.75 kWh/h;

3. Documentation that the System has demonstrated the ability to upload information to NYSERDA's CHP Data Integration Website in conformance with the following section of the QA/QC Plan: Monitoring System Equipment, Installation, Operation, and Maintenance;

4. As-Built Diagrams of the installed system, including an explanation of any deviation of the equipment from that listed in the Application Package. Diagrams may consist of electronic copies of as-built drawings.

Monitoring System Equipment, Installation, Operation, and Maintenance

Figure 5 shows the general location of the meters used to measure biogas input to the engine-generator (**G1**) and the generator electrical output (**S1**).

Information on these data points is shown in Table 2.

Table 2: Monitored Points for ADG System

Point Type	Point Name	Description	Instrument	Engineering Units	Expected Range
Pulse	S1	Engine-Generator Power	Electro Industries GaugeTech Inc. Revenue Grade Meter Model: Shark 200	kW	0-650 kW
Pulse	G1	Engine Biogas Flow	Sage Metering Inc. Model SIP-05-06-DC24-D	SCFH	0-15,000 SCFH

The energy output and power data of the engine-generator will be measured with a Shark 200 Revenue grade meter (S1) to determine the Annual Performance Incentive. The electrical output of the engine-generator system will be measured with the Intelisys NT engine controller. The controller provides an external graphical display of instantaneous kWh and total kWh. The controller will be installed according to the requirements in the appropriate operator guide and will be protected by a dedicated circuit breaker. The measurements available on the controller are for backup purposes only.

The biogas input to the engine will be measured by a Sage Prime mass flow meter (G1) that provides pulse output proportional to the volume flow that is compensated for temperature. The meters will be installed and maintained according to the "Sage Thermal Gas Mass Flow Meter Operations and Instruction Manual for Models SIP/SRP," by the facility. A log of maintenance activities for the meters will be maintained at the site.

The lower heating value for the biogas is estimated to be 550 Btu/ft^3 based on past measurements of the CH_4 content of biogas. This value will be verified weekly based on measurements of methane using a Union Gas INCA4000 for CH_4 range of 0-100%. The farm staff will perform the CH_4 tests and log the results in the project log. This test is performed by taking a gas sample from the low pressure gas supply before it enters the engine generator equipment.

Data logging is going to be done in one of two ways:

1) The control panels being provided may have the capabilities to perform the necessary data logging. This includes receiving signals from the power meter and gas meter (one Modbus 485 signal, and one pulse or 4-20mA or Modbus 485) and logging time stamped data at 15 minute intervals. The data would then need to be made available to CDH Energy, the NYSERDA CHP Website Contractor, in a number of ways:

- A nightly automated email to data_collection@cdhenergy.
- A nightly automated upload to CDH's FTP server.
- If a static IP address can be provided, and the data made available online, CDH could set up automated processes to pull data on a nightly basis.

2) If the control panels do not have the capabilities required, CDH will provide an Obvius AcquiSuite data logger and panel. CDH will then terminate sensor wiring to the logger, and verify that accurate measurements are being received. The facility will be responsible to provide CDH with 110 V power, and either an internet or phone connection. The data logger will be connected to an uninterruptible power supply (UPS) to ensure the data logger retains its settings and data in the event of a power outage. The Farm will provide a static IP address that will be used by CDH Energy to communicate with the data logger.

Management of Monitoring System Data

The farm will perform the following quality assurance and quality control measures to ensure the data produced from our system accurately describes system performance.

On a daily basis, the farm equipment manager will perform inspections of the digester and engine-generator equipment and record findings into the project log.

On a weekly basis, the farm equipment manager will perform inspections of the QA/QC meter installations and complete the routine maintenance on the meters, noting any abnormalities or unexpected readings. The farm will also maintain a weekly log of the cumulative power generation (kWh) from the power meter (**S1**) and gas flow (cf or ft^3) recorded by the Sage meter (**G1**) in the event that data transfer to the NYSERDA CHP Website fails or other anomalies occur.

On a weekly basis, the farm staff will review the data stored in the NYSERDA CHP Website (chp.nyserda.ny.gov) to ensure it is consistent with our observed performance of the ADG system and logged readings. The farm will review the data on the website, including:

- Monitored Data – Download (CSV file)

In addition, the farm staff will also use the Monitored Data – Download (CSV file) that is available at the CHP Website to help track the system performance, including:

- an email report sent out if data is not received at the web site or does not pass the quality checks.

The website will automatically take the data collected from the data-logger and evaluate the quality of the data for each base time interval using range and relational checks. The range checks will be setup based on the expected ranges for the sensors (see Table 2).

The relational check will compare the kWh production data and gas production data for each base time interval to ensure that both meters are reading properly. This check is to ensure that both meters are operating properly; power cannot be produced without gas, and gas cannot be combusted by the engine without producing power.

Data that passes the range and relational quality checks will be used to compile the production amounts used for the incentive calculations. However, all hourly data is available from the NYSERDA CHP Website if the data quality flag of "Data Exists" is selected. In the event of a communications or meter failure, the farm will work with CDH Energy to resolve the issue in a few days.

If unanticipated loss of data occurs when the engine-generator continues to produce electricity, the farm intends to follow the procedures outlined in Exhibit D, of their contract, i.e. use data from similar periods – either just before or after the outage - to replace the lost data. The farm understands that they can use this approach for up to two 36 hour periods within each 12-month performance period. If more than two such data outages occur, the farm will provide information from other acceptable data sources (e.g., weekly recorded logs) to definitively determine the amount of power that was being produced from biogas during the period in question.

Annual Performance Reports

The farm will prepare Annual Performance Reports summarizing the monthly data over the 12-month performance period. The reports will include a table (example provided below) showing the monthly kWh production, biogas use by the engine, and other data listed in Table 3, and if used, any propane or other fuel used for the engine/boiler. The Farm may use the data found on the CHP Website or alternatively, they may provide their own summary of the data using on-site sources along with a narrative justifying why their data and calculations are more appropriate. The methods for calculating these values are provided below.

Table 3 - Summary of Monthly Data for Annual Performance Reports

Start Date of Reporting Period	Number of Days in Each Period	Electricity Production, $kWh_{generator}$	Biogas Used by Engine, (cubic feet)	Biogas Used by Flare, (cubic feet)	LHV_{biogas} (Btu/cf)	Biogas Energy Content, Q_{biogas} (BTU)
TOTALS						

The farm will calculate monthly values for lower heating value of the biogas (LHV_{biogas}) and total energy content of the biogas (Q_{biogas}) as follows.

Monthly Biogas Lower Heating Value

The readings of CO_2 concentration in the biogas gathered weekly will be used to estimate the average monthly Biogas Lower Heating Value using the following equation:

$$LHV_{biogas} = LHV_{methane} \cdot (F_{CH\,4})$$

where:

$LHV_{methane}$ - lower heating value of methane (911 Btu/ft^3 at standard conditions, 60 °F and 1 atm)

F_{CH4} - fraction of biogas that is CH_4 (average of readings for each month)

Monthly Biogas Energy Content

Calculate the average monthly Biogas Energy Content using the following equation:

$$Q_{biogas} = CF \cdot LHV_{biogas}$$

where:

CF - volume (cubic feet or ft^3) of biogas in month

Reasonable Electrical Efficiency

The Annual Performance Report will also provide a comparison of power output and fuel input for the engine to confirm their reasonableness. For instance, the electrical efficiency – measured as power output ($kWh_{generator}$) divided by the energy content of the fuel input (Q_{biogas}) in similar units and based on lower heating value – should be in the 31% to 38% range over any interval for the engine-generator at Adirondack Farms.

Appendices

Cut sheets and Manuals for:

Jenbacher JGS 312, 1,800 Engine

Emerson Leroy Somer LSA 49.1 M6 Alternator

ComAP Intelisys NT Controller IS-NT-BB

Shark200 Revenue Grade Meter 200-60-10-V2-D2-20mAOS-X

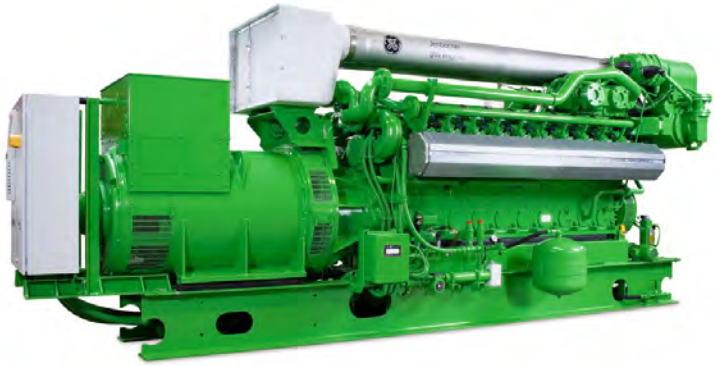
Sage Metering Inc., Model SIP-05-06-DC24-DIG-GAS Mass Flow Meter

Union Gas Analyzer Model INCA4000

Jenbacher type 3

Efficient, durable, reliable

Long service intervals, maintenance-friendly engine design and low fuel consumption ensure maximum efficiency in our type 3 engines. Enhanced components prolong service life even when using non-pipeline gases such as landfill gas. The new type 3D generation offers an outstanding service interval with up to 80,000 operating hours until the major overhaul. This engine type stands out in its 400 to 1,100 kW power range due to its technical maturity and high degree of reliability.



Reference installations

J312 Containerized solution Landfill site; Cavenago, Italy

Fuel	Engine type	Electrical output	Thermal output	Commissioning
Landfill gas	2 x J312	1,202 kW	5,102 MBTU/hr	09/1999

Every system has its own landfill gas feeder line and exhaust gas treatment line. The generated electricity is used on-site, excess power is fed into the public grid. The employment of the CL.AIR* system ensures the purification of the exhaust gas to meet stringent Italian emission requirements. As a special feature, at this plant the thermal energy is used for landfill leachate treatment, as well as for greenhouse heating.

J316 Profusa, producer of coke; Bilbao, Spain

Fuel	Engine type	Electrical output	Thermal output	Commissioning
Coke gas and natural gas	12 x J316	5,642 kW (a), 6,528 kW (b)	-	11/1995

a) with coke gas b) with 60 % coke gas and 40 % natural gas, or 100 % natural gas

This installation designed by GE's Jenbacher product team enables Profusa to convert the residual coke gas with a hydrogen content of approximately 50 % into valuable electrical energy. Beginning 2008, the 12 engines reached a combined total of one million operating hours.

J320 Ecoparc I; Barcelona, Spain

Fuel	Engine type	Electrical output	Thermal output	Commissioning
Biogas and natural gas	5 x J320	5,240 kW	10,040 MBTU/hr (a) 10,263 MBTU/hr (b)	12/2001 to 01/2002

a) with biogas b) with natural gas

In Ecoparc I, organic waste is processed into biogas, which serves as energy source for our gas engines. The generated electricity is used on-site as well as fed into the public power grid. A portion of the thermal energy is used as process heat in the digesters, and the excess heat is bled off in the air coolers.

J320 Amtex Spinning Mills; Faisalabad, Pakistan

Fuel	Engine type	Electrical output	Thermal output	Commissioning
Natural gas	12 x J320	12,072 kW	-	11/2002 (a), 04/2003 (b), 03/2003 (c), 04/2004 (d), 04/2005 (e), 03/2008 (f)

a) 1st–2nd engine b) 3rd engine c) 4th–7th engine d) 8th engine e) 9th, 10th engine f) 11th, 12th engine

The natural gas-driven units generate electricity for spinning mills in one of Pakistan's most important textile centers. Special features of this Jenbacher plant allow for high ambient temperature, dusty inlet air, and operation in island mode.

Technical data

Configuration			V 70°
Bore (inch)			5.31
Stroke (inch)			6.69
Displacement / cylinder (cu.in)			148.5
Speed (rpm)			1,800 (60 Hz)
Mean piston speed (in/s)			402
Scope of supply			Generator set, cogeneration system, generator set / cogeneration in container
Applicable gas types			Natural gas, flare gas, propane, biogas, landfill gas, sewage gas. Special gases (e.g., coal mine gas, coke gas, wood gas, pyrolysis gas)
Engine type	J312	J316	J320
No. of cylinders	12	16	20
Total displacement (cu.in)	1,782	2,376	2,970

Dimensions l x w x h (inch)		
Generator set	J312	190 x 70 x 90
	J316	210 x 70 x 90
	J320	230 x 70 x 100
Cogeneration system	J312	190 x 90 x 90
	J316	210 x 90 x 90
	J320	230 x 80 x 90
Container	J312	480 x 100 x 110
	J316	480 x 100 x 110
	J320	480 x 100 x 110

Weights empty (lbs)		
Generator set	J312	18,740
	J316	22,490
	J320	29,770
Cogeneration system	J312	21,830
	J316	24,910
	J320	30,870

Outputs and efficiencies

Natural gas	**1,800 rpm | 60 Hz**					
NOx <	**Type**	**Pel (kW)[1]**	**ηel (%)[1]**	**Pth (kW)[2]**	**ηth (%)[2]**	**ηtot (%)**
1.0 g/bhp.hr	J312	633	38.1	2,837	50.0	88.1
	J316	849	38.3	3,796	50.2	88.5
	J320	1,062	39.1	4,658	50.3	89.4
0.5 g/bhp.hr	J312	633	36.8	3,053	51.9	88.7
	J316	849	37.0	4,047	51.6	88.6
	J320	1,062	38.2	4,836	51.0	89.2

Natural gas	**1,800 rpm | 60 Hz**					
NOx <	**Type**	**Pel (kW)[1]**	**ηel (%)[1]**	**Pth (kW)[2]**	**ηth (%)[2]**	**ηtot (%)**
1.0 g/bhp.hr	J312	633	38.1	2,764	48.8	86.9
	J316	849	38.3	3,699	48.9	87.3
	J320	1,062	39.1	4,507	48.6	87.8
0.6 g/bhp.hr	J312	633	36.8	2,934	49.9	86.7
	J316	849	37.0	3,914	49.9	86.9
	J320	1,062	37.0	4,951	50.5	87.5

1) Technical data according to ISO 3046
2) Total heat output with a tolerance of +/- 8 %, exhaust gas outlet temperature 120°C, for biogas gas outlet temperature 180°C

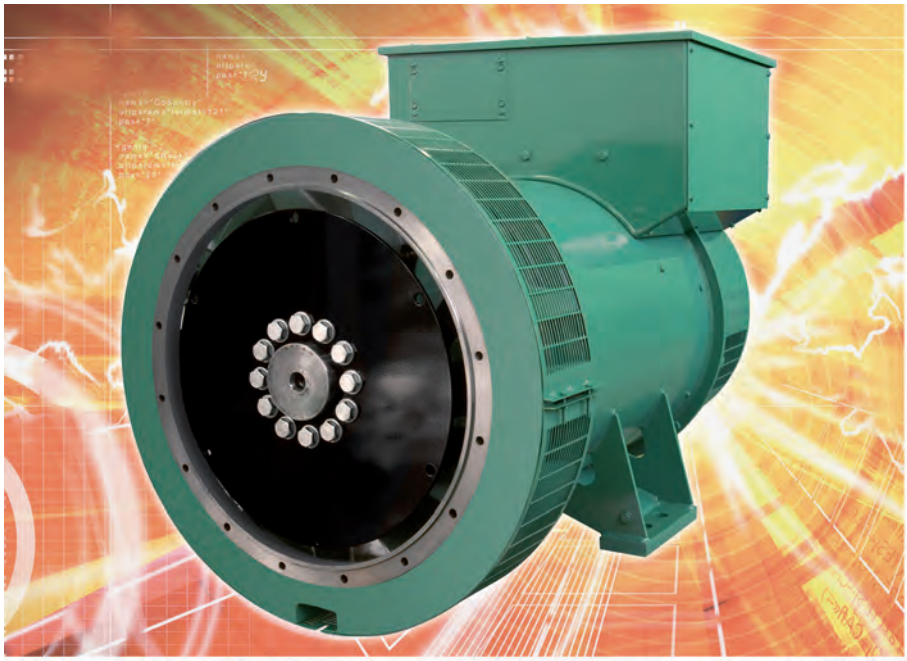
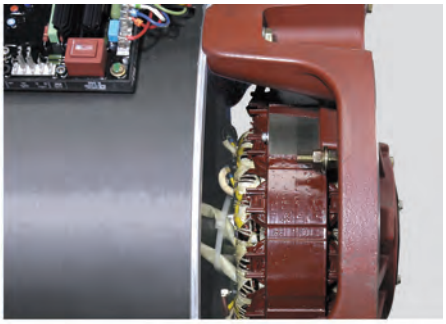
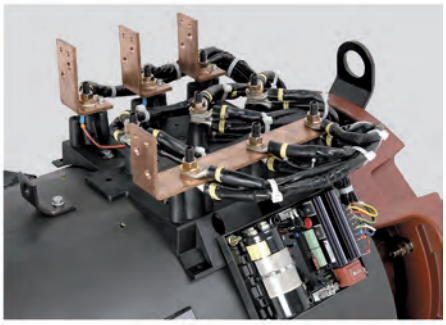
All data according to full load and subject to technical development and modification.

Further engines versions available on request.

Find your local support online:
www.gepower.com/distributedpower

GEA-32390US

EMERSON
Industrial Automation


LEROY SOMER

Low Voltage alternators - 4 pole
LSA 49.1

660 to 1000 kVA - 50 Hz / 792 to 1250 kVA - 60 Hz

Electrical and mechanical data

3867 en - 2014.05 / h

Low Voltage alternators 4 pole 3-phase PARTNER

LSA 49.1

660 to 1000 kVA - 50 Hz / 792 to 1250 kVA - 60 Hz

SPECIALLY ADAPTED TO APPLICATIONS

The LSA 49.1 alternator is designed to be suitable for typical generator applications, such as: backup, marine applications, rental, telecommunications, etc.

COMPLIANT WITH INTERNATIONAL STANDARDS

The LSA 49.1 alternator conforms to the main international standards and regulations:

- IEC 60034, NEMA MG 1.32-33, ISO 8528-3, CSA / UL 1446 (UL 1004 on request), marine regulations, etc.

It can be integrated into a CE marked generator.
The LSA 49.1 is designed, manufactured and marketed in an ISO 9001 environment and ISO 14001.

TOP OF THE RANGE ELECTRICAL PERFORMANCE

- Class H insulation.
- Standard 6-wire re-connectable winding, 2/3 pitch, type no. 6.
- Voltage range 50 Hz: 380V - 400V - 415V and 220V - 230V - 240V.
- Voltage range 60 Hz: 380V - 416V - 440V - 480V and 220 V - 240 V.
- High efficiency and motor starting capacity.
- Other voltages are possible with optional adapted windings:
  - 50 Hz : 440 V (no. 7), 500 V (no. 9), 600 V (no. 22 or 23), 690 V (no. 10 or 52).
  - 60 Hz : 380 V and 416 V (no. 8), 600 V (no. 9).
- R 791 interference suppression conforming to standard EN 55011 group 1 class B standard for European zone (CE marking).

EXCITATION AND REGULATION SYSTEM SUITED TO THE APPLICATION

Excitation system			Regulation options				
Volage regulator	AREP	PMG	Current transformer for paralleling	Mains paralleling	3-phase sensing	3-phase sensing for mains paralleling unbalanced	Remote voltage potentiometer
R450	Std	Option	C.T.	R726	R731	R734	√
D510C	Option	Option	C.T.	included	included	contact factory	√

Voltage regulator accuracy ± 0.5% - √ : possible mounting

PROTECTION SYSTEM SUITED TO THE ENVIRONMENT

- The LSA 49.1 is IP 23.
- Standard winding protection for clean environments with relative humidity ≤ 95 %, including indoor marine environments.

Options :
- Filters on air inlet : derating 5%.
- Filters on air inlet and air outlet (IP 44) : derating 10%.
- Winding protections for harsh environments and relative humidity greater than 95%.
- Space heaters.
- Thermal protection for winding.

REINFORCED MECHANICAL STRUCTURE USING FINITE ELEMENT MODELLING

- Compact and rigid assembly to better withstand generator vibrations.
- Steel frame.
- Cast iron flanges and shields.
- Twin-bearing and single-bearing versions designed to be suitable for engines on the market.
- Half-key balancing.
- Regreasable bearings.
- Standard direction of rotation: clockwise when looking at the drive end view (for anti-clockwise, derate the machine by 5%).

ACCESSIBLE TERMINAL BOX PROPORTIONED FOR OPTIONAL EQUIPMENT

- Easy access to the voltage regulator and to the connections.
- Possible inclusion of accessories for paralleling, protection and measurement.
- Connection bar for reconnecting voltage.

Low Voltage alternators 4 pole 3-phase PARTNER

LSA 49.1

660 to 1000 kVA - 50 Hz / 792 to 1250 kVA - 60 Hz

General characteristics

Insulation class	H	Air flow L11	1.2 m³/s (50 Hz) - 1.4 m³/s (60 Hz)
Winding pitch	2/3 (n° 6S)	Excitation system	AREP or PMG
Number of wires	6	AVR type	R 450
Protection	IP 23	Voltage regulation (*)	± 0.5 %
Altitude	≤ 1000 m	Short-circuit current	300% (3 IN) : 10s
Overspeed	2250 min^{-1}	Totale Harmonic distortion THD (**)	at no load < 4 % - on load < 4 %
Air flow except L11	1 m³/s (50 Hz) - 1.2 m³/s (60 Hz)	Waveform: NEMA = TIF (**)	< 50

(*) Steady state. (**) Total harmonic distortion between phases, no-load or on-load (non-distorting)

Ratings 50 Hz - 1500 R.P.M.

kVA / kW - P.F. = 0.8

Duty/T°C		Continuous duty/40°C			Continuous duty/40°C			Stand-by/40°C			Stand-by/27°C		
Class/T°K		H/125°K			F/105°K			H/150°K			H/163°K		
Phase		3 ph.			3 ph.			3 ph.			3 ph.		
Y		380V	400V	415V	380V	400V	415V	380V	400V	415V	380V	400V	415V
Δ		220V	230V	240V	220V	230V	240V	220V	230V	240V	220V	230V	240V
LSA 49.1 S4	kVA	660	**660**	660	594	594	594	693	693	693	725	**725**	725
	kW	*528*	***528***	*528*	*475*	*475*	*475*	*554*	*554*	*554*	*580*	***580***	*580*
LSA 49.1 M6	kVA	725	**725**	725	653	653	653	760	760	760	800	**800**	800
	kW	*580*	***580***	*580*	*522*	*522*	*522*	*608*	*608*	*608*	*640*	***640***	*640*
LSA 49.1 M75	kVA	775	**800**	775	698	720	698	810	840	810	850	**880**	850
	kW	*620*	***640***	*620*	*558*	*576*	*558*	*648*	*672*	*648*	*680*	***704***	*680*
LSA 49.1 L9	kVA	880	**880**	880	792	792	792	920	920	920	960	**960**	960
	kW	*704*	***704***	*704*	*634*	*634*	*634*	*736*	*736*	*736*	*768*	***768***	*768*
LSA 49.1 L10	kVA	890	**910**	890	800	820	800	934	955	934	979	**1000**	979
	kW	*712*	***728***	*712*	*640*	*656*	*640*	*747*	*764*	*747*	*783*	***800***	*783*
LSA 49.1 L11	kVA	1000	**1000**	1000	910	910	910	1050	1050	1050	1100	**1100**	1100
	kW	*800*	***800***	*800*	*728*	*728*	*728*	*840*	*840*	*840*	*880*	***880***	*880*

Ratings 60 Hz - 1800 R.P.M.

kVA / kW - P.F. = 0.8

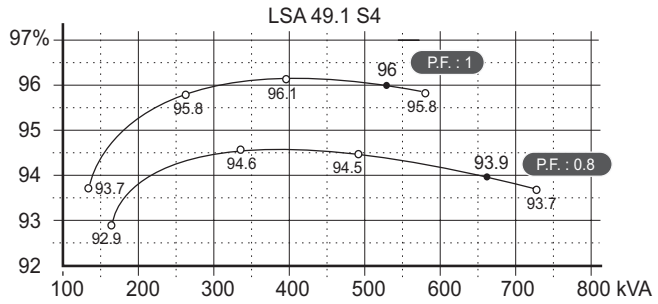
Duty/T°C		Continuous duty/40°C				Continuous duty/40°C				Stand-by/40°C				Stand-by/27°C			
Class/T°K		H/125°K				F/105°K				H/150°K				H/163°K			
Phase		3 ph.				3 ph.				3 ph.				3 ph.			
Y		380V	416V	440V	480V	380V	416V	440V	480V	380V	416V	440V	480V	380V	416V	440V	480V
Δ		220V	240V			220V	240V			220V	240V			220V	240V		
LSA 49.1 S4	kVA	710	710	725	**792**	639	639	652	712	745	745	760	830	781	781	798	**871**
	kW	*568*	*568*	*580*	***634***	*511*	*511*	*522*	*570*	*596*	*596*	*608*	*664*	*625*	*625*	*638*	***697***
LSA 49.1 M6	kVA	780	780	800	**870**	702	702	720	783	819	819	840	913	858	858	880	**957**
	kW	*624*	*624*	*640*	***696***	*562*	*562*	*576*	*626*	*655*	*655*	*672*	*730*	*686*	*686*	*704*	***766***
LSA 49.1 M75	kVA	866	936	960	**960**	780	842	865	865	910	983	1008	1008	953	1030	1056	**1056**
	kW	*693*	*749*	*768*	***768***	*624*	*674*	*692*	*692*	*728*	*786*	*806*	*806*	*762*	*824*	*845*	***845***
LSA 49.1 L9	kVA	910	980	1010	**1056**	819	882	909	950	955	1029	1060	1108	1000	1078	1111	**1162**
	kW	*728*	*784*	*808*	***845***	*655*	*706*	*727*	*760*	*764*	*823*	*848*	*886*	*800*	*862*	*889*	***930***
LSA 49.1 L10	kVA	958	1020	1050	**1092**	862	918	945	983	1006	1071	1102	1146	1054	1122	1155	**1200**
	kW	*766*	*816*	*840*	***874***	*690*	*734*	*756*	*786*	*805*	*857*	*882*	*917*	*843*	*898*	*924*	***960***
LSA 49.1 L11	kVA	1000	1080	1145	**1250**	900	980	1040	1140	1040	1135	1200	1310	1090	1190	1260	**1375**
	kW	*800*	*864*	*916*	***1000***	*720*	*784*	*832*	*912*	*832*	*908*	*960*	*1048*	*872*	*952*	*1008*	***1100***

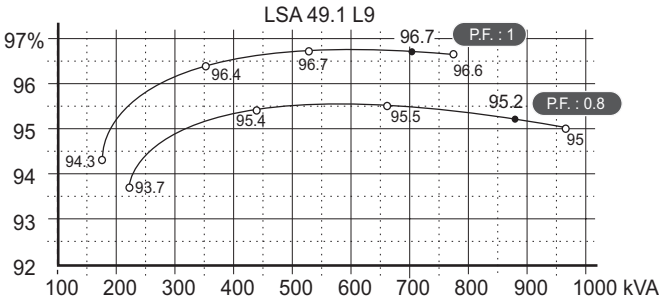
Low Voltage alternators 4 pole 3-phase PARTNER

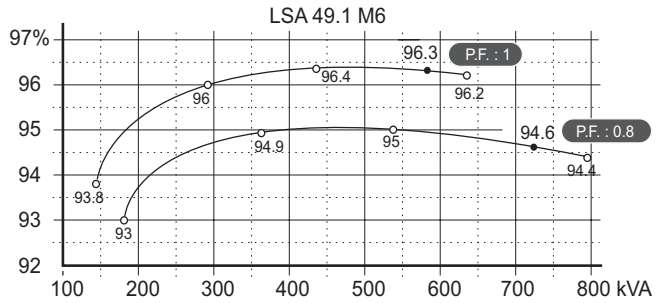
LSA 49.1

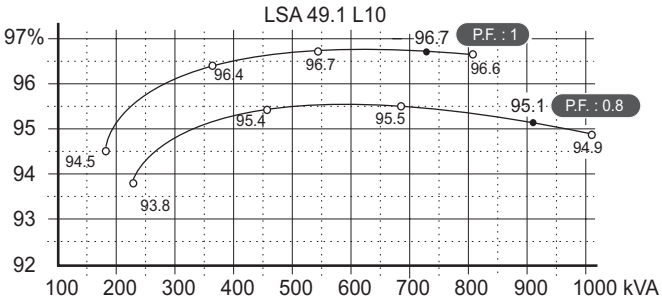
660 to 1000 kVA - 50 Hz / 792 to 1250 kVA - 60 Hz

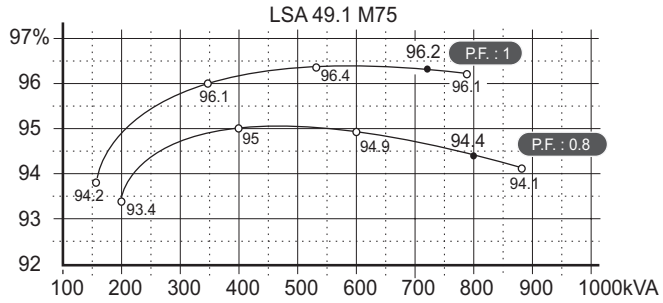
Efficiencies 50 Hz - P.F.: 1 / P.F.: 0.8

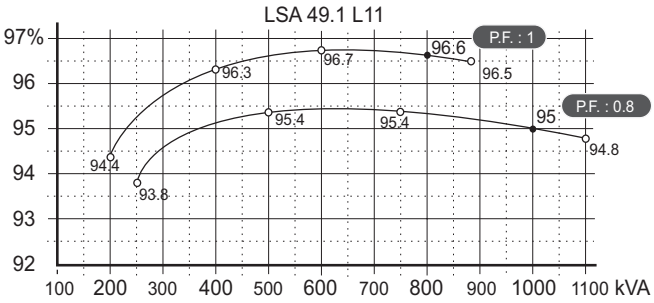












Reactances (%). Time constants (ms) - Class H / 400 V

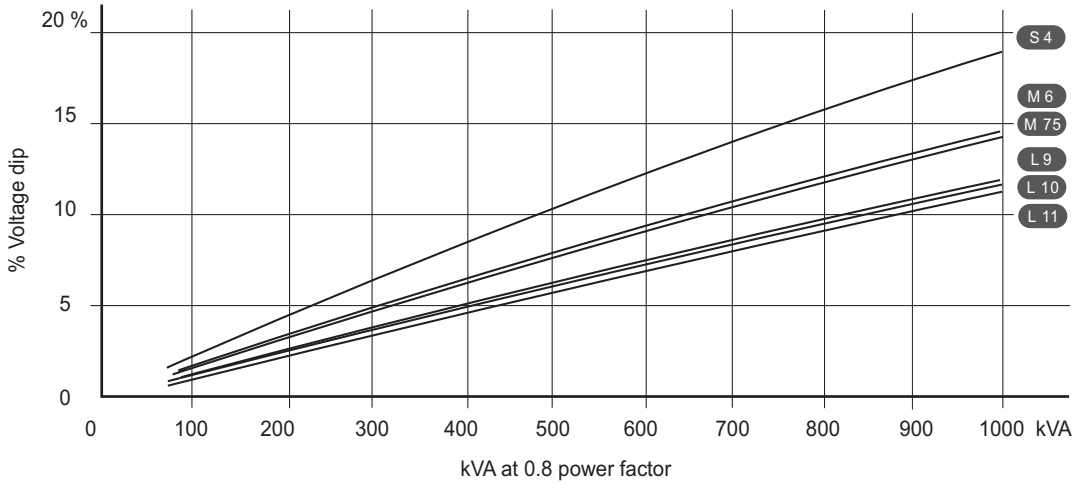
		S4	M6	M75	L9	L10	L11
Kcc	Short-circuit ratio	0.38	0.43	0.39	0.43	0.41	0.37
Xd	Direct-axis synchro. reactance unsaturated	343	301	332	304	315	346
Xq	Quadrature-axis synchro. reactance unsaturated	205	180	199	182	189	207
T'do	No-load transient time constant	1958	2047	2047	2111	2111	2111
X'd	Direct-axis transient reactance saturated	17.5	14.7	16.2	14.4	14.9	16.4
T'd	Short-circuit transient time constant	100	100	100	100	100	100
X"d	Direct-axis subtransient reactance saturated	14	11.7	12.9	11.5	11.9	13.1
T"d	Subtransient time constant	10	10	10	10	10	10
X"q	Quadrature-axis subtransient reactance saturated	16.3	13.1	14.5	12.5	13	14.3
Xo	Zero sequence reactance unsaturated	0.9	0.7	0.8	0.8	0.9	0.9
X2	Negative sequence reactance saturated	15.2	12.5	13.8	12.1	12.5	13.7
Ta	Armature time constant	15	15	15	15	15	15

Other class H/400 V data

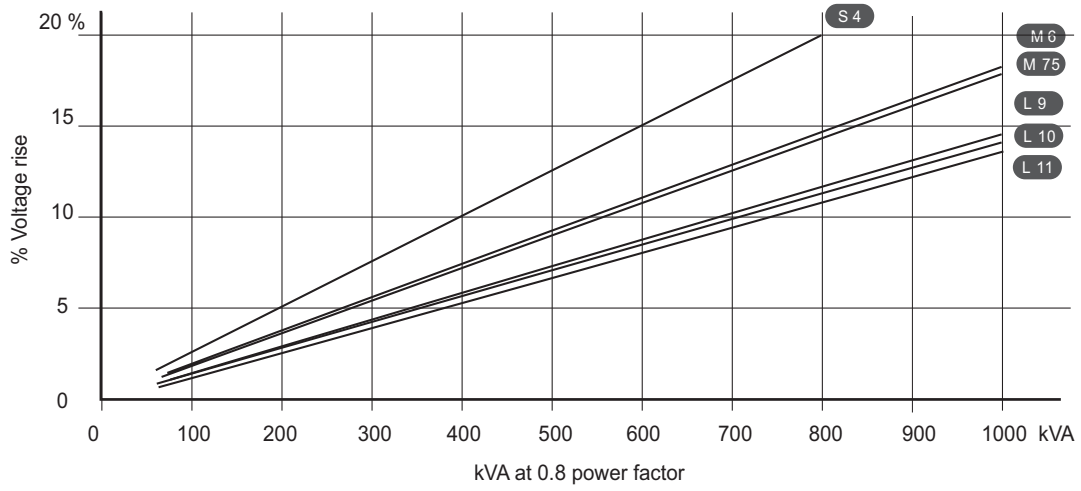
io (A)	No-load excitation current	0.9	0.9	0..9	0.9	0.9	0.8
ic (A)	On-load excitation current	3.6	3.2	3.5	3.3	3.4	3.2
uc (V)	On-load excitation voltage	43	38	41	39	40	38
ms	Response time (ΔU = 20% transient)	500	500	500	500	500	500
kVA	Start (ΔU = 20% cont. or 50% trans.)	1578	1985	1985	2372	2372	2372
%	Transient ΔU (on-load 4/4) - P.F.: 0.8 $_{LAG}$	13.3	10.9	11.7	10.7	11	11.8
W	No-load losses	8110	9000	9000	9860	9860	11050
W	Heat dissipation	33710	32740	37700	35340	37030	41710

Transient voltage variation 400V - 50 Hz

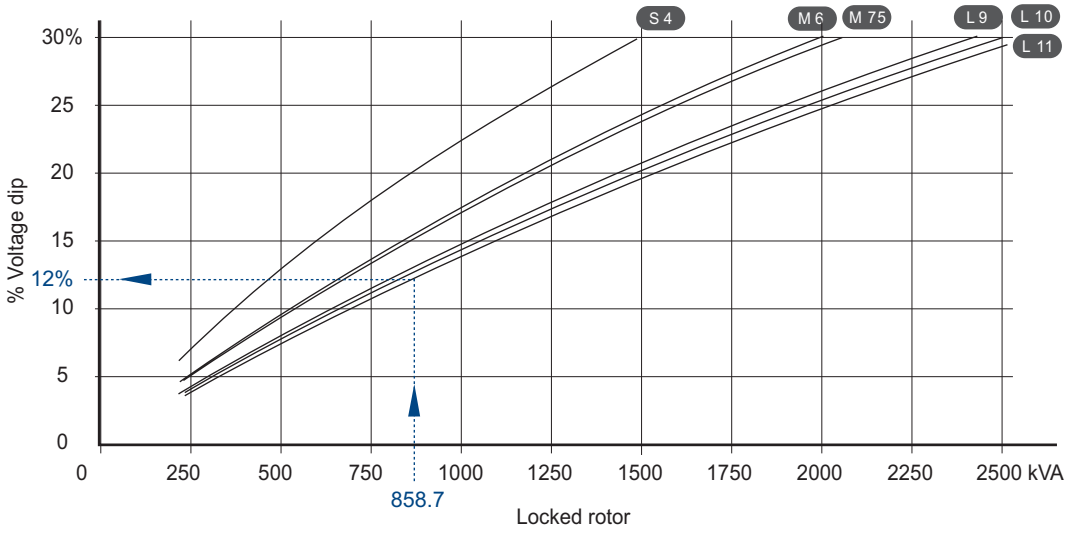
Load application (AREP or PMG system)



Load rejection (AREP or PMG system)



Motor starting (AREP or PMG system)



1) For a starting P.F. other than 0.6, the starting kVA must be multiplied by K = Sine φ /0.8
Calculation example for a different P.F. : Starter motor kVA calculated at 0.4 P.F. = 750 kVA
► Sin φ 0.4 = 0.9165 ► K = 1.145 ► kVA corrected = 858.7 kVA ► Voltage dip corresponding to L11 = 12 %.

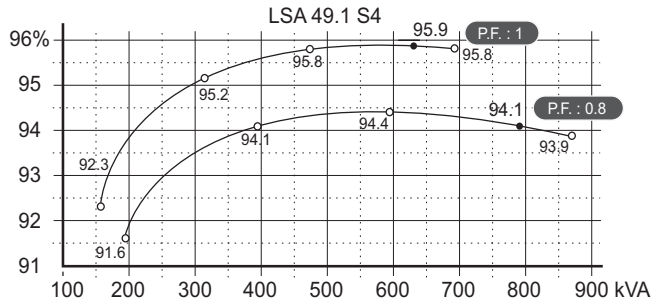
2) For voltages other than 400V (Y) , 230V (△) at 50 Hz, then kVA must be multiplied by $(400/U)^2$ or $(230/U)^2$.

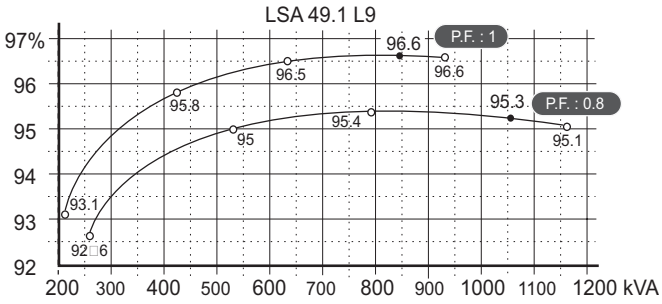
Low Voltage alternators 4 pole 3-phase PARTNER

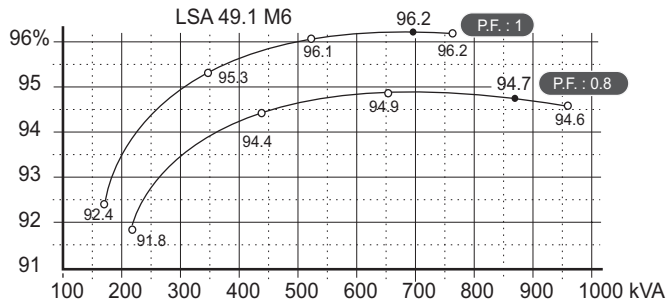
LSA 49.1

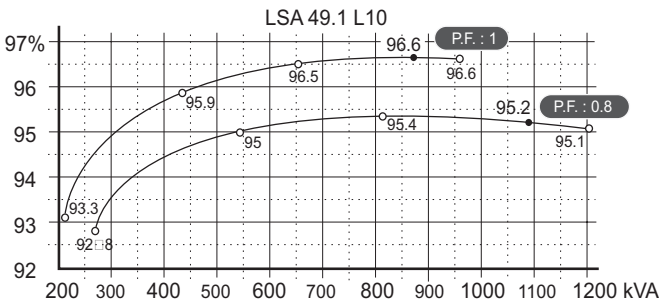
660 to 1000 kVA - 50 Hz / 792 to 1250 kVA - 60 Hz

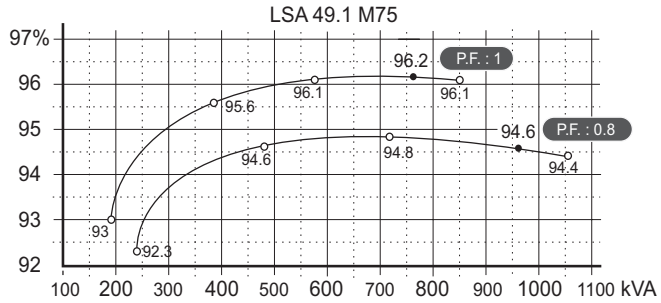
Efficiencies 60 Hz - P.F.: 1 / P.F.: 0.8

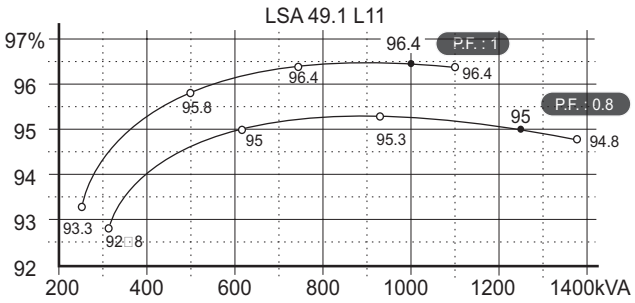












Reactances (%). Time constants (ms) - Class H / 480 V

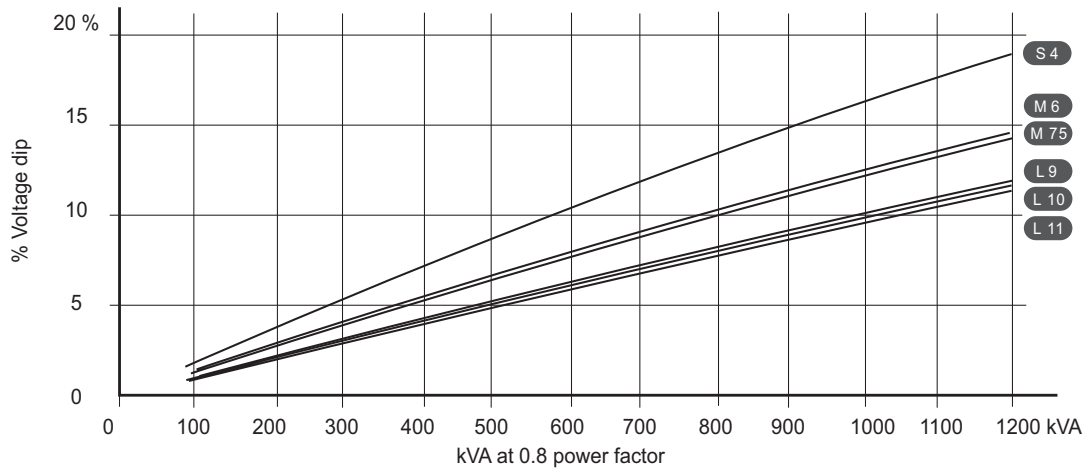
		S4	M6	M75	L9	L10	L11
Kcc	Short-circuit ratio	0.38	0.43	0.39	0.43	0.41	0.36
Xd	Direct-axis synchro. reactance unsaturated	343	301	332	304	315	360
Xq	Quadrature-axis synchro. reactance unsaturated	205	180	199	182	189	216
T'do	No-load transient time constant	1958	2047	2047	2111	2111	2111
X'd	Direct-axis transient reactance saturated	17.5	14.7	16.2	14.4	14.9	17
T'd	Short-circuit transient time constant	100	100	100	100	100	100
X"d	Direct-axis subtransient reactance saturated	14	11.7	12.9	11.5	11.9	13.6
T"d	Subtransient time constant	10	10	10	10	10	10
X"q	Quadrature-axis subtransient reactance saturated	16.3	13.1	14.5	12.5	13	14.9
Xo	Zero sequence reactance unsaturated	0.9	0.7	0.8	0.8	0.9	0.9
X2	Negative sequence reactance saturated	15.2	12.5	13.8	12.1	12.5	14.3
Ta	Armature time constant	15	15	15	15	15	15

Other class H/480 V data

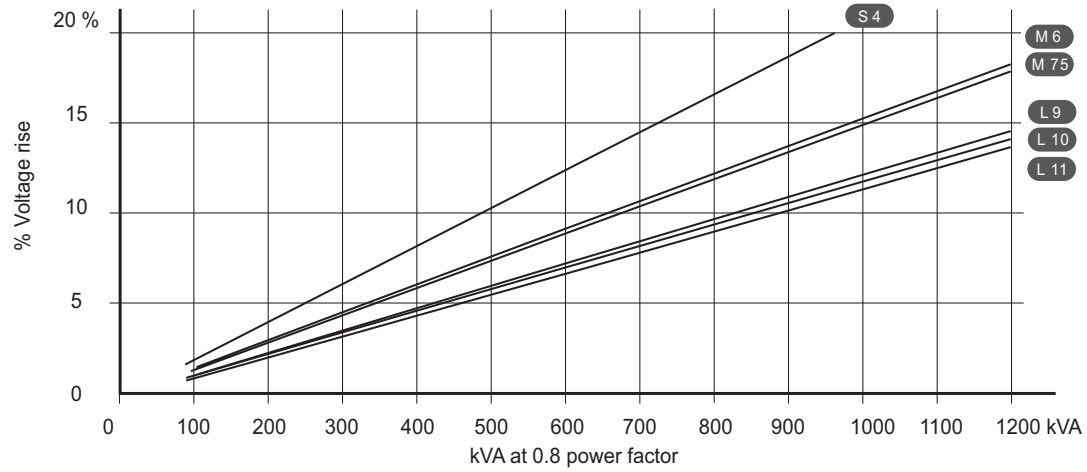
io (A)	No-load excitation current	0.9	0.9	0.9	0.9	0.9	0.8
ic (A)	On-load excitation current	3.6	3.2	3.5	3.2	3.3	3.2
uc (V)	On-load excitation voltage	42	38	41	38	39	38
ms	Response time (ΔU = 20% transient)	500	500	500	500	500	500
kVA	Start (ΔU = 20% cont. or 50% trans.)	1950	2482	2482	2972	2972	2972
%	Transient ΔU (on-load 4/4) - P.F.: 0.8 $_{LAG}$	13.3	10.9	11.7	10.7	11	12.2
W	No-load losses	12570	13820	13820	15030	15030	17160
W	Heat dissipation	39100	38520	43730	41600	43380	51950

Transient voltage variation 480V - 60 Hz

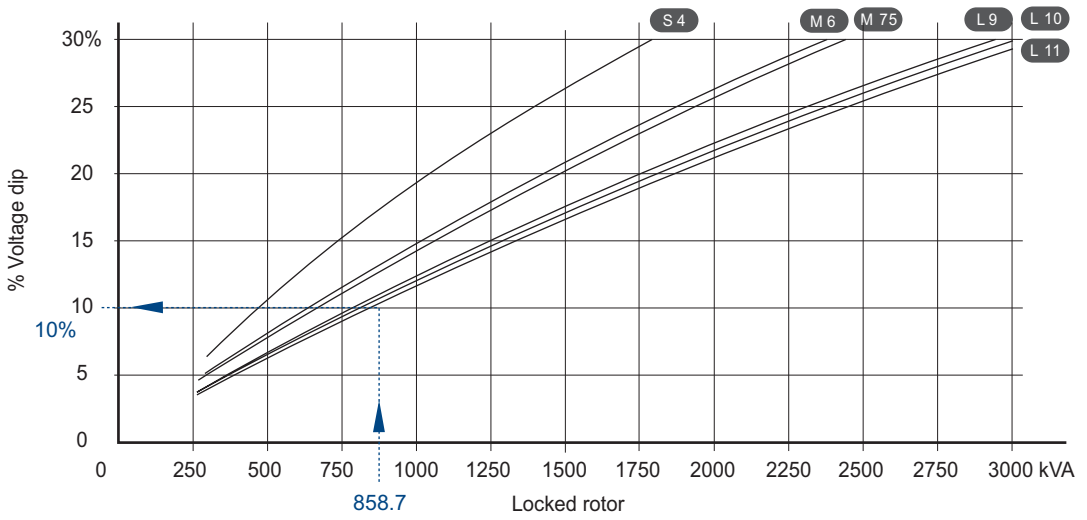
Load application (AREP or PMG system)



Load rejection (AREP or PMG system)



Motor starting (AREP or PMG system)

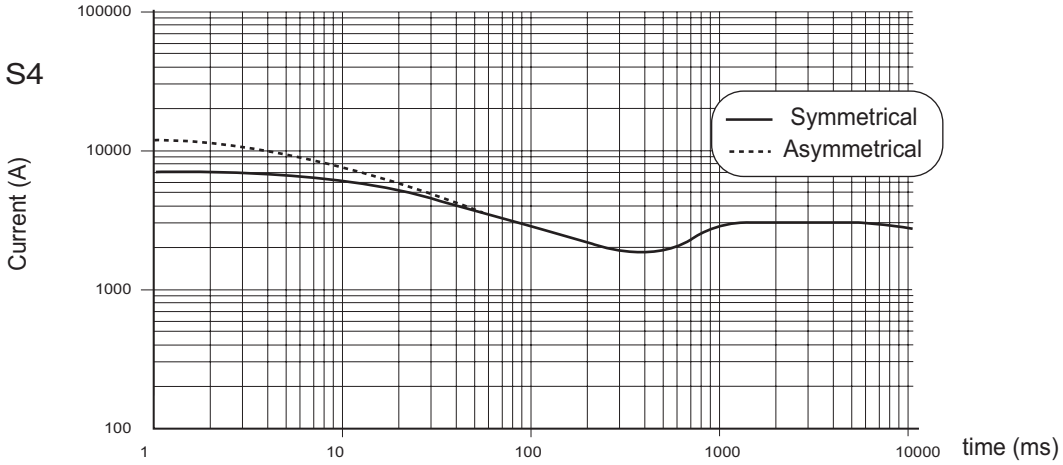


1) For a starting P.F. other than 0.6, the starting kVA must be multiplied by K = Sine φ /0.8
Calculation example for a different P.F. : Starter motor kVA calculated at 0.4 P.F. = 750 kVA
► Sin φ 0.4 = 0.9165 ► K = 1.145 ► kVA corrected = 858.7 kVA ► Voltage dip corresponding to L11 = 10 %.

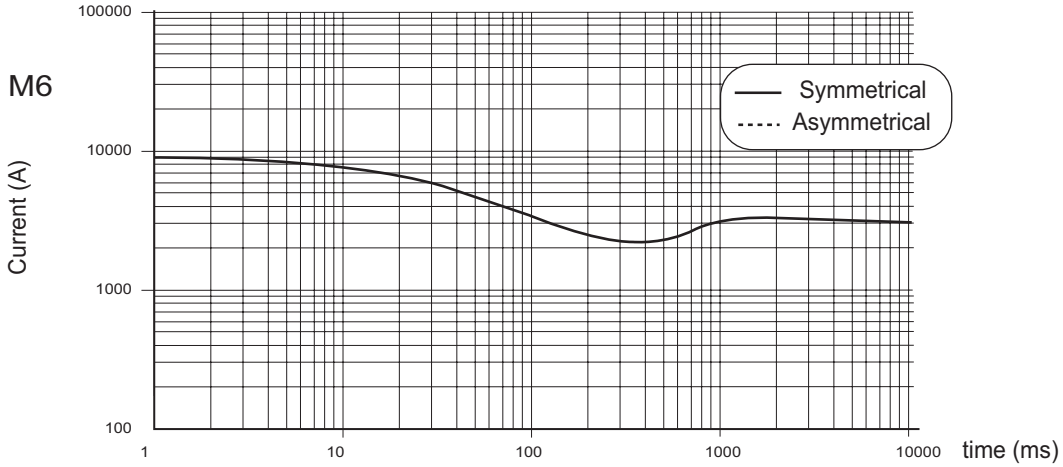
2) For voltages other than 480V (Y), 277V (△), 240V (YY) at 60 Hz ,
then kVA must be multiplied by $(480/U)^2$ or $(277/U)^2$ or $(240/U)^2$.

3-phase short-circuit curves at no load and rated speed (star connection Y)

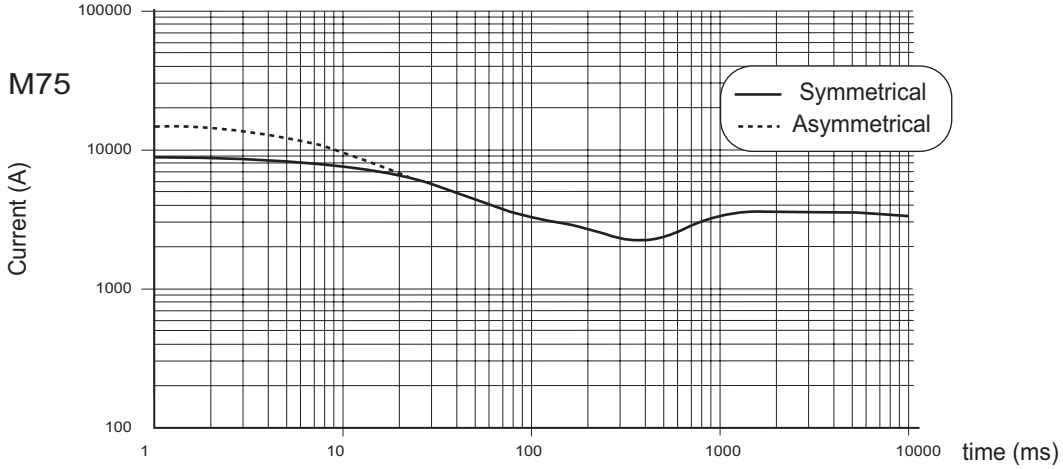
LSA 49.1 S4



LSA 49.1 M6



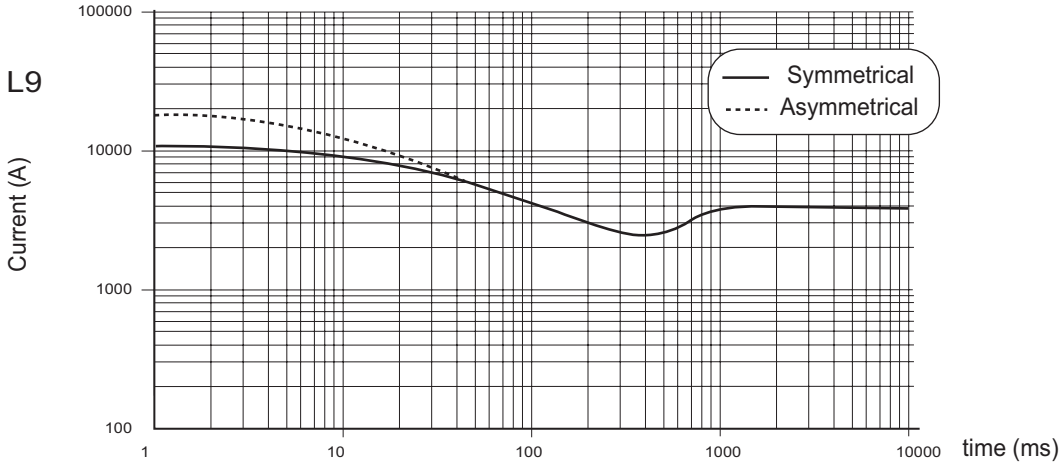
LSA 49.1 M75



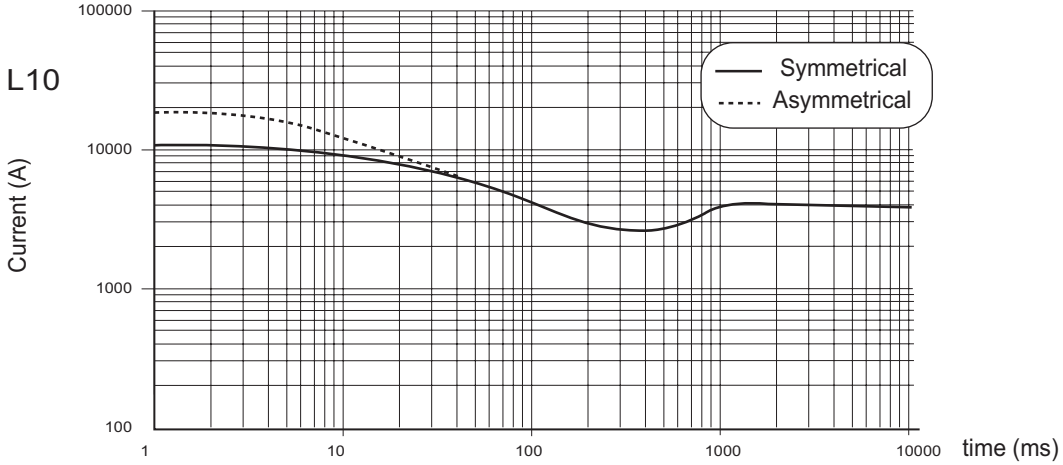
Influence due to connectio
Curves shown are for star (Y) connection.
For other connections, use the following multiplication factors:
- Series delta : current value x 1.732 - Parallel star : current value x 2

3-phase short-circuit curves at no load and rated speed (star connection Y)

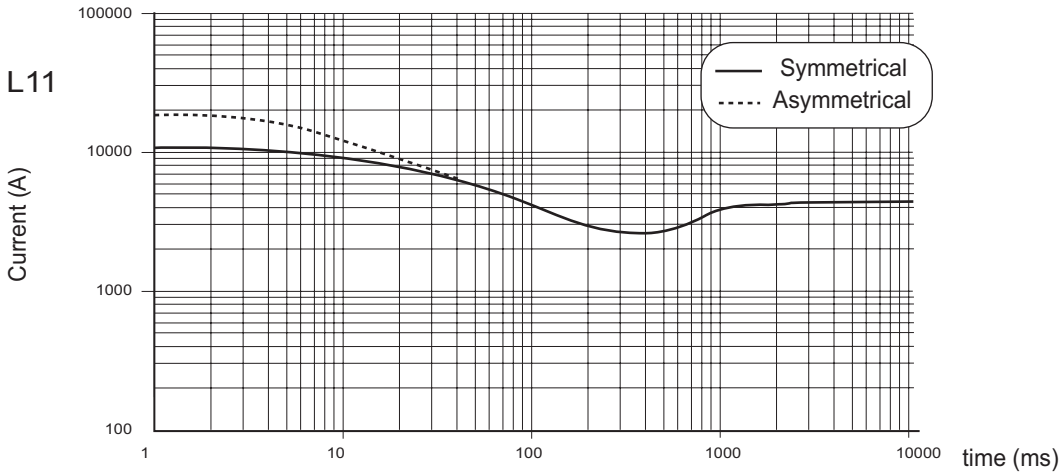
LSA 49.1 L9



LSA 49.1 L10



LSA 49.1 L11



Influence due to short-circui
Curves are based on a three-phase short-circuit.
For other types of short-circuit, use the following multiplication factors.

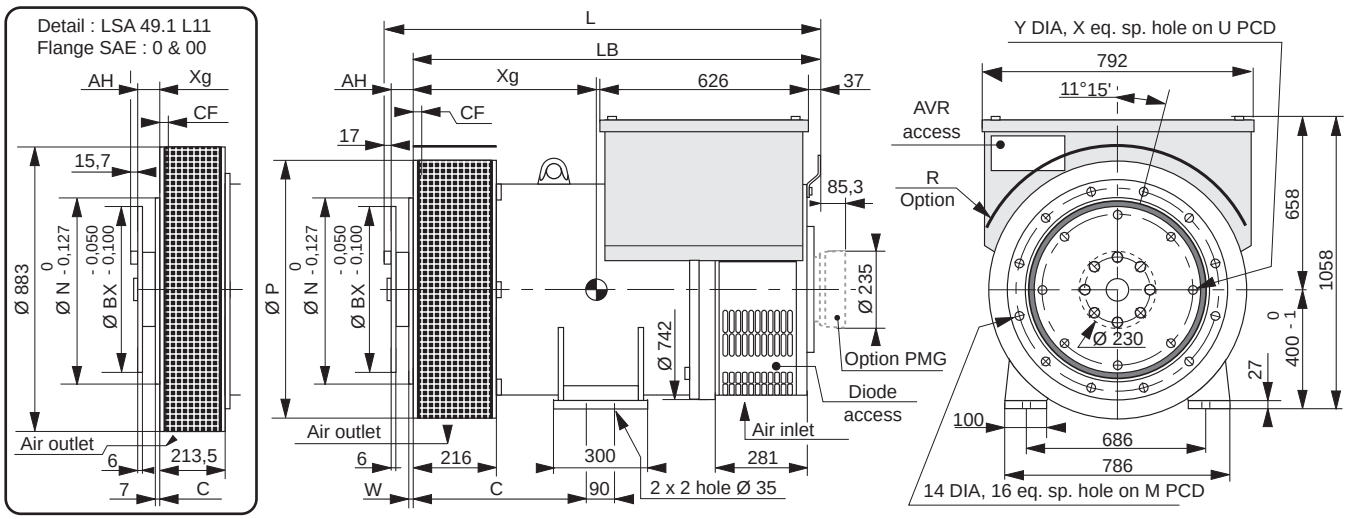
	3-phase	2-phase L/L	1-phase L/N
Instantaneous (max.)	1	0.87	1.3
Continuous	1	1.5	2.2
Maximum duration (AREP/PMG)	10 sec.	5 sec.	2 sec.

Low Voltage alternators 4 pole 3-phase PARTNER

LSA 49.1

660 to 1000 kVA - 50 Hz / 792 to 1250 kVA - 60 Hz

Single bearing dimensions



Dimensions (mm) and weight					
Type	L without PMG	LB	C	Xg	Weight (kg)
LSA 49.1 S4	1315	1272	560	635	1420
LSA 49.1 M6	1415	1372	650	670	1620
LSA 49.1 M75	1415	1372	650	670	1620
LSA 49.1 L9	1515	1472	650	710	1820
LSA 49.1 L10	1515	1472	650	710	1820
LSA 49.1 L11	1480	1448	650	686	1945

Coupling		
Flex plate	14	18
Flange S.A.E 1*	X*	
Flange S.A.E 1/2*	X*	
Flange S.A.E 0	X*	X
Flange S.A.E 00		X

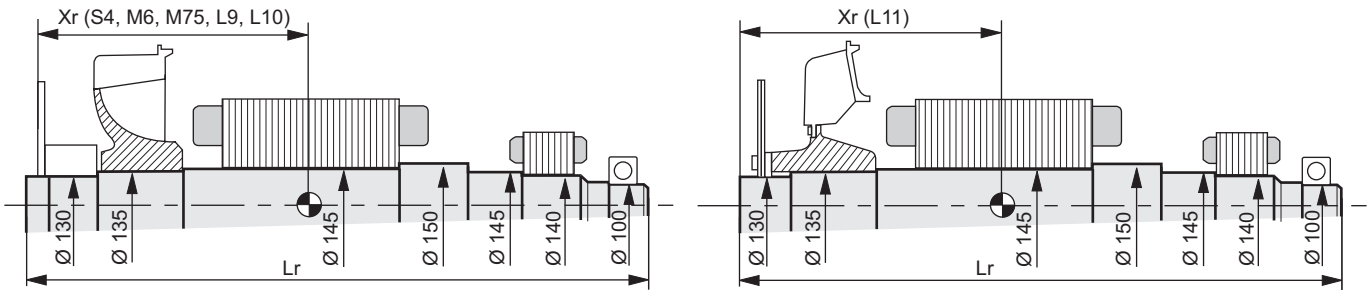
* : not available for LSA 49.1 L11

Flange (mm)						
S.A.E.	P	N	M	W	R	CF
1	753	511.175	530.225	7	438	17
1/2	753	584.2	619.125	6	438	17
0*	753	647.7	679.45	7	438	17
00*	885	787.4	850.9	6	505	15

* : see the flange detail for LSA 49.1 L11 SAE 0 & 00.

Flex plate (mm)					
S.A.E.	BX	U	X	Y	AH
14	466.7	438.15	8	14	25.4
18	571.5	542.92	6	17	15.7

Torsional analysis data



Centre of gravity: Xr (mm), Rotor length: Lr (mm), Weight: M (kg), Moment of inertia: J (kgm²): (4J = MD²)								
	Flange S.A.E. 14				Flange S.A.E. 18			
Type	Xr	Lr	M	J	Xr	Lr	M	J
LSA 49.1 S4	601	1280	536	8.51	591	1280	539	8.76
LSA 49.1 M6	651	1380	618	10.14	641	1380	621	10.39
LSA 49.1 M75	651	1380	618	10.14	641	1380	621	10.39
LSA 49.1 L9	701	1480	700	11.78	691	1480	703	12.03
LSA 49.1 L10	701	1480	700	11.78	691	1480	703	12.03
LSA 49.1 L11	676	1456	747	13.43	672	1456	751	13.70

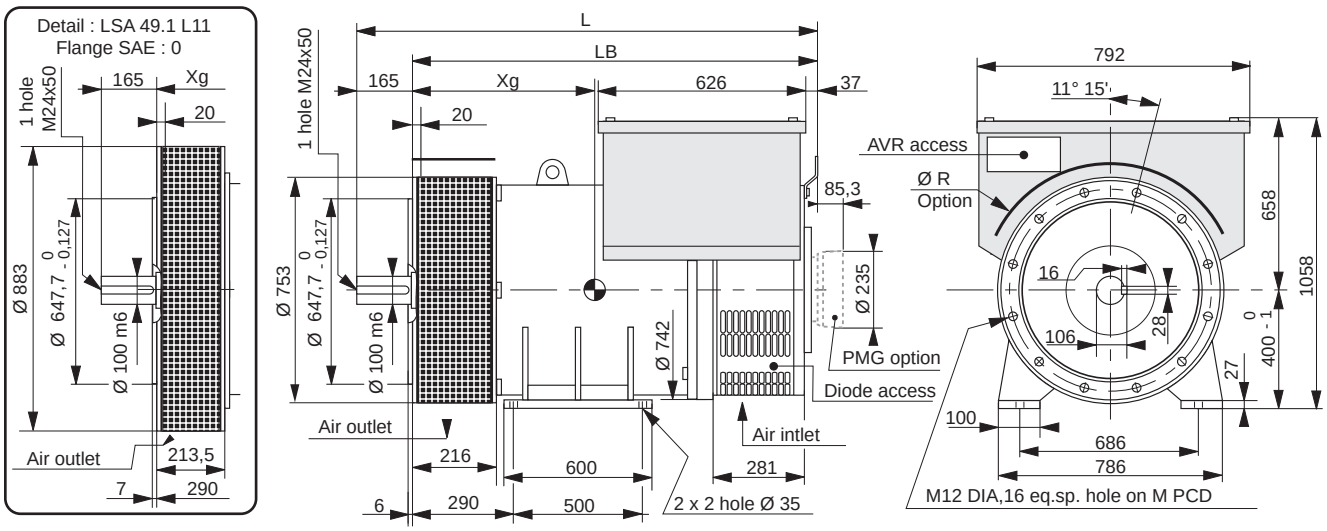
NOTE: dimensions are for information only and may be subject to modifications. Contractuel 2D drawings (.pdf files) can be downloaded from the Leroy-Somer site, 3D drawing files are available upon request.

Low Voltage alternators 4 pole 3-phase PARTNER

LSA 49.1

660 to 1000 kVA - 50 Hz / 792 to 1250 kVA - 60 Hz

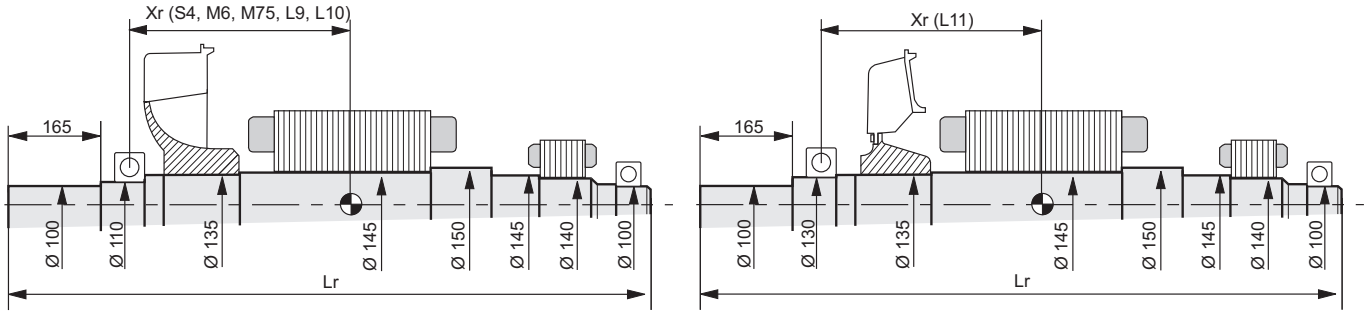
Two bearing dimensions



Dimensions (mm) and weight						
Type	L without PMG	LB	M	R	Xg	Weight (kg)
LSA 49.1 S4	1419	1254	679.45	438	620	1445
LSA 49.1 M6	1519	1354	679.45	438	655	1645
LSA 49.1 M75	1519	1354	679.45	438	655	1645
LSA 49.1 L9	1619	1454	679.45	438	695	1845
LSA 49.1 L10	1619	1454	679.45	438	695	1845
LSA 49.1 L11*	1613	1452	679.45	438	670	1985

* : see the flange detail for LSA 49.1 L11 SAE 0.

Torsional analysis data



Centre of gravity: Xr (mm), Rotor length: Lr (mm), Weight: M (kg), Moment of inertia: J (kgm²): (4J = MD²)				
Type	Xr	Lr	M	J
LSA 49.1 S4	503	1397	502	8.04
LSA 49.1 M6	553	1497	584	9.67
LSA 49.1 M75	553	1497	584	9.67
LSA 49.1 L9	603	1597	666	11.31
LSA 49.1 L10	603	1597	666	11.31
LSA 49.1 L11	601	1591	724	13

NOTE: dimensions are for information only and may be subject to modifications. Contractuel 2D drawings (.pdf files) can be downloaded from the Leroy-Somer site, 3D drawing files are available upon request.

Contact

www.leroy-somer.com

en - 2013.10 / a

LEROY SOMER®

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Industrial Automation

Moteurs Leroy-Somer SAS - RCS 338 567 258 ANGOULÊME - Capital de 65 800 512 €

InteliSys^{NT}

PREMIUM AND COGENERATION GEN–SET CONTROLLER

ComAp

Description

InteliSys^{NT} is an expandable controller for both single and multiple gen-sets operating in standby or parallel modes, especially in cogeneration (CHP) and other complex applications.

Detachable construction (consisting of IS-NT-BB and IS-Display or InteliVision 8) allows easy installation with the potential for many different extension modules designed to suit individual customer requirements.

A built-in synchronizer and digital isochronous load sharer allow a total integrated solution for gen-sets in standby, island parallel or mains parallel. Native co-operation of up to 32 gen-sets is a standard feature.

InteliSys^{NT} supports many standard ECU types and is specially designed to easily integrate new ones.

A powerful graphic display with user-friendly controls allows any user whatever their ability to find the information they need. The display on the basic version is capable of displaying graphical languages (e.g. Chinese).

ComAp is able to offer customized firmware solutions.

Benefits

- Support of engines with ECU (Electronic Control Unit)
- Excellent configurability to match customers' needs exactly
- Complete integrated gen-set solution incorporating built-in PLC and signal sharing via CAN bus – minimum external components needed
- Many communication options – easy remote supervising and servicing
- Perfect price/performance ratio
- Gen-set performance log for easy problem tracing

AMPS

ComAp is a member of AMPS (The Association of Manufacturers of Power generating Systems).

ISO 9001 CERTIFIED

ComAp products meet the highest standards, with every stage of production undertaken in accordance with the ISO certification obtained in 1998.

c UL us

Selected ComAp products have the UL Certification.

Features

- CHP support (programmable PID loops and other built-in PLC functions)
- Support of engines with ECU (J1939, Modbus and other proprietary interfaces); alarm codes displayed in text form
- Automatic synchronizing and power control (via speed governor or ECU)
- Baseload, Import/Export, TempByPower
- Peak shaving
- Voltage and PF control (AVR)
- Generator measurement: U, I, Hz, kW, kVAr, kVA, PF, kWh, kVAhr
- Mains measurement: U, I, Hz, kW, kVAr, PF
- Selectable measurement ranges for AC voltages and currents – 120/277 V, 0–1/0–5 A
- Inputs and outputs configurable for various customer needs
- Controller redundancy
- 2× RS232/RS485 interface with Modbus protocol support; Analog/GSM/ISDN/CDMA modem communication support; SMS messages; ECU Modbus interface; secondary RS485 converter is isolated
- Event-based history (up to 1000 records) with customer-selectable list of stored values; RTC; statistic values
- Integrated PLC programmable functions
- Interface to remote display units (IS-Display or/and InteliVision 8)
- USB 2.0 slave interface
- Dimensions 284×180 mm (front panel)
- Sealed to IP65

Integrated fixed and configurable protections

- 3 phase integrated generator protections (U + f)
- IDMT overcurrent + Shortcurrent protection
- Overload protection
- Reverse power protection
- Earth fault protection
- 3 phase integrated mains protections (U + f)
- Vector shift protection
- All binary/analog inputs free configurable for various protection types: HistRecOnly / Alarm Only / Alarm + History indication / Warning / Off load / Slow stop / BreakerOpen&Cooldown / Shutdown / Shutdown override / Mains protect / Sensor fail
- Phase rotation and phase sequence protection
- Additional 160 programmable protections configurable for any measured value to create customer-specific protections
- Application security

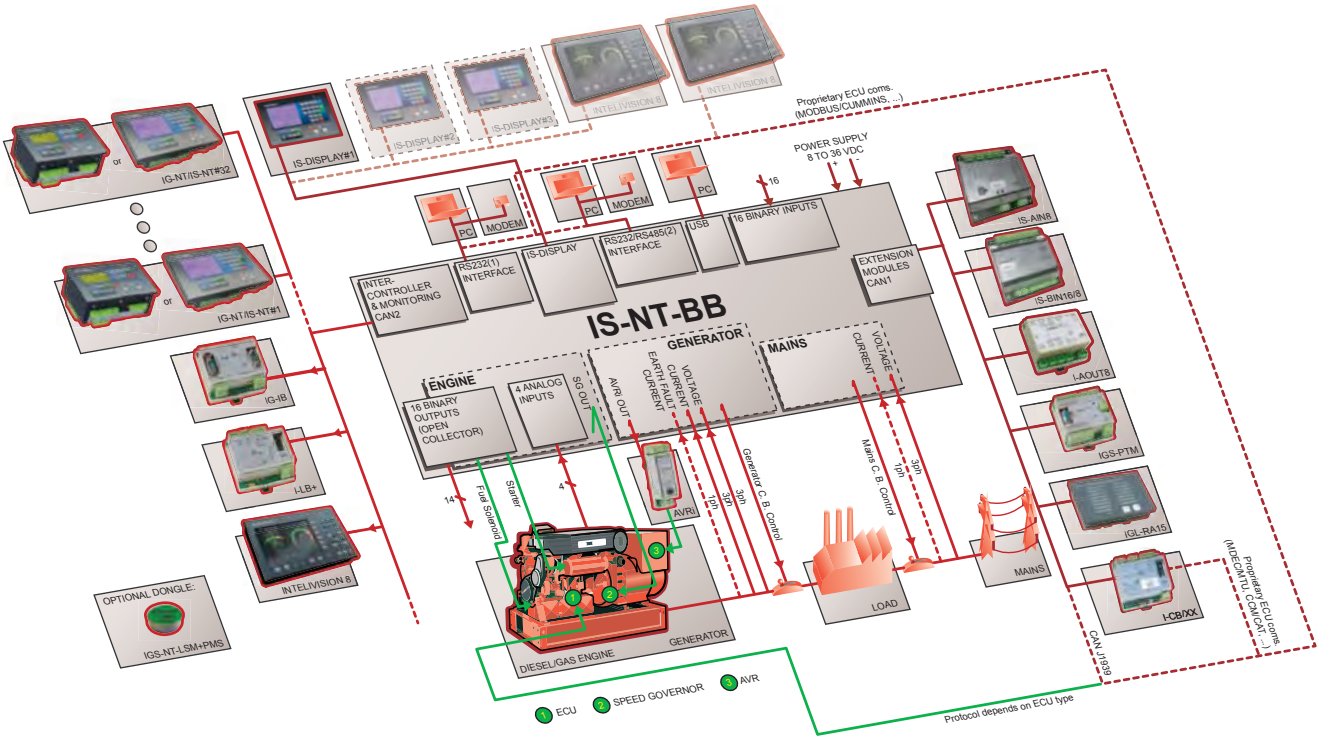
ANSI CODES

ANSI code	Protection
59	Overvoltage
27	Undervoltage
47	Voltage asymmetry
81H	Overfrequency
81L	Underfrequency
50+51	Overcurrent
46	Current unbalance
32	Overload

ANSI code	Protection
50N+64	Earth fault
32R	Reverse power
25	Synchronism check
47	Phase rotation
37	Undercurrent*
55	Power factor*
71	Gas (fuel) level

* can be created using universal protections

Schematic diagram



ComAp

Technical Data

Power supply

	Controller	IS-Display	IG-Display
Voltage supply	8-36V DC	8-36V DC	8-36V DC
Consumption depends on supply voltage	0,4A at 8VDC	0,3A at 8VDC	0,4A at 8VDC
	0,15 A at 24VDC	0,1 A at 24VDC	0,14 A at 24VDC
	0,1A at 36VDC	0,09A at 30VDC	0,12A at 30VDC
Battery voltage measurement tolerance	2 % at 24V		
RTC battery life-cycle	10 year		

Hint:

When internal RTC battery becomes flat, controller function (e.g. Ready for stand by) does not change until controller power supply is switched off. Some time before the battery is completely exhausted, a warning message appears in Alarmlist: "RTCbatteryFlat".
After the next power switch on (with flat battery already) controller:

- Stays in the INIT state (not possible to run genset)
- All History records disappear except of “System log: SetpointCS err” record
- Time and Date values are set to zero
- Statistics values are random

Operating conditions

Operating temperature	-20..+70°C *
Operating temperature IS-NT-BB	-40..+70°C *
Operating temperature (LT version)	-40..+70°C *
Storage temperature	-30..+80°C
Storage temperature IS-NT-BB	-40..+80°C
Flash memory data retention time	10 years
Protection front panel	IP65
Humidity	95% without condensation IEC/EN 60068-2-30
Standard conformity	
Low Voltage Directive	EN 61010-1:95 +A1:97
Electromagnetic Compatibility	EN 50081-1:94 (EN 61000-6-3) EN 50081-2:96 (EN 61000-6-4) EN 50082-1:99 (EN 61000-6-1) EN 50082-2:97 (EN 61000-6-2)
Vibration	5 - 25 Hz, ±1,6mm 25 - 100 Hz, a = 4 g
Shocks	a = 200 m/s^2

Hint:

* USB port should be used only above 0°C.

Dimensions and weight

Dimensions	180x120x80mm
Weight	950g

Mains and generator

Nominal frequency	50-60Hz
Frequency measurement tolerance	0,1Hz

Current inputs

	IG-xx	IG-xxC / IS-NT-BB / IM-NT
Nominal input current (from CT)	5 A	1 A / 5 A
Load (CT output impedance)	< 0,1 Ω	< 0,1 Ω
CT input burden	< 0,2 VA per phase (Inom=5A)	< 0,1 VA per phase (Inom=1A) < 0,2 VA per phase (Inom=5A)
Max. measured current from CT	10 A	2 A / 10 A
Current measurement tolerance	2% from the Nominal current	2% from the Nominal current
Max. peak current from CT	150 A / 1s	150 A / 1s
Max. continuous current	12 A	2,4 A / 12 A

Voltage inputs – IG/IS-NT and modifications

	IG-xx	IG-xxC / IS-NT-BB / IM-NT
Nominal voltage (ph-N / ph-ph)	277/480 VAC	120/207 or 277/480 VAC
Maximal measured/allowed voltage	346/600 VAC	150/260 or 346/600 VAC
Input resistance	0,6 MΩ phase to phase	0,6 MΩ phase to phase
	0,3 MΩ phase to neutral	0,3 MΩ phase to neutral
Voltage measurement tolerance	1 % from the Nominal voltage	1 % from the Nominal voltage
Over voltage class	III / 2 (EN61010)	III / 2 (EN61010)

Hint:
kW, kWh, Load sharing, VAr sharing measurement tolerance is 3%.

Binary inputs and outputs

Binary inputs

	IG-NT / IG-NTC	IG-EE / IG-EEC / IM-NT	IS-NT-BB
Number of inputs	12	6	16
Input resistance	4,7 kΩ	4,7 kΩ	4,7 kΩ
Input range	0-36 VDC	0-36 VDC	0-36 VDC
Switching voltage level for close contact indication	0-2 V	0-2 V	0-2 V
Max voltage level for open contact indication	8-36 V	8-36 V	8-36 V

Binary open collector outputs

	IG-NT / IG-NTC	IG-EE / IG-EEC / IM-NT	IS-NT-BB
Number of outputs	12	6	16
Maximum current	0,5 A	0,5 A	0,5 A
Maximum switching voltage	36 VDC	36 VDC	36 VDC

Analog inputs

Not electrically separated	
Number of inputs	3 / 0 / 4 unipolar (IG-NT(x) / IG-EE(x), IM-NT / IS-NT-BB)
Resolution	10 bits
Jumper selectable range	V, ohm, mA
Maximal resistance range	2500 Ω
Maximal voltage range	5 V
Maximal current range	0 – 20 mA
Input impedance	180 Ω for mA measuring
Input impedance	> 100 kΩ for V measuring
Resistance measurement tolerance	± 2 % ± 2 Ω out of measured value
Voltage measurement tolerance	± 1 % ± 1mV out of measured value
Current measurement tolerance	± 1 % ± 0,5mA out of measured value

D+ function

Max. D+ output current	300 mA
Guaranteed level for signal Charging OK	80% of supply voltage

Speed pick-up input

Type of sensor	magnetic pick-up
Minimum input voltage	2 Vpk-pk (from 4 Hz to 4 kHz)
Maximum input voltage	50 Veff
Minimum measured frequency	4 Hz
Maximum measured frequency	10 kHz (min. input voltage 6Vpk-pk)
Frequency measurement tolerance	0,2 %

Communication interface

RS232 interface

Maximal distance	10m
Speed	up to 57.6kBd

RS485 interface

Maximal distance	1000m
Speed	up to 57.6kBd

CAN bus interface

Galvanically separated	
Maximal CAN bus length	200m
Speed	250kBd
Nominal impedance	120Ω
Cable type	twisted pair (shielded)

Following dynamic cable parameters are important especially for maximal 200 meters CAN bus length and 32 iS-COM units connected:

Nominal Velocity of Propagation	min. 75% (max. 4,4 ns/m)
Wire crosscut	min.0,25 mm^2
Maximal attenuation (at 1 MHz)	2 dB / 100m

Recommended Industrial Automation & Process Control Cables:
BELDEN (see http://www.belden.com):
3082A DeviceBus for Allen-Bradley DeviceNet
3083A DeviceBus for Allen-Bradley DeviceNet
3086A DeviceBus for Honeywell SDS

3087A DeviceBus for Honeywell SDS
3084A DeviceBus for Allen-Bradley DeviceNet
3085A DeviceBus for Allen-Bradley DeviceNet
3105A Paired EIA Industrial RS485 cable

LAPP CABLE (see http://www.lappcable.com)
Unitronic BUS DeviceNet Trunk Cable
Unitronic BUS DeviceNet Drop Cable
Unitronic BUS CAN
Unitronic-FD BUS P CAN UL/CSA

Analog outputs

Speed governor output	± 10 V DC / 5 V PWM (500 – 3000Hz), max. 15 mA
AVRi outputs	PWM to IG-AVRi
Current output	0 – 20 mA ± 0,3mA
Voltage output	0 – 10 V DC, max. 15 mA
Max load resistance	470R at 9,4V

IG-AVRi

Power supply:	18V AC from IG-AVRi Trans/LV or IG-AVRi Trans/100
Absolutely maximum power supply range:	15 - 25 VAC or 20 - 35VDC
Inputs:	+AVR, -AVR (two wires, PWM from IG-CU)
Outputs:	OUT1, OUT2 floating (potential free) voltage source.
AVRi output voltage range:	potentiometer adjustable from +- 1V to +-10V DC.
AVRi output current:	max 15 mA.
Mechanical dimensions:	96 x 27 x 43 mm , DIN rail (35 mm) mounted

IG-AVRi Trans/LV

Primary voltage 1:	230-277 VAC
Absolute low limit:	230 VAC – 20%
Absolute high limit:	277 VAC + 20%
Primary voltage 2:	400-480 VAC
Absolute low limit:	400 VAC – 20%
Absolute high limit:	480 VAC + 20%
Frequency:	50 - 60 Hz
Secondary voltage:	18 V AC, 5 VA
Operating temperature	-30..+70°C

IG-AVRi Trans/100

Primary voltage:	100 – 120 VAC
Absolute low limit:	100 VAC – 20%
Absolute high limit:	120 VAC + 20%
Frequency:	50 - 60 Hz
Secondary voltage:	18 V AC
Operating temperature	-30..+70°C

IGS-PTM

Voltage supply	8-36V DC
Consumption	0,1A depend on supply voltage
Mechanical dimensions:	40 x 95 x 45 mm , DIN rail (35 mm) mounted
Interface to controller	CAN
Operating temperature	-30..+70°C

Binary inputs

Number of inputs	8
Input resistance	4,7 kΩ
Input range	0 - 36 VDC
Switching voltage level for close contact indication	0 - 2 V
Max voltage level for open contact indication	8-36 V

Binary open collector outputs

Number of outputs	8
Maximum current	0,5 A
Maximum switching voltage	36 VDC

Analog inputs

Not electrically separated	
Number of inputs	4
Resolution	10 bits
Maximal resistance range	0 – 250 Ω
Maximal voltage range	0 – 100 mV
Maximal current range	0 – 20 mA
Resistance measurement tolerance	1 % ± 2 Ω out of measured value
Voltage measurement tolerance	1,5 % ± 1mV out of measured value
Current measurement tolerance	2,5 % ±0,5mA out of measured value

Analog output

Not electrically separated	
Number of inputs	1
Resolution	10 bits
Output range	0 to 20 mA ± 0,33 mA

IS-AIN8

Nominal power supply	24 VDC
Power supply range	8 – 36 VDC
Max. consumption	250 mA
Mechanical dimensions:	150 x 160 x 50 mm , DIN rail (35 mm) mounted
Connection to controller (galvanically separated)	CAN1
Operating temperature	-40..+70°C
Storage temperature	-40..+80°C
Protection front panel	IP 20
Humidity	95% without condensation
Standard conformity	
Low Voltage Directive	EN 61010-1:95 +A1:97
Electromagnetic Compatibility	EN 50081-1:94 (EN 61000-6-3) EN 50081-2:96 (EN 61000-6-4) EN 50082-1:99 (EN 61000-6-1) EN 50082-2:97 (EN 61000-6-2)

Analog inputs

Nominal power supply	24 VDC
Power supply range	8 – 36 VDC
Number of inputs	8
Not galvanic separated	
Resolution	16 bits

Each analog input can be software configured to:

		Measuring range From	to	Accuracy
Resistance		0 Ω	2400 Ω	± 0,5 %
		0 Ω	250 Ω	± 1,0 %
Current	Passive	0 / 4 mA	20 mA	± 0,5 %
	Active	4 mA	20 mA	± 0,5 %
	Active	0 mA	± 20 mA	± 0,5 %
Voltage	Thermocouples J, K, L type			± 0,2 %
		0 mV	100 mV	± 0,2 %
		- 1000 mV	+ 1000 mV	± 0,5 %
		0 mV	2500 mV	± 0,5 %

Hint:

Sensors must be isolated from the engine body (except for thermocouples (since HW version 5.0)). Follow rear sticker description and remove the appropriate jumpers in case of thermocouples not isolated from the engine body.
It's possible to connect voltage up to 10V to an analog input if an external volt box which is described on p.53 is used.

I-AOUT8

Voltage supply	8-36V DC
Consumption	0,1A depend on supply voltage
Mechanical dimensions:	40 x 95 x 45 mm , 35 mm DIN rail mounted
Interface to controller	CAN
Operating temperature	-30..+70°C
Number of analog outputs	8 (not electrically separated)
Output range	0 to 10 VDC 0 to 20 mA PWM (1200 Hz)

IS-BIN16/8

Nominal power supply	24 VDC
Power supply range	8 – 36 VDC
Max. consumption	250 mA
Mechanical dimensions:	150 x 160 x 50 mm , DIN rail (35 mm) mounted
Connection to controller (galvanically separated)	CAN1
Operating temperature	-30..+70°C
Storage temperature	-40..+80°C
Protection front panel	IP 20
Humidity	95% without condensation
Standard conformity	
Low Voltage Directive	EN 61010-1:95 +A1:97
Electromagnetic Compatibility	EN 50081-1:94 (EN 61000-6-3) EN 50081-2:96 (EN 61000-6-4) EN 50082-1:99 (EN 61000-6-1) EN 50082-2:97 (EN 61000-6-2)

Binary inputs

Galvanically separated two groups	
Number of inputs	8 + 8
Input resistance	3 kΩ
Input voltage range	0-36 VDC
Input voltage level for open contact	8 to Power supply VDC

Input voltage level for close contact	0 to 2 VDC

Voltage level is defined between Binary input and Binary input COM terminal.

Open collector outputs

Number of outputs (galvanically separated)	8
Maximum current	0,5 A
Maximum switching voltage	36 VDC

Frequency inputs

Number of inputs	2 (RPM1, RPM2)

RPM1

Type of sensor	magnetic pick-up
Minimum input voltage	2 Vpk-pk (from 4 Hz to 4 kHz)
Maximum input voltage	50 Veff
Maximum measured frequency	8 kHz (min. input voltage 6Vpk-pk), frequency mode

RPM2

Type of sensor	Contact or Active sensor
Minimal pulse width	10 ms, integration mode
Maximum measured frequency	60 Hz, integration mode

Note: RPM1, RPM2 are available from IS SW version 2.6

IGL-RA15

Power supply

Voltage supply	8-36V DC
Consumption	0,35-0,1A (+1A max horn output) Depend on supply voltage

Operating conditions

Operating temperature	-20..+70°C
Storage temperature	-30..+80°C
Protection front panel	IP65

Dimensions and weight

Dimensions	180x120x55mm
Weight	950g

Horn output

Maximum current	1 A
Maximum switching voltage	36 VDC

I-CB, I-CR

Power supply

Voltage input	8-36V DC
Consumption	0.1A depend on power supply

Operating conditions

Operating temperature	-20 ÷ +70 °C
Storage temperature	-30 ÷ +80 °C

Humidity	85% without condensation
Protection	IP20

Dimensions and weight

Dimensions	95x96x43 mm, DIN rail (35 mm) mounted
Weight	300g

CAN bus interface

Galvanic separated	
Maximal CAN bus length	200m
Speed	up to 250kBd (depends on ECU type connected)
Nominal impedance	0Ω
Cable type for iS connection	sted pair (shielded)

RS232 interface

Maximal distance	0m
Speed	p to 19.2kbps (depends on ECU type connected)

I-LB

Voltage supply	-36V DC
Consumption	,1A depend on supply voltage
Operating temperature	30..+70°C
Mechanical dimensions:	5 x 96 x 43 mm , DIN rail (35 mm) mounted
Interface to modem or PC	S232, RS422, RS485, (USB – I-LB+ version)
Interface to controller	AN

IG-IB

Voltage supply	-36V DC
Consumption	,1A depend on supply voltage
Mechanical dimensions:	5 x 96 x 43 mm , DIN rail (35 mm) mounted
Interface to controller	S232 or CAN
Interface to modem	S232
Interface to Ethernet	J45 (10baseT)
Operating temperature	30..+70°C
Storage temperature	30..+70°C

I-RBxx

Number of relays:	6 or 8 in sockets
Nominal voltage:	4 VDC
Voltage range:	6,8 – 36 VDC
Relay opens at:	0% of nominal voltage
Electric / mechanic cycles:	00 000 / 10 000 000
Operating temperature range:	40°C to 70°C
Maximal load:	6 A resistive load at 24VDC
	4 A inductive load at 24 VDC
(I-RBxx-231)	2 A at 231VAC
Contacts protection:	aristor 14DK390

IG-MTU

Primary voltage Ph-Ph	x400 VAC / 50Hz (3x480 VAC / 60 Hz)
Secondary voltage Ph-N	x 230 V AC (3x277 VAC / 60 Hz) , 5 VA
Mechanical dimensions:	5 x 95 x 60 mm , DIN rail (35 mm) mounted
Primary/secondary Phase shift	1°
Operating temperature	30..+70°C

Settings for INTELISYS NT Digital Paralleling Genset Controller.

RE: Adirondack Farms Interconnection Project

Name	Firmware ver.	Application	Date	App. ver.	Filename		
Adirondack	IS-NT-AFR-2.0 R:23.05.2012	SPI	2-29-16	2.0	Adirondack SPI 2-29-16.ANT		

Group	Name	Value	Dimension	Password	Description	Low limit	High limit
ProcessControl	Base load	633	kW	7		0	600
ProcessControl	Base PF	1.00		7		0.60	1.20
ProcessControl	Import load	0	kW	7		-32000	32000
ProcessControl	Import PF	1.00		7		0.60	1.20
ProcessControl	Load ctrl PtM	BASELOAD		7			
ProcessControl	PF ctrl PtM	BASEPF		7			
ProcessControl	Export limit	DISABLED		7			
ProcessControl	ParallelEnable	YES		7			
ProcessControl	Synchro enable	FORWARD		7			
ProcessControl	#Neutral cont	EACH		7			

Group	Name	Value	Dimension	Password	Description	Low limit	High limit
Basic settings	Nomin power	633	kW	7		1	32000
Basic settings	Nomin current	953	A	7		1	10000
Basic settings	CT ratio prim	1000	A	7		1	15000
Basic settings	CT ratio sec	/5A		7			
Basic settings	Im3/ErFlCurCTp	1000	A	7		1	15000
Basic settings	Im3/ErFlCurCTs	/5A		7			
Basic settings	VT ratio	1.00	V/V	7		0.10	500.00
Basic settings	Vg InpRangeSel	277 V		7			
Basic settings	Vm VT ratio	1.00	V/V	7		0.10	500.00
Basic settings	Vm InpRangeSel	277 V		7			
Basic settings	GenNomV	277	V	7		80	34641
Basic settings	GenNomVph-ph	480	V	7		130	60000
Basic settings	MainsNomV	277	V	7		80	34641
Basic settings	MainsNomVph-ph	480	V	7		130	60000
Basic settings	Nominal freq	60	Hz	7		45	65
Basic settings	Nominal RPM	1800	RPM	7		100	4000

Group	Name	Value	Dimension	Password	Description	Low limit	High limit
Gener protect	Ishort	150	%	7	ANSI Device 50	100	500
Gener protect	Ishort del	0.00	s	7		0.00	10.00
Gener protect	2Inom del	10.0	s	7	ANSI Device 51	0.0	600.0
Gener protect	Gen >V BOC	110	%	7	ANSI Device 59	90	150
Gener protect	Gen <V BOC	90	%	7	ANSI Device 27	20	110
Gener protect	Gen >V Sd	150	%	7	ANSI Device 59	50	150
Gener protect	Gen V del	600.00	s	7		0.00	600.00
Gener protect	Gen >f	102.0	%	7	ANSI Device 81-O	98.0	150.0
Gener protect	Gen <f	98.0	%	7	ANSI Device 81-U	20.0	102.0
Gener protect	Gen f del	500.00	s	7		0.00	600.00
Gener protect	Reverse power	5	%	7	ANSI Device 32R	0	50
Gener protect	ReversePwr del	5.0	s	7		0.0	600.0
Gener protect	EarthFaultCurr	2000	A	7	ANSI Device 51N	0	10000
Gener protect	EthFltCurr del	3.0	s	7		0.0	600.0
Gener protect	Gen V unbal	10	%	7	ANSI Device 47	0	200
Gener protect	Gen V unb del	3.0	s	7		0.0	600.0
Gener protect	Gen I unbal	50	%	7	ANSI Device 46	0	200
Gener protect	Gen I unb del	3.0	s	7		0.0	600.0

Group	Name	Value	Dimension	Password	Description	Low limit	High limit
Mains protect	Mains >V MP	110	%	7	ANSI Device 59	90	150
Mains protect	Mains > V del	0.50	s	7		0.00	600.00
Mains protect	Mains <V MP	90	%	7	ANSI Device 27	50	110
Mains protect	Mains < V del	0.30	s	7		0.00	600.00
Mains protect	Mains >>V MP	120	%	7	ANSI Device 59	90	150
Mains protect	Mains >> V del	0.00	s	7		0.00	600.00
Mains protect	Mains <<V MP	80	%	7	ANSI Device 27	50	110
Mains protect	Mains << V del	0.00	s	7		0.00	600.00
Mains protect	Mains Avg>V MP	110.0	%	7	ANSI Device 59	100.0	150.0
Mains protect	Mains >f	102.0	%	7	ANSI Device 81-O	98.0	150.0
Mains protect	Mains >f Del	0.50	s	7		0.00	600.00
Mains protect	Mains <f	98.0	%	7	ANSI Device 81-U	50.0	102.0
Mains protect	Mains <f Del	0.30	s	7		0.00	600.00
Mains protect	FwRet break >U	60.0	s	7		0.0	800.0
Mains protect	FwRet break <U	60.0	s	7		0.0	800.0
Mains protect	FwRet break >f	60.0	s	7		0.0	800.0
Mains protect	FwRet break <f	60.0	s	7		0.0	800.0
Mains protect	FwRet break VS	60.0	s	7		0.0	800.0

Mains protect	AfMainsFlRun	60.0	s	7		0.0	600.0
Mains protect	VectorS prot	PARALLEL ONLY		7			
Mains protect	VectorS limit	10	°	7		1	45
Mains protect	Mains V unbal	10	%	7	ANSI Device 47	0	200
Mains protect	Mains Vunb del	1.0	s	7		0.0	600.0

Group	Name	Value	Dimension	Password	Description	Low limit	High limit
Sync/Load ctrl	Voltage window	10.0	%	7	ANSI Device 25 voltage match	0.0	100.0
Sync/Load ctrl	GtoM AngleReq	0	°	7	angle compensation for delta config.	-45	45
Sync/Load ctrl	Phase window	10	°	7	ANSI Device 25 angle match	0	90
Sync/Load ctrl	Dwell time	0.5	s	7	ANSI Device 25	0.0	25.0
Sync/Load ctrl	Load ramp	180	s	7		0	240
Sync/Load ctrl	Load gain	10.0	%	7		0.0	200.0
Sync/Load ctrl	Load int	50	%	7		0	100
Sync/Load ctrl	RampStartLevel	2	%	7		0	100
Sync/Load ctrl	GCB open level	10	%	7		0	100
Sync/Load ctrl	GCB open del	240	s	7		180	1800
Sync/Load ctrl	Sync timeout	NO TIMEOUT	s	7		1	1800; NO TIMEOUT
Sync/Load ctrl	Sync attempts	OFF		7		1	9; OFF

Intelisys NT Digital Genset Controller

Proposed Settings for the Adirondack Farms Interconnection Project 2-29-16

25 Function:

Voltage window [%] (FV)

Maximum difference between generator and mains/bus voltage.

Step: 0,1 % of GenNomV

Range: 0,0 – 100,0 % of GenNomV Setting: 10% of Nominal Voltage.

GtoM AngleReq [°]

Requested phase difference between generator and mains voltage during synchronizing. Use this setpoint for phase correction of potential transformers connection.

Step: 1°

Range: -45° to +45° Setting: 0° Phase Shift.

Phase window [°] (FV)

Maximum phase angle (mains/bus x generator voltage) ±difference between requested and actual angle for synchronizing.

Step: 1°

Range: 0° – 90° Setting: 10° tolerance.

Dwell time [s] (FV)

The period of time that the phase angle must be within *Phase window* and voltage difference within *Voltage window* before a breaker (GCB/MCB) is closed.

Step: 0,1 s

Range: 0,0 – 25,0 s Setting: 0.5 Sec.

SHARK®200

UPGRADABLE FULLY FEATURED POWER & ENERGY METER

Revenue Grade with Advanced I/O and Power Quality

Shark® 200T
Transducer Only

Shark® 200
Meter/Transducer

www.electroind.com

From Simple to Sophisticated

- V-Switch™ Technology Upgrade
- Simple Multifunction Meter: V-Switch™ Key 1
- Historical Data-logging: V-Switch™ Key 2
- Advanced Power Quality Waveform Recorder: V-Switch™ Keys 5 or 6

Industry Leading Performance

- Highly Accurate Metering Technology
- Extensive Data Logging
- Power Quality Recording up to 512 Samples/Cycle
- Embedded Web Server - With Smartphone & Tablet Support
- Dual Ethernet Ports Compatible with Modbus & DNP 3.0 over TCP/IP!

Electro Industries/GaugeTech
The Leader in Power Monitoring and Smart Grid Solutions

HIGH PERFORMANCE WAVEFORM RECORDING

Basic Features Summary

- 0.2% Class Revenue Certifiable Energy and Demand Metering
- Meets ANSI C12.20 and IEC 62053-22 (0.2% Class)
- Multifunction Measurement
- 3 Line .56" LED display and % of Load Bar for Analog Perception
- 0.001 Hz Frequency Measurement for Generating Stations
- Standard RS485 (Modbus and DNP 3.0)
- IrDA Port Enables Laptop PC Reading and Programming
- Ultra-Compact
- Fits both ANSI and DIN Cutouts

Advanced Features Summary

- High Performance Waveform Recorder
- Up to 4 Megabytes Flash for Historical Data Logging & PQ Recording
- Extremely Configurable Field Upgradable I/O
- 100BaseT Ethernet – Rapid Response™ Technology
- V-Switch™ Technology
- High Precision Frequency Measurement for Frequency Control

APPLICATIONS

- Utility Metering
- Substations
- Power Generation
- Submetering
- Power Quality Studies
- Load Studies
- Commercial Metering
- Industrial Metering
- Campus Metering
- Analog Meter Replacement
- Disturbance Recording
- Voltage Recording

ACCURACY AND UPGRADE SWITCHES

Electro Industries introduces a new standard in panel mounted power metering. The Shark® 200 metering system is an ultra-compact power metering device providing industry leading revenue metering functionality combined with advanced data-logging, power quality, communication and I/O traditionally found only in high performance and high cost systems. This product is designed to incorporate advanced features in a cost effective, small package for large scale, low cost deployment within an electrical distribution system.

V-Switch™ TECHNOLOGY

The Shark® 200 meter is equipped with EIG's exclusive V-Switch™ technology. This technology allows users to upgrade and add features to the meter without removing it from installation.

V-Switches Include the Following Features:

Feature	V1	V2	V3	V4	V5	V6
Multifunction Measurement with I/O Expansion	✓	✓	✓	✓	✓	✓
2 Megabytes Data-Logging		✓	✓	✓		
3 Megabytes Data-Logging					✓	
4 Megabytes Data-Logging						✓
Harmonic Analysis			✓	✓	✓	✓
TLC and CT/PT Compensation	✓	✓	✓	✓	✓	✓
Limit and Control Functions				✓	✓	✓
64 Samples per Cycle Waveform Recorder					✓	
512 Samples per Cycle Waveform Recorder						✓

ACCURACY

Measured Parameters	Accuracy %	Display Range
Voltage L-N	0.1%	0-9999 Scalable V or kV
Voltage L-L	0.2%	0-9999 V or kV Scalable
Current	0.1%	0-9999 Amps or kAmps
+/- Watts	0.2%	0-9999 Watts, kWatts, MWatts
+/-Wh	0.2%	5 to 8 Digits Programmable
+/-VARs	0.2%	0-9999 VARs, kVARs, MVARs
+/-VARh	0.2%	5 to 8 Digits Programmable
VA	0.2%	0-9999 VA, kVA, MVA
VAh	0.2%	5 to 8 Digits Programmable
PF	0.2%	+/- 0.5 to 1.0
Frequency	+/- 0.001 Hz	45 to 65 Hz
%THD	+/- 2.0%	1 to 99.99%
% Load Bar	+/- 1 Segment	(0.005 to 6) A

Note: Applies to 3 element WYE and 2 element Delta connections. See full accuracy specifications in Shark® 200 Meter User Manual. Neutral current 2% accuracy.

Advanced Revenue Energy Metering Capabilities

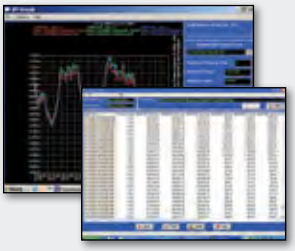
- Line Frequency Time Sync
- Traceable Watt-hour Test Pulse
- Utility Block and Rolling Average Demand
- Historical Load Profiling
- Internal Energy Logging
- Transformer and Line Loss Compensation
- CT/PT Compensation

EXTENSIVE DATA-LOGGING CAPABILITY (V2 and Higher)

The Shark® 200 meter offers the capability of having 2 Megabytes of data-logging to be used for historical trends, limit alarms, I/O changes and sequence of events. The unit has a real-time clock that allows for time stamping of all the data in the instrument when log events are created.

Historical Logs

- 3 Assignable Historical Logs
- Independently Programmed Trending Profiles
- Up to 64 Parameters per Log



Historical Trending

System Events Log

To protect critical billing information, the meter records and logs the following with a time stamp:

- Demand Resets
- System Startup
- Log Resets
- Programmable Settings Changes
- Password Requests
- Energy Resets
- Log Reads

I/O Change Log

- Provides a Time Stamped Log of any Relay Output
- Provides a Time Stamped Log of Input Status Changes
- 2048 Events Available

Limit/Alarm Log

- Provides Magnitude and Duration of an Event
- Includes Time Stamps and Alarm Value
- 2048 Events Available

Alarm Log

Limits Alarms and Control Capability (V4 Option)

Limit Events

- Any measured parameter
- Up to 16 Limits
- Voltage Imbalance
- Current Imbalance
- Based on % of full scale settings

Limit Set Up

HIGH PERFORMANCE POWER QUALITY ANALYSIS (V5 AND V6)

Simultaneous Voltage and Current Waveform Recorder

The unit records up to 512 samples per cycle for a voltage sag or swell or a current fault event. The unit provides the pre- and post-event recording capability shown in the table below. Waveform records are programmable to the desired sampling rate. V5 provides up to 3 Megabytes storage and V6 provides a total of 4 Megabytes.

The meter's advanced DSP design allows Power Quality triggers to be based on a 1 cycle updated RMS. Up to 170 events can be stored until the memory fills. The meter stores waveform data in a first-in/first-out circular buffer to insure data is always recording.

Optional Waveform Recorder

	Samples per Cycle	Pre Event Cycles	Post Event Cycles	Max Waveform per Event	Number of Stored Events
V5	16	32	96	256	85
	32	16	48	128	85
	64	8	24	64	85
V6	128	4	12	32	170
	256	2	6	16	170
	512	1	3	8	170

Note: Sampling rate based on 60Hz systems. For 50Hz systems, multiply by 1.2.

Waveform Scope

The unit uniquely offers a waveform scope to view the real time waveform for voltage and current. Waveform scope allows the meter to be used as a basic oscilloscope throughout a power system.

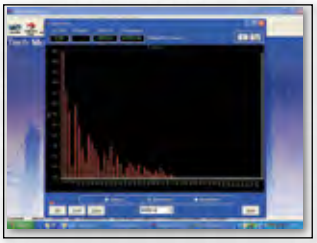
Waveform Scope Display

Independent CBEMA Log Plotting

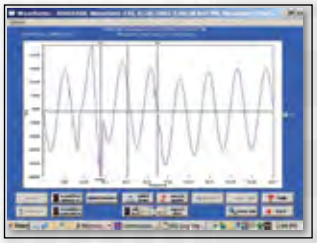
The meter stores an independent CBEMA log for magnitude and duration of voltage events. This allows a user to quickly view total surges, total sags and duration without retrieving waveform data.

Harmonic Recording to the 40th Order

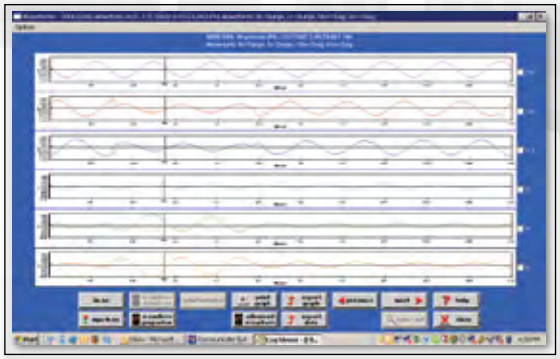
The Shark® 200 meter provides advanced harmonic analysis to the 40th order for each voltage and current channel in real time. Using the stored waveforms, harmonic analysis is available to the 255th order.



Harmonic Spectrum (40th Order)



Waveform Zoomed



6 Channels of Waveforms

STANDARD COMMUNICATION CAPABILITY

The Shark® 200 meter provides two independent communication ports with advanced features.

Rear Mounted Serial Port with KYZ Pulse

- **RS485** - This port allows RS485 communication using Modbus or DNP 3.0 Protocols. Baud rates are from 1200 to 57600.
- **KYZ Pulse** - In addition to the RS485, the meter also includes Pulse Outputs mapped to absolute energy.

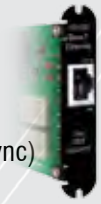
Front Mounted IrDA Communication

Uniquely, the Shark® 200 meter also has an optical IrDA port, allowing you to program it with an IrDA-enabled laptop PC.

FIELD EXPANDABLE I/O AND COMMUNICATION CAPABILITIES

The Shark® 200 meter offers unequaled I/O expandability. Using the two universal option slots, the unit can be easily configured to accept new I/O cards even after installation. The unit auto-detects installed I/O option cards. Up to 2 cards of any type can be used per meter.

1. INP100S: 100BaseT Ethernet Capability



The meter can provide 100BaseT Ethernet functionality.

- Embedded web server
- Network Time Protocol (NTP) support (Network Clock Sync)
- 12 simultaneous Modbus TCP/IP connections
- 5 simultaneous DNP over TCP/IP connections
- Dual Ethernet Ports available

2. 1mAOS: Four Channel Bi-directional 0-1mA Outputs

- Assignable to any parameter
- 0.1% of full scale
- 0 to 10K Ohms
- Range +/- 1.20mA
- Designed for RTUs and generating stations

3. 20mAOS: Four Channel 4-20mA Outputs

- Assignable to any parameter
- 0.1% of full scale
- 0 to 850 Ohms at 24VDC
- Loop Powered using up to 24 Volts DC
- Ideal for any Process Control application

4. RO1S: Two Relay Outputs / Two Status Inputs

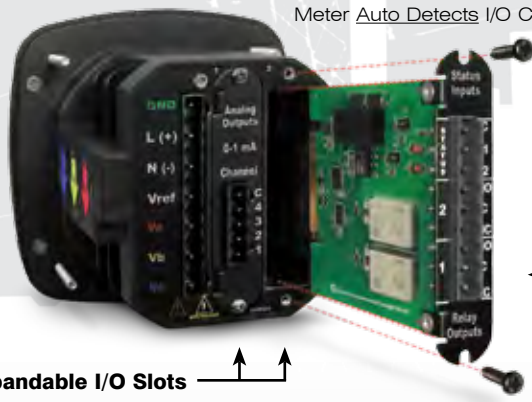
- 250VAC/30VDC - 5A Relays, Form C
- Trigger on user set alarms
- Set delays and reset delays
- Status Inputs – Wet / Dry Auto Detect (Up to 150 VDC)
- Must be used with V4 or higher V-Switch™ option for limit based alarms and control
- Allows for control, alarm and status

5. PO1S: Four Pulse Outputs / Four Status Inputs

- Programmable to any energy parameter and pulse value
- Form A: Normally open contacts
- Also used for End of Interval pulse
- Can function for manual relay control and limit based control (V4-V6 Options)
- 120mA continuous load current
- Status Inputs - Wet / Dry Auto Detect (Up to 150 VDC)
- Provides KYZ outputs and pulse input counting

6. FOVPS or FOSTS: Fiber Optic Card

- EIG's exclusive Fiber Optic Daisy Chain switchable built-in logic mimics RS485 half duplex bus, allowing you to daisy chain meters for lower installation costs. Full duplex is also assignable.
- ST Terminated Option (-FOSTS)
- Versatile Link Terminated Option (-FOVPS)
- Modbus and DNP 3.0 protocols available
- The preferred communication method for intrinsic safety and high reliability



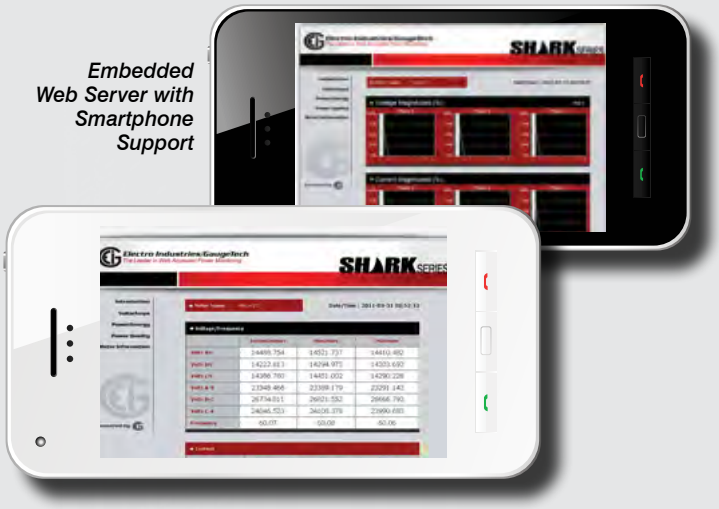
Note: I/O cards can be ordered separately - see last page.

100BASET ETHERNET (INP100S) TABLET / SMARTPHONE CAPABLE WEB SERVER

Simultaneous Data Connections

Simultaneous Connections to Multiple Software Systems

Embedded Web Server with Smartphone Support



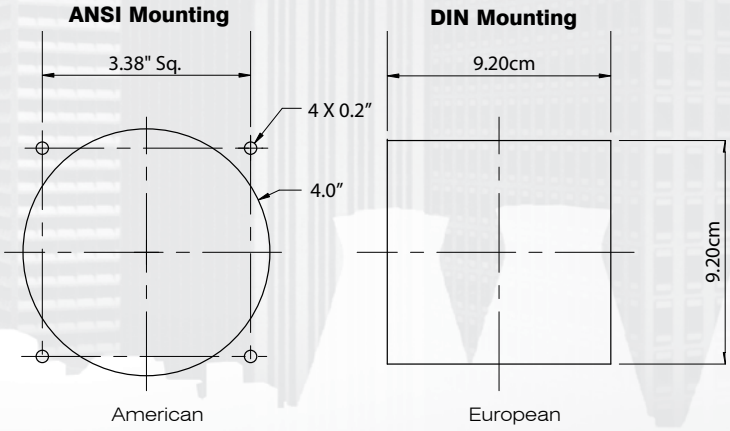
100BaseT ETHERNET AND WEB SERVER

Electro Industries' Rapid Response™ Ethernet card allows for high speed Ethernet communication utilizing a 100BaseT protocol communicating with up to 12 connections of Modbus TCP and 5 DNP over TCP/IP connections. The card supports a static IP address and is treated like a node on the network. The Shark® 200 meter provides fast and reliable updates to HMI packages, SCADA and Communicator EXT™ software. The Web Server allows access by almost all browsers over the Internet, including smartphones and tablets!

- Dual Ethernet Port Capable
- Simultaneous Modbus and DNP over Ethernet

SHARK® 200 METER ANSI AND DIN MOUNTING

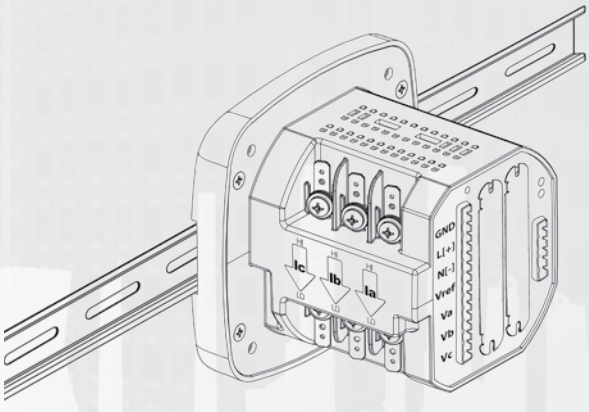
The unit mounts directly in an ANSI C39.1 (4" round form) or an IEC 92 mm DIN square form. This is perfect for new installations and for existing panels. In new installations, simply use DIN or ANSI punches. For existing panels, pull out old analog meters and replace them with the Shark® 200 meter. The meter uses standard voltage and current inputs so that CT and PT wiring does not need to be replaced.



(One meter fits both standards)

SHARK® 200T TRANSDUCER

This transducer version of the Shark® 200 meter does not include a display. The unit mounts directly to a DIN rail and provides an RS485 Modbus or DNP 3.0 output and the expandable I/O.

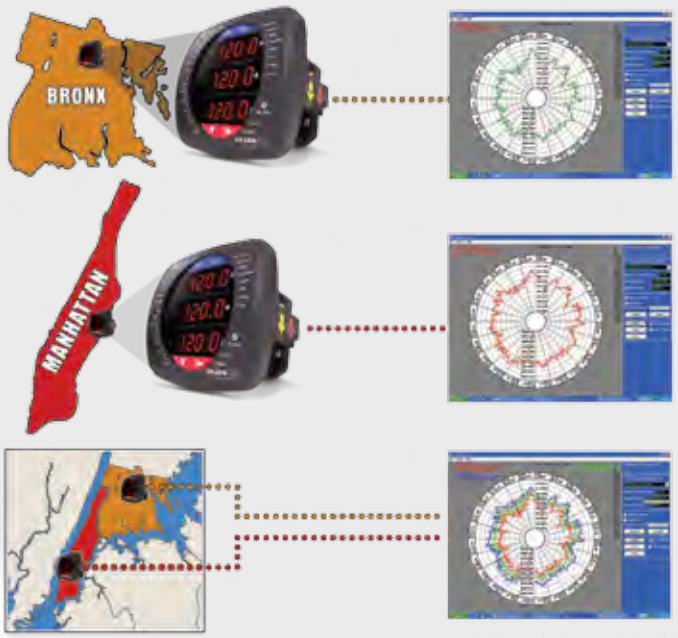


Shark® 200T - DIN Rail Mounted Transducer

SUBSTATION VOLTAGE AND FREQUENCY RECORDING

Traditionally, voltage recording meters were relegated to high cost metering or monitoring solutions. The Shark® 200 meter can be placed throughout an electrical distribution network. The meter provides one of the industry's lowest cost methods of collecting voltage information within a Utility power distribution grid.

- Voltage reliability analysis insuring proper voltage to customers
- Compare voltage reliability throughout transmission or distribution networks
- Monitor the output of substation transformers or line regulators
- Initiate conservation voltage reduction, reducing system demand
- Monitor highly accurate frequency to regulate frequency stability
- Replace costly frequency transducers



INTERVAL LOAD PROFILING

The Shark® 200 meter allows you to log substation data over time with regard to electrical usage, demand, voltage, current, PF and many other parameters. This enables a complete analysis of the power system over time.

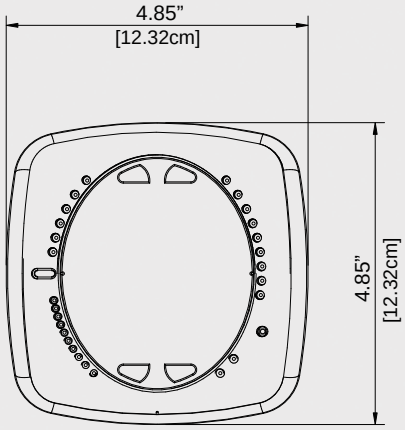
- Provide revenue accurate load profiling
- Determine substation usage
- Analyze feeder capacity and utilization
- Provide time based load profile for planning and estimation
- Data trend PF distribution and imbalances for system efficiency analysis

LOW COST SUBSTATION TELEMETRY

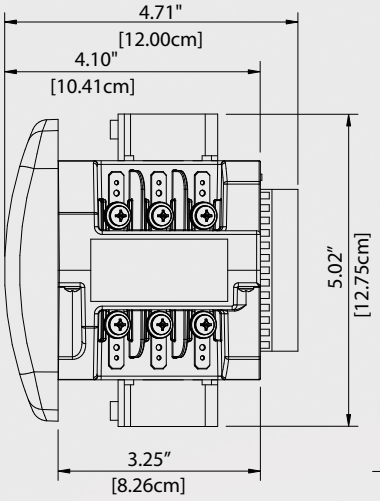
The Shark® 200 meter's advanced output capability brings back data using many different communication media such as RS485, Ethernet and analog outputs. This insures that one meter can be used for almost every substation application no matter what communication infrastructure is needed.

- Perfect for new or retrofit applications
- Multiple Com paths
- One meter provides outputs for every application
- Multiple systems and/or users accessing data simultaneously

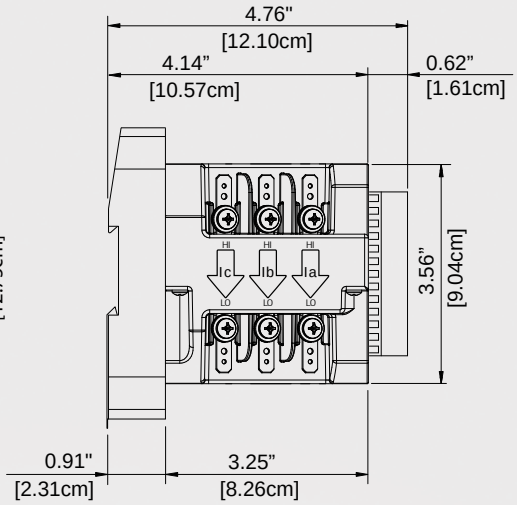
DIMENSIONAL DRAWINGS



Shark® 200 Meter Face

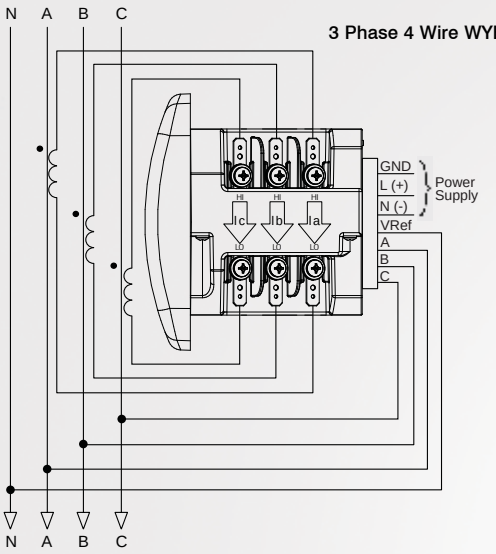


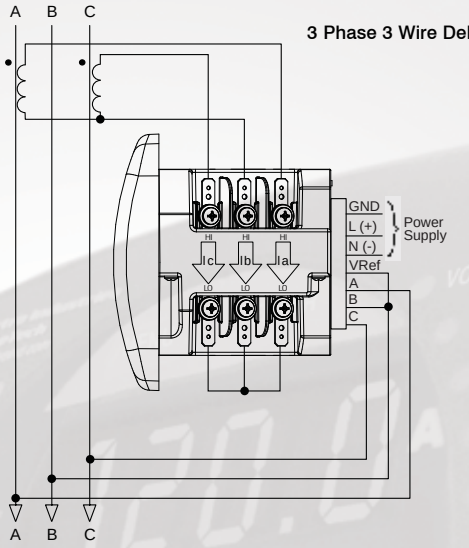
Shark® 200 Meter Side

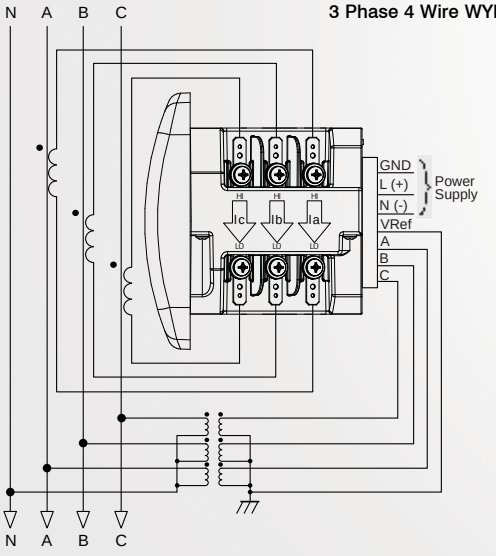


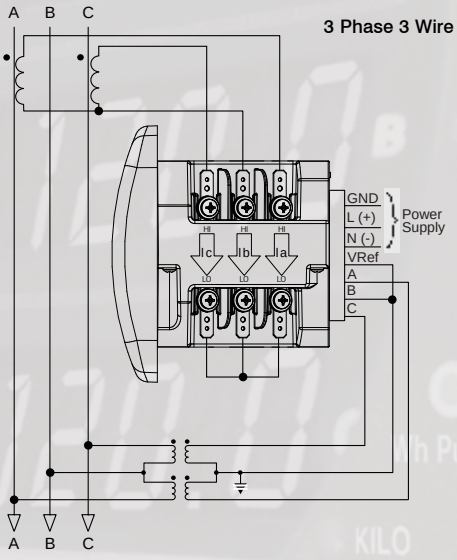
Shark® 200T Transducer Side

WIRING DIAGRAMS









Specifications

Voltage Inputs
- 20-576 Volts Line To Neutral, 0-721 Volts Line to Line
- Universal Voltage Input
- Input Withstand Capability – Meets IEEE C37.90.1 (Surge Withstand Capability)
- Programmable Voltage Range to Any PT ratio
- Supports: 3 Element WYE, 2.5 Element WYE, 2 Element Delta, 4 Wire Delta Systems
- Burden: Input Impedance 1 Mega Ohms. Burden 0.014W at 120 Volts
- Input wire gauge max (AWG 12 / 2.5mm^2)

Current Inputs
- Class 10: (0.005 to 11) A, 5 Amp Nominal
- Class 2: (0.001 to 2) A, 1A Nominal Secondary
- Fault Current Withstand (at 23°C): 100 Amps for 10 Seconds, 300 Amps for 3 Seconds, 500 Amps for 1 Second
- Continuous current withstand: 20 Amps for Screw Terminated or Pass Through Connections
- Programmable Current to Any CT Ratio
- Burden 0.005VA per phase Max at 11Amps
- Pickup Current: 0.1% of Nominal
  Class 10: 5mA
  Class 2: 1mA
- Pass through wire diameter: 0.177" / 4.5mm

Isolation
All Inputs and Outputs are galvanically isolated to 2500 Volts

Environmental Rating
Storage: (-20 to +70)° C
Operating: (-20 to +70)° C
Humidity: to 95% RH Non-Condensing
Faceplate Rating: NEMA12 (Water Resistant)
Mounting Gasket Included

Sensing Method
- True RMS
- Sampling at over 400 samples / cycle on all channels of measured readings simultaneously
- Harmonics resolution to 40th order
- Waveform up to 512 samples/cycle

Update Rate
- Watts, VAR and VA - every 6 cycles
- All other parameters - every 60 cycles

Power Supply
Option D2:
- (90 to 265) Volts AC and (100 to 370) Volts DC. Universal AC/DC Supply

Option D:
- (18-60) Volts DC (24-48 VDC Systems)

Burden: 10VA Max

Standard Communication Format
- 2 Com Ports (Back and Faceplate)
  - RS485 Port (Through Backplate)
  - IrDA (Through Faceplate)
- Com Port Baud Rate: (1200 - 57600)
- Com Port Address: 1-247
- 8 Bit, No parity
- Modbus RTU, ASCII or DNP 3.0 Protocols

KYZ Pulse
- Type Form C Contact
- On Resistance: 35 Ohms Max
- Peak Voltage: 350 VDC
- Continuous Load Current: 120mA
- Peak Load Current: 350mA (10ms)
- Off State Leakage Current@ 350VDC: 1uA

Dimensions and Shipping
- Weight: 2 lbs
- Basic Unit: H4.85" x W4.85" x L4.25"
- Shark® 200 meter mounts in 92mm DIN & ANSI C39.1 4" round cut-outs
- Shark® 200T Transducer DIN rail mounted
- 2-inch DIN Rail Included
- Shipping Container Dimensions: 6" cube

Meter Accuracy
- See page 2
- *Note: For 2.5 element programmed units, degrade accuracy by an additional 0.5% of reading.*
- *Note: For 1A (Class 2) Nominal, degrade accuracy to 0.5% of reading for watts and energy; all other values 2 times rated accuracy.*

Compliance
- IEC 62053-22 (0.2% Accuracy)
- ANSI C12.20 (0.2% Accuracy)
- ANSI (IEEE) C37.90.1 Surge Withstand
- ANSI C62.41 (Burst)
- EN61000-6-2 – Immunity for Industrial Environments: 2005
- EN61000-6-4 – Emission Standards for Industrial Environments: 2007
- EN61326-1 - EMC Requirements: 2006

Ordering Information

All fields must be filled in to create a valid part number.

	Model		Frequency		Current Input		V-Switch Pack		Power Supply		I/O Slot 1*		I/O Slot 2*		Mounting (Shark® 200 Only)
Option Numbers:		–		–		–		–		–		–		–	
Example:	Shark200	-	60	-	10	-	V2	-	D2	-	INP100S	-	X	-	X
	Shark200 (Meter/Transducer)		50 50 Hz System		10 10 Amp Secondary		V1 Multifunction Meter Only		D2 90-265V AC/DC		X None		X None		X ANSI Mounting
	Shark200T (Transducer Only)		60 60 Hz System		2 2 Amp Secondary		V2 Standard Data-Logging Memory		D 18-60V DC		RO1S 2 Relays / 2 Status		RO1S 2 Relays / 2 Status		DIN DIN Mounting Brackets
							V3 Power Quality Harmonics				PO1S 4 Pulses / 4 Status		PO1S 4 Pulses / 4 Status		
							V4 Limits & Control				1mAOS 4 channel Analog Output 0-1 (bidirectional)		1mAOS 4 channel Analog Output 0-1 (bidirectional)		
							V5 64 Samples/cycle Waveform Recording				20mAOS 4 Channel Analog Output 4-20mA		20mAOS 4 Channel Analog Output 4-20mA		
							V6 512 Samples/cycle Waveform Recording				FOSTS Fiber Optic Output ST Terminated		FOSTS Fiber Optic Output ST Terminated		
											FOVPS Fiber Optic Output VPIN Terminated		FOVPS Fiber Optic Output VPIN Terminated		
											INP100S 100BaseT Ethernet		INP100S 100BaseT Ethernet		

* *I/O cards can be ordered separately using the above part numbers.*

Additional Accessories

Communication Converters
9PINC – RS232 Cable

CAB6490 - USB to IrDA Adapter

Unicom 2500 - RS485 to RS232 Converter

Unicom 2500-F – RS485 to RS232 to Fiber Optic Converter

Modem Manager, Model #, MM1 – RS485 to RS232 Converter for Modem Communication

IrDA232 - IrDA to RS232 Adapter for Remote Read

Compliance Documents
Certificate of Calibration, Part #: CCal – This provides Certificate of Calibration with NIST traceable Test Data.

Current Transformer Kits
CT200K – 200/5 Ratio 1.00" Window 3 CTs

CT400K – 400/5 Ratio, 1.25" Window, 3 CTs

CT800K – 800/5 Ratio, 2.06" Window, 3 CTs

CT2000K – 2000/5 Ratio, 3.00" Window, 3 CTs

CT Specifications:
Frequency: 50 to 400Hz; Insulation: 600 Volts, 10kV BIL
Flexible Leads: UL 1015 105°C, CSA Approved, 24" Long, #16AWG

Software Option Numbers
COMEXT3 – CommunicatorEXT 3.0 for Windows®

* Consult factory application engineer for additional transformer ratios, types or window sizes.

Electro Industries/GaugeTech
1800 Shames Drive • Westbury, NY 11590
1-877-EIMETER (1-877-346-3837) • **E-Mail:** sales@electroind.com
Tel: 516-334-0870 • **Web Site:** www.electroind.com • **Fax:** 516-338-4741

E149702 031113 V.1.21

Section B

STYLES AND FEATURES

Principle of Operation of the Thermal Mass Flow Meter

Sage Thermal Mass Flow Meters have two sensors constructed of reference grade platinum windings (RTDs). The two RTDs are clad in a protective 316SS sheath and are driven by a proprietary sensor drive circuit. One of the sensors is self-heated (flow sensor), and the other sensor (temperature/reference sensor) measures the gas temperature. The pair is referred to as the sensing element, and is either installed in a probe as an Insertion style, or inserted into a pipe section as an In-Line style flow meter.

As gas flows by the flow sensor, the gas molecules carry heat away from the surface, and the sensor cools down as it loses energy. The sensor drive circuit replenishes the lost energy by heating the flow sensor until it is a constant temperature differential above the reference sensor. The electrical power required to maintain a constant temperature differential is directly proportional to the gas mass flow rate and is linearized to be the output signal of the meter.

It is essential that this constant temperature differential be maintained, even if there are wide fluctuations in gas temperature. It is the "job" of the Sage proprietary sensor drive circuit to maintain the differential, whether or not the gas temperature changes, or however quickly molecules cool off the flow sensor. It is also necessary to properly calibrate the device with the actual gas (or close equivalent with certain gases), in the Sage National Institute of Standards certified (NIST) calibration facility. By accomplishing these two critical objectives, the Sage meters provide an extremely repeatable (0.2% of Full Scale) and accurate output directly proportional to the mass flow rate of the gas being measured.

Features and Benefits

SAGE PRIME™ THERMAL MASS FLOW METER FOR GASES

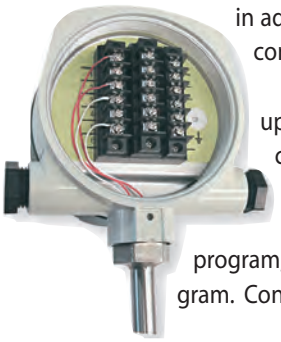
Sage Prime is the top selling meter in our Product Line. The Sage Prime Thermal Mass Flow Meter features a bright, high contrast, photo-emissive OLED display of Flow Rate, Total and Temperature in a robust, yet lightweight, dual-compartment industrial enclosure. The flow rate is also displayed graphically in a horizontal bar graph format. The rear compartment is completely separated from the electronics, and has large, easy-to-access, well marked terminals, for ease of customer wiring (see photo below). It is powered by 24 VDC (12 VDC optional, or 115/230 VAC). The power dissipation is under 2.5 watts (e.g. under 100 ma at 24 VDC).

The Sage Prime Flow Meter is offered in Integral or Remote Style (which has lead-length compensation up to 1000 feet as well as an Explosion Proof Junction Box). Specify any standard probe length or flow body size. It has a 4-20 ma output as well as a Pulsed Output of Totalized Flow (solid state transistor drive). In addition, Sage Prime supports full Modbus® compliant RS485 RTU communications (IEEE 32 Bit Floating Point).

Sage Prime is CE approved, and CSA and UL approved for Hazardous Service[2] (see Approvals tab on the website).

CONTINUOUS DIAGNOSTICS & FIELD CONFIGURABILITY

Sage Prime has continuous diagnostics. The raw calibration milliwatts (mw) is always displayed in the upper left hand corner of the meter's display. At any time, you can check this reading at a "no flow" condition, and compare the reading to the original reported "zero flow" value noted on the last few lines of your meter's Certificate of Conformance or the flow meter's data tag. This in-situ diagnostic procedure not only checks the sensor performance and the "live zero" calibration point, but it also verifies that the sensor is clean. It essentially provides a means to validate that the meter is operating properly, verifies that there is no shift or drift, and eliminates the need for annual factory calibrations. This simple field diagnostic procedure, in addition, verifies that the sensor is free from contamination, even without inspection.



Although Sage Prime is fully configured upon shipment, for the pipe and process conditions requested, there are three strategies if changes are needed: Sage DONGLE; the Sage ADDRESSER software program; or the Sage ADDRESSER advanced program. Contact Sage for details.

MAJOR BENEFITS OF THERMAL MASS FLOW METERS

- Direct Mass Flow – No need for separate temperature or pressure transmitters
- High Accuracy and Repeatability – Precision measurement and extraordinary repeatability
- Turndown of 100 to 1 and resolution as much as 1000 to 1
- Low-End Sensitivity – Measures as low as 5 SFPM (e.g., 1 SCFM in a 6" pipe)
- Negligible Pressure Drop – Will not impede the flow or waste energy
- No Moving Parts – Eliminates costly bearing replacements, and prevents undetected accuracy shifts
- Dirt Insensitive – Provides sustained performance
- Low cost-of-ownership
- Ease of installation and convenient mounting hardware

SPECIFIC BENEFITS OF THE SAGE PRIME

- High contrast photo-emissive OLED display with numerical Flow Rate, Total and Temperature, as well as Graphical Flow Indicator
- Photocell activated Screen Saver to extend display life
- Calibration milliwatts (mw) is continuously displayed, providing for ongoing diagnostics, and in-situ calibration check
- Modbus® compliant RS485 RTU communications
- Isolated 4-20 ma output
- Rugged, user-friendly packaging with easy terminal access
- Option for Solar Energy use (12VDC models)
- Low power dissipation, under 2.5 Watts (e.g. under 100 ma at 24 VDC)
- Powerful state-of-the-art microprocessor technology for high performance mass flow measurement and low cost-of-ownership
- Proprietary digital sensor drive circuit provides enhanced signal stability and unaffected by process temperature & pressure changes
- Remote Style has Lead-Length Compensation. Allows remote electronics up to 1000 feet from probe; Explosion Proof Junction Box has no circuitry, just terminals
- Field reconfigurability via Sage ADDRESSER or Sage DONGLE
- Flow conditioning built into In-Line flow meters (1/2" and up)
- Captive Flow Conditioners for Insertion Meter applications, if required

1 *Note, a built-in photocell continuously monitors the ambient light, and adjusts the display brightness for optimum long-term life, and also senses motion which automatically switches display from Screen Saver mode to Normal mode*

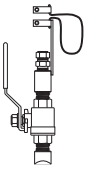
2 *Only available with 24VDC powered meters*

Sage PRIME™ Styles and Specifications

Sage Metering is your source for monitoring, measuring and controlling the gas mass flow in your industrial process, building management system or environmental application. Our high performance, NIST Traceable, Thermal Mass Flow Meters will help increase productivity, reduce energy costs, maximize product yields, and/or help reduce environmental insult. Sage provides high quality In-Line and Insertion Thermal Mass Flow Meters for a wide variety of industrial, commercial, and environmental monitoring needs, including carbon credit verification for Greenhouse Gas reduction.

Our experienced application engineers, many of whom have worked in the Thermal Mass Flow marketplace since its inception, will assist you in choosing the proper gas Flow Meter for your application – and they will be pleased to offer installation guidance to assure that the meter(s) selected will perform as accurately as possible. Additionally, our Service Staff stand ready to support you with any after-sale assistance that you may require.

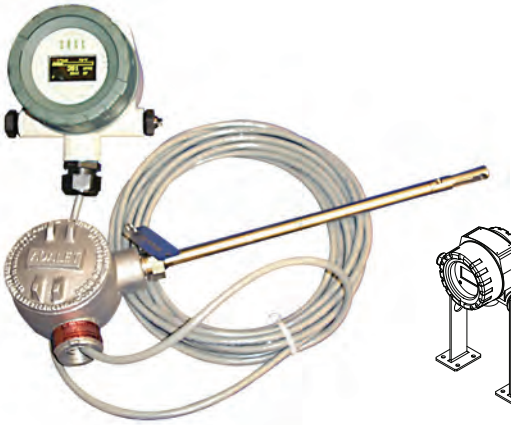
SIP SERIES – INTEGRAL



Optional SVA05 Isolation Valve Assembly

Optional Programmable Dongle

SRP SERIES – REMOTE



Mounting Hardware (included)

PRIME SIP/SRP

Accuracy[4] is +/– 0.5% of Full Scale +/– 1% of reading with a turn-down of 100 to 1 and resolution as much as 1000 to 1. Repeatability is 0.2%. The Flow Meter is Sage Metering, Inc. PRIME Series, with the trade name Sage Prime™.

The electronics has an isolated 4 to 20 ma output proportional to Mass Flow Rate as well as pulsed outputs of Totalized Flow (24 VDC solid state transistor drive). In addition, Modbus RS485 RTU communications is standard (IEEE 32 Bit Floating Pt).

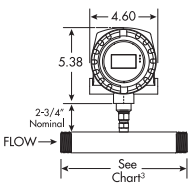
INTEGRAL STYLE ELECTRONICS

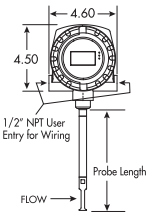
Electronics is Integral Style, with rugged windowed dual compartment enclosure with local display. The display is a high contrast photo-emissive OLED display with Screen Saver, and it displays Mass Flow Rate, Totalized Flow and Temperature as well as a graphical representation of Flow Rate in a horizontal bar graph format. In addition, the calibration milliwatts (mw) is continuously displayed, providing ongoing diagnostics.

REMOTE STYLE ELECTRONICS

Electronics is Remote Style, with rugged windowed dual compartment enclosure with display. The display is a high contrast photo-emissive OLED display with Screen Saver, and it displays Mass Flow Rate, Totalized Flow and Temperature as well as a graphical representation of Flow Rate in a horizontal bar graph format. In addition, the calibration milliwatts (mw) is continuously displayed, providing ongoing diagnostics. Includes Remote Mounting Hardware.

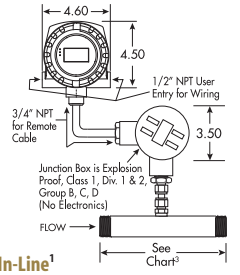
The Flow Element's Junction Box is Explosion Proof (Class 1, Div 1, Groups B, C, D), and does not have any electronics – only a wiring terminal block. The Junction Box is connected to the Remote Electronics by 25 feet of lead-length compensated cable. The cable (6-conductor) can be lengthened or shortened without affecting accuracy (max loop resistance 10 ohms, over 1000 feet), if grounded properly.

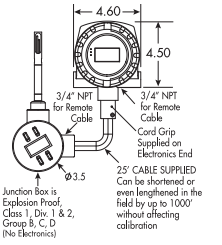




SIP In-Line[1]
Flow Element is In-Line Style consisting of a choice of 316 Stainless Steel Schedule 40 Flow Bodies sized from 1/4" x 6" long to 4" x 12" long.

SIP Insertion[2]
Flow Element is Insertion Style, consisting of a 1/2" OD probe (3/4" optional) with lengths up to 36" long (typically 15" long) suitable for insertion into the center of a process pipe.





SRP In-Line[1]
Flow Element is In-Line Style consisting of a choice of 316 Stainless Steel Schedule 40 Flow Bodies sized from 1/4" x 6" long to 4" x 12" long.

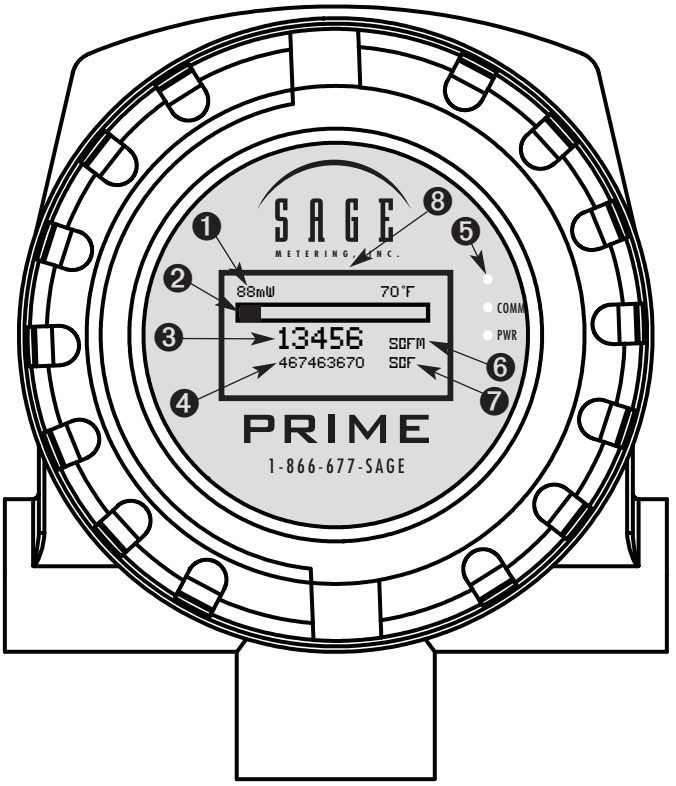
SRP Insertion[2]
Flow Element is Insertion Style, consisting of a 1/2" OD probe (3/4" optional) with lengths up to 36" long (typically 15" long) suitable for insertion into the center of a process pipe.

ENGINEERING SPECIFICATIONS OF OPTIONAL SAGE PRIME PLUS

This is an optional version of Sage Prime offering a separate ground for the 24VDC Power Supply (optional 5 VDC or 12 VDC Power Supplies) which isolates the Modbus ground from the power supply ground. All other features of Prime PLUS are identical to the standard Sage Prime, except Approvals do not apply at this time.

1 *Male NPT ends are standard, with flanged ends, tube, or butt weld optionally available*
2 *Mounting hardware such as Isolation Valve Assemblies, Compression Fittings, and Flanges, are optional*
3 *Chart of Flow Body length is on page 10 of the "Sage Gas Flow Meters" brochure (see "In-Line Flow Meters")*
4 *Enhanced accuracy available upon request, especially if turndown limited. Contact Sage*

Sage PRIME Organic (OLED) Display[1,2,3]



❶ **Raw Calibration milliwatts (mw) for Diagnostics and Periodic "Zero Flow" Calibration Check**

❷ **Graphical Indication of Percentage of Full Scale Flow Rate**

❸ **Flow Rate**

❹ **Totalized Flow (Consumption) (Value is Retained during Power Outage or Power Cycling)**

❺ **Flashes with each pulsed output of consumption**

❻ **Engineering Units of Flow Rate (the last digit can be S(seconds), M(minute), H(hour)**

❼ **Engineering Units of Consumption**

❽ **Photocell activated Screen Saver extends display life**

1 Upon start-up, the Revision No., Serial No., and Modbus ID will display for a few seconds. Also the output configurations symbol is momentarily displayed

2 Note, a built-in photocell continuously monitors the ambient light, and adjusts the display brightness for optimum long-term life, and also senses motion which automatically switches display from Screen Saver mode to Normal mode

3 To view display, wave hand over display or use a flashlight. The Flow Meter displays for one minute, then the Screen Saver resumes

Approvals

HAZARDOUS LOCATION APPROVALS

All 24 VDC Powered Sage Prime Meters (SIP Integral Insertion, SIP In-Line, SRP Remote Insertion, SRP Remote In-Line) are approved for Class 1, Div 2, Groups A, B, C, D, T4 and ATEX: Ex nA IIC T4.
AC Powered Meters are not approved.

Testing is in accordance with the following Safety Standards:

- UL1604, Third Edition, Electrical Equipment for Use in Class I and II, Division 2, and Class III Hazardous (Classified) Locations
- CSA C22.2 No. 213-M1987 (R1999), First Edition, Non-incendive Electrical Equipment for Use in Class I, Division 2 Hazardous Locations
- UL/CSA 61010-1, Second Edition, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements

The following is required to comply with the above mentioned Approvals

1) Repair of the product (or replacement of components) is not possible by the user
2) As noted on the following label (see below) it will contain the following markings: Ex symbol, nA symbol IIC, temperature class
3) All Prime DC meters will be marked with "X" which means that these Special Conditions of Use will apply:
   a) The completed meter must be installed with a rigid or flexible metal conduit in order to satisfy approval conditions.
   b) The meter has been approved for use with the electronics enclosure in an ambient temperature from –20˚C < Ta < 65˚C.
4) Sage Metering considers a linear correction suitable for temperatures exceeding the temp code rating of 40C (104F) thus no customer correction is needed.

SAGE METERING, INC.-MTRY, CA 93940/ PRIME THERMAL MFM

Class I, Div 2, Groups A,B,C,D T4 ATEX: Ex nA IIC T4 X

MODEL #

SERIAL # mW0 =

FOR USE IN HAZARDOUS LOCATIONS–CAUTION–DISCONNECT FROM POWER SUPPLY BEFORE OPERATING. KEEP COVER TIGHT WHILE CIRCUITS ARE ALIVE. CONDUIT SEALS MUST BE INSTALLED WITHIN 18" OF THE ENCLOSURE. ATTENTION–OUVRIR LE CIRCUIT AVANT D'ENLEVER LE COUVERCLE GARDER LE COUVERCLE BIEN FERME TANT QUE LES CIRCUITS SONT SOUS TENSION. UN SCELLEMENT DOIT ETR INSTALLE A MOINS DE 45CM DU BOITER.

CE CONFORMANCE

All AC & DC Powered Sage Metering, Inc. Series SIP (Sage Prime-Integral) and Series SRP (Sage Prime-Remote) are CE Compliant for the following CE directives:

- EN61000-6-4 for Electromagnetic compatibility;
- EN61000-3-2 for Harmonics;
- EN61000-3-3 for Flicker;
- EN61000-6-2 for Electromagnetic Compatibility (Immunity for Industrial Environments), which includes EN61000-4-2 for ESD;
- EN61000-4-3 for Radiated Immunity;
- EN61000-4-4 for EFT/B; EN61000-4-5 for Surge;
- EN61000 for Conducted Immunity;
- EN61000-4-8 for Magnetic Immunity;
- EN61000-4-11 for Voltage Interruptions

CE MEDICAL CONFORMANCE

Contact Sage Metering if Medical CE Conformance is required. (AC Powered Sage Prime Meters only.)
The Standard is to IEC 60601-1-2:2007 Edition 3

INCA Analyzer Series

UNION Instruments GmbH

INSTRUCTION MANUAL

Gas composition measurement of biogas, raw biogas, landfill gas and bio-methane

Version: V1.01R06
Stand: 15.03.2010

PLEASE READ THIS BEFORE PROCEEDING!

- Read all instructions prior to installing, operating and servicing the instrument.
- Follow all important notes and cautions marked on and supplied with the instrument.
- If you do not understand any of the instructions contact your Union Instruments GmbH representative for clarification.
- Install your equipment as specified in the installation instructions with appropriate local and national codes. Connect all products to the proper electrical and pressure sources.
- Use only qualified personnel to install, operate, software update and maintaining the instrument to ensure proper performance.
- When replacement parts are required ensure that you use only spare parts specified by Union Instruments GmbH. Unauthorized parts and procedures can affect the instrument"s performance, place the operation of your process at risk and VOID YOUR WARRANTY. Look-alike substitutions may result in fire, electrical/chemical hazards or improper operation.
- Equipment door should be closed except when maintenance is being performed by qualified personnel to prevent electrical shock and personal injury.

The features of the instrument and the information in this document are subject to change without notice.

For technical or other questions, please contact:

UNION Instruments GmbH
Zeppelinstr. 42
76185 Karlsruhe
Germany

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🖷 +49 (0)721-95243-33
✉ info@union-instruments.com
💻 http://www.union-instruments.com

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Figures

Tables

1 PREFACE

1.1 Purpose

The INCA Analyzer Series are a (semi)continuous[1] measuring instruments to analyze gas compositions in biogas, raw biogas, poor gas and bio-methane. With their capability to measure gas components such as CO_2, CH_4, O_2, H_2S, H_2, specific gravity and additional calculated values, the INCA Analyzer Series can be applied in biogas plants for monitoring, optimization and evaluation of biological processes.

1.2 Technical description

Measurement phase:	discontinuous/continuous/semi-continuous
Channel:	single stream/multiple stream
Autocalibration:	after every purge gas phase (approx. 15 min)
Calibration interval:	manually or automatically (configurable between 1 hour to several weeks)
Calibration duration:	10 minutes (recommended)
Measurement ranges:	depending on the configuration
Ambient conditions	
Temperature:	10 - 40 °C
Humidity:	0 - 95 % relative humidity
Protection class:	IP44
Interfaces:	RS-232 3x digital output (customizable functionality) Optional: 4x or 8x analog output 0 - 20 mA or 4 - 20 mA Ethernet Profibus-DP Modbus RTU

1.3 Remarks

Content of the manual

This manual contains general information of all series of INCA Analyzer. Information concerning specific model of INCA Analyzer are available in the manual of the series.

Further information

Manual INCA xxxx[2]Txxx[3] (e.g. Manual INCA 4000 T100)

[1] Continuous measurement for certain variables of certain INCA types only (see subchapter functionality)
[2] Model of the analyzer
[3] Configuration of the analyzer

2 SAFETY INSTRUCTIONS

This manual should be reviewed with special attention to all the instructions and cautions before the analyzer is out into operation

Power plug and main fuse switch

Before opening the analyzer the power plug has to be disconnected from the power supply. After opening the analyzer the main fuse switch should be turned to OFF position during all installation processes.

Installation

The electrical connection for the analyzer must be carried out by qualified personnel in accordance with all applicable national codes, local regulations and the power supply voltage listed on the rating plate.

Gas connections

Gas connections must be carried out only by qualified personnel in accordance with all applicable national codes and local regulations.

The analyzer will work within the permissible temperature range. To meet the specifications a cooling or heating device might be needed e.g. if the analyzer is placed into another enclosure enough air flow must be provided in the additional casing to purge the analyzers thermal heat and always provide fresh air, which is needed for correct measurement. The analyzer should only be operated indoors. Humidity could affect the measurement and eventually break the analyzer. After assembly all gas-flowing parts should be checked for leakage.

Formation of Ex-mixtures in the device

The analyzer has been carefully leak tested during the production process. There is no operational situation possible, at which gas could penetrate into the device. The enclosure has two independent fans (outside fan and power supply fan) which provide 1~2 m^3 of air circulation per hour. No gas is released inside the enclosure and the flow rate of the gas pump is mechanically restricted to a maximum value of 30 l/h.

Operating and maintenance

The analyzer has left the factory in compliance with all applicable safety regulations. To maintain this operation condition, the user must strictly follow the instructions and consider the warnings in this manual.

Before switching on the analyzer, verify that the electrical supply voltage matches the analyzer‟s operating voltage as described in the manual.

Substances hazardous to health may emerge from the analyzer‟s output. Please pay attention to the safety of your operation personnel. Protective measures must be taken, if required.

Application

The analyzer has been designed as a process gas analyzer and is not applicable for personnel protection, area monitoring or detection of MAC or UEL limits.

All applicable safety regulations must be observed when working with toxic or flammable gases.

Definitions

The following definitions apply to WARNINGS, CAUTIONS and NOTES found throughout this manual.

Warning

Highlights an operation or maintenance procedure, condition, statement, etc.

If not strictly observed, could result in injury, death, or long-term health hazards of personnel.

Caution

Highlights an operation or maintenance procedure, condition, statement, etc.

If not strictly observed, could result in injury, damage to or destruction of analyzer or loss of effectiveness.

Note

Highlights an essential operating procedure, condition, statement, etc.

3 GENERAL DESCRIPTION

The INCA Analyzer Series offers a group of gas measurement instruments to analyze gas compositions in different applications such as the production of biogas, raw biogas, poor gas and bio-methane. With their capability to measure gas components such as CO_2, CH_4, C_2H_6, O_2, H_2S, H_2, specific gravity and additional calculated values of the gas, the INCA Analyzer Series can be applied in biogas plants for monitoring, optimization and evaluation of biological processes.

The analyzer is designed as a modular system. It can be equipped with different sensors selectable from a list as the analyzer is ordered. The customers are able to order a specific INCA Analyzer with specific number, range and accuracy of the sensors. Gas conditioning systems including gas cooler is also optional. Please see list of the available sensors.

3.1 Functionality

3.1.1 Phases of the analyzer

The measurement principle of the standard analyzer consists of four phases in an adjustable cycle.

Phases	Description
Purge gas	Purge gas (usually air) is pumped through the system to clean out the pipes from process gas of previous measurement and to moisturize the electrochemical sensors to increase their lifetime.
Condensate drain	If system has a gas cooler the pump will run during that cycle to drain the condensate from the gas cooler. For this purpose the system is either equipped with a hose pump or an ejector using compressed air.
Change channel	The analyzer starts to run the process gas of the active channel (maximum of 10 channels are available depending on system configuration) through the system. This allows the pumps to build up pressure and also for the process gas to reach the sensor before the measurement is started. Pressures of the pumps are checked and errors are stored if minimum pressures are not reached.
Measurement	The sensors are exposed to the process gas and measurement is performed. At the beginning of this cycle the pumps inside the analyzer are calibrated. At the end of the cycle the measured values are stored in memory.

Table 1: Measurement phases

Note

Continuous measurement analyzers do not operate in this cycle scheme. See Figure 3-2.

3.1.2 Diagrams of the phase transition

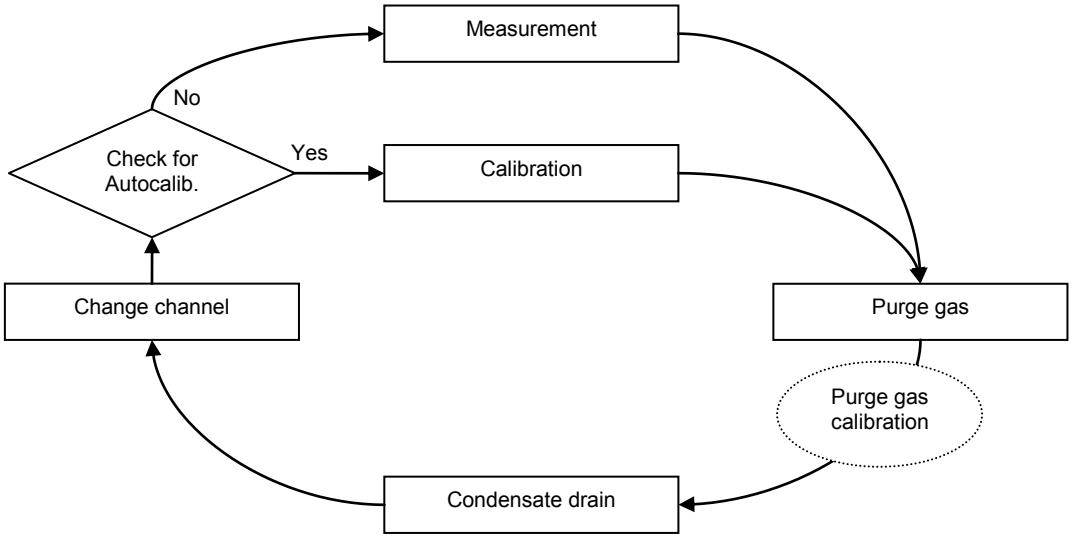


Figure 3-1: Phase transition in standard analyzer

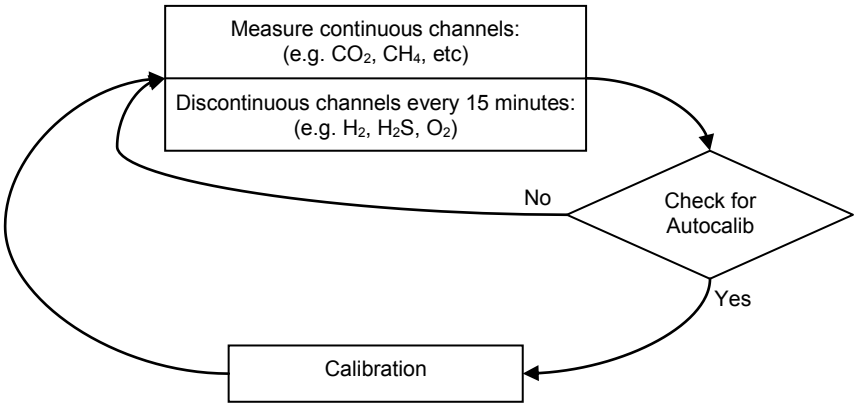


Figure 3-2: Phase transition in continuously measuring analyzer

3.2 Sensor modules

The following sensor modules are available in the INCA Analyzer series.

Type	Variable	Principle	Cross sensitivity	Accuracy	Range	Note
0	$[CO_2]$	NDIR (4.26 µm)	CH_4	±1 % of range	0 – 100 vol.%	P ,T compensated
1	$[CH_4]$	NDIR (3.5 µm)	C_xH_y	±1 % of range	0 – 100 vol.%	P, T compensated
5	$[CH_4]$	NDIR (3.5 µm)	C_xH_y	±1 % of range	0 – 20 vol.%	P, T compensated
6	$[H_2S]$	EC	H_2, CO	±1 ppm	0 – 25 ppm	High sensitive, linear output
7	$[H_2S]$	EC	H_2, CO	±5 ppm	0 – 100 ppm	High sensitive, linear output
8	$[H_2S]$	EC; µPulse	H_2, CO	±10 % of range	0 – 10000 ppm	High sensitive, linear output
9	$[O_2]$	EC	H_2, CO	±3 % of range	0 – 25 vol.%	Linearity : $S=k \log_e 1/(1-C)$
10[4]	$[O_2]$	Paramagnetic	---	±3 % of range	0 – 5 vol.%	Maintenance-free, long lifetime
11[5]	$[O_2]$	Paramagnetic	---	±1.5 % of range	0 – 25 vol.%	Maintenance-free, long lifetime
12	$[H_2]$	EC	CO	±3 % of range	0 – 4000 ppm	Output linear
14	$[CO_2]$	NDIR (4.26 µm)	CH_4, CO	±1 % of range	0 – 5000 ppm	P, T compensated
15[6]	SG	Acoustic	---	±1.5 % of range	0.2 – 2.2	Maintenance-free, long lifetime
16	$[CO_2]$	NDIR (4.26 µm)	CH_4	±1 % of range	0 – 10 vol.%	P, T compensated
19	$[H_2S]$	EC	H_2, CO	±5 ppm	0 – 2000 ppm	High sensitive, linear output
22	$[H_2S]$	EC; µPulse	H_2, CO	±10 % of range	0 – 50000 ppm	High sensitive, linear output
23	$[CH_4]$	EC	C_xH_y	±1 % of range	0 – 5 Vol.%	P, T compensated
24	$[CO_2]$	EC	CH_4	±1 % of range	0 – 20 Vol.%	P, T compensated

Table 2: List of sensor modules

All infrared sensors are pressure and temperature compensated.

[4] under development
[5] under development
[6] under development

3.2.1 NDIR module

The NDIR module is used for measuring CO_2, CH_4 and other possible hydrocarbon gas. Using non-dispersive infrared (NDIR) technique and dual beam method, the setup of two IR sensors and two IR detectors detects two different wavelengths depending on the type of gas, accuracy and range of the measurement. Please see the sensors list for more details.

The module is temperature and pressure compensated and capable to detect and correct the IR-source aging, which is typical for devices using the NDIR technique. If necessary, the sensor head can be individually replaced. See spare parts list at the end of this manual.

The accuracy is better than 1% of full range.

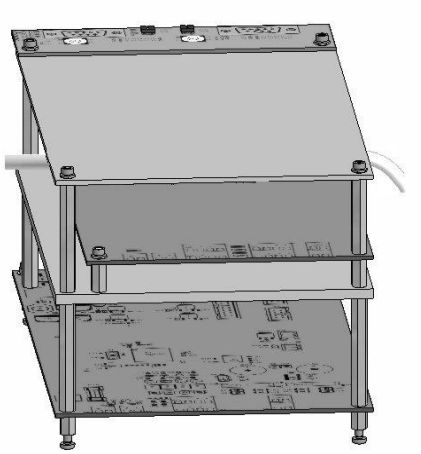


Figure 3-3: NDIR module

3.2.2 EC and EC-µPulse module

The electrochemical module with or without the µPulse module can measure the following gases: O_2, H_2 and H_2S. It has a high durability and a low sensor load using a patented measurement process (µPulse). This technique allows very wide measurement ranges, for example H_2S (0 - 10000 ppm) without burdening the sensor life time.

If necessary, the sensor head can be individually replaced. See spare parts list at the end of this manual.

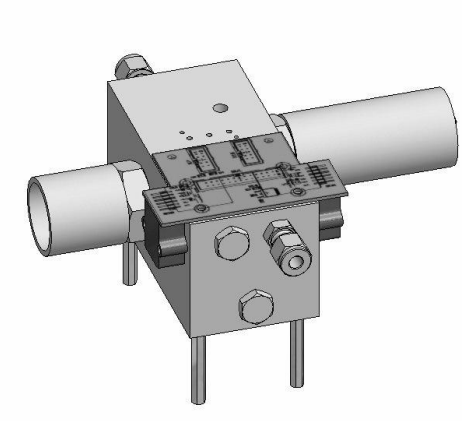


Figure 3-4: EC/EC-µPulse module

3.2.3 Paramagnetic oxygen sensor (Parox) module

The Parox sensor measures the oxygen concentration in a gas by using the oxygen paramagnetic properties.

The paramagnetic sensor offers better accuracy and is practically insensitive to other gases. Compared to EC sensors, it needs no maintenance and offers a longer life time.

Figure 3-5: Parox module

3.2.4 Specific gravity module

The specific gravity module is designed for a continuous, on-line analysis of a gas stream. It determines the specific gravity of the process gas in a specially designed sample chamber using presence of a modulated acoustical field.

The module has high intrinsic linearity, long term stability and a short response time. It requires no regular maintenance. After installation the sensor housing must be able to move freely on the springs.

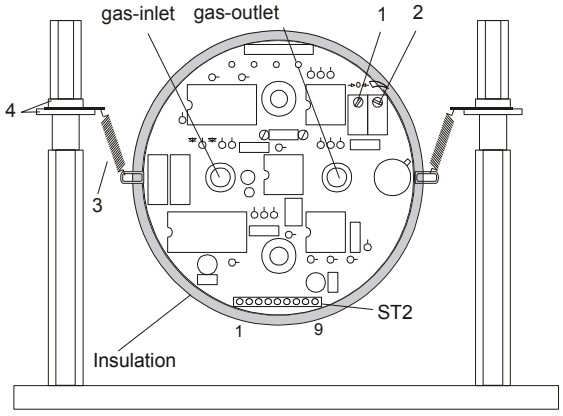


Figure 3-6: Specific gravity measuring cell, heated and insulated

1	Potentiometer 1 Zero	3	Suspension springs
2	Potentiometer 2 Span	4	Insulating discs

Measurement range : 0.2 – 2.2
Specific gravity of air : 1

3.3 Communication with PC using INCACtrl

The INCA Analyzer comes with INCACtrl, a software running on MS Windows XP/Vista™ serving as an interface to communicate through a PC with the analyzer. The software serves as a configuration tool and allows to

- set device specific configuration data
- set measurement specific parameter data
- read the current measurement data from the analyzer
- log current measurement data from the analyzer
- set calibration gas compositions and calibration settings

Requirements:

1. INCA Analyzer
2. INCACtrl software
3. A PC/laptop (operating system: MS Windows XP/Vista™)
4. Null modem cable

3.3.1 Establishing communication with INCACtrl

Do the following steps to establish a communication between INCACtrl running on a PC/laptop with the INCA Analyzer:

1. Connect the RS-232 interfaces between the INCA Analyzer and a PC/laptop using a null modem cable.

2. Start INCACtrl.exe

3. Click **Options → COM port settings** to configure the communication port. By default, **Autodetect COM port** is selected. A port can be manually selected in the menu.

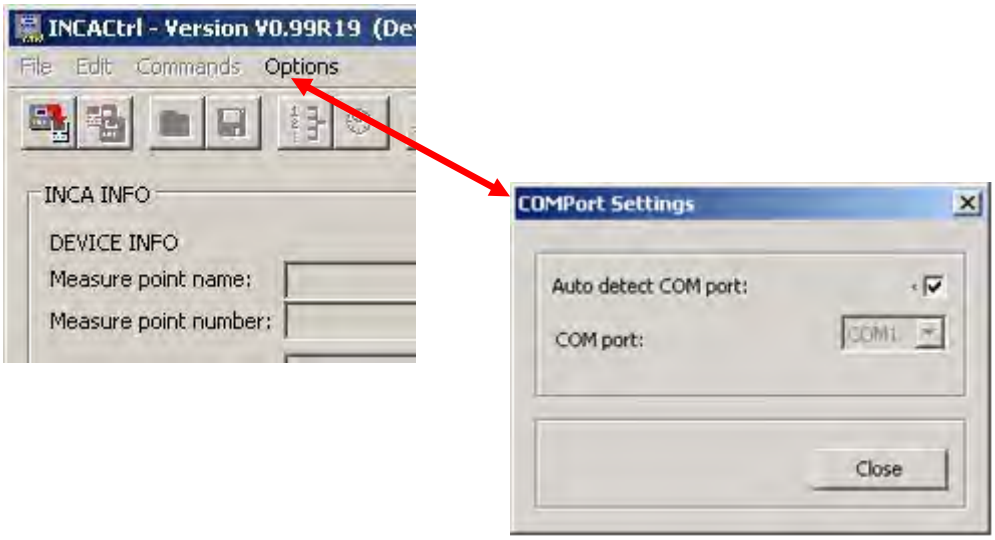


Figure 3-7: INCACtrl COM port settings

4. Click the icon to establish a connection.

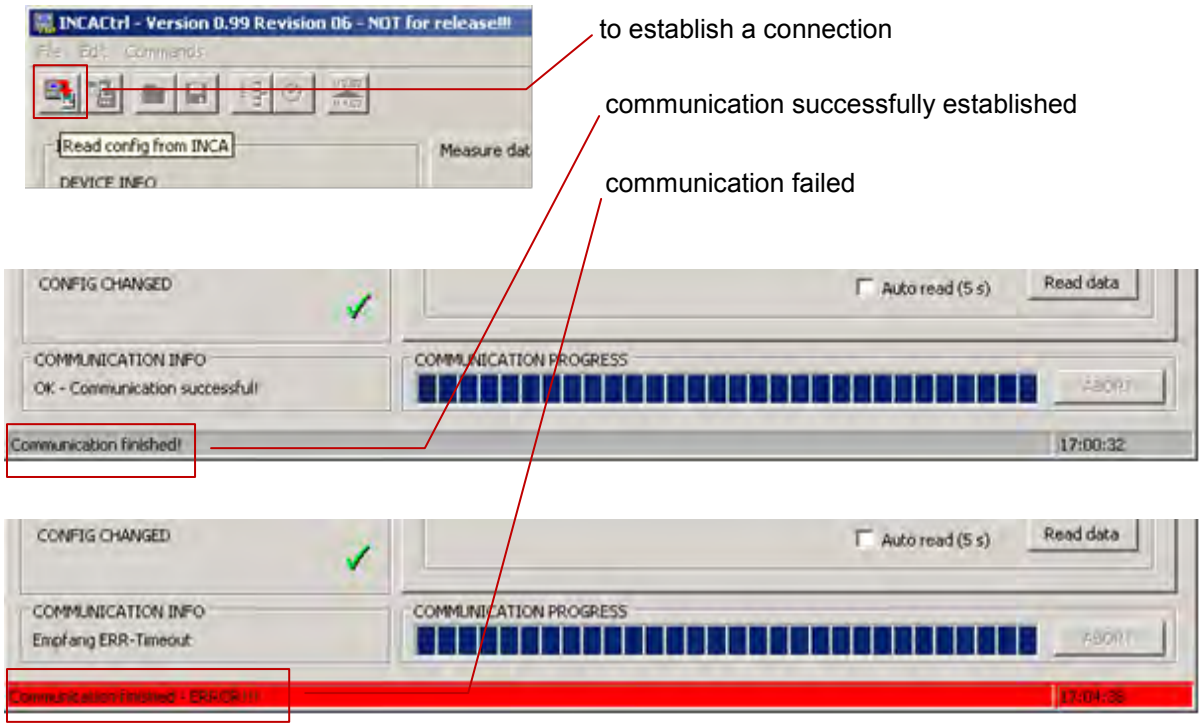


Figure 3-8: Establishing connection between INCACtrl and INCA Analyzer

If you get an error message, check the modem cable. The COM-port setup should also be checked by deactivating the auto-detect and manually choose the port where the null modem cable is connected.

3.3.2 Saving the configuration to the INCA Analyzer

Note

Any change of INCACtrl configuration will only become effective after saving them to the INCA Analyzer.

1. Check the following sign in the INCACtrl. Red cross shows that some changes are made in the INCACtrl configuration

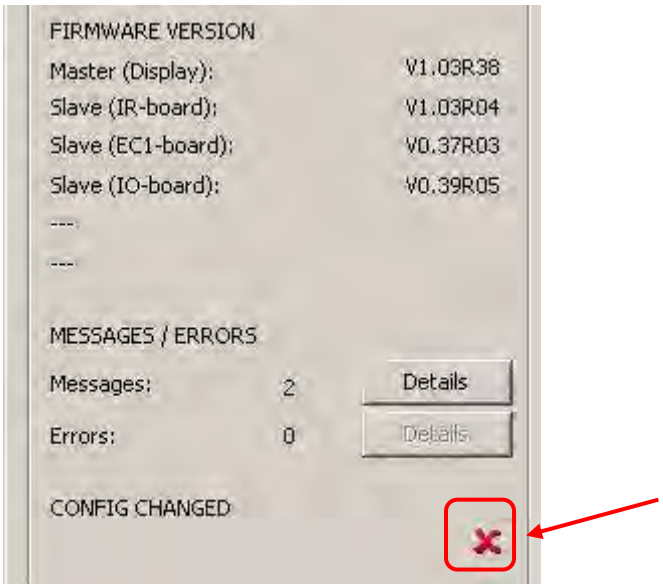


Figure 3-9: Configuration changed

2. Click on this button to save the INCACtrl configuration to the INCA Analyzer.

Figure 3-10: Saving the configuration

3. The green check mark is shown if the saving was successful.

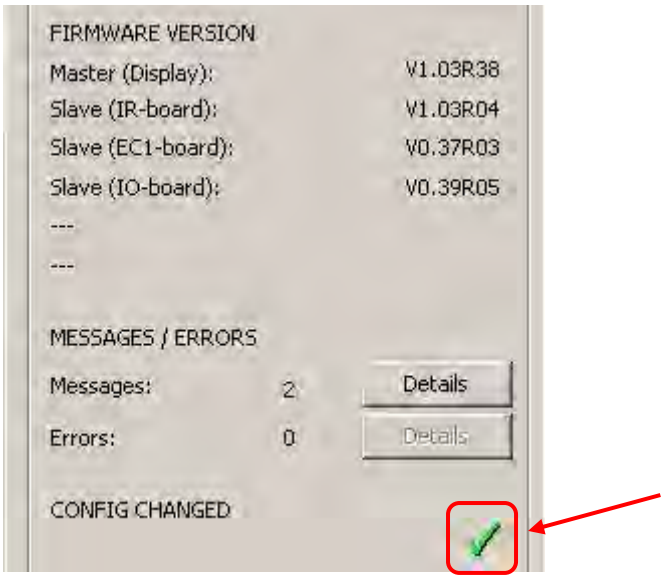


Figure 3-11: Green check mark - saving configuration was successful

4 SYSTEM MAIN MENU

Main menu structure of the analyzer can be broke down as:

Main menu
- *Settings*
  - *Language*
  - *Password*
  - *Cal. purge gas*[7]
  - *Output data*
  - *Communication*
- *Parameters*
  - *Cooler gas temp*[8]
  - *EC meas. cycle*[9]
- *Commands*
  - *Change channel*[10]
  - *Restart system*
  - *Clear messages*
  - *Cal. purge gas*
  - *Cal. gas I*
  - *Cal. gas II*[11]
  - *Reset cal.*
- *System info*
- *System messages*

Figure 4-1: Display overview

[7] only active for certain configurations
[8] only active for INCA Analyzers with gas cooler
[9] only active for certain configurations
[10] only active for INCA Analyzers with more than one channel (multi-channel analyzer)
[11] under development

In the figure above the measuring phase is active and the analyzer will switch to next phase in 4 minutes 57 seconds. Channel 1 of 3 available channels is active and currently measured.
For a continuous measurement setup the display indicates the continuous measurement with a blinking asterisk (“*”) symbol.

Figure 4-2: Display for continuous measurement configuration

Note

All the keys are active as soon as the display is set to its high brightness. Pressing any key makes the display illuminate, which means that keys are active.

4.1 Display keys

4.1.1 Menu function keys

Six main menu keys are located under the screen: *up* ▲, *down* ▼, *left* ◄, *right* ► are keys for navigation, ESC for cancel or go back to previous layer and MENU/↵ to jump to main menu and also to confirm inputs/commands.

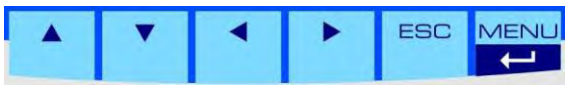
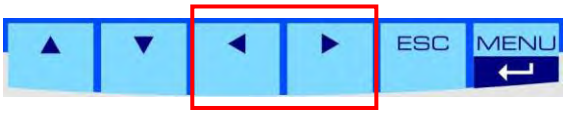


Figure 4-3 Main menu keys

The *left* ◄ and *right* ► keys are used to show the measured values.

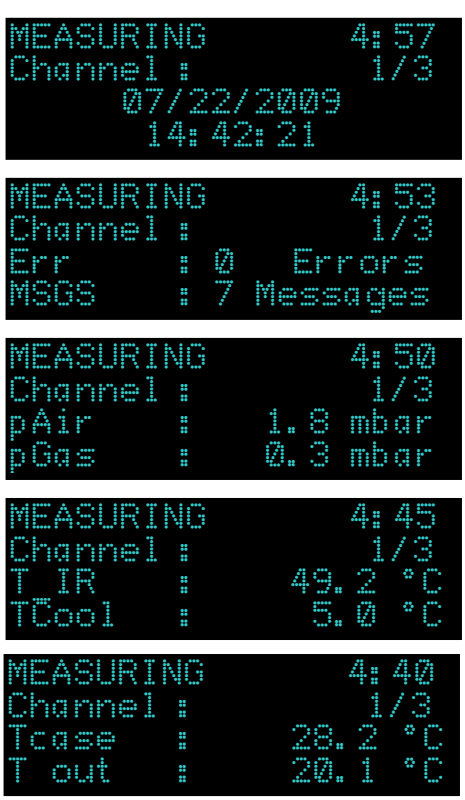


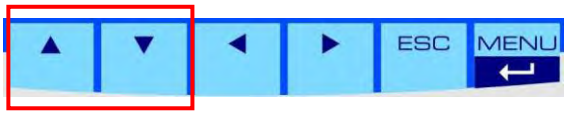
The display shows the *Measuring* phase is active.

Press ◄ and ► to show the measured values.

REMARK:
An asterisk mark which is shown in the display before a measurement value marks that a saved value is being displayed. Values are updated in the display after each measurement phase.
For continuously measuring gases no asterisk is shown since the value is updated continuously.

The *up* ▲ or *down* ▼ keys are used to show the measured pressures and errors/messages.





Press *up* ▲ or *down* ▼ to show the measured pressures and errors/messages.

The pAir and pGas are pressures of air and gas measured by relative pressure sensors.

The *up* ▲ or *down* ▼ do not have function when the display showing the measurement values.

REMARK:
The *up* ▲ or *down* ▼ keys only work when displaying date/time. When the output of measurement values is chosen, the keys will not change the display output.

4.1.2 Measurement data keys

Measurement data functions are available above the screen; with each of them having two keys to change the displayed data.

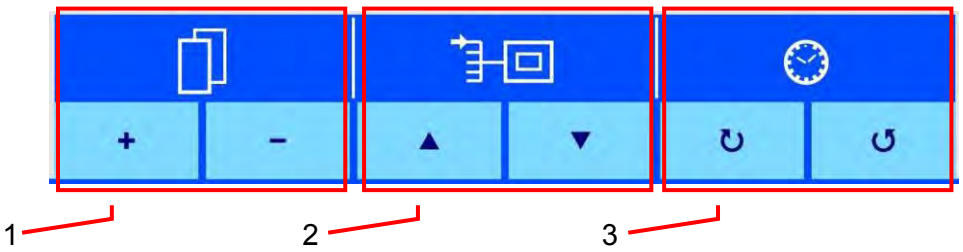
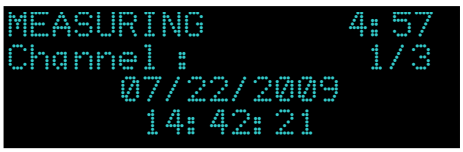


Figure 4-4 Measurement data keys

1 Gas display keys
2 Channel display keys
3 Measuring time keys

Measurement data keys	Description
	Gas display: shows measured concentration of each gas.
	Channel display: shows measured concentration of each channel.
	Measuring time: shows measured concentration of the previous measurements up to 10 previous values.

Table 3: Measurement keys description



Pressing **+** or **–** of the *Gas display key* means showing the actual measured concentration of each gas.

REMARK:
An asterisk mark which is shown in the display before a measurement value marks that a saved value is being displayed. Values are updated in the display after each measurement phase.
For continuously measuring gases no asterisk is shown since the value is updated continuously.

Pressing *up* ▲ or *down* ▼ of the *Channel display keys* means showing the actual reading of each channel.

Pressing ↻ and ↺ means showing the last 10 values of the measured data.

4.2 Analyzer display during warm-up

Figure 4-5: Start-up display

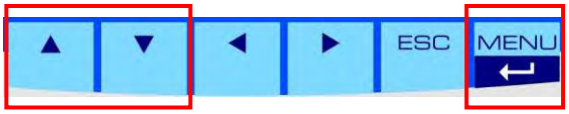
The analyzer with NDIR (infra red) sensor module or a Parox sensor needs warm-up time (usually 10-20 minutes) to meet their operating temperatures. The figure above shows the temperature of NDIR sensor group and the status of the Parox sensor. Since the T(IR) already meets its operating temperature, “OK” is shown in the display.

Operating temperature:
NDIR sensor module : 49 or 64 °C
If the Parox sensor reaches its operating temperature, the display shows T(POX) = 0x0000.

Analyzers without those parts do not need any warm-up time and therefore can be operated immediately. The device starts the actual operating phase after completing the warm-up process. These phases run through and start again from the beginning in a cycle.

4.3 Menu structure

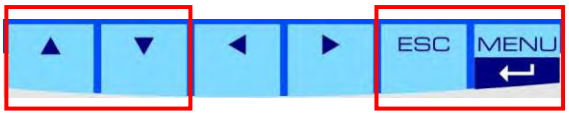
MENU/↵ key takes the display to the main menu system. The menu key *up* ▲ or *down* ▼ changes the highlighted menu up or down. Pressing the MENU/↵ means execute the highlighted menu.



Press MENU/↵ to enter *Main menu*

Press ▲ and ▼ to highlight the submenu. Press MENU/↵ to enter the selected submenu.

The symbol "▲" and "▼" on the left side of the display shows the previous or next submenu on the same layer.



Under *Main menu* pressing MENU/↵ means entering sub menus, for example *Settings*.

Press ▲ and ▼ to highlight the submenu. Press MENU/↵ to enter the selected submenu or press ESC to go back to *Main menu*.

Pressing ESC under *Main menu* means exit from *Main menu*.

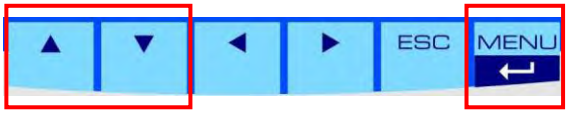
Note

The menu structure could be different for particular INCA Analyzer. It is available upon requirement and factory configuration of the INCA Analyzer.

4.4 Settings

4.4.1 Language

The language dialog allows the user to select the language of the system. There are three languages available: English, German, and Italian.



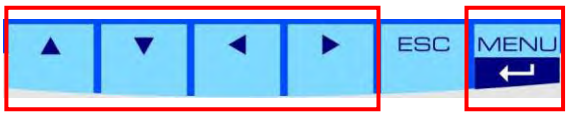
Under *Settings* menu, press ▲ and ▼ to highlight *Language* and press MENU/↵.

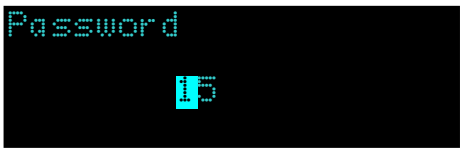
Use ▲ and ▼ to select the language

Press MENU/↵ to store setting

4.4.2 Password

The password dialog allows locking the menu to protect the analyzer‟s settings from accidental changes. The password has a maximum of *4 digits*. As soon as a number is set and saved the password is active. Next time entering the menu, the correct password needs to be entered to perform any changes. Setting the password to „0“ will deactivate the password lock of the menu.





Under *Settings* menu, press ▲ and ▼ to highlight *Password* and press MENU/↵.

Press ◄ and ► to move the blinking cursor to have more password digits. Use ▲ and ▼ to enter the number for every digit.

Press MENU/↵ to store password

Caution

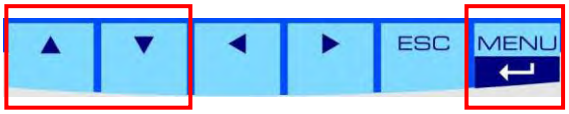
There is no master password. It is not possible to restore password from the analyzer's menu. Use INCACtrl to reset the password.

Note

Setting password to '0' will deactivate the password lock of the menu.

4.4.3 Calibration purge gas (on/off)

The „calibration after purge gas"-option is activated by setting this menu **on** or **off**.



Under *Settings* menu, press ▲ and ▼ to highlight *Cal. purge gas* and press MENU/↵.

Use ▲ and ▼ to select **on** or **off**

Press MENU/↵ to store setting

4.4.4 Output data (on/off)

The menu activates the **unidirectional** interval data output using the RS-232 interface. The output data is always transmitted with a baud rate of 9600 bits/s, regardless of the „Communication" setting. Nevertheless it is mandatory to turn this setting „off" when using the H-Bus protocol to communicate with the analyzer and to read its measurement data.

4.4.5 Communication

The menu provides the communication option of the RS-232 connectivity for **bidirectional** communication:

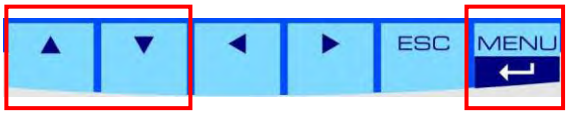
1. INCACtrl – For INCA configuration tool and H-Bus protocol working at 115200 bits/s
2. H-Bus (9600) – H-Bus protocol working at 9600 bits/s
3. H-Bus (2400). – H-Bus protocol working at 2400 bits/s

Further information can be found under the Chapter Output option.

4.5 Parameters

4.5.1 Gas cooler temperature

Set the temperature of the gas cooler (only available if gas cooler is installed).



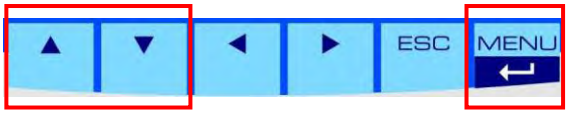
Under *Parameters* menu, press ▲ and ▼ to highlight *Gas cooler temp* and press MENU/↵.

Use ▲ and ▼ to give temperature value of the gas cooler.

Press MENU/↵ to store setting

4.5.2 EC measurement cycle

The measuring cycle of electrochemical sensors is set using this dialog. “1” means that on every measuring phase the cycle runs. “2” means that only every other measuring phase the cycle for EC sensor runs and the gas is measured.



Under *Parameters* menu, press ▲ and ▼ to highlight *EC meas. cycle* and press MENU/↵.

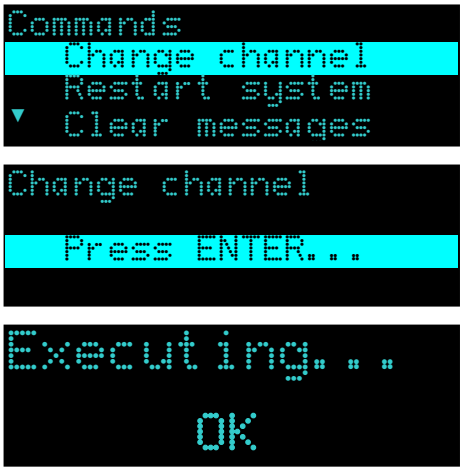
Use ▲ and ▼ to select the cycle's setting.

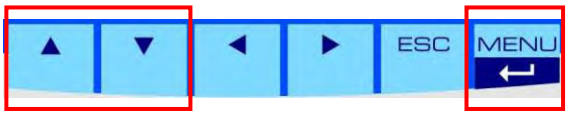
Press MENU/↵ to store setting

4.6 Commands

4.6.1 Change channel

This command is only active for analyzers with more than one channel (multi-channel analyzer) and allows to request the measurement of a certain channel.





Under *Commands* menu, press ▲ and ▼ to highlight *Change channel* and press MENU/↵.

Press MENU/↵ to execute the command.

4.6.2 Restart system

This command restarts the system.

Note

The *Restart system* command can also be used to interrupt the calibration process.

4.6.3 Clear messages

Clear the messages that are stored in the system.

4.6.4 Calibration purge gas

Calibration using purge gas is started.

4.6.5 Calibration gas I

Start the calibration using calibration gas I.

4.6.6 Calibration gas II[12]

Start the calibration using calibration gas II.

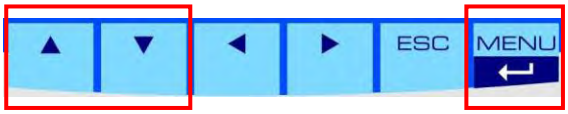
[12] under development

4.6.7 Reset calibration

Reset to the factory calibration. For each gas measured in the analyzer, the command has to be chosen and the gas must then be selected and confirmed by pressing MENU/↵.

4.7 System info

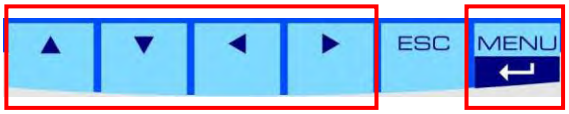
Show the system info.



Under *Commands* menu, press ▲ and ▼ to highlight *Change channel* and press MENU/↵.

4.8 System messages

Show the message(s) that are stored in the system.



Under *Main menu*, press ▲ and ▼ to highlight *System messages* and press MENU/↵.

Press ▲ and ▼ to show next message(s).

Press ◄ and ► to message's date/time and code.

Note

If optional SD card is installed, error codes are displayed with text as seen in the figures above. Otherwise they are displayed only in their codes.

Please see the messages (errors and events) description list in the appendix to understand the messages.

5 CALIBRATION

5.1 Calibration

The analyzer is pre-calibrated by the manufacturer. In the field the analyzer can be re-calibrated using special calibration gases. The calibration gas needs to be connected to the analyzer for manual calibration. For automatic calibration setup (e.g. every week), a calibration gas has to be connected permanently to the analyzer‟s calibration gas inlet

Warning

The gas inlet pressure must not exceed 20 mbar (0.29 psi).

5.1.1 Type of calibrations

There are two types of calibrations:

1. **Calibration using purge gas (i.e. *purge gas calibration*)**
2. **Calibration using calibration gases (simply referred to as *calibration*)**

Gases used in calibration process (codes)	Composition				
	CO_2	CH_4	H_2S	O_2	N_2
Purge gas (S)	--	--	--	20.9 vol.%	80.1 vol.%
Calibration gas A1 (A1)	48 vol.%	52 vol.%	25 ppm	--	--
Calibration gas B1 (B1)	--	100 vol.%	25 ppm	--	--
Calibration gas C (C)	100 vol.%	--	--	--	--

Table 4: Example of calibration gases

Through the calibration process, calibration points of each sensor measured and determined. Depending on the type of sensors used in the analyzer, a purge gas (usually air, 20.9 vol.% O_2; 80.1 vol.% N_2) and one or more calibration gases are required for a complete calibration process. Table above shows an example of gases which are used in to calibrate the sensors.

The table above shows an example of gases which are used to determine calibration points of a particular type of analyzer. The analyzer has the following measurement ranges:

carbon dioxide (CO_2)	0 - 100	vol.%
methane (CH_4)	0 - 100	vol.%
hydrogen sulfide (H_2S)	0 - 10000	ppm
oxygen (O_2)	0 - 25	vol.%

Using those gases, the following calibration points can be measured.

Measured variable / Calibration point	CO_2	CH_4	H_2S	O_2
Zero	B1	S,C	S,C	A1,B1,C
Span	C	B1	A1,B1	S
Mid	A1	A1		

Table 5: Calibration points measured by the example of calibration gases

Caution

It is not possible to calibrate the CO_2 channel with ambient air since there is a cross sensitivity between CH_4 and CO_2 calibrated into the CO_2 channel. For that reason a CO_2-zero-calibration with air would destroy this special calibration and lead to wrong measurements. CO_2-zero-calibration is only possible with 100 vol.% CH_4.

5.1.2 Preparation for calibration

The following materials are required in the calibration process:

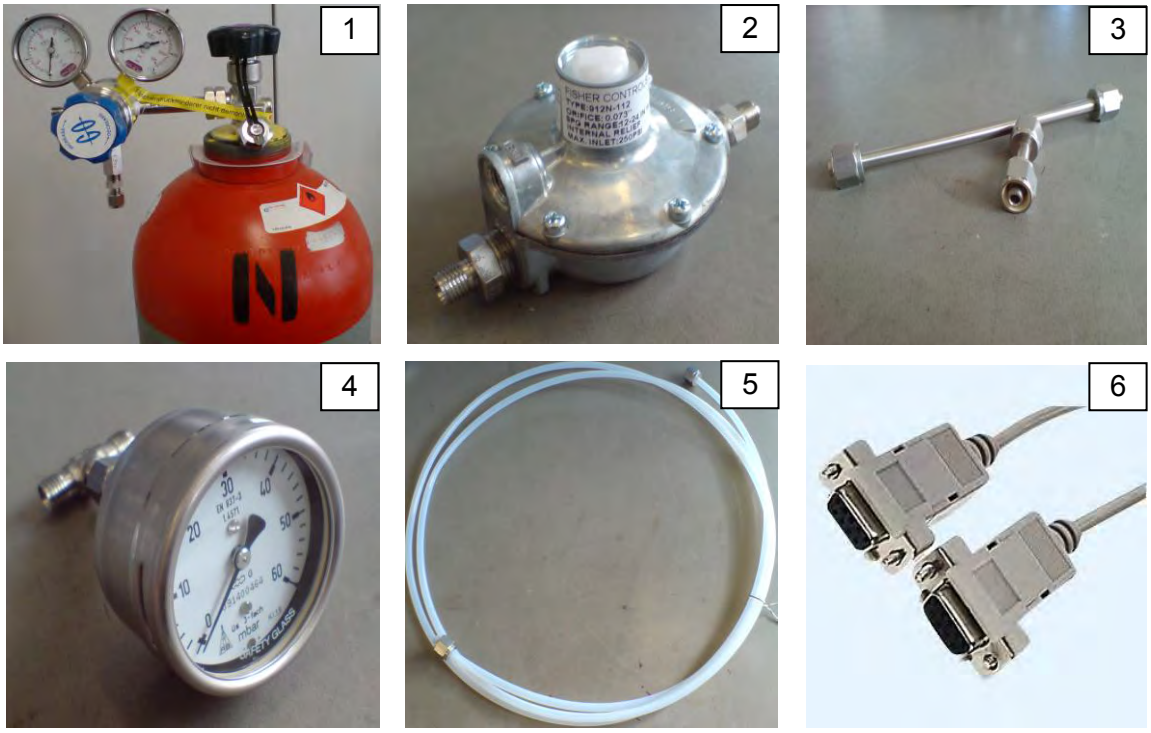


Figure 5-1: Requirement for calibration

1. Calibration gases with two-stage pressure regulator (see list of calibration gases)
2. Pressure regulator (input 1-10 bar and output 0-60 mbar)
3. Stainless-steel pipes with 6 mm fitting
4. Manometer with mbar display
5. PTFE tube (4x6 mm)
6. Nullmodem cable (RS-232)
7. Leak test detector
8. PC or laptop with RS-232 interface
9. Screw wrench (9/16 inch for the 6mm fittings)
10. INCACtrl – software

5.1.3 INCACtrl calibration setting

The communication between PC/laptop with the analyzer is performed using a RS-232 connection and INCACtrl software. Connect the RS-232 interfaces of the PC/laptop and the INCA Analyzer using null modem cable. The RS-232 interface of the INCA Analyzer is located on the INCA main board. The main board is on the back of the analyzer‟s door.

Open the analyzer‟s door to connect the null modem cable.

Figure 5-2: Communication between the INCA Analyzer and PC

Note

Attention!!!
The following procedure only shows an example of INCACtrl setting for a calibration using calibration gas B1 (100 vol.% CH_4 and 25 ppm H_2S).

Setting up calibration gas composition and calibration settings is done through INCACtrl software. For additional information on INCACtrl software please see the INCACtrl user manual.

1. Start INCACtrl.exe and establish a connection between the analyzer and your PC – see chapter **3.3.1 Establishing communication with INCACtrl**.

2. Select tab: ***Calibration***:

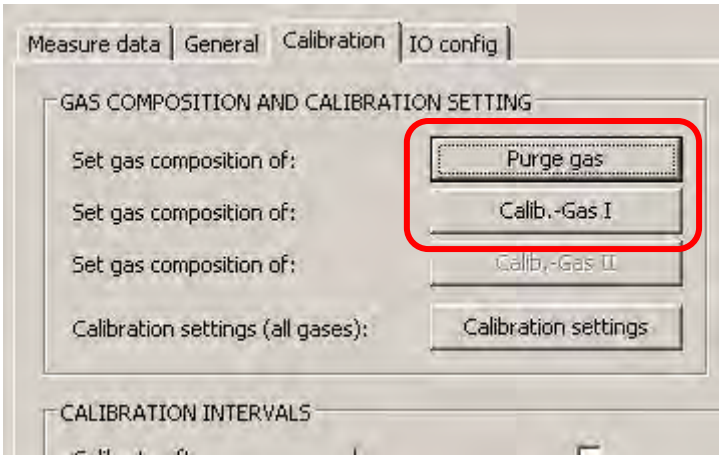


Figure 5-3: INCACtrl – gas composition and calibration setting

Click the ***Purge gas*** button if you want to change setting of purge gas composition or ***Calib.-Gas I*** button if you want to change setting of the calibration gas composition.

3. Set the composition.
   The following figures show an example of setting when using calibration gas B1 (100 vol.% CH_4 and 25 ppm H_2S).

   See figure below. Change the “Gas“, “Conc” (concentration) and “Unit” according to the calibration gas you want to use.

Note

Pay attention on step 3 if you are using different composition of calibration gas. See the list of calibration gases.

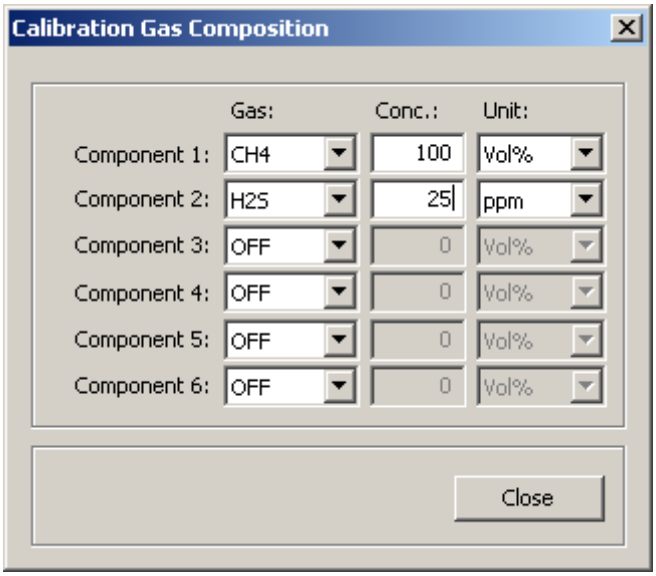


Figure 5-4: INCACtrl - calibration gas composition

4. Close the window and click on the button: ***Calibration settings***:

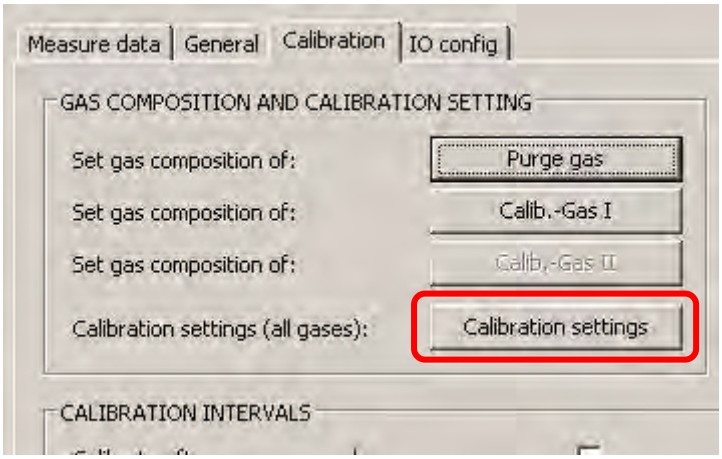


Figure 5-5: INCACtrl - calibration setting

Note

The calibration setting using INCACtrl depends on the composition of calibration gases.

5. Calibration points.
   Choose the calibration points according to your calibration gas. In this example, the following points are selected: Zero CO_2, Span CH_4, Span H_2S, Zero O_2.

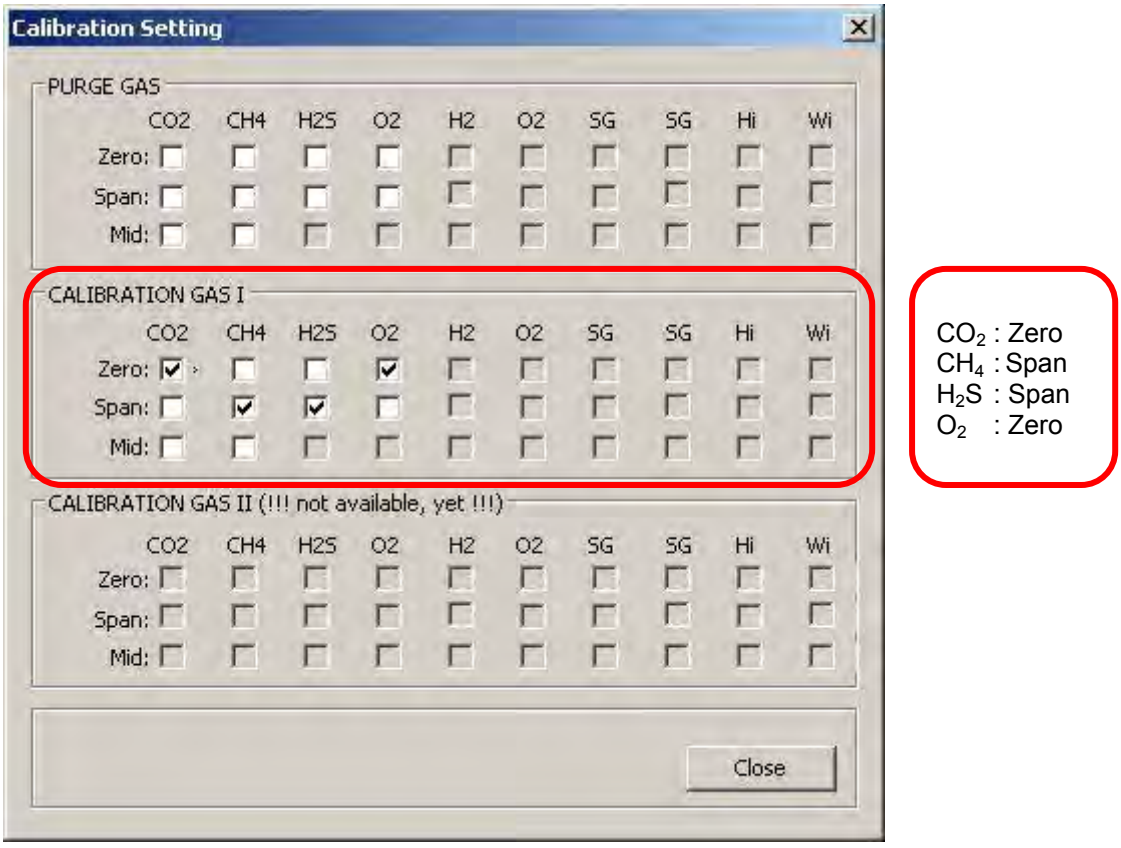


Figure 5-6: INCACtrl - setting of calibration points

Close the window.

6. Check the measure phase time of calibration gas I by clicking the tab: **General**. It should be set to minimum value of 600 s (10 minutes).

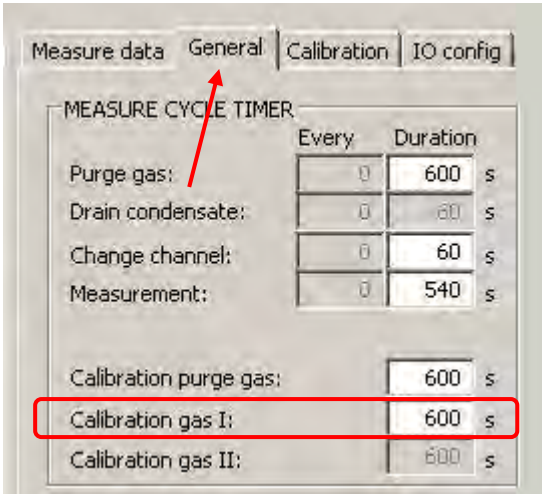


Figure 5-7: INCACtrl - setting of calibration duration

7. Save the configuration to the analyzer.
   Click the following button to save the configuration into the analyzer.

Figure 5-8: Saving the configuration to the analyzer

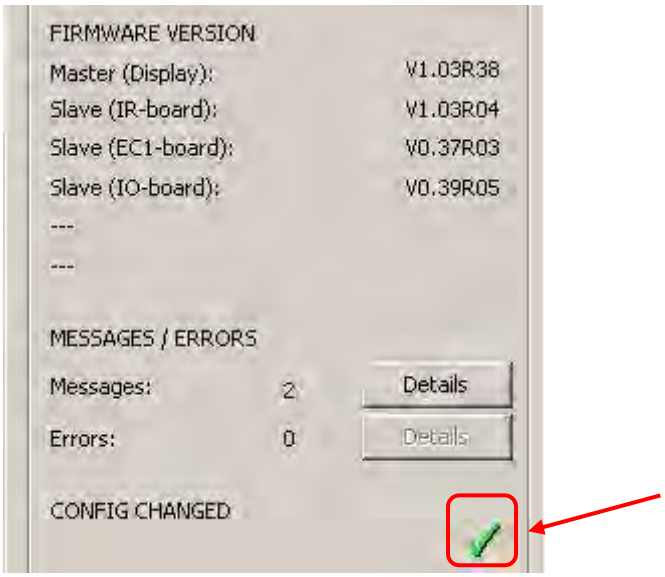


Figure 5-9: New configuration is successfully saved to the analyzer

8. Close the INCACtrl software if all settings are correct. Remove the null modem cable from the interface.

5.1.4 Automatic calibration

The analyzer is pre-programmed doing automatic calibration after every purge gas phase. Depending on the setup of the analyzer (continuous or discontinuous measurement), a purge gas phase is run through from every 15 minutes up to 12 hours between the calibration phases. For automatic calibration, the calibration gas must be permanently connected to the analyzer. Automatic purge gas calibration is performed at the end of the purge gas phase.

It is possible to configure the interval of the automatic calibration using INCACtrl software. (Tab: **Calibration → CALIBRATION INTERVAL**)

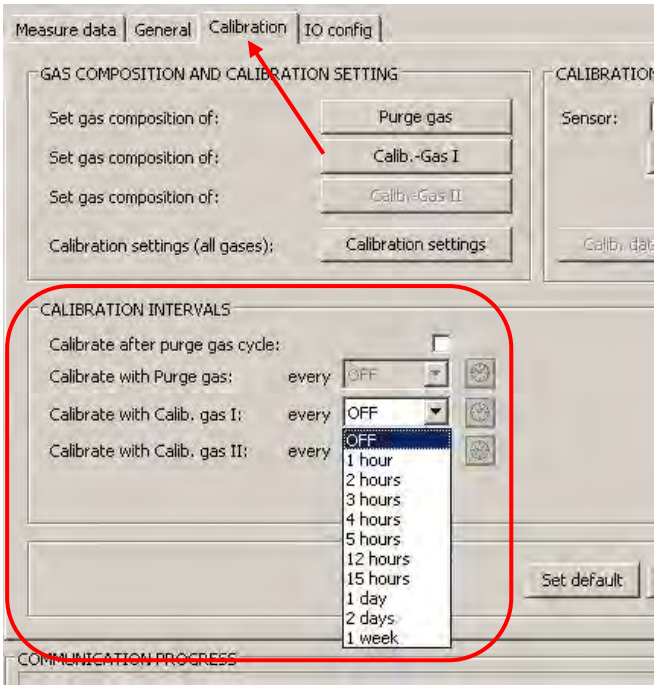
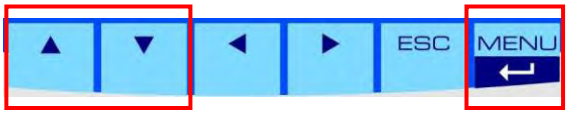


Figure 5-10: Calibration intervals

5.1.5 Manual calibration

Manual calibration can be performed using the user interface of the display. Under *Commands* menu, there perform calibration using purge gas.

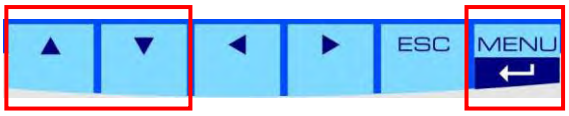


Under the *Commands* menu, press ▲ and ▼ to highlight *Cal. purge gas* and press MENU/↵.

Press MENU/↵ to execute the command.

Calibration using calibration gas

The calibration process can manually be started by a command from user interface of the display.



Under *Commands* menu, press ▲ and ▼ to highlight *Cal. gas I* and press MENU/↵.

Press MENU/↵ to execute the command.

Note

A running calibration can always be interrupted or stopped by choosing Restart system in the display command menu.

Note

INCACtrl software is always required to set up the calibration gas compositions and the calibration points for the calibration process. The setting cannot be performed via display menu.

More information on calibration setting and procedure of certain type of INCA Analyzer, see the corresponding manual.

6 OUTPUT OPTION

The INCA Analyzer can be configured to output the main measurement data through a RS-232 connection. As an option this data can be distributed to field bus devices such as Profibus-DP, Modbus RTU, etc.

6.1 Auto-output implementation

6.1.1 Data structure

The transmitted data will be sent in a data block of 240 bytes in size. This amount of data suits the size of a Profibus-DP telegram.

To enable the detection of a data block with a fieldbus device the 240 bytes are sent within a frame (header and tail):

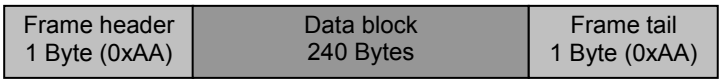


Figure 6-1: Data structure with a frame

Header und tail of the frame are filtered using a HMS Anybus-Communicator (ABC) field bus module and will therefore not be displayed in the data buffer of the device. If data is received directly through a RS-232 connection the header and the tail need to be filtered or ignored by the receiving program.

The 240 bytes are represented in the following structure (ANSI C - notation) and are sent in the Intel format (Little-Endian or LSB first – least significant byte first):

```
ST_TIME_INT     dateTime;
 _WORD          currChnl;
 _WORD          currValues[10];
 _WORD          enclosureTemp;
 _WORD          ambPressure;
 _BYTE          relayServiceRequest[6];
 _WORD          status;
 _WORD          fatalErrorMessage;
 _WORD          errorMessages[10];
 _BYTE          dataValid;
 _WORD          airPumpPressure;
 _WORD          gasPumpPressure;
 _BYTE          measureState;
 _DWORD         secondsInState;
 _BYTE          dataValidDiscontChnls;
 _WORD          gasCoolerTemp;
 _WORD          irTemp;
 _WORD          paroxState;
 _WORD          outerCaseTemp;
 _BYTE          useValidFlagDiscontChnls;
 _BYTE          reserve[156];
```

Using definition:

`_BYTE`	represents 1 Byte (8 Bit)
`_WORD`	represents 2 Bytes (16 Bit)
`ST_TIME_INT`	represents 8 Byte (see below)

The structure ST_TIME_INT for the time representation is defined as follows:

```
_BYTE   sekunden;      //seconds
_BYTE   minuten;       //minutes
_BYTE   stunden;       //hours
_BYTE   tag;           //days
_BYTE   wochentag;     //week day
_BYTE   monat;         //month
_WORD   jahr;          //year
```

The bytes are sent in the above byte order of the structure. The 175 bytes of the reserve are not relevant and do not need to be interpreted. They are reserved for future use.

Additional definition
Invalid values are set to zero. Invalid values occur during the warm up phase of the system after power up or if there is an error. This information can be taken from the status and the transmitted error information.

6.1.2 Interface parameter

Configuration
9600 bit/s, 8 Data bit/n, 1 Stop bit, no parity

Interval for sending
Values are automatically transmitted every 15 seconds.

6.1.3 Data description

The transmitted data is defined as follows:

Name	Bytes	Description
dateTime	8	Current timestamp of the measurement instrument (military time) 1. Byte: seconds (decimal) 2. Byte: minutes (decimal) 3. Byte: hours (decimal) 4. Byte: days (decimal) 5. Byte: - *not defined* - 6. Byte: month (decimal) 7-8 Byte (1 Word): year (decimal)
currChnl	2	Current measured channel / measurement point Range: 1…8
currValues[10]	20	Current measured values from instrument (values, which are also displayed in the instrument). Values, which are transmitted with a decimal place information (DPI), need to be divided by 10^{DPI} to recover the decimal place information For example: CH_4: a transmitted value of 4921 represents 49.21 Vol.% 1. Word: CO_2 DPI: yes (2) Unit: Vol.% 2. Word: CH_4 DPI: yes (2) Unit: Vol.% 3. Word: H_2S DPI: no Unit: ppm 4. Word: O_2 DPI: yes (2) Unit: Vol.%

		5. Word: *n.d.* DPI: *n.d.* Unit: *n.d.* 6. Word: *n.d.* DPI: *n.d.* Unit: *n.d.* 7. Word: *n.d.* DPI: *n.d.* Unit: *n.d.* 8. Word: *n.d.* DPI: *n.d.* Unit: *n.d.* 9. Word: *n.d.* DPI: *n.d.* Unit: *n.d.* 10. Word: *n.d.* DPI: *n.d.* Unit: *n.d.*
enclosureTemp	2	Enclosure temperature (check if value is in valid range: e.g. -25.00 °C – 75.00 °C) Value is transmitted with decimal place information (DPI) Word: T_ENC DPI: yes (2) Unit: °C
ambPressure	2	Absolute ambient pressure Value is transmitted without decimal place information (DPI) Word: P_AMB DPI: no Unit: mbar
relayServiceRequest[6]	6	Maintenance request Each byte represents one output relay. Currently 3 relays can be defined. 1. byte: K0 2. byte: K1 3. byte: K2 4. byte: - *not defined* - 5. byte: - *not defined* - 6. byte: - *not defined* -
status	2	Instrument status Information about the main instrument status. *Value* – *Definition* 0 – OK – no problems detected 1 – Instrument is warming up (wait) 2 – Fatal error (fatalErrorMessage should be read)
fatalErrorMessage	2	Fatal error Error code (refer to document „*INCA – Error codes and description.pdf*“ or INCA manual)
errorMessages[10]	20	Instrument errors Last ten errors of instrument. These errors do NOT coactive lead to a fatal error but inform about requested maintenance or setup problems.
dataValid	1	Data validity of values in *currValues[10]* Informs about validity of measured values and tells if values can be used to be stored. While this value is 1 (true) the instrument also stores the current value at the end of the measurement cycle. Values are defined as invalid while the instrument is purging air or purging calibration gas and performing a calibration. *Value* – *Definition* 0 – Values are not valid 1 – Values are valid
airPumpPressure	2	Pump pressure (air, respectively purge gas) Value is transmitted with decimal place information (DPI) Word: P_AIR DPI: yes (2) Einheit: mbar
gasPumpPressure	2	Pump pressure (process gas respectively calibration gas) Value is transmitted with decimal place information (DPI) Word: P_GAS DPI: yes (2) Einheit: mbar
measureState	1	Current measurement state of device *Value* – *Definition* 0 – Warming up 1 – Purging purge gas (air) 2 – Condensate drain 3 – Measuring

		4 Change channel / measurement point 5 Calibrate with purge gas 6 Calibrate with calibration gas I 7 Calibrate with calibration gas II 15 Error
secondsInState	4	Time in seconds how long analyzer has been in current state (→ measureState).
dataValidDiscontChnls	1	Data validity of values in *currValues[10]* for discontinuously measured channels (e.g. H_2S oder H_2). Only valid for devices which are configured as continuous measurement devices, but also have channels measuring discontinuously. *Value* *Definition* 0 Values are not valid 1 Values are valid
gasCoolerTemp	2	Temperature of gas cooler (if information is available, otherwise 65535 (or 0xFFFF) is returned) Value is transmitted with decimal place information (DPI) Word: T_COOL DPI: yes (2) Unit: °C
irTemp	2	Temperature of infrared cuvette (if information is available, otherwise 65535 (or 0xFFFF) is returned) Value is transmitted with decimal place information (DPI) Word: T_IR DPI: yes (2) Unit: °C
paroxState	2	State of Parox sensor (if information is available, otherwise 65535 (or 0xFFFF) is returned) *Value* *Definition* 0x0000 OK 0x0400 Parox sensor is warming up
outerCaseTemp	2	Ambient temperature (outer case) (check if value is in valid range: e.g. -25.00 °C – 75.00 °C) Value is transmitted with decimal place information (DPI) Word: T_OUT DPI: yes (2) Unit: °C
useValidFlagDiscontChnls	1	Flag, which tells, if the 'dataValidDiscontChnls' information is supposed to be evaluated or not
reserve[156]	156	- *nicht definiert* -

Table 6: Data description

6.2 H-Bus protocol (Master-Slave)

6.2.1 Data structure

Communication with analyzer with a protocol with the following data structure:

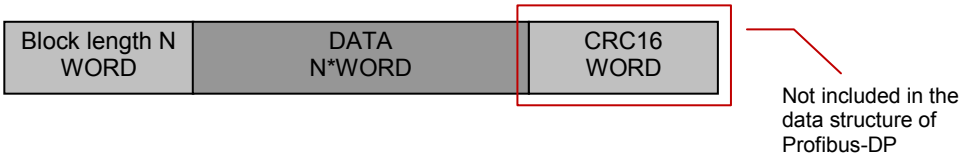


Figure 6-2: H-Bus data structure

Maximum N : 256
Configuration RS-232: 2400 or 9600 Baud, 8 Databit/n, 1 Stopbit, no parity
The DataPackage contains commandos and eventually used data which should be transferred.

Coding of the data is in Intel format (Little Endian). The CRC16 is included only for H-Bus.

For Profibus-DP

Output buffer	5 words (10 Bytes) 2-word-command; 3-word-command
Address	Adjustable in the module (DIP-switch)

For Modbus RTU

Output buffer	5 words 2-word-command; 3-word-command
2-word-command	Register number 1025, 1026
3-word-command	Register number 1027, 1028, 1029
Address & Baud rate	Adjustable in the module (DIP-switch)

Caution

Profibus-DP/Modbus RTU use Baudrate of 9600 Bits/s. The setting is done through the display: Menu→Settings→Communication→H-Bus (9600). Under this setting, communication with INCACtrl is not possible.

6.2.2 Commands description

Note

The following information in brackets indicates the difference of Profibus-DP/ Modbus from direct RS-232 communication.

Note

Communication using Profibus-DP/Modbus RTU does not need CRC16 calcula-tion of bus-master since we use CRC16 calculation of Profibus-DP/Modbus RTU slave.

Command	Bytes	Description
0x0000	6 (4)*	Anybus Flush Format : 0x0001 0x0000 (CRC16)* Response : 0x0001 0x0000 (CRC16)* As dummy instruction during connection of Anybus. It is necessary since it is not allowed to have two identical commands in a row using Profibus-DP.
0x0011	88 (86)*	Sending all measured data Format : 0x0001 0x0011 (CRC16)* Response : 0x002A 0x0011 **measured_data status** (CRC16)* The structure will be sent for each channel which is configured. The block length : 4 x number of channels + 2. Number of channels : 10 Actual measured data, which are displayed on the display. Values, which are transmitted with decimal place information (DPI), need to be divided by 100 to recover the decimal place information. For example: CH_4: a transmitted value of 4921 represents 49.21 vol.% **Measured_data**: 1.Word: Channel 1- CH_4 DPI: yes(2) Unit: vol.% 2.Word:: Channel 1-CO_2 DPI: yes(2) Unit: vol.% 2.Word: Channel 1-O_2 DPI: yes(2) Unit: vol.% 3.Word: Channel 1-H_2S DPI: no Unit: ppm 4.Word: Channel 2-CH_4 DPI: yes(2) Unit: vol.% 5.Word: Channel 2-CO_2 DPI: yes(2) Unit: vol.% … … … 39.Word: Channel 10-O_2 DPI: yes(2) Unit: vol.% 40.Word: Channel 10-H_2S DPI: no Unit: ppm 41.Word: Status **Status**: Status = 1 ; Warmup Status = 0 ; OK Status = -1 ; Message Status = -2 ; Error (fatal) The value -1 (Hexadecimal 0xFFFF) shows that there is no valid measured value or a sensor error disrupt the measured value. **Example**: "0x01 0x00 0x11 0x00 0x0D 0xE0" ; Valid request command 0x0011 (resolved byte-by-byte)
0x0012	128 (126)*	Sending all Measured data (6 Gases) Format : 0x0001 0x0012 (CRC16)* Response : 0x003E 0x0012 **measured_data status** (CRC16)* Identical to command 0x11, only with additionally H_2 and O_2 (Parox) data. The value -1 (Hexadecimal 0xFFFF) shows that there is no valid measured value or a sensor error disrupts the measured value. **Measured_data**: 1.Word: Channel 1-CH_4 DPI: yes(2) Unit: vol.% 2.Word:: Channel 1-CO_2 DPI: yes (2) Unit: vol.% 2.Word: Channel 1-O_2 DPI: yes (2) Unit: vol.%

		3.Word: Channel 1-H_2S DPI: no Unit: ppm 4.Word Channel 1-H_2 DPI: no Unit: ppm 5.Word Channel 1-O_2-Parox DPI: yes(2) Unit: vol.% 6.Word: Channel 2-CH_4 DPI: yes(2) Unit: vol.% 7.Word: Channel 2-CO_2 DPI: yes(2) Unit: vol.% … … … … 59.Word: Channel 10-H_2 DPI: no Unit: ppm 60.Word: Channel 10-O_2-Parox DPI: yes(2) Unit: vol.% 61.Word: Status **Status**: Status = 1 ; Warmup Status = 0 ; OK Status = -1 ; Message Status = -2 ; Error (fatal) The value -1 (Hexadecimal 0xFFFF) shows that there is no valid measured value or a sensor error disrupts the measured value.
0x0016	26 (24)*	Read old data of each channel (minutes) Format : 0x0001 0x0016 (CRC16)* Response : 0x000B 0x0016 **data_block** (CRC16)* **Data_block** : 1.Word: Reading 1 2.Word:: Reading 2 … … 10.Word: Reading 10 The value -1 (Hexadecimal 0xFFFF) shows that there is no valid measured value
0x0017	26 (24)*	Read error numbers Format : 0x0001 0x0017 (CRC16)* Response : 0x000B 0x0017 **data_block** (CRC16)* **Data_block** : 1.Word: Error 1 2.Word:: Error 2 … … 10.Word: Error 10 Error is stored separately for each channel. It is defined and stored as hexadecimal. See Annex Error and Event list. Example: Error number (in Dec) : 785 Error number (in Hex) : 0x0311 Description : Min. pump pressure not reached check pumps
0x0018	---	*--not defined --*
0x0021	---	*--not defined --*
0x0022	---	*--not defined --*
0x0023	---	*--not defined --*
0x0031	8 (6)*	Start measurement Format : 0x0002 0x0031 **channel** (CRC16)* Response : 0x0002 0x0031 **channel** (CRC16)*

		Channel = 0…9
0x0032	---	*--not defined --*
0x0033	---	*--not defined --*
0x0040	8 (6)*	Read firmware version Format : 0x0032 0x0040 (CRC16)* Response : 0x0002 0x0040 SWVERSION (CRC16)* (U_WORD) Exponent -2 i.e. 100 == Version 1.00 (V1.00)
0x0050	6 (4)*	Start calibration using calibration gas I Format : 0x0001 0x0050 (CRC16)* Response : 0x0001 0x0050 (CRC16)*
0x0051	22 (20)*	Read calibration deviation Format : 0x0001 0x0051 (CRC16)* Response : 0x0009 0x0051 **data_block** (CRC16)* **Data_block**: (4Byte)Data Time*) of the last span calibration (in sec.) 0xFFFFFFFF = no calibration 1.Word CO_2 Zero point deviation (value-10000) DPI:yes(2) 2. Word CO_2 the last span deviation (value -10000) DPI:yes(2) 3. Word CO_2 before the last span deviation (value -10000) DPI:yes(2) 4. Word CH_4 Zero point deviation (value -10000) DPI:yes(2) 5. Word CH_4 the last span deviation (value -10000) DPI:yes(2) 6. Word CH_4 before the last span deviation (value -10000) DPI:yes(2) *) Unix time, since 1.1.1970 00:00 h. Can also be used to determine the relative time difference between two Calibrations, so it can be known that a calibration was performed.
0x0052	6 (4)*	Start calibration using calibration gas II Format : 0x0001 0x0052 (CRC16)* Response : 0x0001 0x0052 (CRC16)*

Table 7: Commands description

*) When communicating using Profibus-DP/Modbus RTU, there is no need for CRC16 checksum and these two bytes can be neglected.

7 SERVICE AND MAINTENANCE

Warning

The power plug and gas flow must be disconnected during maintenance and service.

Warning

Gas leak may possibly occur in case of installation or service failure with both health hazards and corrosion damage possibilities.

Warning

Periodic maintenance: All the gas connections should be leak tested every 6 months

Note

Use only original spare parts from the manufacturer to ensure the safety and the accuracy of the analyzer.

Note

If a replacement of an electronic board (main board, I/O board) becomes necessary, a new firmware of the board is required which is delivered together with the new board and the instruction.

Caution

Ignoring regular maintenance in the recommended service intervals may lead to a fault or series of faults that may result in a total analyzer shutdown.

Interval	Maintenance work/replacement
Every 6 months	- All gas connections in the analyzer should be leak tested
Every 1 year	- Air filter - Water trap Sensor replacement: - O_2 sensor (for continuous measurement) - H_2S sensor - H_2 sensor
Every 2 years	- Fire barrier - Fans (for casing and gas cooler) - Gas pump - Air pump - Peristaltic pump (for INCA 4000 T1000) Sensor replacement: - O_2 sensor (for discontinuous measurement)

Table 8: Maintenance work

7.1 Pumps

7.1.1 Diaphragm pump unit

In normal operation the lifetime of both diaphragm pumps is approximately 16000 hours (approx. 2 years).

The air pump does not have a valve. The gas pump has a solenoid valve to prevent air setback into the system.

Both units can be obtained as a spare part and are easily replaceable by the user. New tube connections are also supplied with the pumps.

7.1.2 Peristaltic pump

The peristaltic (hose) pump is a consumable part and should be replaced every 2 years by the user. The hose which can be damaged by abrasives is available as a spare part.

7.1.3 Ejector with valves

The ejector is maintenance-free and has a long lifetime (no specific data available from the manufacturer).

7.2 Sensor modules

7.2.1 Electrochemical sensor

The lifetime of the electrochemical sensors (H_2S, H_2 and O_2) depends on the gas concentrations in the process gas.

H_2S and H_2:
The average lifetime of the H_2S and H_2 sensors is approximately 18 months (more than one year) if operates on normal process gas concentrations.

O_2:
Cont. measurement configuration: approx. 1 year.
Discontinuous measurement (standard): > 2 years.

Pre-calibrated electrochemical sensors are supplied as a spare part. Easy replacement guarantees very little down time of the analyzer.

7.2.2 Optical sensor

The CH_4 and CO_2 optical sensors have a limitless lifetime but are sensitive to dirt and humidity. If necessary (e.g. due to water penetration) the complete sensor block with heater and IR detectors must be replaced. The complete module can be installed by the user.

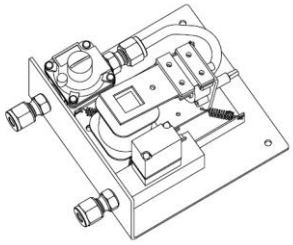
7.2.3 Paramagnetic sensor

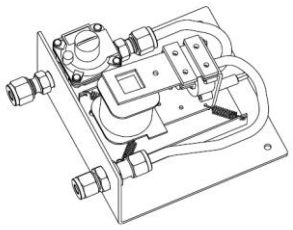
The module is maintenance-free and has a long lifetime (no specific data available from the manufacturer).

7.2.4 Specific gravity sensor

The module is maintenance-free and has a long lifetime (no specific data available from the manufacturer).

8 SPARE PARTS LIST

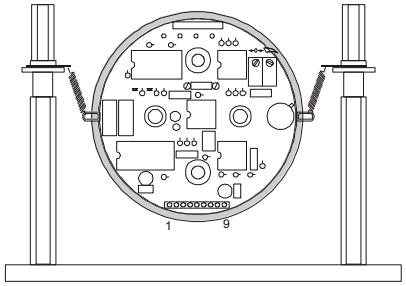
	Assembly group diaphragm gas pump MVG accessories hoses Weight: 675 grams
Description	: Assembly group diaphragm gas pump
Item number	:

	Assembly group diaphragm air pump Accessories hoses Weight: 550 grams
Description	: Assembly group diaphragm air pump
Item number	:

	Electrochemical Sensor H_2S - complete with brackets and electronics - calibrated by the manufacturer Weight: 80 grams
Description	: Electrochemical Sensor H_2S
Item number	:

	Electrochemical Sensor O_2 - complete with brackets and electronics - calibrated by the manufacturer Weight: 150 grams
Description	: Electrochemical Sensor O_2
Item number	:

	Flame arrestor - maximum pressure: 1.1 bar absolute - maximum temperature 60 °C - explosion group IIC Weight: 200 grams
Description	: Flame arrestor SS
Item number	:

	Specific Gravity Sensor - heated - +/-15V / 7VA - **Range 0,2 – 2,2 dv** Weight: 1700 gram
Description	: Specific gravity sensor module
Item number	:

9 APPENDIX

9.1 Abbreviations

EC	Electrochemical
IR	Infrared
MAC	Maximum acceptable concentration
NDIR	Non-dispersive infrared
PTFE	Polytetrafluoroethylene
SG	Specific gravity
UEL	Upper explosion limit

9.2 Errors and events list

9.2.1 State machine errors

Error code	Display description	Full description
0x0100	EVENT OVERFLOW	Firmware development error Too many events were entered into state machine configuration
0x0101	STATE OVERFLOW	Firmware development error Too many states were entered into state machine configuration
0x0102	TIMER LOAD OVERFLOW	Firmware development error Too many timers were initialized in state machine

Fatal state machine error

Error code	Display description	Full description
0x0180	ERROR LIST FULL	Error list is full Can be configured by INCACtrl if this error is supposed to be triggered by software. If not, software will just overwrite oldest errors when new errors occur

9.2.2 Communication errors

Error code	Display description	Full description
0x0200	COMM OPEN PORT	WIN32 exception error Opening COM port failed, COM port either not available or already opened up
0x0201	COMM CLEAR RW BUFFERS	WIN32 exception error Clearing of r-w buffers failed and threw an exception
0x0202	COMM SEND DATA	WIN32 exception error Attempt to sending data on serial port failed and threw an exception
0x0203	COMM TIMEOUT RECEIVE	Bus protocol communication error Not all data was received while communicating due to a timeout
0x0204	COMM CLOSE PORT	WIN32 exception error Closing of COM port failed and threw an exception

0x0210	COMM CMD NOT FOUND	Bus protocol configuration error A command was requested which is not supported/defined by bus protocol
0x0211	COMM CMD TIMEOUT REC. HEADER	Bus protocol communication error Receiving header of protocol failed due to a timeout
0x0212	COMM CMD TIMEOUT REC. TAIL	Bus protocol communication error Receiving tail of protocol failed due to a timeout
0x0213	COMM CMD CRC16 FAILED	Bus protocol communication error Error receiving correct data - checksum
0x0214	COMM CMD WRONG ADDRESS	Bus protocol communication error Wrong address was received by bus master
0x0215	COMM CMD WRONG LENGTH	Bus protocol communication error An invalid length definition was received
0x0216	COMM CMD SEND DATA	Bus protocol communication error Sending data on bus failed
0x0217	COMM CMD CLEAR RW BUFFERS	Bus protocol communication error Clearing r-w buffers failed
0x0218	COMM NO COM PORT OPEN	Bus protocol communication error No COM port open for communication
0x0219	COMM CMD BUFFER SIZE	Bus protocol communication error Buffer size check failed
0x021A	COMM CMD TIMEOUT RECEIVE	Bus protocol communication error Failed receiving all data due to a timeout
0x021B	COMM CMD TIMEOUT HEADER PRT.2	Bus protocol communication error Failed receiving all data while communicating with extended bus communication due to a timeout
0x0230	COMM CMD TIMEOUT RECEIVE ECHO	Bus protocol communication error No echo received on bus due to a problem with bus hardware
0x0231	COMM TIMEOUT NO ANSWER	Bus protocol communication error No answer was received (from a slave) after requesting data
0x0232	COMM SEND BUFFER OVERFLOW	Bus protocol communication error Length set by protocol command setup function is too large for send buffer
0x0233	COMM RECEIVE BUFFER OVERFLOW	Bus protocol communication error Length set by protocol command setup function is too large for receive buffer

9.2.3 Errors reading from or writing to EEPROM

Error code	Display description	Full description
0x0220	COMM SAVE DATA OLD COPY FCTN.	Reading saved EEPROM (sensor/slave) data error Error in old copy function – function error not further specified since this function will not be used anymore in newer firmware versions (>V1.04).
0x0221	COMM SAVE DATA READ NOT OK	Reading saved EEPROM (sensor/slave) data error Slave responded with “not OK” message. Possible solution: More time needed between writing and reading of EEPROM data subsequently
0x0222	COMM SAVE DATA READ NOT CON.	Reading saved EEPROM (sensor/slave) data error No slave EEPROM connected at required EEPROM number

0x0223	COMM SAVE DATA READ NOT AVLB.	Reading saved EEPROM (sensor/slave) data error Function not supported by slave
0x0224	COMM SAVE DATA READ RANGE	Reading saved EEPROM (sensor/slave) data error Too much data was requested from EEPROM
0x0225	COMM SAVE DATA WRITE NOT OK	Writing saved EEPROM (sensor/slave) data error Slave responded with “not OK” message. Possible solution: More time needed between writing and reading of EEPROM data subsequently
0x0226	COMM SAVE DATA WRITE NOT CON.	Writing saved EEPROM (sensor/slave) data error No slave EEPROM connected at required EEPROM number
0x0227	COMM SAVE DATA WRITE NOT AVLB.	Writing saved EEPROM (sensor/slave) data error Function not supported by slave
0x0228	COMM SAVE DATA WRITE RANGE	Writing saved EEPROM (sensor/slave) data error Too much data supposed to be written to EEPROM
0x0229	COMM SAVE DATA EEPROM NOT DEF.	Reading or writing saved EEPROM (sensor/slave) data error EEPROM is not defined – needs to be defined
0x022A	COMM SAVE DATA PTR. NOT SET	Reading or writing saved EEPROM (sensor/slave) data error Pointer to data not set
0x022B	COMM SAVE DATA BUF. TOO LARGE	Reading or writing saved EEPROM (sensor/slave) data error Data buffer too large for communication buffer Solution: Increase communication buffer or reduce size of data to be stored on EEPROM
0x022C	COMM SAVE DATA NO DATA	Reading or writing saved EEPROM (sensor/slave) data error Size of data not set no data can be stored
0x022D	COMM SAVE DATA EEPROM NOT FND.	Reading or writing EEPROM (sensor/slave) data error No EEPROM found – error code of old copy function

9.2.4 Sensor errors

Error code	Display description	Full description
0x0300	SENS CMD BUF FULL	Firmware development error Command list for a sensor is full
0x0301	SENS UNKNOWN DATA TYPE	Firmware development error Unknown data type was loaded with command – values can not be copied
0x0302	SENS DIVISION BY ZERO	Firmware development error Values are set in a way so a division by zero could occur
0x0303	SENS UNKNOWN COMMAND	Firmware development error Unknown command type was set with command
0x0304	SENS CMD WRONG TYPE	Firmware development error Type not supported for command list
0x0305	SENS CAL STATUS ZERO IR1	Zero calibration could not be performed on IR channel 1 --- currently not used ---
0x0306	SENS CAL STATUS SPAN IR1	Span calibration could not be performed on IR channel 1 --- currently not used ---
0x0307	SENS CAL STATUS ZERO IR2	Zero calibration could not be performed on IR channel 2 --- currently not used ---
0x0308	SENS CAL STATUS SPAN IR2	Span calibration could not be performed on IR channel 2 --- currently not used ---
0x0309	SENS CAL STATUS ZERO EC1	Zero calibration could not be performed on EC channel 1 --- currently not used ---

0x030A	SENS CAL STATUS SPAN EC1	Span calibration could not be performed on EC channel 1 --- currently not used ---
0x030B	SENS CAL STATUS ZERO EC2	Zero calibration could not be performed on EC channel 2 --- currently not used ---
0x030C	SENS CAL STATUS SPAN EC2	Span calibration could not be performed on EC channel 2 --- currently not used ---
0x030D	SENS EC PRESSURE AIR	Min. pump pressure not reached – check pumps
0x030E	SENS EC PRESSURE GAS	Min. pump pressure not reached – check pumps
0x030F	SENS EC3 PRESSURE AIR	Min. pump pressure not reached – check pumps
0x0310	SENS EC3 PRESSURE GAS	Min. pump pressure not reached – check pumps
0x0311	SENS EC4 PRESSURE AIR	Min. pump pressure not reached – check pumps
0x0312	SENS EC4 PRESSURE GAS	Min. pump pressure not reached – check pumps
0x0313	SENS CALC. VALUE NOT DEFINED	Firmware development error Method not defined in child class
0x0314	SENS FATAL CHNL. ERR NOT DEF.	Firmware development error Method not defined in child class
0x0315	SENS ABORT MEAS. NOT DEF.	Firmware development error Method not defined in child class
0x0316	SENS FACTORY CALIB. NOT DEF.	Firmware development error Method not defined in child class
0x0317	SENS IR CALIB. NOT READ	Firmware development error Sensor calibration was not read before trying to reset calibration to factory settings
0x0318	SENS IR PRESS. PROCESS GAS	Error for continuous measurement instrument Minimal required pressure in process gas stream not reached – pressure measured through absolute pressure sensors of IR electronic
0x0319	SENS IR PRESS. CALIB GAS	Error for continuous measurement instrument Minimal required pressure in calibration gas stream not reached – pressure measured through absolute pressure sensors of IR electronic
0x031A	SENS SET FACT. CALIB NOT DEF.	Firmware development error Method not defined in child class
0x031B	SENS TYPE NOT DEFINED	Sensor type not defined – error in calibration

Fatal sensor errors

Error code	Display description	Full description
0x0380	SENS GLOB ERROR	Error is returned by a sensor
0x0381	SENS GLOB ERROR IO	Global error occurred in IO board
0x0382	SENS GLOB ERROR IR	Global error occurred in IR board
0x0383	SENS GLOB ERROR EC	Global error occurred in EC board
0x0384	SENS CHNL. ERROR IR1	Fatal channel error occurred in IR channel 1
0x0385	SENS CHNL. ERROR IR2	Fatal channel error occurred in IR channel 2
0x0386	SENS CHNL. ERROR EC1	Fatal channel error occurred in EC channel 1
0x0387	SENS CHNL. ERROR EC2	Fatal channel error occurred in EC channel 2
0x0388	SENS GLOB ERROR EC3	Global error occurred in EC3 board
0x0389	SENS GLOB ERROR EC4	Global error occurred in EC4 board
0x038A	SENS ANLG. OUTPUT NOT VALID	Firmware development error Analog output number too large
0x038B	SENS EC CALIB PTR NOT SET	Firmware development error EC span calibration aborted due to missing pointer
0x038C	SENS EC CALIB ABORT ZERO	Zero calibration for EC sensor aborted

0x038D	SENS EC CALIB ABORT SPAN	Span calibration for EC sensor aborted
0x038E	SENS EC CALIB ABORT MIXER	Mixer calibration for EC sensor aborted
0x038F	SENS EC CALIB ABORT NO DEF.	Calibration for EC sensor aborted
0x0390	SENS NO SLAVE FOUND	No slave was found when booting instrument – check bus connections inside the instrument and firmware versions of slave
0x0391	SENS IR BUFFER OVERFLOW	Internal buffer overflow – calibration data not conform to definition – device needs to be recalibrated in factory
0x0392	SENS IR OLD VERS. CALIBRATION	Old version of calibration on IR slave – device needs to be recalibrated in factory
0x0393	SENS EC OLD VERS. CALIBRATION	Old version of calibration on EC slave – device needs to be recalibrated in factory
0x0394	SENS IR WARMUP OVERRUN	Temperature warming-up of IR board failed
0x0395	SENS IR CHNL. 1 ADC0 ERR	Measured ADC0 signal of IR sensor channel 1 too high
0x0396	SENS IR CHNL. 1 ADC1 ERR	Measured ADC1 signal of IR sensor channel 1 too high
0x0397	SENS IR CHNL. 2 ADC0 ERROR	Measured ADC0 signal of IR sensor channel 2 too high
0x0398	SENS IR CHNL. 2 ADC1 ERROR	Measured ADC1 signal of IR sensor channel 2 too high
0x0399	SENS IR TEMP ADC ERROR	Measured ADC signal of temperature sensor too high
0x039A	SENS IR CHNL. 1 REFERENCE ERROR	Reference signal of channel 1 (IR sensor) is unstable
0x039B	SENS IR CHNL. 2 REFERENCE ERROR	Reference signal of channel 2 (IR sensor) is unstable
0x039C	SENS IR CHNL. 1 REFERENCE LOW	Underflow of reference signal of channel 1 (IR sensor)
0x039D	SENS IR CHNL. 2 REFERENCE LOW	Underflow of reference signal of channel 2 (IR sensor)
0x039E	SENS IR TEMP BROKEN	Temperature sensor failure detected

9.2.5 Command list and task request list errors

Error code	Display description	Full description
0x0400	REQUEST LIST TASK NOT DEF.	Firmware development error Task for request list not defined

Fatal command list and task request list errors

Error code	Display description	Full description
0x0480	CLIST OVERFLOW	Firmware development error Overflow when adding commands
0x0481	REQUEST LIST OVERFLOW	Firmware development error Overflow adding tasks to request list
0x0482	RESET CALIB. LIST OVERFLOW	Firmware development error A not defined sensor was requested to be set to factory

		calibration
0x0483	DYN STR. LIST OVERFLOW	Firmware development error Overflow when creating dynamic signal list

9.2.6 Menu errors

Error code	Display description	Full description
0x0500	MENU OBJECT OVERFLOW	Firmware development error Too many object loaded into menu
0x0501	MENU VALUE NULL POINTER	Firmware development error CMenuValue class object failed to initialize due to NULL pointer
0x0502	MENU TYP UNKNOWN	Firmware development error Defined value type in menu not defined
0x0503	MENU PARSE NUM WRONG ORDER	Error occurred when entering a number, probably too many characters or a minus sign after a number
0x0504	MENU PARSE NUM TOO MANY DOTS	Error occurred when entering a number A number was entered with two or more dots
0x0505	MENU PARSE NUM CONVERSION	Error occurred after entering a number. The entered number could not be converted.
0x0506	MENU ADD SAVE TASK	Firmware development error Adding task to scheduler failed – a changed value was not saved
0x0507	MENU ADD SEND COMM COMMAND	Firmware development error Adding task to scheduler failed – a changed value was not sent to end slave
0x0508	MENU ADD WAIT TASK	Firmware development error Adding task to scheduler failed – a display task will not be performed – restart system
0x0509	MENU MAX INFO ELEMENTS	Firmware development error Too many info elements were added to menu
0x050A	MENU ADD SEND COMMAND	Firmware development error Adding task to scheduler failed – a changed value was not sent to end slave

9.2.7 Storage errors

Error code	Display description	Full description
0x0600	STORE INIT	Error occurred when saving values
0x0601	STORE OPEN FILE FOR READING	WIN32 error Opening file for reading failed
0x0602	STORE OPEN FILE FOR WRITING	WIN32 error Opening file for writing failed
0x0603	STORE ALLOCATE MEMORY	WIN32 error Error allocating memory
0x0604	STORE BUFFER NOT EMPTY	Data buffer not empty
0x0605	STORE BUFFER TOO SMALL	Data buffer too small
0x0606	STORE PTR. SAVE PARAMETERS	Data pointer not set
0x0607	STORE TYPE NOT DEFINED	Storage type not defined
0x0608	STORE NO STORED DATA	Storage of data failed

9.2.8 SD card errors

Error code	Display description	Full description
0x0700	SDCARD POWER ON CMD0	Power on command failed
0x0701	SDCARD INITIALIZE CMD1	Initialize command failed
0x0702	SDCARD READ SECT. SEND CMD	Read section from card failed
0x0703	SDCARD READ SECT. START BYTE	Read section start byte failed
0x0704	SDCARD WRITE SECT SEND CMD	Write section to card failed
0x0705	SDCARD WRITE SECT BUSY	Timeout occurred for writing to card
0x0710	SDCARD FILE IO MOUNT	File mount error
0x0720	SDCARD FILE IO OPEN	File open file error
0x0730	SDCARD FILE IO READ	File read error
0x0740	SDCARD FILE IO WRITE	File writ error
0x0750	SDCARD FILE IO SEEK	File seek error
0x0760	SDCARD FILE IO UNLINK	File delete error

9.2.9 H-Bus errors

Error code	Display description	Full description
0x0801	HBUS CRC	Error occurred when check CRC16 of H-Bus communication
0x0802	HBUS UNKNOWN COMMAND	Unknown command detected on H-Bus

9.2.10 Event messages (not defined as errors)

Error code	Short description	Full description
0x5000	EVENT BOOTING SYSTEM	System was booted up
0x5001	EVENT ENTER WARMUP	System entered warm-up
0x5002	EVENT TIME FORWARD	Daylight saving active time was set forward
0x5003	EVENT TIME BACKWARD	Daylight saving active time was set backward
0x5004	EVENT ENTER ERROR	Message is stored when entering the error state
0x5005	EVENT CALIB STARTED	Event written when calibration is started --- currently not used ---
0x5006	EVENT CALIB FINISHED	Event written when calibration is finished --- currently not used ---