

**Optimize Your Production  
and Transmission**



**Solutions for the  
Oil and Gas Industry**

Analyze • Detect • Measure • Control™

**Thermo**  
ELECTRON CORPORATION

# Thermo in the Upstream Oil and Gas Process



## We Cover Your Process

Thermo Electron Corporation is the world's leading supplier of process instrumentation and service solutions to optimize your upstream oil and gas operation. We offer a wide range of application knowledge, decades of experience, cutting-edge technology and comprehensive automation solutions that span every element of your petroleum process: Exploration, Production and Transmission. As a result of our advanced technology and premier services, Thermo can help the oil and gas industry develop new energy resources more efficiently than ever.





## Service and Training

### Exploration and Completion

Locating new oil and gas reserves cost-effectively and consistently is the key to successful exploration. Data logging companies purchase Thermo's neutron generator detectors to picture the geological structure beneath the surface for evaluation. Cement and Frac completion specialists use the gamma densitometer to control propanol in the cementing or Frac fluids.

### Production

Production starts with bringing the oil and natural gas to the surface. Thermo's rugged flow computers handle single-to-fifteen-run fiscal/custody transfer metering to ensure precise readings for reliable gas fiscal/custody transfer. Our innovative plunger lift software allows the flow computer to lift water as necessary from the well.

With the high price of gas, limitations have been placed on CO<sub>2</sub> amounts. Thermo's CO<sub>2</sub> monitors provide a simple solution for CO<sub>2</sub> monitoring and control. Thermo also offers densitometers using gamma technology for a non-destructive, non-invasive approach to sand warning allowing preservation of downstream equipment.

Thermo supplies H<sub>2</sub>S and CO<sub>2</sub> personnel monitors for workplace safety. Well site storage tanks use BSW (Basic Sediment and Water) analyzers and level meters to monitor NGL or oil tank contents. Valves are controlled through the flow computer with I/P (current to pressure) controllers.

On top of it all, we provide a web-based data management package including hardware to help improve efficiency and streamline operations for the production site.

### Transmission

In the Transmission process, the natural gas is transported to the consumer. Rugged multi-run systems for the pipeline company with customized or programmable software have been Thermo's hallmarks. Cut detection for tanker offloading with our gamma densitometer allows proper sorting of crudes. Thermo provides rapid and accurate online sulfur analysis for transmix variations of finished fuels in the pipeline.



### Comprehensive Service and Training

Your operations will benefit from a comprehensive service offering including installation and maintenance, calibration, training and repair aimed to reduce down time and keep your process working.

We offer field service repair or depot repair on many of our products with options that fit your budget and your deadline. Our spare parts are designed specifically for your Thermo system, and we make it easy for you to secure replacements by maintaining offices around the world that respond quickly to your phone or online request.

Thermo also offers a comprehensive selection of training options to help you increase productivity by optimizing the use of your products and expanding the skills of your operators. You can receive hands-on instruction in your plant or at our training facility in the US, Europe, or Asia. Courses typically cover basic operation, theory, calibration, and routine user level maintenance, but can include circuit board level troubleshooting and certification, if required. Thermo can also provide customized training upon request.

## Flow Computers and Much More for Natural Gas Processing



As an oil or natural gas producer, it is critical for your well operation to run smoothly 24/7. Problems and downtime cost you valuable time and money.

At Thermo, our mission is to provide you with flow computing solutions and much more to help you optimize your well production and pipeline transmission processes. And we have been doing that for more than 40 years. You may have known us as Flow Automation, Hydril, MiniBase, Elliot or Tokheim, but now we are known as Thermo Electron Corporation, a global company

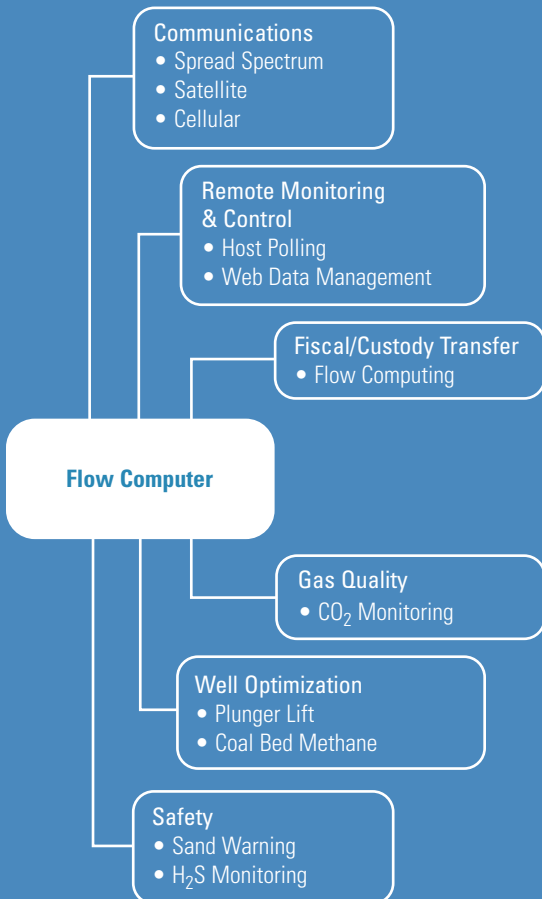
providing superior instruments for the lab, the process and the environment.

Thermo's flow computers provide state-of-the-art, tested and proven lightning protection that is unmatched for field reliability. Our flagship product line includes options for the single-to-multiple run gas flow requirements, innovative algorithms such as plunger lift and coal bed methane as well as unique analyzers, giving you unmatched breadth of control and analysis.

Our innovative low power, radio, modem or Ethernet controlled remote telemetry units

survive in the harshest locations. Thermo is the first flow computer manufacturer to offer a web-based data management system, offering you monitoring and control capabilities. We are also known for our premier service and support including custom software engineering expertise.

At Thermo, we provide the instruments and service that give you the superior uptime and flexibility you need.



### Evolution of Flow Computing

What started out as a remote telemetry fiscal/custody transfer computer to calculate volumes has evolved into the brain center for the entire well site. Today the flow computer is the "Grand Central Station" for all types of input and output including interfacing to analyzers for gas quality or CO<sub>2</sub> levels to plunger lift algorithms for well optimization and to well safety by monitoring H<sub>2</sub>S or detecting sand slugs.

Thermo's philosophy is to enhance the flow computer's functionality. We continue to pioneer new advancements in applications solutions that tie the data highway into the flow computer. Innovative software that provides logic control versus manual controls will be our trademarks of success. We continue to stay abreast of communications advancements including low cost spread spectrum radios, satellite and Ethernet.

# Flow Computers



## AutoPILOT®

### Two-Run, Expandable I/O Flow Computer

The AutoPILOT is Thermo's flagship flow computer and is a proven workhorse capable of handling up to two natural gas runs. Input / Output (I/O) expandability allows the system to monitor and control complex well sites with a multitude of applications. Primary input devices include orifice, turbine, and ultrasonic meters.

Specification	
I/O	14 Discrete In / 14 Discrete Out 8 Analog Out / 3 Analog In 8 Pulse In
Communications	4 RS232 or RS485 Modem, cellular, CPDP, spread spectrum radio, satellite
Control	8 PID & Proportional Outputs 14 Alarm callouts
Calculations	API Ch. 21.1 Compliant, AGA3, AGA7, AGA8, AGA9, AGA10, NX19, ISO, VCone, GOST
Functions	Sampler, Odorant, Historical, Tank Level, Plunger Lift, PLC, Emergency Shutdown

## AutoMATE®

### Four-Run, Expandable I/O Flow Computer

Thermo's successful AutoMATE system is designed for gathering stations or pipeline transmission fiscal/custody transfer points. AutoMATE encompasses all the features of an AutoPILOT with greater I/O and the ability to monitor up to four natural gas runs. Typical control applications include PID/proportional flow rate, emergency shutdown, auxiliary equipment shut-off, run switching, tank gauging, compressor control and audible safety alarm systems.

Specification	
I/O	36 Discrete In / 36 Discrete Out 12 Analog In / 9 Analog Out 10 Pulse In
Communications	4 RS232 or RS485 Modem, cellular, CPDP, spread spectrum radio, satellite
Control	8 PID loops 14 Alarm callouts
Calculations	API Ch. 21.1 Compliant, AGA3, AGA7, AGA8, AGA9, AGA10, NX19, ISO, VCone, GOST
Functions	Sampler, Odorant, Historical, Tank Level, Emergency Shutdown, Plunger Lift, PLC

## AutoGRAPH®

### Single Run, Chart-Replacement Flow Computer

The AutoGRAPH provides simplicity for the first-time user to automated flow computing. A totally integrated device with a differential pressure transmitter plus optional radio and solar power, this flow computer is the perfect choice for chart replacement. The AutoGRAPH with optional radio and solar power features is approved for Class 1, Division 1 hazardous locations. The unit operates on very low power thus requiring a very small solar panel and has wireless communication options to function with any SCADA system.

Specification	
I/O (Input/Output)	1 Discrete In / 1 Discrete Out 3 Analog Out / 2 Analog In
Communications	1 RS232 & 1 RS485 Spread spectrum radio
Control	4 PID Loops 8 Alarm callouts
Calculations	API Ch. 21.1, AGA3, AGA8, AGA9, VCone, Slotted DP
Functions	Sampler, Odorant, Historical



## Optimizing the Well

### Greater Productivity and Well Life Extension with Automated Plunger Lift Capabilities

Thermo provides a cost-effective artificial lift system, PlungerLIFT, with unmatched fuzzy logic intelligence using tubing and casing pressures and predictive modeling for peak performance – no additional controllers are needed. Our proprietary PlungerLIFT algorithm is incorporated

into the AutoPILOT or AutoMATE flow computer's operating software. This smart algorithm evolves with the life of the well. The data gathering is updated once a second providing the sharpest of resolution on trends. The unique key pad provides a window into the critical plunger

lift parameters eliminating the need for a laptop. Remote configuration and adjustment are achieved through Thermo's AutoSCAN host software. Thermo leads the way with innovative solutions that optimize production and extend well life.

Meter	Instantaneous Readings				
	Reading Date	DP	SP	Temp	Instant Rate
Meter 1	08/21/2008 14:58:51	127.87	678.25	84.04	2340.37
Meter 2	08/21/2008 15:04:29	28.04	867.35	78.82	1336.05
Meter 3	08/21/2008 15:04:54	28.85	6.68	82.07	312.38
Meter 4	08/21/2008 15:04:38	38.11	7.82	88.19	410.52
Meter 5	08/21/2008 15:05:20	14.46	6.03	103.10	55.74
Meter 6	08/21/2008 15:04:12	28.32	264.17	113.37	731.00
Meter 7	08/21/2008 15:05:53	28.58	888.57	83.63	185.85



## AutoVANTAGE™

### Web-based Data Management Solutions

Thermo leads the pack with an innovative package for web-based data hosting. Improve field technician routing, decrease well shut-in times and reduce production meetings by monitoring gas production data instantly and securely from the Internet anywhere at anytime.

- Audit trails maintained
- Alter configurations
- Customize reports
- Export to common programs

## AutoSCAN®

### Flow Computer Host Software

AutoSCAN is designed with natural gas production and transmission needs in mind. Why take a SCADA program designed for a processing plant and force feed it to the well site or pipeline? AutoSCAN provides flexibility with the features you already demand. Thermo has industry knowledgeable software engineers on hand to aid in customization and trouble shooting as needed.

	Specification
Poller	Up to 254 polling ports Supports low power management Provides backdoor emulation Extensive debugging diagnostics
Viewer	Primary HMI User configurable summary reports Historical data can be graphically displayed Export and archive data
VOX (Voice)	Configurable call-in Monitor unlimited variables Call-out to phone, pager User recordable messages



## AutoCONFIG™

### Flow Computer Configuration Software

AutoCONFIG for Windows® provides ease of use for the integrator or operator. Built in wizards allow the most inexperienced installer to set up Thermo's flow computers in just a few minutes. Graphical user interface provides a user friendly environment.

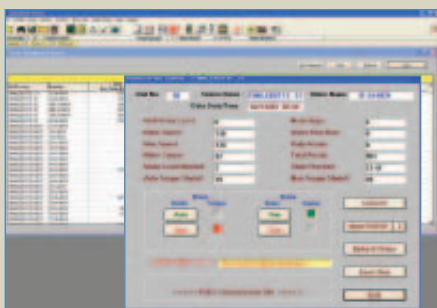
- Complete integrated support for all Thermo flow computers
- Multiple simultaneous views
- User-configurable Microsoft® Outlook®-like tree view
- Remote communications via serial, TCP, radio, satellite, and others
- High contrast option for direct sunlight use

## Optimizing the Well

### Smart Software Modeling to Enhance Coal Bed Methane Productivity

Coal Bed Methane (CBM) wells pose special challenges in dewatering the gas well. Pump jacks or variable speed motors are needed to keep these low pressure wells

flowing. Thermo's innovative control function for CBM built right into the AutoPILOT or AutoMATE puts automated water management in the hands of the producer.





COMING SOON



## Gas Quality Analysis

### AutoCO2

#### CO<sub>2</sub> (Carbon Dioxide) Analyzer

AutoCO2 uses an NDIR (non-dispersive infrared) sensor to detect CO<sub>2</sub> concentrations in natural gas. With natural gas prices at all time highs, limits on CO<sub>2</sub> concentrations are being set at delivery points. Exceeding those limits – typically set at 2% – can result in fines or lost production. The AutoCO2 is another cost-effective Thermo solution used at the wellsite or gathering station to ensure high quality gas.

- Flow through style probe
- Range 0 - 10% CO<sub>2</sub>
- 4-20 mA output to flow computer
- Accuracy ± 5% relative
- Repeatability ± 0.05%
- Class 1, Div. 2 approval pending

## Sand Slug Warning

### TN DensityPro

#### Gamma Density Gauge

The TN DensityPro is a density meter that uses gamma attenuation to identify sand slugs in natural gas pipelines preventing possible blowouts. Thermo's TN DensityPro will immediately alarm the presence of a sand slug allowing the flow computer to shut in the well.

- Under one second response
- Completely non-invasive
- Transportable to other sites as needed
- Hot, vibrating surfaces do not affect the measurement
- Class 1, Div. 1 approved



## Well Safety

### Scout

#### H<sub>2</sub>S (Hydrogen Sulfide) Analyzer

Thermo's Scout uses proven lead acetate tape technology for reliable continuous H<sub>2</sub>S monitoring for safe pipeline operations and corrosion prevention. The Scout has innovative stream switching technology allowing one sulfur analyzer to be used simultaneously on two streams.

- Hassle-free automatic calibration
- 4 high, low, malfunction and tape alarms
- Repeatability 2% of full scale
- Response 20 seconds
- 4-20 mA output



## Reliability is Everything

### Enhanced Lightning and Environmental Stress Screening

Reliability has been the hallmark of our flow computers. Thermo continues to operate in remote, rugged and harsh environments where others fail to pass the grade. We achieve this through diligent board and circuit testing.

Each circuit design is tested with a simulated lightning strike of 6,000 volts

at 3,000 amps. The circuit is tested until failure. Every design can withstand 120 strikes without component failure. The system recovers immediately upon strike.

Every board in our flow computers has been stress tested in our environmental chambers. With the board under power

and running test software, the chamber is temperature cycled from -40°C to +85°C as fast as possible. The chamber is not dehumidified, resulting in condensation and adding to the stress test. Every board must pass this stringent test prior to shipment.

## About Thermo

Thermo Electron Corporation is the world leader in analytical instruments. Our instrument solutions enable our customers to make the world a healthier, cleaner and safer place. Thermo's Life and Laboratory Sciences segment provides analytical instruments, scientific equipment, services and software solutions for life science, drug discovery, clinical, environmental and industrial laboratories. Thermo's Measurement and Control segment is dedicated to providing analytical instruments used in a variety of manufacturing processes and in-the-field applications, including those associated with safety and homeland security. Based near Boston, Massachusetts, Thermo has revenues of approximately \$2.7 billion, and employs approximately 11,000 people in 30 countries. For more information, visit [www.thermo.com](http://www.thermo.com).

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