Adding the X-F.A.C.T.O.R to oil & gas flow computing, automation and control

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ABB is making a world of difference by enabling safe, smart and sustainable operations with integrated solutions that digitalize, automate & electrify the oil and gas industry. We are focused on helping energy companies operate more efficiently to reduce their environmental impact, while enabling new, clean energy value chains to fuel our future.
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Introduction
The importance of flow measurement in the oil and gas industry

Flow measurement is a topic that is fundamentally well understood and incorporated in processes around the world today. However, this has not always been the case. It was not until the advent of industrialization and the establishment of the oil and gas industry that the importance of flow measurement was truly observed and taken to task in pursuit of the highest achievable outcomes. As the world’s reliance on hydrocarbons for energy and consumer products grew over time, so too did the production, transport, and sale of these valuable resources. Consequently, the increasing need for accurate, consistent measurement capabilities and techniques also stemmed out of the necessity to properly account for these precious commodities through the value chain.

When considered in a general context, flow measurement tends to be a benign and straightforward topic. However, when specifically applied to the oil and gas industry, it becomes a vast and complex field that presents many formidable challenges and complications. Achieving accurate, precise, and repeatable flow measurements of hydrocarbon gases and liquids requires careful navigation and a thorough understanding of a multitude of intricacies and obstacles.

This white paper seeks to touch on various, common operations within the oil and gas industry and some of the inherent challenges with which they are associated. It will briefly review the purpose of flow measurement and discuss some of its specific requirements. The paper will also highlight some general thoughts regarding the decision-making processes that surround the selection of equipment needed to support automation and control applications. Lastly, it will provide an overview of ABB’s Totalflow product portfolio, showcasing how their flow computers and RTUs are uniquely suited for oil and gas operations and offer an exceptional advantage to producers and operators in the industry.
Three Segments of the Oil & Gas Industry

Today’s oil and gas industry is a complex operation that consists of many processes and applications. The industry is comprised of three segments which are referred to as the upstream, midstream, and downstream vertical segments.

1. **The upstream segment** consists of operations that pertain to producing hydrocarbons from the ground as well as performing preliminary, first-stage separation of the gases and liquids extracted.

2. **The midstream segment** primarily serves to transport the hydrocarbon gas and liquid from the upstream operations to the downstream operations. The midstream operations also generally employ a secondary level of processing to further clean and treat the gas and liquid. It also performs some additional gas and liquid separation. After these functions have been carried out, the gases and liquids are then transported via pipelines and tankers to the downstream segment.

3. **The downstream segment** involves the further refinement of the hydrocarbon gases and liquids, creating more diverse components, and delivering them to other markets. These markets then supply the hydrocarbon components as fuels to consumers and or to industrial operations that utilize the components as feedstocks to produce various other consumable goods.

Upstream and Midstream Oil & Gas Operations and Applications

In the upstream and midstream oil and gas segments, there are several operations encountered. Within these operations, there are a variety of applications and subsequent equipment needs and solutions applied to carry out the measurement, automation, and control functions required.

For the case of the upstream segment, the well pad operation is the focal point. This is where the hydrocarbons are produced from below the ground and brought to the surface. At the surface, the well pad operation includes the wellhead, gas and liquid separator, and tank gathering processes. Some ancillary operations to the well pad include artificial lift systems (e.g., gas lift, plunger lift, chemical injection, etc.), flare systems and LACT units.

In the case of the midstream segment, it employs operations such as natural gas processing plants, compressor and pump stations, and pipeline delivery networks. Each operation, again, has its own unique applications as well and therefore dictates other certain requirements around equipment and functionality deployed. As such, let’s explore more into the applications of flow measurement, automation, and control.
Purpose of Flow Measurement

There are a variety of reasons flow measurement is conducted, but out of the many reasons there is one common, underlying purpose; that is the need to know and account for the quantity, and in some cases, the quality of process media flowing past a particular point in a process over a given time frame. That’s it! But when it involves oil and gas it’s not a trivial matter and more importantly the level of precision that the measurement can be performed is paramount. This is because the measurement directly affects the efficiency and optimization of the process and the exactness of the buy or sell price of the product being measured. Thus, the less precise the measurement, the greater the cost to the business of either the seller or buyer depending on which side of exact precision the measurement error exists.

The following list identifies some of the upstream and midstream operations that generally require flow measurement applications:

1. Wellhead production
2. Separators
3. Gathering / tank systems
4. Pipelines
   - Transmission
   - Distribution
   - City gates
   - Metering skids
   - Custody transfer sales meters
   - Power plant interconnects
5. Batch systems

Additionally, within these operations, there is also an inherent need for some level of automation and control. Therefore, the characteristics and requirements of the operation will determine the applications required which in turn will dictate the equipment needed for the automation, control, and measurement to be executed properly. Thus, the equipment and its functional attributes can vary with any given operation and application.

Flow Measurement Requirements

In terms of taking flow measurements, the measurement yielded is based on the culmination of inputs from a system of measurement devices and accepted industry standard equations using the input to calculate the result. Furthermore, the accuracy, precision, and repeatability of the measurement are dependent upon the characteristics derived from the industry standard equations and equipment deployed in the overall system. As such, most flow measurements performed in the oil and gas industry are conducted using internationally accepted and established flow equation standards like those from the American Gas Association and the American Petroleum Institute. These standards are further segmented and written to address various devices, measurement elements and system setups used to conduct the measurement. The following is an example of some of the most common standards emphasized and practiced in hydrocarbon gas and liquid flow measurement:

- AGA-3 (orifice meter run)
- AGA-7 (rotary / turbine / ultrasonic)
- IS05167 (orifice meter run)
- V cone meter run
- AGA-8 (compressibility factor of natural gas and related hydrocarbon gases)
- AGA-9 (ultrasonic meters)
- AGA-11 (Coriolis meters) – gas measurement only
- API 11.1 Hydrocarbon liquid measurement (calculations and table values)
- API 11.4.1 water measurement (e.g., flow meter types - mag meter, ultrasonic, turbine, etc.)
- API 21.1 – reporting for gas flow measurement
- API 21.2 – reporting for hydrocarbon liquid flow measurement

It is standards like these that establish methods and practices that any operator can use to ensure consistent, reliable, and quality measurement is conducted throughout the oil and gas industry.
Automation & Control

In many cases, oil and gas operations will require some form of automation and control aside from or in addition to the flow measurement needs. As one might expect, the automation and control schemes for an application in a particular operation can vary from simple to complex depending on its scale and required functions. Due to this fact, it is important to deploy equipment that meets the requirements and objectives of the system architecture to be configured. Specifically, an operator will require a system architecture to be implemented such that it addresses some defined level of performance for key attribute areas that highly affect the operations and overall business like:

- Approach to risk management
- Approach to safety management
- Approach to operational requirements
- Project cost management
- Asset maintenance management
- Asset life-cycle management

Given the wide range of acceptable levels that may be associated with each key attribute area in a company’s project or operation, one can also deduce that a system architecture can vary greatly in quantity and quality of equipment utilized as a result. Hence, the goal is to select the equipment that will best serve the overall balance of the key attribute areas noted above while at the same time optimizing the system architecture needed by the end user to meet internal business objectives and be in compliance with industry regulations and standards. As is typical for most oil and gas processes, the automation and control of a system will be focused on one or more process variables which include, but are not limited to the following:

- Pressure
- Temperature
- Level
- Flow
- Product Composition
- Product Quality / Purity
- Density
- Mass
- Volume

Specific automation and control logic will be deployed to ensure that processes perform as designed and intended. Depending on the application, the control logic implemented may also include more focused forms of control such as batch controls (tanks), discrete and or modulating controls (valves and pumps), compressor/pump controls, artificial lift controls (gas, plunger, chemical injection, etc.), safety shutdown system controls, and alarm system logic. Ultimately, the controls used will be deployed in such a manner as to provide the function for that which meets the minimum requirements necessary for the process to work at some defined and accepted level of performance and safety thresholds.
Field Device and System Integration

To this point, it’s been observed that there are many factors and significant efforts that go into the consideration of what methods and equipment should be deployed for oil and gas operations and their applications to perform as desired. But, to further compound this matter, another consideration that is necessary revolves around device and system integration and the efficiency by which this can be carried out. Now, this topic in and of itself is a deep subject, and one that a whole other paper could be dedicated to, but for the purposes of this discussion, the intent is simply to draw attention to and affirm the fact that all field devices, flow computers, RTUs and SCADA systems are not the same. Furthermore, making them work in concert with each other is not always easy, nor in some cases is it even possible. Hence, the challenges of system integration commence.

The development of a system architecture has many inputs as already mentioned, and thus requires much attention to detail through the entire process. Additionally, as system architectures are developed it is important to have a long-term outlook. This is because once decisions are made and systems are deployed, it may be many years before modifications can be implemented to correct for changing circumstances due to high switching costs.

One example of this situation occurs when selecting field devices and systems that use proprietary communication protocols. The upside commonly is the system integration and setup are more efficient. The downside is the investment is generally locked in for many years for those specific products, systems, and suppliers. Unfortunately, this situation can create switching costs that are too great to overcome when there are improvements and advancements in technology from other suppliers that don’t support the proprietary communication protocol with which the company has invested. Therefore, the achievement of greater process efficiencies, better product quality, more system reliability, etcetera in the future may be put at risk and in some cases become unreachable as technology changes over time, again due to the associated high switching costs. As a result, the realization of greater revenues and or cost-cutting opportunities may be diminished or forfeited completely and generate a persistent negative cost impact on the business.

A second example of things to consider for a long-term outlook regarding system architecture development is the scaling of a system. Some systems and devices may limit expandability over time and create greater costs for the operation if equipment must be changed out to accommodate for process expansion and more complex processing. Therefore, it is ideal and important to consider the deployment of equipment and systems that will not only accommodate the startup size of the operation, but also the size and complexity of the operation if it is to be built out over time.
ABB Totalflow Portfolio Solution

To this point, we have quickly touched on the fact that there are many operations and applications in the oil and gas industry that by their very nature present a host of challenges from an operational and business management perspective. For these reasons, it is important to have the correct equipment for the job so that efforts to best optimize the situation can be achieved. Consequently, this is where ABB Totalflow excels as it pertains to flow computers and RTUs.

The ABB Totalflow portfolio of flow computers and RTUs is a comprehensive trove of solutions that help oil and gas customers optimize their operations to several degrees of freedom. The ABB Totalflow flow computer and RTU solutions possess attributes that greatly help customers balance cost, scalability, quality, functionality, integration, and complexity associated with their operations and business. In fact, the portfolio is so flexible with respect to addressing the deep and broad requirements of the oil and gas market that one could consider the ABB Totalflow flow computer and RTU the X-F.A.C.T.O.R. in flow computing regarding its ability to support the vast and overall desired functionality and performance of the operation.

Besides the positive connotation implying something extra is derived when referring to x-factor attributes, the ABB X-F.A.C.T.O.R. term also represents the inherent nature and foundational reputation of its flow computers which is:

F = Flexible
A = Accurate
C = Cybersecure
T = Trusted
O = Optimal
R = Reliable

In fact, the X-F.A.C.T.O.R. component is the primary reason why so many customers around the world have entrusted their flow measurement, automation and control requirements to ABB Totalflow resulting in the sale of over 430,000 units worldwide since the 1980s to the date of this publication in 2023.

The illustration below is provided to help visualize how ABB Totalflow flow computer and RTU products apply across the three oil and gas segments in service of their respective operations and applications.

Now that a little background on the oil and gas industry, its operations, applications and the various needs and challenges one might expect to encounter as it relates to flow measurement, automation and control requirements has been provided, let us take a closer look specifically at the products that comprise the ABB Totalflow flow computer and RTU portfolio.
The XFC 6200EX/6201EX is a 4th generation ABB flow computer that offers an economical and scalable solution for applications requiring differential pressure and or linear measurement as well as some automation and control capability that can be expanded to some degree with the use of an I/O daughter card. Furthermore, this product is ABB’s only offering for hazardous area locations that require explosion-proof designs. The following is a list of key capabilities and features associated with the product:

- Field mount
- Windows CE OS
- Protocols: Totalflow native (low power), Modbus slave (RTU/ASCII), Modbus master (RTU/ASCII), Enron Modbus
- Hazardous area approval:
  - C/US UL Class 1 Div. 1 (Explosion Proof)
  - C/US UL Class 1 Div. 2 & ATEX & IECEx Class 1 Zone 2
- Enclosure rating: NEMA 3R / IP53 or NEMA 4X / IP66
- Integrated Multivariable Transducer
- Metrology certification: Measurement Canada (Category 2); INMETRO
- Meets low power requirements (9-30 VDC)
- Native Bluetooth
- Up to 18 I/O with daughter card
- Up to 17 meter runs
- 1 second calculation rates
- Calculations per AGA / ISO standards
  - “AGA 3-85, AGA 3-92, ISO-5167 and AGA-5, NX-19, AGA8-92 gross or detail, ISO 12213-2, API 21.1”

The MicroFlo (µFlo)G5 is a 5th generation ABB flow computer that offers an economical flow measurement solution for customers. This flow computer is generally deployed where only minimal flow measurement tubes and simple automation are required. The following is a list of key capabilities and features associated with the product:

- Field mount
- Linux OS
- Protocols: Totalflow native (low power), Modbus slave (RTU/ASCII), Modbus master (RTU/ASCII), Enron Modbus
- Hazardous area approval:
  - C/US UL Class 1 Div. 2
  - ATEX & IECEx Class 1 Zone 2
- Enclosure rating: NEMA 3R / IP54
- Integrated multivariable transducer
- Metrology certification: INMETRO
- Meets low power requirements (9-30 VDC)
- Low-cost communications kits
- Up to 6 I/O (no I/O expansion)
- Up to 9 meter runs (XIMV and up to 8 XMVs in Modbus daisy chain run)
- Minimal control capability
- 1 second calculation rates
- Calculations per AGA / ISO standards
  - “AGA3-85, AGA3-92, AGA3-2012, AGA-7, AGA-5, ISO 5167, API 11.1, API 11.2.2, API 11.2.4 and API 11.4.1, NX-19, AGA8-92 gross or detail, ISO 12213, API 21.1 and API 21.2”
The XFC<sup>G5</sup> is a 5th generation ABB flow computer that offers a very cost-competitive, highly expandable flow measurement, automation, and control solution for customers. This flow computer has an integral multivariable transducer and possesses the capability of offering significant scalability and or flexibility in an application where flow measurement, automation and control are required. The XFC<sup>G5</sup> flow computer is the next step up and mid-tier offering for ABB flow computers because of the greater number of I/O that can be added via the TFIO modules and the number of software applications it can run at one time with one second calculation update rates. The following is a list of key capabilities and features associated with the product:

- Field mount
- Linux OS
- Protocols: Totalflow native (low power), Modbus slave (RTU/ASCII), Modbus master (RTU/ASCII), Enron Modbus
- Hazardous area approval:
  - C/US UL Class 1 Div. 2
  - ATEX & IECEx Class 1 Zone 2
- Enclosure rating: NEMA 3R / IP54
- Integrated multivariable transducer
- Metrology certification: INMETRO
- Meets low power requirements (12 VDC)
- Native Bluetooth & Wi-Fi
- Up to 54 I/O or 6 TFIO modules
- Up to 100 applications can run at one time
- 4+ well pad control & optimization
- 20+ meter runs
- 1 second calc rates
- Calculations per AGA / ISO standards
  - “AGA3-85, AGA3-92, AGA-7,AGA-5 and ISO 5167, NX-19, AGA8-92 Grossor Detail, ISO 12213, API 21.1”

The XRC<sup>G5</sup> is a 5th generation ABB flow computer that offers a very cost-competitive, highly expandable flow measurement, automation, and control solution for customers. Like the XFC<sup>G5</sup>, the XRC<sup>G5</sup> also possesses the capability of offering significant scalability and or flexibility in an application where flow measurement, automation and control are required. The XRC is for all practical purposes an XFC<sup>G5</sup> without the integrated multivariable transducer, and as such, it does offer more I/O capability. The XRC is typically targeted more at small to mid-sized operations requiring an appreciable amount of I/O and having more emphasis on automation and control. The following is a list of key capabilities and features associated with the product:

- Field mount
- Linux OS
- Protocols: Totalflow native (low power), Modbus slave (RTU/ASCII), Modbus master (RTU/ASCII), Enron Modbus
- Hazardous area approval:
  - C/US UL Class 1 Div. 2
  - ATEX & IECEx Class 1 Zone 2
- Enclosure rating: NEMA 3R / IP54 enclosure
- No integrated multivariable transducer
- Metrology certification: INMETRO
- Meets low power requirements (12 VDC)
- Native Bluetooth & Wi-Fi
- Up to 189 I/O or 22 TFIO modules
- Up to 100 applications can run at one time
- 4+ well pad control & optimization
- 20+ meter runs
- 1 second calc rates
- Calculations per AGA / ISO standards
  - “AGA3-85, AGA3-92, AGA-7,AGA-5 and ISO 5167, NX-19, AGA8-92 Grossor Detail, ISO 12213, API 21.1”
The RMC-100 is the premier RTU of the ABB Totalflow flow computer and RTU lineup. Introduced in 2016, this RTU changed the market relative to its power and capabilities. The RMC-100 rivals the I/O capability of a PLC and possesses a processor that allows it to govern over and execute the automation, control and flow measurement requirements of significantly large and complex oil and gas operations. Additionally, there is a RMC-100 Lite version offered that is tuned down a little in processor speed and capabilities to help optimize cost with desired attributes of the RMC-100 to address smaller scale operations. The following is a list of key capabilities and features associated with the product (* denotes RMC-100 Lite specs):

- DIN rail panel mount
- Linux OS
- Protocols: Totalflow native (low power), Modbus slave (RTU/ASCII), Modbus master (RTU/ASCII), Enron Modbus, MQTT
- 720 MHz processor *(300 MHz)
- Hazardous area approval:
  - C/US UL Class 1 Div. 2
  - ATEX & IECEx Class 1 Zone 2
- Enclosure rating: NEMA 3R / IP54 & NEMA 4X / IP66
- Metrology certification: INMETRO
- Meets low power requirements (9-30 VDC)
- Bluetooth capable
- Up to 365 I/O or 44 TFIO modules
- Up to 254 *(104) applications can run at one time
- Up to 10 *(2) IEC 6-1311 applications can run at one time
- 24+ *(6+) well pad control & optimization
- 72+ *(18+) meter runs
- 1 second calc rates
- Calculations per AGA / ISO standards
  - "AGA3-85, AGA3-92, AGA-7,AGA-5 and ISO 5167, NX-19, AGA8-92 Grossor Detail, ISO 12213, API 21.1"

The XIO product is the latest addition to the ABB Totalflow product portfolio. It was released to the market in 2020. Its capabilities and functionality have been very welcomed by the market. The XIO has proven to provide more, valuable capability to a variety of applications while at the same time allowing customers to so save on costs. The XIO is great for applications requiring minimal flow measurement and or automation and control needs. Additionally, just as its name suggests, it is truly a much more economical solution for applications where only remote I/O is required. The following is a list of key capabilities and features associated with the product:

- DIN rail panel mount
- Linux OS
- Protocols: Totalflow native (low power), Modbus slave (RTU/ASCII), Modbus master (RTU/ASCII), Enron Modbus
- Hazardous area approval:
  - C/US UL Class 1 Div. 2
- Enclosure rating: NEMA 3R / IP54 & NEMA 4X / IP66
- Metrology certification: INMETRO
- Meets low power requirements (9-30 VDC)
- Bluetooth and Wi-Fi capable
- Up to 176 I/O or 22 TFIO modules
- Supports the most common Totalflow applications
- 2 well pad control & optimization
- 2 meter runs
- 1 second calc rates
- Calculations per AGA / ISO standards
  - "AGA3-85, AGA3-92, AGA-7,AGA-5 and ISO 5167, NX-19, AGA8-92 Grossor Detail, ISO 12213, API 21.1"
The oil and gas industry encompasses a wide array of operations and applications, influenced by numerous factors that present both challenges and opportunities. Over the years, this industry has witnessed evolving philosophies and approaches to operations driven by technological advancements. With these changes, however, one constant remains: change itself. As such, there is no universal solution that caters to all applications, and it is this fundamental understanding which is embraced by ABB.

To address the diverse needs of the industry, ABB’s flow computer and RTU portfolio comprise a range of offerings. As well, this recognition extends to ABB’s customers who value the attributes of these product configurations that better enhance process optimization, minimize costs, and maximize returns for their processes. This is the reason ABB flow computers and RTUs have consistently stood out as best-in-class products, delivering exceptional performance, quality, and value over the decades.

This enduring reputation is a testament to why customers continue to rely on ABB’s flow computers and RTUs as they endeavor to overcome ongoing and ever-evolving operational and application challenges. The ABB flow computer and RTU portfolio truly provide the sought-after X-F.A.C.T.O.R. that sets it apart from others in the industry. It is this fact to a great extent and in conjunction with other factors that serve to solidify ABB’s offering as one of the highest trusted and relied-upon solutions for customer flow computing, automation, and control needs.