

SG-SMART Data-Acquisition System

The SG-SMART* data-acquisition system is an advanced driller's monitoring system that can accurately measure, monitor, and display all drilling variables in real time. This computer-controlled data-acquisition system employs integrated microcontroller technology and fiber optics to provide accurate, instantaneous measurement and display critical drilling data.

The M-I SWACO* SG-SMART data-acquisition system has been awarded U.S. patents¹ for its intrinsically safe operation in hazardous locations.

Features

Easy to use. A common-sense interface makes the SG-SMART system simple and easy to use, and its self-documenting, menu-driven features facilitate evaluation and analysis.

Designed for the driller. Both the hardware and the software are designed to assist the driller. Data displays in easy-to-read alphanumeric and graphical formats.

Accurate. Integrated microcontroller technology and fiber optics link the sensors with the system to ensure high-speed accuracy, reliability and improved measurement resolution.

Safe and reliable. CSA-approved, field-proven and intrinsically safe for installations in Class I, Division I areas, the SG-SMART system can operate in a wide range of temperatures from -25° to 150° F (-32° to 65° C).

Minimum maintenance. Built-in diagnostics simplify troubleshooting, stainless steel enclosures resist corrosion, and field repairability reduces downtime.

Versatile. Besides measuring and monitoring parameters onsite, all information displayed on the driller's monitor can be transmitted via regular, voice-grade telephone lines to a remote monitor located anywhere in the world.



Features

- Integrated microcontroller technology, fiber optics and state-of-the-art electronics
- Expandable system
- Designed to enhance drilling operations
- Built-in diagnostics to simplify troubleshooting
- Drilling data can be transmitted to a remote monitor
- Optional data storage of all parameters

Benefits

- Real-time measurement and display of critical drilling data
- Intrinsically safe operation in hazardous locations
- Reliable operation in a wide range of temperatures
- Simple, practical and easy to use
- Field repairability reduces downtime
- Stainless steel enclosures resist corrosion



Customer-focused, solutions-driven

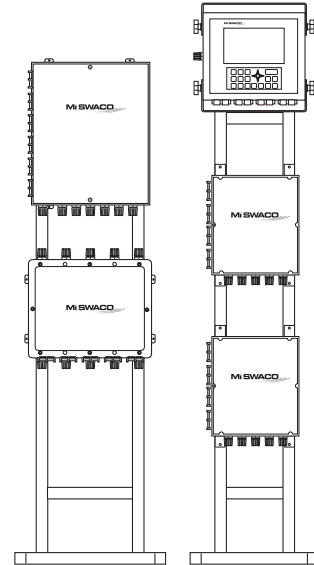
Flexible. Two levels of capability allow expandability:

- **Level I.** Provides basic monitoring and measurement functions of PVT (up to 10 pits), gain or loss, PVT for two trip tanks with gain/loss, total pump strokes (5 pumps), return-flow rate (0 to 100%), fill-stroke count (each fill and total).
- **Level II.** This system monitors and tracks additional information, including: Rate of Penetration (ROP), RPM, pump pressure, hydraulic and rotary torque, weight-on-bit, and hook load.
- **Options.** Choice of additional analog output channels, company man's display, tool pusher's display, circular chart recorder and transmission hardware to remote monitor.

Major Components

The SG-SMART data-acquisition system consists of four major components:

- Driller's Monitor
- CPU Junction Box
- Barrier Box
- One Satellite Box (Level I) or Two Satellite Boxes (Level II)



Measures and Monitors

Critical Drilling Information

The SG-SMART system is a versatile, computerized data-acquisition system that provides complete real-time data.

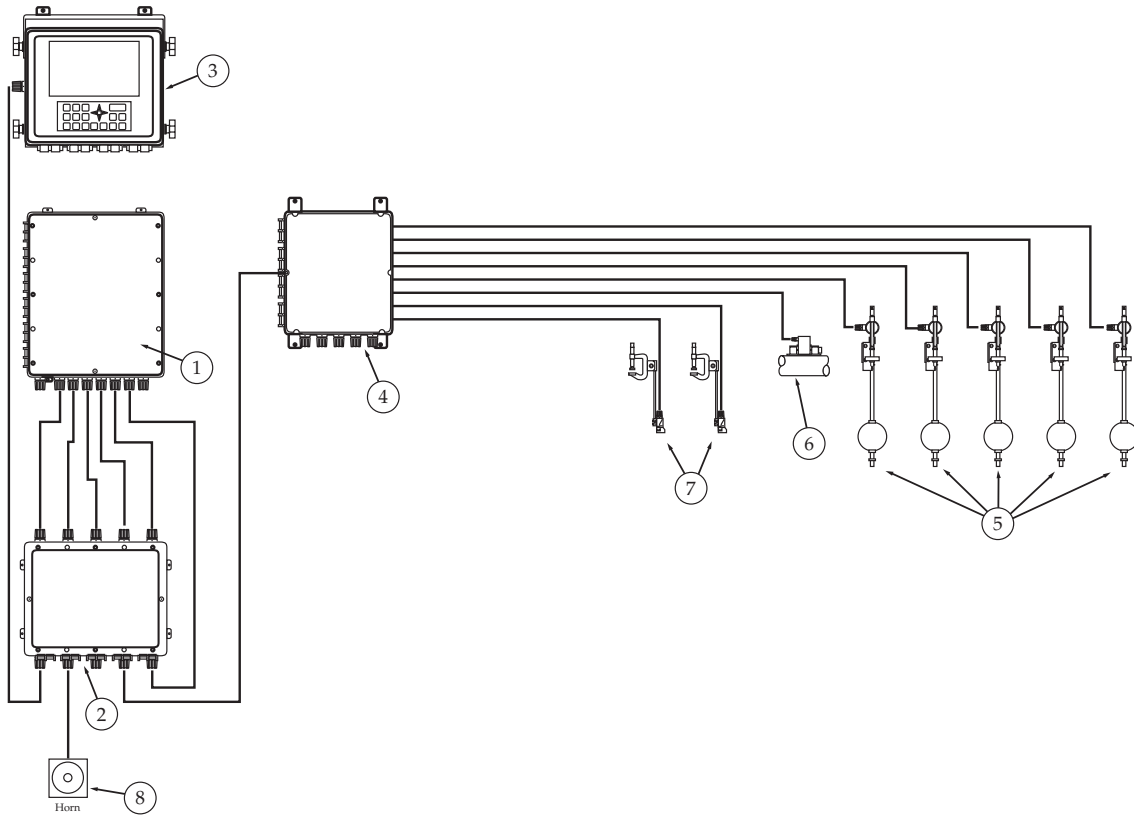
Available in two versions, the basic Level I or the more advanced Level II, the SG-SMART system is simple, practical and easy to use, with modular features that make it expandable for future technologies.

Basic Equipment

	SG-SMART Level I Data-Acquisition System	SG-SMART Level II Data-Acquisition System
Hardware includes	Color driller's monitor; Pits (4); Trip tank; Trip gain/loss; Return flow; Strokes — Pump #1, #2; Strokes per minute — Pump #1, #2; Total strokes; Total strokes per minute; Trip screen — monitors strokes or bbl to fill.	Color driller's monitor; Circular chart recorder, pits (4); Trip tank; Trip gain/loss; Return flow; Strokes — Pump #1, #2; Strokes per minute — Pump #1, #2; Total strokes; Total strokes per minute; Trip screen — monitors strokes or bbl to fill; Pump pressure; Drilling depth and ROP; Hook load and bit weight; Bit rpm; Rotary torque (electric/hydraulic); Annulus pressure; Pump output (calculated); Tool pusher's computer
Optional hardware	Company man's workstation Pump pressure Drilling depth and ROP Hook load and bit weight Bit rpm Rotary torque (electric/hydraulic) Annulus pressure Pump output (calculated) Workstation Slave monitor Circular recorder Printers Additional pit probes	Company man's workstation Additional workstation Additional slave monitor Additional circular recorders Printers Additional pit probes Infrared gas detector

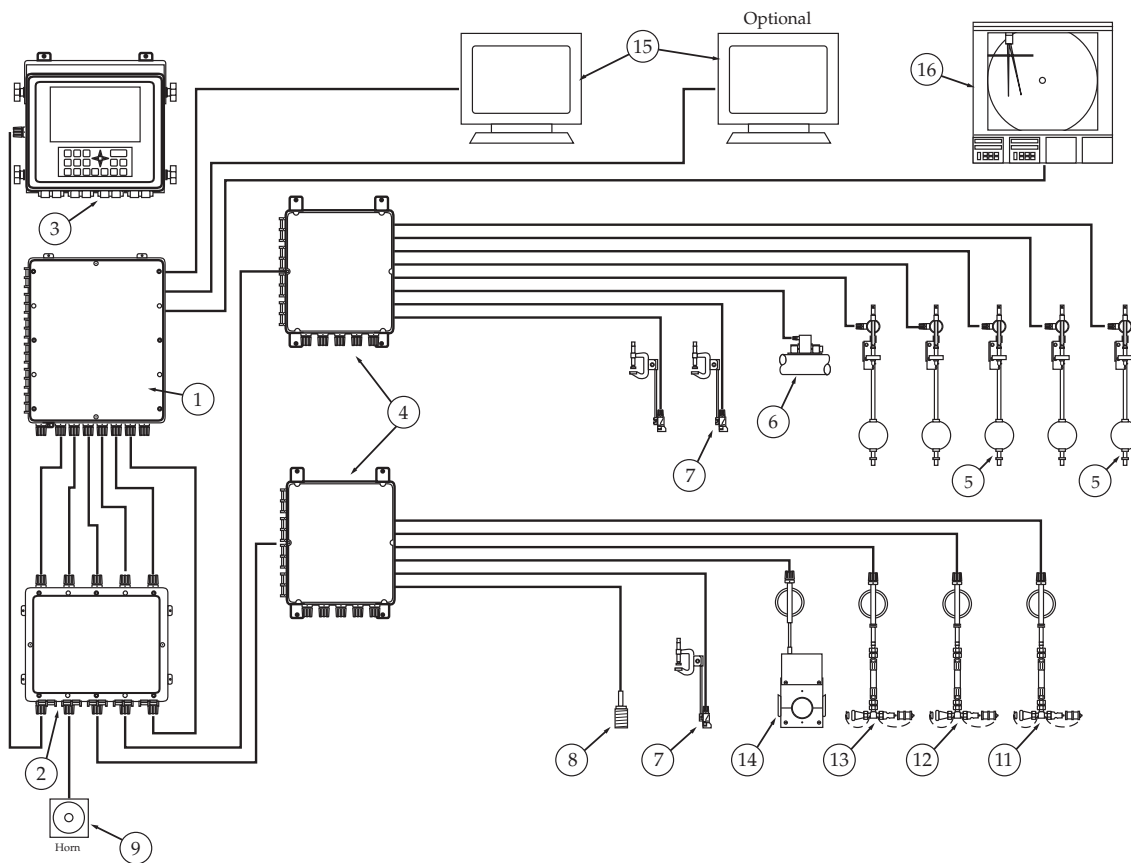
Engineering Drawing: SG-SMART, Level I

Qty	No.	Description
1	1	Box assembly junction interface
1	2	Box assembly junction barrier
1	3	Driller's monitor
1	4	Box assembly junction satellite
5	5	Transmitter assembly pit level 100 in. (2,540 mm) 1.5k OHM without cable
1	6	Transmitter assembly flow ELEC I/S without cable
2	7	Switch assembly proximity I/S without cable
1	8	Horn assembly I/S 24 VDC



Engineering Drawing: SG-SMART, Level II

Qty	No.	Description
1	1	Box assembly junction interface
1	2	Box assembly junction barrier
1	3	Driller's monitor
2	4	Box assembly junction satellite
5	5	Transmitter assembly pit level 100 in. (2,540 mm) 1.5k DHM without cable
1	6	Transmitter assembly flow ELEC I/S without cable
3	7	Switch assembly proximity I/S without cable
1	8	Switch proximity I/S CSA .59-in (15-mm) range
1	9	Horn assembly I/S 24 vdc
5	10	Module assembly communication FDC
2	11	Transducer assembly I/S 1,000 psi (68.9 bar) 1-5 VDC output
1	12	Transducer assembly I/S 6,000 psi (413.7 bar) 1-5 VDC output
1	13	Transducer assembly I/S 10,000 psi (689.5 bar) 1-5 VDC output
1	14	Sensor assembly I/S induction torque 0-2.9v output
1	15	Monitor assembly remote
1	16	Recorder assembly circular chart 2 pen ELEC programmable



Sensor List: SG-SMART, Level I and II

Variable Description	Measured or Calculated	SG-SMART Level I	SG-SMART Level II
Analog Spares	Measured	4	10
Analog Spares Total	Calculated	Yes	Yes
Bit Location	Calculated		Optional
Bit Weight	Calculated		Yes
Block Location	Measured		Optional
Casing Pressure	Measured		Yes
Casing Pressure G/L	Calculated		Yes
CO ₂	Measured		Optional
Connection Distance	Calculated		Optional
Count-up Timer	Calculated	Yes	Yes
Depth	Measured		Yes
Electric Torque	Measured		Yes
Fill Volume	Calculated	Yes	Yes
H ₂ S	Measured		Optional
Hookload	Measured		Yes
Hydraulic Torque	Measured		Yes
Mud Conductivity In	Measured		Optional
Mud Conductivity Out	Measured		Optional
Mud Gas Out	Measured		Optional
Mud Temperature In	Measured		Optional
Mud Temperature Out	Measured		Optional
Mud Weight In	Measured		Optional
Mud Weight Out	Measured		Optional
Pipe Acceleration	Calculated		Optional
Pipe Velocity	Calculated		Optional
Pit G/L	Calculated	Yes	Yes
Pit Tanks	Measured	10	10
Pump Pressure	Measured		Yes
Pump Pressure G/L	Calculated		Yes
Pump SPM	Measured	5	5
Pump Strokes	Measured	5	5
Return Flow	Measured	Yes	Yes
ROP	Calculated		Yes
Rotary rpm	Measured		Yes
Skim Tank G/L	Calculated	Yes	Yes
Skim Tanks	Measured	4	4
Spare Accumulations	Calculated	5	5
Spare Rates	Measured	5	5
Strokes to Fill	Calculated	Yes	Yes
Time in Slips	Calculated		Yes
Total Fill Volume	Calculated	Yes	Yes
Total Pit Volume	Calculated	Yes	Yes
Total Pump SPM	Calculated	Yes	Yes
Total Pump Strokes	Calculated	Yes	Yes
Total Skim Volume	Calculated	Yes	Yes
Total Trip Volume	Calculated	Yes	Yes
Trip G/L	Calculated	Yes	Yes
Trip Tanks	Measured	2	2
Volume per Minute	Calculated	Yes	Yes

Measured Variables

1. **Mud Pit level** — Magnetic float-level type. 0- to 5-volt signal — Optional Ultrasonic².
2. **Trip Tank level** — Same as mud pit.
3. **Skim Tank level** — Same as mud pit.
4. **Analog Spare** — Additional inputs for 0- to 5-volt signal.
5. **Return Flow** — Weighted paddle in the return flowline for 0 to 100% relative flow. 0- to 5-volt signal.
6. **Hookload** — Either 0- to 100-psi (0- to 6.9-bar) sensor on a deadline or 0- to 1,000-psi (0- to 69-bar) sensor on the sensorator.
7. **Pump Pressure** — 0- to 6,000-psi (0- to 413.7-bar) sensor on the stand pipe. 1- to 5-volt signal.
8. **Casing Pressure** — 0- to 10,000-psi (0- to 689.5-bar) sensor on the choke. 1- to 5-volt signal.
9. **Rotary Torque**
 - Electric* — Induction measurement of current in one leg of the drive motor.
 - Hydraulic* — 0- to 1,000-psi (0- to 69-bar) sensor on the rotary hydraulic system.
 - Top Drive* — 4- to 20-mAmp² signal from top drive unit.
10. **Methane Gas** — Infrared hydrocarbon sensor that samples gas from the possum belly.
11. **CO₂, H₂S** — 4- to 20-mAmp² sensors.
12. **Mud weight In/Out** — 4- to 20-mAmp² differential pressure sensor in the discharge and suction pits.
13. **Mud Temperature In/Out** — 4- to 20-mAmp² sensor in the flowline and suction pit.
14. **Mud Conductivity In/Out** — 4- to 20-mAmp² sensor in the discharge and suction pits.
15. **Depth**
 - Standard* — Sensor on the drilling recorder to measure depth.
 - Bit Tracking* — Sensor on the fast sheave that tracks block location.
16. **Downtime Switch** — Input for a mechanical switch to tell the system when system is in downtime if using standard depth.
17. **Rotary RPM**
 - Standard* — Proximity sensor that measures the revolutions of the rotary table.
 - Top Drive* — 4- to 20-mAmp² from top drive unit.

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