

## P - Series Field Installation Manual



Ahead of the Curve<sup>sm</sup>



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#### MODEL: P-4000/4500/5500 Field Installation

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#### 1. P-Series Gauge Overview

The P-Series gauges are proven designs in permanent installations by **Sercel-GRC**. Pressure measured with a Piezo Resistive element and temperature measurements via RTD are transmitted through a single conductor electric line to a surface real-time interface. FSK technology allows up to six channels of data to be communicated on a single TEC.

With its rapid response to temperature and pressure changes, the P-Series downhole monitoring systems are vital for reservoir management. The P-Series gauges are uniquely designed to be field adaptable where the user can mount the gauge external to the tubing on a carrier that can measure annular or tubular pressure, the gauge can be deployed concentrically in the tubing or casing hanging on the TEC, or the gauge can mounted below a pump and fixed in a carrier.

- Pressure rating: 10,000 psi.
- Temperature rating: -20°C to 150°C operational, 25°C to 150°C within pressure spec.
- Pressure accuracy: ±0.05% of Full Scale (±2.5 psi for 5 kpsi, ±5 psi for 10 kpsi)
- Pressure resolution: 0.01 psi
- Temperature accuracy: ±0.3°C
- Temperature resolution: 0.01°C
- Vibration: Vibration will be enabled or disabled at the factory.

	P-4000S/T&B/C	P-4500S/T&B/C	P-5500		
Intake Pressure					
Max Pressure	10,000 psi	10,000 psi	10,000 psi		
Pressure Accuracy	0.05% FS	0.05% FS	0.05% FS		
Pressure Resolution	±0.01 psi	±0.01 psi	±0.01 psi		
Discharge Pressure					
Max Pressure	N/A	N/A	10,000 psi		
Pressure Accuracy	N/A	N/A	0.05% FS		
Pressure Resolution	N/A	N/A	±0.01 psi		
Intake Temperature	Intake Temperature				
Max Temperature	150°C	150°C	150°C		
Temperature Accuracy	0.3°C	0.3°C	0.3°C		
Temperature Resolution	±0.01°C	±0.01°C	±0.01°C		
Discharge Temperature					
Max Temperature	N/A	N/A	150°C		
Temperature Accuracy	N/A	N/A	0.3°C		
Temperature Resolution	N/A	N/A	±0.01°C		
Vibration (X & Y Axis)					
Vibration Range	N/A	0-18g	0-18g		
Vibration Accuracy	N/A	1%	1%		
Vibration Resolution	N/A	.055g	.055g		
Mechanical					
Transducer	Piezoresistive	Piezoresistive	Piezoresistive		
Gauges in Parallel	Up to 6	Up to 3	Up to 2		
Carefiannation	Above or Below the Pump	Above or Below the Pump	Above or Below the Pump		
Configuration	or Concentric in the Tubing/Casing	or Concentric in the Tubing/Casing			
Housing Material	17-4 PH	17-4 PH	17-4 PH		

#### 2. P-Series Specifications

Table 1 – P-Series Specifications

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#### 3. Introduction

This document outlines the correct way to install a P-Series gauge on a work over rig in a vertical well. Please follow the steps precisely to ensure a successful installation. Any shortcuts taken will compromise the integrity of the installation and may affect the life span of the system. If the client representative has any questions about why the installation is taking place in a particular manner, please let him view this document or contact a Field Service Engineer at Sercel-GRC for further explanation.

#### 4. Safety Meeting on Location

The following points should be made while conducting the safety meeting on location.

- The TEC cable is very fragile. You must mind its position at all times, especially in the Sheave Wheel and in the Slips.
- ALWAYS COVER THE HOLE WHEN INSTALLING BANDS OR CLAMPS.
- Make sure that any cabling connected from the Spooling Unit and Slip Ring is well marked so that personnel do not trip over it.
- Watch all pinch points while installing the bands and/or clamps.
- Wear the proper PPE (Personal Protection Equipment) for the job at all times.
- Anytime the cable is being cut, always wear cut resistant hand gloves.
- When making the wire connections and crimp connections, do not wear hand gloves.
- Make sure that the location of all personnel is known at all times.
- Do not stand next to the cable or the spooling unit unless absolutely necessary. The tubing can part at any time causing the spool to turn rapidly and uncontrollably.
- The P-Series gauge should be **connected** to the proper SRO data acquisition system to check for proper operation before beginning installation procedure.

#### 5. Rigging Up of Spooling Unit, TEC Sheave and Slip Ring

- 1. Upon arrival on location, check in with the client representative and introduce yourself and all members of your crew. Let him know what role each representative has in the installation.
- 2. Place sheave near the rig so the winch line can be connected.
- 3. Run TEC through the sheave while on the ground.
- 4. Attach a rope to the sheave to use as a guide line during lifting and decent.
- 5. Hold the rope in one hand and have a crew member hold the TEC cable, release the spool to allow the rig crew to install the sheave wheel in the derrick as shown in Figure 1. Make sure someone is manually advancing the spool and the person holding the TEC on the ground has a firm grip.





Figure 1- Rigging the Spooling Unit

- 6. Locate the spooling unit so that the TEC sheave is in the center of the spool and the ends of the spool are parallel to the TEC sheave.
- 7. Once the sheave is secure on the rig walk the TEC out to the area the gauge is going to be made up and secure the end.
- 8. Secure the guide rope out of the way so it doesn't interfere with the rig or cable.
- 9. Connect the slip ring to the spooling unit if available. See Figure 2.



Figure 2 – Connecting the Slip Ring to the Spooling Unit

- 9.1 Cut the end of the TEC and expose the conductor.
- 9.2 Place the TEC inside the metal junction box using an NPT to Swagelok fitting.
- 9.3 Connect the conductor wire on the slip ring to the conductor wire on the TEC cable, preferably using a terminal connection as shown in the picture above (red positive (+) and brown is negative (-).

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- 9.4 Connect the ground wire on the slip ring to a screw terminal that is conductive with the body of the metal junction box.
- 9.5 Test the conductive side of the connection and the ground side of the connection with an ohmmeter to ensure that the connection was made correctly.

#### 6. P-Series Cable Head Install

- 1. Unpack the gauge and visually check to ensure that no damage has occurred.
- 2. Table 2 contains a minimum list of parts needed ot install the Cable Heads on a P-Series gauge.

ltem	GRC Part Number	Description	QTY
1	10035265	PRIMARY CABLEHEAD, STAINLESS STEEL	1
2	10035261	CABLE HEAD, SECONDARY	2
3	037-0074-04	CRIMPABLE FEMALE BOOT ASSEMBLY	1
4	037-0186-01	RETAINING SLEEVE FOR K-25 SFT	1
5	079-0015-00	O-RING, # 015 VITON, 90 DUROMETER	4
6	089-0239-00	FITTING, SAFETY CHANGER NUT&FER	1
7	089-0278-00	FITTING,SS 1/8NPT X 1/4"	2
8	089-0400-00	PLUG, PIPE,1/8-27 NPT H.PRES,	1
9	140-0010-00	TAPE, TEFLON SEALANT	1
10	140-0112-00	PARKER SUPER O-LUBE, 1/2 OZ	1
11	135-0026-00	NICKEL ANTI-SEIZE 2600°F	1
	Table 2	- P-Sorios Cablo Hoad Install Parts List	

Table 2 – P-Series Cable Head Install Parts List

- 3. The items on this list in Table 2 will be referenced throughout this section.
- 4. Very carefully remove the top Cable Heads (Items 1 & 2) of the gauge.
- 5. Take a resistance check of the gauge with an ohm meter. Connect the positive lead to the pin connector of the gauge and ground the negative lead to the gauge housing at some point. Make a note of these resistances. The positive reading (forward) typically is between  $0.5M\Omega$  to  $10 M\Omega$  and the negative (reverse) should be at least  $10 M\Omega$  and above.
- 6. Connect the FIC-1500P unit to the gauge and record the readings. If addressing needs to be changed now is the time to do it.
- 7. Remove the Santoprene jacket from the tubing for approximately 15 inches. Make sure the 1/4" tubing is smooth, straight, and free of any nicks and/or scratches. See Figure 3.



Figure 3 – Preparing TEC for Connection



 Cut off approximately 2-1/2" of the1/4" tubing and remove the filler. See Figure 4 for strip dimensions. Electrically short inner and outer conductors to discharge cable before attaching pin to cable. It is recommended to install boot assembly as seen in Figure 7 prior to stripping the center conductor.



Figure 4 – Stripping Instructions

9. Install 2 x 2-015 O-ring (Item 5) onto Primary Cable Head (Item 1) lightly applying Super O-Lube (Item 10) to the O-rings. Install Teflon Tape (Item 9) onto male threads of the fitting (Item 7) 1-1/2 to 2 turns counterclockwise. Slide items 7, 2, 6, and 1 starting with item 7 onto the bare ¼" line. See Figure 5 for the cablehead orientation. Note the orientation of the nuts and ferrules (Figure 6) on items 10 and 8. Make sure nuts are not tightened so the TEC can freely slide through them.



Note: Once ferrules and nut are on the TEC cable, verify they are in the correct order. Make sure at least two set of eyes have verified orientation of ferrules. Figure 6 shows the correct orientation of the ferrules on a safety changer.



**Figure 6 - Correct Orientation of Ferrules** 

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10. Grease the insulation of the wire with Super O-Lube (Item 10) and slide Retaining Sleeve (Item 4), Boot, and Teflon sleeve onto the wire up to the .25" jacket. Strip insulation off wire 1/5" as seen in Figure 4. Slide wire into the Insert on the gold side and crimp wire on the gold side. Boot, Teflon Sleeve, and Insert all are part of Item 5. See Figure 7 for clarification on the boot and Connector Assembly to the TEC.



Figure 7 - Installing the Boot and Contact Assembly

11. Install 2 x 2-015 O-ring (Item 5) onto gauge and lightly apply Super O-Lube (Item 11) to the O-rings. Lightly grease external of Insert and slide Teflon and Boot over Insert. Grease inside of Insert and slide onto Connector Pin. Remove from Connector and wipe excess grease off. Install Boot and Insert Assembly back onto connector pin and slide Retaining sleeve over Boot and Insert Assembly. Screw the Retaining Sleeve onto pin hand tight. Make sure to keep the TEC supported so as to not break the connector pin on gauge. See Figure 8 for clarification of how the connector assembly should look when installed onto the gauge.



12. Use Anti-Seize (Item 11) on identified areas in Figure 8. Screw the Primary Cable Head on to the Gauge and torque to **90 ft\*lbs.** Cable Heads have a 7/8" Hex.



- 13. Slide the Nut and Ferrules down the TEC and screw nut onto cable head until finger tight.
- 14. At this time it is recommended to see if the gauge is communicating through the TEC with the data acquisition FIC-1550P.
- 15. Further tighten nut with 9/16" wrench 1-1/4 turns.
- 16. Lubricate areas identified in Figure 9 with Anti-Seize (Item 11). Ensure the O-Rings have a layer of Super O-Lube (Item 10)



Figure 9 – Primary Cable Head Lubrication

- 17. Slide Secondary Cable Head (Item 3) down TEC and screw onto the Primary Cable Head (Item 1). Torque to **90ft\*lbs.**
- 18. Screw the fitting to the Secondary Cable Head to finger tight. Then, using a 1/2" wrench on wrench flats indicated in Figure 10, screw the fitting down 2-3 turns.



Figure 10 - Installing Fitting onto Secondary Cable Head

19. Hand tighten the fitting nut. Further tighten nut with 9/16" wrench 1-1/4 turns.

#### 7. Cable Head Pressure Test

- 1. It is recommended but not required to pressure test the seals of the Primary Cable Head through the port holes on the Secondary Cable Head.
- 2. Remove 1/8" NPT plug using a 3/16" Allen wrench from cable head as seen in Figure 11.







Figure 11 – Pressure Test Port on Secondary Cable Head

- 3. Connect hydraulic line from a 5,000 psi Hydraulic pump to the 1/8" NPT hole on the cable head.
- 4. Fill Cable head with fluid and purge air.
- 5. Pressure cable head to 1,500 psi and hold for 3 min.
- 6. Pressure cable head to 5,000 psi and hold for 15 min.
- 7. Replace the 1/8" NPT plug Per the instructions below.
  - a. Wrap the Teflon Tape (Item 9) onto the Plug 1-1/2 to 2 turns in the counterclockwise direction as seen in Figure 12.



Figure 12 – Teflon Tape Install on NPT Plug

- b. Screw the plug in to the port clockwise on the cable head to finger-tight torque.
- c. Screw the NPT Plug 2-3 turns past hand tight.

#### 8. Installing the P-4000/4500 Gauge Onto the Mandrel

1. Table 2 contains a minimum list of parts needed to install a P-Series gauge onto a mandrel once the Cable Heads are installed.

GRC Part Number	Description	QTY
10034590	ADAPTER, CARRIER, LIFE OF THE WELL	1
089-0242-00	COLLAR, 9/16" 316SS	1
10036327	ASSY, 9/16" ANTI-VIBRATION COLLET GLAND	1
079-0012-02	O-RING, # 012 VITON, 75 DUROMETER	4
089-0400-00	PLUG, PIPE,1/8-27 NPT H.PRES,	1
140-0010-00	TAPE, TEFLON SEALANT	1
140-0112-00	PARKER SUPER O-LUBE, 1/2 OZ	1
135-0026-00	NICKEL ANTI-SEIZE 2600°F	1
	GRC Part Number10034590089-0242-0010036327079-0012-02089-0400-00140-0010-00140-0112-00135-0026-00	GRC Part Number         Description           10034590         ADAPTER, CARRIER, LIFE OF THE WELL           089-0242-00         COLLAR, 9/16" 316SS           10036327         ASSY, 9/16" ANTI-VIBRATION COLLET GLAND           079-0012-02         O-RING, # 012 VITON, 75 DUROMETER           089-0400-00         PLUG, PIPE, 1/8-27 NPT H.PRES,           140-0010-00         TAPE, TEFLON SEALANT           140-0112-00         PARKER SUPER O-LUBE, 1/2 OZ           135-0026-00         NICKEL ANTI-SEIZE 2600°F

Table 3 – P-4000/4500 Gauge Install Parts List

2. The items on this list in Table 3 will be referenced throughout this section.



- 3. The P-4000/4500 should come with the Carrier Adapter (Item 1) installed on the gauge from the factory. In the event this is not the case or if the gauge is being re-ran the below steps will describe how to install.
  - a. Install two #012 O-rings (Item 4) onto Carrier Adapter and lubricate with Super O-Lube (Item 7) see Figure 13 for illustration.
  - b. Apply Nickel Anti-Seize (Item 8) to threads and face as indicated in Figure 13.
  - c. Ensure port on gauge is completely clean and free of any debris.



Figure 13 – Carrier Adapter Preparation for Install

- d. Screw carrier adapter into port on gauge and torque to **70 ft\*lbs**. A small gap of around .06" as seen in Figure 14 is designed to ensure metal to metal seals engage internally.
- 4. Prior to installing the gauge on the mandrel ensure the Anti-Vibration Gland Assembly (Item 3) as seen in Figure 14 is assembled in the order shown. Use Nickel Anti-Seize (Item 8) on all threads and indicated face.



Figure 14 - Installing Fittings and O-Rings on Nose of Gauge

- 5. Slide the collar (Item 2) onto nose and screw onto nose until it bottoms out. The threads are left hand threaded so turn counterclockwise to install. See Figure 14 for clarification. Make sure that the gland nut (top locking nut) is loose.
- 6. Apply Super O-Lube (Item 7) onto O-rings (Item 4) and install on nose. See Figure 14.
- 7. Screw the body of the fitting into the port and torque to **55ft\*lbs**. Then torque locking nut to 55ft\*lbs. See Figure 15.







8. It is recommended to verify communication on the PIEZO gauge and document the pressure and temperature.

#### 9. Installing the P-5500 Gauge Onto the Mandrel

- 1. The P-5500 cablehead install follows same install process as described in Section 6. The part number of the Secondary Cablehead for the P-5500 (Item 2 in Table 2) is 10041228.
- 2. It is recommended but not required to pressure test the seals of the Primary Cable Head through the port holes on the Secondary Cable Head. Test per steps described in Section 7.
- 3. Table 4 list parts unique to the P-5500 gauge install to the mandrel. The parts in this table will be refered to throughout the rest of this section.

Item	GRC Part Number	Description	QTY	
1	10041316	GAUGE CLAMP, P-5500 CARRIER	1	
2	10041318	SCREW, SKT HD CAP, 1/4-20, 1/2 LG, SS	2	
Table 4 D 5500 Mendeal leadall Darte				

Table 4 – P-5500 Mandrel Install Parts

- 4. Installing the P-5500 onto the mandrel follows all the steps in Section 8 in addition to following steps.
- 5. Once the gauge is installed to the port apply anti-seize to the clamp screws (Item 2).
- 6. Slide clmap (Item 1) over gauge and install screws. Torque screws to **65in\*lbs** with a 3/16" Allen Hex wrench. See Figure 16 for clarification.







Figure 16 – P-5500 Clamp Install on Mandrel

#### 10. Carrier Pressure Test

- 1. It is recommended but not required to pressure test the seals of the Mandrel and Gauge.
- 2. Remove 1/8" NPT plug using a 3/16" Allen wrench from cable head as seen in Figure 17



Figure 17- Test Port on Mandrel

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- 3. Connect the hydraulic line from a 5,000 psi Hydraulic pump to the 1/8" NPT hole on the port.
- 4. Fill the port with fluid and purge air.
- 5. Pressure the port to 1,500 psi and hold for 3 minutes.
- 6. Pressure the port to 5,000 psi and hold for 15 minutes.
- 7. Remove the line ..
- 8. Replace the 1/8" NPT plug in carrier as per instructions in Section 7 Step 8 a-c

#### 11. Tubing Clamp Gauge Carrier (Mid Joint Type)

- 1. After gauge is connected to the TEC cable place gauge inside clamp pocket.
- 2. Place clamp around tubing. Use a clamp closing tool to close clamp. Figure 18. Note: Clamp closing tool shown is manual but a pneumatic tool may be used.





Figure 18 – Install Clamp on Tubing and use a Clamp Closing Tool

3. Use a pneumatic hammer to drive the locking pin into the clamp. See Figure 19.







#### **12. RIH with the P-Series Gauge and Mandrel**

- 1. Hold a pre-job safety meeting on the rig floor and make sure that all personnel are aware of the role that they will carry as the job is conducted.
- 2. Align the rotary table so that the groove on the bushing is oriented so that the TEC will pass through the groove.
- 3. Place and band on above and below the collar on top of the gauge carrier.
- 4. Once the tubing is lowered and the slips are set, pull and hold the TEC back out of the way so that the next tubing joint can be installed and the tubing tongs do not damage the cable.
- 5. As the tubing continues to be installed, place a band above each collar after and one band in the middle of the joint.

NOTE: DO NOT PUT ANY BACK TENSION ON THE SPOOLING UNIT UNTIL AT LEAST 4 BANDS HAVE BEEN PLACE ON THE TUBING STRING.

6. Continue the steps above until the tubing hanger is reached.



### TUBING WRAP PROCEDURE IF REQUIRED by Customer

- Determine the length of cable needed outside the well head with a minimum length of 3 feet
- 2. Multiply that number by 3.
- 3. Mark the cable at the tubing hanger or well head outlet
- 4. Measure off a length of cable equal to the value of step 2.
- 5. Assemble the tubing hanger or well head flange onto the tubing
- 6. Raise the tubing to a height equal to Step 2.
- 7. Place a band or clamp on the tubing string below where the wraps will be oriented.
- 8. Tightly wrap the cable around the tubing so that the length of cable is 2 times the step one measurement.
- 9. If there is a connection on the bottom of the tubing hanger or well head outlet, slide the compression fitting over the cable and double check the ferrule configuration.
- 10. Feed the cable through the well head outlet or tubing hanger.
- 11. Place a compression fitting or TEC to connect to a tubing hanger or place the compression fitting or well head outlet onto the TEC once the well head is landed.
- 12. Continue with nipple down procedure and prepare to terminate the well head outlet.







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### 13. Cable Termination Feed-Thru at the Tubing Hanger

- 1. Once the Tubing hanger is installed, have the driller lift the tubing hanger 15 feet above the rotary table. It will be necessary to use a tape measure to measure the distance.
- 2. Place a band/clamp on the tubing 15 feet below the tubing hanger.
- 3. Remove the air pressure (tension) from the spooling unit.
- 4. Pull the TEC off the spooling unit, measuring 45 feet of line from the last band that was place 15 feet below the hanger.
- 5. Cut the TEC at the end of the 45 feet mark.
- 6. Coil the TEC to the same diameter as it was on the reel and hold it.
- 7. With one person holding the TEC at the last band and one person holding the TEC Coil, make 15-20 wraps (depending on Tubing size, enough wraps to wrap a total of 15 feet) around the tubing.
- 8. Slightly bend the TEC so that it can go up alongside the tubing to the tubing hanger.
- 9. Place another band above the wraps.
- 10. Stand next to the tubing and put your arm straight up in the air.
- 11. Have the driller lower the tubing hanger so that the bottom of the tubing hanger hits the top of your fingers.
- 12. Slide the correct size NPT to ¼ in Swagelok fittings over the TEC cable.

# NOTE: VERIFY WITH TWO SETS OF EYES THAT THE FERRULES ARE ORIENTED CORRECTLY

- 13. Put a piece of black tape around the TEC cable below the hanger so that the fitting does not slide.
- 14. Slide the TEC Cable through the tubing hanger.
- 15. Slide the fitting up the TEC cable and screw it into the tubing hanger with the correct size spanner until tight. Make sure that Teflon tape is wrapped around the NPT side of the fitting.
- 16. Tighten the Swagelok fitting.
- 17. Slide the NPT fitting that is going to be installed on top of the hanger over the TEC
- 18. Repeat steps 15 and 16.
- 19. Using the Tubing Bender, bend the tubing 90 deg at the top tubing hanger fitting. (This is dependent on your well head and not usually needed)
- 20. Wrap the TEC around the top of the tubing hanger 5 times. (Only if required by customer)



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- 21. Cut the TEC Cable.
- 22. Reconnect the TEC cable to the FIC-1500P and record a reading on the gauge
- 23. Install a cap on the end of the TEC Cable.
- 24. Use wire ties to secure the TEC cable to the top of the hanger so that it can be lowered into the casing hanger.

#### 14. Wellhead Outlet and Cable Termination

Several types of wellhead outlets and cable terminations can be used at this point. This procedure will explain the easiest method.

- 1. After the rig crew nipples down the BOP and riser, unwrap the TEC cable and straighten as much as possible.
- 2. Feed the TEC cable through the exit hole on the Christmas tree.
- 3. Slide the exit bushing over the TEC cable and screw into the exit hole on the Christmas tree.
- 4. Verify that the nut and ferrule are correctly oriented.
- 5. Tighten the nut and ferrule onto the exit bushing.
- 6. Run the TEC cable to the junction box where the surface cable will be terminated.
- 7. Terminate the TEC cable at the junction box.
- 8. Reconnect the SRO to the surface cable and record the reading on the gauge.

