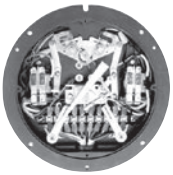
MODELS 288A/288C/290D
DIFFERENTIAL PRESSURE INDICATING-SWITCHES

(M288C for Industrial Service and Barton® brand M288A (non-C) for Nuclear Service)

Model 288C



288A uses 224 DPU
288C/290D use 224C DPU

Installation Manual

Part No. 10300, Rev. 01
July 2007

[This manual is for indicating-switch only - see separate 224/224C DPU manual.]

CONTENTS

SAFETY

Before installing this instrument , become familiar with the installation instructions in Section 2 and in the separate 224/224C DPU manual.

DANGER notes indicate the presence of a hazard which will cause severe personal injury, death, or substantial property damage if warning is ignored.

WARNING notes indicate the presence of a hazard which can cause severe personal injury, death, or substantial property damage if warning is ignored.

CAUTION notes indicate the presence of a hazard which will or can cause moderate personal injury or property damage if warning is ignored.

DANGER, WARNING, and/or CAUTION notes that appear on the following pages of this manual should be reviewed before proceeding: 13 . (Important! Before installing or operating this instrument, review all safety notices contained in the separate 224/224C DPU manual, per models listed on front page.)

DPU "C" VERSION DESIGN CHANGE

The 288C and 290D utilize a 224 C DPU, which is a redesigned version of the 224 DPU. The "C" version is identical in function, performance, installation, and operation to the previous version - redesign was for improved manufacturing only. This design change does not affect the instrument being actuated. Barton-brand instruments, using the Model 224 (Non-C) DPU, are for Nuclear service only.

RECORD OF CHANGES

	DATE	DESCRIPTION
03E08n	5/03	Booklet; Combined 288/290 & 289/291 manuals (replaces ID#10300 & 10310); Assigned unique ID# (10305); Revised Wiring diagrams, Fig. 2-1; Reorganized; Removed explosion - proof "A" Case version information; Add Drive Arm to Torque Tube Locking procedure/Tightness Test; Add Bezel/Lens in - stall/removal procedure; Updated ODD drawings; Updated Parts Drawings; Updated Parts Lists
03H10f	8/03	Combined 288A/288C/290D Versions; Removed 289 and 291 information (Replaces 288/290 portions of (10305) Manual; Rev. Co. Name/Logo to PRIME Measurement Products;
04A05a	1/04	Rev. para. 1-3: ref.: Std. models can have one or two alarm sw.
04C05a	6/04	Corrected version number to 04C05a. No other changes.
06G08a	7/06	Rev. pg. 2 statements; Updated to new wire color coding scheme {Add Table 2-1 - Wire Color Coding, Rev. wiring diagrams throughout, and Rev. Section 4 throughout (parts drawings/lists)]; Updated Section 5; Ref. Barton brand for Nuclear Service (cover) ; Non-technical changes throughout
01	7/07	Revised corporate name/logo/contact information to reflect Cameron ownership.

SECTION 1 - INTRODUCTION

1-1. General

The weatherproof Models 288A, 288C, and the explosion-proof Model 290D are DP Indicating Switches. The 288A and 288C have a NEMA-4 watertight die-cast aluminum case (finished with a weather-resistant black epoxy resin paint). The cover lens is secured in the bezel with an elastomer ring to reduce the possibility of accidental breakage. This ring also acts as a seal between the bezel and the case to ensure a moisture, fume and dust-free atmosphere for the indicator and switch mechanism.

Model 290D has an explosion-proof case that is certified for Class I, Division 1, Groups B, C & D service. The large cover lens allows maximum readability of the indicating pointer.

Switches and all adjustments are readily accessible when the cover is removed.

The built-in switches energize either single or dual alarm circuits when the mea - sured differential pressures exceed predetermined limits. These limits may be either maximum, minimum, or both.

1-2. Main Components

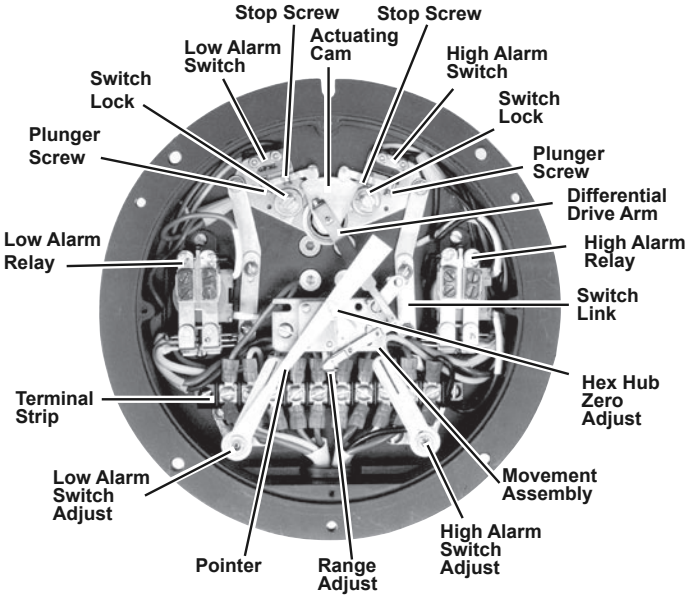


Figure 1-1. Switch Components

A. Indicating Switch

B. Differential Pressure Unit (DPU)

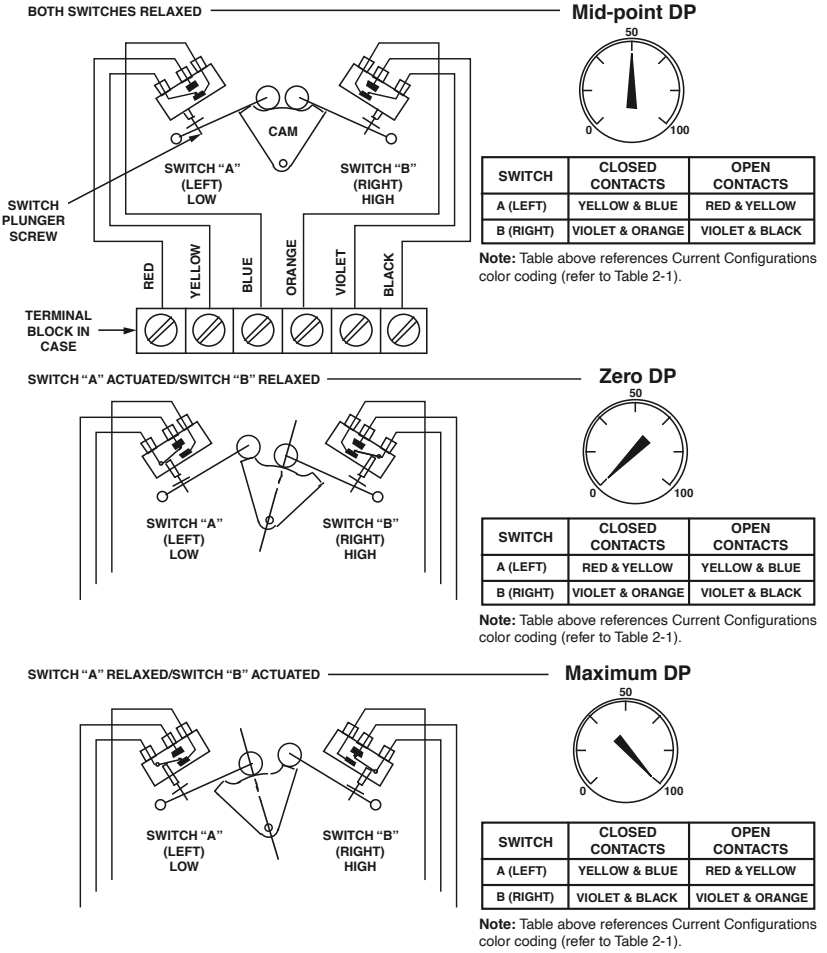
- 288A is actuated by a Model 224 DPU
- 288C and 290D are actuated by a Model 224 C DPU

For detailed information on the DPU, see separate 224/224C DPU manual.

1-3. Indicating Switch (refer to Figures 1-2/2-1 to 2-6 and Table 2-1)

Rotation of DPU torque tube shaft is coupled through connecting linkage within the switch case to move the pointer across the scale plate. An actuating cam, directly connected to torque tube shaft, rotates with the motion of the shaft. Two cam follower roller/actuator arm assemblies, one for each switch, respond to torque tube rotation by opening and closing the switches as they ride on and off the cam. The levels of DP at which the switches actuate are adjustable with high and low alarm switch adjustments on the scale plate.

Standard models can have one or two alarm switches. Each switch can be con - nected to operate normally-opened or normally-closed. The direct-set switch contacts are adjustable over a scale range of 5-95% nominal.



SWITCH	CLOSED CONTACTS	OPEN CONTACTS
A (LEFT)	YELLOW & BLUE	RED & YELLOW
B (RIGHT)	VIOLET & ORANGE	VIOLET & BLACK

Note: Table above references Current Configurations color coding (refer to Table 2-1).

SWITCH	CLOSED CONTACTS	OPEN CONTACTS
A (LEFT)	RED & YELLOW	YELLOW & BLUE
B (RIGHT)	VIOLET & ORANGE	VIOLET & BLACK

Note: Table above references Current Configurations color coding (refer to Table 2-1).

SWITCH	CLOSED CONTACTS	OPEN CONTACTS
A (LEFT)	YELLOW & BLUE	RED & YELLOW
B (RIGHT)	VIOLET & BLACK	VIOLET & ORANGE

Note: Table above references Current Configurations color coding (refer to Table 2-1).

Figure 1-2. Switch Actuation Example
(current configuration color codes - see Table 2-1)

Notes: (1) Cam rotates counter-clockwise with increased pressure; (2) Switches shown w/low at 25% DP and high at 75% DP; (3) To change setpoint: loosen lock screw, move switch plate, tighten screw, and test setpoint; (4) Internal wires use No. 22 AWG and external wires use No. 18 AWG

1-4. Specifications

General:

Actuating Unit (DPU) ..... per specific instrument model (refer to page 1 of this manual)

Dial Size ..... 6-inches (150 mm)

Accuracy of Indication ..... ±1% * of full scale DP

Accuracy at
Point of Switch Actuation ..... ±1.5% * of full scale differential pressure

*NOTICE: Accuracy varies with DP range, bellows size, etc.. For general accuracy information, refer to Ind/Switch/Xmtr Product Bulletin (ID#21920). For specific model/configuration accuracy specifications, consult F actory.

Temperature Limits (Ambient) ... -40°F/°C to +180°F (+80°C)

Switch:

Accuracy of:

- Switch Repeatability ..... ±0.25% of full scale
- Switch Deadband ..... ±5% (SPDT); ±6% (DPDT)

Switch Type ..... Mechanical, Snap-Acting; all switches are SPDT (DPDT switches are stacked SPDT switches with a common actuator)

Contact Type ..... Single Pole, Double Throw (SPDT)
Double Pole, Double Throw (DPDT)

Adjustment ..... All switches are adjustable between 5% and 95% of factory calibrated scale

Activation ..... Switches can be calibrated to actuate either increasing or decreasing scale

Switch Contact Rating:

- 2.5 Amps @ 250 VAC, 50/60 Hz ❶
- 5.0 Amps @ 250 VAC, 50/60 Hz
- 5.0 Amps @ 125 VAC, 50/60 Hz ❶
- 3.0 Amps @ 30 VDC (Resistive) ❶❷
- 0.4 Amps @ 125 VDC (Resistive)
- 0.2 Amps @ 125 VDC (Inductive) ❶❸
- 0.1 Amp @ 30 VDC (Inductive) ❷❸

See Notes on page 6.

(continued on next page...)

1-4. Specifications (continued)

Relay:

Contact Types ..... Single Pole, Double Throw (SPDT)
Double Pole, Double Throw (DPDT)

Relay Contact Ratings:

25 Amps @ 150/250 VAC, 50/60 Hz, SPDT
25 Amps @ 300 VAC, 50/60 Hz, DPDT
5.0 Amps @ 600 VAC, 50/60 Hz
13 Amps @ 28 VDC ❷
20 Amps @ 15 VDC ❷
0.75 HP @ 200/240 VAC, 50/60 Hz
1.0 HP @ 200/240 VAC, 50/60 Hz, SPDT
1.5 HP @ 200/240 VAC, 50/60 Hz, DPDT
10 Amps (Resistive) @ 120 VAC ❶
5 Amps (Inductive) @ 120 VAC ❶❸
10 Amps (Resistive) @ 26.5 VDC ❸❷
5 Amps (Inductive) @ 26.5 VDC ❶❷❸
0.5 HP @ 120 VAC ❶
1.0 HP @ 120 VAC ❶

Relay Coil Voltages:

6 VAC @ 5VA Max.
12 VAC @ 5VA Max.
24 VAC @ 5VA Max.
120 VAC @ 5VA Max.
230 VAC @ 5VA Max.
6 VDC @ 2W Max.
12 VDC @ 2W Max.
24 VDC @ 2W Max.
110 VDC @ 2W Max.

Switch/Relay Wiring:

Size..... 22 AWG for internal Switch/Relay Coil Wires;
18 AWG for all external wires and relay con - tacts

Insulation..... Standard (CSA) - PVC;
Radiation Resistant - Tefzel

Notes:

❶ CSA Approved
❷ CE Approved (Voltage limited to less than 50 VDC or 35 VAC for CE applications)
❸ Arc suppression recommended for inductive loadings.

SECTION 2 - INSTALLATION

2-1. General

The instrument should be inspected at time of unpacking to detect any damage that may have occurred during shipment. Note: The unit was checked for accuracy at the factory — do not change any of the settings during examination or accuracy will be affected.

For applications requiring special cleaning/precautions, a polyethylene bag is used to protect the instrument from contamination. This bag should be removed only under conditions of extreme cleanliness.

2-2. Mounting/Piping/DPU Installation

Refer to the appropriate DPU Manual for the Model being installed.

2-3. Electrical Connection (Switches/Relays)

Units are supplied with either single or dual alarm switches and/or relays (depending on customer order). The direct-set switch contacts are adjustable over the entire scale range.

Table 2-1 shows switch and relay wiring color coding for legacy and current configurations. Figures 2-1 through 2-6 show switch and relay wiring.

The high switch and low switch set point adjustment procedures are covered in paragraph 3-7, page 16.

For physical location of switches, see page 3.

2-4. Switch Use

Switch contact life is influenced by various application conditions such as temperature, humidity, airborne contamination, vibration, amount of plunger travel, cycling rate, and rate of plunger travel (and others), as well as by the electrical (circuit) characteristics.

NOTICE: Arc suppression for inductive loads will prolong the life of the switch contacts.

Note: Due to their size, subminiature switches have small mechanical clearances; therefore, no rating above 250 VAC has been established.

2-5. Startup

For startup procedures, Warnings, and information, refer to the separate DPU Manual that is appropriate for the indicator-switch model (see front page of this manual).

NOTICE

To ensure the unit calibration is within factory-set calibration tolerances, perform the Calibration Check procedure in paragraph 3-4, page 13.

TABLE 2-1. SWITCH/RELAY WIRE COLOR CODING (4/06c)

	LEGACY CONFIGURATIONS 288A, 288C, 289A (prior to Jan. 2005 - No CSA label or prior to Apr. 2006 w/Tefzel insulation)			LEGACY CONFIGURATIONS 290B, 290D, 291B (prior to Aug. 2005)			**CURRENT CONFIGURATIONS** (Note 2) **288A, 288C, 289A, 290D, 291B, 321, 322, 1512** (290D/291B after Aug. 2005) (288A/288C/289A w/CSA Label after Jan. 2005) (288A/288C/289A w/Tefzel Insulation after Apr. 2006) (All other Models after Jun. 2006 [est.])		
	NO	**C**	**NC**	**NO**	**C**	**NC**	**NO**	**C**	**NC**
SPDT SWITCHES									
Low	Red	Yellow	Blue	Red	Yellow	Blue	Red	Yellow	Blue
High	Black	Green	White	Black	Violet	White	Black	Violet	Orange
DPDT SWITCHES									
Low #1	Red	Yellow	Blue	Red	Yellow	Blue	Red	Yellow	Blue
Low #2	White/Red	White/Yellow	White/Blue	White/Red	White/Yellow	White/Blue	White/Red	White/Yellow	White/Blue
High #1	Black	Green	White	Black	Violet	White	Black	Violet	Orange
High #2	White/Black	White/Green	White/Violet	White/Black/Gray	White/Black/Violet	White/Black/Blue	White/Black	White/Violet	White/Orange
4-INDEPENDENTLY ADJUSTABLE SWITCHES									
Low #1	Red	Yellow	Blue	Red	Yellow	Blue	Red	Yellow	Blue
Low #2	White/Red	White/Yellow	White/Blue	White/Red	White/Yellow	White/Blue	White/Red	White/Yellow	White/Blue
High #1	Black	Green	White	Black	Violet	White	Black	Violet	Orange
High #2	White/Black	White/Green	White/Violet	White/Black/Gray	White/Black/Violet	White/Black/Blue	White/Black	White/Violet	White/Orange
SWITCHES FOR RELAYS									
Low	Red	Yellow	Blue (Note 1)	Red	Yellow	Blue (Note 1)	White/Brown	Brown	White (Note 1)
High	Black	Green	White (Note 1)	Black	Violet	White (Note 1)	White/Gray	Gray	White (Note 1)
RELAYS									
Low #1	Gray	Blue	Brown	Gray	Blue	Brown	Red	Yellow	Blue
Low #2	White/Gray	White/Blue	White/Brown	White/Gray	White/Blue	White/Brown	White/Red	White/Yellow	White/Blue
High #1	Violet	White	Orange	White/Red	White	Orange	Black	Violet	Orange
High #2	White/Violet	White/Black	White/Orange	White/Violet	White/Black	White/Orange	White/Black	White/Violet	White/Orange
Coil Wiring:	**Legacy Ver.:** Low = Red and High = Black						**Current Ver.:** Low = White/Brown and High = White/Gray		

Note 1: Wire is NOT connected. **Note 2:** The Current Configurations wiring information does not apply to Model 288C for military service.

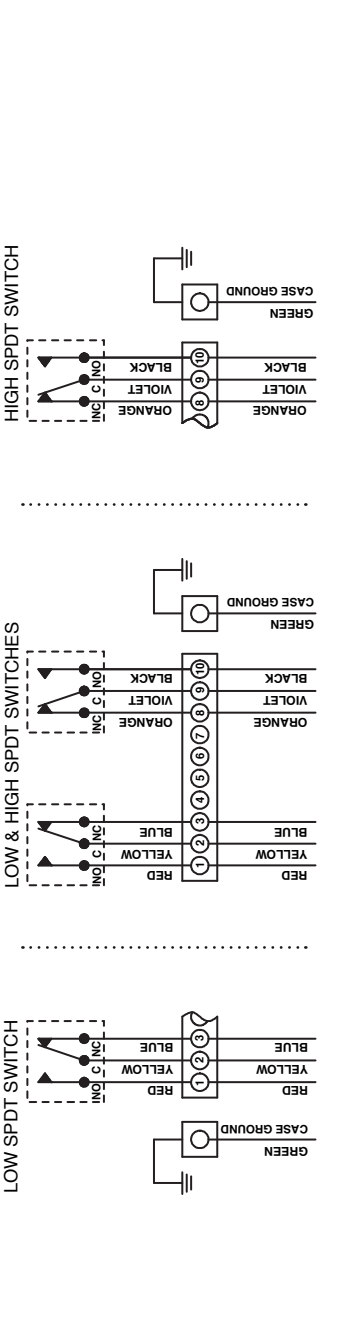


Figure 2-1. Low/High SPDT Switch Diagrams (current configuration color codes - see Table 2-1)

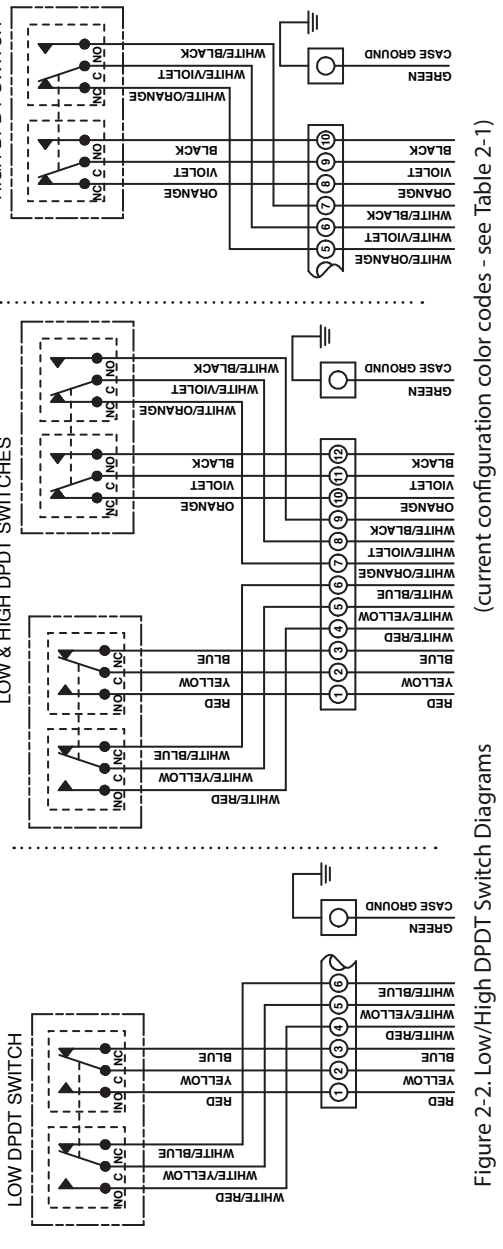


Figure 2-2. Low/High DPDT Switch Diagrams (current configuration color codes - see Table 2-1)

NOTICE: Figures 2-1 through 2-6 show: switch & relay contacts in the relaxed (shelf) condition, the low switch set to trip at a position below the pointer scale position, and the high switc h set to trip at a position above the pointer scale position. NO = Normally Open in (shelf) condition. NC = Normally Closed in (shelf) condition. C= Common.

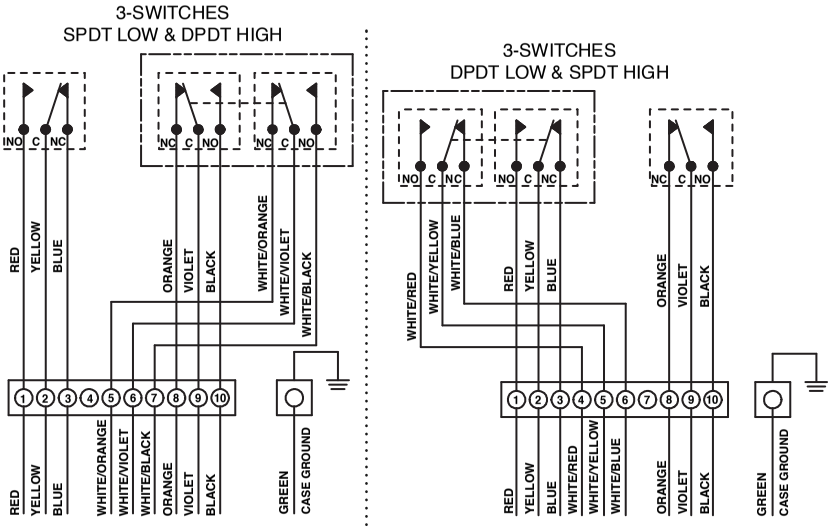


Figure 2-3. 3-Switches
(current configuration color codes - see Table 2-1)

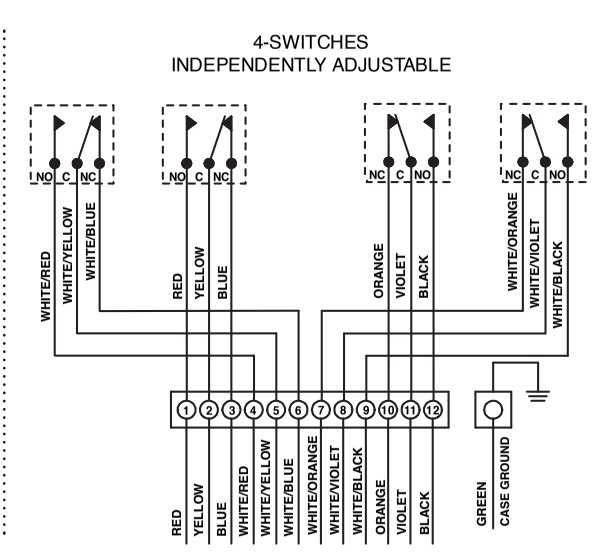


Figure 2-4. 4-Switches, Independently Adjustable
(current configuration color codes - see Table 2-1)

NOTICE: Figures 2-1 through 2-6 show: switch & relay contacts in the relaxed (shelf) condition, the low switch set to trip at a position below the pointer scale position, and the high switch set to trip at a position above the pointer scale position. NO = Normally Open in (shelf) condition. NC = Normally Closed in (shelf) condition. C= Common.

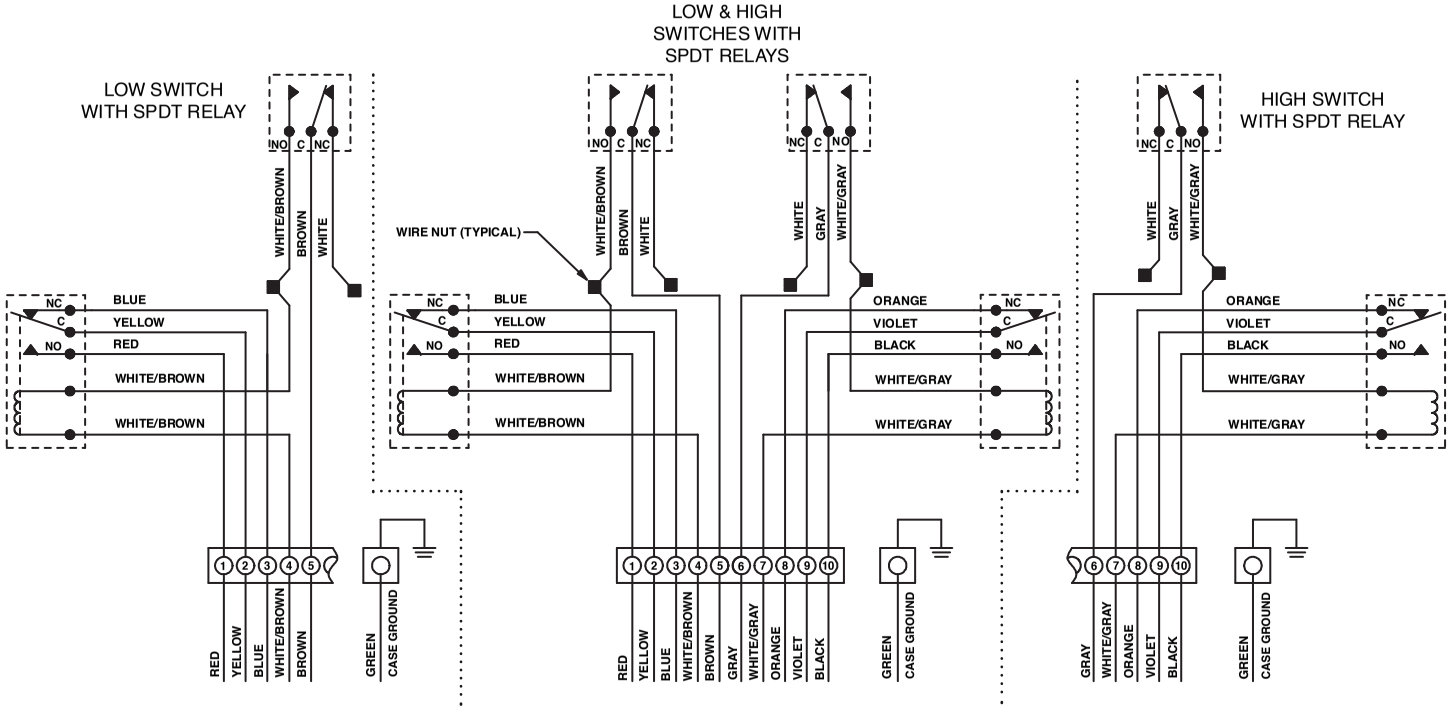


Figure 2-5. Low/High Switch(es) w/SPDT Relay(s) Diagrams (current configuration color codes - see Table 2-1)

NOTICE: Figures 2-1 through 2-6 show: switch & relay contacts in the relaxed (shelf) condition, the low switch set to trip at a position below the pointer scale position, and the high switch set to trip at a position above the pointer scale position. NO = Normally Open in (shelf) condition. NC = Normally Closed in (shelf) condition. C= Common.

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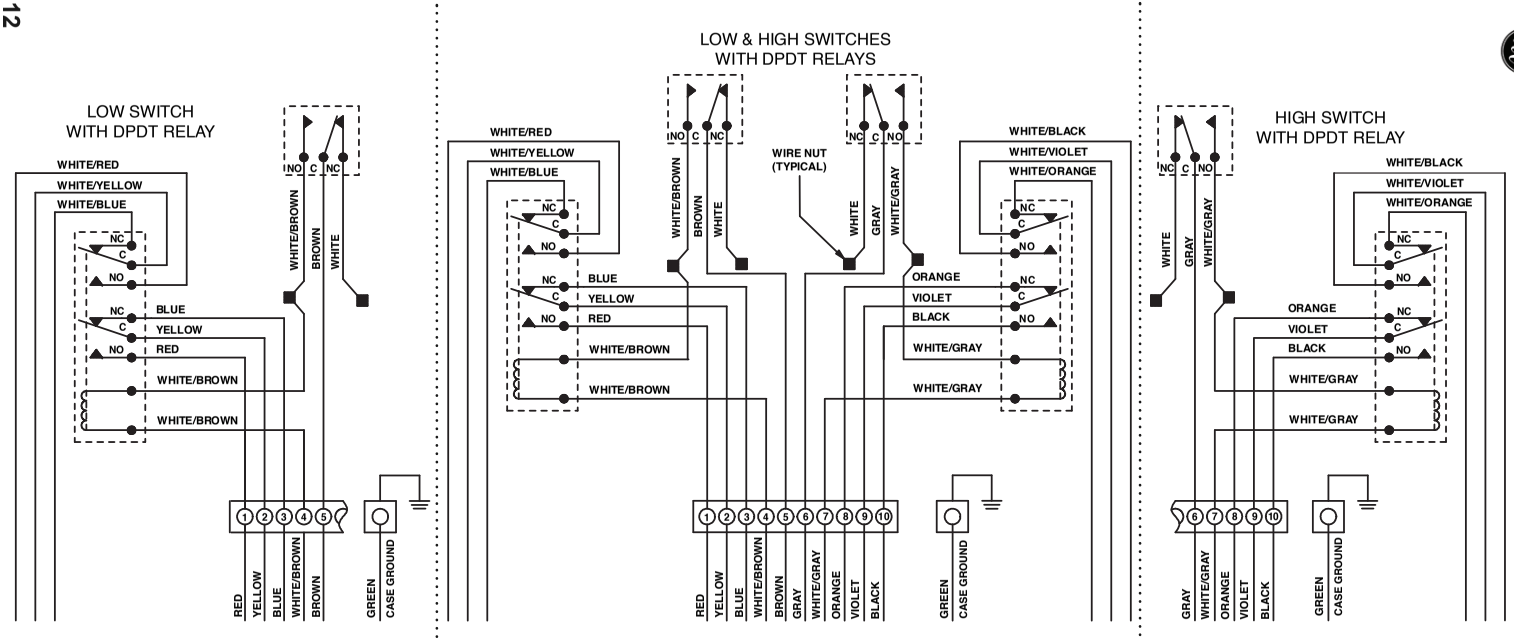

Figure 2-6. Low/High Switch(es) w/DPDT Relay(s) Diagrams (current configuration color codes - see Table 2-1)

NOTICE: Figures 2-1 through 2-6 show: switch & relay contacts in the relaxed (shelf) condition, the low switch set to trip at a position below the pointer scale position, and the high switch set to trip at a position above the pointer scale position. NO = Normally Open in (shelf) condition. NC = Normally Closed in (shelf) condition. C= Common.

SECTION 3 - MAINTENANCE AND CALIBRATION

3-1. DPU Installation/Maintenance/Repair

DPU inspection, cleaning, service, repair, range change, and BUA replacement procedures (along with applicable WARNINGS , CAUTIONS , and NOTICES) are presented in the separate 224/224C DPU manual .

3-2. Tools

Table 3-1. Tools

Equipment	Purpose
Pointer Puller	Pointer Removal
Small Screwdriver	Calibration Adjustment
Medium Screwdriver	Bezel Removal and Replacement
1/4" and 1/8" Open-end Wrenches	Zero (1/4") and Range (1/8") Adjustments
1/8 Hex Allen Wrench	Switch Setpoint Adjustment

3-3. Bezel/Lens (or Cover) Installation and Removal

WARNING

(EXPLOSIONPROOF UNITS)

PRIOR TO LOOSENING ANY ATTACHING HARDWARE, HOUSING BOLTS, OR COVER ASSEMBLY, ASSURE SURROUNDING AREA IS, AND REMAINS, WELL VENTILATED.

PRIOR TO LOOSENING OR REMOVAL CASE/COVER ASSEMBLY, ALL ELECTRICAL POWER SUPPLIES MUST BE TURNED OFF.

THE COVER MUST BE REMOVED TO CALIBRATE THE INSTRUMENT.

BEFORE ANY MAINTENANCE/CALIBRATION, REVIEW THE APPROPRIATE (SEPARATE) DPU MANUAL.

For non-SST/non-explosionproof units , the bezel gasket (p/n 0277-0026C) must be installed as shown below (also ref. Fig. 4-1):

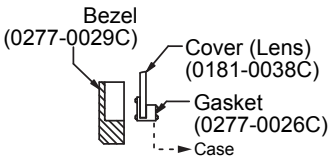

Figure 3-1. Bezel/Lens

To remove the bezel and cover lens on non-SST/non-explosion - proof units:

1. Loosen three screws on the front of bezel.
2. Tilt out bottom of bezel and slide bezel upward.

The two snubbers (p/n 0266-0028C) on the scaleplate should not be compressed against the lens cover and the pointer should not touch the lens.

(Continued on next page...)

3-3. Bezel/Lens (or Cover) Installation and Removal (Continued)

NOTICE

Ensure correct bezel gasket orientation before placing instrument back in service. Incorrect bezel gasket orientation will cause the instrument indicator to jam, resulting in inaccurate readings.

For 288C SST Version units , refer to Fig. 4-2, page 31.

For Explosionproof units , cover is unscrewed to gain access to the inter - nal components. When re-installing cover, tighten cover securely and inspect lens for cracks or other defects that may affect the explosionproof rating. Refer to Fig. 4-3, page 32.

3-4. Calibration Check

To ensure the unit calibration is within factory-set calibration tolerances, per - form the following procedure. NOTICE: Review all procedures, WARN - INGS/NOTICES in the separate 224/224C DPU manual BEFORE performing this procedure.

1. Mount instrument in an approx. level position and connect to a standard pressure source (see separate 224/224C manual).
2. If the zero indication is incorrect, remove bezel/lens assembly (cover on explosionproof units) and re-adjust zero, per the following:
   With a 1/4" open-end wrench (in - cluded in calibration kit 0288-1032B), hold the hexagon pointer hub fixed and rotate the pointer with fingers until the pointer accurately indicates ZERO on the scale. See Figure 3-2.
   Replace bezel/lens or cover.

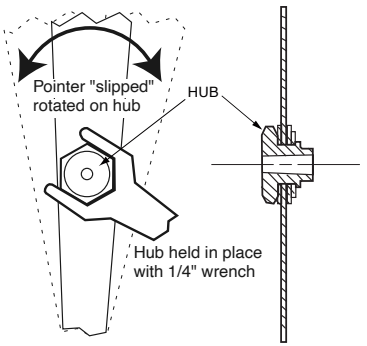

Figure 3-2. "Slipping" Pointer

3. To test for reverse travel, connect pressure source to LP housing and vent HP housing. Apply pressures approximately 150% of the DP range. The pointer should move approximately 5% to 10% below zero.
4. To test for overtravel, connect pressure source to HP housing and vent LP housing. Apply pressures approximately 150% of DP range. The pointer should move approximately 5% to 10% above full scale.
5. Apply 0, 50, and 100% of full scale pressure. If indication is within speci - fied limits, no adjustments are necessary. If indication is not within specified limits, perform a complete calibration, per paragraph 3-7, page 16.
6. Make sure instrument zero indication is correct; otherwise, repeat step 2.
7. Verify switch set points (refer to paragraph 3-8, page 18).

3-5. Pointer Installation and Removal

During adjustment and calibration of the unit, it may be necessary to r emove and reinstall the pointer, per the following procedures:

A. Pointer Installation

1. Position pointer on movement shaft with pointer set at zero scale. It may be necessary to enlarge the hub hole, using a tapered broach (included in the toolkit (p/n 0288-1032B).
2. Lightly tap pointer hub with a hand-set or other flat-end tool. Use perpendicular blows to avoid bending shaft.
3. Check indicating switch for calibration over its entire range (refer to Switch Calibration in this section). If indicating switch is corr ectly calibrated, secure pointer to movement shaft by tapping hub with a hand-set or other flat-end tool.

B. Pointer Removal

Pointer is removed with Pointer Puller (included in the calibration toolkit 0288-1032B), see Figure 3-3.

1. Slide pointer puller along pointer until pin protruding from tip of screw in pointer puller is directly over movement shaft and arms of pointer puller are directly under pointer.
2. Gently turn knurled head of screw clockwise, pushing pin against movement shaft and lifting pointer with arms. Finger pressure should be sufficient to pull the pointer free. If more pressure is required, an Allen wrench (inserted into head of the screw) can be used. How - ever, care should be exercised: too much pressure can cause the pin to break.

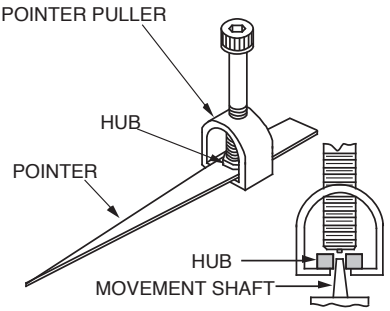

Figure 3-3. Pointer Puller (p/n 0163-0005B)

3-6. Indicator Calibration

(DP=Differential Pressure)

1. Securely mount instrument in an approx. level position and connect DPU into the test setup, as described in the appropriate (separate) DPU manual.
2. Align linkage between drive arm and movement, per Figure 3-4.
3. Check pointer for zero indication. If necessary, set pointer to zero, by slipping pointer on hub, per para - graph 3-4, step 2.

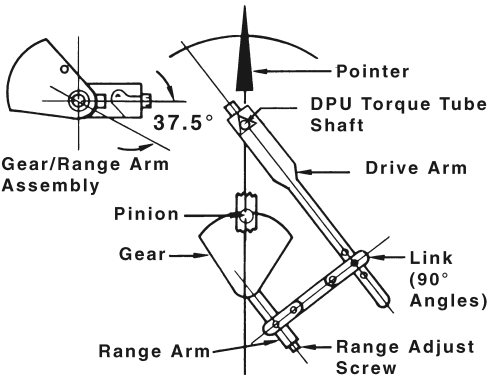

Figure 3-4. Range/Linearity Adj. (50% DP)

3-6. Indicator Calibration (Continued) (DP=Differential Pressure)

4. Apply 100% pressure. If pointer exceeds full-scale, lengthen movement range arm.
5. Release pressure. Set pointer to zero, by slipping pointer on hub, per paragraph 3-4, step 2.
6. Repeat steps 4 and 5, as necessary, to obtain correct zero/full-scale.
7. Apply 50% DP. If pointer does not indicate 50% scale, a linearity adjustment is necessary. Loosen drive arm screw and move arm to shift pointer in direction of error a distance of about 10 times linearity error. Tighten drive arm screw.
8. Release pressure and reset pointer at zero. Check the span. If gear in movement reaches limit of travel as a result of linearity adjustment (step 7), slip range arm along gear approximately 5 degrees from normal 37.5 degree angle to approximately 43 degrees (see step 2). Range arm is slipped by applying pressure to range arm with thumb, while holding gear firmly in place. Retest pointer response at 50%, 0%, and 100% of full-scale differential pressure, and adjust linkage until readings are acceptable.
9. Apply 0%, 25%, 50%, 75%, 100%, 75%, 50%, 25%, and 0% of full-scale differential pressure consecutively to instrument without overshoot. Lightly tap indicator to overcome friction. Pointer should accurately indicate each applied pressure.
10. Test instrument repeatability by applying 0%, 50%, 0%, 50% of full-scale differential pressure. Indicator should accurately indicate each applied pressure.
11. Set stops to prevent pointer from striking snubbers on scale. Test setting by moving pointer from zero position to 50% position manually and then letting pointer return freely. If necessary, tap pointer hub to tighten it to shaft.

3-7. Complete Calibration (See Warning on page 13)

Before performing complete calibration procedure, verify that instrument is out of calibration, by performing calibration check procedure (para. 3-4, page 14).

If instrument is out of calibration, before performing complete calibration procedure, remove bezel/lens and inspect switch mechanism to verify the following:

- The roller rotates without wobble or binding.
- The cam does not touch the roller side shields.
- The actuator arm moves freely on its pivot.
- All switch mounting screws are tight.
- Linkages are straight and do not bind at the pivots.

Correct any problems that are encountered.

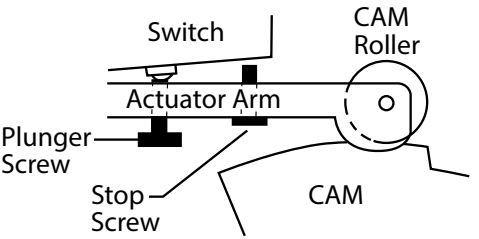

Figure 3-5. Cam/Follower Position

3-7. Complete Calibration (Continued) (See Warning on page 13)

A. Calibration Setup

1. Connect lamp or buzzer to switch output leads. Connect a test voltage to switch input terminals on terminal strip. (A low voltage is recommended for safety.) If relay is installed in instrument, coil voltage must be applied to switch.
2. Unlock switch plate and move plate until roller is positioned at top of the cam.
3. Advance plunger screw until switch actuates, then advance plunger screw an additional 60° (one flat).
4. Exercise switch roller across top of cam to verify steady operation. Advance stop screw to touch switch, then back out screw 1.5 turns (9 flats).

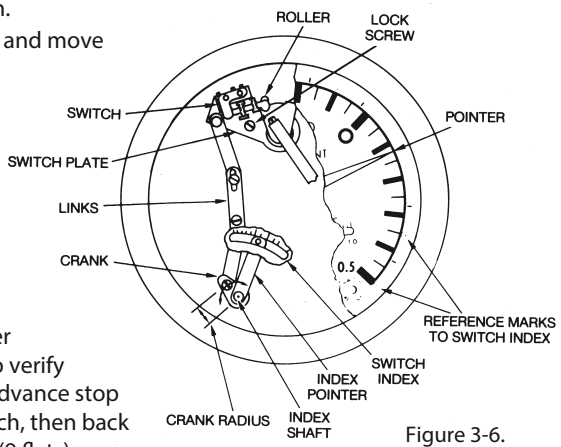

Figure 3-6. Linkage Arrangement

B. Calibration Procedure (see Figure 3-6)

To calibrate switch linkage (required when unit is rebuilt):

1. Loosen three linkage screws and turn crank to 12 o'clock position.
2. Use a 1/8-inch Allen wrench to hold index shaft and slip index pointer to 0 on switch index. Tighten screw on crank to mid-slot position.
3. Turn switch index pointer to "1" (index numbers refer to numbers on outer edge of scale plate).
4. Apply 10% differential pressure and adjust switch plate until switch actuates. Lock the two linkage screws.
5. Rotate index pointer to "9." Apply 90% differential pressure and adjust crank radius until switch actuates.
6. Recheck 10% and 90% set points. Adjust crank radius and index pointer until both set points are 2% accurate (nominal).
7. If switch is to be field-set at low differential pressure values (1% or 2% of pressure range), check crank to prevent a top-dead-center position. Otherwise, minimum set point position will be restricted and set point may become reversed.
8. Adjust switch to actuate at desired pressure by applying test pressures in a decreasing direction, in discrete steps. Allow unit and pressure system to stabilize. Then change pressure a small amount. The magnitude of the pressure change is determined by desired accuracy of test. Tighten lock screw before testing switch performance.

(Continued on next page...)

B. Calibration Procedure (Cont.) (see Fig. 3-6) (See Warning , page 13)

To calibrate switch linkage (required when unit is rebuilt):

8. (Cont.)
   The high switch is usually set to actuate at increasing pressure — when calibrating high switch, apply test pressure in an increasing direction. This amount of loading will prevent cam-runout of a similar condition.
   Excessive plunger loading (more than 3 flats) may cause roller to drag on cam. Cam friction will be apparent by excessive hysteresis, erratic pointer readings and inconsistent switch operation.
9. Check switch deadband, (actuate to reset) by applying differential pres - sures in a decreasing then increasing (opposite for high switch direc - tion). Observe pressures. To reduce deadband, advance plunger screw (two flats maximum).
10. Adjust high switch to actuate at desired pressure. The procedure is the same as for the low switch.

3-8. Changing Switch Setpoint

(Tools: Screwdriver, 1/8 Hex Allen wrench) (See Warning on page 13)

Set Point — The measured pressure at which the snap-switch actuates and thereby changes the states of the N.O and N.C. contacts. For example, the set point of the low switch is 24 psid with decreasing pressure.

Deadband — The difference in measured pressures between switch-actuation and switch-reset. Deadband is usually expressed as percent of full scale (% of F.S.). Deadband is not adjustable. For example, the switch above was found to reset at 26.4 psid with increasing pressure. The deadband was 2.4 psi, or 4% of the full scale (0 to 60 psid).

A. In-Service Instruments (calibration pressures cannot be applied)

1. Remove bezel/cover. Do not remove pointer or scale.
2. Insert hex wrench in switch adjust post, (item A, Fig. 3-7).
3. Loosen switch lock-screw, (item B), 1/2 to 1 turn.
4. With hex wrench, move index pointer (item C) to new set point as indicated on switch index (item D).
5. If possible, check set point by varying pro - cess pressures and observing pointer readings when switch actuates. (Open manifold bypass valve slowly and watch for “pointer-jump” at set point or by electrical signal.) Improve set - ting if necessary, repeat test several times to verify stability.

Note: Switch index has 10 div., marked 0, 5, and 10. These match markings on outer edge of scale.

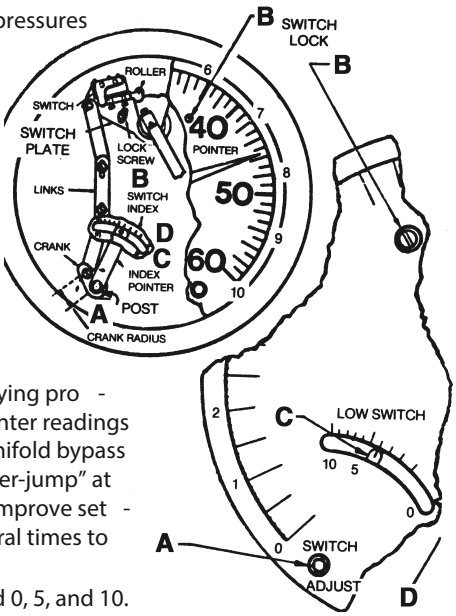

Figure 3-7.
Setpoint Adjustment

3-8. Changing Switch Setpoint (Cont.) (See Warning on page 13)

A. In-Service (Continued)

Example: Scale has range of 0-60 psid. Set point is 24 psid, with decreasing pressure, (24/60 x 10 = 4). Move index pointer (item C) to division 4. Start from bottom of switch index (0 on low, 10 on high). Tighten switch lock (Item B) snug plus 1/4 turn. Do not overtighten.This will place set point within ±2% of full scale.

B. Out-of-Service (Disconnected from process lines or mounted on bench)

1. Drain and vent housings.
2. Attach calibration pressure source (air or N_2) to HP housing.
3. Apply pressures and observe pointer readings for accuracy. Use a pressure standard (Heise gage or equiv.) for reference. Change pressures slowly in discrete steps. A "bleed-pressure" method may cause errors.
4. Change switch set point as described in Part A.
5. Check set point by changing measured pressure to actuate switch.
   For Example: To verify low-switch set point to 24 psid, apply approximately 30 psi. Then reduce pressure to approximately 25 psid, hold for a few seconds, then continue in 1/4 psid steps until switch actuates. If set point is incorrect, continue instructions in Part A.
6. To measure switch deadband, reduce pressure to zero, then increase pressure until switch resets.
7. To verify repeatability of set point, repeat step 5 several times. For improved accuracy, use smaller increments of pressure. Allow extra time for slow response gages and for test systems that have long runs of small bore tubing.
8. High alarm switches right side of the scale) are adjusted in a similar manner. Apply increasing pressure to establish the switch set point, decreasing pressure to measure deadband.

C. Notes

1. Always check set point after tightening switch lock screws.
2. Either switch may be set at any point of the scale, except allowance must be made for deadband to enable switch to reset itself. For example, high switch (right side of scale) may be set at 100% of F.S., but should not be set near zero. Also, low switch may be set at zero, but not near full scale. (Observe deadband values for specific models).
3. If switch performance is unsatisfactory (set point does not repeat, deadband is excessive, pointer exhibits hysteresis, contacts are unstable. etc.) remove scale and inspect switch and mechanism. Scale is split for removal without pulling pointer.
4. Switch Variations: (a) SPDT: This is the standard model (low, high, or both); (b) DPDT: Two switches are stacked and actuated by a single lever (low, high, or both); (c) Three (or four) SPDT: Switches have independent switch points - No.1 and 3 are usually low switches set for decreasing pressures. Nos. 2 and 4 for increasing pressures;
   (d) Hermetically Sealed Switch (Micro 11HM41): this switch has wide deadband, case is modified for electrical clearances, amperes are reduced for 60 Hz service.

3-9. Preventative Maintenance

- Indicating Switch — Periodically inspect alarm switch mechanism to verify that all mounting screws are seated properly. Inspect linkage for wear. Inspect integrity of electrical circuits. Tighten as necessary.
- DPU — Warning/Caution notices , inspection/cleaning procedures, and maintenance procedures are presented in the appropriate (separate) DPU manual. Do Not perform any maintenance/repair on the instrument or DPU without first reviewing all procedures and Warning/Caution notices in the separate DPU manual.

3-10. Locking Drive Arm to Torque Tube

Refer to the appropriate (separate) DPU manual. For explosionproof units , refer to Section 4, 290D Detail Drawing, page 33 (See Warning on page 13).

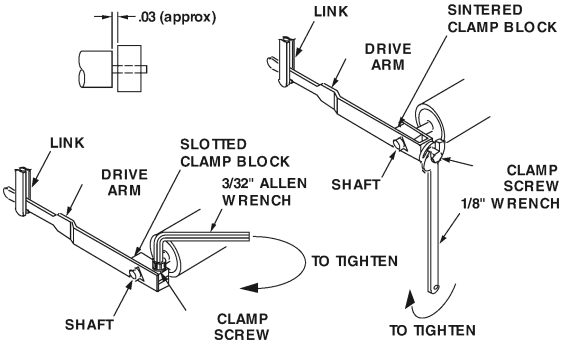

Figure 3-8. Locking Drive Arm to Torque Tube

1. Slip drive arm over torque tube shaft; clear end of torque-tube housing by approximately 0.030-inches before securing to prevent interference.
2. To tighten drive arm assembly onto torque-tube shaft:
   a. While supporting block/shaft, tighten clamp screw until snug to shaft.
   b. Still supporting block/shaft, tighten clamp screw an additional:
      - Sintered: 1/3 to 1/2 turn (This screw can normally turn one full revolution before breaking.)
      - Slotted: 1/4 to 1/3 turn (The slot in the slotted clamp block should still be open.)

NOTICE: For Seismic and High Shock Qualified Units, perform Drive Arm Tightness Test, per paragraph 3-11.

3-11. Drive Arm Tightness Test (See Warning on page 13)

This procedure tests the drive arm to torque tube attachment for tightness, by applying torque developed by the DPU onto a fixed drive arm. Care should be taken to apply pressure slowly, as torque is being applied to the connection through the torque tube drive shaft.

With pointer at normal 0% torque tube rotation position (max. minimum scale position or 0% on a normal 0 to 100% scale unit), adjust drive arm stop bracket (or use alternate means) to prevent pointer from moving (stop bracket interferes with drive arm movement). Note: On reverse acting/split range units, it will be necessary to pressurize DPU to move pointer to max. minimum scale position, and on suppressed units, it will be necessary to apply pressure to establish a reference point to check for "zero" shift.

Pressurize DPU to full calibrated scale DP (100% of full scale range) to achieve 8-degrees of torque tube drive shaft equivalent torque onto the connection.

Observe shift in the unit "zero" following DPU depressurization (as required) and drive arm stop bracket readjusting (to allow free movement of drive arm and pointer). A downscale (counter-clockwise) shift in "zero" of greater than 1/2% is indicative of drive arm slippage necessitating further clamp block tightening.

3-12. Troubleshooting

(See Warning on page 13)

Refer to Table 3-1 and the separate 224/224C DPU manual.

Table 3-1. Troubleshooting

Problem	Possible Source	Probable Cause	Corrective Action
Low or No Indication	Primary Element or DPU (Refer to DPU Manual)	Orifice installed backwards or oversized	Replace Orifice
		Flow Blocked Upstream from run	Clean out run or open valve
		Loss of liquid in Reference Leg (liquid level)	Refill Reference Leg
		Density changes in process media or Reference Leg	Refill Reference Leg with same density liquid as process media
	Primary Element to DPU Piping (Refer to DPU Manual)	Pressure tap holes plugged and/or piping plugged	Clean out piping
		Bypass Valve Open or Leaking	Close bypass valve(s) and/or repair leaks
		Liquids or Gases trapped in piping	Vent piping
		Block or shutoff valves closed	Open block or shutoff valves
		Piping leaks on HP side	Repair leaks
	Bellows Unit (Refer to DPU Manual)	Housing filled with solids restricting bel - lows movement	Clean out housing
		Gas (liquid service) or liquid (gas service) trapped in housing	Vent housing
		HP housng gasket leak	Replace gasket
		DPU tampered with	Return BUA for repair
	Indicator, Alarm Switch Mecha- nism	Loose linkage or movement	Tighten or replace
		Out of Calibration	Calibrate
		Pointer loose	Tighten pointer
		Dirty or corroded mechanism	Clean or replace
		Wiring interfering with movement	Re-route wiring
		Dirty mechanism	Clean mechanism

Continued on next page...

3-12. Troubleshooting (Continued) (See Warning on page 13)

Refer to Table 3-1 and the separate 224/224C DPU manual.

Table 3-1. Troubleshooting (Continued)

Problem	Possible Source	Probable Cause	Corrective Action
High Indication	Primary Source	Orifice partially restricted or too small	Clean out or replace
	Primary Element to DPU piping	Piping leaks on LP side	Repair leaks
	Bellows Unit (Refer to DPU Manual)	Gas (liquid service) or liquid (gas service) trapped in housing	Vent housing
		LP housng gasket leak	Replace gasket
		Range Spring broken or DPU tampered with	Return BUA for repair
	Indicator, Alarm Switch Mecha-nism	Loose linkage or movement	Tighten or replace
		Out of Calibration	Calibrate
Erratic Indication	Primary Element	Flow pulsating	Install dampening device upstream of DPU run
	Primary Element to DPU piping	Liquid (gas service) or gas bubble (liquid service) trapped in piping	Remove
		Vapor generator incorrectly installed	Re-pipe
		Reference Leg gassy or Liquid vaporizing	See piping instructions in DPU Manual
	Bellows Unit (Refer to DPU Manual)	Obstructed Bellows Travel	Clean Bellows
		Gas trapped in DPU HP or LP housing	Remove (see Startup procedure)
		Linkage dragging or dirty	Adjust or Clean
		Pointer Dragging on Scaleplate	Ajust Pointer Position
Inac-curate or No Electrical Alarm	Power Supply	Blown Fuse	Replace Fuse
		Broken or loose wire	Repair
	Alarm Switch	Switch not properly Adjusted	Adjust Switch
		Dirty or Burned	Replace switch con - tacts

Continued on next page...

3-12. Troubleshooting (Continued) (See Warning on page 13)

Refer to Table 3-1 and the separate 224/224C DPU manual.

Table 3-1. Troubleshooting (Continued)

Problem	Possible Source	Probable Cause	Corrective Action
Switch Drifts (set-point not repeat-able)	Process Changes	Transients or surges cause switches to actuate prematurely	Add time delay gages or add time circuit
		Setpoint and/or Deadband are too wide in pressure valves	Specify DP Range as low as practical; set-point repeatability and deadband are percent-age of full range
		Electrical overloads affect the spring prop-erties of the leaf actuator in the switch	Examine circuits for Voltage, amperes
		DC inductive loads cause arcing and burn-ing of contacts	Consider arc-suppres-sion devices or relays
		Accumulation of fluids in piping generate artificial signal	Vent gas or drain liq-uids from signal lines
	Calibra-tion Tech-niques	Failure to check setpoint after locking	Verify setpoint repeat-ability after locking switch plate
		Rapid pressure change or venting system	During calibration, make pressure changes in slow, discrete steps
		Pressure application in reverse	Test low-alarm with decreasing pressure and high-alarm with increasing pressure
		Reference Gage Inaccuracy	Suitable pressure stan-dard such as manom-eter, dead-weight tester, or Heise-type gage may be required
		Damage to Switch Contacts	Adjust plunger Screws carefully to avoid damage to internal parts of switch