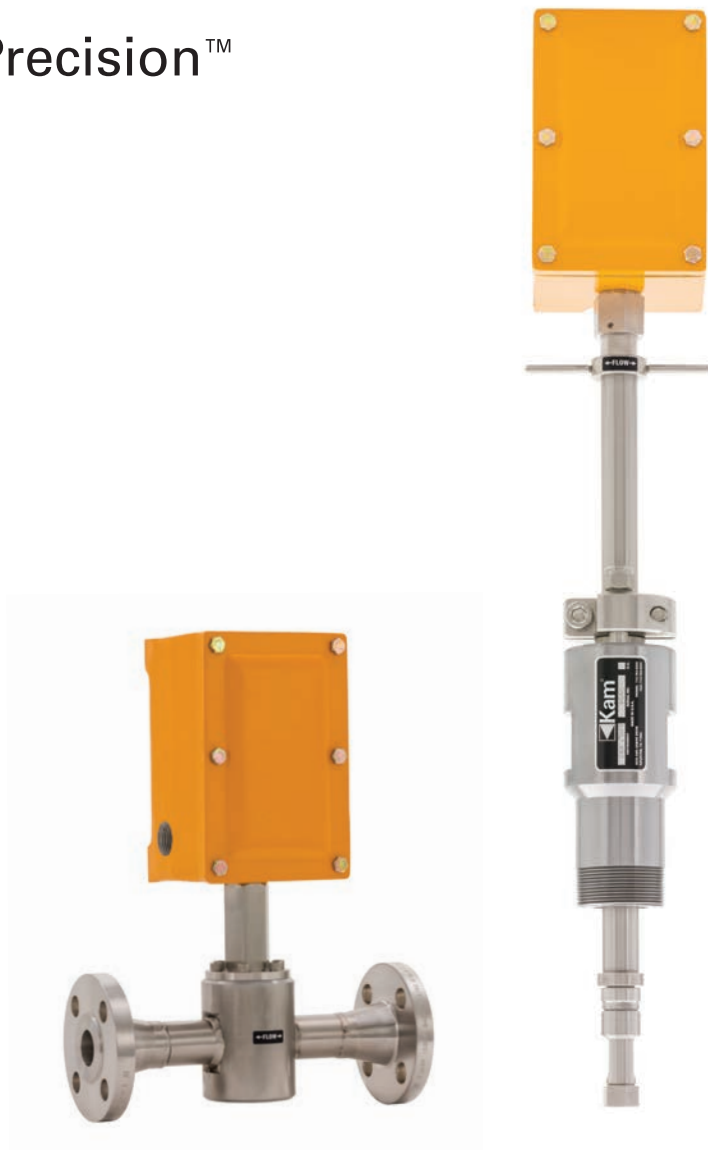




Simple Precision™



# KAM® CHA™ COLORIMETER/HAZE ANALYZER



PTB 04 ATEX 1027  
II 2 G Ex db IIB T6 Gb  
IECEX PTB 21.0012  
Ex db IIB T6 Gb

User Manual  
CHAMANUAL 0921

TEL +1 713 784 0000  
FAX +1 713 784 0001  
Email Sales@Kam.com  
KAM CONTROLS, INC.  
3939 Ann Arbor Drive  
Houston, Texas 77063 USA  
www.KAM.com

An ISO 9001 certified company

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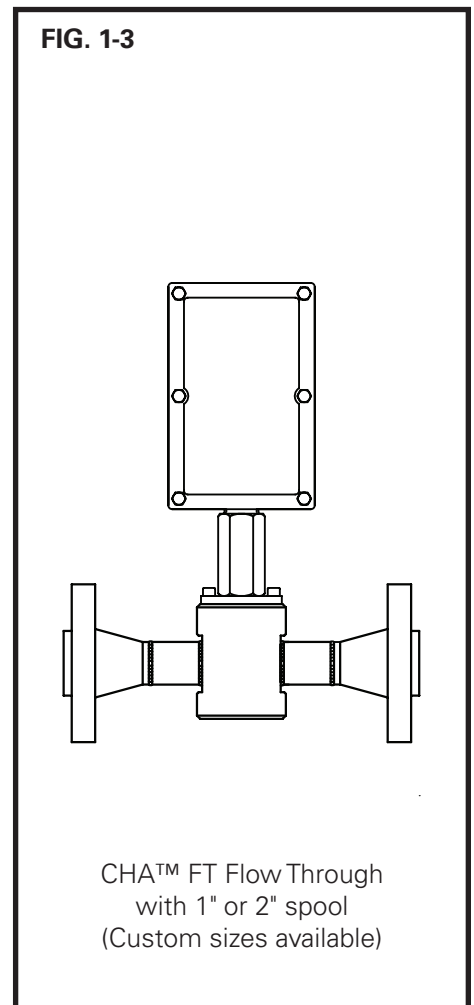
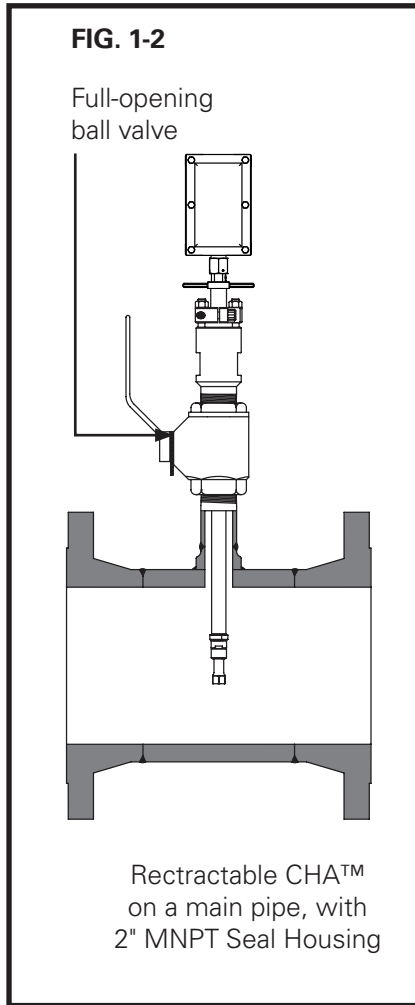
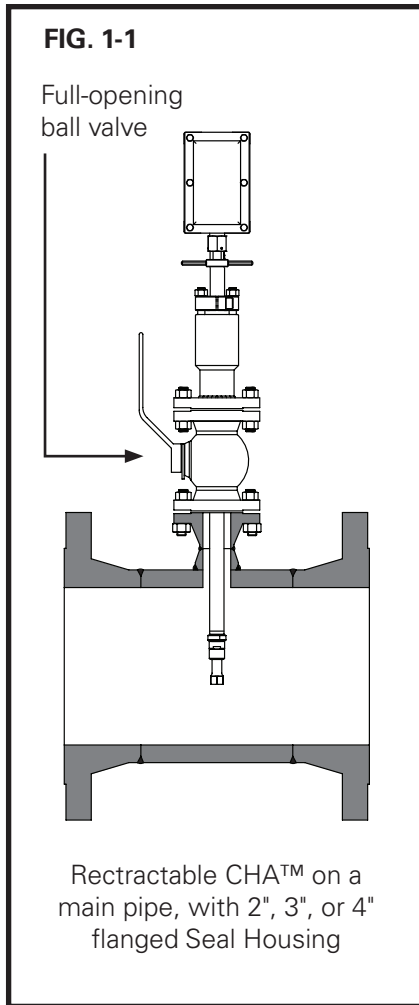
## CAUTION:

When installing the CHA™ sensor in a pipeline containing petroleum products, petro-chemicals, waste waters with the presence of pressure & temperature, and high-pressure steam refer to the Pipeline Operators' "Health, Safety and Environmental Policy Procedures" to ensure safe installation.

KAM CONTROLS, INC. reserves the right to make changes to this document without notice.

# INTRODUCTION

## AVAILABLE MODELS and MOUNTING OPTIONS



## THEORY OF OPERATION

Color variations in refined products indicate impurities and/or the presence of water. Refined products are often prone to haze or diffused water contamination due to cooling towers which use water and in turn can saturate the product. This can be a significant liability as color differentiation can be easily detected by the end user. The KAM® CHA™ Colorimeter/Haze Analyzer is the ideal quantitative solution for monitoring both the color of refined products, including dyed product, and the presence of haze (trace/dissolved water) in pipelines following the refining process. The KAM® CHA™ detects interface color variations within 1%, and unlike most colorimeters can detect the entire range of visible color as defined by CIE 1931 (International Commission on Illumination). The simplicity of design and quality of engineering employed in the Colorimeter/Haze Analyzer mean there are no moving parts. Using long-lasting LED light sources ensures long-term, stable performance with limited maintenance and power requirements. The CHA does not require field calibration at any point. In addition, locating the electronics within an explosion-proof enclosure directly on the atmospheric end of the optical probe creates a complete and compact unit with maximum installation flexibility. The KAM® CHA™ easily installs where other colorimeters, weighed down by large electronics/computer units, cannot.

The five LED sources (Red, Blue, Green, Yellow, and IR) send light via fiber optics to the sensor end inserted into the pipeline or analyzer loop. These beams of light pass through a 25mm window of pipeline fluids and then are reflected back through fiber optics to the electronics enclosure for a total path of 50mm. KAM uses four LED's for color determination to increase the accuracy over three-color (RGB) models. The fifth (IR) LED provides haze detection.

# INTRODUCTION CONTINUED

The disparity in light output versus light reflected back is then converted into an electronic or optical signature which is amplified and sent to the computer. The computer in turn utilizes a mathematical formula to determine the exact color and haze (turbidity) of the fluid in the pipeline. Final color measurement from the KAM® CHA™ can be expressed as haze plus three color (X, Y, Z, CIE 1931) or in several other industry-standard color scales including, Saybolt, Platinum and Cobalt, and ASTM D1500 (see Specifications, Section 2).

The computer automatically adjusts for electronic noise and any LED fluctuations. Because the absorption rates of the different colored fluids vary resulting in different signal strengths, the computer also automatically adjusts the amplification or gain accordingly.

Measurement is fully automatic without the need for operator intervention or supervision. The output signal can be sent to the SCADA, PLC's, or to a central control room for logging or display on chart recorders or monitors.

The KAM® CHA™ probe can be installed in an analyzer loop or in the main line, and because it's easily mounted through a full-opening ball valve, you can insert or retract the probe without having to ever drain the pipe.

## FEATURES

- 5-LED design offers greater accuracy over other, 3-LED models
- Uses LEDs for long-term performance with minimal power and maintenance requirements
- Does not require field calibration
- Inserts in directly in pipeline under process conditions
- Outputs for industry scales ASTM D1500, Platinum-Cobalt, Saybolt plus Haze
- All requisite electronics housed on atmospheric end of probe; requires no additional controller

## APPLICATIONS

- Multi-product pipeline interface detection
- Transmix/regrade reduction
- Haze monitoring/quality control at refineries and pipeline terminals
- Haze monitoring/quality control for incoming diesel fuel in power and marine applications
- Haze/quality control for aviation fuels at pipeline, tank farm, fuel trucks and carts

# SPECIFICATIONS

Media:	Refined products
Material:	Wetted parts—316 stainless steel, sapphire Electronics enclosure—Copper-free aluminum
Power:	12–24 VDC 5 Watts max
Outputs:	4-20 mA (2) reflect values for Haze plus designated color scale (see Color Range P15)
Communication Interface:	RS-485 MODBUS (X,Y, Z values plus all color scales, and individual LED readings)
Fluid temperature:	-40° to 176° F (-40° to 80° C)
Ambient temperature:	-4° to 140° F (-20° to 60° C)
Pressure ratings:	ANSI 150, 300, 600
Hazardous area:	PTB 04 ATEX 1027 Ex II 2 G Ex db IIB T6 Gb IECEX PTB 21.0012 Ex db IIB T6 Gb
Accuracy:	Haze $\pm$ 5%, Color $\pm$ 1%
Repeatability:	Haze $\pm$ 1%, Color $\pm$ 1%
Reproducibility:	Haze $\pm$ 1%, Color $\pm$ 1%
Haze Range:	0-100%
Color Range:	Complete range of: ASTM D1500; ASTM D156 (Saybolt); ASTM D1209 (APHA Platinum-Cobalt)
Mounting:	1" or 2" flanged flow-through spool (custom sizes available) 2" MNPT Seal Housing 2", 3", or 4" Flanged Seal Housing
Sensor Dimensions:	3.5" x 1.25"Ø (89 mm x 32 mm)
EX enclosure:	4.6" x 7.1" x 4.4" (117 mm x 180 mm x 112 mm)
Shaft length:	12" to 60" – Off-the-shelf lengths are 12", 24", 36", 48", and 60" (305 mm, 610 mm, 762 mm, 914 mm, 1219 mm, 1524 mm)
Pipe size:	1" to 48" (25 mm to 1219 mm)
Weight:	from 20 lbs. (9 kg)

# INSTALLATION

## PRIOR TO INSTALLATION

Remove all the protective packaging materials, and ensure that the CHA™ sensor was not damaged during transit.

## INSTALLATION DOs and DON'Ts

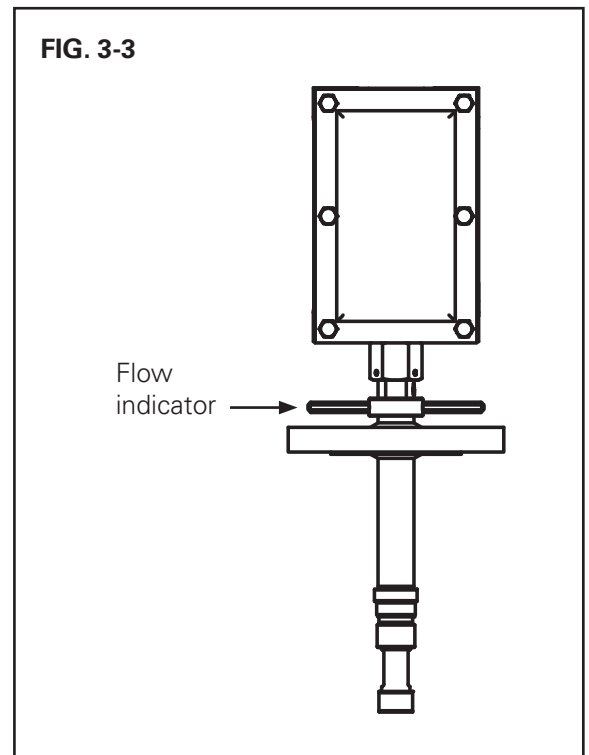
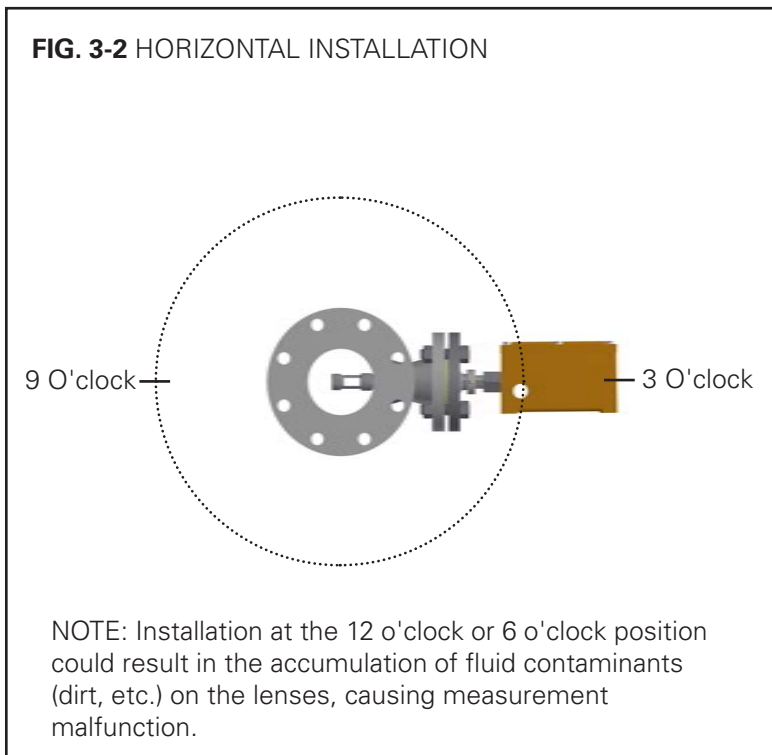
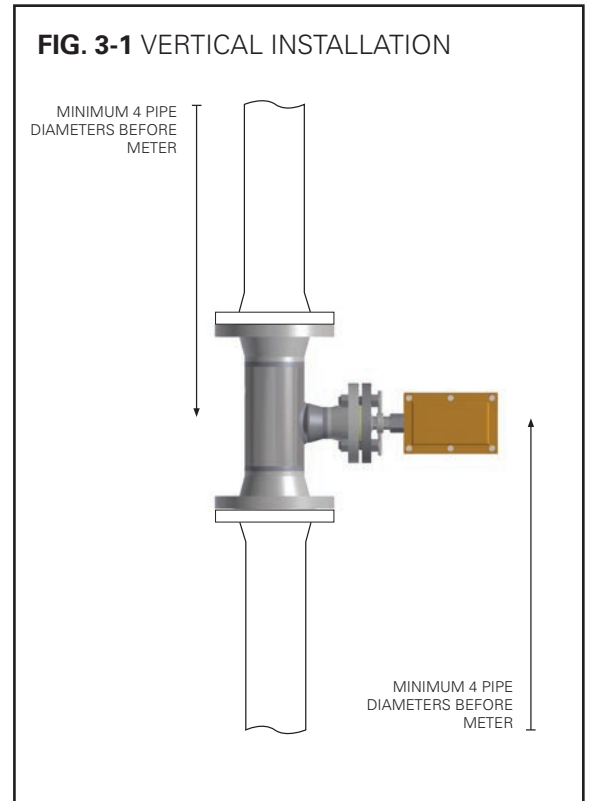
Do not install the CHA in direct sunlight

Ensure there is no entrained air in the line or excessive levels of organic compounds such as rouge.

CHA should be installed after a minimum of 4 pipe diameters of straight run to reduce flow turbulence. FIG. 3-1.

The CHA should be installed on a vertical line. If the unit must be installed on a horizontal line, it should be at 3 or 9 o'clock position. FIG. 3-2.

The KAM CHA probe must be oriented so that the flow indicator is parallel to the flow direction of the pipe to enable flow through the measurement window. FIG. 3-3.



# INSTALLATION CONTINUED

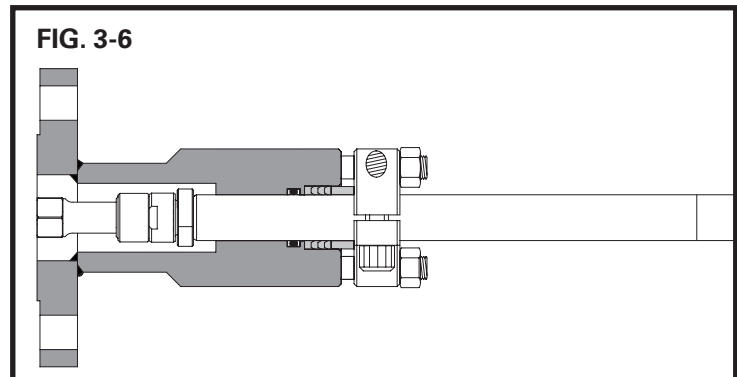
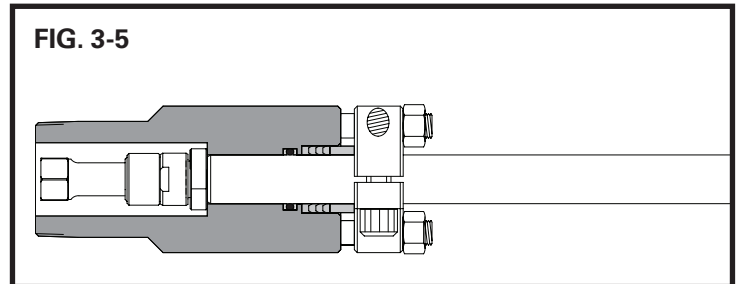
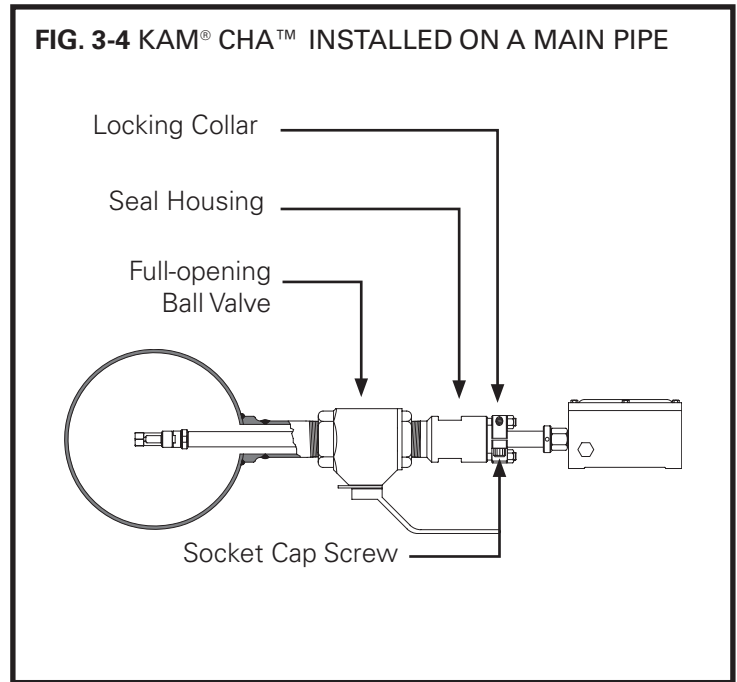
## MAIN LINE INSTALLATION

**CAUTION:** For probe installations and removal when line pressure is above 100 psi, a KAM® IT Insertion Tool must be used.

Without the IT, pressure above 100 psi could cause the probe to forcibly move outward from the pipeline, risking bodily injury and/or damage to the probe.

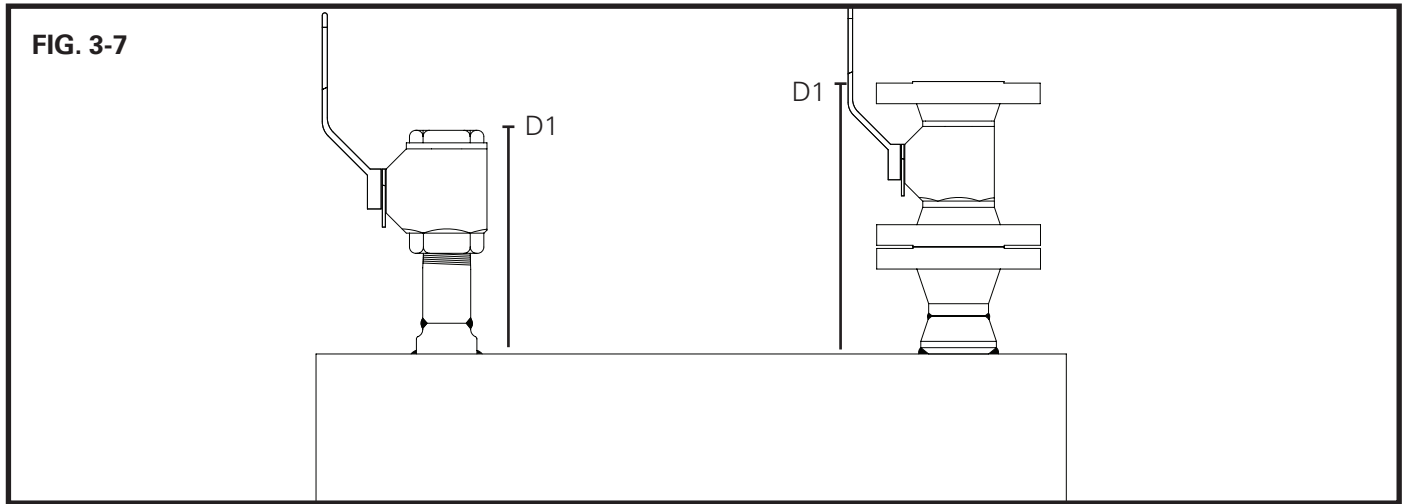
The KAM® CHA™ sensor should be installed according to FIG. 3-4, ideally in a vertical flow or at the 3 or 9 o'clock position within the pipeline. Installing the instrument horizontally prevents the long-term buildup of any sediment on the sapphire windows. A full-opening ball valve is used to isolate the CHA™ sensor from the pipeline during installation or removal. The Seal Housing of the CHA™ sensor allows the probe to be inserted and removed from the pipe under pressure and flow conditions. The CHA™ sensor should be inserted so that the window of the probe is fully located within the pipeline. See page 7 of this manual to determine the proper insertion depth.

1. Prior to mounting verify that the tip of the sensor is fully inside the Seal Housing. FIG. 3-5, 3-6.
2. If sensor is not fully enclosed inside the Seal Housing, loosen the Socket Cap Screws and pull the shaft back until the probe is all the way in the Seal Housing and re-tighten the Socket Cap Screws on the Locking Collar. This will prevent the CHA™ shaft from ejecting and the probe from getting damaged during mounting.



# INSTALLATION CONTINUED

- To ensure proper installation depth, measure the distance (D1) from the outside diameter of main pipe to the end of the connection where the CHA™ sensor is going to be installed. FIG. 3-7.



- You must now calculate the minimum insertion distance for the CHA (minimum depth to ensure probe is fully in flow):

D1        –        Distance from the top of the valve to the pipe  
 WT        –        Pipe Wall Thickness  
 ST        –        Seal Thickness

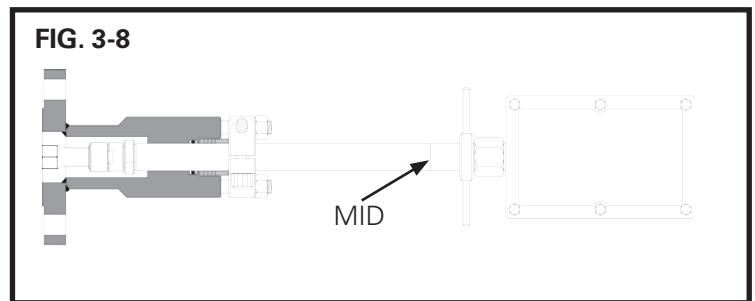
$$\text{Minimum Insertion Distance (MID)} = D1 + WT + ST + 2"$$

Example: D1=16"  
 WT=1/4"  
 ST=1/8"

$$\text{MID} = 16" + 1/4" + 1/8" + 2"$$

$$\text{MID} = 18 \frac{3}{8}"$$

- Measure the calculated MID from the top of the seal clamp and place a mark with a permanent marker or tape on the Shaft. FIG. 3-8.



- Bolt or screw the CHA™ sensor to the valve or designated installation location. (KAM CONTROLS recommends using thread sealant and not Teflon tape for the threaded CHA™).
- Open full-opening valve.
- Loosen Socket Cap Screws on the Locking Collar.

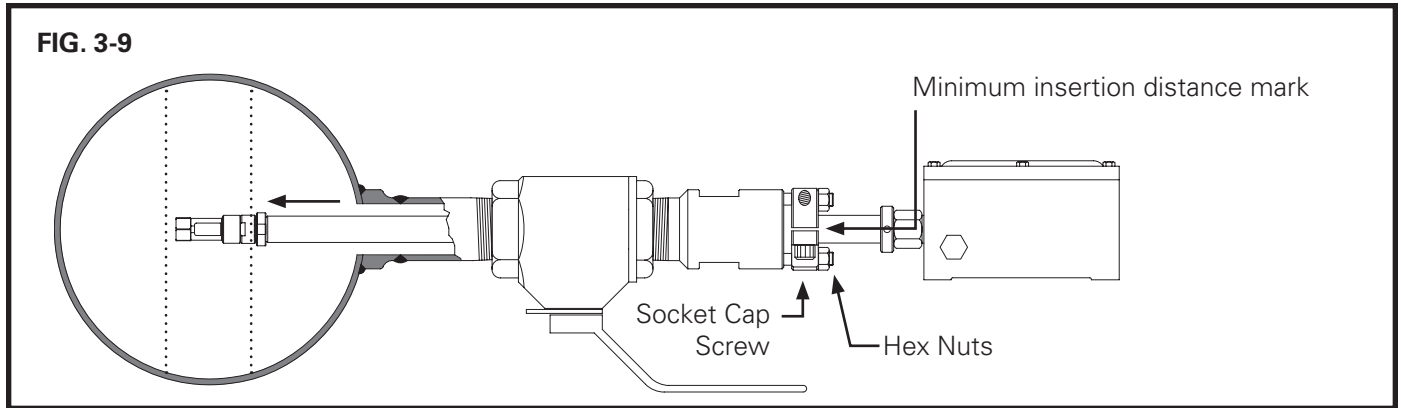
REMINDER: Line pressure must be below 100 psi for CHA installation and removal or a KAM® IT Insertion Tool must be in place.



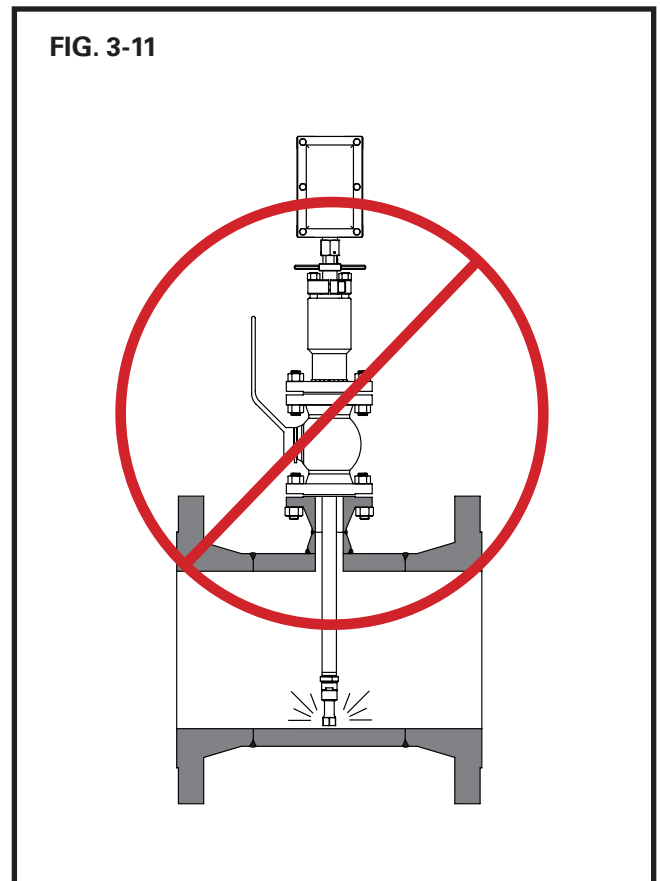
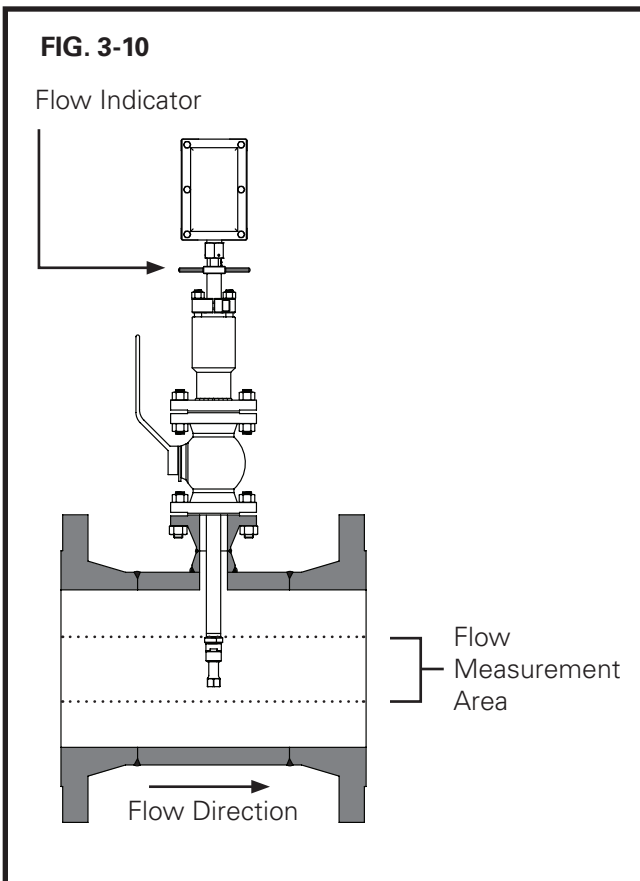
# INSTALLATION CONTINUED

9. Push CHA™ sensor in until the minimum insertion distance mark is at the top edge of the Locking Collar. FIG. 3-9  
Ensure that CHA™ flow indicator is aligned with pipeline flow direction. FIG. 3-10

CAUTION: Inserting CHA™ beyond MID mark into opposing pipeline wall could result in probe damage, include damage to sapphire windows. FIG. 3-11



10. Re-tighten the Socket Cap Screws with a torque of 750-800 lb-in or 62.5 to 66.6 lb-ft.
11. Tighten the Hex Nuts on the top of the Locking Collar one half turn. These nuts should never be over-tightened. Their major function is to apply light pressure on the chevron packing to ensure a seal between the Seal Housing body and the insertion shaft.



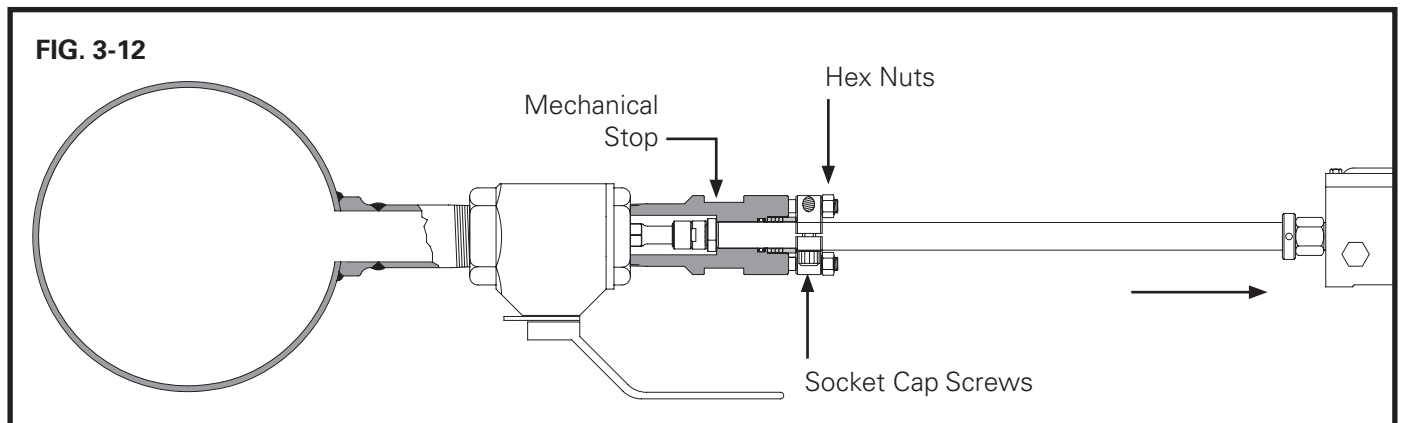
# INSTALLATION CONTINUED

## REMOVING THE CHA™ SENSOR

1. To remove the CHA™ sensor, first disconnect all electrical connections to the CHA™ enclosure.
2. Make sure that the line pressure is below 100 psi. If line pressure is over 100 psi, install a KAM IT Insertion tool onto the unit and follow extraction directions per the IT manual.
3. If pressure is under 100 psi, then loosen Hex Nuts on top Locking Collar, then slowly and with caution loosen the Socket Cap Screws. FIG. 3-12.

NOTE: Once the Socket Cap Screws have been loosened, the CHA shaft may push out from the line.

4. Slide the CHA™ sensor away from pipeline until it cannot go further and the probe rests inside the Seal Housing. FIG. 3-12. The mechanical stop prevents further movement or ejection of the shaft and/or sensor.
5. Close the Full-opening Ball Valve tightly. The CHA™ sensor may now be unbolted from the system.



# INSTALLATION CONTINUED

## WIRING

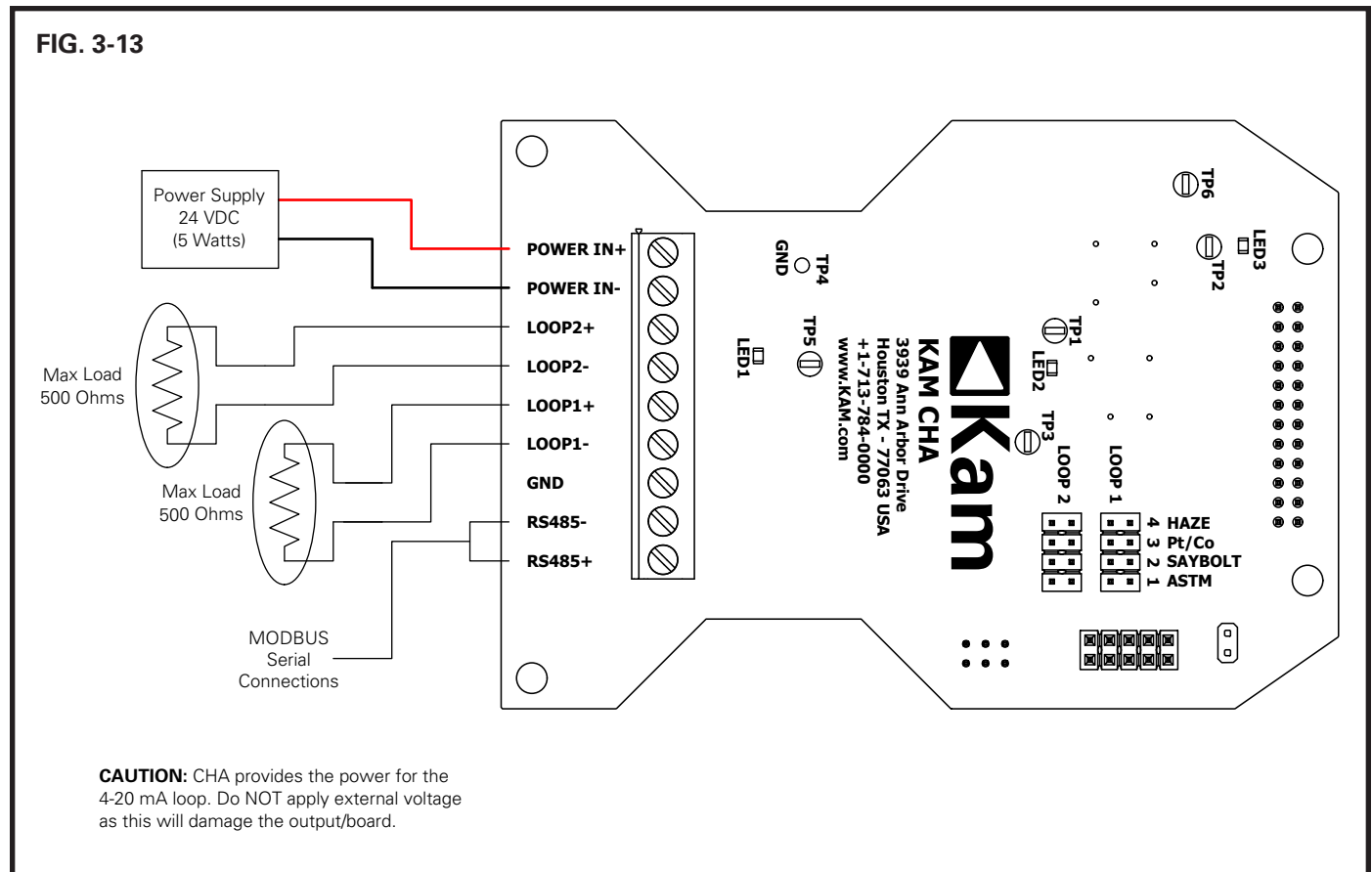
CAUTION: When electronics enclosure is open, be extremely careful to avoid any contact with interior fiber optic connections. Failure to do so could result in the CHA malfunctioning.

- The installed 3/4" NPT plug is not part of the instrument installation and should be replaced by the appropriate Ex certified 3/4" NPT plug for the final installation.
- The Optical Interface Detector KAM OID resp. KAM CHA Color Haze Analyzer EX shall be connected by means of suitable cable entries, resp. conduit systems which correspond technically to the requirements at least of the standard conditions, indicated on the cover sheet, and for which a separate test certificate is available. Thereby the operating conditions specified in the appropriate certificates of the components are to be considered absolutely.
- Cable entries (heavy-gauge screwed cable glands) and sealing plugs of simple construction shall not be used. For connection of the Optical Interface Detector KAM OID resp. KAM CHA Color Haze Analyzer EX by means of an approved conduit entry, the associated sealing device must be arranged directly at the enclosure.
- Non used openings shall be sealed according to EN 60079-1, section 13.8.
- The connecting lead of the Optical Interface Detector KAM OID resp. KAM CHA Color Haze Analyzer EX shall be installed as permanent installation and as such that it is sufficiently protected against damage.

# INSTALLATION CONTINUED

## WIRING CONTINUED

**NOTE:** Grounding the CHA™ sensor through the 4-20 mA output signal and power lines will not protect the CHA™ sensor against power surges or lightning strikes.



1. To access the boards, use a 7/16" wrench to remove the (6) screws on the electronics enclosure and remove the cover. Ensure that power to the CHA is turned off before proceeding.
2. Prior to connecting power for the CHA™ sensor, first check both wires from the source for polarity and voltage, then label appropriately. KAM recommends using shielded twisted pair wire for both power and signal.
3. Connect positive wire to POWER IN+. See FIG. 3-13.
4. Connect negative wire to POWER IN-. See FIG. 3-13.
5. Turn on power to the CHA and check voltage and polarity at the terminal block. Measurement should be close to supply voltage.

# INSTALLATION CONTINUED

## WIRING CONTINUED

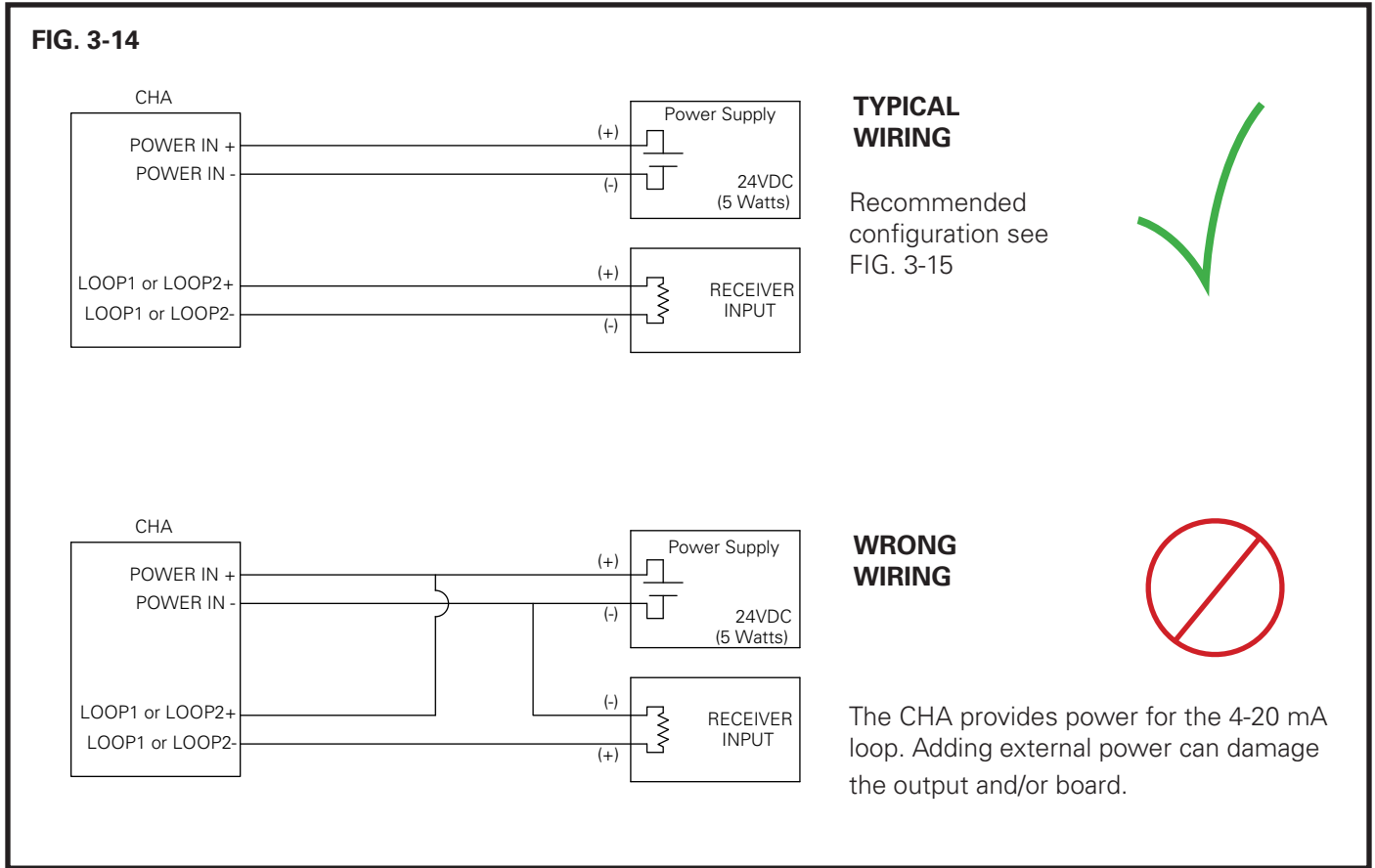
### COMMUNICATION

1. Connect the wiring to the desired outputs and/or serial port. FIG. 3-13.
2. For 4-20 mA outputs, LOOP1 will be set to Haze and LOOP2 to specified color range unless otherwise noted. To change selected ranges see page 16 of this manual.
3. The RS485 serial port can be used for X,Y,Z data or MODBUS (see page 18 of this manual).
4. When wiring is complete, ensure that the lid is properly placed back in place and that all bolts are tightened.

# INSTALLATION CONTINUED

## WIRING CONTINUED

### TYPICAL POWER AND LOOP WIRING CONFIGURATION

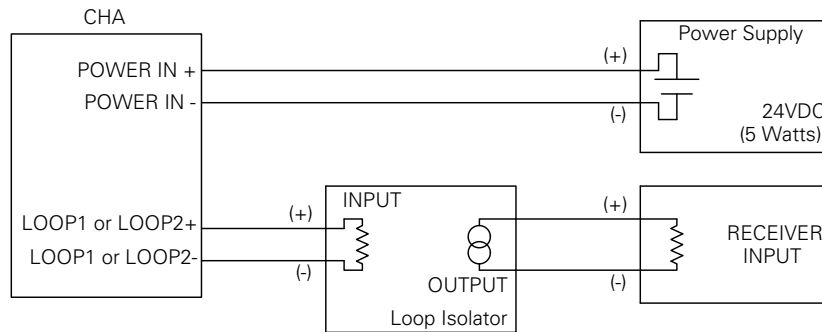


# INSTALLATION CONTINUED

## WIRING CONTINUED

### POWER SUPPLY AND OUTPUT WIRING WITH LOOP POWERED ISOLATOR (recommended)

**FIG. 3-15**

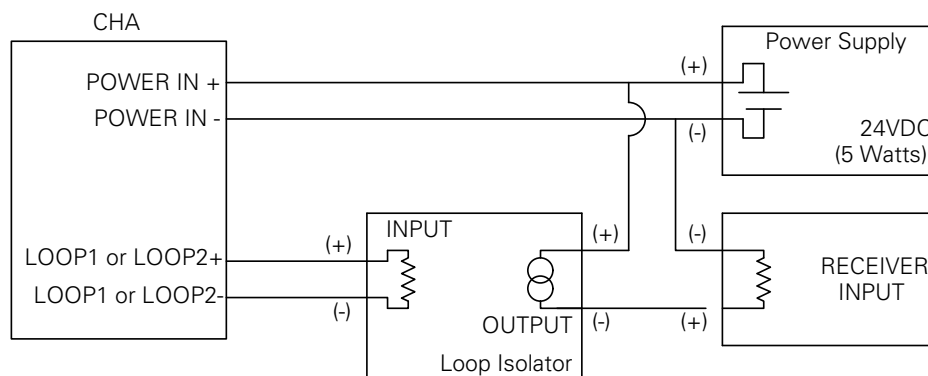


#### Recommended 4-20 mA Loop Isolators:

1. ASI X756526 Loop Powered Analog Signal Isolator, DIN Rail, Slim Line Single Channel
2. ASI 451129 4-20 mA Loop Powered Analog Signal Isolator, Single Channel, DIN Rail

### POWER SUPPLY AND OUTPUT WIRING WITH EXTERNAL POWER ISOLATOR

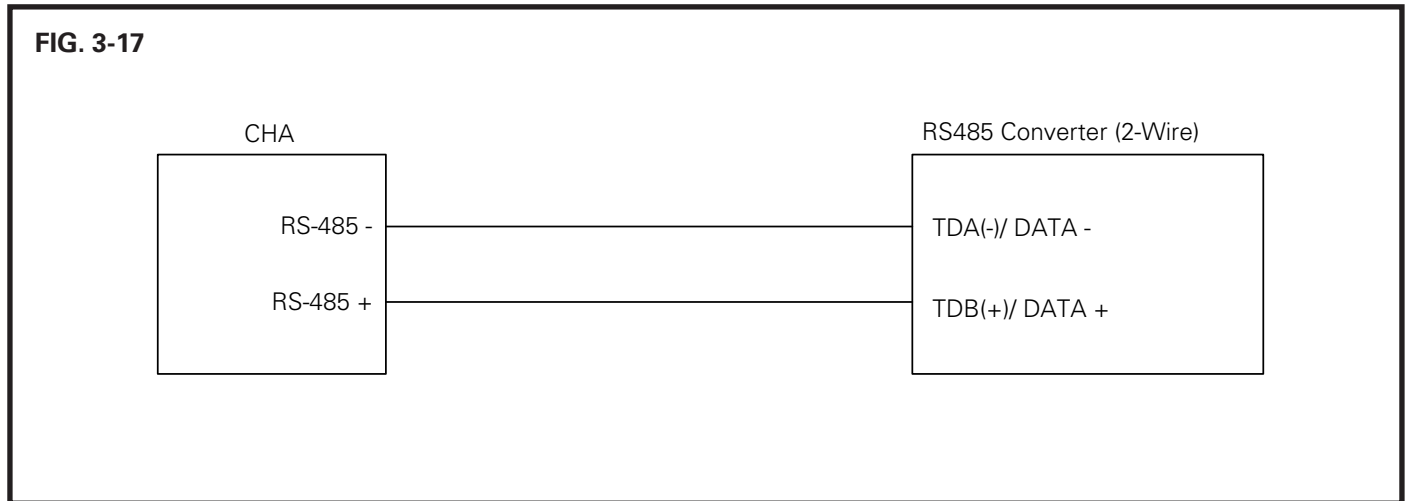
**FIG. 3-16**



# INSTALLATION CONTINUED

## WIRING CONTINUED

### RS485 WIRING DIAGRAM





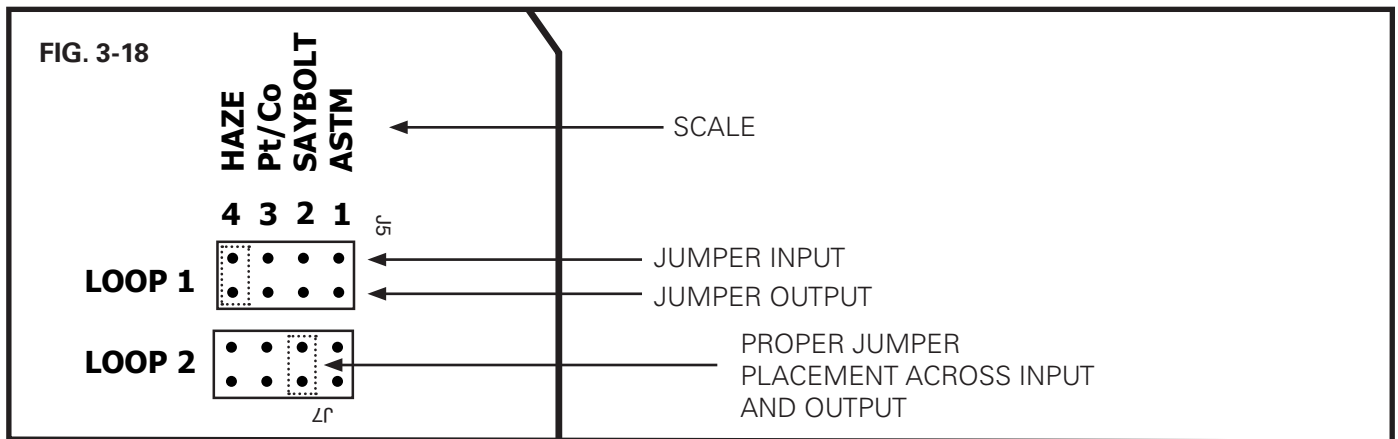
# OPERATIONS AND MAINTENANCE

## CHANGING THE SCALE FOR 4-20 mA OUTPUTS

LOOP1 and LOOP2 can output signals for any 2 of 4 different scales: ASTM, Saybolt, Platinum/Cobalt, and Haze. This will be set at factory according to end user specifications.

To change 4-20 mA output scale, insert a jumper across the pins next to the label for the desired scale. See FIG. 3-18. Place ONE jumper in J5 (LOOP 1) and one in J7 (LOOP2) to select two scales total. The CHA does not require recalibration after changing scales. In most cases LOOP1 will be set for haze and LOOP2 to the specified color scale.

CAUTION: Inserting more than one jumper for either LOOP or inserting the jumper across two inputs or two outputs will result in the malfunctioning of the instrument.



## CALIBRATION

The CHA is factory calibrated to ASTM certified color standards. It should not require recalibration for any reason.

## COLOR SCALE RANGES

Scale	Range
ASTM	0.5 to 8
Saybolt	30 to -16
Platinum/Cobalt	0 to 500
Haze	0 to 100

To change scale(s), see directions on the "Changing the Scale for 4-20 mA Outputs" section.

# OPERATIONS AND MAINTENANCE CONTINUED

## CLEANING AND INSPECTION

Under normal operation, the KAM CHA should not require cleaning, unless pipeline usage is limited to a small number of products, or products are contaminated with debris, organics, etc. Gasoline products or jet fuel in the pipeline will clean the CHA without removal.

To remove any oil residues for visual inspection use a clean cloth with oil solvent or part washer. Preferred solvents include, any petroleum solvent such as mineral spirits, xylene, toluene, gasoline, or diesel.

NOTE: Do not use WD40 or other chemicals.

If you have a question regarding cleaning solvents, please contact KAM CONTROLS directly at +1 713 784-0000, or email: AskAnEngineer@Kam.com

## READINGS VERIFICATION

The following steps allow operators to check for proper operation of the KAM CHA's individual signals and outputs outside of process conditions. To test unit with mineral spirits, fill a clear vessel (beaker, etc.) with enough mineral spirits to fully submerge the CHA probe – approximately 2.5".

**TABLE 4-1**

1. Connect power to the CHA per instructions on pages 11 to 14 of this manual.
2. Connect to the RS-485 Serial Port using a RS485 to USB converter or RS485 to Serial converter.
3. Place CHA probe in a clear vessel with mineral spirits (if desired).
4. Configure Modbus software using the settings on page 18 of the manual.
5. Modbus addresses from 40111 to 40129 should conform to the values listed in Table 4-1.

Register	Type	Description	Expected values with probe in air	Expected values with probe in mineral spirits
40111	32 bit Float	Blue LED signal transmission percent	50 to 65	90-100
40113	32 bit Float	Green LED signal transmission percent	50 to 65	90-100
40115	32 bit Float	Yellow LED signal transmission percent	50 to 65	90-100
40117	32 bit Float	Red LED signal transmission percent	50 to 65	90-100
40119	32 bit Float	IR LED signal transmission percent	54 to 65	90-100
40121	32 bit Float	X color coordinate	90-100	90-100
40123	32 bit Float	Y color coordinate	90-100	90-100
40125	32 bit Float	Z color coordinate	90-100	90-100
40127	32 bit Float	Haze output signal 0-100	51-65	90-100
40129	32 bit Float	ASTM 1500 Color Signal .5 to 8	0.5	90-100
40131	32 bit Float	Saybolt Color Signal 30 to -16	15-25	20-30
40133	32 bit Float	PT-Cobalt Color signal 0-500	0	0

# MODBUS CONFIGURATION

## MODBUS SETTINGS AND REGISTERS

Recommendations for CHA Modbus TCP Client devices:  
 Enable serial port FIFO. Add a delay between Modbus TCP request of at least 500ms.

SETTINGS	
MODE	RTU
BAUD RATE	9600
DATA BITS	8
STOP BITS	1
PARITY	None
SLAVE ID	1
OFFSET	40001

CHA Holding Modbus Registers		
Register No	Type	Description
40100	16 bit integer	Amplifier gain
40101	16 bit integer	Blue LED raw signal from probe
40102	16 bit integer	Green LED raw signal from probe
40103	16 bit integer	Yellow LED raw signal from probe
40104	16 bit integer	Red LED raw signal from probe
40105	16 bit integer	IR LED raw signal from probe
40106	16 bit integer	Blue LED signal from reference fiber
40107	16 bit integer	Green LED signal from reference fiber
40108	16 bit integer	Yellow LED signal from reference fiber
40109	16 bit integer	Red LED signal from reference fiber
40110	16 bit integer	IR LED signal from reference fiber
40111	32 bit float	Blue LED signal transmission percent
40113	32 bit float	Green LED signal transmission percent
40115	32 bit float	Yellow LED signal transmission percent
40117	32 bit float	Red LED signal transmission percent
40119	32 bit float	IR LED signal transmission percent
40121	32 bit float	X color coordinate
40123	32 bit float	Y color coordinate
40125	32 bit float	Z color coordinate
40127	32 bit float	Haze output signal 0-100
40129	32 bit float	ASTM 1500 color signal 0.5 to 8
40131	32 bit float	Saybolt color signal 30 to -16
40133	32 bit float	PT-Cobalt color signal 0-500