Lynx™
Flush Mount
Cavity Pressure Sensors

LS-F-25-20K, LS-F-40-20K

Installation & Use Instructions

10/19/04

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RJG's Lynx™ Flush Mount Cavity Pressure Sensors

Introduction

RJG, Inc. Cavity Pressure Sensors assist in providing accurate sensor-based Statistical Process Control (SPC) and are also rugged and reliable. The Lynx™ Flush Mount Pressure Sensor (LS-F-25-20K, LS-F-40-20K) is a strain gauge design in a compact 2.5 mm, 4 mm, or 6 mm head for the direct replacement of other flush mount pressure sensors. This sensor does not use an ejector pin, can be mounted in any location in the cavity, and maintains a constant calibration.

The Flush Mount pressure sensor is available in standard lengths of 12", 24", 36", and 48" measured from the bottom of the connector box to the end of the sensor as shown in Figure 1 on page 2. Other lengths are available upon customer request.

Lynx™ Sensors as a Part of RJG's eDART™ System

Lynx™ sensors are designed to be used with RJG's eDART™ System. The output from a Lynx™ sensor is digital and communicates with the eDART™.

No Setup

The Lynx™ cavity pressure sensor greatly simplifies setup. The only entry required by the user is the pin size when using an indirect sensor.

Serial Numbers

Each Lynx™ sensor is programmed with a serial number, which is recorded by the eDART™ as it is assigned to molds, machines, or other equipment. When a sensor is disconnected and later attached to an eDART™, the eDART™ "knows" that sensor is connected to a specific mold and changes the job setup accordingly.

Self-Monitoring

Most of the sensors used by an eDART™ System are capable of sensing if they have failed. The processor in the sensor head detects broken wires and other errors and alerts the eDART™ that the sensor is not functioning. This prevents failed sensors from controlling a process and can shut down the process on sensor failure (or disconnection) if the sensor is critical to the process.

Operating Principle

RJG's strain gauge-based design sensors are configured in a Wheatstone bridge, which converts mechanical energy into electrical energy. Strain gauges operate on the principle that the resistance of a wire changes as pressure on the wire changes (See Figure 1).

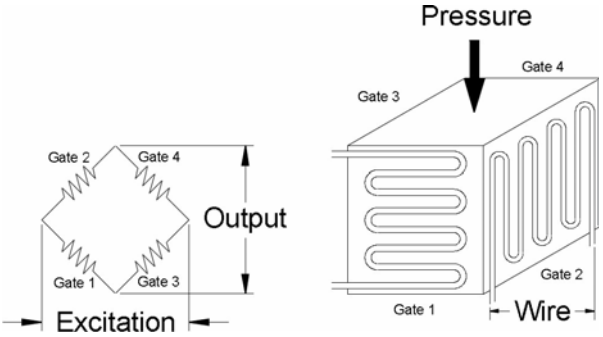


***Figure 1**: Strain Gauge Operating Principle*

A Flush Mount sensor, when inserted into the mold, becomes a part of the cavity wall. Plastic under pressure in a mold cavity exerts a force on the exposed end of the sensor causing an imbalance in the strain gauge bridge. When calibrated, the imbalance is converted to a voltage signal that directly correlates to the plastic pressure in the cavity. This voltage signal is then converted to a digital signal that is linearized and sent to the eDART™.

NOTE: *Any sensor requires a signal conditioner to display pressure it is seeing.*

Universal Cavity Pressure Sensor Installation

To ensure the successful application of cavity pressure monitoring and control technology, it is vitally important that sensors be installed properly. Proper installation requires two (2) fundamental things. First, the sensor should be located in the correct region of the cavity so that proper information will be obtained. Secondly, the mechanical installation must be done properly to ensure that the sensor can be installed and removed and that it will not have pre-loads, side loads, or other mechanical impediments to the successful detection of the cavity pressure.

Sensor Placement Strategy

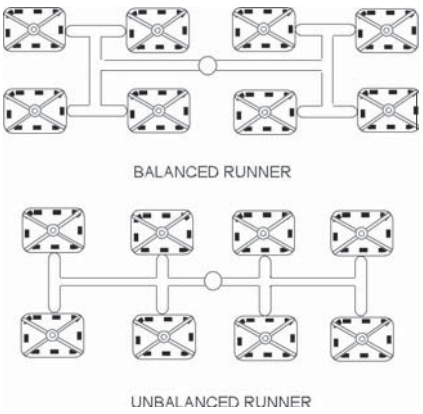
The strategy for locating the sensor will be different depending on whether your primary goal is process monitoring or process control.

Process Monitoring Applications:

If the sensor is primarily going to be used for monitoring rather than control, the end-of-cavity is the best location. This specifically applies to accomplishing SPC, predicting good vs. bad parts, correlating cavity pressure to part conditions, or simply detecting non-fills (short shots). This location will show the maximum amount of variation of in-cavity pressure and act as a "catch-all" for the process to detect change. A good way to find the sensing location at the end-of-cavity is to make a shot approximately 10% short by reducing the injection stroke and turning off 2nd stage pressure. The sensor can be placed beneath a pin in the unfilled region.

If the pressure drop across the cavity is to be detected or if the maximum amount of information is to be obtained using sensors, a sensor near the gate in conjunction with one at the end of the cavity will provide optimum capability. This will allow monitoring of the degree of packing across the entire part, as well as an estimate of average cavity pressure. It will also provide the maximum ability to monitor part quality.

In multiple cavity tools with cold runner systems, monitoring of one or two cavities will generally allow the prediction of quality in the other cavities. This assumes that proper attention is paid to mold balance, mold deflection, and mold temperature control so that each cavity is influenced in an identical fashion. It is easier to predict part quality in a balanced mold than an unbalanced mold. If an unbalanced runner system is used, installing a sensor in the first and last cavities to fill will usually be sufficient for monitoring purposes in most applications.



Hot runner molds are different because the temperature of the tips often varies over time so the balance is rarely consistent. This means that monitoring of one cavity will not necessarily predict quality in other cavities; therefore, more sensors are required for monitoring. If monitoring of all cavities is not practical, you can monitor one cavity in each zone instead (See Figure 2). Alternatively, you can identify problematic cavities and only monitor these. In single parts with multiple drops, the last point to fill beneath each drop should be monitored for maximum quality monitoring effectiveness (See Figure 3).

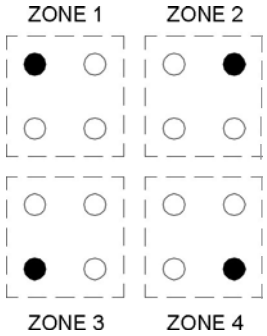


***Figure 2**: Monitoring One Cavity in Each Zone*

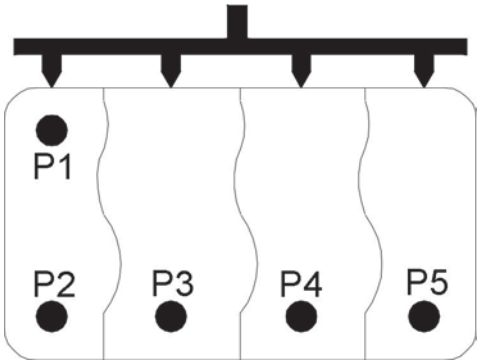


***Figure 3**: Typical Knit Line: Pressure Measurement in Single Cavity Multiple Gate Runnerless Systems*

NOTE: *In hot runner applications, if there is any question, contact RJG Customer Support for assistance before locating sensors in the mold.*

Process Control Applications:

If control of the molding machine is the primary reason for the implementation of cavity pressure sensing or if flashed parts or gate seal/non-seal is always to be detected, placing the cavity pressure sensor near the gate end of the part inside the cavity is correct. RJG strongly recommends that end-of-cavity locations be avoided for control as the machine cannot react fast enough to use this for control.

Control sensors should be located in the "Area of Influence". This is the region of the part where the last material was flowing. An easy way to find the Area of Influence is to change from a translucent material to a colored material. The region where the first color appears is in the Area of Influence (See Figure 4).

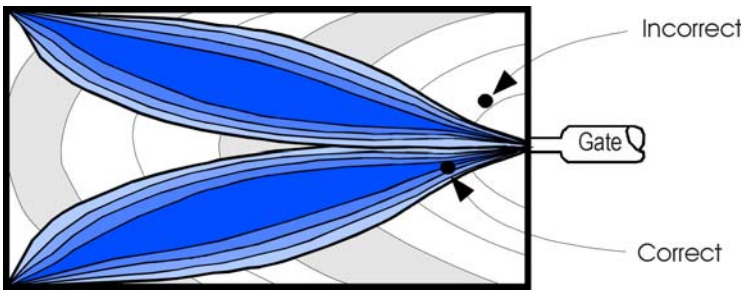
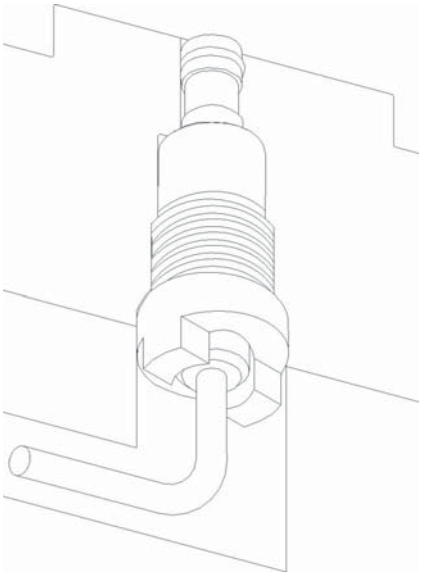


***Figure 4**: Area of Influence in a Cavity*

Mechanical Placement

The sensing end of the sensor must fully contact plastic in the mold runner or cavity and not contact mold steel in such a way as to impart a pre-load and cause false readings. A sensor located flush with the cavity wall will be able to directly measure in-cavity pressure.



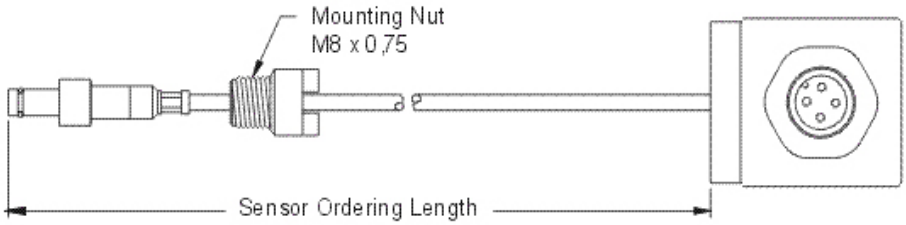


Figure 5: *Lynx™ Flush Mount Sensor Length Reference*

Sensor	Sensor Diameter	Ordering Length*
LS-F-25-20K LS-F-40-20K	2.5 mm 4 mm	12", 24", 36", 48"

Table 1*: Sensor Dimensions*

**Lengths over 48" require special ordering*

Pressure Range (Overload Capacity)
LS-F-25-20K, LS-F-40-20K.....20000 psi (30000 psi)
O-Ring Used
LS-F-25-20K.....0.047" x 0.024"
LS-F-40-20K.....0.098" x 0.026"
Maximum Temperature - Sensor.....425°F [218°C]
Maximum Temperature - Connector.....140°F [60°C]
Temp. Comp. of Zero & Sensitivity Accuracy.....± 2% FS/100°F [38°C]
Accuracy.....1.0% FS
Repeatability.....0.5% of Output
Std. Connector.....Microstyle DC Receptacle

Table 2*: Technical Specifications*

Installation and Mold Modifications

Lynx™ Flush Mount Sensors

Flush Mount sensors are supported from the cable end with a mounting nut. The following pages outline the installation of the LS-F-25-20K and LS-F-40-20K Flush Mount sensors. Figures 6 - 7 on page 8 provide the dimensions of each Flush Mount sensor for installation.

Use the installation tool (MA-6157-TL1) to protect against damaging the cable during installation and to prevent overtightening the nut. Tighten the nut to 20 in. lb. torque (using a torque wrench) to ensure accurate readings from the sensor. See *Appendix A - Mounting Accessories* on page 14 for more information.

NOTE: *The cable does not detach at the sensor body. The nut is assembled over the cable and is not removable.*

IMPORTANT: *Make sure that the mounting hole is cut to specification.*

IMPORTANT: *Make sure that no debris gets between the sensor and the nut or between the sensor and the bottom of the mounting hole.*

NOTE: *If the sensor's cable becomes damaged during installation, DO NOT try to re-solder the wires back together at your facility. Instead, send the sensor back to RJG to have the wires re-soldered and the sensor re-calibrated. Splicing and soldering a damaged cable may cause calibration errors.*

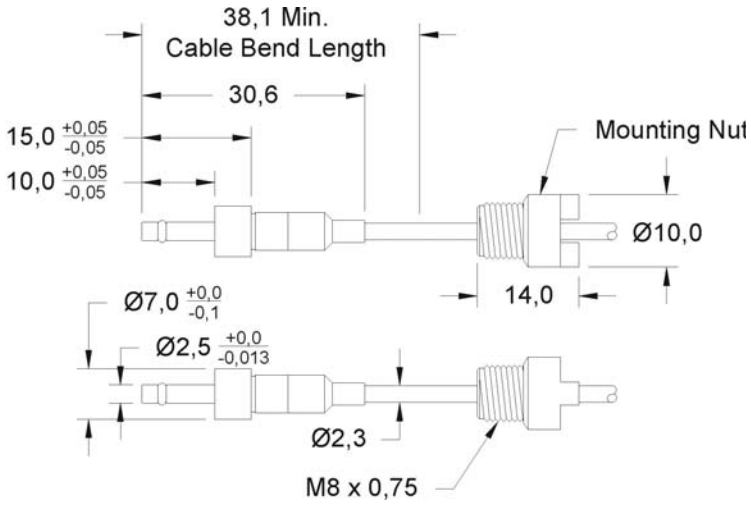


***Figure 6**: LS-F-25-20K Sensor Dimensions*

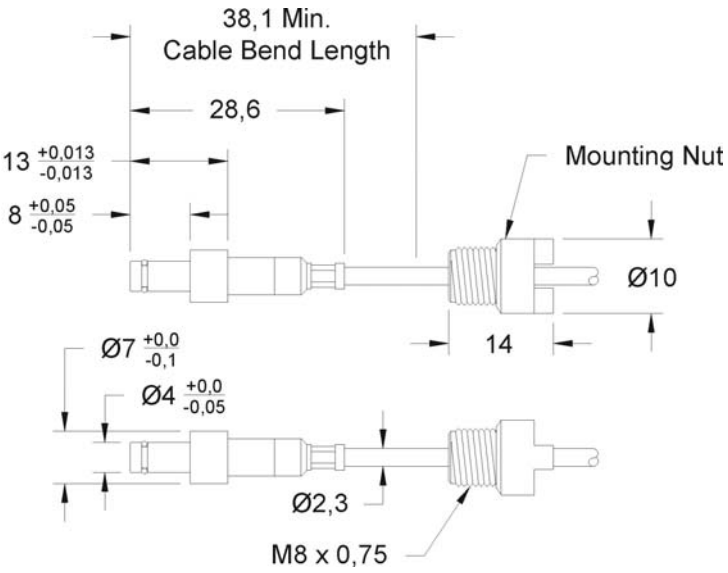


***Figure 7**: LS-F-40-20K Sensor Dimensions*

Figure 9 outlines the dimensions for attaching the Lynx Connector to the mold. The length of the Flush Mount sensor is measured from the bottom of the connector box to the end of the sensor as shown in Figure 5 on page 6. The sensors' standard lengths are also listed on page 6.

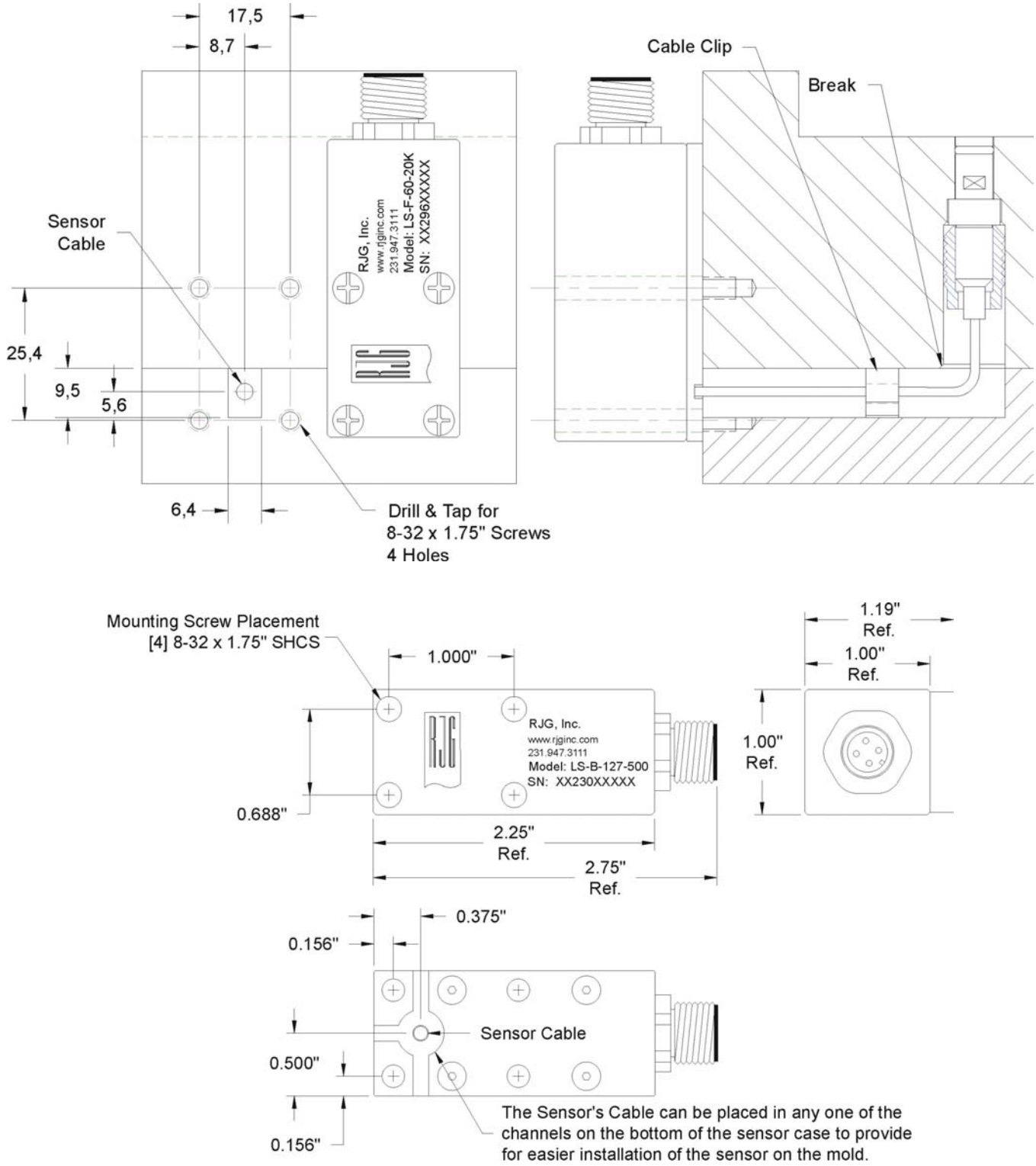
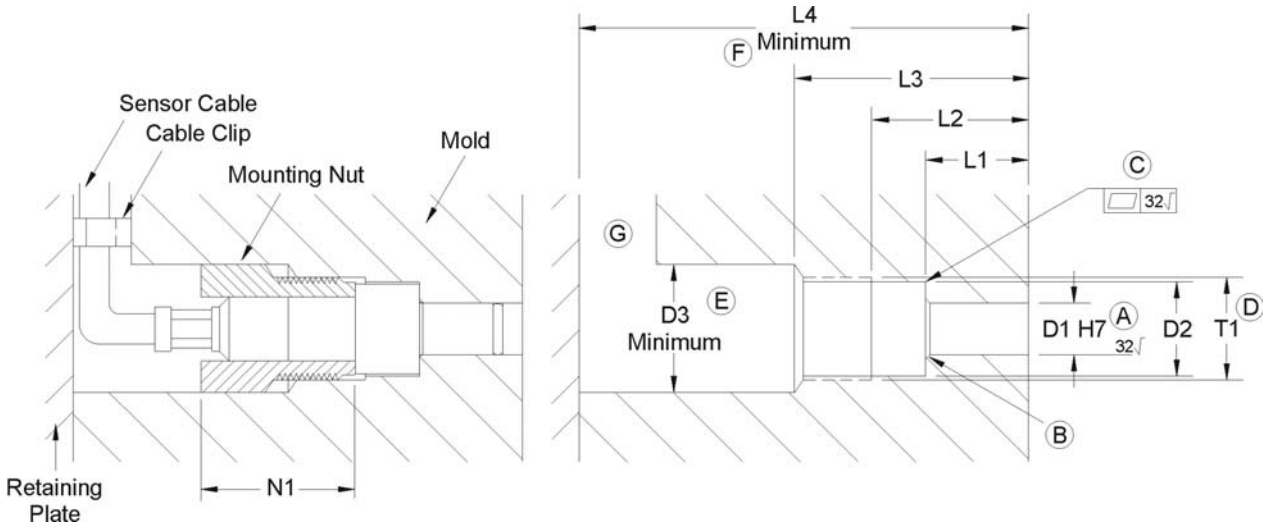


***Figure 9**: Recessed Mounting of the Lynx Flush Mount Sensor with Connector Dimensions*

NOTE: *The cable does not detach at the sensor body.*

Figure 10 shows the installation of the Lynx Flush Mount sensor. Use installation tool (MA-6157-TL1) to protect against damaging the cable during installation and to prevent overtightening of the nut. See *Appendix A - Mounting Accessories* on page 14 for more information.



	D1	D2	D3	T1	L1	L2	L3	L4	N1
LS-F-25-20K	2.5 mm	7.25 mm	10 mm	M8 x 0.75	10 mm	13 mm	20.5 mm	38 mm	14 mm
LS-F-40-20K	4 mm	7.25 mm	10 mm	M8 x 0.75	8 mm	11 mm	18.5 mm	38 mm	14 mm
LS-F-60-20K	6 mm	10.2 mm	14 mm	M12 x 1	12 mm	14 mm	32 mm	43 mm	15.2 mm

***Figure 10**: Installation of the Lynx Flush Mount Sensor*

NOTE: *The D2 measurement is a MINIMUM.*

(A) The D1 diameter for the sensor tip should have a surface finish of 32 $\sqrt{}$ or better as shown. The H7 tolerance is +0.01/-0 for the LS-F-25-20K and +0.012/-0 for the LS-F-40-20K. The sensor should be snug, but not bind (approximately 0.02 - 0.03 mm clearance around the tip).

(B) A 0.3 - 0.4 mm x 60° chamfer can be added if desired to allow easy insertion into the mold.

(C) Corner "C" must be sharp (max. radius 0.05 mm). The inside must be flat with a surface finish of 32 $\sqrt{}$ or better.

(D) Drill and tap for thread (See T1 above).

(E) The recommended diameter for each sensor is listed above. This dimension can be made slightly larger (See D3 above).

(F) The L4 minimum overall sensor depth is required to allow space for the sensor cable. If more space is available, the chance of damage to the cable is reduced.

(G) Machine a cable slot from the back of the sensor to the outside of the mold. The slot dimensions should be 9.5 mm deep x 6.4 mm wide if you plan to use the cable clips provided with this sensor (Figure 12).

NOTE: *De-burr and clean all mounting holes before installation.*

Retaining the Sensor Cable

At the Platen

The sensor cable, which goes from the pressure sensor connector to the eDART™, should be retained to prevent damage over time. The cable should not be left dangling from the sensor connector. The cable should be strained-relieved to the ejector/retainer plate so the cable and the sensor move as a complete assembly. There should be no movement between the cable plug and the sensor mating connector as it may have a tendency to wear on the connector insert causing premature failure.

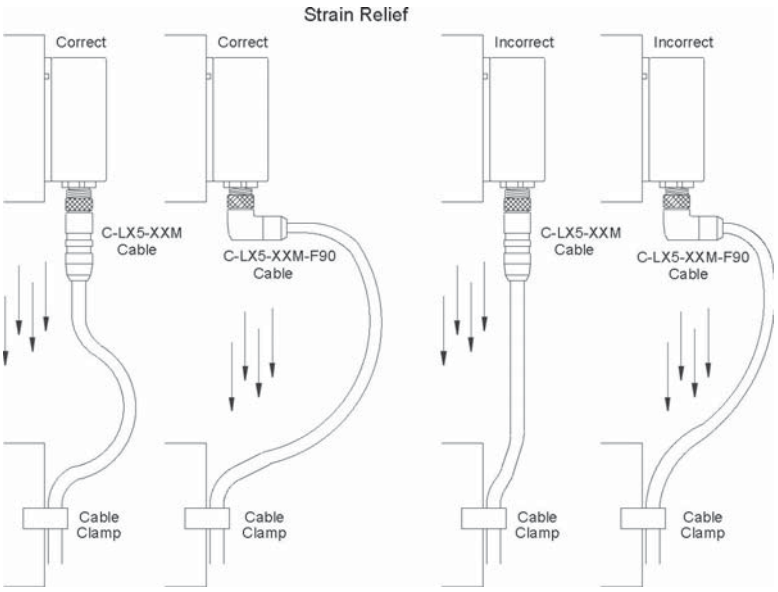


***Figure 11**: Retaining the Sensor Cable*

NOTE: *If the sensor's cable becomes damaged during installation or on subsequent production runs, whereas the cable wires are accidentally cut or pulled out of the sensor body or connector, **DO NOT** try to re-solder the wires back together at your facility. Instead, send the sensor back to RJG to have the wires re-soldered and the sensor re-calibrated. Splicing and soldering a damaged cable may cause calibration errors.*

Replacement sensor cables are available from RJG, Inc. and other electrical distributors.

In the Mold

Self-locking cable clips were included with your sensor order. These clips help to retain the sensor's cable in the mold. The clips will greatly reduce the risk of damage caused to the cable when the mold is reassembled. RJG recommends spacing the clips approximately 3" apart along the channel.

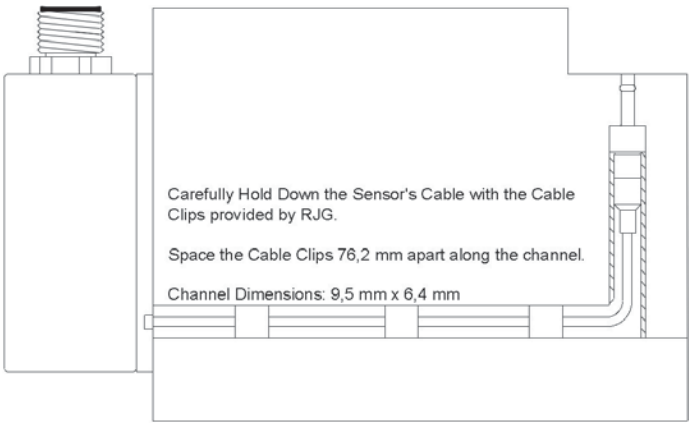


***Figure 12**: Self-Locking Cable Clips*

Wiring Failure

The most common causes of sensor failures are short circuits or broken wires. Refer to the *Retaining the Sensor Cable at the Platen* section on page 11 for preventing cable wire failures.

Using the Raw Data Viewer

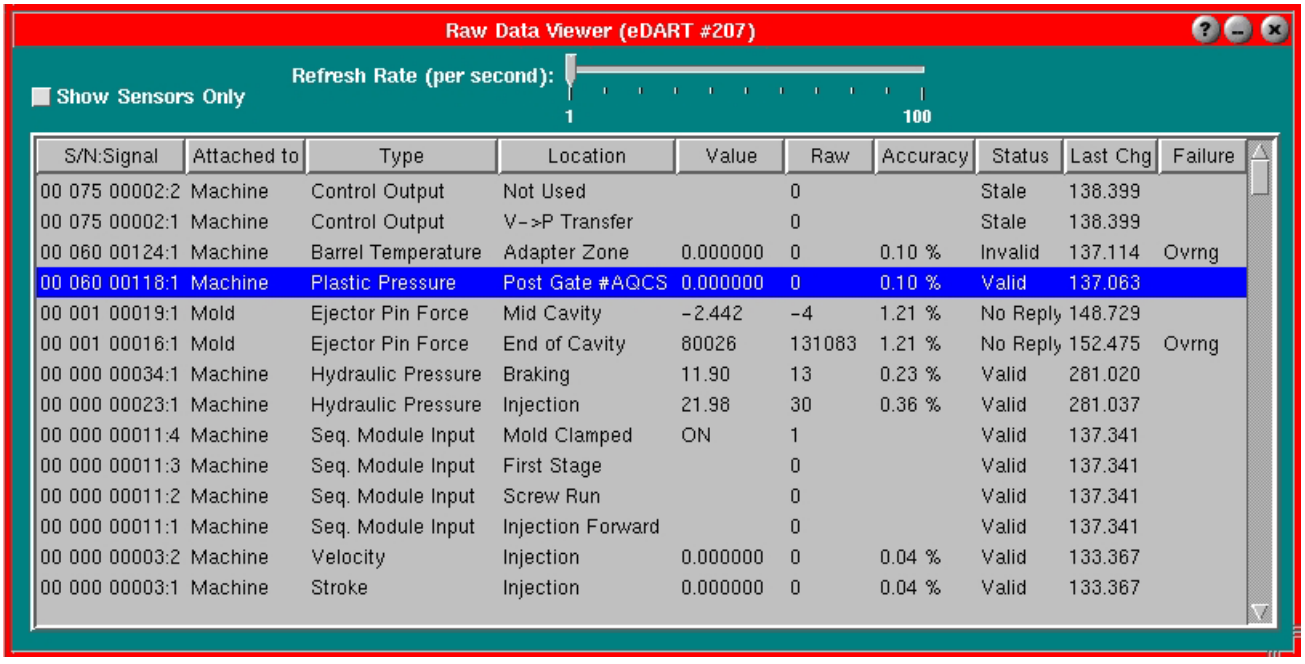
The best way to verify that a Lynx™ sensor is operational is to use the eDART™ software. Under the Main Menu is the "Raw Data Viewer" selection, which allows you to view the status of the sensor.

Valid
If the Status is "Valid" and the "Raw" counts change when a force is applied to the sensor, you can be confident that the sensor is operating properly.

No Reply
If the Status is "No Reply", the sensor is not communicating on the network. The sensor may have been unplugged from its network connection.

Stale
A "Stale" Status indicates that the sensor is not being used.

Invalid
If the Status is "Invalid, the Failure mode will read "Ovrng" or "Undrng". "Ovrng" indicates that the sensor had shifted outside the upper spec. "Undrng" indicates that the sensor has shifted outside the lower spec.



S/N:Signal	Attached to	Type	Location	Value	Raw	Accuracy	Status	Last Chg	Failure
00 075 00002:2	Machine	Control Output	Not Used		0		Stale	138.399	
00 075 00002:1	Machine	Control Output	V->P Transfer		0		Stale	138.399	
00 060 00124:1	Machine	Barrel Temperature	Adapter Zone	0.000000	0	0.10 %	Invalid	137.114	Ovrng
00 060 00118:1	Machine	Plastic Pressure	Post Gate #AQCS	0.000000	0	0.10 %	Valid	137.063	
00 001 00019:1	Mold	Ejector Pin Force	Mid Cavity	-2.442	-4	1.21 %	No Reply	148.729	
00 001 00016:1	Mold	Ejector Pin Force	End of Cavity	80026	131083	1.21 %	No Reply	152.475	Ovrng
00 000 00034:1	Machine	Hydraulic Pressure	Braking	11.90	13	0.23 %	Valid	281.020	
00 000 00023:1	Machine	Hydraulic Pressure	Injection	21.98	30	0.36 %	Valid	281.037	
00 000 00011:4	Machine	Seq. Module Input	Mold Clamped	ON	1		Valid	137.341	
00 000 00011:3	Machine	Seq. Module Input	First Stage		0		Valid	137.341	
00 000 00011:2	Machine	Seq. Module Input	Screw Run		0		Valid	137.341	
00 000 00011:1	Machine	Seq. Module Input	Injection Forward		0		Valid	137.341	
00 000 00003:2	Machine	Velocity	Injection	0.000000	0	0.04 %	Valid	133.367	
00 000 00003:1	Machine	Stroke	Injection	0.000000	0	0.04 %	Valid	133.367	

***Figure 13**: Raw Data Viewer*

Calibration

The output from the Lynx™ sensor is digital. The sensor communicates with an RJG eDART™. Since the signals from the sensor are digital, no errors inherent with analog measurement systems are introduced.

Lynx™ Flush Mount sensors are calibrated at the factory to an accuracy of 1.5% of full scale or better.

The electronics in the aluminum case store the serial number, calibration, and date of calibration.

Appendix A
Mounting Accessories

Accessories for installing Flush Mount sensors are listed below along with their ordering information.

The installation tool assists with the insertion of the mounting nuts for Flush Mount pressure sensors and prevents overtightening of the nut during installation. The tool's standard length is 8".

Installation Tool

Installation of the Self-locking cable clips is illustrated in Figure 12 on page 11.

Part #	Product	Size
MA-6157-TL1	Installation Tool	Ø 0.375" x 8.5" Overall Length
MA-CLIP-MPT	Self Locking Cable Clip	Package of 25 (1 Clip per 3" of cable)
85-6159-000 85-6157-000 85-6153-000	O-Rings	0.047" x 0.024" 0.098" x 0.026" 0.172" x 0.037"

***Table 3**: Mounting Accessories*

Appendix B
Fitting the Sensor

Use the dimensions provided previously to correctly fit the sensor into the mold to avoid additional machining of the tip. If additional machining is necessary to accurately fit the surface of the cavity, follow the steps below.

Machining the Tip

Material can be easily removed from the Flush Mount sensor at a maximum rate of 0.0005" per pass using a dry grind.

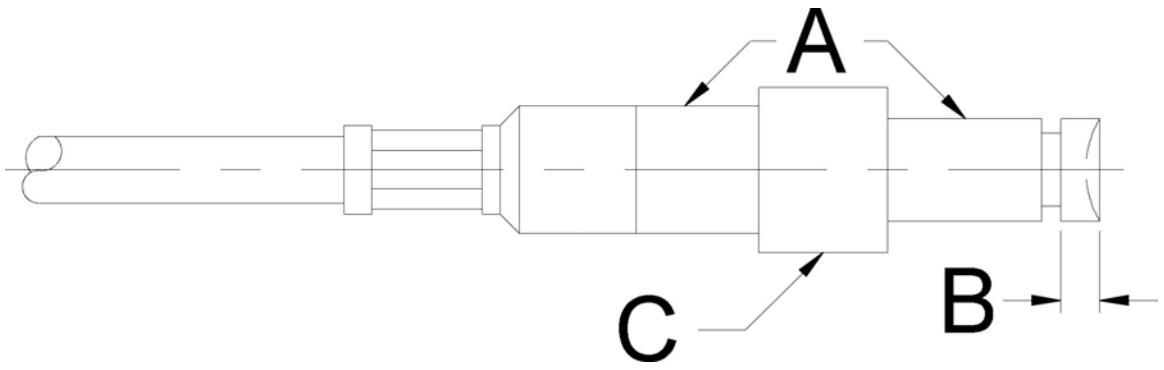


***Figure 14**: Machining the Tip*

A - Clamp the sensor here.
B - A maximum of 0.035" can be ground off the tip of the sensor.
C - Avoid clamping on this diameter as the sensing element may be damaged.

RJG Product Disclaimer

Inasmuch as RJG, Inc. has no control over the use to which others may put this material, it does not guarantee that the same results as those described herein will be obtained. Nor does RJG, Inc. guarantee the effectiveness or safety of any possible or suggested design for articles of manufacture as illustrated herein by any photographs, technical drawings and the like. Each user of the material or design or both should make his own tests to determine the suitability of the material or any material for the design, as well as the suitability of the material, process and/or design for his own particular use. Statements concerning possible or suggested uses of the materials or designs described herein are not to be construed as constituting a license under any RJG, Inc. patent covering such use or as recommendations for use of such materials or designs in the infringement of any patent.

RJG, Inc. is not responsible for the improper installation of this equipment, or any other equipment RJG manufactures.

Proper RJG equipment installation does not interfere with original equipment safety features of the machine. Safety mechanisms on all machines should never be removed.