Guidelines for Presenting Specifications of Analog Process Measurement and Control Instruments

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GUIDELINES FOR PRESENTING SPECIFICATIONS OF ANALOG PROCESS MEASUREMENT AND CONTROL INSTRUMENTS

1. SCOPE AND PURPOSE

1.1 Scope

This guideline proposes formats by which specifications for analog process measurement and control instruments may be presented by the manufacturer. The subject is treated from the generic point of view; that is, this guideline shows examples of how to present specifications without regard to the particular type or class of instrumentation. This guideline is intended to apply to specifications for instruments designed for use in either field or control room areas. Because of the generic nature of this document, not all specifications apply to all types of instruments.

1.2 Purpose

The purpose of this guideline is to provide a standardized manner in which manufacturers may present the various specifications applicable to the operational and physical parameters of analog process measurement and control instruments. This should better enable the purchaser to select the proper instrument for the application by comparison of specifications.

2. DEFINITIONS

Definitions for terms used in this document can be found in the current version of ANSI/ISA Standard S51.1, Process Instrumentation Terminology.

Specification, as used in this document, is defined as: A statement of the maximum expected performance limits of an instrument for each of the various parameters applicable to that instrument.

Terms that cannot be qualified, such as "typical" and "neglibible" are not used in this document, and it is recommended that they not be used in manufacturer's specifications. If such terms are used, a definition must be provided.

3. TEST PROCEDURES

Unless otherwise stated, test procedures for the determination or verification of specifications as contained in this document shall be conducted in accordance with the current version of Standard , Generic Test Methods for the Testing and Evaluation of Process Measurement and Control Instrumentation.

Although there is no intent by this document to dictate the method to be used in analyzing data for the establishment or verification of specifications, the manufacturer should make the user aware of those methods which were used to derive the specification.

4. SPECIFICATIONS

4.1 Specifications for Accuracy-Related Factors

4.1.1 Accuracy Rating

Accuracy Rating should be specified as in one of the following examples:

When expressed in terms of:	The specification should read:
• Measured variable	Accuracy: ±[ ]°C or ±[ ]°F
• Percent of output span	Accuracy: ±[ ]% of output span
• Percent of upper range value	Accuracy: ±[ ]% of upper range value
• Percent of scale length	Accuracy: ±[ ]% of scale length
• Percent of ideal output	Accuracy: ±[ ]% of ideal output reading

4.1.2 Linearity (or Conformity)

Linearity should be specified as in one of the following examples:

Independent Linearity: ±[ ]% of output span.

Terminal-based Linearity: ±[ ]% of output span.

Zero-based Linearity: ±[ ]% of output span.

4.1.3 Hysteresis

Hysteresis should be specified as in the following example: Hysteresis: [ ]% of output span.

4.1.4 Dead Band

Dead Band should be specified as in the following example: Dead Band: [ ]% of input span.

4.1.5 Repeatability

Repeatability should be specified as in the following example: Repeatability: [ ]% of output span.

4.1.6 Gain or Proportional Band

Gain should be specified as in one of the following examples:

- Static Gain: [ ] (minimum)
- Derivative Gain: [ ]dB (maximum)
- The gain is adjustable between [ ] and [ ].
- Gain Dial Accuracy: ±[ ]% of (Reading or Setting)

Proportional Band should be specified as in the following example: The proportional band is adjustable between [ ] and [ ]%. Proportional Band Dial Accuracy: ±[ ]% of (reading or setting).

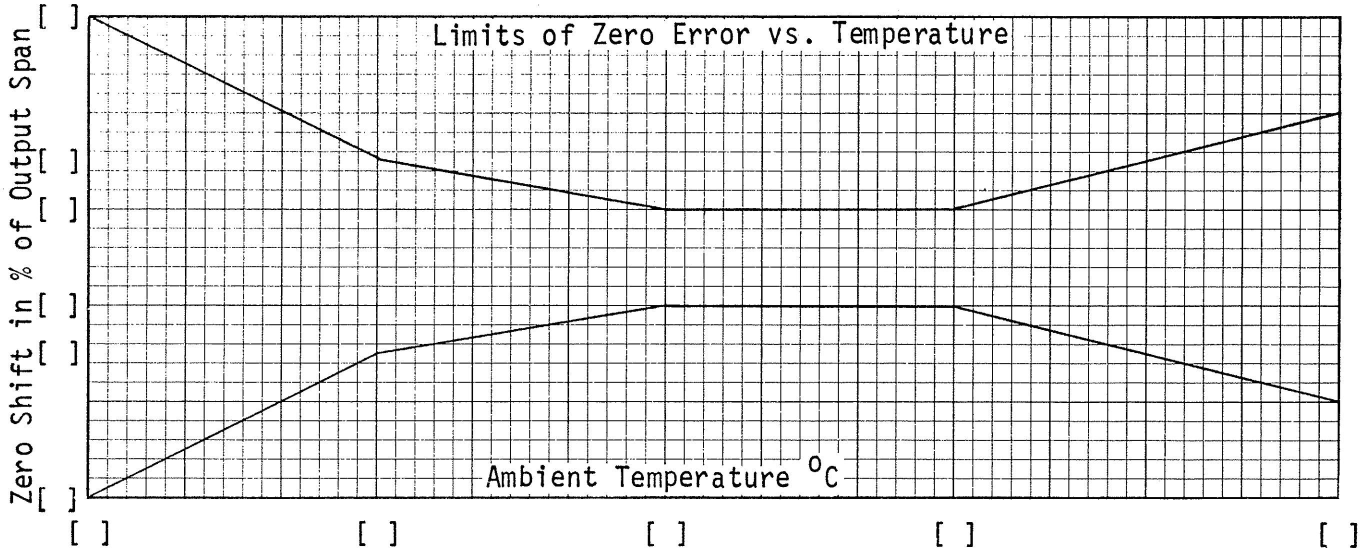
4.2 Specifications for Operating Influences

4.2.1 Ambient Temperature Effects

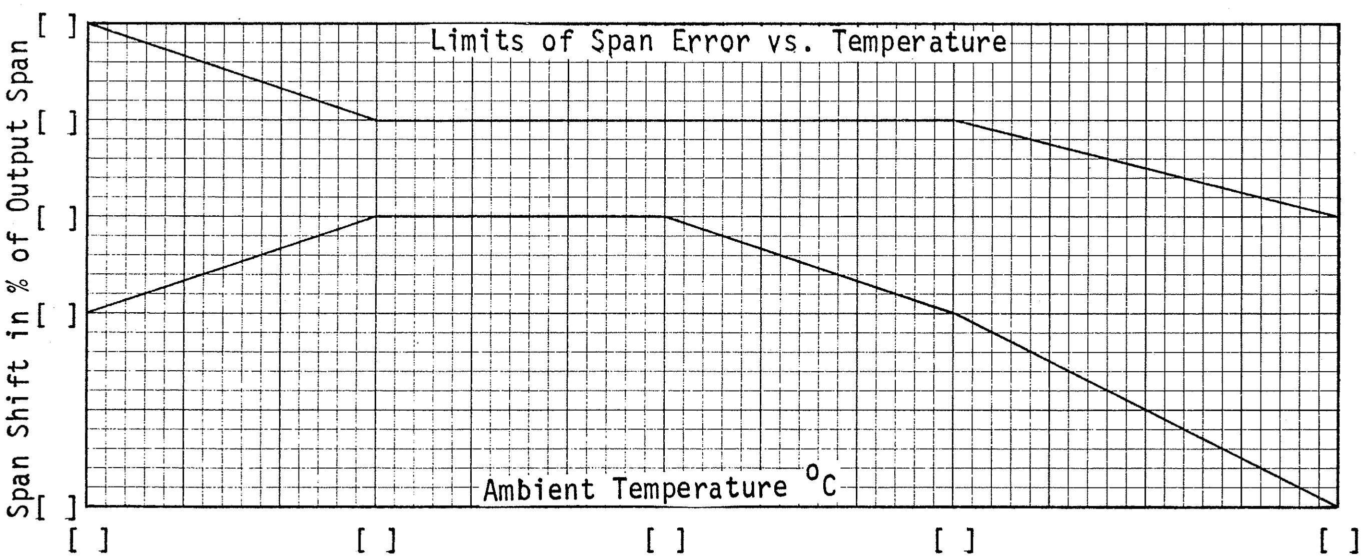
The effect of changes in ambient temperature on the output of the instrument should be specified as in one of the following examples:

For Instruments With Non-Linear Effects:

Zero Shift will be within the envelope shown in the following figure.



Span Shift will be within the envelope shown in the figure below.



For Instruments With Linear Effects:

Zero Shift: ±[ ]%/°C of output span over the temperature range of [ ]°C to [ ]°C.

Span Shift: ±[ ]% of output span over the temperature range of [ ]°C to [ ]°C.

4.2.2 Ambient Relative Humidity Effects

The effect of ambient relative humidity on the output of the instrument should be specified as a percent of output span, as in the following example:

Ambient Relative Humidity Effect for a change in RH from [ ] to [ ]% at [ ]°C ambient temperature.

Zero shift: ±[ ]% of output span
Span shift: ±[ ]% of output span

4.2.3 Vibration

The effect of vibration on the output of the instrument should be specified as a percent of output span along with acceleration level and frequency range, as in the following example:

Vibration Effect: output shift of ±[ ]% of output span at an acceleration of [ ]m/s² over the range of [ ] to [ ] Hz.

4.2.4 Drop and Topple

The effects on the output of the instrument due to the knocks and jolts likely to occur due to rough handling should be specified as in the following example:

Drop and Topple: Zero shift: ±[ ]% of output span
Span shift: ±[ ] of output span

4.2.5 Mounting Position

Mounting position effect on the output of the instrument should be specified as in the following example:

Effect of
±[ ]° tilts from the normal mounting position:
Zero shift: ±[ ]% of output span
Span shift: ±[ ]% of output span

4.2.6 Output Load Resistance Effects

The effects of variations in load resistance on the output of the instrument should be specified as in the following example:

External Load Resistance Effects:

Zero Shift:
±[ ]% of output span ([ ] ohms to [ ] ohms)
Span Shift:
±[ ]% of output span ([ ] ohms to [ ] ohms)

4.2.7 Common Mode Interference

The effects of Common Mode voltages applied to the input of the instrument should be specified as in the following example:

For dc Common Mode Interference
maximum ±[ ] V or [ ] x input span (whichever is lesser)

Applied bilaterally: Output shift: [ ]% of output span

Applied + input: Output shift: [ ]% of output span

Applied - input: Output shift: [ ]% of output span

For ac Common Mode Interference
maximum [ ] V RMS, [ ] Hz

Applied bilaterally: Output shift: [ ]% of output span,
AC feed-thru: [ ] RMS

Applied to + input: Output shift: [ ]% of output span,
AC feed-thru: [ ]V RMS

Applied to -input: Ouput shift: [ ]% of output span,
AC feed-thru: [ ]V RMS

4.2.8 Normal Mode Interference

The effect on the output of the device due to interference voltages in the normal mode should be specified for DC input devices as in the following example:

Normal Mode Voltage: [ ]V RMS, [ ] or [ ]Hz

Output shift: [ ]% of span,
AC feed-thru: [ ]V RMS

The effect on the output of the device due to interference voltages applied in the normal mode for AC input devices should be specified as in the following example:

Normal Mode Voltage: [ ] V dc

Output Shift: ±[ ]% of span

4.2.9 Supply Voltage Effects

The effects on the output of the instrument due to variations of supply voltage should be specified as in the following example:

Supply Voltage Effect:
Zero Shift: ±[ ]% of output span for +[ ]% or -[ ]% variation from reference supply voltage

Span Shift: ±[ ]% of output span for +[ ] or -[ ]% variation from reference supply voltage

4.2.10 Supply Frequency Effects

The effects on the output of the instrument due to variations of supply line frequency should be specified as in the following example:

Supply Frequency Effect: Zero Shift will not exceed [ ]% of output span when the supply frequency is varied -[ ]% or +[ ]% from the reference frequency. Span Shift will not exceed [ ]% of output span when the supply frequency is varied -[ ]% or +[ ]% from the reference frequency.

4.2.11 Harmonic Distortion Effects

The effect on the output of the instrument due to the presence of harmonics on the ac power supplying the instrument should be specified as the maximum expected error in percent of span. The specification should include the harmonics in question and their value as a percent of the sinusoidal fundamental, as in the following example:

Harmonic Distortion Effects:

±[ ]% of output span for [ ]% second harmonic
±[ ]% of output span for [ ]% third harmonic
. . . .
. . . .
±[ ]% of output span for [ ]% nth harmonic

If applicable, the following note may be necessary:

> The actual output shift within the bandwidth specified is dependent upon the phase relationship between the fundamental and the harmonic.

4.2.12 Magnetic Field Effects

The effect on the output of the instrument due to operating the instrument in a magnetic field should be specified as the maximum expected error in percent of ideal output span. Specifications shall include the magnetic field intensity, whether AC or DC, and the frequency range if an AC field.

Magnetic field effect should be specified as in the following example:

Magnetic Field Effects: ±[ ]% of output span at [ ]mT dc or [ ]mT ac at [intended mains frequency]Hz

4.2.13 Supply Pressure Effects

The effects on the output of the instrument due to variations in the steady state supply pressure should be specified as the maximum expected error in percent of ideal output span per unit of pressure within the supply pressure limits of the instrument.

Steady state supply pressure effects should be specified as in the following example:

Steady State Supply Pressure Effect: ±[ ]% of output span per psi change from nominal supply pressure from [ ] to [ ]psi

4.2.14 Static Pressure Effects

The effect of static pressure on the output of the instrument should be specified as the maximum error expected in percent of the ideal output span per ¼th of the static pressure limit, as in the following example:

Static Pressure Effect:

Static Pressure (psi)	Zero Shift (% of [ ] Span)	Span Shift (% of [ ] Span)
[1/4th of Max.]	[ ]	[ ]
[1/2 of Max.]	[ ]	[ ]
[3/4ths of Max.]	[ ]	[ ]
[Maximum]	[ ]	[ ]

4.2.15 Overrange Effects

The effect of overrange on the output of the instrument should be specified as in the following example:

Zero shift: ±[ ]% of minimum input span.
±[ ]% at maximum input span.

Span shift: ±[ ]% of calibrated span.

4.2.16 Signal Terminal Grounding Effects

The effect on the output of the instrument due to grounding the input signal terminals should be specified as in the following example:

Zero Shift: [ ]% of output span (negative input);
[ ]% of output span (positive input)

Span Shift: [ ]% of output span (negative input);
[ ]% of output span (positive input)

4.2.17 Ambient Pressure Effects

The effect of ambient pressure on the instrument should be specified as the output shift for a change in ambient pressure from 66 to 108 kPa, or its equivalent, as in the following example:

Zero Shift: ±[ ]% of output span

Span Shift: ±[ ]% of output span

4.2.18 Electromagnetic Susceptibility

The effect of radio frequency electromagnetic interference on the output of the device should be specified including the maximum applicable severity level of field strength (Table I) to which the device may be exposed in service.

TABLE I

SEVERITY LEVELS OF FIELD STRENGTHS

LEVEL	FIELD STRENGTH (V/m)
1	1
2	3
3	10
4	Special

Level 1 - Low level electromagnetic radiation environments, e.g., levels typical of local radio/television stations located more than one mile and levels typical of low power transceivers.

Level 2 - Moderate electromagnetic radiation environments, e.g., portable tranceivers that can be relatively close to the equipment but not closer than one meter.

Level 3 - Severe electromagnetic radiation environments, e.g., level typical of high power transceivers in close proximity to the control equipment.

Level 4 - Open class for situations involving very severe electromagnetic radiation environments. The level subject to negotiations between the user and manufacturer or as defined by the manufacturer.

These levels are applicable over the frequency range of 27 to 500 MHz.

Two examples of how electromagnetic susceptibility may be specified are as follows:

Electromagnetic Susceptibility: [ ]% of span over the frequency range of 27 to 500 MHz at a field strength of 1 volt per meter.

Electromagnetic Susceptibility: [ ]% of reading from 27 to 50 MHz at [ ]V/m, [ ]% of reading from 50 to 500 MHz at [ ] V/m.

It should be thoroughly realized that the above examples may be quite simplified compared to the possible responses of a particular device to EMI over the frequency range of concern. The specification for devices which exhibit complex responses should necessarily be more complex.

4.3 Specifications for Functional Characteristics

4.3.1 Frequency Response

To accurately describe the frequency response of the instrument, the specification should include the peak-to-peak magnitude and mean level of the input sine wave and a description of the loading conditions used in testing the instrument.

Frequency response should be specified as in one of the following examples:

Frequency Response: Gain is attenuated 3 dB at [ ] Hz, [ ]° Phase Lag for [ ]% peak-to-peak input sine wave at 50% mean level with [ ]m of [ ]mm tubing, [ ]mm wall into a [ ]ml terminal volume.

Frequency Response: Gain is attenuated 3 dB at [ ] Hz, [ ]° Phase Lag for [ ]% peak-to-peak input sine wave at 50% mean level into a [ ] ohm load.

4.3.2 Step Response

To accurately describe the step response of the instrument, the specification should include the magnitude and direction of the input step and a description of the loading conditions.

Step response should be specified as in the following example:

For a [ ] to [ ]% step into a [ ] ohm load:
50% Response Time: [ ] seconds
90% Response Time: [ ] seconds
Transient Overshoot: [ ]%
Damped Frequency: [ ] Hz
Settling Time:
[ ] seconds to come within [ ]% of final value

As an alternative for first-order systems only, 63% and 95% response times may be specified in lieu of 50% and 90% response times.

4.3.3 Input Resistance

The input resistance of the instrument should be specified as in one of the following examples:

Input Resistance: [ ] ohms ±[ ]%.

Input Resistance: [ ] ohms (minimum).

4.3.4 Dielectric Strength

The dielectric strength of the instrument should be specified as in the following example:

Dielectric Strength: [ ] V RMS for [time]*

*For Example:
1500 V Rms for 1 minute
or
2000 V Rms for 1 second

4.3.5 Insulation Resistance

The insulation resistance of the instrument should be specified as the minimum resistance at the specified test voltage.

Insulation Resistance should be specified as in the following example:

Insulation Resistance: [ ] Mohm minimum at [ ]V dc after 1 minute.

4.3.6 Leakage Current

Leakage current of the instrument should be specified as in one of the following examples:

Leakage Current: [ ] mA RMS at [ ] V ac input voltage.

Leakage Current: [ ] mA dc at [ ] V dc input voltage.

4.3.7 Warmup

The time required for the output of the device to stabilize after initial power-on should be specified as in the following example:

Warmup: Input at 0%, output reaches 99.9% of final value within [ ] minutes,
Input at 100%, output reaches 99.9% of final value within [ ] minutes.

4.3.8 Point Drift

The point drift of the instrument should be specified as in the following example:

Point Drift: ±[ ]% of output span for [ ] days.
(alternately), ±[ ]% of output span for [ ] year(s).

4.3.9 Power Consumption

The power consumption of the instrument should be specified at the input level which produces the maximum consumption. If the power is dc, the consumption should be expressed in watts. If the power is ac, both real power (watts), and apparent power (volt-amperes) should be specified.

Power consumption should be specified as in the following examples:

dc Power Consumption: [ ] watts at [ ] Vdc supply voltage.

ac Power Consumption: [ ] watts, [ ] VA, at 60 Hz,
[ ] Vac supply voltage.
[ ] watts, [ ] VA, at 50 Hz,
[ ] Vac supply voltage.

4.3.10 Output Ripple and Noise

The amplitude and characteristics of the output ripple and noise of the instrument should be specified at the specified maximum and minimum output loads as in the following example:

Output Ripple: [ ]% of output span at maximum load resistance.
[ ]% of output span at minimum load resistance.
Predominant Frequency: [ ] Hz.

Output Noise: [ ]% of output span at maximum load resistance.
[ ]% of output span at minimum load resistance.
Predominant Characteristics:
[-]

4.3.11 Steady State Air Consumption

The air consumption of the device should be specified as in the following example:

Steady State Air Consumption: No greater than [ ]m^3/h at reference supply pressure.

4.3.12 Pneumatic Delivery Capability and Pneumatic Exhaust Capability

The pneumatic delivery and exhaust capability of the instrument should be specified as in the following example:

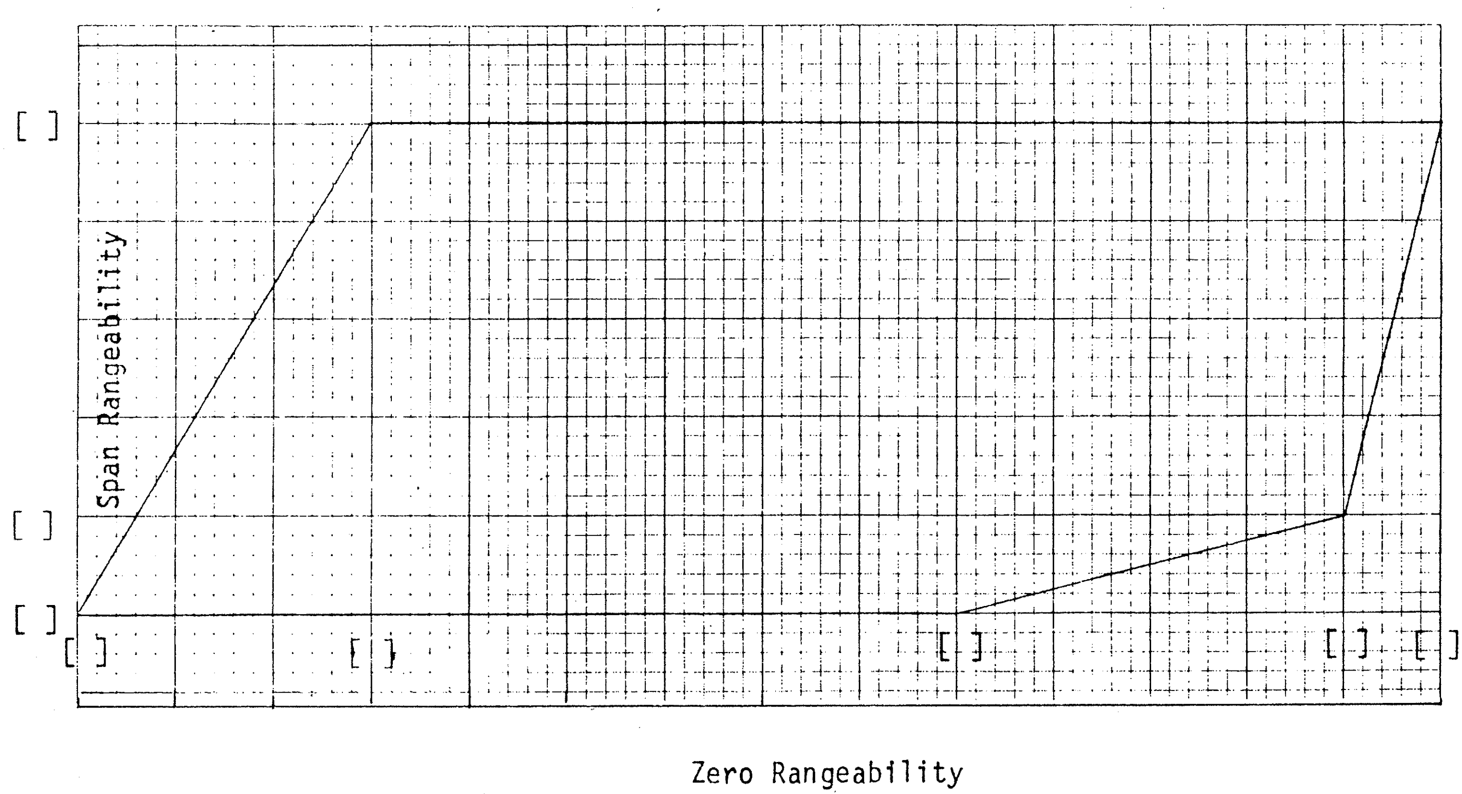
	Output, % of Span		
	25	50	75
Max Delivery Capability (m^3/h)	[ ]	[ ]	[ ]
Max Exhaust Capability (m^3/h)	[ ]	[ ]	[ ]

4.3.13 Zero and Span Rangeability

The zero and span rangeability of the device should be expressed as a function of input signal for the four combinations of maximum and minimum zero and span adjustment points, as in the following example:

	Min. Zero with Min. Span	Min. Zero with Max. Span	Max. Zero with Min. Span	Max. Zero with Max. Span
Input Span	[ ]	[ ]	[ ]	[ ]
Input Zero	[ ]	[ ]	[ ]	[ ]

Alternatively, a graph such as shown below may be provided:



4.3.14 Alarm Lockup

The alarm lockup of the instrument should be specified as in the following example:

Alarm Lockup: [ ]% of input span (maximum).
[ ]% of input span (minimum).

4.4 Specifications for Physical Characteristics

The following physical characteristics should be specified:

- Physical dimensions, including tolerances
- Weight
- Description of materials and finishes
- Electrical and mechanical connections
- Supply requirements
- Normal operating conditions and operating limits
- Mounting means and constraints
- Electrical safety classifications, method(s) of protection and Agency approvals.