An Overview of IEEE 1451.4 Transducer Electronic Data Sheets (TEDS)

Introduction

IEEE 1451.4 is a new standard for adding plug and play capabilities to analog transducers. The underlying mechanism for plug and play identification is the standardization of a Transducer Electronic Data Sheet (TEDS). A TEDS contains the critical information needed by an instrument or measurement system to identify, characterize, interface, and properly use the signal from an analog sensor. The TEDS can be deployed for a sensor in one of two ways. First, the TEDS can reside in embedded memory, typically a EEPROM, within the analog transducer, as defined in the IEEE 1451.4 standard. Second, a Virtual TEDS can exist as a separate file, downloadable from the internet. This concept of Virtual TEDS extends the benefits of the standardized TEDS to legacy sensors and applications where the embedded memory or EEPROM is not available.

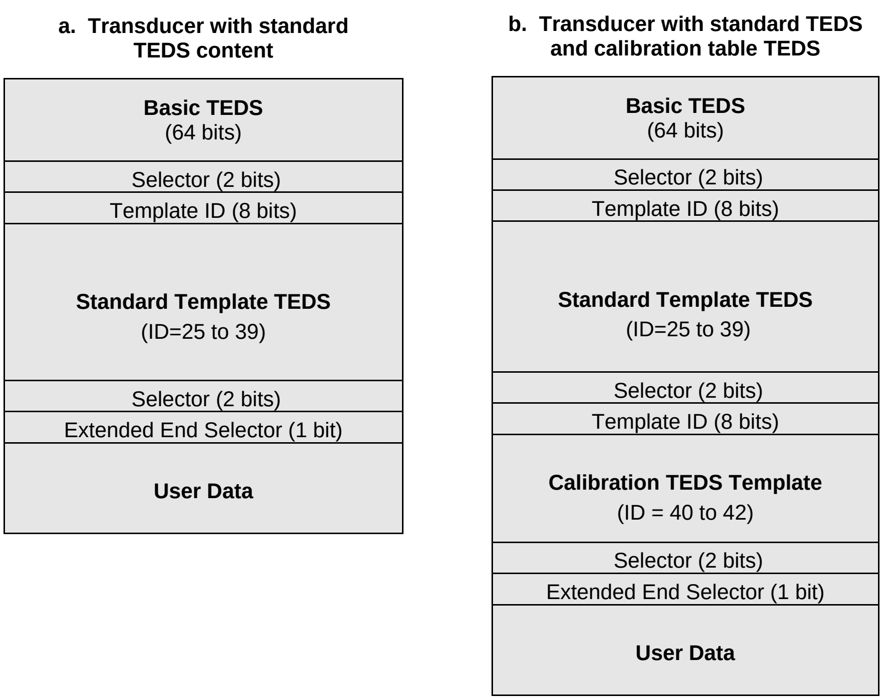
IEEE 1451.4 defines the method of encoding TEDS information for a broad range of senor types and applications. In order to cover such a broad range while also keeping memory usage to a minimum, the IEEE 1451.4 TEDS concept utilizes the concept of templates that define the specific properties for different sensor types. This paper describes the structure and contents of IEEE 1451.4 TEDS, including the Basic TEDS.

The TEDS Structure

The IEEE 1451.4 specification defines a TEDS as consisting of multiple sections chained together to form a complete TEDS. The first section is the Basic TEDS, comprising of the essential identification information. Typically, one IEEE standard TEDS that defines the important properties for a particular sensor type will follow the Basic TEDS. Optionally, this standard template TEDS can be followed by a calibration template. Two-bit selectors in the TEDS data indicate the following section. Finally, the end section of the TEDS is specified as open user area.

TEDS data that is programmed into an EEPROM, as opposed to a virtual TEDS file, will also include a checksum value, which is not included in Figure 1.

Figure 1. TEDS Examples



Basic TEDS

The first 64 bits of the transducer TEDS is the Basic TEDS. The Basic TEDS uniquely identifies the transducer and includes the Manufacturer ID (14 bits), model number (15 bits), version letter (5-bit character code), version number (6 bits) and serial number of the device (24 bits). This data shall be organized according to the format described Table a in a non-volatile memory.

Table 1. Basic TEDS Content

	Bit Length	Allowable Range
Manufacturer ID	14	17 – 16381
Model Number	15	0-32767
Version Letter	5	A-Z (data type Chr5)
Version Number	6	0-63
Serial Number	24	0-16777215

NOTE — Some transducers, mostly accelerometers and microphones, have been manufactured using draft versions (D0.9x) of this standard, which described a different format for the basic TEDS than that used in this standard. For information about these see Appendix A.

The Manufacturer ID is an enumeration of manufacturers. Several IDs have been assigned to early adopters, and future assignments will be managed by IEEE. These ID assignments will also be available in an ASCII text file available from the IEEE or software providers. Software can use this file to display the manurfacturer names. Values 0-16 and 16382-16383 are reserved for special uses, such as node lists in a multi-node configuration, and user-defined templates.

The application and assignment of the remainder of the Basic TEDS are left to the discretion of the manufacturer. Specifically, the Model Number may be defined as a enumeration of the model name for a given manufacturer. This enumeration may be available from manufacturers as an ASCII file for software applications.

Standard Templates – Transducer Types

The standard defines a collection of templates for common classes of transducers as listed in Table 2. Templates 25 through 39 are transducer type templates that contain properties that are needed for the specific types of transducers. Templates 40, 41, and 42 are calibration templates and can be used with one of the transducer type templates.

Table 2. IEEE standard templates

Type	Template ID	Name of Template
Transducer Type Templates	25	Accelerometer & Force
	26	Charge Amplifier (w/ attached accelerometer)
	43	Charge Amplifier (w/ attached force transducer)
	27	Microphone with built-in preamplifier
	28	Microphone Preamplfiers (w/ attached microphone)
	29	Microphones (capacitive)
	30	High-Level Voltage Output Sensors
	31	Current Loop Output Sensors
	32	Resistance Sensors
	33	Bridge Sensors
	34	AC Linear/Rotary Variable Differential Transformer (LVDT/RVDT) Sensors
	35	Strain Gage
	36	Thermocouple
	37	Resistance Temperature Detectors (RTDs)
	38	Thermistor
	39	Potentiometric Voltage Divider
Calibration Templates	40	Calibration Table
	41	Calibration Curve (Polynomial)
	42	Frequency Response Table

The tables in the following sections summarize the contents of each IEEE standard template. Each row of the table corresponds to a property command (designated in templates with "%") or control command that utilizes bits from the TEDS, such as a Select Case. The first column in many of the tables, labeled Select, indicate the different cases for Select Cases in the templates. For example, a 2 bit Select Case read from the TEDS may have four different cases, each containing a section of template that is used for the corresponding Select Case value.

The tables also detail the number of bits used for each property, the access level (user, calibration, or identification), and the data type. The datatypes used in these standard templates are summarized in Table 3.

Table 3. Data types used in IEEE standard templates

Data type	Description
UNINT	Unsigned integer
Chr5	5-bit character
ASCII	Standard 7-bit ASCII
Date	Number of days since January 1, 1998
Single	Single-precision floating point
ConRes	Constant resolution. This is a custom data type for compressed floating point values that provides a linear mapping of a defined interval
ConRelRes	Constant relative resolution. This is a custom data type for compressed floating point values that provides a logarithmic mapping of a defined interval
Enumeration	References a defined enumerated data type defined in the template

ConRes and ConRelRes provide a method of coding non-integer values with minimal bit usage by defining a limited range over which the bits are mapped. The range and resolution for ConRes and ConRelRes properties are listed in the template.

The data types in Table 3 is not a complete list of data types in the standard; only the data types included in the standard template.

Template 25: Accelerometer and Force Transducers

This template is intended for use with dynamic accelerometers and force transducers which are constant-current pwered, or IEPE.

Table 4. Accelerometer/Force transducer Template (ID = 25) Summary

Select		Property/Command	Description	Access	Bits	Data Type (and Range)	Units
–		TEMPLATE	Template ID	–	8	Integer (value = 25)	–
Select Case – Acceleration / Force					1	Select Case	–
Case 0 (Accel)	Select Case – Extended Functionality (Programmable Gain)				1		
	Case 0	%Sens@Ref	Sensitivity @ ref. condition	CAL	16	ConRelRes (5E-7 to 172, ±0.015%)	V/(m/s^2)
		%TF_HP_S	High pass cut-off freq. (F hp)	CAL	8	ConRelRes (0.005 to 13k, ±3%)	Hz
	Case 1 (Ext Funct.)	%Passive[Initialize]	Initialization not needed	ID	–	Assign = 0	–
		%Passive[CtrlFunctionMask]	Control Function Mask	ID	–	Assign = 0b11	–
		%Passive[ReadWrite]	Write only	ID	–	Assign = 3	–
		%Passive[FunctionType]	Passive control type	ID	–	Assign = 0 (checkmark)	–
		%Passive[Function]	Passive mode	USR	–	BitBin, (Assign = “xx,00”)	–
		%Sens[Initialize]	Initialization not needed	ID	–	Assign = 0	–
		%Sens[CtrlFunctionMask]	Control Function Mask, Sens.	ID	–	Assign = 0b11	
		%Sens[ReadWrite]	Write only	ID	–	Assign = 3	–
		%Sens[FunctionType]	Sensitivity control type	ID	–	Assign = 1 (one exactly)	–
		%Sens[Function]	%Sens@Ref[“10”]	USR	–	BitBin, (Assign = “10”)	
		%Sens[Function]	%Sens@Ref[“01”]	USR	–	BitBin, (Assign = “01”)	
		%DefaultFR	Default Sensitivity	ID	2	UNINT (00: no, 1:low, 2: high)	
		%Passive	Supports multiplexer mode	ID	1	UNINT	–
		%Sens@Ref[“01”]	Low sensitivity @ reference	CAL	16	ConRelRes (5E-7 to 172, ±0.015%)	V/(m/s^2)
		%Sens@Ref[“10”]	High sensitivity @ reference	CAL	16	ConRelRes (5E-7 to 172, ±0.015%)	V/(m/s^2)
		%TF_HP_S[“01”]	Low sens high pass cut-off	CAL	8	ConRelRes (0.005 to 13k, ±3%)	Hz
		%TF_HP_S[”10”]	High sens high pass cut-off	CAL	8	ConRelRes (0.005 to 13k, ±3%)	Hz
Case 1 (Force)	Select Case – Extended Functionality (Programmable Gain)				1		
	Case 0	%Sens@Ref	Sensitivity @ reference condition	CAL	16	ConRelRes (5E-7 to 172, ±0.015%)	V/N
		%TF_HP_S	High pass cut-off freq. (F hp)	CAL	8	ConRelRes (0.005 to 13k, ±3%)	Hz
		%Stiffness	Stiffness of transducer	CAL	6	ConRelRes (1E6 to 8.1E10, ±10%)	N/m
		%Mass_below	Mass below gage	CAL	6	ConRelRes (0.1 to 8114, ±10%)	gram
	Case 1 (Ext Funct.)	%Passive[Initialize]	Initialization not needed	ID	–	Assign = 0	–
		%Passive[CtrlFunction Mask]	Control Function Mask, Passive	ID	–	Assign = 0b11	–
		%Passive[ReadWrite]	Write only	ID	–	Assign = 3	–
		%Passive[FunctionType]	Passive control type	ID	–	Assign = 0 (checkmark)	–
		%Passive[Function]	Passive mode	USR	–	BitBin, (Assign = “xx,00”)	–
		%Sens[Initialize]	Initialization not needed	ID	–	Assign = 0	–

		%Sens[CtrlFunctionMask]	Control Function Mask, Sens.	ID	–	Assign = 0b11	
		%Sens[ReadWrite]	Write only	ID	–	Assign = 3	–
		%Sens[FunctionType]	Sensitivity control type	ID	–	Assign = 1 (one exactly)	–
		%Sens[Function]	%Sens@Ref[“10”]	USR	–	BitBin, (Assign = “10”)	
		%Sens[Function]	%Sens@Ref[“01”]	USR	–	BitBin, (Assign = “01”)	
		%DefaultFR	Default Sensitivity	ID	2	UNINT (00: no, 1:low, 2: high)	
		%Passive	Supports multiplexer mode	ID	1	UNINT	–
		%Sens@Ref[“01”]	Low sensitivity @ reference	CAL	16	ConRelRes (5E-7 to 172, ±0.015%)	V/N
		%Sens@Ref[“10”]	High sensitivity @ reference	CAL	16	ConRelRes (5E-7 to 172, ±0.015%)	V/N
		%TF_HP_S[“01”]	Low sens. high pass cut-off freq.	CAL	8	ConRelRes (0.005 to 13k, ±3%)	Hz
		%TF_HP_S[”10”]	High sens. high pass cut-off freq.	CAL	8	ConRelRes (0.005 to 13k, ±3%)	Hz
		%Stiffness	Stiffness of transducer	CAL	6	ConRelRes (1E6 to 8.1E10, ±10%)	N/m
		%Mass_below	Mass below gage	CAL	6	ConRelRes (0.1 to 8114, ±10%)	g
		%PhaseCorrection	Phase Correction @ ref	CAL	6	ConRes (-3.2 to 3.0, step 0.1)	°
–	–	%Direction	Sensitivity direction (x, y, z)	CAL	2	Enumeration: x | y | z	–
–	–	%Weight	Transducer weight	CAL	6	ConRelRes (0.1 to 8114, ±10%)	gram
–	–	%ElecSigType	Transducer elect. signal type	ID	-	Assign = 0, “Voltage Sensor”	–
–	–	%MapMeth	Mapping Method	ID	-	Assign = 0, “Linear”	–
–	–	%ACDCCoupling	AC or DC coupling	ID	-	Assign = 1, “AC”	–
–	–	%Sign	Polarity (sign)	CAL	1	Enumeration: positive | negative	–
Select Case – Transfer Function					1	Select Case	
Case 0	–		No transfer function specified				
Case 1	–	%TF_SP	Low pass cut-off (F lp)	CAL	7	ConRelRes (10 to 1.6E+6, ±5%)	Hz
	–	%TF_KPr	Resonance frequency (F res)	CAL	9	ConRelRes (100 to 2.4E+6, ±1%)	Hz
	–	%TF_KPq	Quality factor at F res	CAL	9	ConRelRes (0.4 to 9.7k, ±1%)	–
	–	%TF_SL	Amplitude slope (a)	CAL	7	ConRes (-6.3 to 6.3, step 0.1)	%/decade
	–	%TempCoef	Temperature Coefficient (b)	CAL	6	ConRes (-0.8 to 0.75, step 0.025)	%/°C
–	–	%Reffreq	Reference frequency	CAL	8	ConRelRes (0.35 to 2.18k, ±1.75%)	Hz
–	–	%RefTemp	Reference temperature (T ref)	CAL	5	ConRes (15 to 30, step 0,5)	°C
–	–	%CalDate	Calibration date	CAL	16	DATE	–
–	–	%CalInitials	Calibration initials	CAL	15	CHR5	–
–	–	%CalPeriod	Calibration period	CAL	12	UNINT	days
–	–	%MeasID	Measurement location ID	USR	11	UNINT	–

Template 27: Microphones (with Built-in Preamplifiers)

This template is intended for measurement microphones that include an integrated preamplifier. Typically, these devices will have a constant-current powered, or IEPE, interface.

Table 5. Microhones (with Built-in Preamplifier) Template (ID = 27) Summary

Select	Property/Command	Description	Access	Bits	Data Type (and Range)	Units
–	TEMPLATE	Template ID	–	8	Integer (value = 27)	–
Select Case – Extended Functionality (Programmable Gain)				1	Select Case	–
Case 0	%Sens@Ref	Sensitivity @ ref condition	CAL	16	ConRelRes (10E-6 to 4.916, ±0.01%)	V/Pa
Case 1	%Passive[Initialize]	Initialization not needed	ID	–	Assign = 0	–
	%Passive[CtrlFunctionMask]	Control Function Mask, Pass.	ID	–	Assign = 0b11	–
	%Passive[ReadWrite]	Write only	ID	–	Assign = 3	–
	%Passive[FunctionType]	Passive control type	ID	–	Assign = 0 (checkmark)	–
	%Passive[Function]	Passive mode	USR	–	BitBin, (Assign = "xx,00")	–
	%Sens[Initialize]	Initialization not needed	ID	–	Assign = 0	–
	%Sens[CtrlFunctionMask]	Control Function Mask, Sens.	ID	–	Assign = 0b11	
	%Sens[ReadWrite]	Write only	ID	–	Assign = 3	–
	%Sens[FunctionType]	Sensitivity control type	ID	–	Assign = 1 (one exactly)	–
	%Sens[Function]	%Sens@Ref["10"]	USR	–	BitBin, (Assign = "10")	
	%Sens[Function]	%Sens@Ref["01"]	USR	–	BitBin, (Assign = "01")	
	%DefaultFR	Default Sensitivity	ID	2	UNINT (00: no, 1:low, 2: high)	
	%Passive	Supports multiplexer mode	ID	1	UNINT	–
	%Sens@Ref["01"]	Low Sensitivity @ ref. cond.	CAL	16	ConRelRes (10E-6 to 4.916, ±0.01%)	V/Pa
	%Sens@Ref["10"]	High Sensitivity @ ref. cond.	CAL	16	ConRelRes (10E-6 to 4.916, ±0.01%)	V/Pa
–	%Reffreq	Reference frequency	CAL	8	ConRelRes (0.35 to 2.18k, ±1.75%)	Hz
–	%Refpol	Polarization voltage	CAL	2	Enum: Pre-polarized; 28; 200 V	–
Select Case – System test available (Test gain)				1	Select Case	–
Case 0	–	No system test available	–	–	–	–
Case 1	%TestGain	Test gain	CAL	10	ConRes (0 to –102.2, step 0.1)	dB
–	%MicType	Microphone Type	CAL	2	Enum: Free | Press | Random | Other	–
–	%Size	Microphone Size	CAL	2	Enum: 1" | 1/2" | 1/4" | 1/8"	–
–	%Equi_Vol	Equiv microphone volume	CAL	8	ConRes (0 to 254E-9, step 1E-9)	m3
Select Case – Transfer Function Specified				1	Select Case	–
Case 0	–	No transfer function	–	–	–	–
Case 1	%Resp_Type	Actuator / Corrected response	CAL	1	Enum: Actuator; Corrected	–
	%TF_HP_S	Lowest High pass cut-off freq	CAL	7	ConRelRes (0.005 to 821, ±5%)	Hz
	%TF_HP_S	High pass cut-off frequency	CAL	8	ConRelRes (0.05 to 7.6, ±1%)	Hz
	%TF_SP	F low lift (Low pass cut-off)	CAL	7	ConRelRes (5 to 700, ±2%)	Hz
	%TF_SZm	F high /F low lift	CAL	8	ConRelRes (1 to 2.1, ±0.15%)	Hz
	%TF_KPr	Resonance frequency (F res)	CAL	8	ConRelRes (2k to 306k, ±1%)	Hz
	%TF_KPq	Quality factor at F res	CAL	8	ConRelRes (0.2 to 31, ±1%)	–
	%TF_KPr	2nd resonance freq (F res)	CAL	6	ConRelRes (10k to 371k, ±3%)	Hz
	%TF_KPq	Quality factor at 2nd F res	CAL	7	ConRelRes (0.2 to 309, ±3%)	–
–	%Sign	Polarity (sign)	CAL	1	Enumeration: positive | negative	–
–	%MapMeth	Mapping Method	ID	-	Assign = 0, "Linear"	–
–	%ElecSigType	Transducer elect. signal type	ID	-	Assign = 0, "Voltage Sensor"	–
–	%ACDCCoupling	AC or DC coupling	ID	-	Assign = 1, "AC"	–
–	%CalDate	Calibration date	CAL	16	DATE	–
–	%CalInitials	Calibration initials	CAL	15	CHR5	–
–	%CalPeriod	Calibration period	CAL	12	UNINT	days
–	%MeasID	Measurement location ID	Usr	11	UNINT	–

Templates 26, 28, 29 and 43

Templates 26 and 43 are intended for charge amplifiers, with the provision for describing an attached piezoelectric transducer, either an accelerometer or force transducer. Template 28 is a microphone preamplifier template, which can specify an attached microphone capsule. Template 29 is a template describing a capacitive microphone.

Details for the contents and makeup of templates 26, 28, 29, and 43 are included in Annex A of the IEEE 1451.4 specification.

Template 30: High-Level Voltage Output Template

This template is a general-purpose template designed to be usable with a very wide range of sensors. Virtually any sensor with an analog voltage output can use this template. The first 6-bit Select Case will indicate the physical measurand and the corresponding units (i.e. PSI, N, m/s^2, mm, %______, etc.).

Table 5. High Level Voltage Output Template (ID = 30) Summary

Select	Property	Description	Access	Bits	Data Type (and Range)	Units
–	TEMPLATE	Template ID	–	8	Integer (value = 30)	–
–	%ElecSigType	Electrical signal type	ID	-	Assign = 0, "Voltage Sensor"	–
Select Case – Selects Type of Physical Measurand (Units)				6	Select Case	–
Cases 0 - 45	%MinPhysVal	Minimum physical value	CAL	32	Single	Various*
	%MaxPhysVal	Maximum physical value	CAL	32	Single	Various*
Select Case – Selects Full-Scale Electrical Value Precision				2	Select Case	–
Case 0 (0-10V)	%MinElecVal	Minimum voltage output	CAL	-	Assign = 0.0	Volts
	%MaxElecVal	Maximum voltage output	CAL	-	Assign = 10.0	Volts
Case 1 (±10V)	%MinElecVal	Minimum voltage output	CAL	-	Assign = -10.0	Volts
	%MaxElecVal	Maximum voltage output	CAL	-	Assign = 10.0	Volts
Case 2	%MinElecVal	Minimum voltage output	CAL	11	ConRes (-20.5 to 20.4, step 0.02)	Volts
	%MaxElecVal	Maximum voltage output	CAL	11	ConRes (-20.5 to 20.4, step 0.02)	Volts
Case 3	%MinElecVal	Minimum voltage output	CAL	32	Single	Volts
	%MaxElecVal	Maximum voltage output	CAL	32	Single	Volts
–	%MapMeth	Mapping Method	ID	-	Assign = 0, "Linear"	–
–	%ACDCCoupling	AC or DC coupling	ID	1	DC or AC	–
–	%SensorImped	Sensor output impedance	ID	12	ConRelRes (1 to 1.1M, ±0.17%)	Ohms
–	%RespTime	Response time	ID	6	ConRelRes (1E-6 to 7.9, ±15%)	seconds
Select Case – Selects Inclusion of Excitation/Power Requirements				1	Select Case	–
Case 0 (none)	–	No power supply/excitation source	–	–	–	–
Case 1 (specify supply)	%ExciteAmplNom	Power supply level, nominal	ID	9	ConRes (0.1 to 51.1, step 0.1)	Volts
	%ExciteAmplMin	Power supply level, min.	ID	9	ConRes (0.1 to 51.1, step 0.1)	Volts
	%ExciteAmplMax	Power supply level, max.	ID	9	ConRes (0.1 to 51.1, step 0.1)	Volts
	%ExciteType	Power supply type	ID	2	DC, Bipolar DC, or AC	–
	%ExciteCurrentDraw	Max current at nom. power	ID	6	ConRelRes (1E-6 to 1.6, ±13%)	Amps
–	%CalDate	Calibration date	CAL	16	DATE	–
–	%CalInitials	Calibration initials	CAL	15	CHR5	–
–	%CalPeriod	Calibration period	CAL	12	UNINT	days
–	%MeasID	Measurement location ID	USR	11	UNINT	–

* Units for %MinPhysVal and %MaxPhysVal are determined by value of Select Case "Physical Measurand (Units)" as summarized in Table 15

Template 31: Current Loop Output Template

Like the voltage output template, this template is a general purpose template designed to be usable with a very wide range of sensors. Virtually any sensor with an current loop output (typically 4-20 mA or 0-20 mA) can use this template. The first 6-bit Select Case will indicate the physical measurand and the corresponding units (i.e. PSI, N, m/s^2, mm, %, etc.).

Table 6. Current Loop Output Sensors Template (ID = 31) Summary

Select	Property	Description	Access	Bits	Data Type (and Range)	Units
–	TEMPLATE	Template ID	–	8	Integer (value = 31)	–
–	%ElecSigType	Electrical signal type	ID	-	Assign =1, "Current Sensor"	–
Select Case – Selects Type of Physical Measurand (Units)				6	Select Case	–
Cases 0 - 45	%MinPhysVal	Minimum physical value	CAL	32	Single	Various*
	%MaxPhysVal	Maximum physical value	CAL	32	Single	Various*
Select Case – Selects Full-Scale Electrical Value Precision				1	Select Case	–
Case 0	%MinElecVal	Minimum current output	CAL	-	Assign = 4.0	mA
	%MaxElecVal	Maximum current output	CAL	-	Assign = 20.0	mA
Case 1	%MinElecVal	Minimum current output	CAL	32	Single	Amps
	%MaxElecVal	Maximum current output	CAL	32	Single	Amps
–	%MapMeth	Mapping Method	ID	-	Assign = 0, "Linear"	–
–	%RespTime	Response time	ID	6	ConRelRes (1E-6 to 7.9, ±15%)	seconds
Select Case –Selects Loop Powered Versus External Powered				1	Select Case	–
Case 0 (Loop)	%LoopSuppyMin	Minimum compliance	ID	9	ConRes (0.1 to 51.1, step 0.1)	Volts
	%LoopSuppyMax	Maximum compliance	ID	9	ConRes (0.1 to 51.1, step 0.1)	Volts
Case 1 (Ext.)	%ExciteAmplNom	Power supply level, nominal	ID	9	ConRes (0.1 to 51.1, step 0.1)	Volts
	%ExciteAmplMin	Power supply level, min.	ID	9	ConRes (0.1 to 51.1, step 0.1)	Volts
	%ExciteAmplMax	Power supply level, max.	ID	9	ConRes (0.1 to 51.1, step 0.1)	Volts
	%ExciteType	Power supply type	ID	1	DC or Bipolar DC	–
	%ExciteCurrentDraw	Max current at nominal power	ID	6	ConRelRes (1E-6 to 2, ±13%)	Amps
–	%CalDate	Calibration date	CAL	16	DATE	–
–	%CalInitials	Calibration initials	CAL	15	CHR5	–
–	%CalPeriod	Calibration period	CAL	12	UNINT	days
–	%MeasID	Measurement location ID	USR	11	UNINT	–

* Units for %MinPhysVal and %MaxPhysVal are determined by value of Select Case "Physical Measurand (Units)" as summarized in Table 15.

Template 32: Resistive Output Sensors Template

This template is a general-purpose template intended for any sensor whose electrical output is a variable resistance. If a resistive sensor is configured as a potentiometer, then template 39 may be more appropriate. The first 6-bit Select Case will indicate the physical measurand and the corresponding units (i.e. PSI, N, m/s^2, mm, %, etc.).

Table 7. Resistance Output Sensors Template (ID = 32) Summary

Select	Property	Description	Access	Bits	Data Type (and Range)	Units
–	TEMPLATE	Template ID	–	8	Integer (value = 32)	–
–	%ElecSigType	Electrical signal type	ID	-	Assign = 2, "Resistance Sensor"	–
Select Case – Selects Type of Physical Measurand (Units)				6	Select Case	–
Cases 0 - 45	%MinPhysVal	Minimum physical value	CAL	32	Single	Various*
	%MaxPhysVal	Maximum physical value	CAL	32	Single	Various*
Select Case – Selects Full-Scale Electrical Value Precision				2	Select Case	–
Case 0 (7 bit)	%MinElecVal	Minimum resistance	CAL	7	ConRes (0 to 1.3k, step 10)	Ohms
	%MaxElecVal	Maximum resistance	CAL	7	ConRes (0 to 1.3k, step 10)	Ohms
Case 1 (10 bit)	%MinElecVal	Minimum resistance	CAL	10	ConRes (0 to 1M, step 1k)	Ohms
	%MaxElecVal	Maximum resistance	CAL	10	ConRes (0 to 1M, step 1k)	Ohms
Case 2 (16 bit)	%MinElecVal	Minimum resistance	CAL	16	ConRes (0 to 65.4k, step 1)	Ohms
	%MaxElecVal	Maximum resistance	CAL	16	ConRes (0 to 65.4k, step 1)	Ohms
Case 3 (32 bit)	%MinElecVal	Minimum resistance	CAL	32	Single	Ohms
	%MaxElecVal	Maximum resistance	CAL	32	Single	Ohms
–	%MapMeth	Mapping Method	ID	2	Linear , Inverse m/(x+b), or Inverse b+m/x	–
–	%RespTime	Response time	ID	6	ConRelRes (1E-6 to 7.9, ±15%)	seconds
–	%ExciteAmplNom	Excitation current, nominal	ID	8	ConRelRes (1E-6 to 0.12, ±2%)	Amps
–	%ExciteAmplMax	Excitation current, max.	ID	8	ConRelRes (1E-6 to 0.12, ±2%)	Amps
–	%CalDate	Calibration date	CAL	16	DATE	–
–	%CalInitials	Calibration initials	CAL	15	CHR5	–
–	%CalPeriod	Calibration period	CAL	12	UNINT	days
–	%MeasID	Measurement location ID	USR	11	UNINT	–

* Units for %MinPhysVal and %MaxPhysVal are determined by value of Select Case "Physical Measurand (Units)" as summarized in Table 15.

Template 33: Bridge Sensors Template

The bridge sensors template is intended for any sensor whose electrical output interface is a resistive bridge with a linear output. For example, this may be a load cell, pressure sensor, or accelerometer. The first 6-bit Select Case will indicate the physical measurand and the corresponding units (i.e. PSI, N, m/s^2, mm, %, etc.).

Table 8. Bridge Sensors Template (ID = 33) Summary

Select	Property	Description	Access	Bits	Data Type (and Range)	Units
–	TEMPLATE	Template ID	–	8	Integer (value = 33)	–
–	%ElecSigType	Electrical signal type	ID	-	Assign = 3, "Bridge Sensor"	–
Select Case – Selects Type of Physical Measurand (Units)				6	Select Case	–
Cases 0 - 45	%MinPhysVal	Minimum physical value	CAL	32	Single	Various*
	%MaxPhysVal	Maximum physical value	CAL	32	Single	Various*
Select Case – Selects Full-Scale Electrical Value Precision				2	Select Case	–
Case 0 (11 bits)	%MinElecVal	Minimum electrical output	CAL	11	ConRes (±1E-3, step 1E-6)	V/V
	%MaxElecVal	Maximum electrical output	CAL	11	ConRes (±1E-3, step 1E-6)	V/V
Case 1 (19 bits)	%MinElecVal	Minimum electrical output	CAL	19	ConRes (±6.55E-3, step 25E-9)	V/V
	%MaxElecVal	Maximum electrical output	CAL	19	ConRes (±6.55E-3, step 25E-9)	V/V
Case 2 (32 bits)	%MinElecVal	Minimum electrical output	CAL	32	Single	V/V
	%MaxElecVal	Maximum electrical output	CAL	32	Single	V/V
–	%MapMeth	Mapping Method	ID	-	Assign = 0, "Linear"	–
–	%BridgeType	Bridge type	ID	2	Enumeration: Quarter | Half | Full	–
–	%SensorImped	Bridge element impedance	ID	18	ConRes (1 to 26.2k, step 0.1)	Ohms
–	%RespTime	Response time	ID	6	ConRelRes (1E-6 to 7.9, ±15%)	seconds
–	%ExciteAmplNom	Excitation level, nominal	ID	9	ConRes (0.1 to 51.1, step 0.1)	Volts
–	%ExciteAmplMin	Excitation level, min.	ID	9	ConRes (0.1 to 51.1, step 0.1)	Volts
–	%ExciteAmplMax	Excitation level, max.	ID	9	ConRes (0.1 to 51.1, step 0.1)	Volts
–	%CalDate	Calibration date	CAL	16	DATE	–
–	%CalInitials	Calibration initials	CAL	15	CHR5	–
–	%CalPeriod	Calibration period	CAL	12	UNINT	days
–	%MeasID	Measurement location ID	USR	11	UNINT	–

* Units for %MinPhysVal and %MaxPhysVal are determined by value of Select Case "Physical Measurand (Units)" as summarized in Table 15.

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Template 34: AC LVDT/RVDT Template

The bridge sensors template is intended for AC-based linear variable differential transformer (LVDT) and rotary variable differential transform (RVDT) sensors. The first 3-bit Select Case will indicate the physical measurand and the corresponding units (i.e. m, mm, inches, radians, or degrees).

Table 9. LVDT/RVDT Template (ID = 34) Summary

Select	Property	Description	Access	Bits	Data Type (and Range)	Units
–	TEMPLATE	Template ID	–	8	Integer (value = 34)	–
–	%ElecSigType	Electrical signal type	ID	–	Assign = 4, "LVDT Sensor"	–
Select Case – Selects Type of Physical Measurand				3	Select Case	–
Cases 0-4	%MinPhysVal	Negative full-scale position	CAL	32	Single	m, mm, in, rad, deg.
	%MaxPhysVal	Positive full-scale position	CAL	32	Single	m, mm, in, rad, deg.
Select Case - Full-Scale Electrical Value Precision				1	Select Case	–
Case 0 (11 bits)	%MinElecVal	Electrical output at negative full-scale	CAL	11	ConRes (-1 to 1, step 0.001)	V/V
	%MaxElecVal	Electrical output at positive full-scale	CAL	11	ConRes (-1 to 1, step 0.001)	V/V
Case 1 (32 bits)	%MinElecVal	Electrical output at negative full-scale	CAL	32	Single	V/V
	%MaxElecVal	Electrical output at positive full-scale	CAL	32	Single	V/V
–	%MapMeth	Mapping Method	ID	–	Assign = 0, "Linear"	–
–	%RespTime	Response time	ID	6	ConRelRes (1E-6 to 7.9, ±15%)	seconds
–	%ExciteAmplNom	Excitation amplitude, nominal	ID	8	ConRes (0.1 to 25.5, step 0,1)	Volts
–	%ExciteAmplMax	Excitation amplitude, max.	ID	8	ConRes (0.1 to 25.5, step 0,1)	Volts
–	%ExciteType	Excitation voltage type	ID	–	Assign = 2, "AC (rms)"	–
–	%ExciteFreqNom	Excitation frequency, nominal	ID	12	ConRes (1 to 40,950, step 10)	Hz
–	%ExciteFreqMin	Excitation frequency, min.	ID	12	ConRes (1 to 40,950, step 10)	Hz
–	%ExciteFreqMax	Excitation frequency, max.	ID	12	ConRes (1 to 40,950, step 10)	Hz
–	%SensorImped	Sensor input impedance	ID	7	ConRelRes (1 to 32.7k, ±4%)	Ohms
–	%CalDate	Calibration date	CAL	16	DATE	–
–	%CalInitials	Calibration initials	CAL	15	CHR5	–
–	%CalPeriod	Calibration period	CAL	12	UNINT	days
–	%MeasID	Measurement location ID	USR	11	UNINT	–

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Template 35: Strain Gage Template

The strain gage template is intended for strain gages used in a bridge measurement configuration. While the scaling of readings from the bridge will be based on the gage factor, and may or may not be linear, the properties for minimum and maximum physical and electrical ranges are still included to define the operating range of the sensor.

Strain gages are unique in that many of the measurement parameters are determined by how the gages is installed and mounted. Therefore, the template includes more properties that are determined by the measurement configuration and the property to which the gage is mounted. Examples of this are Poisson's coefficient, Young's modulus, and BridgeType.

Table 10. Strain Gage Template (ID = 35) Summary

Property	Description	Access	Bits	Data Type (and Range)	Units
TEMPLATE	Template ID		8	Integer (value = 35)	–
%ElecSigType	Transducer electrical signal type	ID	–	Assign = 3, “Bridge Sensor”	–
%MinPhysVal	Negative full-scale strain	CAL	14	ConRes (-0.4 to 0.4, step 50E-6)	strain
%MaxPhysVal	Positive full-scale strain	CAL	14	ConRes (-0.4 to 0.4, step 50E-6)	strain
%MinElecVal	Minimum electrical output	CAL	14	ConRes (-1 to 1, step 125E-6)	V/V
%MaxElecVal	Maximum electrical output	CAL	14	ConRes (-1 to 1, step 125E-6)	V/V
%MapMeth	Mapping method	ID	–	Assign = 6, “Bridge”	–
%GageType	Gage Type	ID	5	Enumeration of gage configurations	–
%GageFactor	Gage Factor	CAL	13	ConRelRes (1.5 to 1500, ±0.0422%)	–
%GageTransSens	Transverse Sensitivity	CAL	9	ConRes(-5 to 5, step 0.02)	%
%GageOffset	Zero offset after installation	USR	20	ConRes (-50E-3 to 50E-3, step 100E-9)	V/V
%PoissonCoef	Poisson coefficient after installation	USR	14	ConRes (0 to 1, step 1E-4)	–
%YoungsMod	Young’s Modulus	USR	14	ConRes (0 to 1.6E+12, step 100E+6)	Pa
%GageArea	Area of each gage element	ID	7	ConRelRes(0.2 to 3250, ±4%)	mm^2
%BridgeType	Type of bridge	ID	2	Quarter, half, or full bridge	–
%SensorImped	Resistance of each bridge element	ID	13	ConRelRes (50 to 7.9k, ±0.0328%)	Ohms
%RespTime	Response time	ID	6	ConRelRes (1E-6 to 7.9, ±15%)	Seconds
%ExciteAmplNom	Excitation voltage, nom.	ID	8	ConRes (0.1 to 25.5, step 0,1)	Volts
%ExciteAmplMax	Excitation voltage, max.	ID	8	ConRes (0.1 to 25.5, step 0,1)	Volts
%CalDate	Calibration date	CAL	16	DATE	–
%CalInitials	Calibration initials	CAL	15	CHR5	–
%CalPeriod	Calibration period	CAL	12	UNIINT	days
%MeasID	Measurement location ID	USR	11	UNINT	–

Template 36: Thermocouple Template

The thermocouple template includes designation of the measurement range, electrical output range, and type of thermocouple. Detailed specification of non-standard thermocouple curves is not included in this template.

Table 11. Thermocouple Template (ID = 36) Summary

Property	Description	Access	Bits	Data Type (and Range)	Units
TEMPLATE	Template ID		8	Integer (value = 36)	–
%ElecSigType	Transducer electrical signal type	ID	–	Assign = 0, "Voltage Sensor"	–
%MinPhysVal	Minimum temperature	CAL	11	ConRes (-273 to 1,770, step 1)	ºC
%MaxPhysVal	Maximum temperature	CAL	11	ConRes (-273 to 1,770, step 1)	ºC
%MinElecVal	Minimum electrical output	CAL	7	ConRes (-25E-3 to 0.1 step 1E-3)	V
%MaxElecVal	Maximum electrical output	CAL	7	ConRes (-25E-3 to 0.1 step 1E-3)	V
%MapMeth	Mapping method	ID	–	Assign = 3, "Thermocouple"	–
%TCType	Thermocouple type	ID	4	B, E, J, K, N, R, S, T, or non-std.	–
%CJSource	Cold junction compensation required	ID	1	CJC Required or Compensated	–
%SensorImped	Thermocouple resistance	ID	12	ConRelRes (1 to 319k, ±0.155%)	Ohms
%RespTime	Sensor response time	ID	6	ConRelRes (1E-6 to 7.9, ±15%)	seconds
%CalDate	Calibration date	CAL	16	DATE	–
%CalInitials	Calibration initials	CAL	15	CHR5	–
%CalPeriod	Calibration period	CAL	12	UNINT	days
%MeasID	Measurement location ID	USR	11	UNINT	–

Template 38: Thermistor Template

The thermistor template specifies the operation of a thermistor using Steinhart-Hart thermistor equation.

Table 12. Thermistor Template (ID = 38) Summary

Property	Description	Access	Bits	Data Type (and Range)	Units
TEMPLATE	Template ID	–	8	Integer (value = 38)	–
%ElecSigType	Transducer electrical signal type	ID	–	Assign = 2, "Resistance Sensor"	–
%MinPhysVal	Minimum temperature	CAL	11	ConRes (-200 to 1,846, step 1)	ºC
%MaxPhysVal	Maximum temperature	CAL	11	ConRes (-200 to 1,846, step 1)	ºC
%MinElecVal	Minimum resistance output	CAL	18	ConRes (0 to 262k, step 1)	Ohms
%MaxElecVal	Maximum resistance output	CAL	18	ConRes (0 to 262k, step 1)	Ohms
%MapMeth	Mapping method	ID	–	Assign = 4, "Thermistor"	–
%RTDCoef_R0	Resistance of thermistor at 0°C	ID	20	ConRelRes (10 to 5.5E+6, ±6.3ppm)	Ohms
%SteinhartA	Steinhart-Hart Coefficient A	ID	32	Single	1/C
%SteinhartB	Steinhart-Hart Coefficient B	ID	32	Single	1/C
%SteinhartC	Steinhart-Hart Coefficient C	ID	32	Single	1/C
%RespTime	Sensor response time	ID	6	ConRelRes (1E-6 to 7.9, ±15%)	seconds
%ExciteAmplNom	Nominal current excitation	CAL	8	ConRelRes (1E-6 to 120E-3, ±2.3%)	Amps
%ExciteAmplMax	Maximum current excitation	ID	8	ConRelRes (1E-6 to 120E-3, ±2.3%)	Amps
%SelfHeating	Self heating constant	ID	5	ConRelRes (0.25E-3 to 16E-3, ±7.4%)	W/ºC
%CalDate	Calibration date	CAL	16	DATE	–
%CalInitials	Calibration initials	CAL	15	CHR5	–
%CalPeriod	Calibration period	CAL	12	UNINT	days
%MeasID	Measurement location ID	USR	11	UNINT	–

Template 37: Resistance Temperature Detector (RTD) Template

The RTD template, through the "RTD Curve" select case, allows the specification of a standard DIN curve (cases 0 through 5) or custom curve (cases 6 and 7) using Callendar-Van Dusen coefficients.

Table 13. RTD Template (ID = 37) Summary

Select	Property/Command	Description	Access	Bits	Data Type (and Range)	Units
–	TEMPLATE	Template ID	–	8	Integer (value = 37)	–
–	%ElecSigType	Electrical signal type	ID	–	Assign = 2, "Resistance Sensor"	–
–	%MinPhysVal	Minimum temperature	CAL	11	ConRes (-200 to 1,846, step 1)	ºC
–	%MaxPhysVal	Maximum temperature	CAL	11	ConRes (-200 to 1,846, step 1)	ºC
–	%MinElecVal	Minimum electrical output	CAL	11	ConRes (0 to 2.05 k, step 1)	Ohms
–	%MaxElecVal	Max. electrical output	CAL	13	ConRes (0 to 8.2 k, step 1)	Ohms
–	%MapMeth	Mapping method	ID	–	Assign = 5, "RTD"	–
Select Case – Selects R0 Resistance (standard or specified)				2	Select Case	–
Case 0 *(100 Ω)*	%RTDCoef_R0	Resistance R0	ID	–	Assign = 100.0	Ohms
Case 1 *(120 Ω)*	%RTDCoef_R0	Resistance R0	ID	–	Assign = 120.0	Ohms
Case 2 *(1 kΩ)*	%RTDCoef_R0	Resistance R0	ID	–	Assign = 1000.0	Ohms
Case 3	%RTDCoef_R0	Resistance R0	ID	20	ConRelRes (1 to 12.5k, ±4.5 ppm)	Ohms
Select Case – Selects RTD Curve (Callendar-Van Dusen Coefficients)				3	Select Case	–
Case 0 *α=.00375*	%RTDCoef_A	CVD Coefficient A	ID	-	Assign = 3.8100E-3	1/C
	%RTDCoef_B	CVD Coefficient B	ID	-	Assign = -6.0200E-7	1/C²
	%RTDCoef_C	CVD Coefficient C	ID	-	Assign = -6.000E-12	1/C³
Case 1 *α=.003851*	%RTDCoef_A	CVD Coefficient A	ID	-	Assign = 3.9083E-3	1/C
	%RTDCoef_B	CVD Coefficient B	ID	-	Assign = -5.7750E-7	1/C²
	%RTDCoef_C	CVD Coefficient C	ID	-	Assign = -4.183E-12	1/C³
Case 2 *α=.003911*	%RTDCoef_A	CVD Coefficient A	ID	-	Assign = 3.9692E-3	1/C
	%RTDCoef_B	CVD Coefficient B	ID	-	Assign = -5.8495E-7	1/C²
	%RTDCoef_C	CVD Coefficient C	ID	-	Assigne = -4.229E-12	1/C³
Case 3 *α=.003916*	%RTDCoef_A	CVD Coefficient A	ID	-	Assign = 3.9739E-3	1/C
	%RTDCoef_B	CVD Coefficient B	ID	-	Assign = -5.8700E-7	1/C²
	%RTDCoef_C	CVD Coefficient C	ID	-	Assign = -4.39E-12	1/C³
Case 4 *α=.003920*	%RTDCoef_A	CVD Coefficient A	ID	-	Assign = 3.9787E-3	1/C
	%RTDCoef_B	CVD Coefficient B	ID	-	Assign = -5.8685E-7	1/C²
	%RTDCoef_C	CVD Coefficient C	ID	-	Assign = -4.160E-12	1/C³
Case 5 *α=.003928*	%RTDCoef_A	CVD Coefficient A	ID	-	Assign = 3.9888E-3	1/C
	%RTDCoef_B	CVD Coefficient B	ID	-	Assign = -5.915E-7	1/C²
	%RTDCoef_C	CVD Coefficient C	ID	-	Assign = -3.816E-12	1/C³
Case 6 *(custom)*	%RTDCoef_A	CVD Coefficient A	ID	13	ConRes(3.8E-3 to 4E-3, step 2.5E-8)	1/C
	%RTDCoef_B	CVD Coefficient B	ID	10	ConRes(-6.1E-7 to –5.6E-7)	1/C²
	%RTDCoef_C	CVD Coefficient C	ID	7	ConRes (-6E-12 to –3E-12)	1/C³
Case 7 *(custom)*	%RTDCoef_A	CVD Coefficient A	ID	32	Single	1/C
	%RTDCoef_B	CVD Coefficient B	ID	32	Single	1/C²
	%RTDCoef_C	CVD Coefficient C	ID	32	Single	1/C³
–	%RespTime	Sensor response time	ID	6	ConRelRes (1E-6 to 7.9, ±15%)	seconds
–	%ExciteAmplNom	Excitation current, nom.	CAL	8	ConRelRes (1E-6 to 120E-3, ±2%)	Amps
–	%ExciteAmplMax	Excitation current, max.	ID	8	ConRelRes (1E-6 to 120E-3, ±2%)	Amps
–	%CalDate	Calibration date	CAL	16	DATE	–
–	%CalInitials	Calibration initials	CAL	15	CHR5	–
–	%CalPeriod	Calibration period	CAL	12	UNINT	days
–	%MeasID	Measurement location ID	USR	11	UNINT	–

Template 39: Potentiometric Voltage Divider Template

Tempate 39 is intended for sensors whose outputs are configured as a potentiometer, in a resistive voltage divider configuration. The first 6-bit Select Case will indicate the physical measurand and the corresponding units (i.e. PSI, N, m/s^2, mm, %, etc.).

Table 14. Potentiometric Voltage Divider Template (ID = 39) Summary

Select	Property/Command	Description	Access	Bits	Data Type (and Range)	Units
–	TEMPLATE	Template ID	–	8	Integer (value = 39)	–
–	%ElecSigType	Electrical signal type	ID	–	Assign = 5, "Potentiometric Voltage Divider Sensor"	–
Select Case – Select Type of Physical Measurand (Units)				6	Select Case	–
Cases 0 – 45	%MinPhysVal	Minimum physical value	CAL	32	Single	Various*
	%MaxPhysVal	Maximum physical value	CAL	32	Single	Various*
Select Case – Electrical Value Precision				1	Select Case	–
Case 0 (0–1.0)	%MinElecVal	Minimum electrical output	CAL	–	Assign = 0.0	V/V
	%MaxElecVal	Maximum electrical output	CAL	–	Assign = 1.0	V/V
Case 1 (20 bit)	%MinElecVal	Minimum electrical output	CAL	20	ConRes (0 to 1, step 1E-6)	V/V
	%MaxElecVal	Maximum electrical output	CAL	20	ConRes (0 to 1, step 1E-6)	V/V
–	%MapMeth	Mapping method	ID	–	Assign = 0, "Linear"	–
–	%SensorImped	Sensor input impedance	ID	12	ConRelRes (1 to 1.1M, ±0.17%)	Ohms
–	%RespTime	Sensor response time	ID	6	ConRelRes (1E-6 to 7.9, ±15%)	seconds
–	%ExciteAmplNom	Excitation level, nominal	ID	9	ConRes (0.1 to 51.1, step 0.1)	Volts
–	%ExciteAmplMin	Excitation level, min.	ID	9	ConRes (0.1 to 51.1, step 0.1)	Volts
–	%ExciteAmplMax	Excitation level, max.	ID	9	ConRes (0.1 to 51.1, step 0.1)	Volts
–	%ExciteType	Power supply type	ID	2	DC, Bipolar DC, or AC	–
–	%CalDate	Calibration date	CAL	16	DATE	–
–	%CalInitials	Calibration initials	CAL	15	CHR5	–
–	%CalPeriod	Calibration period	CAL	12	UNINT	days
–	%MeasID	Measurement location ID	USR	11	UNINT	–

* Units for %MinPhysVal and %MaxPhysVal are determined by value of Select Case "Physical Measurand (Units)" as summarized in Table 15.

Table 15. Enumeration of Select Case Values for "Physical Measurand (Units)" Used in Templates 30, 31, 32, 33, and 39.

Case	Physical Units	Case	Physical Units	Case	Physical Units	Case	Physical Units
0	K	12	Pa	24	radian/s	36	gpm
1	°C	13	psi	25	rpm	37	cfm
2	strain	14	Kg	26	Hz	38	l/min
3	microstrain	15	G	27	g/l	39	RH
4	N	16	m	28	kg/m^3	40	%
5	lb	17	mm	29	mole/m^3	41	Volts
6	kgf	18	in	30	mole/l	42	Volts rms
7	m/s^2	19	m/s	31	m^3/m^3	43	Amperes
8	ga	20	mph	32	l/l	44	Amperes rms
9	Nm/radian	21	fps	33	kg/s	45	Watts
10	Nm	22	radians	34	m^3/s		
11	oz-in	23	degrees	35	m^3/hr		

Standard Templates – Calibration Templates

The IEEE standard includes three standard templates designated as calibration templates that can be used in conjunction with one of the standard transducer templates in the previous section. The calibration table and calibration curve templates provide mechanisms for fully specifying the input-versus-output curves for the sensor.

The Calibration Table Template (ID = 40) allows the inclusion of mulitple data pairs to specify the input-output function of the sensor. The Calibration Table Template uses the minimum and maximum physical and electrical values contained in the standard transducer template, and specifies an arbitrary number (value *n* in Table 16) of data pairs within these ranges.

Table 16. Calibration Table Template (ID = 40) Summary

Property	Description	Bits	Data Type (and Range)
TEMPLATE	Template ID	8	Integer (value = 40)
%CalTable_Domain	Domain parameter	1	Electrical or physical
STRUCTARRAY CalTable	Number of data pairs (*n*)	7	Size from 1 to 127
%CalPoint_DomainValue (0)	Domain Cal Point 0 (% of full span)	16	ConRes (0 to 100%, step 0.0015)
%CalPoint_RangeValue (0)	Range Cal Deviation 0 (% of full span)	21	ConRes (-100 to 100, step 1E-4)
%CalPoint_DomainValue (1)	Domain Cal Point 1 (% of full span)	16	ConRes (0 to 100%, step 0.0015)
%CalPoint_RangeValue (1)	Range Cal Deviation 1 (% of full span)	21	ConRes (-100 to 100, step 1E-4)
. . .	. . .		. . .
%CalPoint_DomainValue (*n*)	Domain Cal Point *n* (% of full span)	16	ConRes (0 to 100%, step 0.0015)
%CalPoint_RangeValue (*n*)	Range Cal Deviation *n* (% of full span)	21	ConRes (-100 to 100, step 1E-4)

The Calibration Curve Template (ID = 41) allows the specification of the input-output function of the sensor as a multi-segment multi-polynomial curve. The Calibration Curve Template uses the minimum and maximum physical and electrical values contained in the standard transducer template, and specifies an arbitrary number of polynomial curves within these ranges.

Table 17. Calibration Curve Template (ID = 41) Summary

Property/Command	Description	Bits	Data Type (and Range)
TEMPLATE	Template ID	8	Integer (value = 41)
%CalCurve_Domain	Domain parameter	1	Electical or Physical
STRUCTARRAY CalCurve	Number of Cal Curve Segments	8	Dimension size of 1 to 255
%CalCurve_PieceStart (0)	Start of segment 0 (% of FS)	13	ConRes (0 to 100, step 0.01)
STRUCTARRAY CalCurve_Poly (0)	Num. of polynomials for segment 0	7	Dimension size of 1 to 127
%CalCurve_Power (array)	Power of domain value	7 per value	ConRes (-32 to 32, step 0.5)
%CalCurve_Coef (array)	Polynomial coefficients	32 per value	Single
STRUCTARRAY CalCurve_Poly (1)	Num. of polynomials for segment 1	7	Dimension size of 1 to 127
%CalCurve_Power (array)	Power of domain value	7 per value	ConRes (-32 to 32, step 0.5)
%CalCurve_Coef (array)	Polynomial coefficients	32 per value	Single
. . .	. . .		. . .
STRUCTARRAY CalCurve_Poly (*n*)	Num. of polynomials for segment *n*	7	Dimension size of 1 to 127
%CalCurve_Power (array)	Power of domain value	7 per value	ConRes (-32 to 32, step 0.5)
%CalCurve_Coef (array)	Polynomial coefficients	32 per value	Single

The Frequency Response Table Template (ID = 42) allows the specification of the frequency response function of the sensor as a set of amplitudge-frequency data pairs.

Table 18. Frequency Response Table Template (ID = 42) Summary

Property	Description	Bits	Data Type (and Range)	Units
TEMPLATE	Template ID	8	Integer (value = 42)	–
STRUCTARRAY TF_Table	Number of data pairs (*n*)	7	Size from 1 to 127	–
%TF_Table_Freq (0)	Frequency point (0)	15	ConRelRes (1 to 1.3E+6, ±0.02%)	Hz
%TF_Table_Ampl (0)	Amplitude point (0) (% of full span)	21	ConRes (-100 to 100, step 0.0001)	%
%TF_Table_Freq (1)	Frequency point (1)	15	ConRelRes (1 to 1.3E+6, ±0.02%)	Hz
%TF_Table_Ampl (1)	Amplitude point (1) (% of full span)	21	ConRes (-100 to 100, step 0.0001)	%
. . .	. . .		. . .	
%TF_Table_Freq (*n*)	Frequency point (*n*)	15	ConRelRes (1 to 1.3E+6, ±0.02%)	Hz
%TF_Table_Ampl (*n*)	Amplitude point (*n*) (% of full span)	21	ConRes (-100 to 100, step 0.0001)	%

Legacy Transducer Templates (v0.9)

Many transducers are in use with a preliminary version of the IEEE 1451.4 standard designated as v0.9. The TEDS in these sensors use a different format for the Basic TEDS as well as different templates. Although templates with ID values 0 through 24 have been in use, the following tables summarize the most poplular legacy templates, along with the Basic TEDS used in these sensors.

Table 19. Basic TEDS content for v0.9 legacy sensors

	Bit Length	Allowable Range
Manufacturer ID	12	17 – 4095
Model Number	16	0-65535
Version Letter	5	A-Z (data type Chr5)
Version Number	6	0-63
Serial Number	24	0-33554431

Table 20. Summary of Accelerometer (ID = 0) Legacy Template

Property Name	Description	Type	Bits	Data Type (and Range)	Units
TEMPLATE	Template ID	–	8	Integer (value = 0)	–
%CalDate	Calibration Date	CAL	16	DATE	–
%Sens@Ref	Sensitivity @ ref condition	CAL	16	ConRelRes (100E-6 to 49, ±0.01%)	$V/(m/s^2)$
%Reffreq	Reference frequency	CAL	8	ConRelRes (10 to 19k, ±1.5%)	Hz
%TF_HP_S	High pass cut-off frequency (F hp)	CAL	12	ConRelRes (0.01 to 36, ±0.1%)	Hz
%Sign	Polarity (sign)	CAL	1	Positive or negative	–
%Direction	Sensitivity direction (x, y, z)	CAL	2	x, y, or z	–
%MeasID	Measurement location ID	USR	9	UNINT	–

Table 21. Summary of Accelerometer (ID = 1) Legacy Template

Property Name	Description	Type	Bits	Data Type (and Range)	Units
TEMPLATE	Template ID	–	8	Integer (value = 1)	–
%CalDate	Calibration Date	CAL	16	DATE	–
%Sens@Ref	Sensitivity @ ref condition	CAL	16	ConRelRes (100E-6 to 49, ±0.01%)	$V/(m/s^2)$
%Reffreq	Reference frequency	CAL	8	ConRelRes (8 to 13k, ±1.5%)	Hz
%TF_HP_S	High pass cut-off frequency	CAL	12	ConRelRes (0.01 to 2k, ±0.15%)	Hz
%Sign	Polarity (sign)	CAL	1	Enumeration: positive ⏐ negative	–
%TF_SP	Low pass cut-off frequency	CAL	12	ConRelRes (20 to 4E+6, ±0.15%)	Hz
%TF_KPr	Resonance frequency (f res)	CAL	9	ConRelRes (100 to 2.5E6, ±1%)	Hz
%TF_KPq	Quality factor at f res	CAL	8	ConRelRes (0.3 to 490, ±3%)	–
%TF_SL	Amplitude slope (a)	CAL	7	ConRelRes (0.85 to 1, ±0.1%)	%/decade
%PhaseCorrection	Phase Correction at Fref	CAL	6	ConRes (-3.2 to 3.1, step 0.1)	°
%TempCoef	Temperature Coefficient (b)	CAL	9	ConRelRes (1e-6 to 25e-3, ±1%)	%/°C
%Direction	Sensitivity direction (x, y, z)	CAL	2	Enumeration: x ⏐ y ⏐ z	–
%MeasID	Measurement location ID	USR	9	UNINT	–

Table 22. Summary of Accelerometer (ID = 24) Legacy Template

Property Name	Description	Type	Bits	Data Type (and Range)	Units
TEMPLATE	Template ID	–	8	Integer (value = 24)	–
%CalDate	Calibration Date	CAL	16	DATE	–
%Sens@Ref	Sensitivity @ ref condition	CAL	16	ConRelRes (5E-7 to 172, ±0.015%)	$V/(m/s^2)$
%Reffreq	Reference frequency	CAL	8	ConRelRes (8 to 13k, ±1.5%)	Hz
%Sign	Polarity (sign)	CAL	1	Enumeration: positive | negative	–
%TF_HP_S	High pass cut-off frequency	CAL	12	ConRelRes (0.01 to 2k, ±0.15%)	Hz
%TF_SP	Low pass cut-off frequency	CAL	12	ConRelRes (20 to 4E+6, ±0.15%)	Hz
%TF_KPr	Resonance frequency (f res)	CAL	9	ConRelRes (100 to 2.5E6, ±1%)	Hz
%TF_KPq	Quality factor at f res	CAL	7	ConRelRes (0.3 to 490, ±3%)	–
%TF_SL	Amplitude slope (a)	CAL	7	ConRes (-6.3 to 6.4, step 0.1)	%/decade
%TempCoef	Temperature Coefficient (b)	CAL	9	ConRes (-0.5 to 0.5, step 0.002)	%/°C
%RefTemp	Reference temperature (T ref)	CAL	5	ConRes (15 to 30, step 0,5)	°C
%Direction	Sensitivity direction (x, y, z)	CAL	2	Enumeration: x | y | z	–
%MeasID	Measurement location ID	USR	11	UNINT	–

Table 23. Summary of Microphone (ID = 12) Legacy Template

Property Name	Description	Type	Bits	Data Type (and Range)	Units
TEMPLATE	Template ID	–	8	Integer (value = 12)	–
%CalDate	Calibration Date	CAL	16	DATE	–
%Sens@Ref	Sensitivity @ 250 Hz	CAL	16	ConRelRes (100E-6 to 49, ±0.01%)	V/Pa
%Prepolarized	Prepolarized 0/1	CAL	1	UNINT	
%MeasID	Measurement location ID	USR	9	UNINT	–