File: \NOAA\Resonon\doc\Aux_data_via_LabJack_for_MOBY-Refresh.pptx & .pdf
Date: 06-May-2016, By: MF/MLML (rev: 09May2016)
What: Auxiliary data collection via LabJack U6 USB DAQ for MOBY-Refresh instruments.

In May-2016 MF moved the acquisition of MOBY-Refresh auxiliary data to a LabJack U6 USB DAQ (see **Fig. 1**) This was done to free-up the SLM's DVM and simplify my wiring mess, and because the MOBY-Refresh instruments will employ internal U6 DAQs for control and acquisition.

The U6 5 Vdc power source (supplied via USB cable connection) is used to supply voltage-divider input for 5x thermistors for temperature measurements, and 2x humidity sensors for %RH measurements. The Resonon instruments have 3x internal temperature sensors and 1x internal humidity sensor (**Fig. 2-5**). An external %RH + °C sensor (see **Fig. 6**) monitors ambient conditions, and another external thermistor is available to attach to another device – ex. Fiber splitter (**Fig. 7**). There are 2x not-used channels wired and available in the U6 connector box for future use.

For now, data acquisition is via commercial LabJack software: LJLogUD V1.19 (Windows only).

<u>The auxiliary data measured / logged are:</u>
Chan 01 = 5 Vdc Supply (Vdc) [LJ U6 via USB]
Chan 02 = Internal Slit Thermistor (Vdc) [US Sensors PT103J2]
Chan 03 = Internal Near-camera Thermistor (Vdc) [US Sensors PT103J2]
Chan 04 = Internal Under-cap Thermistor (Vdc) [US Sensors PT103J2]
Chan 05 = Ambient Thermistor (Vdc) [Meas. Spec. HTM2500LF]
Chan 06 = External Thermistor (Vdc) [Cantherm CWF4B103G3380]
Chan 07 = NA (Vdc)
Chan 08 = NA (Vdc)
Chan 09 = Internal Humidity Sensor (Vdc) [Honeywell HIH-5030]
Chan 10 = External Humidity Sensor (Vdc) [Meas. Spec. HTM2500LF]

All thermistors are wired in resistive voltage divider circuits, following the equation:

Vout = Vin * (R2 / (R1 + R2)), where
Vout = measured output Voltage across the 10 kΩ NTC thermistor (i.e. temperature probe)
Vin = input supply voltage, measured as Chan 1
R1 = NTC resistance (Ohm), nominal 10 kΩ at 25°C
R2 = batch resistance (Ohm), 10 kΩ ± 0.1%, 5 ppm temp. coef. PTF5610K000BZEB (see **Fig. 8**)

So that the unknown NTC resistance can be solved from the above equation as:
R1 = R2 * ((Vin / Vout) – 1)

LJLogUD logging software saves tab-delimited ASCII *.dat files, were the first column is a time stamp of seconds since midnight January 1st (Universal Time), 1904. The next 10 columns are the 10 channels of Vdc data listed above.

LabJack U6-PRO

Multifunction DAQ - USB

The U6 incorporates a wide range of features including our highest performance 24-bit analog inputs with on-board instrumentation amplifier.

$369

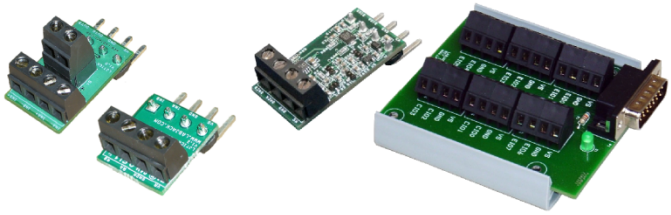
labjack.com/u6

I/O Features

- Analog input resolution as low as **1µV noise-free**
- Analog input ranges: ±10V, ±1V, ±0.1V and ±0.01V
- Expand to **84 analog inputs** with $150 add-on
- 16-bit high-speed ADC (up to 50kHz)
- **24-bit** low-speed ADC
- 14 analog inputs built-in
- 20 digital I/O
- Watchdog system
- Up to 2 counters
- 2 analog outputs (12-bit, 0-5V)
- Serial protocols: SPI, I2C, and more ...
- Up to 4 PWM, quadrature, pulse width, and more ...
- Thermocouples, load cells, bridges, and more ...
- Industrial temperature range (-40 to 85°C)

Other Highlights

- Each purchase includes **lifetime support**
- **Free applications** to configure, test, and log data to file
- Free examples: **C/C++**, **C#**, **Delphi**, **Java**, **LabVIEW**, **Matlab**, **Python**, **VB.NET** and more...
- Free UD Library - Wraps the low-level protocol and USB driver layer for ease-of-use
- Expansion boards - Add ±10V DACs, 4-20 mA inputs, terminal boards, relay boards and more...



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-Brad
Neuro-Test Inc

Figure 1, Features of LabJack U6 USB DAQ

Moby Blue wiring chart

Connector 1	
Pin 1	Slit Thermistor
Pin 2	Slit Thermistor
Pin 3	Near-camera Thermistor
Pin 4	Near-camera Thermistor
Pin 5	Unused

Connector 2	
Pin 1	Humidity Sensor –ve (0 V)
Pin 2	Humidity Sensor Signal Out*
Pin 3	Humidity Sensor +ve (+3.3 V)
Pin 4	Under-cap Thermistor
Pin 5	Under-cap Thermistor

*No load has been bridged to ground as suggested in the Honeywell Typical Application Circuit.

Figure 1: Connectors 1 and 2

Figure 2, Resonon Wiring Chart for BS01

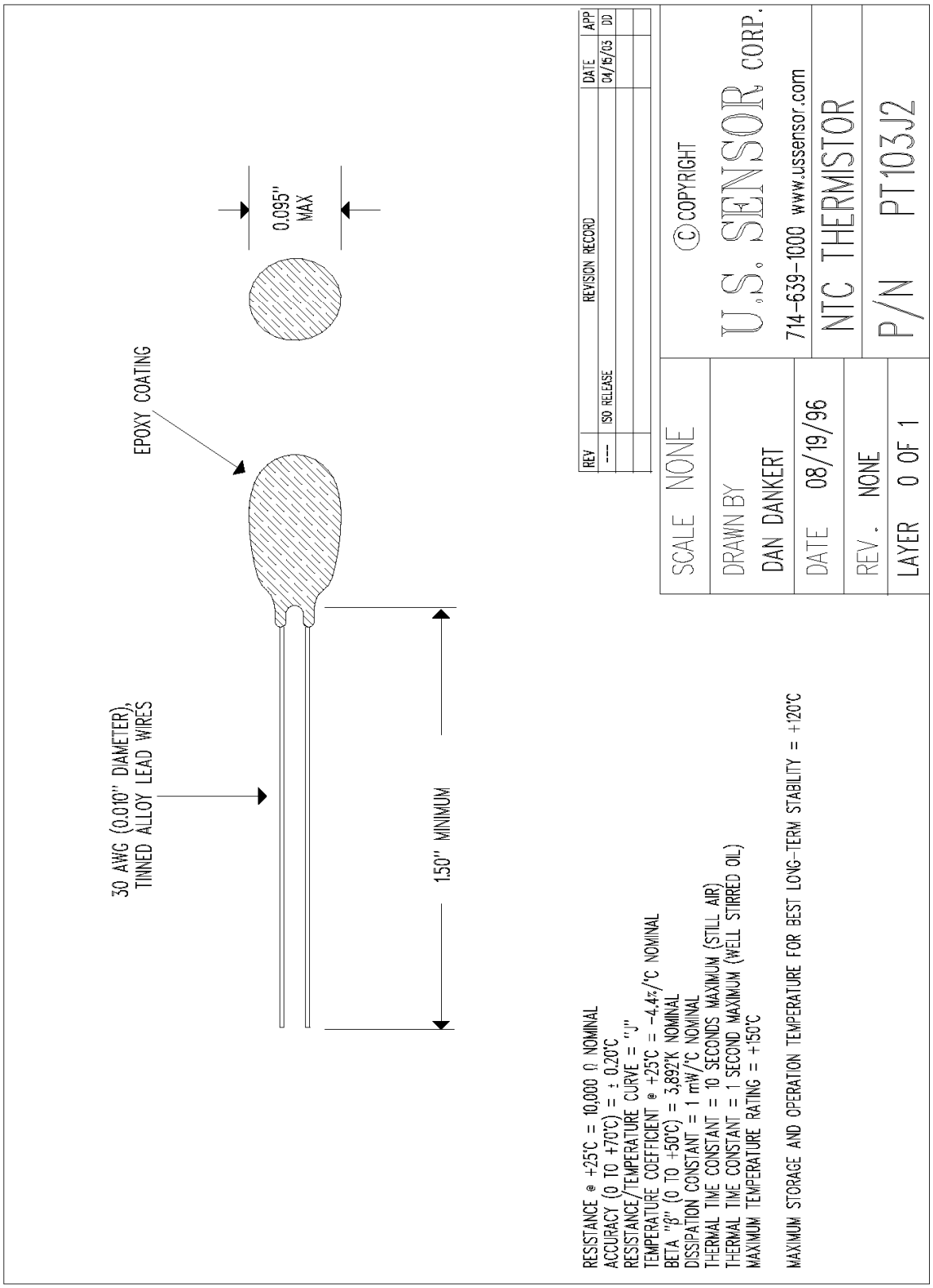

Figure 3, Specifications for Internal Resonon thermistors = DigiKey part # 615-1010-ND / US Sensor PT103J2

Table 1. Performance Specifications (At 3.3 Vdc supply and 25 °C [77 °F] unless otherwise noted.)

Parameter	Minimum	Typical	Maximum	Unit	Specific Note
Interchangeability (first order curve)					
0 % RH to 10 % RH, 90 % RH to 100 % RH	-7	–	7	% RH	–
11 % RH to 89 % RH	-3	–	3	% RH	
Accuracy (best fit straight line) 11% RH to 89% RH	-3	–	+3	% RH	4
Hysteresis	–	2	–	% RH	–
Repeatability	–	±0.5	–	% RH	–
Settling time	–	–	70	ms	–
Response time (1/e in slow moving air)	–	5	–	s	–
Stability (at 50% RH in 5 years)	–	±1.2	–	% RH	1
Voltage supply	2.7	–	5.5	Vdc	2
Current supply	–	200	500	µA	–
Voltage output (1st order curve fit)	$V_{OUT}=(V_{SUPPLY})(0.00636(\text{sensor RH}) + 0.1515)$, typical at 25 °C				
Temperature compensation	True RH = (Sensor RH)/(1.0546 – 0.00216T), T in °C				
Output voltage temp. coefficient at 50% RH, 5 V	–	-2	–	mV/°C	–
Operating temperature	-40[-40]	See Figure 2.	85[185]	°C[°F]	–
Operating humidity (HIH-5030)	0	See Figure 2.	100	% RH	3
Operating humidity (HIH-5031)	0	See Figure 2.	100	% RH	–
Storage temperature	-50[-58]	–	125[257]	°C[°F]	–
Storage humidity	See Figure 3.			% RH	3

Specific Notes:

1. Includes stress outside of recommended operating zone.
2. Device is tested at 3.3 Vdc and 25 °C.
3. Non-condensing environment. When liquid water falls on the humidity sensor die, output goes to a low rail condition indicating no humidity.
4. Total accuracy including interchangeability is ±3 %RH.

General Notes:

- Sensor is ratiometric to supply voltage.
- Extended exposure to ≥90 % RH causes a reversible shift of 3 % RH.
- Sensor is light sensitive. For best performance, shield sensor from bright light.

Figure 10. Typical Application Circuit

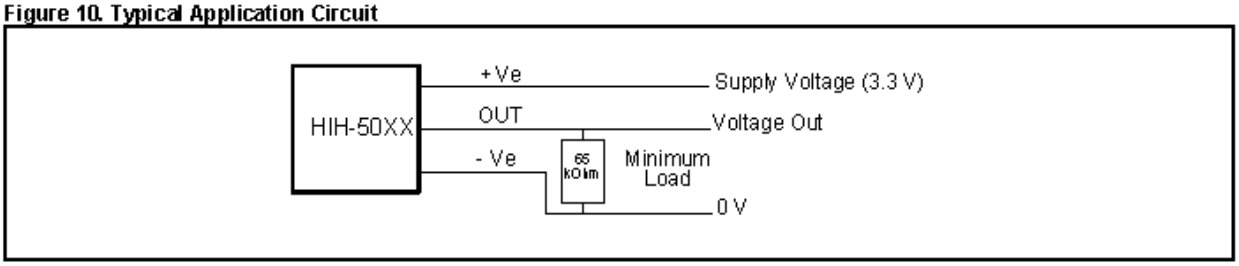

Figure 4, Specifications for Internal Resonon Humidity Sensor = DigiKey part # 480-3294-1-ND / Honeywell HIH-5030-001

PART NUMBER SYSTEM - EXAMPLE

HUMG - 2 - BCR

- BCR - Bulkhead Connector Receptacle
  CCP - Cable Connector Plug
  DSR - Dummy Sealing Receptacle
  DSP - Dummy Sealing Plug
- Number of Contacts
- Shell Size (G, K, L)
- HUMMER Connector Series

GENERAL INFORMATION

COMPONENT	MATERIAL
BULKHEAD BODY**	Brass (CA #360)
CCP/DSR/DSP	Neoprene
CONTACTS	Brass-gold plated
O-RING	Nitrile (formerly known as Buna N)
ENGAGING NUT**	Delrin® (DuPont trademark for Acetal Resin)
IN-LINE CABLE*** G2, K5, L12 G5, K12, L28	Teflon® (Registered trademark for DuPont) Insulated, Neoprene Jacketed Neoprene #22 Gage Neoprene #28 Gage
STANDARD LENGTH	18 inches
HOOK-UP WIRE	Teflon® (Registered trademark for DuPont) or Tefzel® #22/#28

CATEGORY	VALUE
OPEN FACE PRESSURE	Up to 10,000 psi (700 bar) by special order
MATED PRESSURE	10,000 psi (700 bar)
VOLTAGE RATING	300 VDC
INSULATION RESISTANCE	>200 megohms @ 300 VDC (acceptance level)
OPERATING TEMPERATURE	25°F to 140°F (-4°C to 60°C)
BULKHEAD MOUNTING TORQUE	HUMG 12in-lb HUMG 30in-lb HUML 60in-lb
TORQUE VALES REFER TO INSTALLATION INTO DRY METAL THREADS	

AMPACITY CHART FOR STANDARD PARTS

PART DESCRIPTION NUMBER OF CONTACTS	AMPACITY
HUMG - 2	1.50 amps
HUMG - 5	0.24 amps
HUMK - 5	1.10 amps

PART DESCRIPTION NUMBER OF CONTACTS	AMPACITY
HUMK - 12	0.16 amps
HUML - 12	0.80 amps
HUML - 28	0.10 amps

NOTES:

- Amperage ratings are based on standard cables.
- Maximum rating is for a "fully loaded" connector and cable rating must not be exceeded.

- * In service rating 300 VDC.
- ** Contact SEACON for special order materials.
- *** Incorporation of special cables will be determined on a case by case basis.

SIZE	HUMMER SERIES CONTACT CONFIGURATIONS (MALE FACE VIEW ONLY - NOT TO SCALE)*
G	 2#22 5#28

Figure 5, Specifications for Resonon external SeaCon cabling = SeaCon HUMG-5-CCP

measurement SPECIALTIES™

HTM2500LF – Temperature and Relative Humidity Module

- **Hermetic Housing**
- **Humidity calibrated within +/-2% @55%RH**
- **Temperature measurement through NTC 10kOhms +/-1% direct output**
- **Small size product**
- **Typical 1 to 4 Volt DC output for 0 to 100%RH at 5Vdc**

RoHS

ELECTRICAL CHARACTERISTICS

(Ta=23℃, Vs=5Vdc +/-5%, R_L>1MΩ unless otherwise stated)

Humidity Characteristics	Symbol	Min	Typ	Max	Unit
Humidity Measuring Range	RH	1		99	%RH
Relative Humidity Accuracy (10 to 95% RH)	RH		+/-3	+/-5	%RH
Supply Voltage	Vs	4.75	5.00	5.25	Vdc
Nominal Output @55%RH (at 5Vdc)	Vout	2.42	2.48	2.54	V
Current consumption	Ic		1.0	1.2	mA
Temperature Coefficient (10 to 50℃)	Tcc		+0.1		%RH/℃
Average Sensitivity from 33% to 75%RH	ΔVout/ΔRH		+26		mV/%RH
Sink Current Capability (R_L=15kΩ)	Is			300	μA
Recovery time after 150 hours of condensation	tr		10		s
Humidity Hysteresis			+/-1.5		%RH
Long term stability	T		+/-0.5		%RH/yr
Time Constant (at 63% of signal, static) 33% to 76%RH (1)	τ		5		s
Output Impedance	Z		70		Ω

(1) At 1m/s air flow

(Ta=25℃)

Temperature Characteristics	Symbol	Min	Typ	Max	Unit
Nominal Resistance @25℃	R		10		kΩ
Beta value: B25/50	β	3347	3380	3413	K
Temperature Measuring Range*	Ta	-40		85	℃
Nominal Resistance Tolerance @25℃	R_N			1	%
Beta Value Tolerance	β		1		%
Response Time	τ		10		s

** For temperature upper than 60℃, specific high te mperature cable is required: HTM2500LFL products*

- **Steinhart-Hart coefficients**

According to the equation below, the Steinhart-Hart coefficients for the operating temperature range for HTM2500LF thermistor are:

$$\frac{1}{T} = a + b*\ln(R) + C*\ln(R)*\ln(R)*\ln(R)$$

R	NTC resistance in Ω at temperature T in K
T	Temperature in K
a	Constant value (a = 8.54942E-04)
b	Constant value (b = 2.57305E-04)
c	Constant value (c = 1.65368E-07)

Figure 6, Specifications for external %RH and °C sensor = DigiKey # HTM2500LF-NT, Meas. Spec. HTM2500LF

Specification

CWF □□□□ – 103 J 3380

① ② ③ ④ ⑤

① NTC Temp sensor
② Package Option
1- Dipped ethoxyline resin (ex. 1A)
2- Aluminum,copper, or stainless steel housing (ex. 2A)
3- Plastic body (ex. 3AA)
4- Sheet metal attachment fixtures (ex. 4B)
5- Special probes (ex. 5B)
③ The Rated Resistance at 25ºC
Example:103=10×103=10000Ω=10KΩ
④ The Precision Symbol of Rated Resistance
F:±1% G:±2% H:±3% J:±5%
⑤ B value (25/50°C) B value example: 3380K

Technical Specifications

Part No.	Rated Resistance R25		B Value (25/50ºC)		Dissi.Coef. (mW/ºC)	Thermal time Constant (S)	Operating Temp. (ºC)
	Range	Allowable	(K)	Allowable			
CWF□□□3100	0.1-20	± 1 ± 2 ± 3 ± 5	3100	± 1 ± 2	≥ 2.2	≤ 70	-55 to 125
CWF□□□3270	0.2-20		3270				
CWF□□□3380	0.5-50		3380				
CWF□□□3470	0.5-50		3470				
CWF□□□3600	1-100		3600				
CWF□□□3950	5-100		3950				
CWF□□□4000	5-100		4000				
CWF□□□4050	5-200		4050				
CWF□□□4150	10-250		4150				
CWF□□□4300	20-1000		4300				
CWF□□□4500	10-1000		4500				

CANTHERM

Supplying high-quality bimetal and thermal sensor products.

Figure 7, Specifications for external thermistor / °C sensor = DigiKey # 317-1385-ND, Cantherm CWF4B103G3380

Metal Film Resistors, High Precision, High Stability

FEATURES

- Extremely low temperature coefficient of resistance
- Very low noise and voltage coefficient
- Very good high frequency characteristics
- Can replace wirewound bobbins
- Proprietary epoxy coating provides superior moisture protection
- For surface mount product, see Vishay Dale's PSF datasheet
- Compliant to RoHS Directive 2002/95/EC

STANDARD ELECTRICAL SPECIFICATIONS

GLOBAL MODEL	HISTORICAL MODEL	POWER RATING (3) $P_{85\,°C}$ W	LIMITING ELEMENT VOLTAGE MAX. (1) V	TEMPERATURE COEFFICIENT ± ppm/°C	TOLERANCE ± %	RESISTANCE RANGE Ω
PTF51	PTF-51	0.05	200	5, 10, 15	0.02, 0.05, 0.1, 0.25, 0.5, 1	15 to 100K
PTF56	PTF-56	0.125	300	5, 10, 15	0.01, 0.02, 0.05, 0.1, 0.25, 0.5, 1	15 to 500K
PTF65	PTF-65	0.25	500	5, 10, 15	0.05, 0.1, 0.25, 0.5, 1	15 to 1M

Notes

- Marking: Print-marked-model, value, tolerance, TC, date code
- DSCC has created a drawing to support the need for a precision axial-leaded product. Vishay Dale is listed as a resource on this drawing as follows:

DSCC DRAWING NUMBER	VISHAY DALE MODEL	POWER RATING $P_{85\,°C}$ W	RESISTANCE RANGE Ω	TOLERANCE ± %	TEMPERATURE COEFFICIENT ± ppm/°C	MAXIMUM WORKING VOLTAGE (1) V
89088	PTF56..31 PTF56..32 (2)	0.100	15 to 100K	0.01, 0.05, 0.1, 0.5, 1	5, 10	200
90038	PTF65..16 PTF65..14 (2)	0.250	15 to 100K	0.05, 0.1, 0.5, 1	5, 10	200

This drawing can be viewed at: www.dscc.dla.mil/Programs/MilSpec/ListDwgs.asp?DocType=DSCCdwg

(1) Continuous working voltage shall be $\sqrt{P \times R}$ or maximum working voltage, whichever is less.
(2) Hot solder dipped leads
(3) For operation of the PTF resistors at higher power ratings, see the Load Life Shift Due to Power and Derating table. This table gives a summary of the effects of using the PTF product at the more common combinations of power rating and case size, as well as quantifies the load life stability under those conditions.

TEMPERATURE COEFFICIENT CODES

GLOBAL TC CODE	HISTORICAL TC CODE	TEMPERATURE COEFFICIENT
Z	T-16	5 ppm/°C
Y	T-13	10 ppm/°C
X	T-10	15 ppm/°C

GLOBAL PART NUMBER INFORMATION

New Global Part Numbering: PTF5620K500BYRE (preferred part numbering format)

P	T	F	5	6	2	0	K	5	0	0	B	Y	R	E			

GLOBAL MODEL	RESISTANCE VALUE	TOLERANCE CODE	TEMP. COEFFICIENT	PACKAGING	SPECIAL
PTF51 PTF56 PTF65	R = Ω K = kΩ M = MΩ 15R000 = 15 Ω 500K00= 500 kΩ 1M0000= 1.0 MΩ	T = ± 0.01 % (4) Q = ± 0.02 % (4) A = ± 0.05 % B = ± 0.1 % C = ± 0.25 % D = ± 0.5 % F = ± 1 %	Z = 5 ppm Y = 10 ppm X = 15 ppm 0 = Special	EK = Lead (Pb)-free, bulk EA = Lead (Pb)-free, T/R (full) EB = Lead (Pb)-free, T/R (1000 pieces) BF = Tin/lead, bulk RE = Tin/lead, T/R (full) R6 = Tin/lead, T/R (1000 pieces)	Blank = Standard (Dash number) (Up to 3 digits) From 1 to 999 as applicable

Historical Part Number example: PTF-5620K5BT-13R36 (will continue to be accepted)

PTF-56	20K5	B	T-13	R36
HISTORICAL MODEL	RESISTANCE VALUE	TOLERANCE CODE	TEMP. COEFFICIENT	PACKAGING

Note

(4) Historical tolerance codes were BB for 0.01 % and BC for 0.02 %

* Pb containing terminations are not RoHS compliant, exemptions may apply

Figure 8, Specifications for batch resistor in voltage divider circuits = DigiKey # PTF10KDCT-ND, Vishay Dale PTF5610K000BZEB