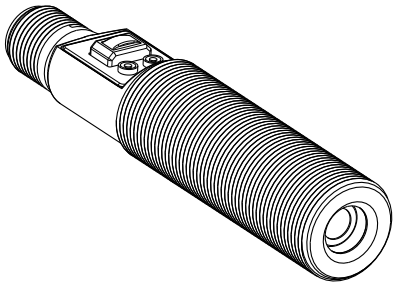
T-GAGE™ M18T Series Infrared Temperature Sensors

18 mm sensor with 0-10V and 4-20mA analog output and TEACH-mode programming

For the latest technical information about this product, including specifications, dimensions, and wiring, see *www.BannerEngineering.com*

Features



- Fast 75 ms response time
- Easy-to-use TEACH mode programming; no potentiometer adjustments
- Small self-contained package, no auxiliary controller needed
- Rugged encapsulated design for harsh environments
- Choose 2 meter or 9 meter unterminated cable, or 5-pin Euro-style QD connector
- Product motion not required for sensing
- Remote Teach available in both Static and Dynamic modes
- Alarm output for signal maximum
- Programming for either positive or negative analog slope based on teach order

CE

Models

Model	Cable*	D:S Ratio	Sensing Face	Supply Voltage	Output
M18TUP8	5-wire, 2 m (6.5') shielded cable	8:1	Integrated lens	12 to 30V dc	0 to 10V dc analog, plus PNP Alarm
M18TUP8Q	5-pin Euro-style integral QD				
M18TUP6E	5-wire, 2 m (6.5') shielded cable	6:1	Enclosed Plastic face (for food industry use)		
M18TUP6EQ	5-pin, Euro-style integral QD				
M18TUP14	5-wire, 2 m (6.5') shielded cable	14:1	Germanium lens		
M18TUP14Q	5-pin, Euro-style integral QD				
M18TIP8	5-wire, 2 m (6.5') shielded cable	8:1	Integrated lens		4 - 20 mA analog, plus PNP Alarm
M18TIP8Q	5-pin Euro-style integral QD				
M18TIP6E	5-wire, 2 m (6.5') shielded cable	6:1	Enclosed Plastic face (for food industry use)		
M18TIP6EQ	5-pin, Euro-style integral QD				
M18TIP14	5-wire, 2 m (6.5') shielded cable	14:1	Germanium lens		
M18TIP14Q	5-pin, Euro-style integral QD				

* For 9 m (30') cable, add suffix "**W/30**" to the model number of any cabled model (e.g., **M18TUP8 W/30**). A model with a QD connector requires an accessory mating cable. See *Quick-Disconnect Cables* on page 8 for more information.

WARNING: Not To Be Used for Personnel Protection

Never use this product as a sensing device for personnel protection. Doing so could lead to serious injury or death. This product does NOT include the self-checking redundant circuitry necessary to allow its use in personnel safety applications. A sensor failure or malfunction can cause either an energized or de-energized sensor output condition.

Overview

The T-GAGE analog sensor is a passive, non-contacting, temperature-based device. It is used to detect object(s) temperature within a sensing window and output a proportional voltage or current.

While it looks and operates just like an Expert™ photoelectric sensor, the T-GAGE detects the infrared light energy emitted by objects, instead of its own emitted light. The sensor uses a thermopile detector, made up of multiple infrared-sensitive elements (thermocouples) to detect this infrared energy within its field of view (see *Figure 2. Detection spot size versus distance from sensor* on page 2).

Potential applications include:

- Hot part detection (baked goods, metals, bottles, rubber)
- Ejection verification of injection-molded parts
- Flame process verification
- Hot glue detection (packaging equipment, book binding, product assembly)
- Cold part detection (frozen foods, ice, dairy)
- Roller monitoring

NOTE: The T-GAGE M18T sensor is not intended for absolute temperature measurement or for safety-related fire detection use.

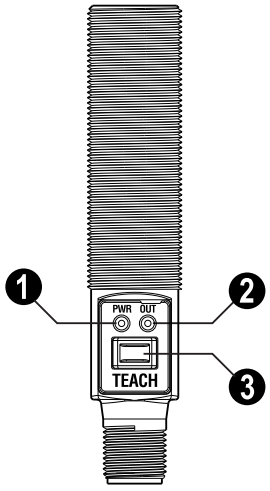
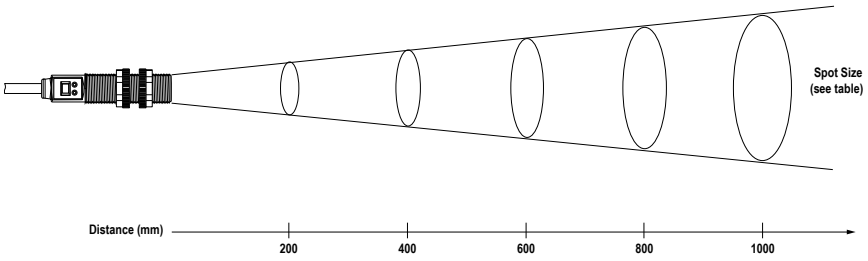


Figure 1. Sensor Features

1	Power/Teach LED
2	Alarm Output LED
3	TEACH Push Button

Sensing Field of View

The sensing range is determined by the sensor's field of view (FOV), or viewing angle, combined with the size of the object(s) being detected (see *Figure 2. Detection spot size versus distance from sensor* on page 2). The sensor's distance-to- spot size ratio (D:S ratio) is inversely related to the viewing angle; a sensor with a small viewing angle will have a large D:S ratio. The T-GAGE M18T sensors have D:S ratios of 6:1, 8:1 or 14:1. For a sensor with an 8:1 D:S ratio, the sensor's spot size is a 1" diameter circle at a distance of 8"; farther from the sensor face the spot size will be larger.



Sensor D:S Ratio	Distance from Sensor Face Versus Spot Size										
	100	200	300	400	500	600	700	800	900	1000	Distance (mm)
6:1	17	33	50	67	83	100	117	133	150	167	Spot Size (mm)
8:1	13	25	38	50	63	75	88	100	113	125	
14:1	7	14	21	29	36	43	50	57	64	71	

Figure 2. Detection spot size versus distance from sensor

Apparent Temperature

Two factors that have a large influence on apparent temperature are the object's *emissivity* and whether or not the object fills the sensor's field of view.

Object Emissivity:

A "blackbody" is a "perfect" emitter, with an emissivity of 1.0 at all temperatures and wavelengths. Most surfaces emit only a fraction of the amount of thermal energy that a blackbody would. Typical T-GAGE applications will be sensing objects with emissivities ranging from 0.5 to 0.95. Many references are available with tables of emissivity coefficients for common materials. In general, shiny unpainted metals have low emissivity, while non-glossy surfaces have high emissivity.

Shiny surfaces: a mirror or shiny surface can redirect an object's emitted energy to an undesired location, or even bring additional unintended thermal energy into the sensor's field of view (see *Application Note* on page 6).

Object Size:

If the object being detected does not fill the sensor's field of view, then the sensor will average the temperature of that object and whatever else is in the sensing field of view. For the sensor to collect the maximum amount of energy, the object should completely fill the sensor's field of view. However, in some applications, when the object is too small, this may not be possible. In such cases, if the object is hot enough, the thermal contrast may still be adequate to trigger the sensor's output.

Alarm Output

The alarm output will activate when the analog output is at 10V or 20mA, depending on model (see *Figure 3. Analog/Alarm outputs as a function of taught conditions* on page 3).

Analog Output

The T-GAGE analog sensor can be programmed for either positive or negative output slope, based on the teach order (see *Figure 3. Analog/Alarm outputs as a function of taught conditions* on page 3). If the cold limit is taught first, the slope will be positive; if the hot limit is taught first, the slope will be negative. Banner's scalable output automatically distributes the output signal over the width of the programmed sensing window.

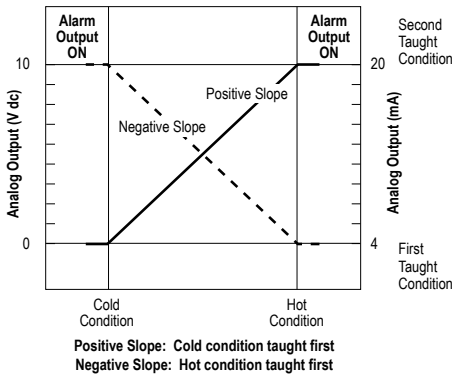


Figure 3. Analog/Alarm outputs as a function of taught conditions

Sensor Programming

Two TEACH methods may be used to program the sensor:

- Teach individual minimum and maximum limits (Two-Point Static Teach), or
- Dynamic Teach for on-the-fly programming.

The sensor may be programmed either via its push button, or via a remote switch. Remote programming also may be used to disable the push button, preventing unauthorized personnel from adjusting the programming settings. To access this feature, connect a normally open switch between the sensor's gray wire and dc common or connect the gray wire to a digital input (PLC).

NOTE: The impedance of the Remote Teach input is 3 kΩ.

Programming is accomplished by following the sequence of input pulses (see *Teaching Limits Using Two-Point Static TEACH* on page 4). The duration of each pulse (corresponding to a push button "click"), and the period between multiple pulses, are defined as "T":

0.04 seconds < T < 0.8 seconds

Status Indicators

Power ON/OFF LED	Indicates
OFF	Power is OFF
ON Green	Sensor is in Run mode
ON Red	TEACH is active

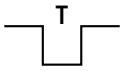
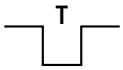
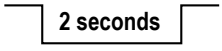
Alarm Output LED	Indicates
OFF	**Run Mode:** Alarm output is OFF
	TEACH Mode: Waiting for Span condition
ON Yellow	**Run Mode:** Alarm output is energized
	TEACH Mode: Waiting for Null condition
Flashing Yellow	Dynamic TEACH active

Teaching Limits Using Two-Point Static TEACH

Two-Point TEACH is the traditional setup method, used when two conditions can be presented individually by the user. The sensor establishes the Null (0V or 4mA) output condition with the first taught condition and the Span (10V or 20mA) output condition with the second taught condition, and it scales between these points.

General Notes on Programming

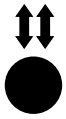
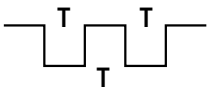
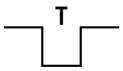
- The sensor will return to RUN mode if the first TEACH condition is not registered within 60 seconds
- After the first limit is taught, the sensor will remain in PROGRAM mode until the TEACH sequence is finished

	Two-Point TEACH Procedure		Result
	Push Button	Remote Line (0.04 sec < T < 0.8 sec)	
Programming Mode	• Push and hold push button for 2 seconds 	No action required	• Power LED turns Red • Alarm LED turns ON
Learn Null Condition	• Present condition for Null output • "Click" the push button 	• Present condition for Null output • Single-pulse the remote line 	• Alarm LED turns OFF
Learn Span Condition	• Present condition for Span output • "Click" the push button 	• Present condition for Span output • Single-pulse the remote line 	**Teach Accepted** • Power LED turns Green • Sensor automatically sets the analog range and returns to Run mode **Teach Unacceptable** Sensor returns to beginning of Teach
Exit Without Save	• Push and hold push button for 2 seconds 	• Hold remote line low for 2 seconds 	Sensor returns to Run mode without saving new settings

Teaching Limits Using Dynamic TEACH

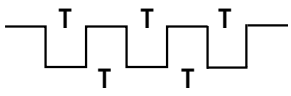
Dynamic TEACH is a method of setting the sensor's limits while the application is active. Dynamic TEACH will sense the high and low temperature limits of the process and automatically set the analog range between these limits.

The output slope will remain in the direction of the most recently taught Two-Point Static TEACH or default to positive.

	Dynamic TEACH Procedure		Result
	Push Button	Remote Line (0.04 sec < T < 0.8 sec)	
Programming Mode	• Push and hold push button for 2 seconds 	No action required	• Power LED turns Red • Alarm LED turns OFF
Enter Dynamic TEACH Process	• "Double-click" the push button 	• Double-pulse the remote line 	• Sensor begins dynamic learning process • Alarm LED flashes Yellow @ 2 Hz
End Dynamic TEACH Process	• "Single-click" the push button 	• Single-pulse the remote line 	• Sensor ends data collection; sets Null and Span limits • Power LED turns Green • Sensor returns to Run mode

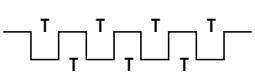
Changing Direction of Output Slope

The following procedure changes the direction of the analog output slope from negative to positive or from positive to negative. See *Analog Output* on page 3 for an explanation of the analog output slope.

	Procedure		Result
	Push Button	Remote Line (0.04 sec < T < 0.8 sec)	
Change Output Slope Direction	Not available via push button	• Three-pulse the remote line 	• Output slope changes from negative to positive or from positive to negative

Push Button Lockout

The push button lockout feature enables or disables the push button to prevent unauthorized adjustment of the program settings.

	Procedure		Result
	Push Button	Remote Line (0.04 sec < T < 0.8 sec)	
Push Button Lockout	Not available via push button	• Four-pulse the remote line 	• Push button is either enabled or disabled, depending on previous condition

Installation Notes

Align the sensor toward the object to be detected. Visually align if possible, or use the alignment device accessory listed in *Additional Accessories* on page 9.

Specifications

Temperature Measurement Range
0º to 300º C (32º to 572º F) standard; custom ranges available

Sensing Range
Depends on object size and sensing field of view (see *Sensing Field of View* on page 2)

Wavelength
8 to 14 µm

Distance to Spot Size (D:S) Ratio
6:1, 8:1, or 14:1, depending on model

Supply Voltage
12 to 30V dc (10% maximum ripple) @ less than 35 mA (exclusive of load)

Output Configuration
Analog: 0-10V or 4-20 mA, depending on model
Alarm: PNP (current sourcing)

Output Protection
Protected against short circuit conditions

Output Ratings
Analog Voltage: 2.5 kΩ minimum load resistance
Analog Current: 1 kΩ max. @ 24V input; max. load resistance = [(Vcc - 4)/0.02]Ω
For current output (4-20mA models): Ideal results are achieved when the total load resistance R = [(Vin - 4)/0.02]Ω. **Example**, at Vin = 24 V dc, R ~= 1kΩ (1 watt)
Alarm: Off-state leakage: < 10 microamps; **Saturation:** < 1.2 V @ 10 mA and < 1.6V @ 100 mA

Delay at Power-Up
1.5 seconds

Output Response Time
75 ms (for a 95% step change)

Repeatability
± 1% of measurement, or ± 1º C, whichever is greater

Minimum Taught Differential
10º C

Linearity
From 0º to 50º C: ±2ºC
From 50º to 300º C: ±1ºC or ±1%, whichever is greater

Adjustments
TEACH-Mode programming

Indicators
One bicolor (Green/Red) status LED, one Yellow LED (see *Status Indicators* on page 4)

Remote Teach Input
Impedance: 3 kΩ minimum load resistance

Construction
Threaded Barrel: 304 stainless steel
Push Button Housing: ABS/PC
Push Button: Santoprene
Lightpipes: Acrylic

Operating Conditions
Temperature: -20º to +70º C (-4º to 158º F)

Environmental Rating
Leakproof design is rated IEC IP67; NEMA 6

Temperature Warm-Up Time
5 minutes

Certifications
CE for voltage models (M18TU..)
Current models (M18TI..) are pending CE

Application Note

Following are examples of materials with high and low emissivity. (Many more examples can be found in sources such as the Internet.)

Sensor-Friendly Materials (High Emissivity)

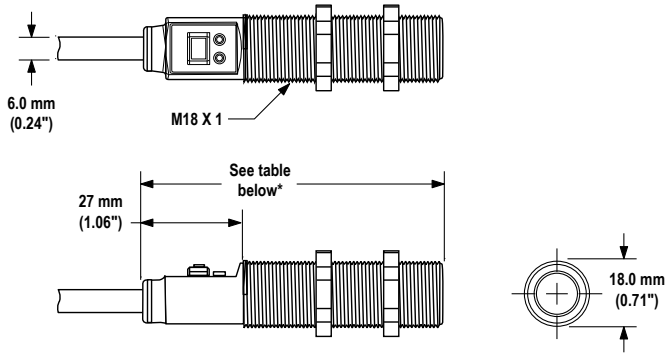
- Aluminum - anodized
- Asphalt
- Brick
- Carbon - lampblack or plate material
- Cardboard - corrugated or chipboard
- Concrete
- Glass - smooth, lead, or borosilicate (e.g., Pyrex®)
- Gypsum (including finished boards)
- Ice
- Iron and steel (except bright galvanized)
- Paper - most types, regardless of color
- Styrofoam® insulation
- Plastics
- Water
- Wood
- Rubber (e.g., tires)

Materials to Sense with Caution (Low Emissivity - Test, Test, Test!)

- Aluminum - plain or highly polished
- Copper
- Galvanized iron
- Stainless steel
- Vapor-deposited materials

Dimensions

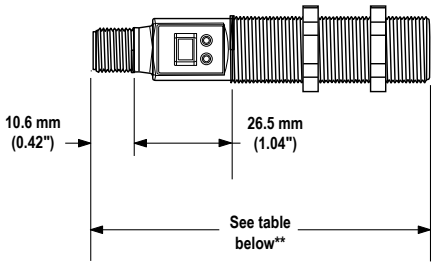
Cabled Models



*Overall Length

Model M18T..8	81.2 mm (3.20")
Model M18T..6E	81.7 mm (3.22")
Model M18T..14	86.5 mm (3.41")

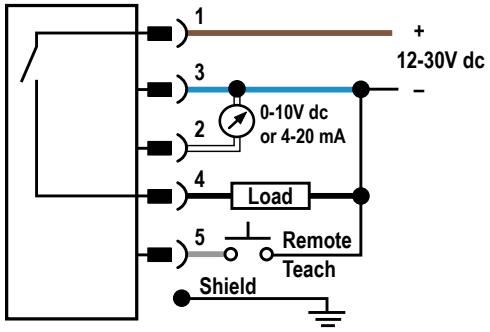
QD Models



**Overall Length

Model M18T..8Q	91.3 mm (3.59")
Model M18T..6EQ	91.8 mm (3.61")
Model M18T..14Q	96.6 mm (3.80")

Hookups

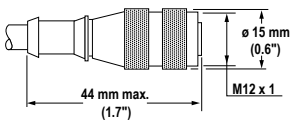
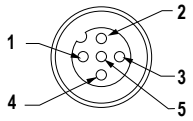
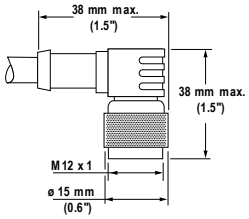


Cable and QD hookups are functionally identical.

NOTE: It is recommended that the shield wire be connected to earth ground or dc common. Shielded cord-sets are recommended for all QD models.

Accessories

Quick-Disconnect Cables

Style	Model	Length	Dimensions	Pinout
5-pin Euro-style straight, with shield	MQDEC2-506	2 m (6.5')		 1 = Brown 2 = White 3 = Blue 4 = Black 5 = Gray
	MQDEC2-515	5 m (15')		
	MQDEC2-530	9 m (30')		
5-pin Euro-style right-angle, with shield	MQDEC2-506RA	2 m (6.5')		
	MQDEC2-515RA	5 m (15')		
	MQDEC2-530RA	9 m (30')		

Accessory Mounting Brackets

Model	Description	
SMB18A	• 12-gauge, stainless steel, right-angle mounting bracket with a curved mounting slot for versatility and orientation • Clearance for M4 (#8) hardware	
SMB18SF	• 18 mm swivel bracket • Black thermoplastic polyester • Includes stainless steel hardware	
SMB18UR	• 2-piece universal 18 mm swivel bracket • 300 series stainless steel • Includes stainless steel swivel locking hardware	

Additional Accessories

Air-Purge Collar
APC-18

- Positive air pressure prevents water, dust, and other air-borne contaminants from collecting on the sensor face.
- Air flow helps cool sensors affected by ambient heat in the sensing environment.
- Works with many of Banner's 18 mm threaded-barrel photoelectric and temperature sensors.

Note: Because air temperature affects the speed of sound, the Collar should not be used with ultrasonic sensors.

Laser Alignment Tool
LAT1812

- Enables easy sensor alignment at long distances.
- Kit includes one SMB1812 bracket and M12 laser emitter.
- Thread bracket housing onto barrel of mounted sensor; M12 laser emitter inserted into housing provides a precise laser spot for aiming temperature sensor. (Refer to Banner data sheet p/n 122529 for more information.)
- Remove laser emitter before using sensor.

Banner Engineering Corp Limited Warranty

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