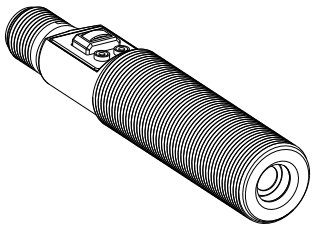
T-GAGE™ M18T Series Infrared Temperature Sensors

Datasheet

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

To view or download the latest technical information about this product, including specifications, dimensions, accessories, and wiring, see *http://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

WARNING: Not To Be Used for Personnel Protection

Never use this device as a sensing device for personnel protection. Doing so could lead to serious injury or death. This device 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.

Models

Model	Cable[1]	D:S Ratio	Sensing Face	Supply Voltage	Output
M18TUP8	5-wire, 2 m (6.5 ft) shielded cable	8:1	Integrated lens	12 to 30 V dc	0 to 10 V dc analog, plus PNP Alarm
M18TUP8Q	5-pin Euro-style integral QD				
M18TUP6E	5-wire, 2 m (6.5 ft) 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 ft) shielded cable	14:1	Germanium lens		
M18TUP14Q	5-pin, Euro-style integral QD				
M18TIP8	5-wire, 2 m (6.5 ft) shielded cable	8:1	Integrated lens		4 to 20 mA analog, plus PNP Alarm
M18TIP8Q	5-pin Euro-style integral QD				
M18TIP6E	5-wire, 2 m (6.5 ft) 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 ft) shielded cable	14:1	Germanium lens		
M18TIP14Q	5-pin, Euro-style integral QD				

[1] To order the 9 m (30 ft) cable model, add the suffix "W/30" to the cabled model number. For example, M18TUP8 W/30. Models with a quick disconnect require a mating cordset.See *Quick-Disconnect Cables* on page 7 for more information.

Overview

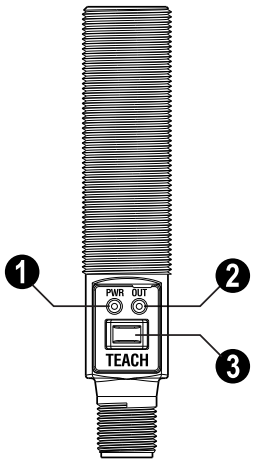
The T-GAGE analog sensor is a passive, non-contacting, temperature-based device. It is used to detect object(s) temperature within a sensing window and output a proportional voltage or current.

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* 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.

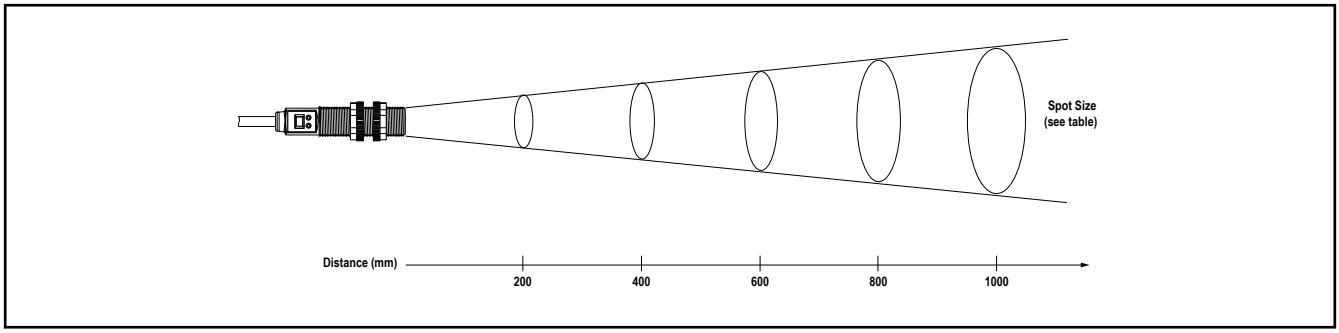


1 Power/Teach LED
2 Alarm Output LED
3 TEACH Push Button

Figure 1. Sensor Features

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* 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 7).

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* 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* 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.

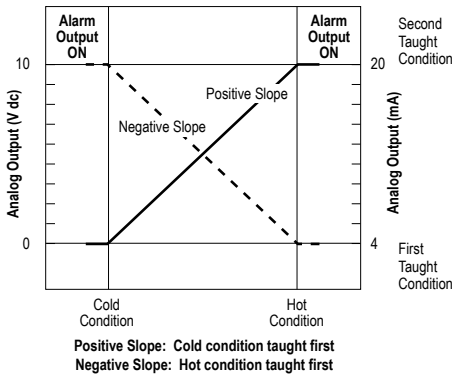
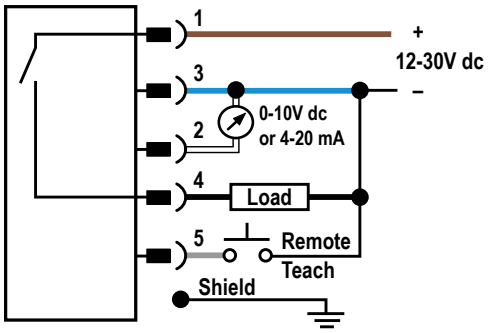


Figure 3. Analog/Alarm outputs as a function of taught conditions

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 8.

Wiring Diagram



Cable and QD hookups are functionally identical.

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

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 Amber	Run Mode: Alarm output is energized TEACH Mode: Waiting for Null condition
Flashing Amber	Dynamic TEACH active

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

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 (0 V or 4 mA) 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 returns to RUN mode if the first TEACH condition is not registered within 60 seconds
- After the first limit is taught, the sensor remains in PROGRAM mode until the TEACH sequence is finished

1. Enter Programming Mode.

Method	Action	Result
Push Button	Press and hold the push button for 2 seconds. 	• Power LED turns Red • Alarm LED turns ON
Remote Input[2]	No action required.	

2. Learn the Null Condition.

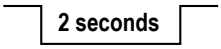
Method	Action	Result
Push Button	• Present the condition for Null output • Press the push button 	• Alarm LED turns OFF
Remote Input	• Present the condition for Null output • Single-pulse the remote line 	

3. Learn the Span Condition.

[2] 0.04 sec < T < 0.8 sec

Method	Action	Result
Push Button	• Present the condition for Span output • Press the push button 	Teach Accepted • Power LED turns Green • The sensor automatically sets the analog range and returns to Run mode Teach Not Accepted The sensor returns to the beginning of the Teach process.
Remote Input	• Present the condition for Span output • Single-pulse the remote line 	

4. Exit without saving, if desired.

Method	Action	Result
Push Button	Press and hold the push button for 2 seconds. 	The sensor returns to Run mode without saving new settings.
Remote Input	Hold the remote line low for 2 seconds. 	

Teaching Limits Using Dynamic TEACH

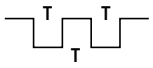
Dynamic TEACH is a method of setting the sensor's limits while the application is active. Dynamic TEACH will sense the high and low temperature limits of the process and automatically set the analog range between these limits.

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

1. Enter Programming mode.

Method	Action	Result
Push Button	Press and hold the push button for 2 seconds. 	• Power LED turns Red • Alarm LED turns OFF
Remote Input[3]	No action required.	

2. Enter the Dynamic TEACH process.

Method	Action	Result
Push Button	Double-click the push button. 	• The sensor begins the dynamic learning process • Alarm LED flashes Amber at 2 Hz
Remote Input	Double-pulse the remote line. 	

3. End the Dynamic TEACH process.

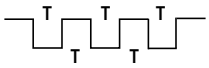
Method	Action	Result
Push Button	Press the push button one time. 	• Sensor ends data collection; sets Null and Span limits • Power LED turns Green • Sensor returns to Run mode
Remote Input	Single-pulse the remote line. 	

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.

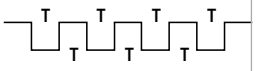
Change the output slope direction.

[3] (0.04 sec < T < 0.8 sec)

Method	Action	Result
Push Button	Not available via the push button.	The output slope changes from negative to positive or from positive to negative.
Remote Input[4]	Three-pulse the remote line. 	

Push Button Lockout

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

Method	Action	Result
Push Button	Not available via the push button.	The push button is either enabled or disabled, depending on the previous condition.
Remote Input[5]	Four-pulse the remote line. 	

Specifications

Temperature Measurement Range
0 °C to +300 °C (+32 °F to +572 °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 30 V dc (10% maximum ripple) at less than 35 mA (exclusive of load)

Output Configuration
Analog: 0 to 10 V or 4 to 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 maximum at 24 V 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 at 10 mA and < 1.6 V at 100 mA

Delay at Power-Up
1.5 seconds

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

Factory Defaults

Setting	Default
Taught Range[6]	−20 °C to +280 °C (−4 °F to +536 °F)
Slope	Positive
Alarm High Temp	+280 °C (+536 °F)
Alarm Lo Temp	+265 °C (+509 °F)
Alarm Offset	50%
Alarm Configuration	PNP
Alarm Delay	Off
Alarm Hold	Off
Push Button	Enabled

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

Minimum Taught Differential
10 °C

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

Adjustments
TEACH-Mode programming

Indicators
One bicolor (Green/Red) status LED, one Amber 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
−20 °C to +70 °C (−4 °F to +158 °F)

Environmental Rating
Leakproof design is rated IEC IP67; NEMA 6

Temperature Warm-Up Time
5 minutes

Certifications
CE

[4] 0.04 sec < T < 0.8 sec
[5] 0.04 sec < T < 0.8 sec
[6] For maximum measurement performance, Banner recommends that the Temperature Measurement Range is within the specified 0 °C to 300 °C (=32 °F to 572 °F).

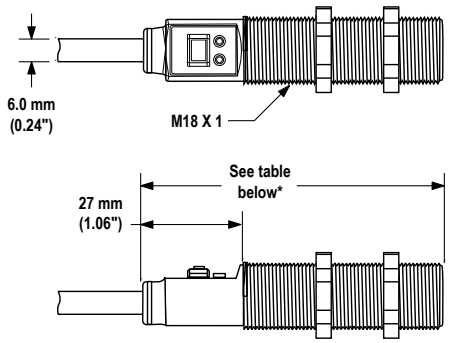
Application Note

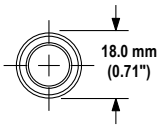
Following are examples of materials with high and low emissivity. (Many more examples can be found in sources such as the Internet.)

Sensor-Friendly Materials - (High Emissivity)		Materials to Sense with Caution - (Low Emissivity - Test, Test, Test!)
• 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)	• Aluminum - plain or highly polished • Copper • Galvanized iron • Stainless steel • Vapor-deposited materials

Dimensions

Cabled Models

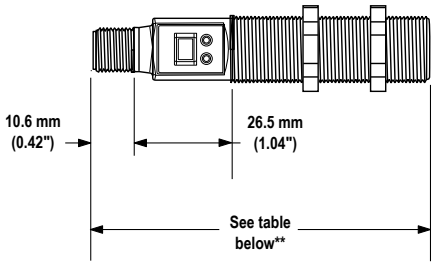




*Overall Length

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



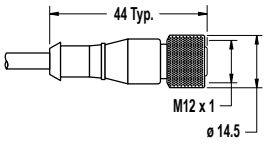
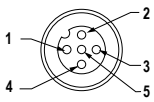
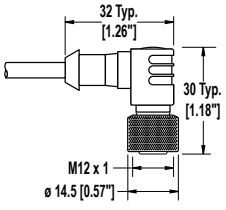
**Overall Length

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

Accessories

Quick-Disconnect Cables

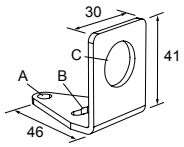
5-Pin Threaded M12/Euro-Style Cordsets—with Shield

Model	Length	Style	Dimensions	Pinout (Female)
MQDEC2-506	1.83 m (6 ft)	Straight		
MQDEC2-515	4.57 m (15 ft)			
MQDEC2-530	9.14 m (30 ft)			
MQDEC2-550	15.2 m (50 ft)			
MQDEC2-506RA	1.83 m (6 ft)	Right-Angle		1 = Brown 2 = White 3 = Blue 4 = Black 5 = Gray
MQDEC2-515RA	4.57 m (15 ft)			
MQDEC2-530RA	9.14 m (30 ft)			
MQDEC2-550RA	15.2 m (50 ft)			

Mounting Brackets

SMB18A

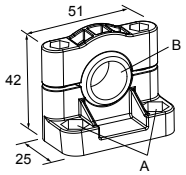
- Right-angle mounting bracket with a curved slot for versatile orientation
- 12-ga. stainless steel
- 18 mm sensor mounting hole
- Clearance for M4 (#8) hardware



Hole center spacing: A to B = 24.2
Hole size: A = ø 4.6, B = 17.0 × 4.6, C = ø 18.5

SMB18SF

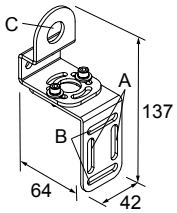
- 18 mm swivel bracket with M18 × 1 internal thread
- Black thermoplastic polyester
- Stainless steel swivel locking hardware included



Hole center spacing: A = 36.0
Hole size: A = ø 5.3, B = ø 18.0

SMB18UR

- 2-piece universal swivel bracket
- 300 series stainless steel
- Stainless steel swivel locking hardware included
- Mounting hole for 18 mm sensor



Hole center spacing: A = 25.4, B = 46.7
Hole size: B = 6.9 × 32.0, C = ø 18.3

Additional Accessories

Air-Purge Collar - APC-18

- Positive air pressure prevents water, dust, and other airborne 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

Banner Engineering Corp. warrants its products to be free from defects in material and workmanship for one year following the date of shipment. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture which, at the time it is returned to the factory, is found to have been defective during the warranty period. This warranty does not cover damage or liability for misuse, abuse, or the improper application or installation of the Banner product.

THIS LIMITED WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES WHETHER EXPRESS OR IMPLIED (INCLUDING, WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE), AND WHETHER ARISING UNDER COURSE OF PERFORMANCE, COURSE OF DEALING OR TRADE USAGE.

This Warranty is exclusive and limited to repair or, at the discretion of Banner Engineering Corp., replacement. IN NO EVENT SHALL BANNER ENGINEERING CORP. BE LIABLE TO BUYER OR ANY OTHER PERSON OR ENTITY FOR ANY EXTRA COSTS, EXPENSES, LOSSES, LOSS OF PROFITS, OR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES RESULTING FROM ANY PRODUCT DEFECT OR FROM THE USE OR INABILITY TO USE THE PRODUCT, WHETHER ARISING IN CONTRACT OR WARRANTY, STATUTE, TORT, STRICT LIABILITY, NEGLIGENCE, OR OTHERWISE.

Banner Engineering Corp. reserves the right to change, modify or improve the design of the product without assuming any obligations or liabilities relating to any product previously manufactured by Banner Engineering Corp. Any misuse, abuse, or improper application or installation of this product or use of the product for personal protection applications when the product is identified as not intended for such purposes will void the product warranty. Any modifications to this product without prior express approval by Banner Engineering Corp will void the product warranties. All specifications published in this document are subject to change; Banner reserves the right to modify product specifications or update documentation at any time. Specifications and product information in English supersede that which is provided in any other language. For the most recent version of any documentation, refer to: *www.bannerengineering.com*.

BANNER®
more sensors. more solutions