

TMCx-1D Data Sheet Generic Specifications	TMCx-1D series of Temperature Measuring line Cameras: The superior embedded combination of a MWIR sensitive line scanner and a visual spectrum IP-Camera							
	High temperature models with 3-stage or 2-stage TE-coolers (Thermo-Electric-coolers)				Low temperature models with 3-stage TE-coolers			
	TMC8-1DH3	TMC7-1DH3	TMC6-1DH3	TMC5-1DH3/H2	TMC4-1DH3/H2	TMC8-1DL3	TMC7-1DL3	TMC6-1DL3
1. Optical Properties.								
¹⁾ Resolution at 50% signal contrast.	0.8 mrad (1:1250)	1.3 mrad (1:770)	1.8 mrad (1:550)	2.2 mrad (1:450)	2.7 mrad (1:370)	2.0 mrad (1:500)	2.7 mrad (1:370)	3.3 mrad (1:300)
¹⁾ Resolution at 90% signal contrast.	2.0 mrad (1:500)	3.3 mrad (1:300)	4.5 mrad (1:220)	5.5 mrad (1:180)	6.7 mrad (1:150)	5.0 mrad (1:200)	6.7 mrad (1:150)	8.3 mrad (1:120)
Focusing range (working distance).	0.8m to infinity.		0.6m to infinity.		0.4m to infinity.		0.6m to infinity.	
Field Of View (useful FOV angle).	Standard GESOTEC video synchronization signal = 120° FOV(Factory preset). Selectable Agema/FLIR [®] -THPx compatible standards = 110° FOV (THP7) or 90° FOV (THP5/6).							
Optical entrance window design.	Solid VIS/IR-grade Sapphire or CaF2. Overall spectral transparency range 0.95>tau>0.85 (0.3µm-8µm). Special IP67 mounting frame with a 6° window tilt to reduce internal reflections.							
Integrated spectral optical filter.	Specific applications require suitable spectral optical filters with a corresponding optimized camera calibration to achieve best possible temperature measurement accuracy/repeatability.							
2. Temperature Measurement.								
²⁾ Typical measurement ranges.	+50°C to +600°C w/o spectral optical filter. +55°C to +1600°C overall range with suitable spectral optical filters.					0°C to +250°C w/o filter. Overall filter range: +10°C to +1100°C.		
²⁾ Optimized measurement ranges.	E.g. +75°C to +700°C for rotary cement kiln temperature monitoring with an "IRF2-type" spectral optical filter.					E.g. +80°C/+350°C for plastic thermoforming with a suitable filter.		
³⁾ Thermal sensitivity (NETD).	H3 models: <1.0°C at +75°C, <0.02°C at +500°C. H2 models: <3.0°C at +75°C, <0.1°C at +500°C.					L3 models: <1.0°C at 0°C, <0.02°C at +200°C.		
⁴⁾ Measurement accuracy >200°C.	H3 models: ±0.5% ±2.0°C. H2 models: ±1.0% ±2.0°C.					L3 models: ±0.5% ±0.5°C.		
⁴⁾ Measurement accuracy ≤200°C.	H3 models: ±3°C. H2 models: ±4°C.					L3 models: ±1.5°C.		
⁵⁾ Measurement repeatability.	H3 models: <±1°C. H2 models: <±2°C.					L3 models: <±1°C.		
3. Detector-Unit and Signal-I/O.								
IR-detector material, size.	H3 models: MCT, 100µm x 100µm. H2 models: MCT, 100µm x 100µm / PbSe 125µm x 125µm.					L3 models: MCT, 250µm x 250µm.		
TE-cooler design features.	H3/L3 models: 3-stage TE-cooler with a cold shield background limiting aperture. H2 models: 2-stage TE-cooler without a cold shield background limiting aperture.							
Spectral sensitivity/responsivity.	Two distinct MWIR detector responsivity characteristics "R1/R2" are available for the H3/L3 models to optimize the signal output for a particular application or spectral optical filter. Short wavelength range "R1": 2.2-4.5µm, response peak @ 3.9µm+/-5%. Long wavelength range "R2": 3.2µm-5.5µm, response peak @ 4.9µm+/-5%.							
"Scan-line-video" output signals.	DC coupled analog signals: +5VDC single ended, 10VDC differential. Line-sync signals: 120°/110°/90° scan-line, position encoder-channels "A/B/I", configurable PLL pixel clock.							
External analog input channels.	Four DC input channels (0-20mA, +5V, ±5V) multiplexed to factory preset free positions within the 360° scan cycle of the analog scan-line-video signal (e.g. pyrometers signals).							
⁶⁾ Embedded Ethernet/IP-camera.	Industrial type 1080p/720p resolution visual-spectrum IP-camera for early recognition of optical window contamination, supervision of proper camera alignment, detection of scan obstacles..							
4. Deflection-Unit (scan mirror/motor).								
Optical & mechanical features.	Design for best possible scan line position accuracy: Optical grade pentagon type rotating mirror. Ten adjustable counter-balance weights. High precision individual dynamic balancing.							
⁷⁾ Momentary scan line stability.	H3/L3 models: <±0.4 mrad. H2 models: <±0.6 mrad.							
⁷⁾ Absolute scan line accuracy.	H3/L3 models: <±0.8 mrad. H2 models: <±1.2 mrad.							
Scan motor assembly & MTBF.	Long-life brushless DC servo-motor. Precision high resolution optical position encoder. MTBF >90.000 hours at fp = 20Hz, ambient temperature -20°C to +50°C, upright position ±15°.							
Available scan frequency ranges.	Standard scan frequency range: 8Hz ≤ fx ≤ 30Hz (factory preset fp = 20Hz ±0.5%). Optional scan frequency ranges for H3 models: 30Hz-50Hz, 40Hz-60Hz, 60Hz-80Hz, 80Hz-100Hz.							
Scan frequency control/accuracy.	Digital ECDC motor controller. Frequency control via hall-sensor (H2 -models) or via optical position encoder (H3 models). Accuracy <±1% or <±0.5% of the frequency range high limit).							
5. PC interface options.								
Digital data-link motherboard.	ADC electronics with automatic scan speed synchronization of the pixel clock signal from a "precision optical encoder PLL". Up to 36.000 real-time 16bit pixels per 360° scan line cycle.							
PC interface modules m1/m2	m1 : SPI master type synchronous Serial-Peripheral-Interface. m2 : Industrial IoT-Ethernet transceiver. Data transmission at 10-1000Mbit/s via fiber-optic cable or via CAT7 type cable.							
Fiber optic cable specifications.	≥2x G50/125 multi-mode fiber (category OM2/OM3/OM4) or ≥2x E9/125 single-mode fiber (category OS1/OS2).							
6. Power Supply Requirements.								
Standard DC power-in requirements.	Single-Volt wide range input: 20VDC(1.5A) to 48VDC(0.6A), Ripple <1% p-p, Tolerances ±4%. Overvoltage/Overload protection. Ambient temperature range -40°C to +70°C.							
Optional DC power-in requirements.	Classic FLIR [®] Tri-Volt input: +5VDC(2A), +15VDC(1A), -15VDC(1A), Ripple <1% p-p, Tolerances ±4%. Overvoltage/Overload protection. Ambient temperature range -40°C to +70°C.							
7. Environment.								
³⁾ Ambient operating temperature.	H3 models: -30°C to +60°C (Option: -20°C to +70°C). H2 models: -20°C to +50°C (Option: -10°C to +60°C).					L3 models: -40°C to +50°C (Option: -35°C to +55°C).		
Ambient humidity.	Relative Humidity 10% ≤ RH ≤ 95% non-condensing, according to IEC 68-2-30 / MIL-STD-810E, Method 507.3							
Operating altitude.	≤4200m according to IEC 68-2-13 / MIL-STD-810E, Method 500.3							
Vibration & shock.	Vibration according to IEC 68-2-6 (3 directions): 5Hz-150Hz, 0.5g / 2g (operating / non-op.). Shock according to IEC 68-2-29 (1000 bumps): 5g / 25g (operating / non-operating).							
Storage & shipment.	Storage temperature range: -50°C to +85°C (+95°C for <6 hours). Storage altitude: ≤4200m. Storage relative humidity: 10% ≤ RH ≤ 90% (non-condensing).							
Standard environmental protection.	IP67/NEMA-4X for the solid type optical entrance windows VIS/IR-grade CaF2 or Sapphire. IP64 for "emergency repair IR-foil". Applicable Standards: DIN40050, EN60529, IEC529.							
Optional environmental protection.	Various solutions are available for extra camera protection and/or cooling and/or heating: Overall ambient operating temperature range -50°C to +180°C, IP11 to IP67, Ex II (ATEX).							
8. Dimensions (Size / Weight).								
Width x Hight x Depth / Weight.	270mm x 260mm x 170mm / ~8kg (standard large size housing for all TMCx-1D models). 270mm x 200mm x 170mm / ~8kg (optional small size housing for TMC4/5/6-1D models).							
9. Footnotes: Specifications are subject to change without prior notice.								
¹⁾ Typical values of the "Slit Response Function", regularly verified for each TMCx-1D line camera model: Signal contrast of 50% = "hot-spot detection". Signal contrast of 90% = "spot size for real temperature measurement".								
²⁾ Application related MWIR type spectral optical filters and optimized temperature measurement ranges must be specified with the initial purchase order. ³⁾ Operating temperatures ≥50°C and optical filters cause higher NETD values.								
⁴⁾ Valid for biennial standard laboratory instrument calibration with 8 traceable blackbody temperatures. ⁵⁾ Valid for annual workshop verification/re-calibration. Add ±1°C for biennial workshop verification/re-calibration.								
⁶⁾ A "marker line" in the IP-camera display indicates the actual scan line position on the object surface. ⁷⁾ Valid for annual workshop verification/re-calibration. Add ±0.1 mrad for biennial workshop verification/re-calibration.								