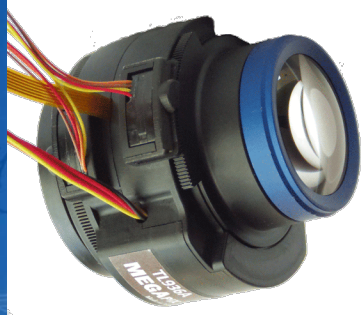


Theia TECHNOLOGIES

TL936 Motorized Telephoto
Day/Night 4K Compatible Megapixel Lens

9mm

36mm

- ✓ Compatible with 4K cameras (1/2.3” Sony IMX172 for example) with **5+ megapixel resolution** for demanding applications
- ✓ **Fully motorized versions**, or combinations with zoom, focus, iris, IR cut, and limit switch
- ✓ **4x zoom**: 9-36mm for long reach and field of view optimization
- ✓ Available in DC **auto-iris** and **P-iris** versions
- ✓ IR corrected for true **Day/Night** cameras
- ✓ **Compact** design (< 50mm TTL) to fit into domes as small as 4” mini-dome size
- ✓ CS-mount and smooth D25 board mount options
- ✓ For 1/3”, 1/2.7” HD, 1/2.5” and 1/2.3” 4K* sensors

TL936 lens family specifications

Focal length	9-36mm
Resolution	5+ megapixel
F/#	F/1.5 to close
IR Correction	Day/Night
Lens length	<50mm
Focus range	2.5m - infinity
Operating temperature	-20C to 60C (<70% humidity, non-condensing)
Storage temperature	-20C to 70C (<90% humidity, non-condensing)
CS mount slip range	320°

Field of view for sensor sizes

Sensor size	1/3”	1/2.7” HD	1/2.5”	1/2.3” 4K*
Field of view (H)	30° - 7.1°	37° - 8.6°	36° - 8.5°	39° - 10°
Field of view (V)	22° - 5.3°	20° - 4.8°	27° - 6.3°	19° - 5.0°
Field of view (D)	38° - 8.8°	42° - 9.9°	46° - 10.6°	44° - 11°

*4K format 4000x2000 pixels

Lens designation

TL936x xx -xx

blank: CS mount
25: smooth Ø25mm mount

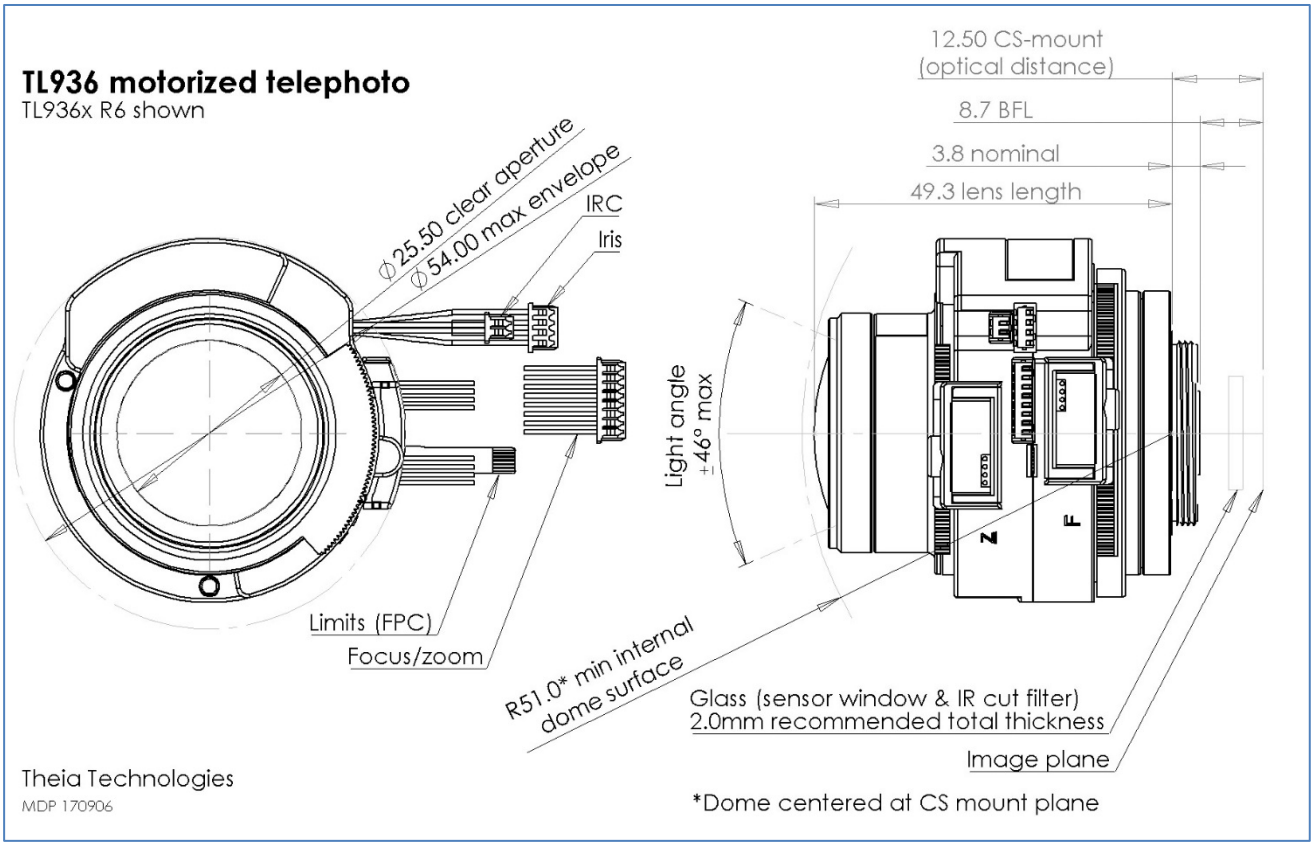
A: autoiris
P: P-iris

R3: motorized zoom, focus, iris
R4: motorized zoom, focus, iris, IRC
R5: motorized zoom, focus, iris, with limit switch for zoom, focus limits
R6: motorized zoom, focus, iris, IRC, with limit switch for zoom, focus limits

Production versions (call for other version)**:**

TL936A R6	TL936P R6	TL936P R6 25
TL936A R5		
TL936A R4	TL936P R4	
	TL936P R3	

Other versions are available by special request and may be added to regular production depending on volume.



Zoom/Focus motor specifications

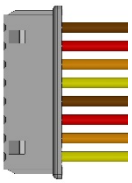
Drive	Stepper motor 2 phase bipolar drive
Operation voltage	3.3V (operating range 2.6~4.8V)
Maximum continuous operation time (seconds) for operation voltage and ambient temperature	
Coil resistance	28.5Ω ±7%
Gear ratio	1:2308
Zoom number of steps	2994 steps between hard stops
Zoom speed range	600pps to 1000pps*
Zoom cam rotation	57°
Focus number of steps	5180 steps between hard stops
Focus speed range	600pps to 1000pps*
Focus cam rotation	101°
Focus/zoom connectors	Housing: Molex 51021-0800 Terminal: Molex 50058-8000
Cable length	150mm

	3.3V	4.0V	4.8V
20C	60s	12s	6s
40C	35s	9s	5s
60C	20s	6s	4s

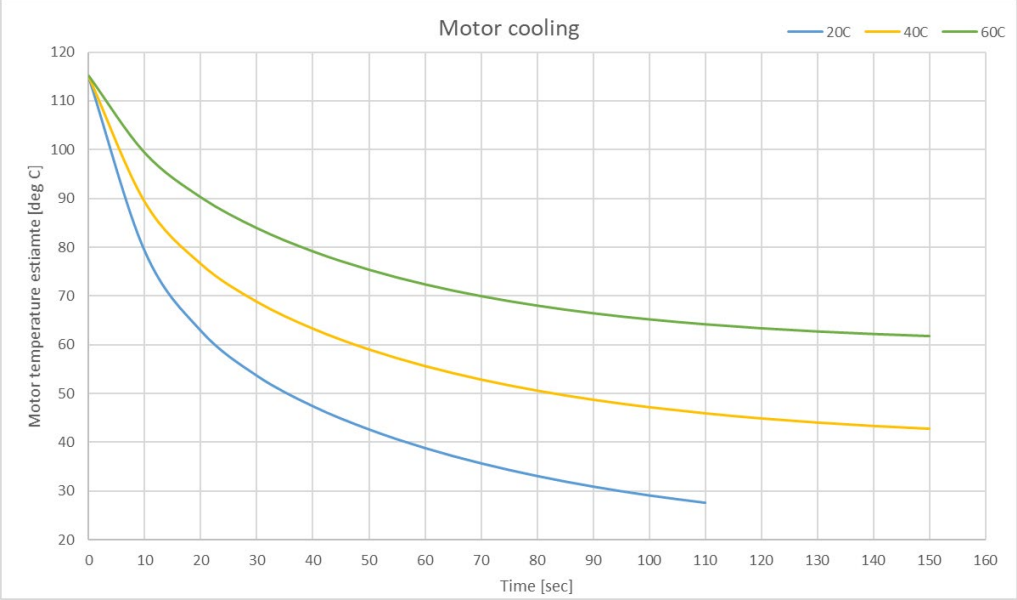
Zoom: Wide -> Tele
Focus: Near -> ∞

Step	A+	A-	B+	B-
0	H	L	H	L
1	L	H	H	L
2	L	H	L	H
3	H	L	L	H

Pin	Color	Function	Motor
1	Brown	A+	Focus
2	Red	A-	Focus
3	Gray	B+	Focus
4	Yellow	B-	Focus
5	Brown	A+	Zoom
6	Red	A-	Zoom
7	Gray	B+	Zoom
8	Yellow	B-	Zoom



*Do not let motor temperature exceed 115°C
Measuring motor temperature is difficult due to the degree of motor integration. Temperature can be estimated based on the maximum operation times. The graph below shows the time for motors to cool to ambient temperature.

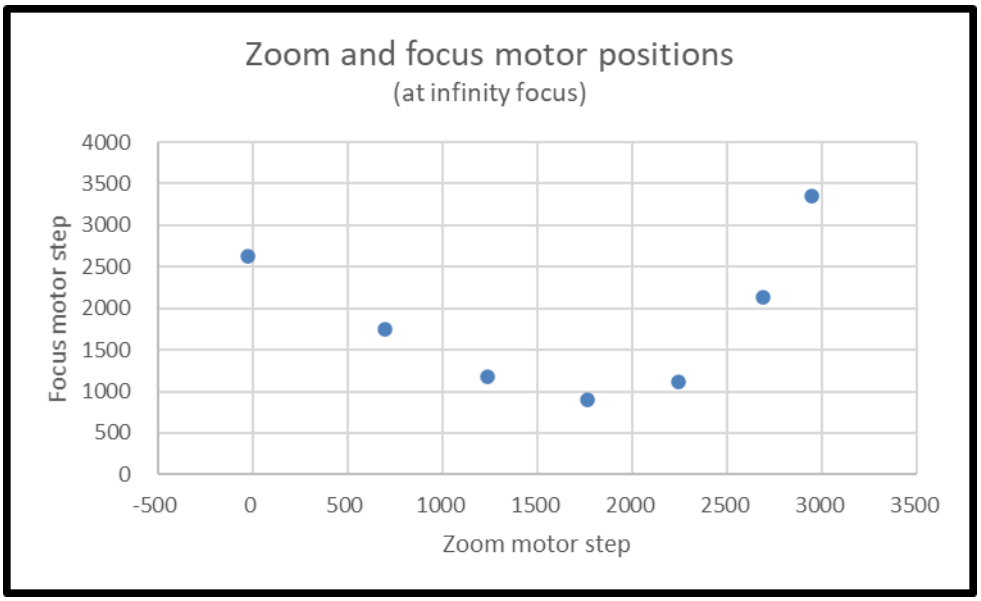


Zoom/Focus motor step map (at infinite focus position)

Zoom motor			***Focus motor***		
Note	*Step (-R5, -R6)*	*Step (-R3, -R4)*	*Note*	*Step (-R5, -R6)*	*Step (-R3, -R4)*
Hard stop (wide)	-36	0	Hard stop (far)	-52	0
Wide design position	-26	10	Far focus design	-26	26
PI (1) position	0	NA	PI (1) position	0	NA
PI (2) position	2923	NA	PI (2) position	5077	NA
Tele design position	2949	2985	Near focus design	5103	5155
Hard stop (tele)	2959	2995	Hard stop (near)	5129	5181

Zoom/Focus synchronizing map (step numbers based on -R5, -R6 lenses, observe min/max motor speeds)

Focal length	***Zoom motor note***	***Zoom motor step number***	***Focus motor step number***
[mm]		*[#]*	*[#]*
9.27	Wide end	-26	2631
12.19		696	1743
15.3		1238	1186
19.47		1764	898
24.56		2245	1117
30.86		2689	2138
35.45	Tele end	2949	3353



Notes:

1. Zoom and focus **motor positions may be affected** by backlash and lost steps during movement. Zoom motor lost steps are tested to <20 over the full 2923 step range. Focus motor lost steps are tested to <20 over the full 5077 step range.

2. These motorized lenses are intended for integration into cameras and require motor drivers and controllers. Typically, Theia works with the camera manufacturer to ensure that the camera motor controller matches the lens. It is possible to supply your own motor controller, but Theia cannot guarantee that your motor controller will not damage the lens. Theia does not offer any warranty on the suitability of these motorized lenses for any particular camera. These motorized lenses are **not intended for continuous use** of the motors as in PTZ applications. Theia offers motor control boards that are suitable to control motorized lenses with P-iris.

DC autoiris motor specifications

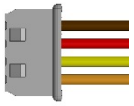
Applicable models: TL936Axx

Drive	DC
Operation voltage	3V (2.5~5.0V)
Max current consumption	26mA
Drive coil resistance	190Ω ±10%
Damper coil resistance	855Ω ±7%

Applicable models: **TL936A R4, TL936A R6**

Connector type 1	Molex
Connector type	Housing: Molex 51021-0400 Terminal: Molex 50058-8000
Cable length	150mm

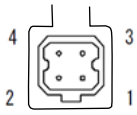
Pin	Color	Function
1	Brown	Control -
2	Red	Control +
3	Yellow	Drive +
4	Orange	Drive -



Applicable models: **TL936A R3, TL936A R5**

Connector type 2	CCTV
Connector type	Housing: EYC 221
Cable length	300mm

Pin	Function
1	Control -
2	Control +
3	Drive +
4	Drive -



P-iris motor specifications

Applicable models: TL936Pxx

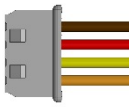
Drive	Stepper motor 2 phase bipolar drive
Operating voltage	4V (2.7~5.0V)
Number of steps	Step 1: stop Step 2: Full open Step 72: Full close Step 75: stop
Basic step angle	18°
Maximum response freq.	200 pps
Coil resistance	30Ω ±10% (each phase)

P-iris: open->close				
Step	A+	A-	B+	B-
0	H	L	H	L
1	L	H	H	L
2	L	H	L	H
3	H	L	L	H

Applicable models: **TL936P R4, TL936P R6**

Connector type 1	Molex
Connector type	Housing: Molex 51021-0400 Terminal: Molex 50058-8000
Cable length	150mm

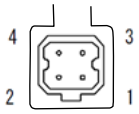
Pin	Color	Function
1	Brown	B+
2	Red	B-
3	Yellow	A+
4	Orange	A-



Applicable models: **TL936P R3, TL936P R5**

Connector type 2	CCTV
Connector type	Housing: EYC 221
Cable length	300mm

Pin	Function
1	B+
2	A+
3	A-
4	B-



P-iris motor map

Step	Aperture Size [mm2]	F/#
1	95.0	1.54
5	90.8	1.54
10	82.1	1.61
15	72.8	1.71
20	63.4	1.83
25	54.0	1.98
30	44.9	2.17
35	36.0	2.42

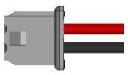
Step	Aperture Size [mm2]	F/#
40	27.7	2.76
45	20.0	3.24
50	13.2	3.98
55	7.5	5.30
60	3.1	8.20
65	0.8	15.71
70	0.1	56.29
72	0.0	Closed

IR Cut specifications

Applicable models: TL936A R4, TL936A R6, TL936P R4, TL936P R6

Electrical specifications	
Drive	DC
Operating voltage	4.0V
Drive coil resistance	130Ω ±10%
Connector type	Housing: Molex 51021-0200 Terminal: Molex 50058-8000
Cable length	150mm
Optical specifications for IR filter (Day)	
Cut-on wavelength	405nm ±10nm
Visible transmission	430-610nm
Cut-off wavelength	650nm ±10nm
IR transmission	<5% max 700-1000nm <10% ave 1000-1100nm
Optical specifications for clear filter (Night)	
Visible transmission	400-1050nm

Mode	Pin 1	Pin 2
Day (IR filter)	L	H
Night (clear filter)	H	L
Wire color	Red	Black



Zoom/Focus limit switch

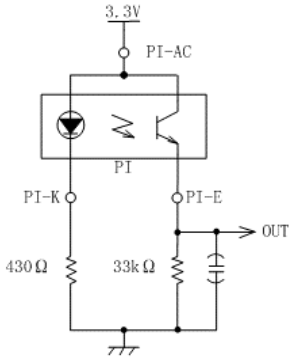
Applicable models: TL936A R5, TL936A R6, TL936P R5, TL936P R6

Type	Photo interrupter phototransistor
Part model	Sharp GP1S396HCPSF
Operating voltage	3.3V
Output level	>2.2V HIGH <0.6V LOW
Connector type	FPC cable
Board-side mating connector type (not supplied)	Molex 52746-0671 Molex 52745-0697 Molex 52559-0652
Cable length	90mm

Pin*	Function	Motor
1	Emitter	Focus
2	Anode/Collector	
3	Cathode	
4	Emitter	Zoom
5	Anode/Collector	
6	Cathode	

*cable side pin designation matches Molex 52746-0671 connector (contacts on bottom)

Recommended circuit for each photo interrupter



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Revisions

Version	Change	Reason
160104	Changed DC iris damper coil resistance	Corrected error
	Changed IR cut pin-out	Changed to match industry standard
	Updated production version list	Added new models
160113	Added motor energizing time maximums	Clarification to prevent focus/zoom motor overheating
	Updated temperature spec	Consistent with motor supplier specification
161107	Changed drawing	Added 2mm glass to drawing
170109	Changed PI FPC pin-out	To match bottom side contacts connector; top side connector may have been discontinued
170906	Added pictures and drawings of different lens versions	
180117	Corrected FPC pinout	Pinout numbering was reversed
181206	Motor speed	Updated focus/zoom motor speeds, recommended speeds were not specified. Updated P-iris speed
	Added QR code	Linked to TL936 webpage
200106	Added page number and revision in footer	Revision control
200306	Added Z/F motor step note	Motor position accuracy not previously specified
	Updated motor speed specs	Focus/zoom recommended speed too high, adjusted to tested range
	Zoom/focus map	Changed the map to be more clear and corrected zoom step errors in the table
200327	Added motor cooling graph	New information
	Highlighted model numbers	Clarified which specification sections are applicable to different family members