Theia®
TECHNOLOGIES

4K
12 MEGApix

DAY NIGHT

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4K Megapixel Resolution Lenses
Fully Motorized
Compact Size
Superior Day/Night Correction

www.TheiaTech.com

TL410 family
4K Resolution Day/Night lenses up to 1/1.7” sensors

- ✓ **Ultra high resolution for 4K cameras**, up to 12.4 megapixel
- ✓ Available in DC **auto-iris**, **P-iris,** and **manual iris** versions
- ✓ **Fully motorized versions**, or combinations with zoom, focus, iris, IR cut, limit switch; non-motorized versions also available
- ✓ IR corrected for true **Day/Night** cameras
- ✓ **Compact design** to fit into domes as small as 4” mini-dome size
- ✓ **CS-mount** and smooth **D25 board mount** options, as well as **C-mount**
- ✓ Used for sensor sizes 1/2.5”, 1/2.3”,1/ 2” 1/1.8”, and **up to 1/1.7”** (Sony IMX178, Sony IMX226 for example)

TL410 lens family specifications

Focal length	4-10mm
Image circle	Ø9.4mm
Resolution	12.4 megapixel
F/#	F/1.4 @ 4mm – F/2.4 @ 10mm to close
Focus Range	0.5m to infinity
IR Correction	Day/Night
Lens length	< 64mm TTL
Back focal length	BFL 8.4mm (in air)
CRA	< 7°
Distortion	< 61% at 4mm, < 8% at 10mm
Relative illumination	>45%
Lens transmission	>80%
Weight	69-78g (depending on version)
Operating temperature	-20C to 60C (<70% humidity, non-condensing)
Storage temperature	-30C to 70C (<90% humidity, non-condensing)

Field of view for sensor sizes

Sensor size	1/1.7”	1/1.8”	1/1.8” 4K*	1/2”	1/2.3”	1/2.5”
Horizontal	112° - 44°	110° - 43°	110° - 43°	93° - 37°	90° - 36°	83° - 33°
Vertical	81° - 33°	71° - 29°	52° - 21°	68° - 28°	67° - 27°	60° - 25°
Diagonal	149° - 55°	139° - 52°	126° - 48°	120° - 46°	117° - 45°	106° - 42°

*4K format = 4000 x 2000 pixels

Lens designation

xx410x xx -xx

CS: CS mount
D25: smooth Ø25mm mount

TL: motorized
SL: non-motorized
ML: C mount

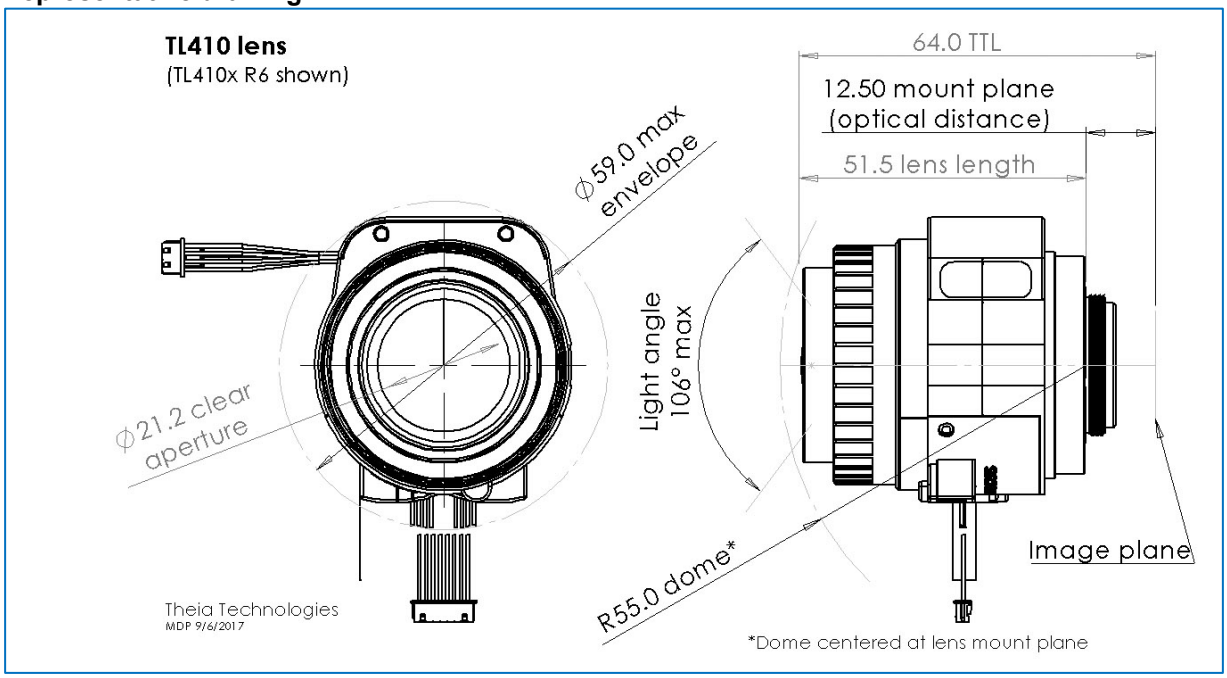
A: autoiris
P: P-iris
M: manual iris

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 versions)
SL410M (manual lens, manual iris, CS mount)
SL410A (manual lens, DC autoiris, CS mount)
SL410P (manual lens, P-iris, CS mount)
ML410M (manual lens, manual iris, C mount)
TL410A R6-CS (fully motorized, DC autoiris lens)
TL410P R6-CS (fully motorized, P-iris lens)
TL410P R6-25 (fully motorized, P-iris, D25 mount)

Other versions are available by special request and may

Representative drawing



Zoom/Focus motor specifications (TL410)

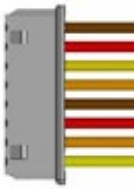
Drive	Stepper motor 2 phase bipolar drive
Operation voltage	3.3V (operating range 2.6~4.8V)
Maximum continuous operation time (seconds) for operation voltage and ambient temperature*	3.3V / 4.0V / 4.8V 20C: 200s / 90s / 50s 40C: 100s / 60s / 30s 60C: 40s / 30s / 15s
Coil resistance	28.5Ω (±7%)
Gear ratio	1:2025
Zoom number of steps	4073 steps between hard stops
Zoom speed range	600pps to 1000pps*
Zoom cam rotation	85°
Focus number of steps	9354 steps between hard stops
Focus speed range	600pps to 1000pps*
Focus cam rotation	196°
Focus/zoom connectors	Housing: Molex 51021-0800 Terminal: Molex 50058-8000
Cable length	150mm

*Do not let motor temperature exceed 92°C. Download Theia's motor temperature calculator at bit.ly/motorTemp

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	Yellow	B+	Focus
4	Gray/Orange	B-	Focus
5	Brown	A+	Zoom
6	Red	A-	Zoom
7	Gray/Orange	B+	Zoom
8	Yellow	B-	Zoom

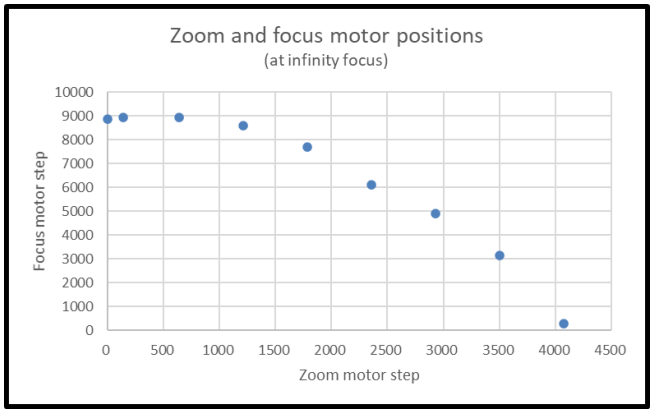


Zoom/Focus motor step map (at infinite focus position). PI positions only available with -R5 and -R6 lenses.

Zoom motor		*Focus motor*	
Note	*Step*	*Note*	*Step*
Hard stop (wide)	4073	Hard stop (far)	9353
Wide design position	4073	Far focus design	8771
PI position	154	PI position	8652
Tele design position	0	Near focus design	188
Hard stop (tele)	0	Hard stop (near)	0

Zoom/Focus synchronizing map (observe min/max motor speeds)

Focal length	*Zoom motor note*	*Zoom motor step number*	*Focus ring note*	*Focus motor step number*
[mm]		*[#]*		*[#]*
4.15	Wide end	4073		288
4.96		3501		3149
5.77		2929		4892
6.58		2356		6125
7.39		1784		7687
8.19		1212		8599
9.00		640		8960
9.70		139		8931
9.90	Tele end	0		8871



Notes:

1. Zoom and focus **motor positions may be affected** by backlash and lost steps during movement. Zoom motor lost steps are tested to <45 over the full 3934 step range. Focus motor lost steps are tested to <30 over the full 8464 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.

TL1250 family
4K Resolution Day/Night lenses for 1/1.7” sensors

- ✓ **Ultra high resolution for 4K cameras**, up to 12.4 megapixel
- ✓ Available in DC **autoiris**, **P-iris,** and **manual iris** versions
- ✓ **Fully motorized versions**, or combinations with zoom, focus, iris, IR cut, limit switch; non-motorized versions also available
- ✓ IR corrected for true **Day/Night** cameras
- ✓ **Compact design** to fit into domes as small as 4” mini-dome size
- ✓ **CS-mount** and smooth **D25 board mount** options
- ✓ Used for sensor sizes 1/2.5”, 1/2.3”, 1/2" 1/1.8”, and **up to 1/1.7”** (Sony IMX178, Sony IMX226 for example)

TL1250 lens family specifications

Focal length	12-50mm
Image circle	Up to Ø9.4mm
Resolution	12.4 megapixel
F/#	F/1.8 @ 12mm - F/2.4 @ 50mm to close
IR Correction	Day/Night
Focus Range	2.0m - infinity
Lens length	< 64mm TTL
Back focal length	BFL 8.2mm (in air)
CRA	< 7°
Distortion	< 10% at 12mm, < 2% at 50mm
Relative illumination	>40%
Lens transmission	>80%
Weight	TBD
Operating temperature	-20C to 60C (<70% humidity, non-condensing)
Storage temperature	-30C to 70C (<90% humidity, non-condensing)

Field of view for sensor sizes

Sensor size	1/1.7”	1/1.8”	1/1.8” 4K*	1/2”	1/2.3”	1/2.5”
Horizontal	36° - 8.6°	36° - 8.6°	35° - 8.5°	30° - 7.4°	30° - 7.2°	27° - 6.7°
Vertical	26° - 6.5°	23° - 5.8°	17° - 4.3°	23° - 5.6°	22° - 5.5°	20° - 5.0°
Diagonal	46° - 11°	44° - 10°	40° - 9.5°	39° - 9.2°	38° - 9°	34° - 8.3°

*4K format = 4000 x 2000 pixels

Lens designation

xx1250x xx -xx

Blank or CS: CS mount
D25: smooth Ø25mm mount

TL: motorized
SL: non-motorized

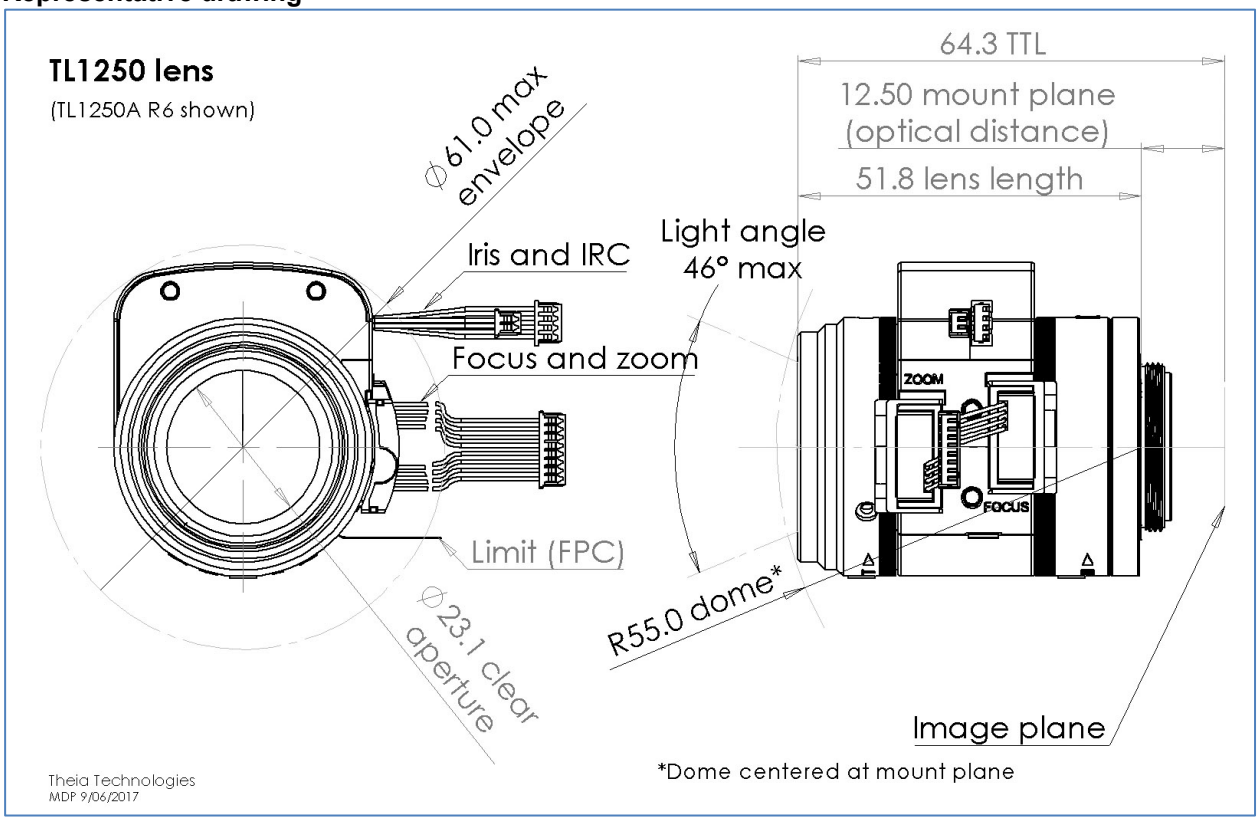
A: autoiris
P: P-iris
M: manual iris

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 versions)
SL1250M (manual lens, manual iris, CS mount)
SL1250A (manual lens, DC autoiris, CS mount)
SL1250P (manual lens, P-iris, CS mount)
TL1250AR6-CS (fully motorized, DC autoiris lens)
TL1250PR6-CS (fully motorized, P-iris lens)
TL1250PR6-25 (fully motorized, P-iris lens, D25 mount)

Other versions are available by special request and may be added to regular production

Representative drawing



Zoom/Focus motor specifications (TL1250)

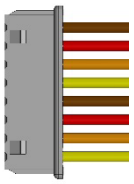
Drive	Stepper motor 2 phase bipolar drive
Operation voltage	3.3V (operating range 2.6~4.8V)
Maximum continuous operation time (seconds) for operation voltage and ambient temperature*	3.3V / 4.0V / 4.8V 20C: 200s / 90s / 50s 40C: 100s / 60s / 30s 60C: 40s / 30s / 15s
Coil resistance	28.5Ω (±7%)
Gear ratio	1:1954
Zoom number of steps	3256 steps between hard stops
Zoom speed range	600pps to 1000pps*
Zoom cam rotation	75°
Focus number of steps	8467 steps between hard stops
Focus speed range	600pps to 1000pps*
Focus cam rotation	195°
Focus/zoom connectors	Housing: Molex 51021-0800 Terminal: Molex 50058-8000
Cable length	150mm

*Do not let motor temperature exceed 92°C. Download Theia's motor temperature calculator at bit.ly/motorTemp

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	Orange	B+	Focus
4	Yellow	B-	Focus
5	Brown	A+	Zoom
6	Red	A-	Zoom
7	Orange	B+	Zoom
8	Yellow	B-	Zoom

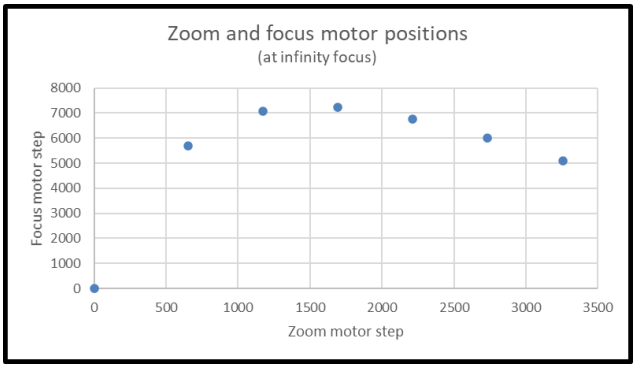


Zoom/Focus motor step map (at infinite focus position). PI positions only available with -R5 and -R6 lenses.

Zoom motor		***Focus motor***	
Note	*Step*	*Note*	*Step*
Hard stop (wide)	3256	Hard stop (far)	8466
Wide design position	3256	Far focus design	8140
PI position	3147	PI position	8031
Tele design position	0	Near focus design	326
Hard stop (tele)	0	Hard stop (near)	0

Zoom/Focus synchronizing map (observe min/max motor speeds)

Focal length	***Zoom motor note***	***Zoom motor step number***	***Focus motor note***	***Focus motor step number***
[mm]		*[#]*		*[#]*
12.36	Wide end	3256		5104
14.83		2735		6007
18.05		2214		6776
22.28		1693		7241
27.86		1172		7080
35.20		651		5687
49.00	Tele end	0		0



Notes:

1. Zoom and focus **motor positions may be affected** by backlash and lost steps during movement. Zoom motor lost steps are tested to <40 over the full 3147 step range. Focus motor lost steps are tested to <45 over the full 7705 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.

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 or CS: CS mount
D25: smooth Ø25mm mount

A: autoiris
P: P-iris

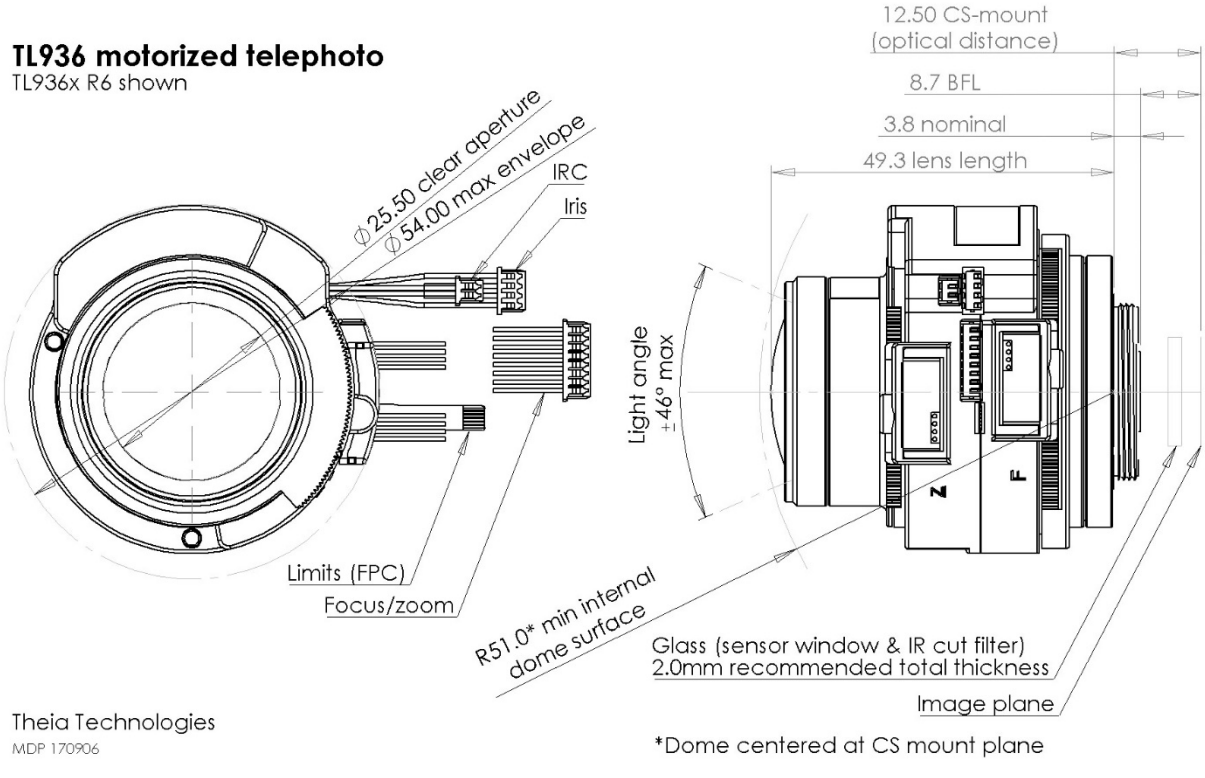
R3: motorized zoom, focus, iris
R4: motorized zoom, focus, iris, IRC
R5: motorized zoom, focus, iris, with limit switch for zoom, focus limits
R6: motorized zoom, focus, iris, IRC, with limit switch for zoom, focus limits

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.

Representative drawing



Zoom/Focus motor specifications (TL936)

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*	

	3.3V	4.0V	4.8V
20C	200s	90s	50s
40C	100s	60s	30s
60C	40s	30s	15s

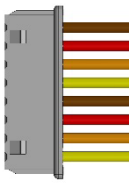
Coil resistance	28.5Ω ±7%
Gear ratio	1:2308
Zoom number of steps	2994 steps between hard stops
Zoom speed range	600pps to 1000pps*
Zoom cam rotation	57°
Focus number of steps	5180 steps between hard stops
Focus speed range	600pps to 1000pps*
Focus cam rotation	100°
Focus/zoom connectors	Housing: Molex 51021-0800 Terminal: Molex 50058-8000
Cable length	150mm

*Do not let motor temperature exceed 92°C. Download Theia's motor temperature calculator at bit.ly/motorTemp

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

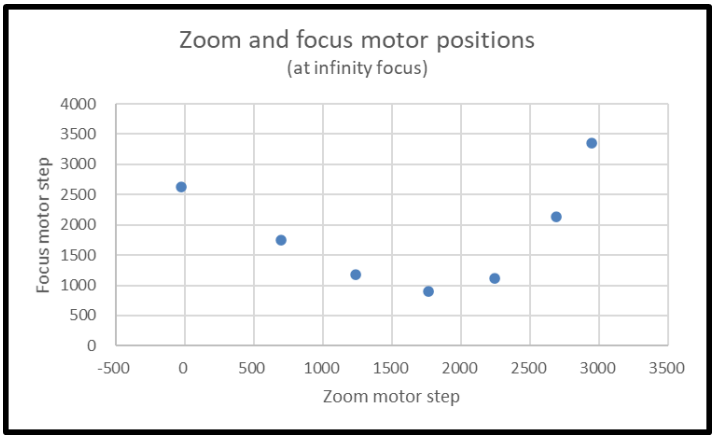


Zoom/Focus motor step map (at infinite focus position)

	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.

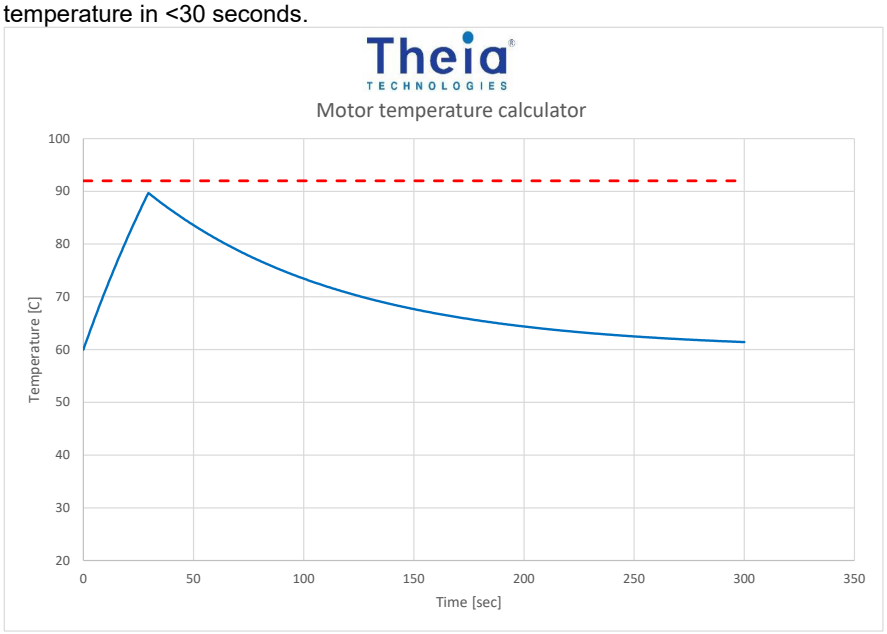
Common motor specifications
For all motorized lenses

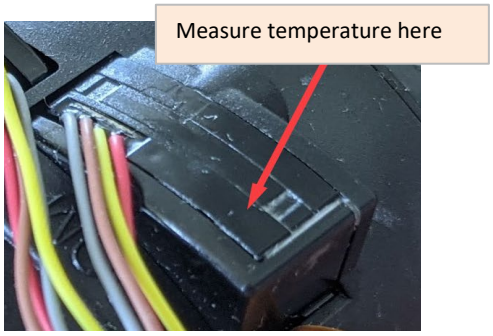
*Do not let motor temperature exceed 92°C.

Theia's motor temperature calculator can be used to estimate the focus and zoom motor temperatures after a set number of run/ cool down cycles. This can be downloaded from Theia's website (see the QR code below).

Motors require 5 minutes to cool down completely to ambient temperature.

The example below shows 60C ambient and 4V motor driven at 1000pps. Motors reach maximum temperature in <30 seconds and should be allowed to cool down. If the motor is run again before complete cool down it will reach maximum temperature in <30 seconds.





Motor temperature calculator
bit.ly/motorTemp

DC autoiris motor specifications

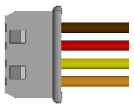
Applicable models: TLxxxA R3, TLxxxA R4, TLxxxA R5, TLxxxA R6

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: TLxxxA R4, TLxxxA R6

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

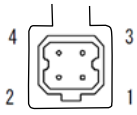
Pin	Color	Function
1	Brown	Control -
2	Red	Control +
3	Yellow	Drive +
4	Orange	Drive -



Applicable models: TLxxxA R3, TLxxxA 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: TLxxxP R3, TLxxxP R4, TLxxxP R5, TLxxxP R6

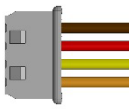
Drive	Stepper motor 2 phase bipolar drive
Operating voltage	4V (2.7~5.0V)
Number of steps	Step 1: stop Step 2: Full open Step 72: Full close Step 75: stop
Basic step angle	18°
Maximum response freq.	200pps
Coil resistance	30Ω ±10% (each phase)

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: TLxxxP R4, TLxxxP R6

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

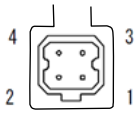
Pin	Color	Function
1	Brown	B+
2	Red	B-
3	Yellow	A+
4	Orange	A-



Applicable models: TLxxxP R3, TLxxxP 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 (TL410)

Step	Aperture Size [mm2]	F/#
1	65.0	1.43 (open)
19	65.0	1.43 (open)
20	63.4	1.50
25	54.0	1.63
30	44.9	1.78
35	36.0	1.98
40	27.7	2.26
45	20.0	2.65
50	13.2	3.26
55	7.5	4.34
60	3.1	6.71
65	0.8	12.86
70	0.1	46.06
72	0.0	Closed

P-iris motor map (TL1250)

Step	Aperture Size [mm2]	F/#
1	95.0	1.84
5	90.8	1.88
10	82.1	1.98
15	72.8	2.10
20	63.4	2.25
25	54.0	2.43
30	44.9	2.67
35	36.0	2.98
40	27.7	3.39
45	20.0	3.98
50	13.2	4.90
55	7.5	6.52
60	3.1	10.10
65	0.8	19.34
70	0.1	69.29
72	0.0	Closed

P-iris motor map (TL936)

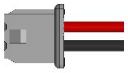
Step	Aperture Size [mm2]	F/#
1	95.0	1.54
5	90.8	1.54
10	82.1	1.61
15	72.8	1.71
20	63.4	1.83
25	54.0	1.98
30	44.9	2.17
35	36.0	2.42
40	27.7	2.76
45	20.0	3.24
50	13.2	3.98
55	7.5	5.30
60	3.1	8.20
65	0.8	15.71
70	0.1	56.29
72	0.0	Closed

IR Cut specifications

Applicable models: TLxxxA R4, TLxxxP R4, TLxxxA R6, TLxxxP R6

Electrical specifications	
Drive	DC
Operating voltage	4.0V
Drive coil resistance	130Ω
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

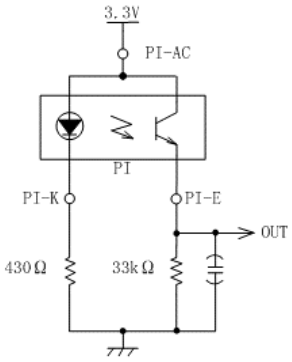


Zoom/Focus limit switch

Applicable models: TLxxxA R5, TLxxxP R5, TLxxxA R6, TLxxxP 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	150mm

Recommended circuit for each photo interrupter



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

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

Revisions

Version	Change	Reason
210429	Added revision table	Table was not present in previous versions
	Updated lens pictures	Prototype lens was shown TL410/TL1250
	Change document name	Website SEO optimization
	Changed motor run time limits	Motor testing and modeling
220112	Changed TL410 naming convention key	Error