Motorized zoom lenses

MOTORIZED ZOOM / FOCUS / IRIS LENSES
DESIGNED FOR LARGER IMAGE SENSORS KITTED
WITH MOTION CONTROLLERS.

DATASHEET

KUROKESU

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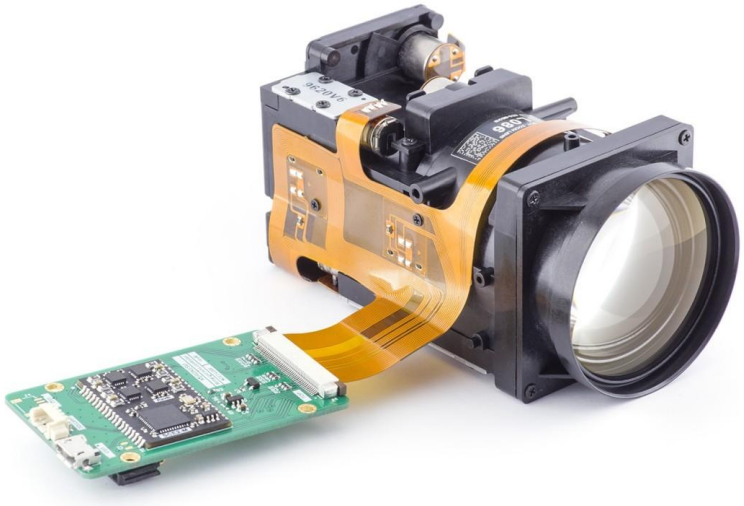
L086-DEVKIT

Brief

L086 is 6.8-120mm focal length (18x) motorized zoom lens is designed for 1/1.8" image sensors, has zoom/focus/iris functions, designed for 8M sensors.



Specifications

Optics

Image sensor	1/1.8" Effective image area > 9.2mm
Focal distance	6.8 ~ 120mm / ±5%
Aperture	f/1.6 ~ f/4.1
Focus range	• WIDE: 1.0m - infinity • TELE: 2.0m - infinity
Field of view (D=8.81mm)	• WIDE: 65.3° • TELE: 4.2°
Distortion	• WIDE: 0.4% • TELE: 0.11%

Mechanics

Mechanical back focus	+0.374 (in glass t=0.3 IRCF)
Lens zoom structure	The stepper motor is directly connected to the screw
Lens focusing structure	The stepper motor is directly connected to the screw
Lens size	• Length: 90.4mm • Width: 45mm • Height: 45mm • Front end diameter: 40.5mm

Motor specifications

Screw pitch	0.4mm
Spiral rotation direction	Right
Rated voltage	5.0 VDC
Coil resistance	60Ω ± 10% / phase (T=25°C)
Phase count	2
Step angle	18° / step
Max start frequency	800 PPS/min @ at 5.0 VDC
Max operating frequency	1200 PPS/min @ 5.0 VDC
Pull torque	2.8 gf-cm min (at 480 PPS @ 5.0 VDC)
Push torque	3.8 gf-cm min (at 480 PPS @ 5.0 VDC)
Operating temperature range	-30°C ~ +70°C

Position alignment sensor PI

Model number	RPI-222 / ROHM

Iris

Driving resistance	120Ω ± 10% (T=20°C, 65% RH)
Braking resistance	120Ω ± 10% (T=20°C, 65% RH)
Close to open operation	3.5 ~ 5.0V
Open to close operation	0 ~ 0.8V

IR switch

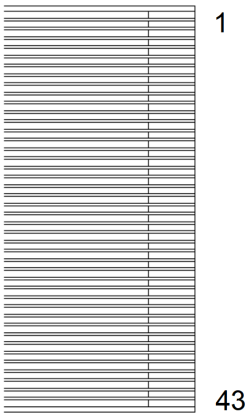
Coil resistance	22.5 ± 10% (T=20°C)
Operation voltage	4.5 ~ 5.0V
Current consumption	144 ~ 200mA
Filter thickness	0.3mm
Switching time	200 ~ 500ms
Filters	• Open air • 380 ~ 650nm (T_{AVG} >90%)

Zoom-Focus curve diagram

<TODO: TBD>

Wiring

Lens signals routed by 43 pin 0.5mm pitch FFC cable. Contacts facing top.



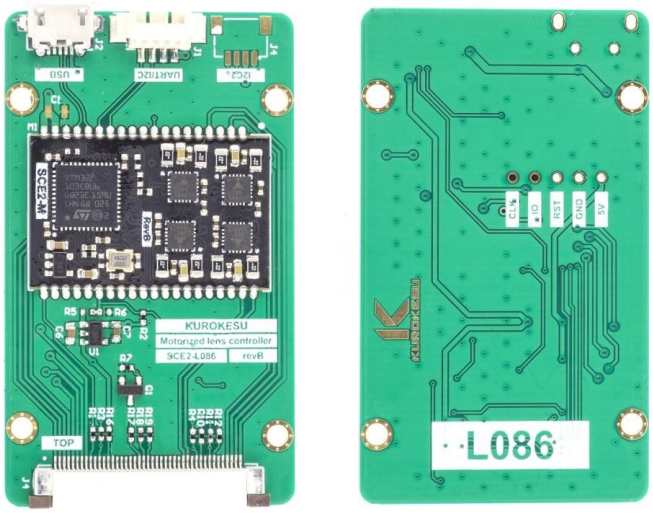
Nr	Function
1	ZOOM1 MOTOR B-
2	ZOOM1 MOTOR A+
3	ZOOM1 MOTOR B+
4	ZOOM1 MOTOR A-
5	ZOOM2 MOTOR B-
6	ZOOM2 MOTOR A+

7	ZOOM2 MOTOR B+
8	ZOOM2 MOTOR A-
9	ZOOM1 PI(ANODE)
10	ZOOM1 PI(CATHODE EMITTER)
11	ZOOM1 PI(COLLECTOR)
12	GND
13	IRIS DRIVE+
14	GND
15	IRIS HALL-
16	IRIS BIAS-
17	IRIS HALL+
18	IRIS BIAS+
19	GND
20	IRIS DRIVE-
21	IRIS CONT-
22	IRIS CONT+
23	
24	
25	
26	
27	
28	
29	
30	IR-
31	IR+
32	FOCUS PI(CATHODE EMITTER)
33	FOCUS PI(COLLECTOR)
34	FOCUS PI(ANODE)
35	ZOOM2 PI(CATHODE EMITTER)
36	ZOOM2 PI(COLLECTOR)

37	ZOOM2 PI(ANODE)
38	TEMP COM
39	TEMP OUT
40	FOCUS MOTOR B-
41	FOCUS MOTOR A+
42	FOCUS MOTOR B+
43	FOCUS MOTOR A

Controller SCE2-L086

SCE2-L086 is inexpensive dual layer application board designed to match lens FFC routing and topology based on SCE2-M 4 channel stepper motor controller module. Controller is based on STM32 microprocessor and TMC2300 motor drivers. Modern stepper motor drivers allow wide range of operation and suitable from operating NEMA17 to micro motor. Control logic is based on CNC control firmware GRBL.



Revisions

RevA

- Initial lens tests
- Simplified DC iris control (on/off)
- For testing use 44pin FFC
- Check IR filter control with trinamic

- Check actual homing, fine tune GRBP parameters
- Check if FFC connector numbering matches cable
- Add I2C thermometer

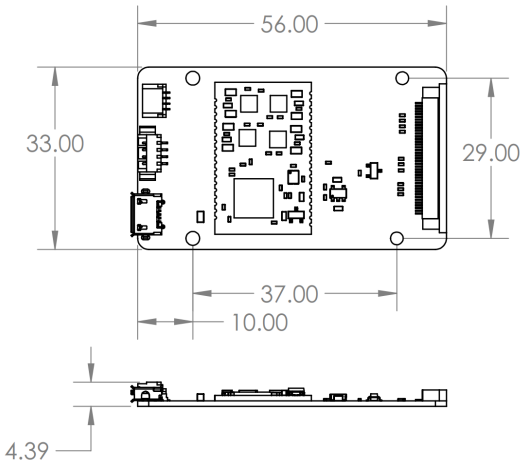
RevB

- Refine design
- Use new 43 pin FFC connector
- Replace internal I2C thermometer with slave connector
- Use NTC with on-board ADC for temperature reading

Features

- USB and 3.3V UART control
- 4 axis motion controller
- Fully integrated design
- Powered by USB 5V rail
- I2C slave for external sensors and controllers (Functionality is determined by firmware)
- Linear path interpolation

Dimensions



Operation

Detailed SCE2-M controller documentation is located here. Information and examples below explains how to use lens functions.

Parameters

In order to function properly, controller has to be configured. There are many things that should be adjusted: max motor speed, direction, homing parameters, motor acceleration, motor steps per mm calibration and more. Mostly suitable parameter table is maintained along with source code on SCE2-SDK repository on GitHub. Most parameters can be updated during normal operation, but controller restart might be required. Motors are calibrated to match g-code travel value with physical motor travel length in mm.

Firmware has 2 startup command lines that are executed during power on sequence. Any G-code command can be used. However for smaller motors we recommend setting lower so motors will not overheat.

Iris

Iris (also known as aperture) is responsible for:

- Light gathering capabilities (larger aperture lets collect more light).
- Depth of field (DOF). Open aperture will yield shallow depth of field.
- Spatial resolution. Usually lens sharpness is affected by aperture position. Usually maxes out somewhere at the middle of range.

New lenses have 2 types of iris mechanisms;

- **P-Iris** - so called precision iris, driven by a stepper motor.
- **DC-Iris** - more often found in older lenses. Construction is simpler but control and precise positioning is much more complicated. Uses hall sensor to establish position. Current controller allows only on or off control of this iris type.

⚠ Due to construction topology DC-Iris is always closed after controller is reset

Homing

Two interpretations of homing are used in lenses and controllers.

- One is used by GRBL code derived from CNC control where home means axis can't move any further. It is in most minimal position and in normal operation should operate in positive range of axis. In normal operation axis should never reach limit switches.
- Another scheme is used by a lens. Lens is designed in such a way that limit switch is placed roughly in the middle of the axis. In most configurations optical train can't go far from center axis position. And motor operates in positive and negative range of axis.

If standard firmware detects that limit switch is actuated it decides that it is dangerous situation and motors should be powered down. While for CNC this behavior is perfect it is not acceptable for lens control. It is pretty easy to configure controller to operate normally when limit switch is actuated. However if limit switch is already actuated homing procedure will fail. This functionality should be fixed in upcoming firmware updates. Meanwhile prior to homing procedure axes should be moved away from limit switches manually before performing homing procedure.

Control commands

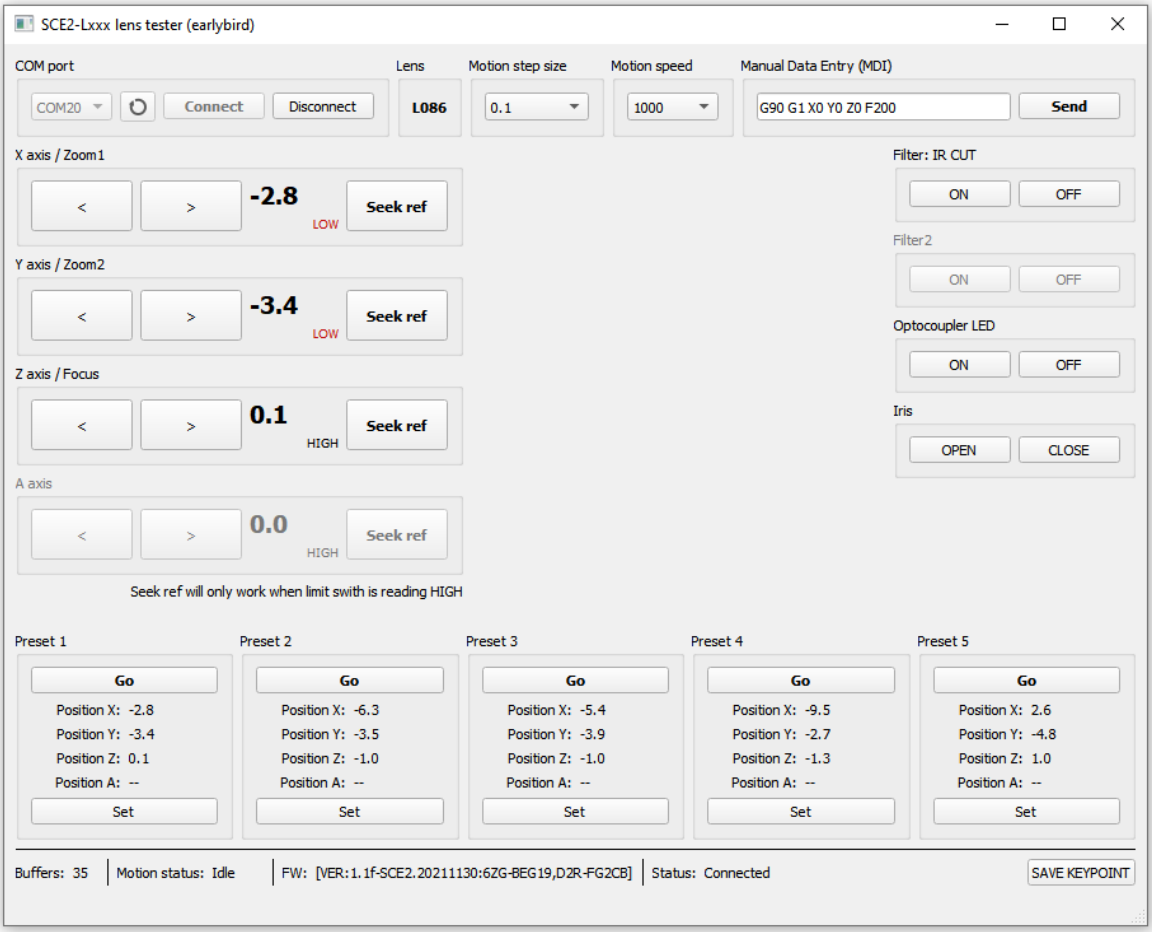
<TODO: TBD>

SDK

Source code of development kit is maintained on GitHub.

Lens Tester GUI

- Open python script `main.py`
- Select COM port and click Connect, lens should be automatically detected and status info filled
- Normally Iris is closed. Click OPEN
- Change desired active filter
- Reference each axis. If position sensor shows LOW, move axis manually until status changes to HIGH. Recent firmware does not know how to perform home cycle when limit switch is actuated. This behavior is perfectly normal for CNC machines and operation will be updated in future firmware releases
- After each axis is referenced try lens train presets.

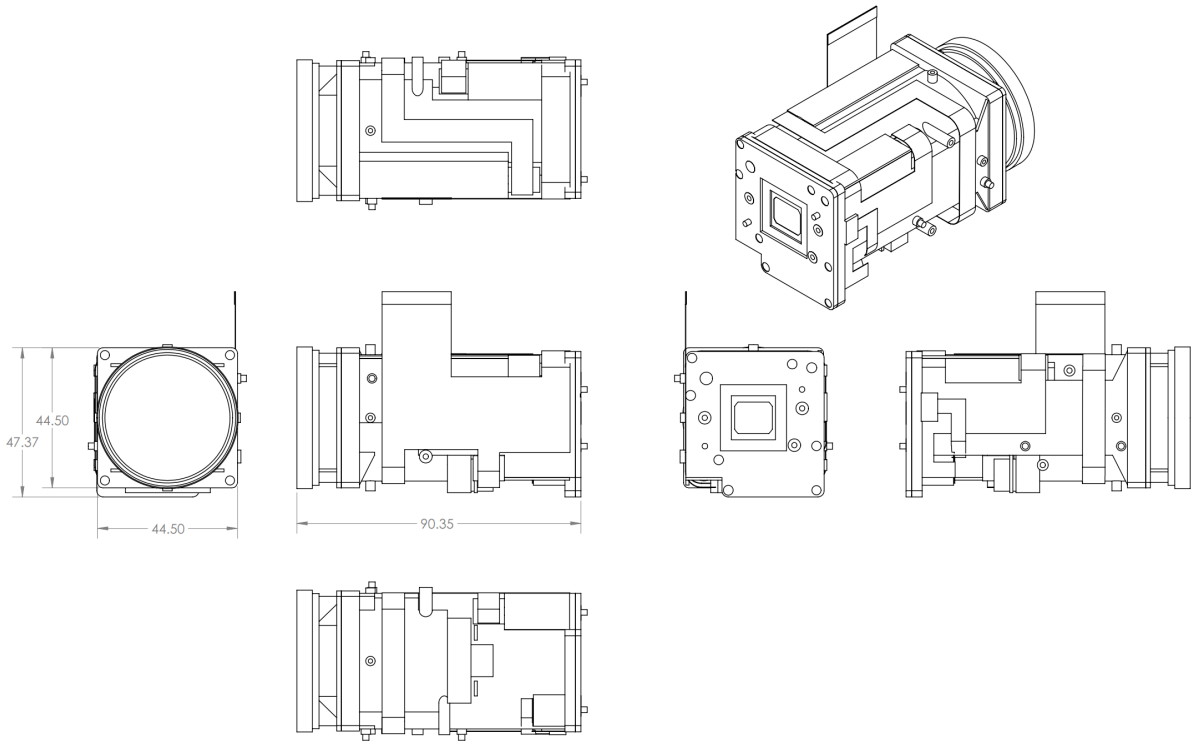


Console demo

- Edit `Lxxx.py` script and change COM port
- Open python script `Lxxx.py`
- Controller will move lens train and toggle various parameters. See code for more details

```
C:\Windows\System32\cmd.exe
> $I
< [VER:1.1f-SCE2.20211130:6ZG-BEG19,D2R-FG2CB]
< [TLENS:2114]
< [OPT:ZHL,35,254]

* Firmware version: 1.1f-SCE2.20211130
* ID strings: ['6ZG-BEG19', 'D2R-FG2CB']
 o L086 lens detected, SN: BEG19
 o SCE2-L086 controller detected, SN: FG2CB

* 12 Bit ADC (Vref=3.3V): 2114 / 1.703 V

> G90
< ok

> M120 P1
< ok

> M114 P1
< ok

> G90 G1 A0.3 F1
< ok
* Moving out of home position: X
* Moving out of home position: Y
* Moving out of home position: Z

> $HX
< ok

> $HY
< ok

> $HZ
< ok

> G90 G1 X-8.2 Y-5.1 Z-2.6 F1000
< ok

> G90 G1 X-7.2 Y-5.9 Z-2.98 F1000
```

Dimensions



Detailed 3D model is hosted on GitHub 3D models repository