Canon

Service Manual

ENGLISH EDITION

CANON LENS
EF 50mm1:1.8
EF 28mm1:2.8
EF 15mm1:2.8
ELECTRICAL DIAGRAMS

© CANON INC. 1987
CY8-2023-001-200
EF 50mm 1:1.8
CANON LENS EF50mm 1:1.8
Ref. No. C21-6211

Special Optical Adjustments:

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centering</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Tilt</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>
TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.  EOS LENS Repair Precautions</td>
<td>I-1</td>
</tr>
<tr>
<td>II. New Functions and Terms, with Glossary</td>
<td>II-1</td>
</tr>
<tr>
<td>1. EF Electronic Mount</td>
<td>II-2</td>
</tr>
<tr>
<td>2. Autofocus Drive (AFD)</td>
<td>II-5</td>
</tr>
<tr>
<td>3. Electromagnetic diaphragm (EMD)</td>
<td>II-9</td>
</tr>
<tr>
<td>III. Block Diagrams</td>
<td>III-1</td>
</tr>
<tr>
<td>IV. Circuit Analysis</td>
<td>IV-1</td>
</tr>
<tr>
<td>V. Specifications</td>
<td>V-1</td>
</tr>
<tr>
<td>VI. DISASSEMBLY &amp; ASSEMBLY</td>
<td>VI-1</td>
</tr>
<tr>
<td>1. EMD Unit Removal</td>
<td>VI-1</td>
</tr>
<tr>
<td>2. AFD Unit Removal</td>
<td>VI-2</td>
</tr>
<tr>
<td>3. External Parts</td>
<td>VI-3</td>
</tr>
<tr>
<td>4. Helicoid Disassembly</td>
<td>VI-4</td>
</tr>
<tr>
<td>VII. ADJUSTMENTS</td>
<td>VII-1</td>
</tr>
<tr>
<td>1. Focus Adjustment</td>
<td>VII-1</td>
</tr>
<tr>
<td>2. Pulse Adjustment</td>
<td>VII-2</td>
</tr>
<tr>
<td>3. &quot;Best Focus Adjustment&quot; Service Policy</td>
<td>VII-3</td>
</tr>
</tbody>
</table>

NOTICE: Sections I, II, III, and IV of this repair guide apply in general to all EF lenses. If, in the future, more information is necessary, it will be included in the repair guide for the first product with the feature.

EF50mm f/1.8 Lens Expendables List

**ADHESIVES**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Name</th>
<th>Remarks</th>
<th>Plastic Safe?</th>
</tr>
</thead>
<tbody>
<tr>
<td>CY4-9301-000</td>
<td>Double faced tape</td>
<td>Always use new tape (New)</td>
<td>YES</td>
</tr>
<tr>
<td>CY9-8007-000</td>
<td>Aron Alpha</td>
<td>Instant Bond (Cyanoacrylate)</td>
<td>YES</td>
</tr>
<tr>
<td>CY9-8009-000</td>
<td>Arontite R</td>
<td>For staking screws</td>
<td>NO</td>
</tr>
<tr>
<td>CY9-8011-000</td>
<td>Screw-lock</td>
<td>For staking screws</td>
<td>YES</td>
</tr>
<tr>
<td>CY9-8076-000</td>
<td>Vinylole 2200</td>
<td>General Purpose</td>
<td>YES</td>
</tr>
</tbody>
</table>

**LUBRICANTS**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Name</th>
<th>Remarks</th>
<th>Plastic Safe?</th>
</tr>
</thead>
<tbody>
<tr>
<td>CY9-8045-000</td>
<td>GE-C4</td>
<td>Helicoid &amp; cam (metal OK)</td>
<td>YES</td>
</tr>
<tr>
<td>CY9-8086-000</td>
<td>FF-10</td>
<td>Helicoid &amp; cam (NEW)</td>
<td>YES</td>
</tr>
<tr>
<td>CY9-8087-000</td>
<td>Lozoid 6308/31-F</td>
<td>Manual focusing ring (New)</td>
<td>YES</td>
</tr>
</tbody>
</table>
I. EOS LEN S Repair Precautions

1. FD lenses can be checked individually, but EOS lenses can only be checked as a part of the EOS system. In particular, diaphragm operation and autofocus operation can only be checked when combined with an EOS camera body.

2. Stepping motors are used in the diaphragm unit (EMD – see glossary) and the focusing motor (AFD – see glossary). They can only be checked outside the assembled lens by wiring the units to the contacts in a lens mount and attaching the mount to a camera body. (Only operation, not accuracy, can be checked in this manner.)

3. A majority of the parts are made of plastic. Always use plastic-safe lubricants, cleaners, and bonds; and be careful when tightening screws or using a soldering iron. Use Keton only where specifically indicated, and then use as little as possible.

4. At the factory, lens focus is adjusted by shaving the lens mount. Since this is impossible in the field, special service mounts are stocked in 0.1mm increments, and fine adjustment washers in 0.02mm and 0.05mm. Do not use more than 0.07mm total thickness of adjustment washers since the gap between the mount and lens barrel will become noticeable.

5. After repair, always clean the body contacts with Fronsolve.

6. New Expendable Materials

<table>
<thead>
<tr>
<th>Name and Number</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>FF-10 (CY9-8086-000)</td>
<td>Focusing helicoid grease (Apply just enough to wet the surface with lens tissue.</td>
</tr>
<tr>
<td>Lozoid 6308/31-F (CY9-8087-000)</td>
<td>Used on gears and the inner contact surface of the manual ring. (Replaces GE-C4, which is too light to give the necessary feel.)</td>
</tr>
<tr>
<td>SO-820(CY9-8088-000)</td>
<td>This is a adhesive whose surface remains sticky. It is used on lens with screw-in type name rings to stake the ring, and in other places to prevent dust entry.</td>
</tr>
</tbody>
</table>

7. New Tools

<table>
<thead>
<tr>
<th>Name and Number</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>EF Mount Adaptor (CY9-2001-003)</td>
<td>This tool allows mounting EF lenses on the lens focus collimator or projection test unit.</td>
</tr>
</tbody>
</table>
II. New Functions and Terms, with Glossary

When developing the EOS system, great weight was given to developing an open-ended system that would not quickly become outdated. All electromechanical interfaces are placed as close as possible to the actual mechanical part with all communication being electronic. To realize this, we have developed several new actuators.

The original Canon SLR mount (B mount) has served well through several incarnations without loosing basic interchangeability, and it would have been possible to modify it to an autofocus system, as proved by the T80, but the decision was made to make the radical departure to a new mount for the following reasons.

1. To realize a quality AF SLR system at a competitive price.
2. To integrate the latest technology with the new features.
3. To build a system compatible with future developments.

Glossary

Actuator
An actuator is the interface between the electrical circuit and the mechanism which actually performs work. Examples are motors and solenoids.

Autofocus Drive (AFD)
As used in this guide, AFD is the name of one type of autofocus drive being used in EF lenses (See USM).

Electromagnetic Diaphragm (EMD)
The EMD is the powered diaphragm used in EF lenses. It consists of an modified stepping motor designed so the normal round lens shape is maintained with very little increase in diameter.

Stepping Motor
A stepping motor is a motor that moves in short, essentially uniform steps rather than continuously. In applications in EF lenses, it is driven by pulses generated by the lens computer.

Ultrasonic Motor (USM)
This is a completely new type of ring motor driven by ultrasonic vibrations which is being considered for future EF lenses. It will have superb characteristics including high torque, low speed, and virtually no operating noise making it an ideal AF actuator. More about this exciting development later.
1. EF Electronic Mount

The electronic mount is designed with the power and signal pins on different levels so that the lens power pins do not contact the body signal pins as the lens is being bayoneted to the body.

![Electronic mount signals](image)

<table>
<thead>
<tr>
<th>Diameter of contact surface</th>
<th>$\phi 54\ mm$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside diameter</td>
<td>$\phi 65\ mm$</td>
</tr>
<tr>
<td>Lens mounting rotation angle</td>
<td>$60^\circ$</td>
</tr>
<tr>
<td>Flange back</td>
<td>$44\ mm$</td>
</tr>
</tbody>
</table>

**Signal transfer**
- All-electronic signal transfer through 8 contacts
  - (1) VBAT (AFD-USM, EMD drive power supply)
  - (2) P-GND (VBAT ground)
  - (3) P-GND (VBAT ground)
  - (4) VDD (Power supply for IC and peripheral circuits in lens)
  - (5) DCL (data from camera to lens)
  - (6) DLC (Data from lens to camera)
  - (7) LCLK (Data transfer clock)
  - (8) D-GND (VDD ground)

**Material**
- Stainless steel
Basically, there are four types of signals carried over pins (5) and (6). They are:

1) Request for present lens data.
2) Command to focus lens according to data transmitted.
3) Command to stop down lens X number of steps.
4) Command to open diaphragm.

Principal data sent by the lens in response to command (1) are as follows (grouped according to function).

<table>
<thead>
<tr>
<th>Type of information</th>
<th>Purpose AF Prec.</th>
<th>AF Control</th>
<th>AE Control</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lens status</td>
<td></td>
<td>X</td>
<td></td>
<td>Oper. status Lens in use</td>
</tr>
<tr>
<td>Lens type (ID code)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Photometry</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. aperture f/No.</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Minimum aperture</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Focal length</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>AF drive</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Focusing ring position</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lens ext. response factor</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lens ext. resp. correction</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Focusing ring drive const.</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Maximum defocus quantity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Best focus compensation</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) Lens state

<table>
<thead>
<tr>
<th>Information</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focusing ring</td>
<td>This data indicates the state of the focusing ring, and prevents AF while the focusing ring is accelerating or decelerating.</td>
</tr>
<tr>
<td>Ranging disabled</td>
<td></td>
</tr>
<tr>
<td>Electronic ring drive on</td>
<td>Information required for power to USM</td>
</tr>
<tr>
<td>Drive ineffective</td>
<td>Tells the camera that drive was stopped because the focusing ring can't move.</td>
</tr>
</tbody>
</table>
(2) Lens type (ID code)

The following items are checked concerning the lens being used.

a. Zoom lens  
   b. Macro function  
   c. Soft focus  
   d. Model  
   e. Minimum focal length  
   f. Maximum focal length

(3) Metering data

This data is required for AF control and AE control, and consists of the maximum and minimum aperture.

(4) Focal length information

Focal length information is provided by each lens. With zoom lenses, it is divided into 32 intervals between WIDE and TELE. The focal length is communicated to the camera as necessary as the lens is zoomed. The purposes of this information are as follows.

<table>
<thead>
<tr>
<th>Control</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>AF control</td>
<td>The microprocessor automatically switches information required for AF control according to the output of the zoom encoder.</td>
</tr>
<tr>
<td>AE control</td>
<td>Automatic zoom flash and intelligent program settings.</td>
</tr>
</tbody>
</table>

(5) AF drive information

a) Focusing ring travel (drive quantity)

This information indicates how much the focusing ring has been driven since the focus pulse counter was reset, and is indicated by the number of pulses produced by the focus pulse plate (chopper wheel).

b) Lens extension, sensitivity coefficient, and sensitivity compensation coefficient

Sensitivity is the differential of the amount of focusing movement with respect to a certain amount of lens extension; this value varies according to focal length and the position of the focusing lens. The sensitivity coefficient is the average sensitivity over the range from closest focus to infinity, and is one of the factors required in order to calculate the necessary extension based on the defocus quantity and direction detected by the system. The sensitivity compensation coefficient is a correction factor that is applied to the sensitivity coefficient under a variety of conditions that affect lens sensitivity.
Factors affecting sensitivity and corrective measures are:

<table>
<thead>
<tr>
<th>Condition affecting sensitivity</th>
<th>Correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lens Model</td>
<td>A sensitivity coefficient is established for each lens model.</td>
</tr>
<tr>
<td>Varying focal length zoom lenses</td>
<td>The zoom range is divided into 32 parts and a sensitivity coefficient is established for each part.</td>
</tr>
<tr>
<td>Differences due to variations in focusing lens position</td>
<td>Establishment of a sensitivity compensation coefficient.</td>
</tr>
<tr>
<td>Difference between front blur and rear blur</td>
<td>Establishment of two sensitivity compensation coefficients.</td>
</tr>
</tbody>
</table>

c) Maximum defocus quantity

This is the maximum amount by which each lens can be out of focus, a value that changes as the lens is zoomed or the macro selection is switched. The camera uses the maximum defocus quantity to calculate the best focus for each lens.

d) Best focus compensation value

This value is used to compensate for errors in the AF focus value (defocus quantity) resulting from effects of the lens optics. The value changes as the lens is zoomed or the macro selection is switched. This value is of two types, one for normal visible light, and one for the infrared light that is used for auxiliary illumination with AF flash.

2. Autofocus Drive (AFD)

This is one of the types of autofocus locomotion used in EF lenses. It is a new type of actuator consisting of a modified Hall motor designed so it can be built into the lens barrel without changing the nominal shape. In some literature, this type is called "Arc Formed Drive".

2-1 Outline

Figure 1 shows the AFD mechanism. Drive power from the is transferred through multiple gears to the focusing which uses a helicoid or cam to move
the focusing lens. The relationship between rotor pitch (90°) and the amount of movement required for is established according to the focusing accuracy of the lens, and the gear ratio is selected so that the lens be in the in-focus range when the rotor is within ±1 pitch of the best focus position.

Figure 2 shows the AFD's power control block diagram. Output from Hall elements is input to the logic circuit through the amplifiers and comparators, and results calculated by the logic circuits are added to the lens drive command to control drive.
2-2 Principle of operation

The motor used for AFD is rotated using the same principle as in an ordinary stepping motor, and the position of the rotor is detected magnetically with contactless Hall elements. The phases of coils C and D of the motor are shifted by 90° by the Hall elements, and stators 1 to 4 are arranged around the perimeter of the rotor, a 2-pole permanent magnet.

A) At (A) in figure 1, the Hall elements output causes current to flow from C1 to C2 in coil C and from D1 to D2 in coil D. This causes stators 1 and 3 to become N poles, and stators 2 and 4 to become S poles. At this time, the rotor is repelled by stators 1 and 2, and is attracted by stators 3 and 4, causing it to turn 45° in the counterclockwise direction.

B) When the rotor reaches the position indicated in figure 2, the output of the stator 3 Hall element causes the direction of current flow in coil D to reverse, reversing the polarity of stators 3 and 4. This causes stators 3 to 4 to repulse the rotor and 1 and 2 to attract it so that rotation continues.

C) When the rotor reaches the position indicated in figure 3, the output of the stator 1 Hall element causes the direction of current flow in coil C to reverse, reversing the polarity of stators 1 and 2. This causes stators 1 to 2 to repulse the rotor and 3 and 4 to attract it so that rotation continues.

Rotation is maintained by controlling the drive polarity of the stators in this manner. Figure 4 shows how the waveform of voltage applied to the coils by the control circuit varies with respect to the output voltage of the Hall elements.
2-3 Features

The motor is arc shaped, making electronic control possible while retaining the conventional lens shape.

Since the space available for windings is limited in conventionally packaged miniature motors multipole rotors are necessary. This makes it impossible to use strong magnets and severely limits the amount of torque that can be obtained. With the AFD, the arc-shaped layout of the motor makes ample space available for windings, and makes it possible to attain high torque using a 2-pole, miniature rotor.

Since the rotor is small in diameter, it has good starting and stopping response.

The nature of the motor allows designed to be optimized to match the characteristics of different lenses.

Since the actuator couples directly to the operating mechanism, it is simple and quiet.

Use of a brushless motor with Hall elements for position detection provides superior wear resistance and reliability.
3. Electromagnetic diaphragm (EMD)

The EMD consists of a diaphragm actuator (a type of stepping motor) and the diaphragm unit.

3-1 The basic structure of the diaphragm is unchanged, except that an electronically controlled stepping motor is used instead of mechanical coupling.

The stepping motor (Fig. 1) drives the diaphragm rotor through a rack and pinion. Each tooth of rotation produces a 1/8 step change in the aperture. Except for being electronically controlled, the diaphragm itself has the same basic structure as with conventional mechanical units.

The block diagram (Fig. 2) shows the steps from photometry to diaphragm control. The number of aperture steps input from the camera is converted into a number of EMD steps by the microprocessor, then the logic circuit drives the drive circuit to control operation of the EMD.
3-2 Principle of operation

A) Since the rotor pole forms a magnetic path through the stator when no current is passing through the coil, the rotor stops with its poles in opposition to stators 1 and 2. Since the rotor polarity is not in opposition to stators 3 and 4 at this time, it stops with a 1/2 pitch offset. Stators 1 and 2 are offset from stators 3 and 4 by 1/2 pitch to achieve this positional relationship. This is illustrated by (1), and is the same situation as if current were flowing through coil A from A1 to A2.

<table>
<thead>
<tr>
<th></th>
<th>A1 to A2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Al to A2</td>
</tr>
<tr>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>S</td>
<td>N</td>
</tr>
</tbody>
</table>

B) In (2) with current flowing from A1 to A2 and B1 to B2, the polarity of stators 1 and 3 becomes N and that of stators 2 and 4 becomes S. This repulses (or attracts) the N and S poles around the perimeter of the rotor so that the rotor rotates 1/4 pitch in the counterclockwise direction. (Each pole is 1/8 pitch.)

<table>
<thead>
<tr>
<th></th>
<th>A1 to A2, B1 to B2</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Al to A2, B1 to B2</td>
</tr>
<tr>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>S</td>
<td>N</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Position: 1/8F (Rotor aligns between N & N center)
C) Power to coil A is then turned off and current is passed through coil B from B2 to B1. This causes the polarity of stator 3 to become N and that of stator 4 to become S, inducing the rotor to turn counterclockwise by an additional 1/4 pitch.

D) Current then passes from A1 to A2 through coils A and from B2 to B1 through coil B, to change the polarity of stators 1 and 4 to S and that of stators 2 and 3 to N. As in 2) above, mutual repulsion and attraction between the rotor and stators causes the rotor to turn by an additional 1/4 pitch.

By changing the manner in which current flows through coils A and B in this manner, the rotor and stators can be made to repulse each other so that the rotor turns to any of eight desired angles. In practice, this is done by switching the combination and direction of current flow between eight possible combinations.

<table>
<thead>
<tr>
<th>No.</th>
<th>A Coil</th>
<th>B Coil</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A1 → A2</td>
<td>Off</td>
</tr>
<tr>
<td>2</td>
<td>A1 → A2</td>
<td>B1 → B2</td>
</tr>
<tr>
<td>3</td>
<td>Off</td>
<td>B1 → B2</td>
</tr>
<tr>
<td>4</td>
<td>A2 → A1</td>
<td>B1 → B2</td>
</tr>
<tr>
<td>5</td>
<td>A2 → A1</td>
<td>Off</td>
</tr>
<tr>
<td>6</td>
<td>A2 → A1</td>
<td>B2 → B1</td>
</tr>
<tr>
<td>7</td>
<td>Off</td>
<td>B2 → B1</td>
</tr>
<tr>
<td>8</td>
<td>A1 → A2</td>
<td>B2 → B1</td>
</tr>
</tbody>
</table>

EF50/1.8, II-11
3-3 Features

Arrangement of the diaphragm drive mechanism in an arc around the perimeter of the diaphragm unit enables electronic control with the conventional lens shape.

Small rotor diameter makes it easy to control starting and stopping of the diaphragm.

Since the diaphragm and the diaphragm drive mechanism are combined into one unit, more precise control is possible that when the aperture is controlled through levers, etc., from the camera. This configuration also provides quiet operation.

Since the only friction in the stepping motor is the bearing, this configuration also provides greater reliability and resistance to wear.
Block Diagram (EF70-210 f/4.0)

Lines

- V-BAT 2
- P-GND
- VDD
- DCL
- DLC
- LCLK
- D-GND

EOS BODY

- A
- A
- B
- B
- OPEN SW
- COM-1

EMD COIL

EMD MAX APERTURE SW

- C
- C
- D
- D
- PR
- LED
- E1
- D-GND

AFD COIL

Pr

- HS11
- HS12

H1

- D-GND

KVC

- HS21
- HS22

H2

- MANUAL
- A/M *
- AF
- MACRO

AF MODE SW

- MACRO AREA SW
- COM-1

MICRO SW

- COM-1

- ZOOM 0

- ZOOM 1

- ZOOM 2

- ZOOM 3

- ZOOM 4

ZOOMING BRUSH
IV. Circuit Analysis

[Lens ℄ Camera communications]

The EOS system features fully electronic signal coupling between the camera body and lens. Communication starts with request from the camera to the lens to send data. This is known as "COMMAND DATA" and is made up of the following three subdivisions.

Transmit Command: This is the request for the lens to transmit its characteristics and present condition to the camera.

Receive Command: This is the command for the lens to standby to receive data, such as aperture and focusing data, from the camera.

Drive Command: This is the actual drive (or stop) command for aperture or focusing.

Actually the request and drive commands are four bit signals which are combined into a single "Command data".

These signals are carried over three lines, LCLK, DLC, and DCL. Their functions are:

LCLK
   Camera ℄ lens clock pulse [62.5KHz, (16uS pulse)]
   Lens ℄ camera busy signal

DLC
   Lens ℄ camera data, datarequest

DCL
   Camera ℄ lens data

One unit of data is 8 bits (1 byte) transmitted in series transmitted simultaneously in both directions over separate lines.

After the lens receives a data unit it issues a "busy" signal over the LCLK line until it is ready to handle another unit of data. If the clock pulse is incorrect for some reason, the lens issues both "busy" and "data request" signals simultaneously and ignores data form the camera indication that there is a malfunction somewhere.

Step 1: Lens mounted on camera

1. When the lens is mounted, power is applied through the mount pins to apply VDD to the lens CPU activating the clock oscillator (OSC). (The CPU is reset at this time by C3 and voltage sensor IC VDET.)

2. The camera and lens's CPU's communicate over the LCLK, DLC, and DCL lines. After a certain time interval, the camera sends a command to the lens CPU to turn the OSC off, or if the camera's DC-DC convertor is turned off communication stops.

3. If the A/M switch is switch, the lens CPU oscillates turning on the cameras DC-DC convertor and repeating the lens mounting communication sequence.
Step 2: SW 1 On

When the camera SW1 is turned on it turns on the DC-DC convertor if it is off and camera <-> lens communication starts. The camera request the zoom, soft, best focus correction, focus and aperture condition data from the lens and the lens sends it. As necessary, the camera sends focus and aperture commands to the lens.

Step 3: Autofocus Drive

(1) The camera sends focus drive commands (pulse drive, servo drive) the the lens CPU. The CPU sends a low from the E1 ON pin (37) turning RTr on and applying E1 to the C-IC (control IC).

(2) The CPU, through the LCLK, DLC, and DCL lines, sends the AFD control and PTr LED lighting commands to C-IC. A 5mA current flows through the LED and the light is felt by the photo transistor depending on the chopper wheel position causing current to flow through the PR terminal. This is compared to the reference Iadj. determined by VR7 and depending on whether the current is greater or smaller than the reference, a digital signal is output at the PULSE terminal to the CPU where the pulses are counted.

(3) To eliminate gear backlash, a low voltage V2 is applied initially to insure the gears Arontite R (White Cap) in contact. This voltage, as well as the other drive voltages (V1 - V6) is established by the resistance of the resistors (R1 - R6) at the AFD voltage pins.

(4) The commence drive command from the CPU to the C-IC immediately follows the backlash command.

(5) The outputs of the Hall elements HS11, HS12, HS21, and HS22 are sine waves which cause current flow through pins M11 - M14, and M21 - 24 which in turn controls which transistors in the arrays are on driving the focusing. Blanking time is controlled by fixed resistors Ladj 1 and 2 (R9 & R10).

(6) As focusing progresses, drive voltage is raised to maximum, focus movement counted and stopped when necessary.

(7) When focus is reached, the CPU sends a brake command to the C-IC which applies a high to M13, M14, M23, and M24 turning them on thus braking the focusing motor.

(8) 32ms after the brake is applied, the CPU sends AFD and LED off signals to the C-IC, and the C-IC removes power from the AFD and photo-interrupter LED circuits.

(9) In the search mode, once the focus had hit the near and distant focusing limit switches and there is no change in pulse output, the CPU determines focusing is impossible and sends the off command to the C-IC.
Step 4: Focus (AFD) Control Details

The AFD motor is driven by six different voltages during the focusing cycle in the following manner.

1) Backlash removal —> 2) Acceleration —> 3) Top drive —> to 4)

4) Variable low speed drive —> 5) Braking —> 6) Power off

   Search Mode: 1) —> 2) —> 3) —> 6)
   For small movements: 1) —> 4) —> 5) —> 6)

(1) Backlash removal: When the lens receives the AFD drive signal from the camera there is no pulse count, but V2 is initially applied. If two pulses are received within 30ms, the voltage is reduced to V1 for the remainder of the 30ms. Even if two pulses are not received within 30ms, backlash removal is considered complete at 30ms.

(2) Acceleration mode: At the end of the 30ms, the voltage is stepped up toward V6 on each successive command, and pulse information starts to be generated.

(3) Top gear drive: V6 drive continues until the lens reaches a point a set number of pulses (the number varies with each type of lens) short of the number of pulses determined by the cameras focusing computer. [If the travel is quite short, the lens may not go all the way to top speed (V6)].

(4) Variable low speed drive: When the lens reaches the point described above, the speed is reduced - either to one set speed, or to one of two predetermined speeds. In models with two speeds, if the pulses come faster or slower than the prescribed speed, the speed is dropped or raised one speed.

(5) Braking: Even though the motor is in low speed drive near the end of the focusing cycle there is still some overrun which varies with the model. At a given point before the focus point the brake is applied. Braking duration is 32ms. At the end of braking pulse counting is stopped.

Step 5: Diaphragm (EMD) Drive

(1) When the lens receives the aperture drive signal from the camera CPU, the lens issues a "busy" (a low on the LCLK line) signal.

(2) The lens CPU then applies a low to the E1ON pin turning RTr on thus applying E1 to the C-IC.

(3) The CPU then sends the aperture drive command to C-IC via the CE, CLK, and DB lines. The C-IC applies the necessary signals to energize TALY1 only in the A to "bar A" direction setting the rotor in the correct initial position.

(4) The CPU sends the stepping pulse "PSM" on each clock pulse to the C-IC to change the SM1 through SM8 signals which control the state of the
transistors in TALY 1 and 2 causing the current the coils to change and the diaphragm to stop down.

(5) A certain time after the last PCM pulse is sent from the CPU to the C-IC, the busy signal is removed from the LCLK line.

(6) The camera sends the diaphragm stop signal to the lens CPU which sends it over the CE, CLK, and DB lines to remove the power from SM1 through SM8.

<table>
<thead>
<tr>
<th>Electronic Component</th>
<th>Mfg. No./ Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU</td>
<td>MN15829-AX</td>
<td>Microprocessor IC [I] indicates lens.</td>
</tr>
<tr>
<td>C-IC</td>
<td>AN8336</td>
<td>Control (or Interface) IC</td>
</tr>
<tr>
<td>TALY1, 2</td>
<td>UN206</td>
<td>EMD drive circuit IC</td>
</tr>
<tr>
<td>TALY3, 4</td>
<td>UN205</td>
<td>AFD drive circuit IC</td>
</tr>
<tr>
<td>OSC</td>
<td>C4CB</td>
<td>CPU oscillator</td>
</tr>
<tr>
<td>VDET</td>
<td>MN15821</td>
<td>Voltage detector IC for CPU reset</td>
</tr>
<tr>
<td>RTr</td>
<td>UN-212Y</td>
<td>E1 power supply</td>
</tr>
<tr>
<td>C1</td>
<td>4.7uF</td>
<td>$V_{BAT}$-2 filter capacitor</td>
</tr>
<tr>
<td>C2</td>
<td>4.7uF</td>
<td>VDD filter capacitor</td>
</tr>
<tr>
<td>C3</td>
<td>1.0uF</td>
<td>CPU Reset capacitor</td>
</tr>
<tr>
<td>C4</td>
<td>1.0uF</td>
<td>E1 filter capacitor</td>
</tr>
<tr>
<td>D11</td>
<td>MA3062WA</td>
<td>DCL, DLC protection</td>
</tr>
<tr>
<td>D12</td>
<td>MA6100</td>
<td>LCLK HOGO protection</td>
</tr>
<tr>
<td>R1</td>
<td>10 OHM</td>
<td>AFD Torque setting</td>
</tr>
<tr>
<td>R2</td>
<td>3.3 KOHM</td>
<td>AFD torque setting</td>
</tr>
<tr>
<td>R3</td>
<td>4.7 KOHM</td>
<td>AFD torque setting</td>
</tr>
<tr>
<td>R4</td>
<td>6.2 KOHM</td>
<td>AFD torque setting</td>
</tr>
<tr>
<td>R5</td>
<td>9.1 KOHM</td>
<td>AFD torque setting</td>
</tr>
<tr>
<td>R6</td>
<td>4.64 KOHM</td>
<td>AFD torque setting</td>
</tr>
<tr>
<td>VR7</td>
<td>10 KOHM</td>
<td>PTr output setting</td>
</tr>
<tr>
<td>R8</td>
<td>130 OHM</td>
<td>LED brightness setting</td>
</tr>
<tr>
<td>R9</td>
<td>4.7 KOHM</td>
<td>Blanking time (Hall element H1 output)</td>
</tr>
<tr>
<td>R10</td>
<td>4.7 KOHM</td>
<td>Blanking time (Hall element H2 output)</td>
</tr>
</tbody>
</table>

Note: Fixed resistor values may vary with lens type.

EMD | Aperture Drive
AFD | Focus drive
PTr | Chopper wheel phototransistor
OPEN SW | Aperture fully open indicator
ZOOM SW | Zoom position indicator
H1, H2 | AFD rotor position (Hall elements)
MACRO SW | Macro range indicator
MACRO ENABLE SW | Enables focusing into macro range
AF/M SW | Autofocus / manual focusing switch
<table>
<thead>
<tr>
<th>Signal (Voltage)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VBAT2</td>
<td>6V</td>
</tr>
<tr>
<td>PGND</td>
<td>0V</td>
</tr>
<tr>
<td>VDD</td>
<td>5.5V (CPU voltage supply)</td>
</tr>
<tr>
<td>DGND</td>
<td>0V</td>
</tr>
<tr>
<td>DCL</td>
<td>Data from camera to lens</td>
</tr>
<tr>
<td>DLC</td>
<td>Data from lens to camera</td>
</tr>
<tr>
<td>LCLK</td>
<td>Camera and lens clock pulse (62.5 KHz)</td>
</tr>
<tr>
<td>CLK</td>
<td>Lens CPU and C-IC clock pulse (62.5KHz)</td>
</tr>
<tr>
<td>DB</td>
<td>Data</td>
</tr>
<tr>
<td>CE</td>
<td>LOW level for communication between CPU and C-IC</td>
</tr>
<tr>
<td>PULSE</td>
<td>Focusing drive pulse (C-IC --&gt; CPU)</td>
</tr>
<tr>
<td>PSM</td>
<td>Aperture drive pulse (CPU --&gt; C-IC)</td>
</tr>
<tr>
<td>E1</td>
<td>5.5V (C-IC voltage supply)</td>
</tr>
<tr>
<td>PR</td>
<td>Phototransistor (PTr) output</td>
</tr>
<tr>
<td>LED</td>
<td>PTr LED</td>
</tr>
<tr>
<td>KVC</td>
<td>1.8V (Hall element voltage)</td>
</tr>
<tr>
<td>H11, H12</td>
<td>Hall element (H1) output</td>
</tr>
<tr>
<td>H21, H22</td>
<td>Hall element (H2) output</td>
</tr>
<tr>
<td>A, A</td>
<td>EMD coil A phase</td>
</tr>
<tr>
<td>B, B</td>
<td>EMD coil B phase</td>
</tr>
<tr>
<td>C, C</td>
<td>AFD coil C phase</td>
</tr>
<tr>
<td>D, D</td>
<td>AFD coil D phase</td>
</tr>
</tbody>
</table>
IC Pin Tables

<table>
<thead>
<tr>
<th>Pin Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSC 1, 2</td>
<td>Oscillator crystal connections</td>
</tr>
<tr>
<td>D/GND</td>
<td>CPU device ground</td>
</tr>
<tr>
<td>DCL</td>
<td>Camera $\rightarrow$ lens data</td>
</tr>
<tr>
<td>DLC</td>
<td>Lens $\rightarrow$ camera data, datarequest</td>
</tr>
<tr>
<td>LCLK</td>
<td>Camera $\leftrightarrow$ lens data</td>
</tr>
<tr>
<td></td>
<td>camera $\rightarrow$ lens clock pulse [62.5KHz, (16uS pulse)]</td>
</tr>
<tr>
<td></td>
<td>lens $\rightarrow$ camera busy signal</td>
</tr>
<tr>
<td>AF Adj. 0, 1</td>
<td>Best focus and production tolerance compensation. (The CPU contains several possible best focus and production tolerance compensations. The appropriate ones are selected by shorting either pin, both or neither to COM1.)</td>
</tr>
</tbody>
</table>
MACRO ENABLE SW: On lenses with "macro" the switch allows autofocusing into the macro range.

COM1: This is the ground connection for the various switches (Zoom, Soft, Macro, etc.).

OPEN SW: This pin determines if the OPEN SW is on (diaphragm not fully open) or off (diaphragm fully open).

SOFT 0, 1: These are the input terminals for the soft focus position information necessary for soft focus lenses. The lens markings SOFT 1 & 2 correspond to the CPU’s SOFT 0 & 1.

ZOOM 0 - 4: The 5 bit zoom brush connects to these pins giving the present focal length in 32 (2^5) steps.

MACRO SW: On lenses with MACRO, the MACRO SW indicates whether the focusing ring is in the macro focusing range.

CLK: CPU → C-IC clock pulse [62.5KHz, (16uS pulse)]

DB: CPU ←→ C-IC data

CE: CPU → C-IC data (data request)

PULSE: The AFD unit includes a "photo-interrupter" chopper wheel circuit which is converted into a digital pulse in the C-IC. This pulse is sent to the CPU and the number and timing of the pulses forms the basis of the autofocus data.

PSM: This is the pulse sent for the lens CPU to the C-IC to control the EMD which operates the diaphragm. Each pulse changes the current direction causing the motor to make one step.

A/M: This is the autofocus / manual focus input from the A/M switch.

COM2: This terminal is connected the the autofocus side of the A/M switch.

DC/DC: This terminal is connected to the manual side of the AM switch.

E1 ON: This is the power switch for C-IC. When it is low, RTr is turned on and E1 voltage is supplied the C-IC. If it is high, RTr is off and to E1 supply to C-IC is cut off.

RESET: This is the CPU reset pin.

VDD: This is the power supply for the CPU.
<table>
<thead>
<tr>
<th>Pin Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>DGND</td>
<td>C-IC device ground</td>
</tr>
<tr>
<td>E1</td>
<td>C-IC power supply, controlled from CPU.</td>
</tr>
<tr>
<td>VC</td>
<td>Check pin for internal reference voltage</td>
</tr>
<tr>
<td>PSM</td>
<td>This is a pulse from the lens CPU to the C-IC to control the EMD. Each pulse changes the current direction causing the motor to make one step.</td>
</tr>
<tr>
<td>PULSE</td>
<td>The AFD unit generates a chopper wheel pulse which is converted into a digital pulse in this IC. This pulse is sent to the CPU and the number and timing of the pulses form the basis of the autofocus data.</td>
</tr>
<tr>
<td>CE</td>
<td>CPU ——&gt; C-IC data enable (sets start of data train)</td>
</tr>
<tr>
<td>DB</td>
<td>CPU &lt;—— C-IC data</td>
</tr>
<tr>
<td>CLK</td>
<td>CPU ——&gt; C-IC clock pulse [62.5KHz, (16uS pulse)]</td>
</tr>
<tr>
<td>SM1, SM2; SM5, SM6.</td>
<td>Control pins for the EMD transistor array ICs. Each pin is connected to the base of one transistor in one of the two</td>
</tr>
</tbody>
</table>
EMD transistor arrays. A low on one of these pins turns on the transistor.

SM3, SM4; SM7, SM8. Control pins for the EMD transistor array ICs. Each pin is connected to the base of one transistor in one of the two EMD transistor arrays. A high on one of these pins turns on the transistor.

PGND Motor power supply ground

V1 through V6 AFD voltage control pins. The voltage on each is established by the resistor (R1 - R6) attached to it, and the voltage controls the speed of the AF Drive.

VBAT2 Motor power supply voltage

M11, M12; M21, M22. AFD transistor array ICs control pins. Each pin is connected to a transistor base in one of the two AFD transistor arrays. Voltage on the pin depends on the AFD voltage established by pins V1 through V6. When the control voltage is applied to a pin, it turns on the transistor, and applies the voltage to the motor coil.

M13 M14; M23, M24. Control pins for the AFD transistor array ICs. Each pin is connected to the base of one transistor in one of the two EMD transistor arrays. A high on one of these pins turns on the transistor.

HS11, HS12; HS21, HS22 Hall element inputs. The outputs of the Hall elements are sine waves of 100 to 120mVpp centered on VC, and generated magnetically by motor rotation.

KVC Hall elements power supply voltage

Ladj1, Ladj2 AFD motor blanking angle pins. The resistors, which are NOT an adjustment as erroneously indicated by the name, determine the blanking angle of the C and D motor coils. This determines the torque of the motor.

LEDADJ This is the factory LED current adjustment.

IADJ Photo-interrupter photo receptor threshold adjustment pin. VR7 determines the the output above which a high signal is generated. This is a service adjustment.

LED This pin provides a current path to ground, limited by the LEDADJ resistor, for the photo-interrupter LED.

PR This is the input from the photo-interrupter photo transistor which is converted into a digital pulse.
V. Specifications

The 50mm f/1.8 was developed as the standard lens of the EOS series. An objective of development was to achieve even greater optical performance than that provided by the FD50mm f/1.8 lens, which was the mainstay of the FD lens series.

Features

Provides better optical contrast than the FD50mm f/1.8.

As the standard lens of the EOS lens series, provides standard color in CCI representation (the international standard for color balance).

Has a shorter minimum focusing distance of 0.45m (0.15X) than the 0.6 m (0.1X) minimum focusing distance of the FD50mm f/1.8.
1. Format: 24 x 36 mm

2. Focal length/aperture: 50mm, f/1.8

3. Optical structure: 5 groups, 6 elements (Super Spectra Coating)

4. Angle of view (at infinity):
   - Diagonally (43.2 mm) 46°
   - Vertically (24 mm) 27°
   - Horizontally (36 mm) 40°

5. Autofocus (AF)
   - 5-1 Drive system: AFD
   - 5-2 Drive speed: 0.44 seconds (Actual operation between infinity and closest focus, not including AF operation)
   - 5-3 Manual: Mechanically clutched focusing ring

6. Focusing:
   - 6-1 Extension system: Double helicoid
   - 6-2 Range: 0.45m to infinity
   - 6-3 Rotation angle, amount of extension
     | Condition       | Rotation angle | Extension |
     |-----------------|---------------|-----------|
     | 0.45m to infinity| 152.4°        | 7.62mm    |
     | Infinity overrun| None          | None      |
   - 6-4 Distance scale:
     | 1.5  | 2   | 2.5   | 3.5  | 5   | 8   | 15   | ft (fluorescent green) |
     | 0.45 | 0.6 | 0.8   | 1    | 1.5 | 2.5 | 5    | m (gray) |
   - 6-5 Maximum magnification & field of view
     | Condition     | Magnification (power) | Field of view (mm) |
     | Close focus   | 0.15X               | 160 x 240mm        |
7. Mount

7-1 Type: New Canon mount

7-2 Signal transfer function: EOS system, with 5 signals as follows:
   A) Lens condition
   B) Lens type
   C) Photometry signal
   D) Focal length
   E) AF drive information

8. Aperture mechanism

8-1 Diaphragm control: Pulse control using EMD

8-2 Aperture range: f/1.8 - f/22

8-3 Number of diaphragm blades: 5

8-4 Depth-of-field scale: Provided

8-5 Infrared index: Provided

9. Filter thread: 52mm, 0.75mm pitch

10. Dimensions, weight: 67.4 mm diameter x 42.5 mm length, 190g

11. Related products

11-1 Hood: SS-65 (new)

11-2 Lens cap: E-52 (new)

11-3 Lens case: S (new soft case), LHP-C8

11-4 Dust cap: Common to all EF lenses (new)

12. Other: Maximum number of filters usable: 2
VI. DISASSEMBLY & ASSEMBLY

EF50mm f/1.8

1. EMD Unit Removal

Set lens to infinity before beginning.

Turn CCW to unlock bayonet. One lug of the bayonet is wider, so it will only couple one way.

Bayonet lugs - Stake with screw-lock.

Clean the maximum aperture switch, but DO NOT disturb the eccentric. (A factory tool is required to adjust it.)

Water-soluble bond

EMD Flex holder

Stake head with screw-lock.

Main flex unit - Unsolder 30 points (A) through (E). (A) & (B) only to remove EMD. CAUTION: PLASTIC PARTS - Use soldering iron with care.

Insulating sheet

This screw need not be removed.
VI. DISASSEMBLY & ASSEMBLY  EF50mm f/1.8

2. AFD Unit Removal
   Set lens to closest focus before beginning.

   AFD Unit (8) Removal
   1. Remove screws (5), (6), & (7), as shown below.
   2. Lift and gently wiggle the AFD Flex in the clockwise direction.

   AFD Unit (8) Installation
   1. Reverse the removal procedure.
   2. Install and lightly tighten screw (6).
   3. Install and lightly tighten screw (7).
   4. Mate the switch knob and AF/M lever with the clutch lever.
   5. Install screw (5).

   AFD Unit (8) Alignment
   6. Move the flex with tweezers at "A" (above). Work the flex slightly, with screw (6) as the fulcrum, screw (7) should move about 0.3mm.
   7. Just slightly inside the midpoint of this travel, tighten screws (7) and (6).
   8. Operate the manual focusing ring to check for smooth focusing. [This adjustment sets the mesh of the AFD final drive and the helicoid's focus gear.]

(1) - (4): See previous page
VI. DISASSEMBLY & ASSEMBLY  EF50mm f/1.8

3. External Parts

1. Opposite index
2. Turn CCW to decouple bayonet
   Screw-lock (bayonet lugs)
3. Screw-lock (bayonet lugs)
4. Index
5. Lozoid 6308/31-F (Friction and gear surfaces)
6. See next page

Aron Alpha - four spots near claws
[Push out to remove. Claws break easily.
Don't leave plastic chips in lens.]

Hi-lock (threads)
2 x 2

Vinylole (4 clips)
Push from above to remove.
4. Helicoid Disassembly

- Revolving helicoid (4)-6 disengages from the near focus end. [When reinstalling, install key, with focus stopper (4)-7 attached at the AF/M mark.]
- Pry three ears out to disengage them. [Orientate properly when reinstalling.]
- Unscrew (normal thread) [When reinstalling, tighten lightly and then back off about 6mm. Stake at three points with about 1cm of screw-lock.]

- FF-10 (Just enough to wet threads --- this reduces resistance to lighten load on the motor.)
- Revolving helicoid
- Focus stopper (press fit)
- GE-C4 (on friction surfaces)

Close focus stopper
VII. ADJUSTMENTS EF50mm f/1.8

1. Focus Adjustment

STANDARD: ± 0.03mm

Focus washers are not used in the factory adjustment of EOS lenses. The service adjustment uses washers and/or undercut lens mounts.

1. Check Method

Two different methods can be used to adjust EF lenses for correct focus. Both adjustments are carried out with the lens in manual focusing mode.

1.1 800mm Lens Focus Collimator Method

Install the EOS lens mount adaptor on the collimator and check several lenses from stock to establish an average. Adjust repaired lenses to that average.

1.2 Camera Method

Use a known-good camera with a type B focusing screen (split-image) and a magnifier. Check infinity focus on a collimator or with an actual target at least 100ft distant.

2. Adjustment Method

2.1 If the lens focuses past infinity (plus), focusing washers up to a combined thicknesses of 0.07mm can be used. If the defocus is greater than 0.07mm plus, or minus, measure the lens mount thickness and choose the appropriate undercut lens mount and focus washers to bring the focus within limits.

2.2 After adjustment, attach the lens to the camera and range an infinity target in the AF mode. The index should align with the infinity marker. Projection testing is not necessary for this lens.

At finite distances, the index should be within the f/5.6 D-O-F.

Table 1: Resolution Chart

<table>
<thead>
<tr>
<th>Image Height (mm)</th>
<th>0</th>
<th>4</th>
<th>8</th>
<th>12</th>
<th>16</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axial</td>
<td>100</td>
<td>63</td>
<td>40</td>
<td>40</td>
<td>63</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>100</td>
<td>100</td>
<td>63</td>
<td>40</td>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>
VII. ADJUSTMENTS EF50mm f/1.8

2. Pulse Adjustment

STANDARD: \(0.9T \leq t \leq 1.1T\)

Adjust if any of the three units shown at the right are changed. If not adjusted, AFD may work correctly at normal temperatures but fail at high or low temperatures.

Adjustment Method

1. Assemble the lens up to the point where the mount portion is attached to the rest of the lens.

2. Temporarily attach leads to the pads marked [PULS CH] and [D-GND] in figure 2.

3. Attach the lens mount to a camera body. Since the main part of the lens is hanging by the flex, be careful not to tear it.

4. Attach the leads (step 2) to the oscilloscope probe.

5. Set the lens in the AF mode and the camera in the ONE-SHOT mode, and press the shutter button. (The AF will search continuously because the lens is not in place.)

6. Adjust VR7 so the waveform is like figure 3 (C).
VII. ADJUSTMENTS EF50mm f/1.8

3. "Best Focus Adjustment" Service Policy

**STANDARD:** $\pm \frac{1}{4} \text{Fe} \quad \text{Fig.} = f/\text{number}
\[ c = 0.035 \text{mm (Canon circle of confusion)} \]

REF: AF Focus Point Limits: The difference in the best focus point and the actual point where the lens focuses must be within $\pm \frac{1}{4} \text{Fe}$.]

There is bound to be some discrepancy between the focus point determined by the autofocus system and the actual best focus point of the interchangeable lenses due to the inherent differences between the different lens types.

In the EOS system, the difference between the AF focus and the optical best focus has been determined for each lens type and the information written into the lenses Read Only Memory (ROM) so that correction for the difference at maximum aperture is made electronically.

In actuality, in addition to this type difference, there is a difference between individual lenses within each type, which can be noticeable if not corrected. At the factory, correction is written into the individual lens' ROM with a expensive, special tool. This is called the "Best Focus Adjustment". Because of the tooling cost involved, this adjustment will not be a part of the service procedure. In its stead, the following actions will be taken.

Service Actions:

1. **Main Flex Replacement**
   Check the AF ADJ0 and AF ADJ1 pads on the flex being replaced and bridge the pads on the new flex in the same way.

2. **G4/5 (CP2-0875) Replacement**
   Open any bridges on the AF ADJ0 and AF ADJ1 pads.

3. **Other Parts Replacement**
   No action is required.

Best Focus Correction (Reference)

<table>
<thead>
<tr>
<th>Correction</th>
<th>AF ADJ0</th>
<th>AF ADJ1</th>
</tr>
</thead>
<tbody>
<tr>
<td>$-\frac{1}{4} \text{Fe}$</td>
<td>Closed</td>
<td>Open</td>
</tr>
<tr>
<td>$-\frac{1}{4} \text{Fe}$</td>
<td>Closed</td>
<td>Closed</td>
</tr>
<tr>
<td>$+\frac{1}{4} \text{Fe}$</td>
<td>Open</td>
<td>Open</td>
</tr>
<tr>
<td>$+\frac{1}{4} \text{Fe}$</td>
<td>Open</td>
<td>Closed</td>
</tr>
</tbody>
</table>

Correction varies with individual lens.

Correction set at 70% of maximum spherical aberration.
EF 28mm f:2.8
CANON LENS EF28mm 1:2.8
Ref. No. C21-5281

Special Optical Adjustments:

<table>
<thead>
<tr>
<th>Adjustment</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centering</td>
<td>☑</td>
<td></td>
</tr>
<tr>
<td>Tilt</td>
<td>☑</td>
<td>☑</td>
</tr>
</tbody>
</table>

Notice: The optical centering adjustment must be done with the lens projector. The 800mm lens focus collimator is not suitable.
TABLE OF CONTENTS

I. Specifications .................................................. I-1

II. DISASSEMBLY & ASSEMBLY................................. II-1
   1. EMD Unit Removal ........................................ II-1
   2. AFD Unit Removal ........................................ II-2
   3. External Parts ......................................... II-3
   4. Helicoid Disassembly ................................. II-4

III. ADJUSTMENTS .................................................. III-1
   1. Optical Centering (Tilt Adjustment) ............. III-1
   2. Focus Adjustment ................................. III-2
   3. Pulse Adjustment ............................... III-3
   4. "Best Focus Adjustment" Service Policy .... III-4

NOTICE: For general information about this lens, see sections I, II, III, and IV of the EF50mm f/1.8 repair guide.

EF28mm f/2.8 Lens Expendables List

<table>
<thead>
<tr>
<th>-ADHESIVES-</th>
<th>Name</th>
<th>Remarks</th>
<th>Plastic Safe?</th>
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<tr>
<td>CY4-9301-000</td>
<td>Double faced tape</td>
<td>Always use new tape (New)</td>
<td>YES</td>
</tr>
<tr>
<td>CY9-8007-000</td>
<td>Aron Alpha</td>
<td>Instant Bond (Cyanoacrylate)</td>
<td>YES</td>
</tr>
<tr>
<td>CY9-8009-000</td>
<td>Arontite R</td>
<td>For staking screws</td>
<td>NO</td>
</tr>
<tr>
<td>CY9-8011-000</td>
<td>Screw-lock</td>
<td>For staking screws</td>
<td>YES</td>
</tr>
<tr>
<td>CY9-8015-000</td>
<td>Water-soluble bond</td>
<td>Light duty,</td>
<td>YES</td>
</tr>
<tr>
<td>CY9-8076-000</td>
<td>Vinylole 2200</td>
<td>General Purpose</td>
<td>YES</td>
</tr>
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<table>
<thead>
<tr>
<th>- LUBRICANTS -</th>
<th>Name</th>
<th>Remarks</th>
<th>Plastic Safe?</th>
</tr>
</thead>
<tbody>
<tr>
<td>CY9-8045-000</td>
<td>GE-C4</td>
<td>Helicoid &amp; cam (metal OK)</td>
<td>YES</td>
</tr>
<tr>
<td>CY9-8086-000</td>
<td>FF-10</td>
<td>Helicoid &amp; cam (New)</td>
<td>YES</td>
</tr>
<tr>
<td>CY9-8087-000</td>
<td>Lozoid 6308/31-F</td>
<td>Manual focusing ring (New)</td>
<td>YES</td>
</tr>
</tbody>
</table>
I. Specifications

The 28 mm f/2.8 was developed to allow a wide angle effect with large subject depth of field for taking snapshots and scenery. Development objectives were compactness and high performance through use of molded glass aspherical lens elements.

[Features]

Compactness achieved together with high performance through use of molded glass aspherical lens elements. This lens has a 5 group, 5 element structure as opposed to the 7 group, 7 element structure of the FD28 mm f/2.8, and provides better optical contrast than the FD28 mm f/2.8.
1. Format: 24 x 36 mm

2. Focal length, aperture: 28mm, f/2.8

3. Optical structure: 5 groups, 5 elements

4. Angle of view (at infinity):
   - Diagonally (43.2 mm) 75°
   - Vertically (24 mm) 46°
   - Horizontally (36 mm) 65°

5. Autofocus (AF)
   - 5-1 Drive system: AFD
   - 5-2 Drive speed: 0.44 seconds (Actual operation between infinity and closest focus(0.3m), not including AF operation)

   - 5-3 Manual: Mechanically clutched focusing ring

6. Focusing:
   - 6-1 Extension system: Double helicoid
   - 6-2 Range: 0.3m to infinity
   - 6-3 Rotation angle, amount of extension
     - Condition | Rotation angle | Extension
     - 0.3m to infinity | 151° 6' | 3.8mm
     - Infinity overrun | None | None

   - 6-4 Distance scale:
     - 1 1.25 2 3.5 5 7 ft (fluorescent green)
     - 0.3 0.4 0.6 1 1.5 2 m (gray)

   - 6-5 Maximum magnification, field of view
     - Condition | Magnification (power) | Field of view (mm)
     - Close focus | 0.13X | 186 x 279mm
7. Mount

7-1 Type: New Canon mount

7-2 Signal transfer function: EOS system, with 7 signals as follows:
   A) Lens condition
   B) Lens type
   C) Photometry signal
   D) Focal length
   E) AF drive information

8. Aperture mechanism

8-1 Diaphragm control: Pulse control using EMD

8-2 Aperture range: f/2.8 - f/22

8-3 Number of diaphragm blades: 5

8-4 Depth-of-field scale: Provided

8-5 Infrared index: Provided

9. Filter thread: 52mm, 0.75mm pitch

10. Dimensions & weight: 67.4 mm diameter x 42.5 mm length / 185g

11. Related products

11-1 Hood: SS-65 (new)

11-2 Lens cap: E-52 (new)

11-3 Lens case: S (new soft case), LHP-C8

11-4 Dust cap: Common to all EF lenses (new)

12. Other: Maximum number of filters usable: 1
II. DISASSEMBLY & ASSEMBLEY 28 mm f/2.8

1. EMD Unit Removal

Set lens to infinity before beginning.
Lift with a flat-bladed screwdriver or similar tool, being careful not to mar the lens element.
Bayonet lugs (3) - Stake with screw-lock.
Apply screw-lock to threads.
On the lens projector, adjust the lens position for best central and peripheral resolution and fix in position with screw (2).
Clean the maximum aperture switch, but DO NOT disturb the eccentric. (A factory tool is required to adjust it.)

Water-soluble bond

EMD Flex holder

Stake head with screw-lock.

Main flex unit - Unsloider 30 points (A) through (E). (A) & (B) only to remove EMD. CAUTION: PLASTIC PARTS - Use soldering iron with care.

Insulating sheet

This screw need not be removed.
VI. DISASSEMBLY & ASSEMBLY EF28mm f/2.8

2. AFD Unit Removal  (Set lens to closest focus before beginning.)

AFD Unit (8) Removal

1. Remove screws (5), (6), & (7).
2. Lift at [B] and gently wiggle flex in the clockwise direction to remove.

AFD Unit (8) Installation

1. Reverse the removal procedure.
2. Install and lightly tighten screw (6).
3. Install and lightly tighten screw (7).
4. Mate the switch knob and AF/M lever with the charge lever.
5. Install screw (5).

AFD Unit (8) Alignment

6. Move the flex with tweezers at "A" (above). Work the flex slightly, with screw (6) as the fulcrum, screw (7) should move about 0.3mm.
7. At a point just slightly inside the midpoint of this travel, tighten screws (7) and (6).
8. Operate the manual focusing ring to check for smooth focusing. [This adjustment sets the mesh of the AFD final drive and the helicoid's focus gear.]

(1) - (4): See previous page
VI. DISASSEMBLY & ASSEMBLY

EF28mm f/2.8

3. External Parts

- Opposite index
- Turn CCW to decouple bayonet
- Screw-lock (bayonet lugs)
- Screw-lock (bayonet lugs)
- Index
- Lozoid 6308/31-F (Friction and gear surfaces)

See next page

- Aron Alpha - four spots near claws
  Push out to remove. Claws break easily.
  Don't leave plastic chips in lens.

- Hi-lock (threads)
- Vinylole (4 clips)

Push from above to remove.
II. DISASSEMBLY & ASSEMBLE EF28mm f/2.8

4. Helicoid Disassembly

Revolution helicoid (4)-6 disengages from the near focus end.
[When reinstalling, install key, with focus stopper (4)-7 attached at the AF/M mark.]

Pry three ears out to disengage them.
[Orientate properly when reinstalling.]

Unscrew (normal thread)
[When reinstalling, tighten lightly and then back off about 6mm. Stake at three points with about 1cm of screw-lock.]

FF-10 (Just enough to wet threads --- this reduces resistance to lighten load on the motor.)

Revolving helicoid

Focus stopper (press fit)

GE-C4 (on friction surfaces)

Close focus stopper
VII. ADJUSTMENTS EF28mm f/2.8

1. Optical Centering (Tilt Adjustment)

<table>
<thead>
<tr>
<th>STANDARD:</th>
<th>Table 1: Resolution Chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image Height (mm)</td>
<td>0</td>
</tr>
<tr>
<td>S</td>
<td>100</td>
</tr>
<tr>
<td>Axial</td>
<td>100</td>
</tr>
<tr>
<td>Test Distance: f x 50, f/2.8</td>
<td></td>
</tr>
</tbody>
</table>

Check Method

1. Remove the front ring (1) and mount on the lens projector with the EOS mount adaptor attached.

2. Loosen, but do not remove, three screws (2).

3. Install the front lens assembly in the helicoid by matching the three slots. While watching the chart, turn the lens slightly until best edge and corner (16 and 20mm) resolution is obtained.

4. Tighten the screws.

Note: The main purpose of this adjustment is to prevent lens tilt. The 800mm lens focus collimator cannot be used in this case because of the great difference in the test lens and collimator focal length.

For facilities without lens projectors, place tape on the front lens assembly (fig. 3) to reduce the space between the unit and the helicoid so the lens unit is as nearly centered as possible without a tool or projector. If tape is not used and the lens assembled without a projector, there may be as much as three to four steps difference between corners (20mm). When tape is used, this difference can be reduced to about one step. If poor resolution or resolution differences from one side to the other are the reason the lens is being repaired, then it is mandatory that the repair be done at a facility with a lens projector.
VII. ADJUSTMENTS EF28mm f/2.8

1. Focus Adjustment

**STANDARD: ± 0.03mm**

Focus washers are not used in the factory adjustment of EOS lenses. The service adjustment uses washers and/or undercut lens mounts.

1. Check Method
Two different methods can be used to adjust EF lenses for correct focus. Both adjustments are carried out with the lens in manual focusing mode.

1.1 800mm Lens Focus Collimator Method
Install the EOS lens mount adaptor on the collimator and check several lenses from stock to establish an average. Adjust repaired lenses to that average.

1.2 Camera Method
Use a known-good camera with a type B focusing screen (split-image) and a magnifier. Check infinity focus on a collimator or with an actual target at least 100ft distant.

2. Adjustment Method

2.1 If the lens focuses past infinity (plus), focusing washers up to a combined thicknesses of 0.07mm can be used. If the defocus is greater than 0.07mm plus, or minus, measure the lens mount thickness and choose the appropriate undercut lens mount and focus washers to bring the focus within limits.

2.2 After adjustment, attach the lens to the camera and range an infinity target in the AF mode. The index should align with the infinity marker. Projection testing is not necessary for this lens.

At finite distances, the index should be within the f/5.6 D-O-F.
VII. ADJUSTMENTS EF28mm f/2.8

2. Pulse Adjustment

STANDARD: \(0.9T \leq t \leq 1.1T\)

Adjust if any of the three units shown at the right are changed. If
not adjusted, AFD may work incorrectly at normal temperatures but
fail at high or low temperatures.

Adjustment Method

1. Assemble the lens up to the point where the mount portion is
   attached to the rest of the lens.

2. Temporarily attach leads to the pads marked [PULS CH] and
   [D-GND] in figure 2.

3. Attach the lens mount to a camera body. Since the main part
   of the lens is hanging by the flex, be careful not to tear it.

4. Attach the leads (step 2) to the oscilloscope probe.

5. Set the lens in the AF mode and the camera in the ONE-SHOT
   mode, and press the shutter button. (The AF will search continu-
   ously because the lens is not in place.)

6. Adjust VR7 so the waveform is like figure 3 (C).
VII. ADJUSTMENTS EF28mm f/2.8

3. "Best Focus Adjustment" Service Policy

STANDARD: $\pm \frac{1}{4} \text{Fe}$  

Fig. $= f$/number  

$e = 0.035 \text{mm} \text{ (Canon circle of confusion)}$

REF: AF Focus Point Limits: The difference in the best focus point and the actual point where the lens focuses must be within $\pm \frac{1}{4} \text{Fe}.$

There is bound to be some discrepancy between the focus point determined by the autofocus system and the actual best focus point of the interchangeable lenses due to the inherent differences between the different lens types.

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In actuality, in addition to this type difference, there is a difference between individual lenses within each type, which can be noticeable if not corrected. At the factory, correction is written into the individual lens' ROM with an expensive, special tool. This is called the "Best Focus Adjustment". Because of the tooling cost involved, this adjustment will not be a part of the service procedure. In its stead, the following actions will be taken.

Service Actions:

1. Main Flex Replacement
   Check the AF ADJ0 and AF ADJ1 pads on the flex being replaced and bridge the pads on the new flex in the same way.

2. Rear Lens (CG9-5172) Replacement
   Open any bridges on the AF ADJ0 and AF ADJ1 pads.

3. Other Parts Replacement
   No action is required.

Best Focus Correction (Reference)

<table>
<thead>
<tr>
<th>Correction</th>
<th>AF ADJ0</th>
<th>AF ADJ1</th>
<th>Correction varies with individual lens.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$-\frac{1}{4} \text{Fe}$</td>
<td>Closed</td>
<td>Open</td>
<td>Correction set at 70% of maximum spherical aberration.</td>
</tr>
<tr>
<td>$-\frac{1}{4} \text{Fe}$</td>
<td>Closed</td>
<td>Closed</td>
<td></td>
</tr>
<tr>
<td>$+\frac{1}{4} \text{Fe}$</td>
<td>Open</td>
<td>Open</td>
<td></td>
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<tr>
<td>$+\frac{1}{4} \text{Fe}$</td>
<td>Open</td>
<td>Closed</td>
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</table>
CANON LENS EF15mm 1:2.8
Ref. No. C21-5291

Special Optical Adjustments:

<table>
<thead>
<tr>
<th>Adjustment</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centering</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Tilt</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Note: For best results, the air gap between G4, in the front group, and G5, in the rear group, must be adjusted. See details.
TABLE OF CONTENTS

I. Specifications ............................................. I-1

II. DISASSEMBLY & ASSEMBLY................................. II-1

1. EMD Unit Removal ....................................... II-1
2. AFD Unit Removal ....................................... II-2
3. External Parts .......................................... II-3
4. Helicoid Disassembly ................................. II-4

III. ADJUSTMENTS ................................................ III-1

1. Optical Element Spacing (S Adj.) .................. III-1
2. Focus Adjustment ........................................ III-2
3. Pulse Adjustment ........................................ III-3
4. "Best Focus Adjustment" Service Policy ........ III-4

NOTICE: For general information about this lens, see sections I, II, III, and IV of the EF50mm f/1.8 repair guide.

EF15mm f/2.8 Lens Expendables List

-ADHESIVES-

<table>
<thead>
<tr>
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<th>Name</th>
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<th>Plastic Safe?</th>
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<tr>
<td>CY4-9301-000</td>
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<td>YES</td>
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<td>Instant Bond (Cyanoacrylate)</td>
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</tr>
<tr>
<td>CY9-8009-000</td>
<td>Arontite R</td>
<td>For staking screws</td>
<td>NO</td>
</tr>
<tr>
<td>CY9-8011-000</td>
<td>Screw-lock</td>
<td>For staking screws</td>
<td>YES</td>
</tr>
<tr>
<td>CY9-8015-000</td>
<td>Water-soluble bond</td>
<td>Light duty</td>
<td>YES</td>
</tr>
<tr>
<td>CY9-8076-000</td>
<td>Vinylole 2200</td>
<td>General Purpose</td>
<td>YES</td>
</tr>
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- LUBRICANTS -

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<tr>
<th>Part Number</th>
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<td>FF-10</td>
<td>Helicoid &amp; cam (New)</td>
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<tr>
<td>CY9-8087-000</td>
<td>Lozoid 6308/31-F</td>
<td>Manual focusing ring (New)</td>
<td>YES</td>
</tr>
</tbody>
</table>
1. Specifications

This lens is a full-frame fisheye lens developed for the EOS. In developing this lens, the objective was to improve performance over that of the FD15 mm f/2.8 while reducing the number of lens elements.

Features

Low distortion; within 1.2% of that for upright solid square projection.

To increase freedom of choice in filters, the built-in turret has been discarded in favor of a gelatin filter holder on the rear of the lens.

Performance has been improved over the FD15mm f/2.8 while reducing the number of lens elements by one.

---

**EF 15mm f/2.8 FE**

---

**Diaphragm**

**Mount Plane**

**Film Plane**

62.67

(BF: 39.73)

(Back Focus)
1. Format: 24 x 36 mm

2. Focal length/aperture:

3. Optical structure: 7 groups, 8 elements (Super Spectra Coating)

4. Angle of view (at infinity):
   Diagonally (43.2 mm) 180°

5. Autofocus (AF)
   5-1 Drive system: AFD
   5-2 Drive speed: 0.36 sec (Actual operation between infinity and closest focus, not including AF operation)
   5-3 Manual: Mechanically clutched focusing ring

6. Focusing:
   6-1 Extension system: Double helicoid
   6-2 Range: 0.2 m to infinity
   6-3 Rotation angle/amount of extension

   
   Condition | Rotation angle | Extension
   0.2 m to infinity | 86° 4' | 2.16
   Infinity overrun | 9.6° | 0.34mm

   6-4 Distance scale:

   | 0.7 | 1 | 1.75 | 3.5 | ft (fluorescent green) |
   | x   | 0.2 | 0.3  | 0.5  | 1   | m (gray) |

   6-5 Maximum magnification/field of view

   Condition | Magnification (power) | Field of view (mm)
   Close focus | 0.14X | NA
7. Mount

7-1 Type: New Canon mount

7-2 Signal transfer function: EOS system, with 5 signals as follows:
   A) Lens condition
   B) Lens type
   C) Photometry signal
   D) Focal length
   E) AF drive information

8. Aperture mechanism

8-1 Diaphragm control: Pulse control using EMD

8-2 Aperture range: f/2.8 - f/22

8-3 Number of diaphragm blades: 5

8-4 Depth-of-field scale: Provided

8-5 Infrared index: Provided

9. Filter: Commercial gelatin filters cut to size

10. Dimensions/weight: 73mm diameter x 62.2mm length / 360g

11. Related products

11-1 Hood: Built-in

11-2 Lens cap: 73mm (special)

11-3 Lens case: (new soft case), LHP-C

11-4 Dust cap: Common to all EF lenses (new)

12. Other: Maximum number of filters usable: one
II. DISASSEMBLY & ASSEMBLY

1. EMD Unit Removal

EF15mm f/2.8

Unscrew (The assembly collar may loosen.)

Dust Shield

Lens element spacing "S" collar.

EMD Unit: Clean the maximum aperture switch, but DO NOT disturb the eccentric. (A factory tool is required to adjust it.)

EMD Spacer (The same EMD unit is used in other lenses.)

(See Pg.6)

EMD Flex holder (Place flex in crook.)

Stake head with screw-lock.

(A) & (B) only to remove EMD, but it is better to unsolder [A] through [E] and remove attached to the mount (7). When unsoldering [A] and [B], lift the main flex unit slightly and unsolder carefully. CAUTION: PLASTIC PARTS - Use soldering iron with care.

This screw need not be removed.

(See Pg.6)
VI. DISASSEMBLY & ASSEMBLY

2. AFD Unit Removal

Set lens to closest focus before beginning.

AFD Unit (8) Removal
1. Remove screws (5), (6), & (7).
2. Lift at [B] and gently wiggle the flex in the clockwise direction.
3. Lift [A] to remove.

AFD Unit (8) Installation
1. Reverse the removal procedure.
2. Install and lightly tighten screw (6).
3. Install and lightly tighten screw (7).
4. Mate the switch knob and AF/M lever with the clutch lever.
5. Install screw (5).

AFD Unit (8) Alignment
6. Move the flex with tweezers at "A" (above). Work the flex slightly, with screw (6) as the fulcrum, screw (7) should move about 0.3mm.
7. At a point just slightly inside the midpoint of this travel, tighten screws (7) and (6).
8. Operate the manual focusing ring to check for smooth focusing. [This adjustment sets the mesh of the AFD final drive and the helicoid's focus gear.]

(1) - (4): See previous page
II. DISASSEMBLY & ASSEMBLY  EF15mm f/2.8

3. External Parts

Bayonet: Turn CCW to remove. (The long hood sections go at the top and bottom.)

Excessive tightening of these screws will deform helicoid. Watch carefully for deformation from front of lens as you tighten.

Cut-outs are for applying screw-lock to prevent name ring loosening. Run keton in and apply even pressure around to unscrew. If removal is impossible, remove from the rear with a screwdriver, taking care not to mar (4).

Lube: Lozoid 6308/31-F (Friction and gear surfaces)

See next page

Instant Bond - four spots near claws [Push out to remove. Claws break easily. Don't leave plastic chips in lens.]

Hi-lock (threads)

Push on the claws from the top.

Lube: Vinylole (on claws)
4. Helicoid Disassembly

- Revolving helicoid (5)-6 disengages from the near focus end. Mark before removing.

- Pry three ears out to disengage them. [Orientate properly when reinstalling.]

- Unscrew (normal thread) when reinstalling, tighten lightly and then back off about 6mm. Stake at three points with about 1cm of screw-lock.

- FF-10 (Just enough to wet threads — this reduces resistance to lighten load on the motor.)

- Focus stopper (press fit)

- GE-C4 (on friction surfaces)

- Close focus stopper
III. ADJUSTMENTS EF15mm f/2.8

1. Optical Element Spacing (S Distance) Adjustment

Standard: 7.48 ± 0.03mm (G4-G5 spacing)
Tester: Micro Tester (Height Gage)

Calculation: \[ X = (A) - (B) + 7.48 \text{mm} \]

\( X \): washer thickness

(A): G4R2 to FLU front end (with G1 removed)

(B): G5R1 to lens mount (with contact assy removed)

S distance washers sizes

<table>
<thead>
<tr>
<th>A SIZE (mm)</th>
<th>A SIZE (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.45</td>
<td>1.65</td>
</tr>
<tr>
<td>1.50</td>
<td>1.70</td>
</tr>
<tr>
<td>1.55</td>
<td>1.75</td>
</tr>
<tr>
<td>1.60</td>
<td></td>
</tr>
</tbody>
</table>

S distance washer

Service method (for facilities without micro height gages)

Improper tolerances results in slight increases in spherical aberration and distortion, but the changes are slight. Using the existing washer usually results in good results.

If the customers complaint is specifically about poor resolution, send the lens to a fully-equipped service facility for complete testing.

<table>
<thead>
<tr>
<th>Table 1: Resolution Chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image Height (mm)</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>S</td>
</tr>
<tr>
<td>S</td>
</tr>
<tr>
<td>M</td>
</tr>
<tr>
<td>M</td>
</tr>
</tbody>
</table>
III. ADJUSTMENTS EF15mm f/2.8

2. Focus Adjustment

STANDARD: ± 0.03mm

Focus washers are not used in the factory adjustment of EOS lenses. The service adjustment uses washers and/or undercut lens mounts.

1. Check Method
Two different methods can be used to adjust EF lenses for correct focus. Both adjustments are carried out with the lens in manual focusing mode.

1.1 800mm Lens Focus Collimator Method
Install the EOS lens mount adaptor on the collimator and check several lenses from stock to establish an average. Adjust repaired lenses to that average.

1.2 Camera Method
Use a known-good camera with a type B focusing screen (split-image) and a magnifier. Check infinity focus on a collimator or with an actual target at least 100f² distant.

2. Adjustment Method

2.1 If the lens focuses past infinity (plus), focusing washers up to a combined thicknesses of 0.07mm can be used. If the defocus is greater than 0.07mm plus, or minus, measure the lens mount thickness and choose the appropriate undercut lens mount and focus washers to bring the focus within limits.

2.2 After adjustment, attach the lens to the camera and range an infinity target in the AF mode. The index should align with the infinity marker. Projection testing is not necessary for this lens.

At finite distances, the index should be within the f/5.6 D-O-F.
III. ADJUSTMENTS EF15mm f/2.8

2. Pulse Adjustment

STANDARD: \(0.9T \leq t \leq 1.1\)T

Adjust if any of the three units shown at the right are changed. If not adjusted, AFD may work correctly at normal temperatures but fail at high or low temperatures.

Adjustment Method

1. Assemble the lens up to the point where the mount portion is attached to the rest of the lens.

2. Temporarily attach leads to the pads marked [PULS CH] and [D-GND] in figure 2.

3. Attach the lens mount to a camera body. Since the main part of the lens is hanging by the flex, be careful not to tear it.

4. Attach the leads (step 2) to the oscilloscope probe.

5. Set the lens in the AF mode and the camera in the ONE-SHOT mode, and press the shutter button. (The AF will search continuously because the lens is not in place.)

6. Adjust VR7 so the waveform is like figure 3 (C).
III. ADJUSTMENTS EF15mm f/2.8

4. "Best Focus Adjustment" Service Policy

STANDARD: $\pm \frac{1}{4}\text{Fe}$  

$F = f/\text{number}$  

$e = 0.035\text{mm} \ (\text{Canon circle of confusion})$

REF: AF Focus Point Limits: The difference in the best focus point and the actual point where the lens focuses must be within $\pm \frac{1}{4}\text{Fe}$.]

There is bound to be some discrepancy between the focus point determined by the autofocus system and the actual best focus point of the interchangeable lenses due to the inherent differences between the different lens types.

In the EOS system, the difference between the AF focus and the optical best focus has been determined for each lens type and the information written into the lenses Read Only Memory (ROM) so that correction for the difference at maximum aperture is made electronically.

In actuality, in addition to this type difference, there is a difference between individual lenses within each type, which can be noticeable if not corrected. At the factory, correction is written into the individual lens' ROM with an expensive, special tool. This is called the "Best Focus Adjustment". Because of the tooling cost involved, this adjustment will not be a part of the service procedure. In its stead, the following actions will be taken.

Service Actions:

1. Main Flex Replacement
   Check the AF ADJ0 and AF ADJ1 pads on the flex being replaced and bridge the pads on the new flex in the same way.

2. If lens G3 (CN2-1103) or G4 (CY1-2221) is replaced, open all bridges.

<table>
<thead>
<tr>
<th>Best Focus Correction (Reference)</th>
<th>AF ADJ0</th>
<th>AF ADJ1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$-\frac{1}{4}\text{Fe}$</td>
<td>Closed</td>
<td>Open</td>
</tr>
<tr>
<td>$-\frac{1}{4}\text{Fe}$</td>
<td>Closed</td>
<td>Closed</td>
</tr>
<tr>
<td>$+\frac{1}{4}\text{Fe}$</td>
<td>Open</td>
<td>Open</td>
</tr>
<tr>
<td>$+\frac{1}{4}\text{Fe}$</td>
<td>Open</td>
<td>Closed</td>
</tr>
</tbody>
</table>

Correction varies with each lens.  
Correction is set at 70% of maximum spherical aberration.
ELECTRICAL DIAGRAMS