

EF 50mm1 : 1.8

CANON LENS EF50mm 1:1.8
Ref. No. C21-6211

Special Optical Adjustments:

Centering.	Yes	<input checked="" type="radio"/> No
Tilt	Yes	<input checked="" type="radio"/> No

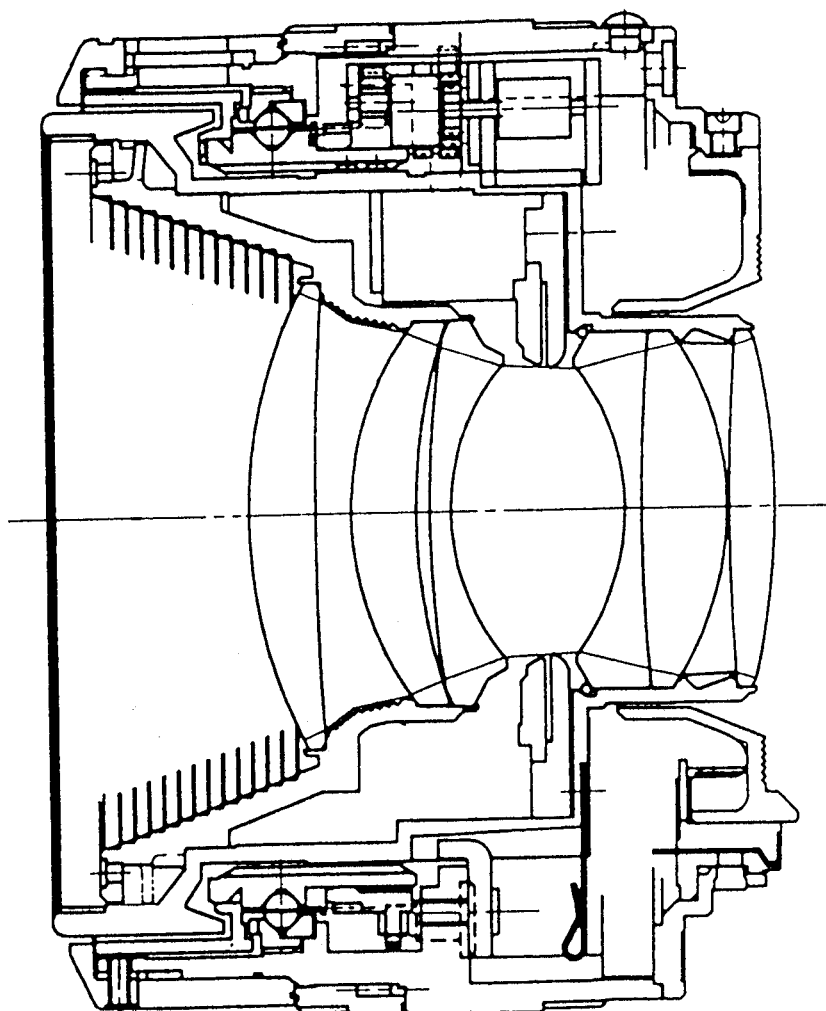


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NOTICE: Sections I, II, III, and IV of this repair guide apply in general to all EF lenses. If, in the future, more information is necessary, it will be included in the repair guide for the first product with the feature.

EF50mm f/1.8 Lens Expendables List

-ADHESIVES-

Part Number	Name	Remarks	Plastic Safe?
CY4-9301-000	Double faced tape	Always use new tape (New)	YES
CY9-8007-000	Aron Alpha	Instant Bond (Cyanoacrylate)	YES
CY9-8009-000	Arontite R	For staking screws	NO
CY9-8011-000	Screw-lock	For staking screws	YES
CY9-8076-000	Vynlolle 2200	General Purpose	YES

- LUBRICANTS -

Part Number	Name	Remarks	Plastic Safe?
CY9-8045-000	GE-C4	Helicoid & cam (metal OK)	YES
CY9-8086-000	FF-10	Helicoid & cam (NEW)	YES
CY9-8087-000	Lozoid 6308/31-F	Manual focusing ring (New)	YES

I. EOS LENS 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 auto-focus 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

Name and Number	Use
FF-10 (CY9-8086-000)	Focusing helicoid grease (Apply just enough to wet the surface with lens tissue.
Lozoid 6308/31-F (CY9-8087-000)	Used on gears and the inner contact surface of the manual ring. (Replaces GE-C4, which is too light to give the necessary feel.)
SO-820(CY9-8088-000)	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.

7. New Tools

EF Mount Adaptor (CY9-2001-003)	This tool allows mounting EF lenses on the lens focus collimator or projection test unit.
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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 electro-mechanical 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 losing 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.

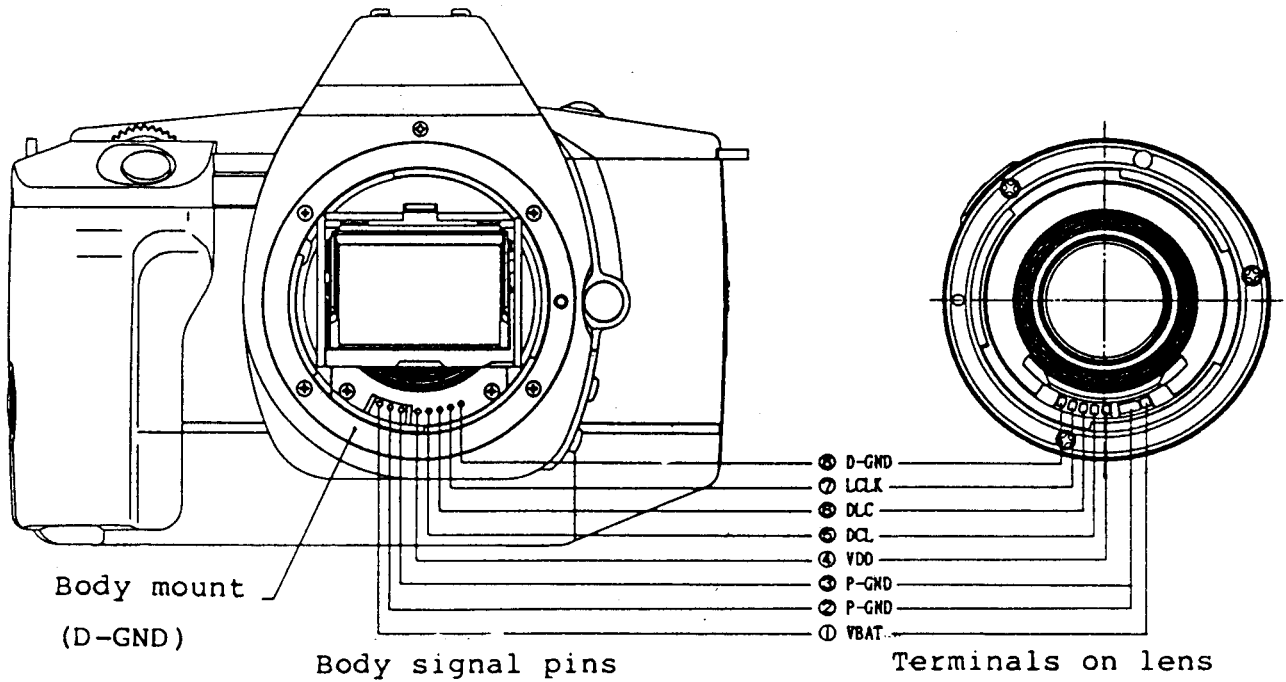
Ultrasonic Motor (USM)

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.

[1]-Fig.-2 Electronic mount signals



Diameter of contact surface	ø54 mm
Outside diameter	ø65 mm
Lens mounting rotation angle	60°
Flange back	44 mm
Signal transfer	All-electronic signal transfer through 8 contacts
Signals	(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).

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

(1) Lens state

Information	Purpose
Focusing ring Ranging disabled	This data indicates the state of the focusing ring, and prevents AF while the focusing ring is accelerating or decelerating.
Electronic ring drive on	Information required for power to USM
Manual focus	Prevent AF operation during manual focusing.
Drive ineffective	Tells the camera that drive was stopped because the focusing ring can't move.

(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.

Control	Purpose
AF control	The microprocessor automatically switches information required for AF control according to the output of the zoom encoder.
AE control	Automatic zoom flash and intelligent program settings.

(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:

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

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.

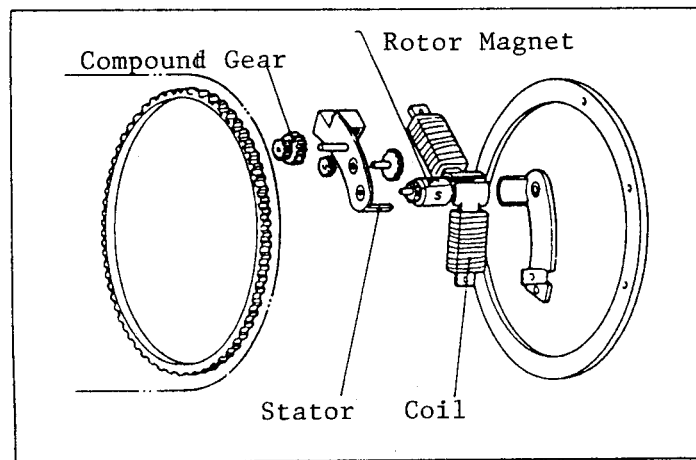


Fig. 1

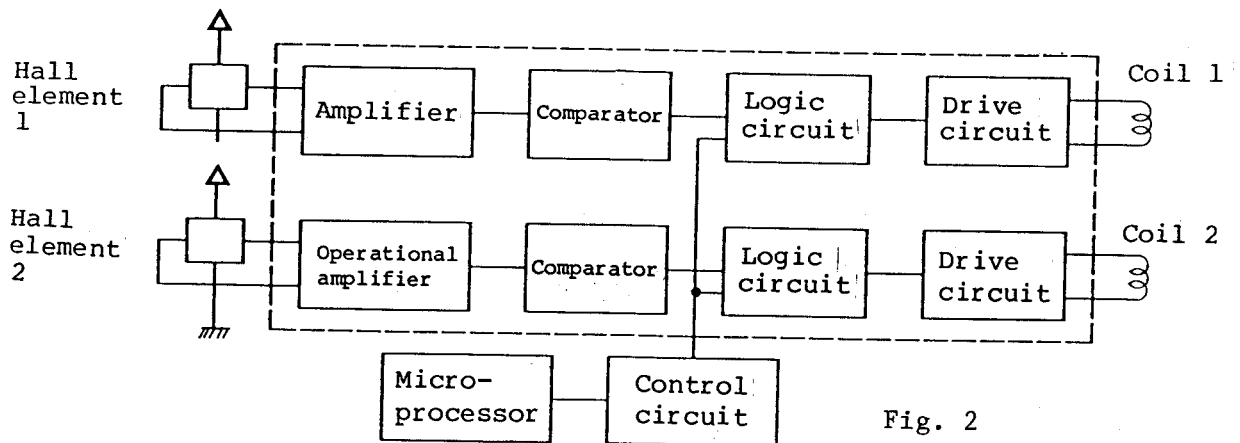


Fig. 2

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 repulsed by stators 1 and 2, and is attracted by stators 3 and 4, causing it to turn 45° in the counterclockwise direction.

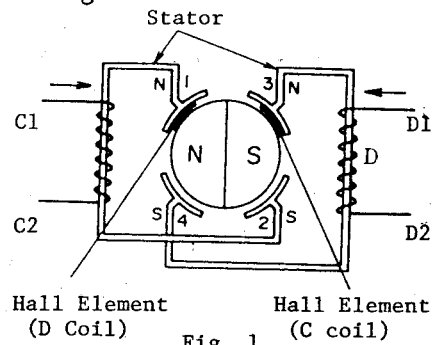


Fig. 1

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.

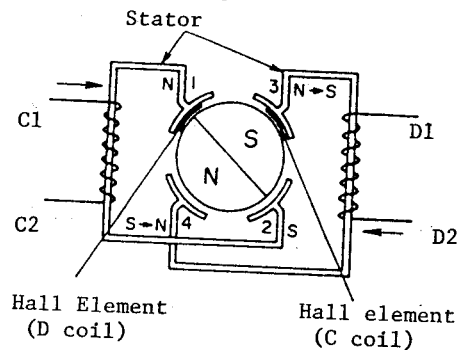


Fig. 2

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.

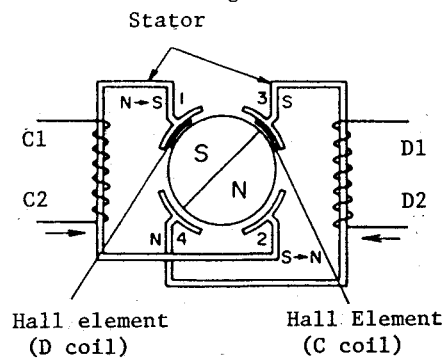
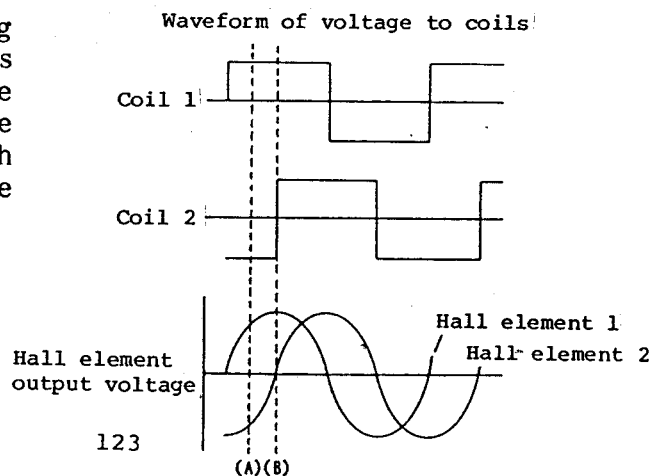


Fig. 3

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.

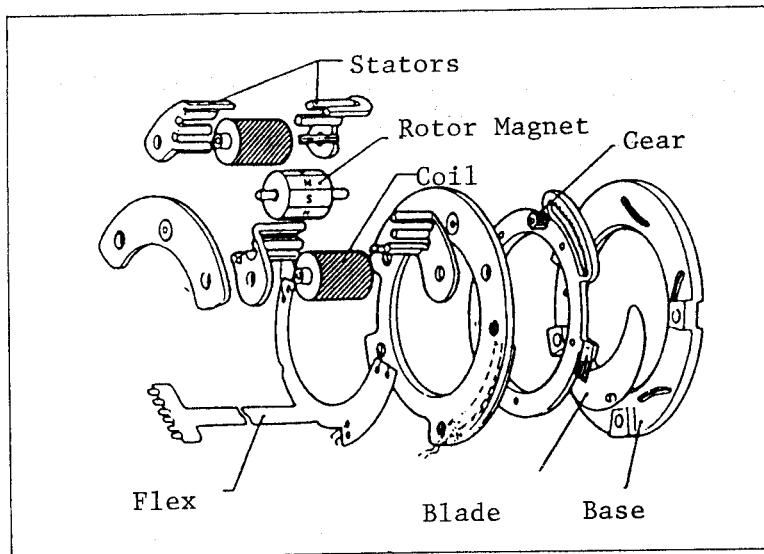


Fig. 1

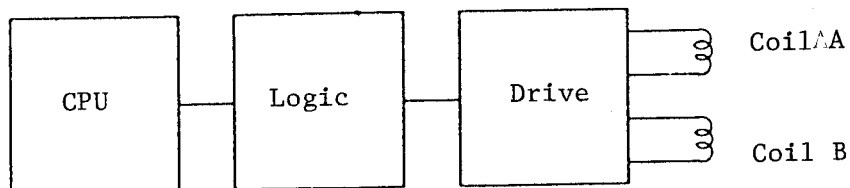
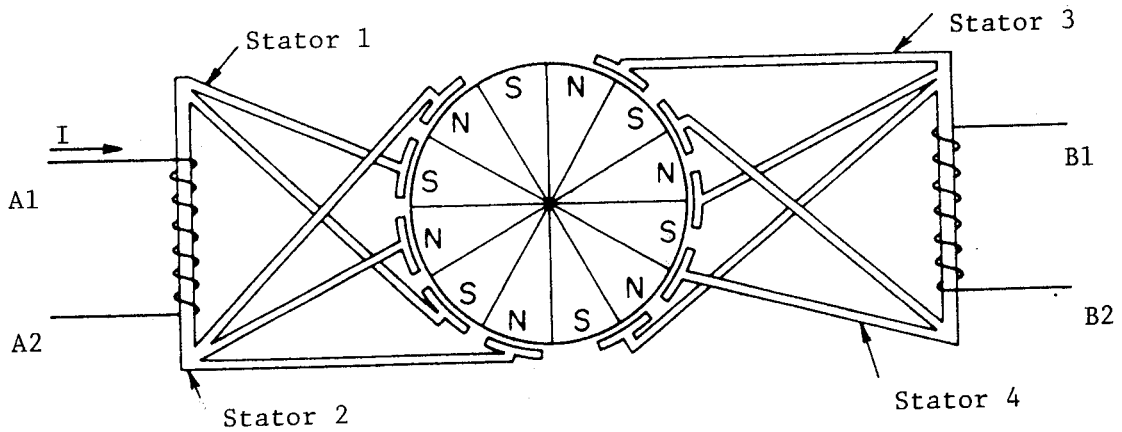
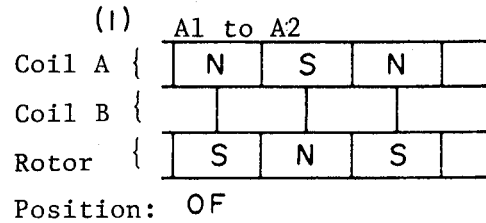


Fig. 2

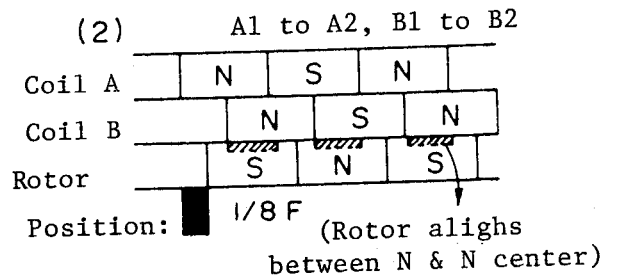
3-2 Principle of operation



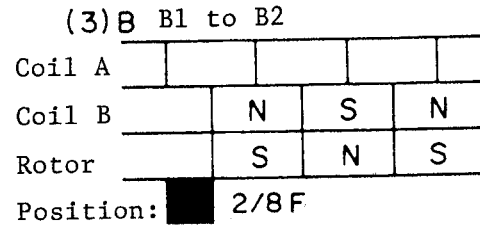
A) Since the rotor pole forms a magnetic path through the stator when no current is passing through the coil, the rotor stops with its poles in opposition to stators 1 and 2. Since the rotor polarity is not in opposition to stators 3 and 4 at this time, it stops with a 1/2 pitch offset. Stators 1 and 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.



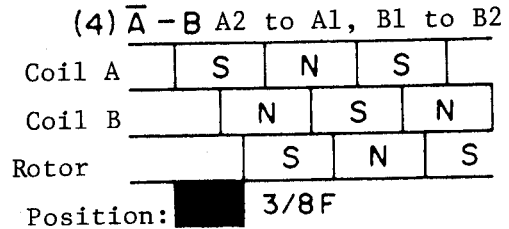
B) In (2) with current flowing from A1 to A2 and B1 to B2, the polarity of stators 1 and 3 becomes N and that of stators 2 and 4 becomes S. This repulses (or attracts) the N and S poles around the perimeter of the rotor so that the rotor rotates 1/4 pitch in the counterclockwise direction. (Each pole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



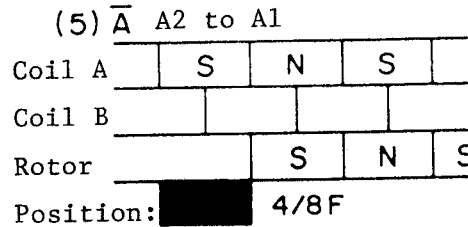
C) Power to coil A is then turned off and current is passed through coil B from B2 to B1. This causes the polarity of stator 3 to become N and that of stator 4 to become S, inducing the rotor to turn counterclockwise by an additional 1/4 pitch.



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 angle. In practice, this is done by switching the combination and direction of current flow between eight possible combinations.



No.	A Coil	B Coil
1	A1 → A2	Off
2	A1 → A2	B1 → B2
3	Off	B1 → B2
4	A2 → A1	B1 → B2
5	A2 → A1	Off
6	A2 → A1	B2 → B1
7	Off	B2 → B1
8	A1 → A2	B2 → B1

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.

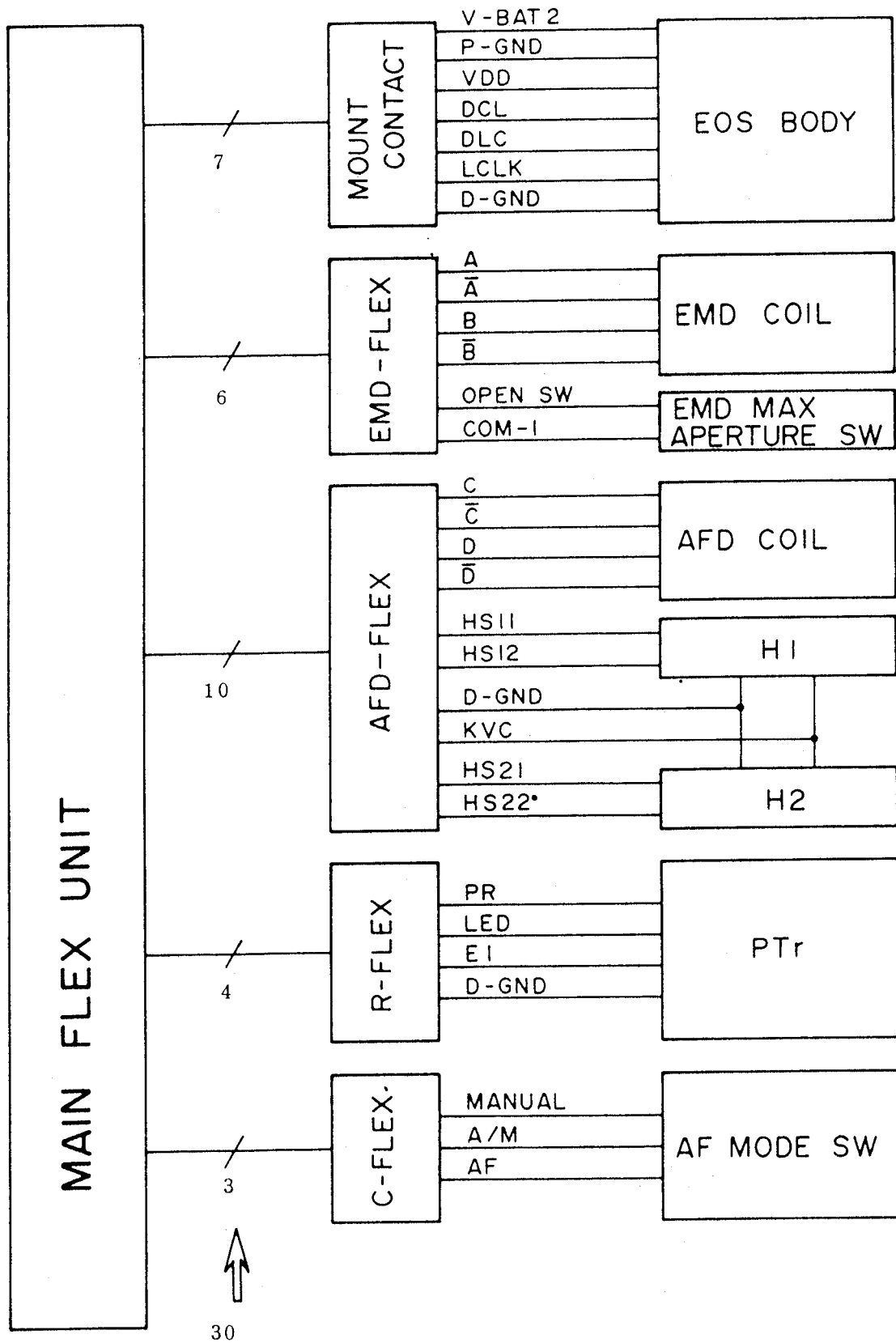
Small rotor diameter makes it easy to control starting and stopping of the diaphragm.

Since the diaphragm and the diaphragm drive mechanism are combined into one unit, more precise control is possible than 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.

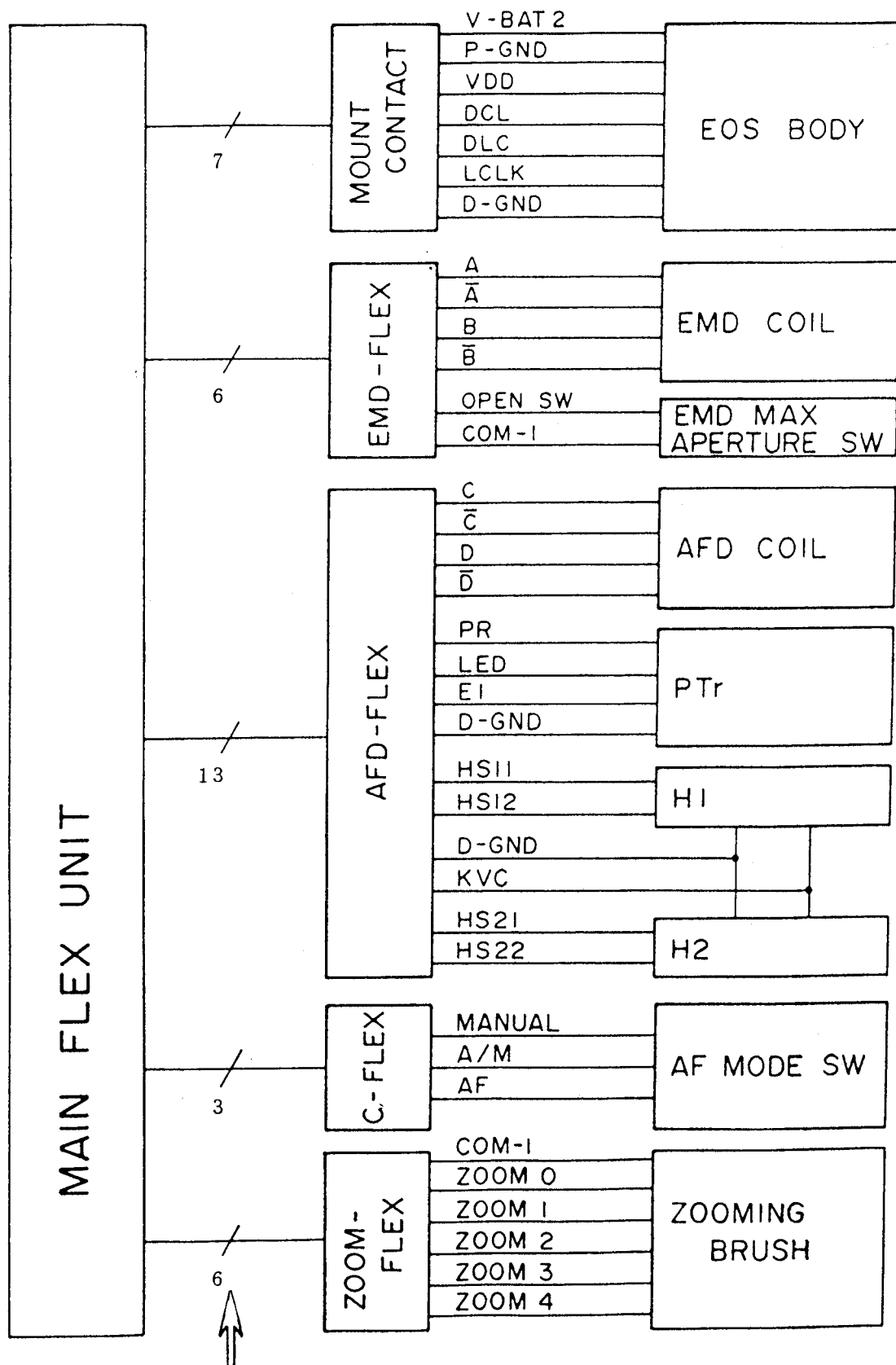
III.-1 Block Diagram (EF50mm f/1.8)

Lines



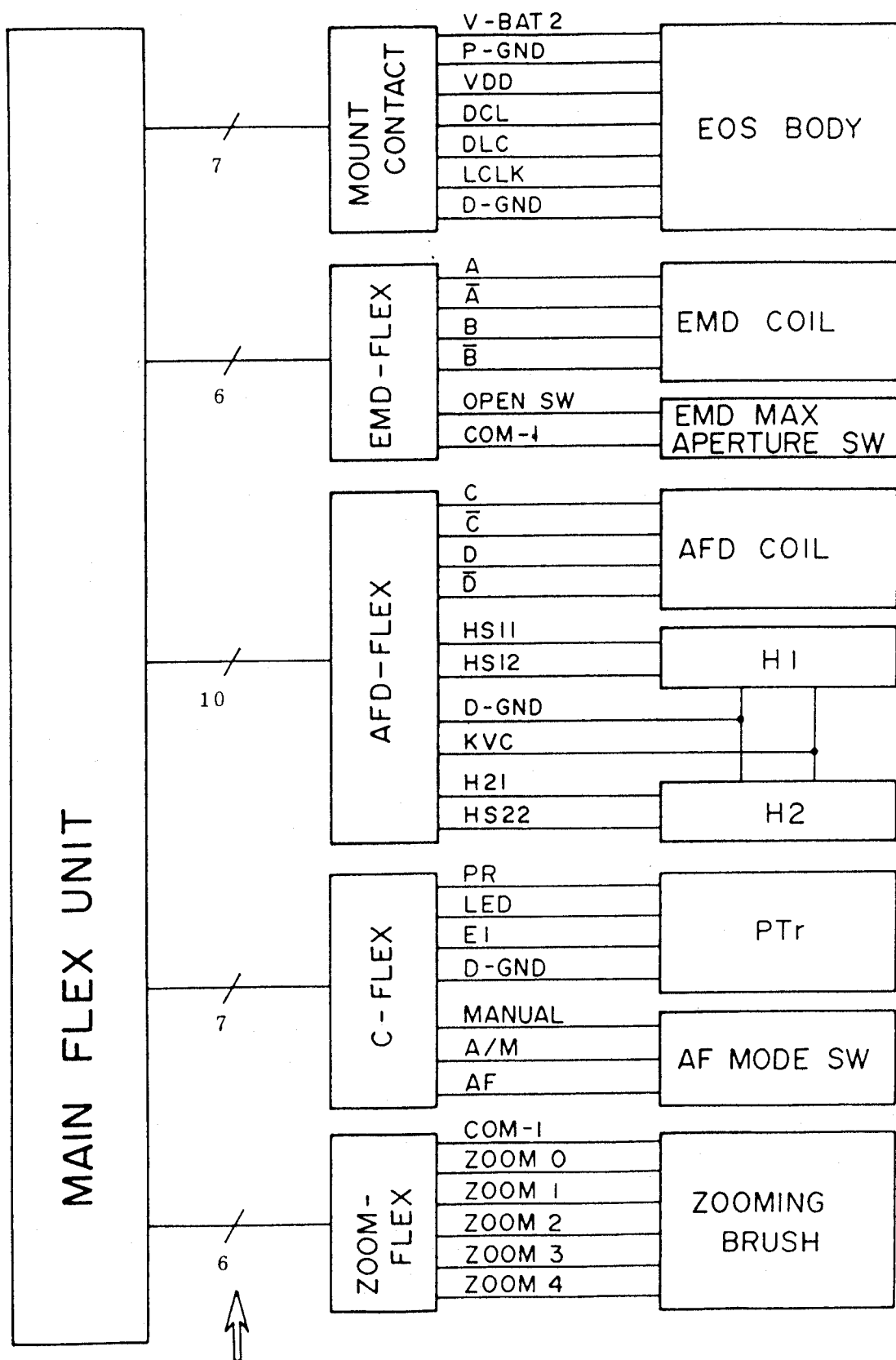
III.-2 Block Diagram (EF35-70mm f/3.5-4.5)

Lines



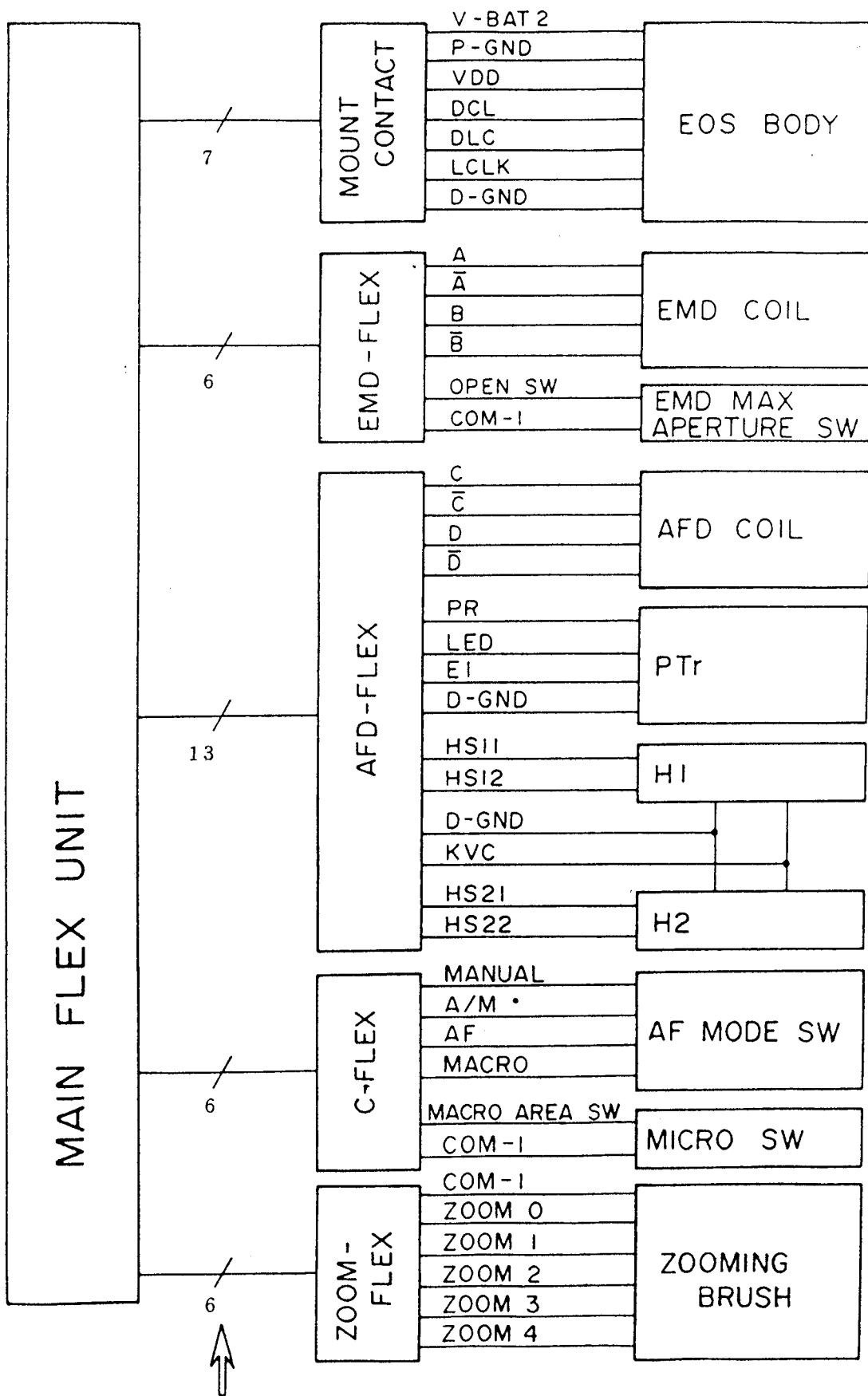
III.-3 Block Diagram (EF35-105 f/3.5-4.5)

Lines



III.-2 Block Diagram (EF70-210 f/4.0)

Lines



IV. Circuit Analysis

[Lens \longleftrightarrow 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 \longrightarrow lens clock pulse [62.5KHz, (16uS pulse)]
	Lens \longrightarrow camera busy signal
DLC	Lens \longrightarrow camera data, data request
DCL	Camera \longrightarrow 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 from 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 CPU's communicate over the LCLK, DCL, and DLC 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 camera's 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 \longleftrightarrow 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) to 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 $\overline{\text{LCLK}}$ 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 TALLY1 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.

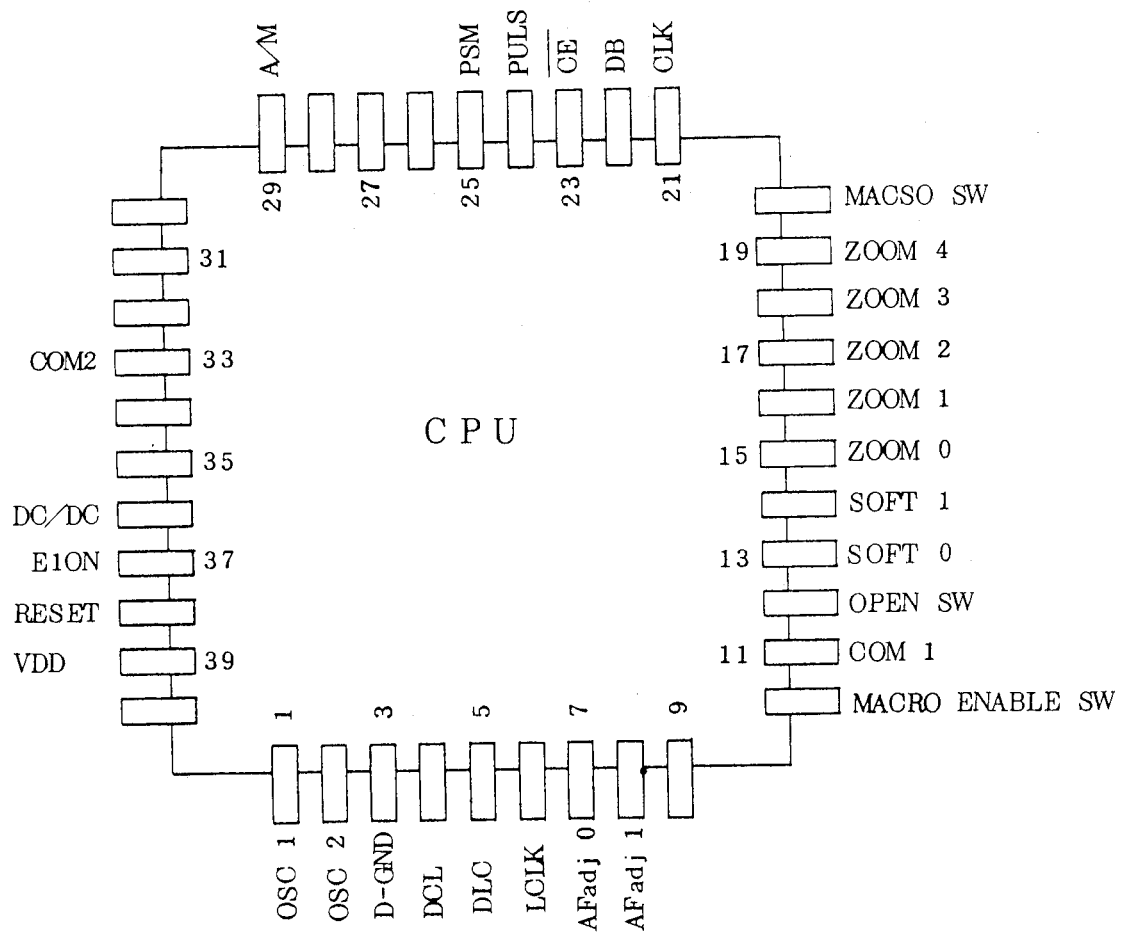
Electronic Component	Mfg. No./ Rating	Description
CPU	MN15829-AX [] []	Microprocessor IC [I] indicates lens.
C-IC	AN8336	Control (or Interface) IC
TALY1, 2	UN206	EMD drive circuit IC
TALY3, 4	UN205	AFD drive circuit IC
OSC	C4CB	CPU oscillator
VDET	MN15821	Voltage detector IC for CPU reset
RTr	UN-212Y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

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

Signal (Voltage)	Description
VBAT2	6V
PGND	0V
VDD	5.5V (CPU voltage supply)
DGND	0V
DCL	Data from camera to lens
DLC	Data from lens to camera
LCLK	Camera and lens clock pulse (62.5 KHz)
CLK	Lens CPU and C-IC clock pulse (62.5KHz)
DB	Data
CE	LOW level for communication between CPU and C-IC
PULSE	Focusing drive pulse (C-IC --> CPU)
PSM	Aperture drive pulse (CPU --> C-IC)
E1	5.5V (C-IC voltage supply)
PR	Phototransistor (PTr) output
LED	PTr LED
KVC	1.8V (Hall element voltage)
H11, H12	Hall element (H1) output
H21, H22	Hall element (H2) output
A, A	EMD coil A phase
B, B	EMD coil B phase
C, C	AFD coil C phase
D, D	AFD coil D phase

IC Pin Tables



Pin Name	Function
OSC 1, 2	Oscillator crystal connections
DGND	CPU device ground
DCL	Camera → lens data
DLC	Lens → camera data, data request
LCLK	Camera ↔ lens data camera → lens clock pulse [62.5KHz, (16uS pulse)] lens → camera busy signal
AF Adj. 0, 1	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.)

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 \longrightarrow C-IC clock pulse [62.5KHz, (16uS pulse)]

DB CPU \longleftrightarrow C-IC data

CE CPU \longrightarrow 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.

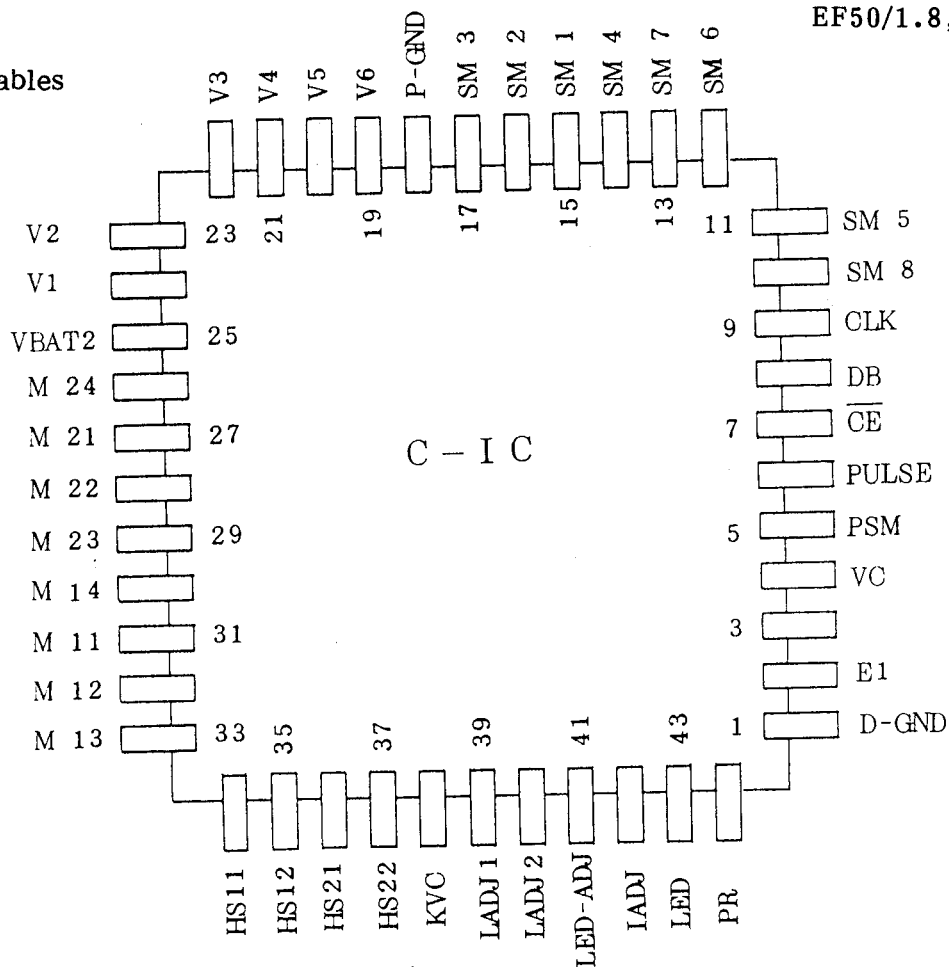
DC/DC This terminal is connected to the manual side of the AM switch.

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.

IC Pin Tables



Pin Name

Function

DGND	C-IC device ground
E1	C-IC power supply, controlled from CPU.
VC	Check pin for internal reference voltage
PSM	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.
PULSE	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.
CE	CPU → C-IC data enable (sets start of data train)
DB	CPU ↔ C-IC data
CLK	CPU → C-IC clock pulse [62.5KHz, (16uS pulse)]
SM1, SM2; SM5, SM6.	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 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

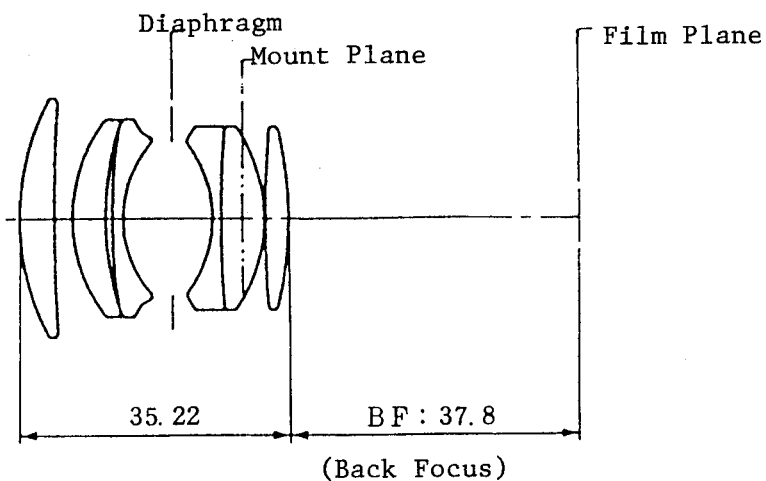
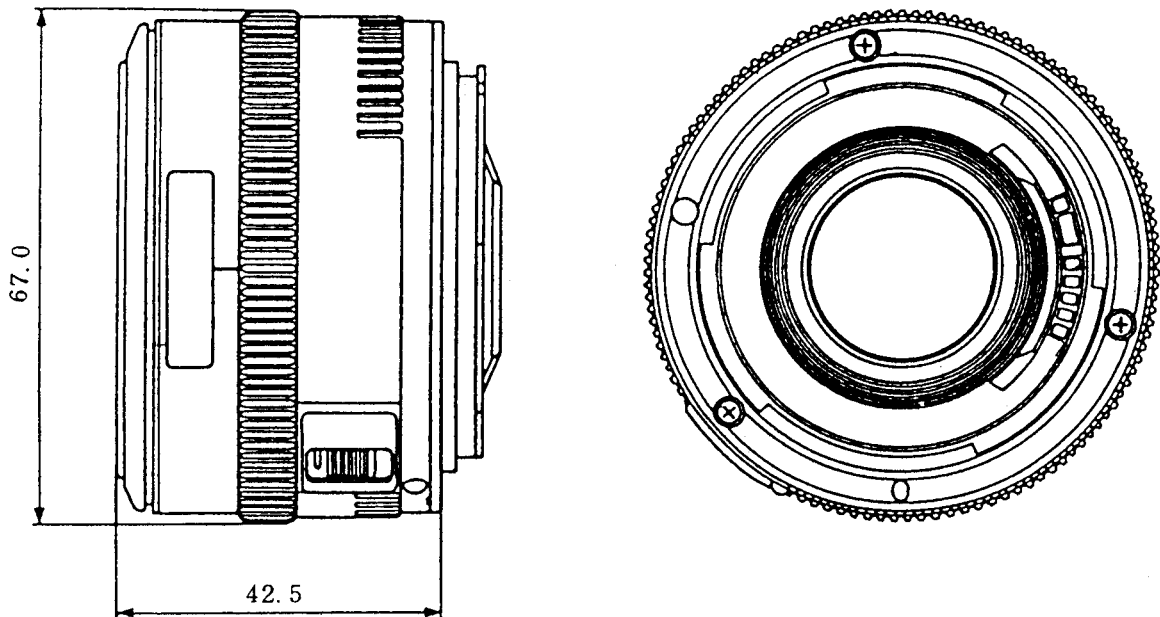
The 50mm f/1.8 was developed as the standard lens of the EOS series. An objective of development was to achieve even greater optical performance than that provided by the FD50mm f/1.8 lens, which was the mainstay of the FD lens series.

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)

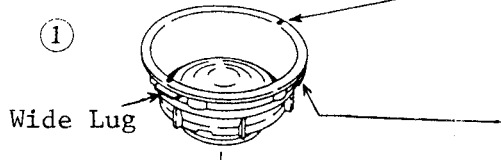
12. Other: Maximum number of filters usable: 2

VI. DISASSEMBLY & ASSEMBLY EF50mm f/1.8

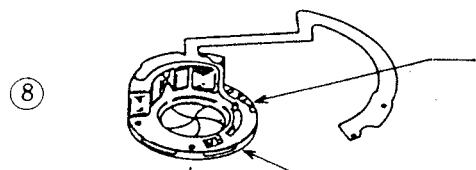
1. EMD Unit Removal

Set lens to infinity before beginning.

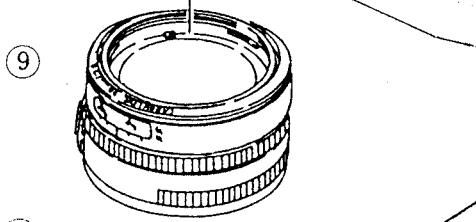
Turn CCW to unlock bayonet. One lug of the bayonet is wider, so it will only couple one way.



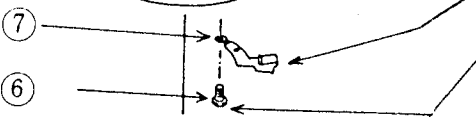
Bayonet lugs - Stake with screw-lock.



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

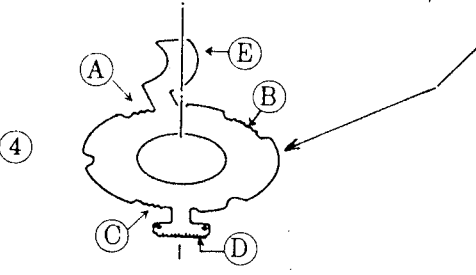


Water-soluble bond

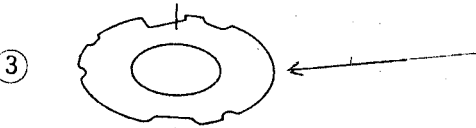


EMD Flex holder

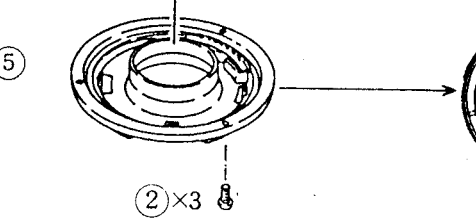
Stake head with screw-lock.



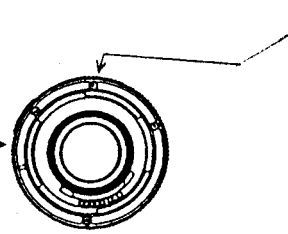
Main flex unit - Unsloder 30 points (A) through (E). (A) & (B) only to remove EMD. CAUTION: PLASTIC PARTS - Use soldering iron with care.



Insulating sheet



(2) x 3



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.

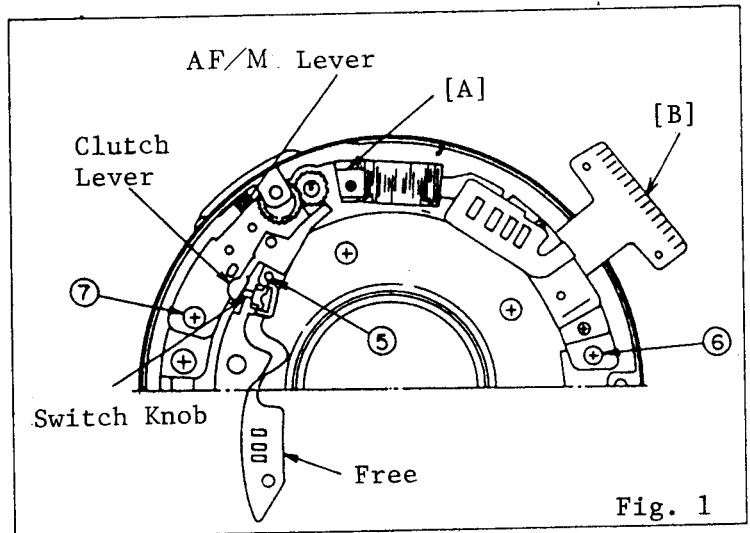
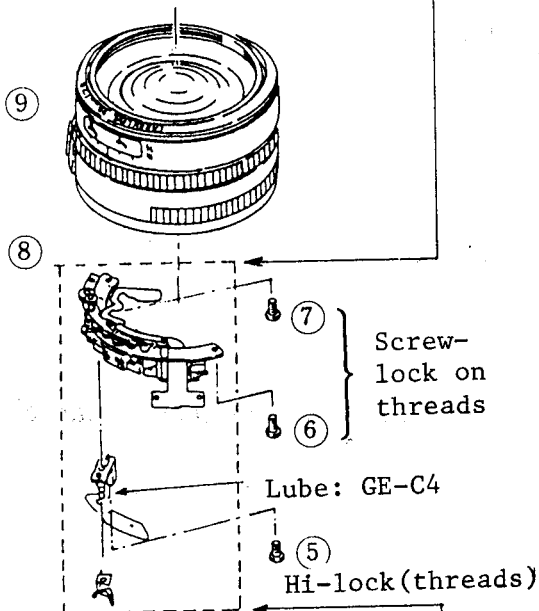


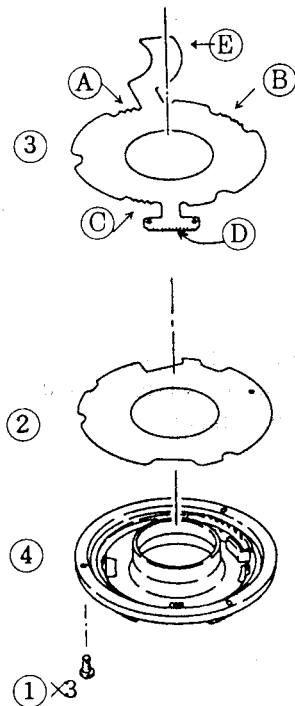
Fig. 1

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

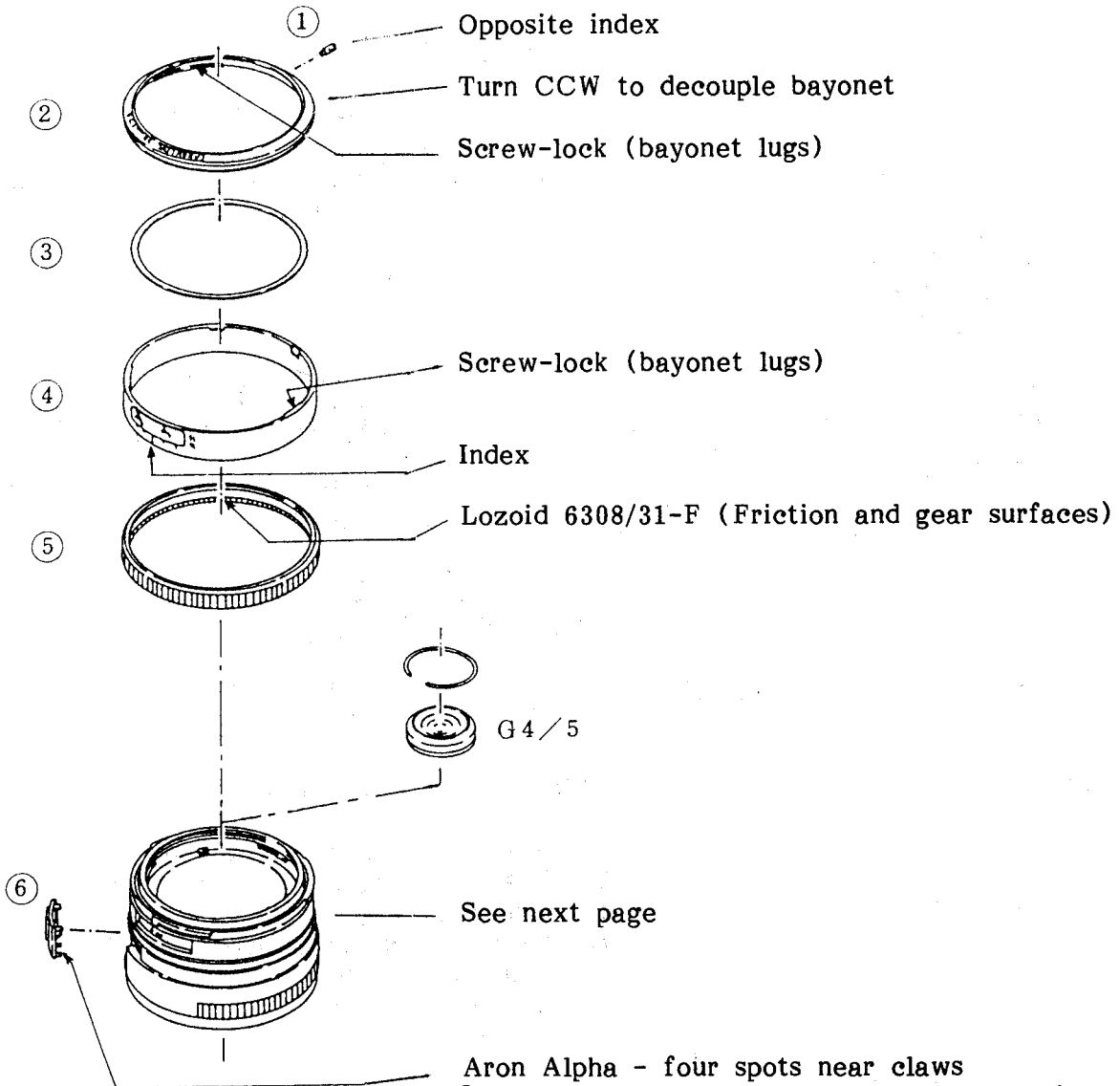
6. Move the flex with tweezers at "A" (above). Work the flex slightly, with screw (6) as the fulcrum, screw (7) should move about 0.3mm.
7. Just slightly inside the midpoint of this travel, tighten screws (7) and (6).
8. Operate the manual focusing ring to check for smooth focusing. [This adjustment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



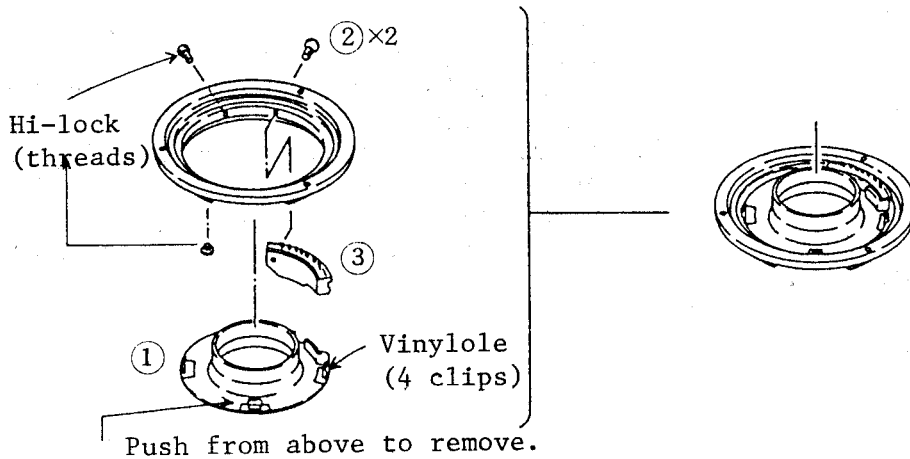
(1) - (4): See previous page

VI. DISASSEMBLY & ASSEMBLY EF50mm f/1.8

3. External Parts

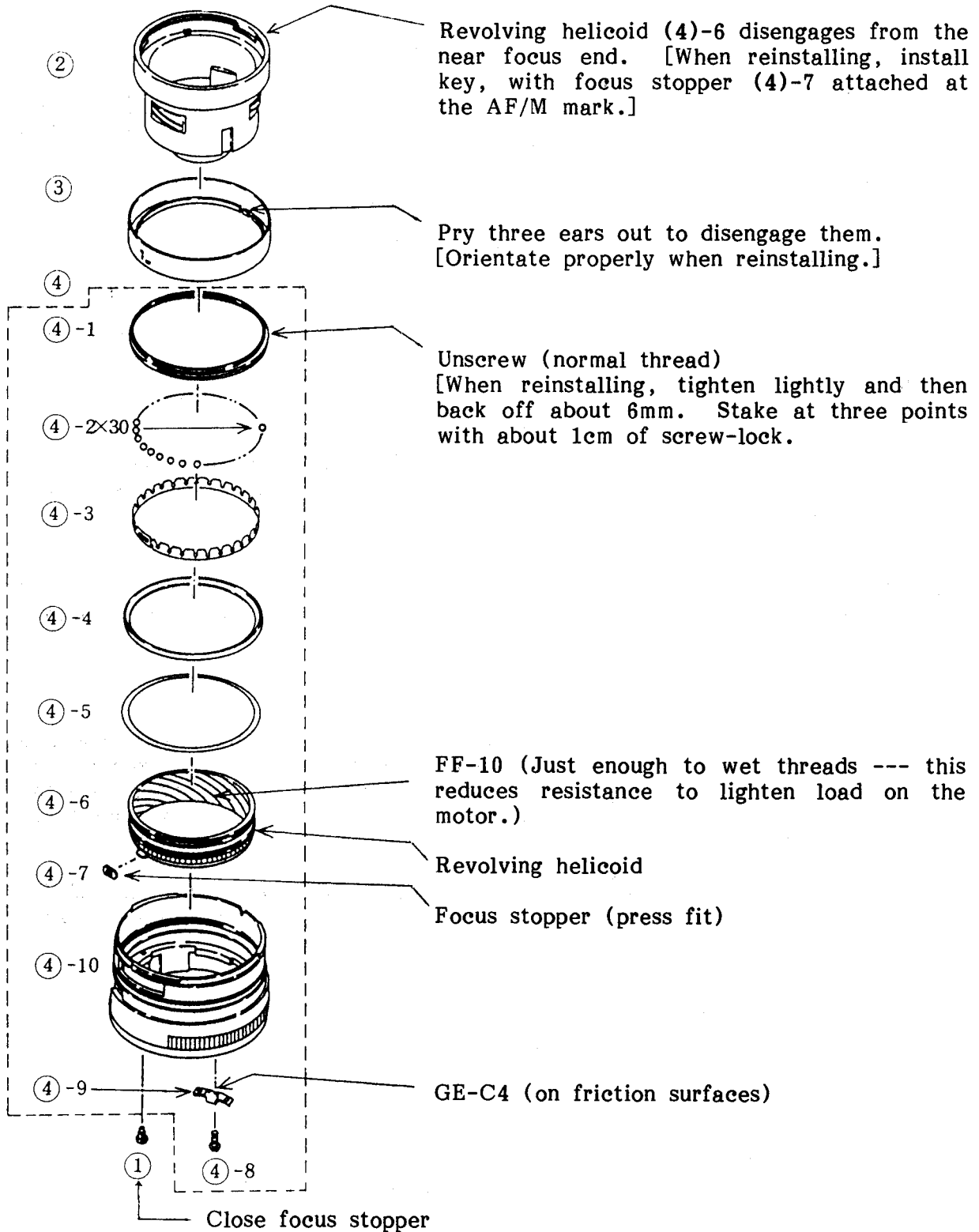


Aron Alpha - four spots near claws
 [Push out to remove. Claws break easily.
 Don't leave plastic chips in lens.]



VI. DISASSEMBLY & ASSEMBLY EF50mm f/1.8

4. Helicoid Disassembly



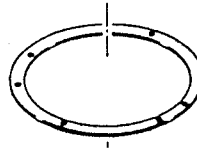
VII. ADJUSTMENTS EF50mm f/1.8

1. Focus Adjustment

STANDARD: $\pm 0.03\text{mm}$

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

Focus Washer (Service Parts)

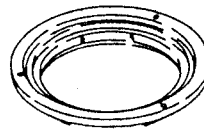


Service Use Only.		
	A	SIZE
	0.02 mm	(002)
	0.05 mm	(005)

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.

Lens Mount (Service Parts)



	A	SIZE
	1.7 mm	(170)
	1.8 mm	(180)
	1.9 mm	(190)
	2.0 mm	(200)
	2.1 mm	(210)

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 $100f^2$ 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

Image Height (mm)	0	4	8	12	16	20
S		100	63	40	40	63
Axial	100					
M		100	100	63	40	40

VII. ADJUSTMENTS EF50mm f/1.8

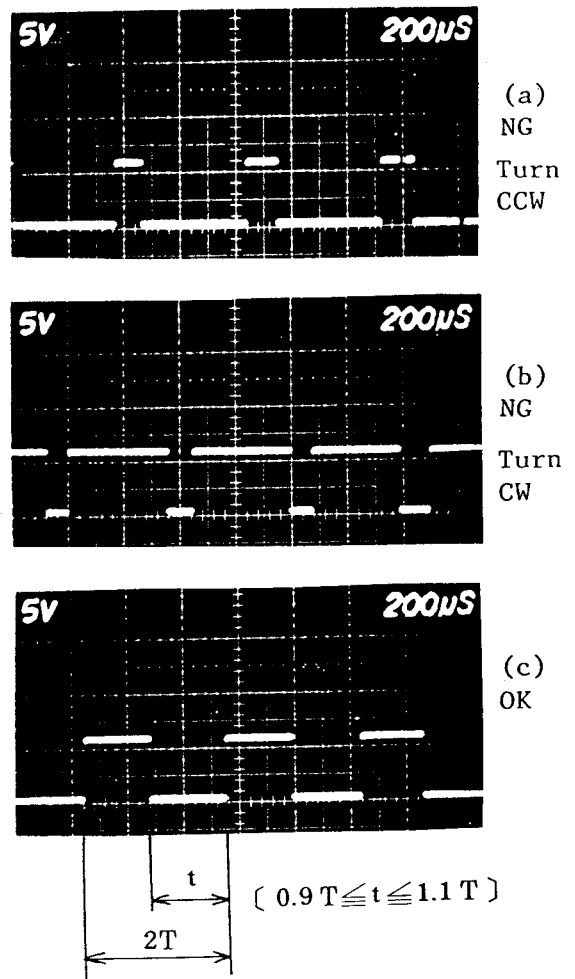
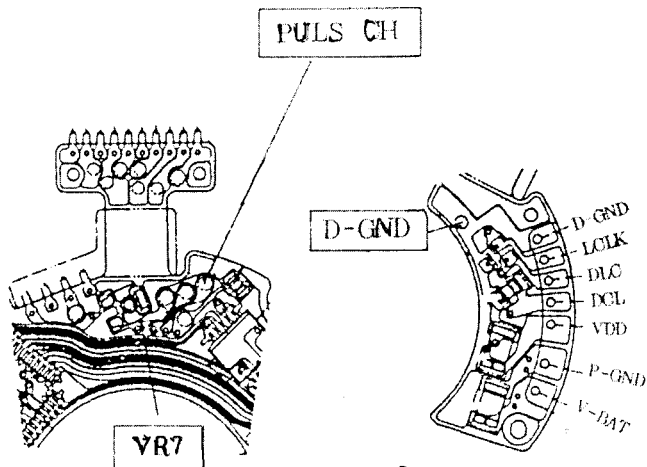
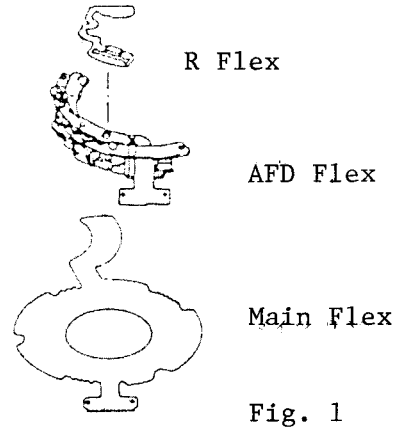
2. Pulse Adjustment

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: $\pm \frac{1}{4}Fc$

Fig. = f/number

c = 0.035mm (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 $\pm \frac{1}{4}Fc$.]

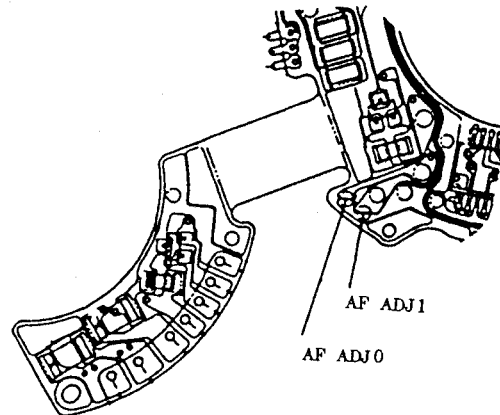
There is bound to be some discrepancy between the focus point determined by the autofocus system and the actual best focus point of the interchangeable lenses due to the inherent differences between the different lens types.

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.

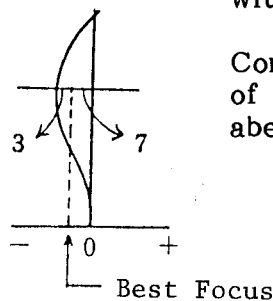


Best Focus Correction (Reference)

Correction	AF ADJ0	AF ADJ1
$-\frac{1}{4}Fc$	Closed	Open
$-\frac{1}{2}Fc$	Closed	Closed
$+\frac{1}{4}Fc$	Open	Open
$+\frac{1}{2}Fc$	Open	Closed

Correction varies with individual lens.

Correction set at 70% of maximum spherical aberration.



EF 28mm1:2.8

CANON LENS EF28mm 1:2.8
Ref. No. C21-5281

Special Optical Adjustments:

Centering.	<input checked="" type="radio"/> Yes	<input type="radio"/> No
Tilt	<input type="radio"/> Yes	<input checked="" type="radio"/> No

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

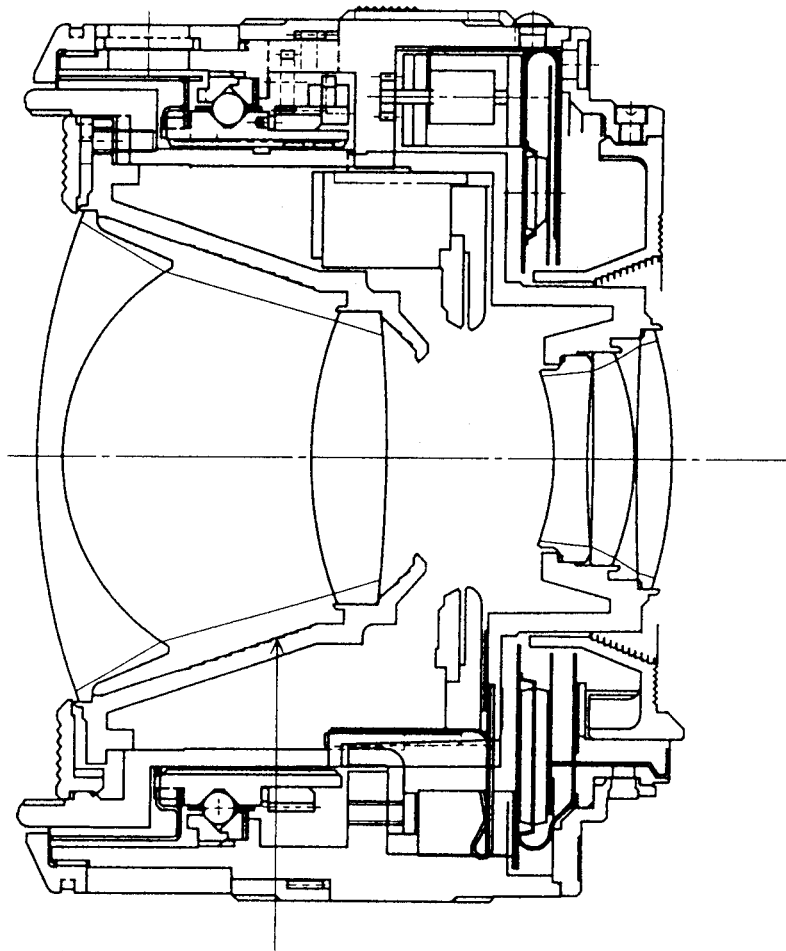


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NOTICE: For general information about this lens, see sections I, II, III, and IV of the EF50mm f/1.8 repair guide.

EF28mm f/2.8 Lens Expendables List

-ADHESIVES-

Part Number	Name	Remarks	Plastic Safe?
CY4-9301-000	Double faced tape	Always use new tape (New)	YES
CY9-8007-000	Aron Alpha	Instant Bond (Cyanoacrylate)	YES
CY9-8009-000	Arontite R	For staking screws	NO
CY9-8011-000	Screw-lock	For staking screws	YES
CY9-8015-000	Water-soluble bond	Light duty,	YES
CY9-8076-000	Vynlole 2200	General Purpose	YES

- LUBRICANTS -

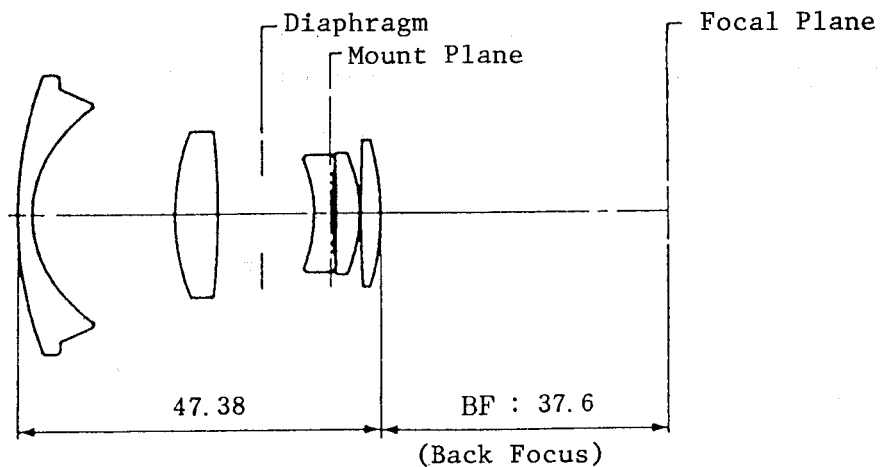
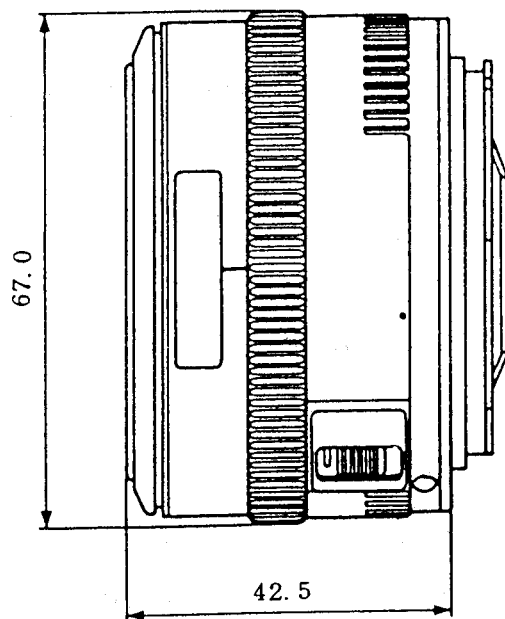
Part Number	Name	Remarks	Plastic Safe?
CY9-8045-000	GE-C4	Helicoid & cam (metal OK)	YES
CY9-8086-000	FF-10	Helicoid & cam (New)	YES
CY9-8087-000	Lozoid 6308/31-F	Manual focusing ring (New)	YES

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

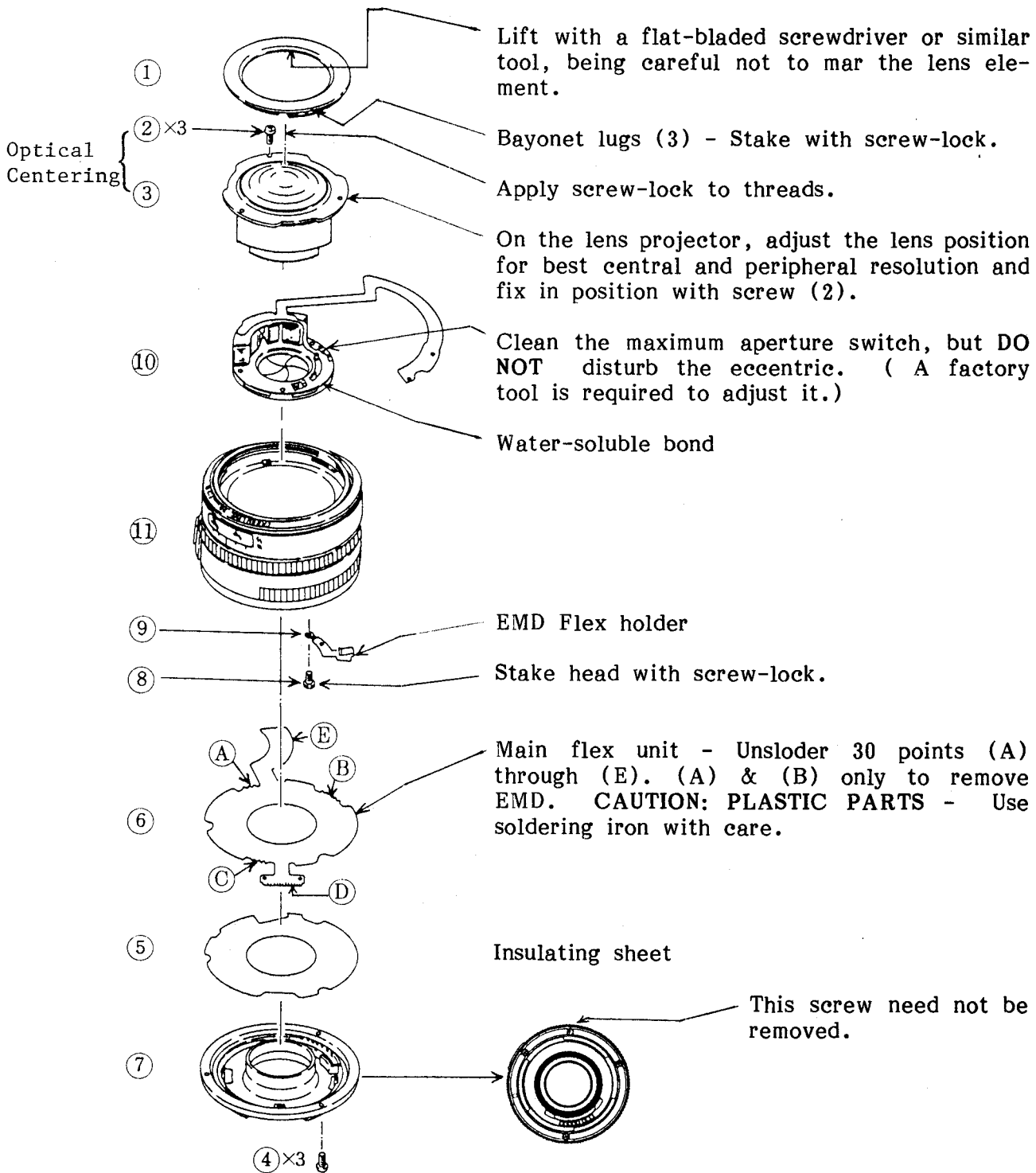
11-4 Dust cap: Common to all EF lenses (new)

12. Other: Maximum number of filters usable: 1

II. DISASSEMBLY & ASSEMBLY EF28mm f/2.8

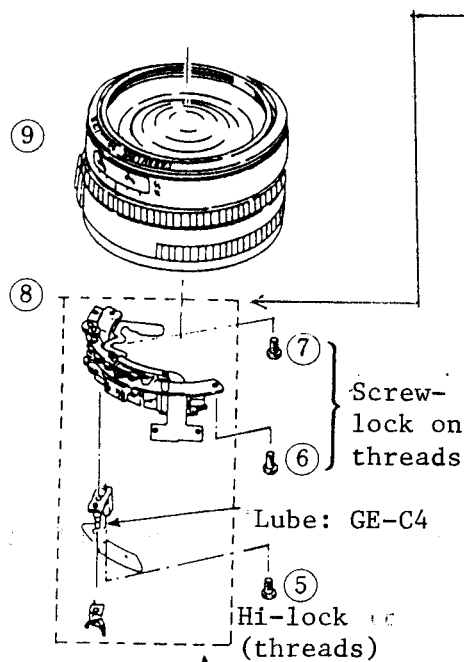
1. EMD Unit Removal

Set lens to infinity before beginning.



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.

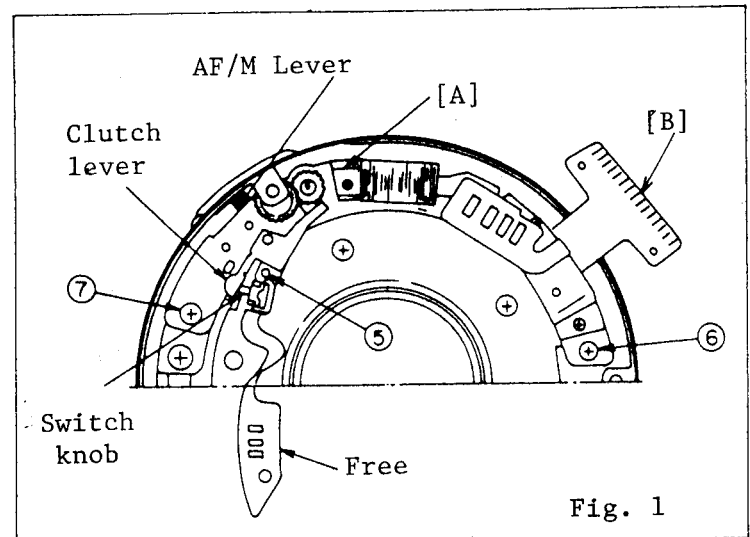
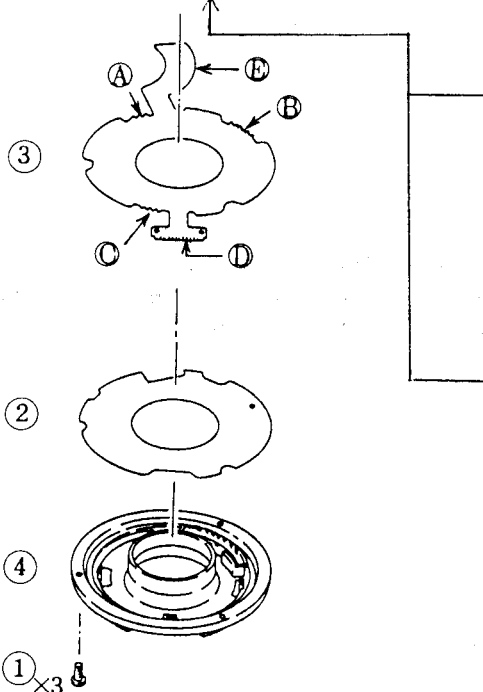


Fig. 1



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).

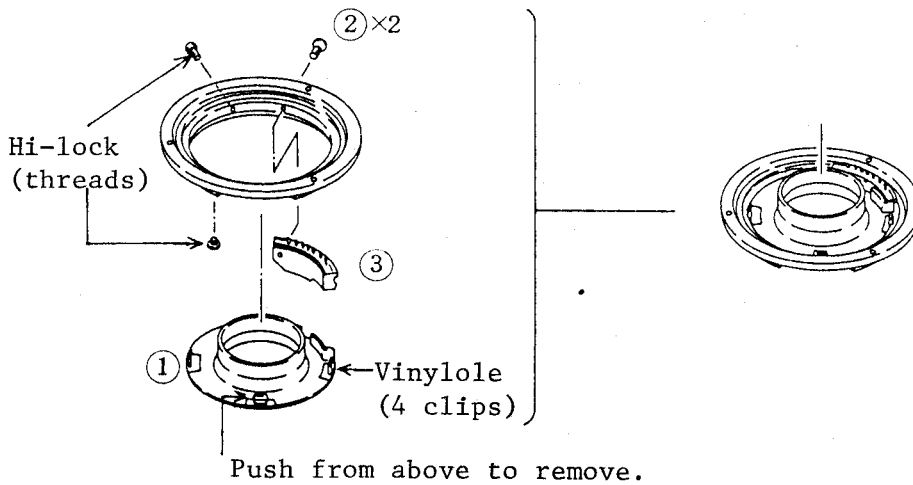
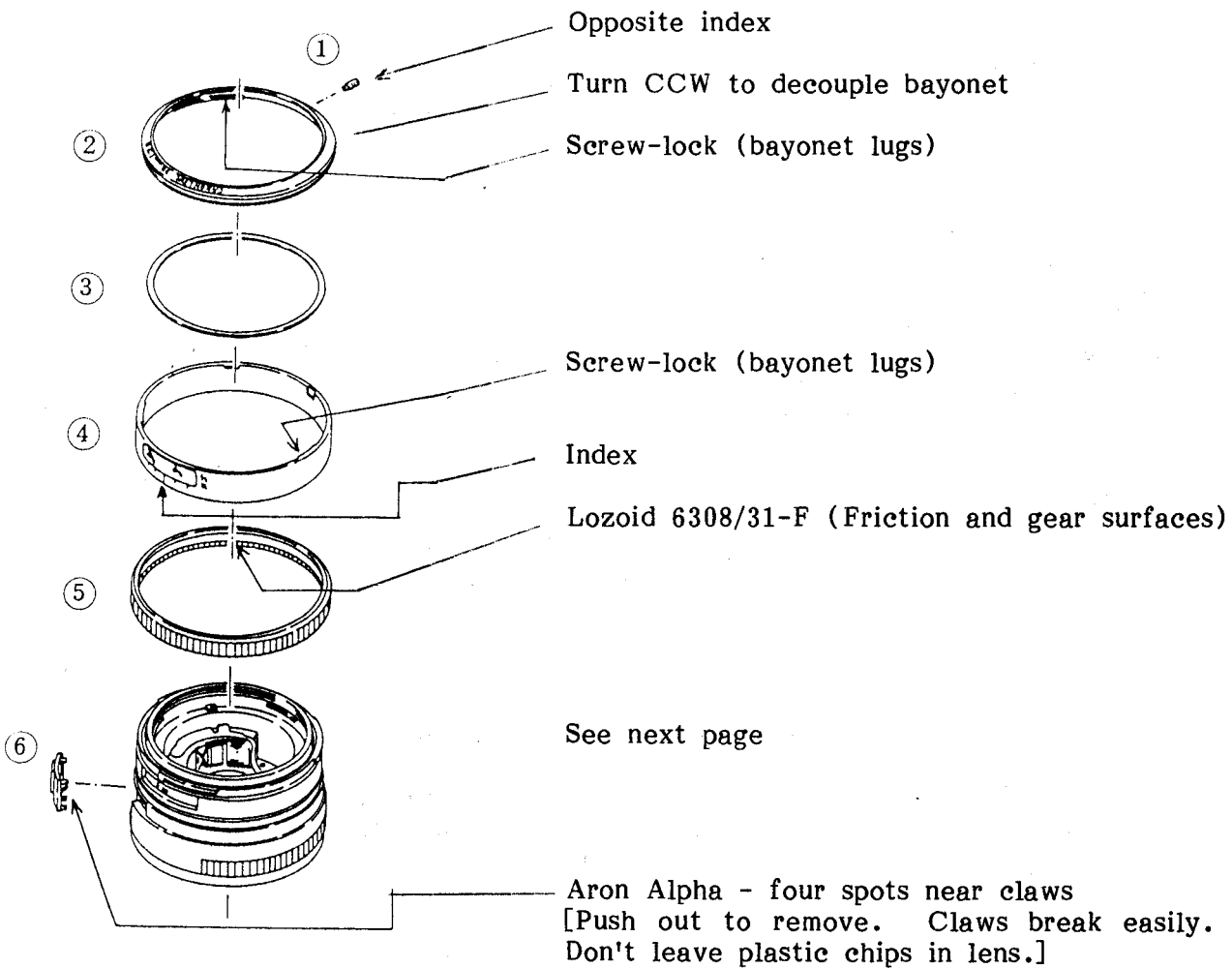
AFD Unit (8) Alignment

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

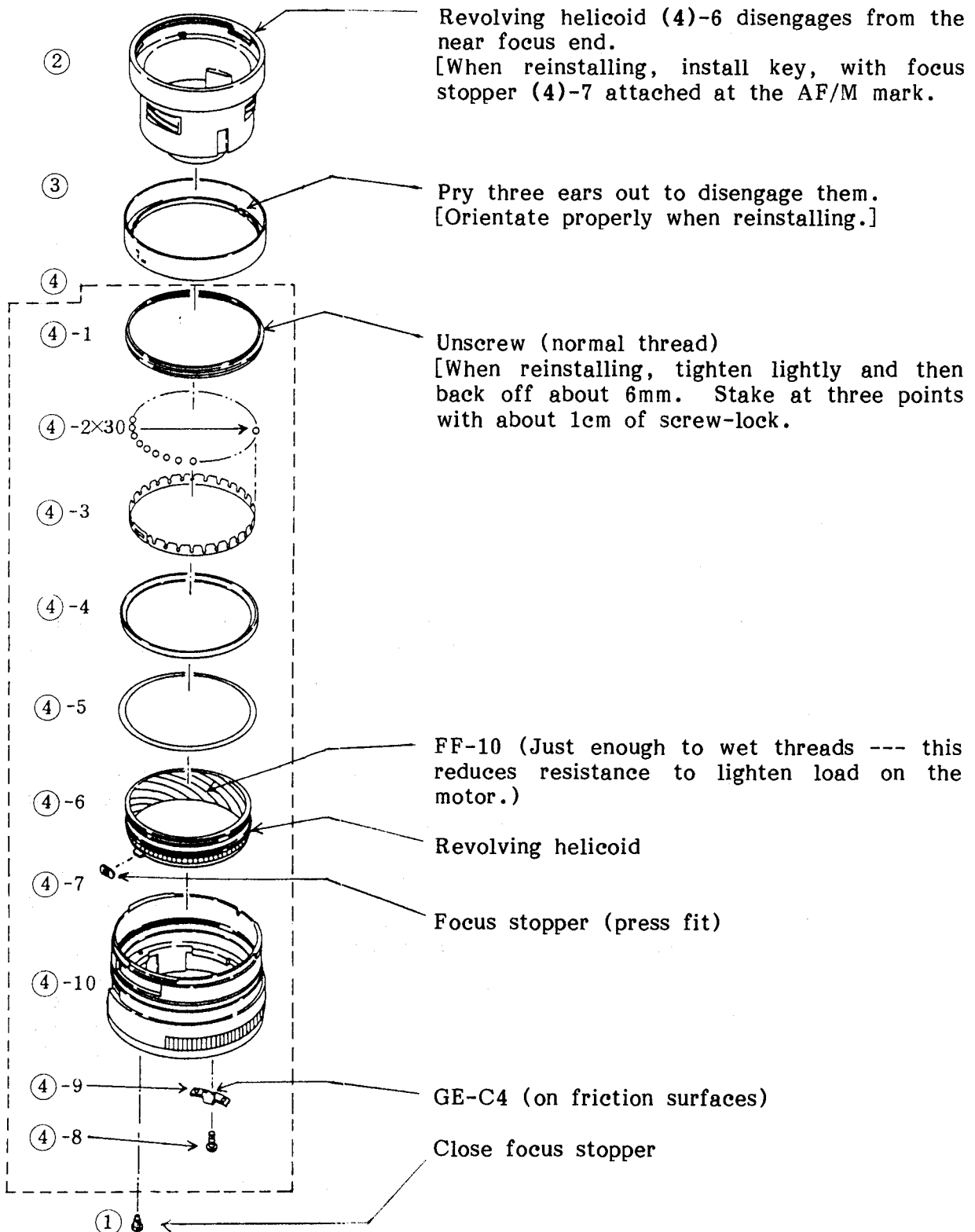
VI. DISASSEMBLY & ASSEMBLY EF28mm f/2.8

3. External Parts



II. DISASSEMBLY & ASSEMBLY EF28mm f/2.8

4. Helicoid Disassembly

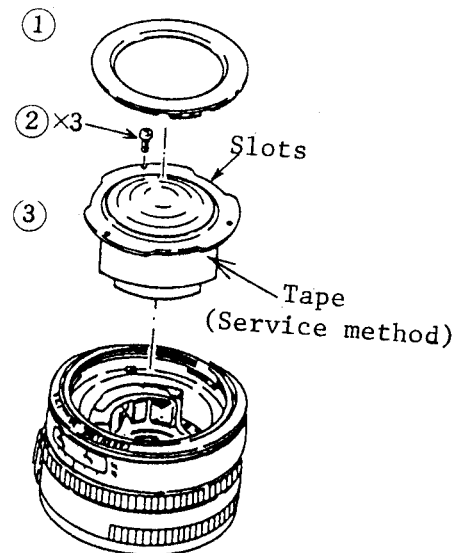


VII. ADJUSTMENTS EF28mm f/2.8

1. Optical Centering(Tilt Adjustment)

STANDARD:

Table 1 : Resolution Chart							
Image Height (mm)	0	4	8	12	16	20	
S		100	63	40	40	25	
Axial	100						
M		100	63	63	40	25	

Test Distance: $f \times 50, f/2.8$ 

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.

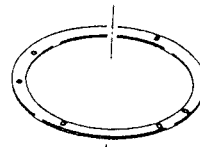
VII. ADJUSTMENTS EF28mm f/2.8


1. Focus Adjustment

STANDARD: $\pm 0.03\text{mm}$

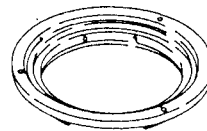
Focus washers are not used in the factory adjustment of EOS lenses. The service adjustment uses washers and/or undercut lens mounts.


Focus Washer (Service Parts)



	A	SIZE
	0.02 mm	(002)
	0.05 mm	(005)

Lens Mount (Service Parts)



	A	SIZE
	1.7 mm	(170)
	1.8 mm	(180)
	1.9 mm	(190)
	2.0 mm	(200)
	2.1 mm	(210)

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 $100f^2$ 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 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).

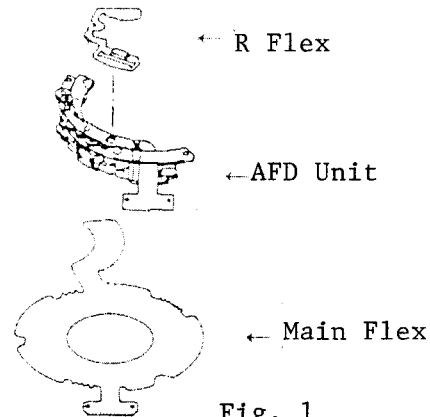


Fig. 1

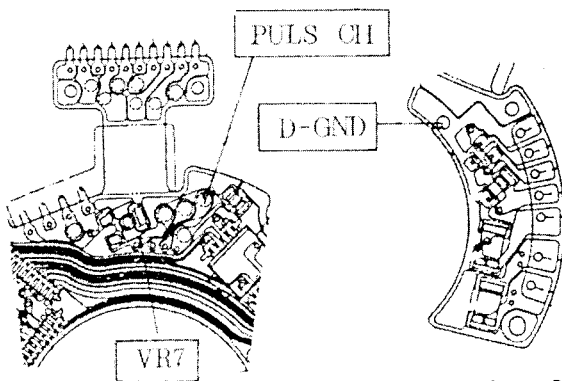


Fig. 2

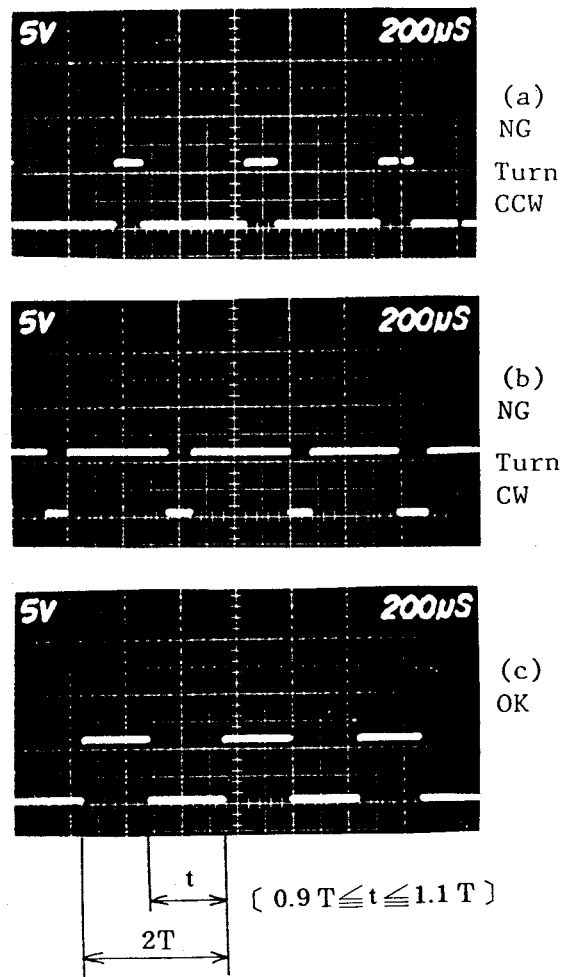


Fig. 3

VII. ADJUSTMENTS EF28mm f/2.8

3. "Best Focus Adjustment" Service Policy

STANDARD: $\pm \frac{1}{4}Fc$

Fig. = f/number

c = 0.035mm (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 $\pm \frac{1}{4}Fc$.]

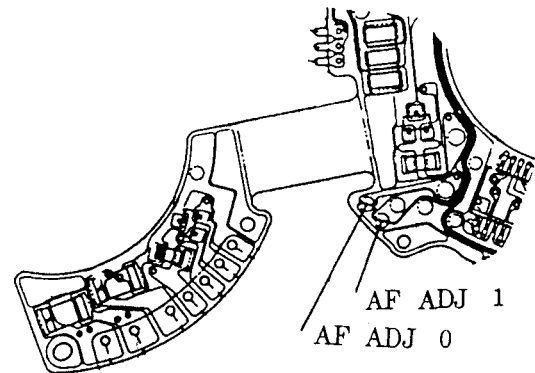
There is bound to be some discrepancy between the focus point determined by the autofocus system and the actual best focus point of the interchangeable lenses due to the inherent differences between the different lens types.

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. 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)

Correction	AF ADJ0	AF ADJ1	Correction varies with individual lens.
$-\frac{1}{4}Fc$	Closed	Open	Correction set at 70% of maximum spherical aberration.
$-\frac{1}{2}Fc$	Closed	Closed	
$+\frac{1}{4}Fc$	Open	Open	
$+\frac{1}{2}Fc$	Open	Closed	



CANON LENS EF15mm 1:2.8
Ref. No. C21-5291

Special Optical Adjustments:

Centering. Yes No

Tilt Yes No

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

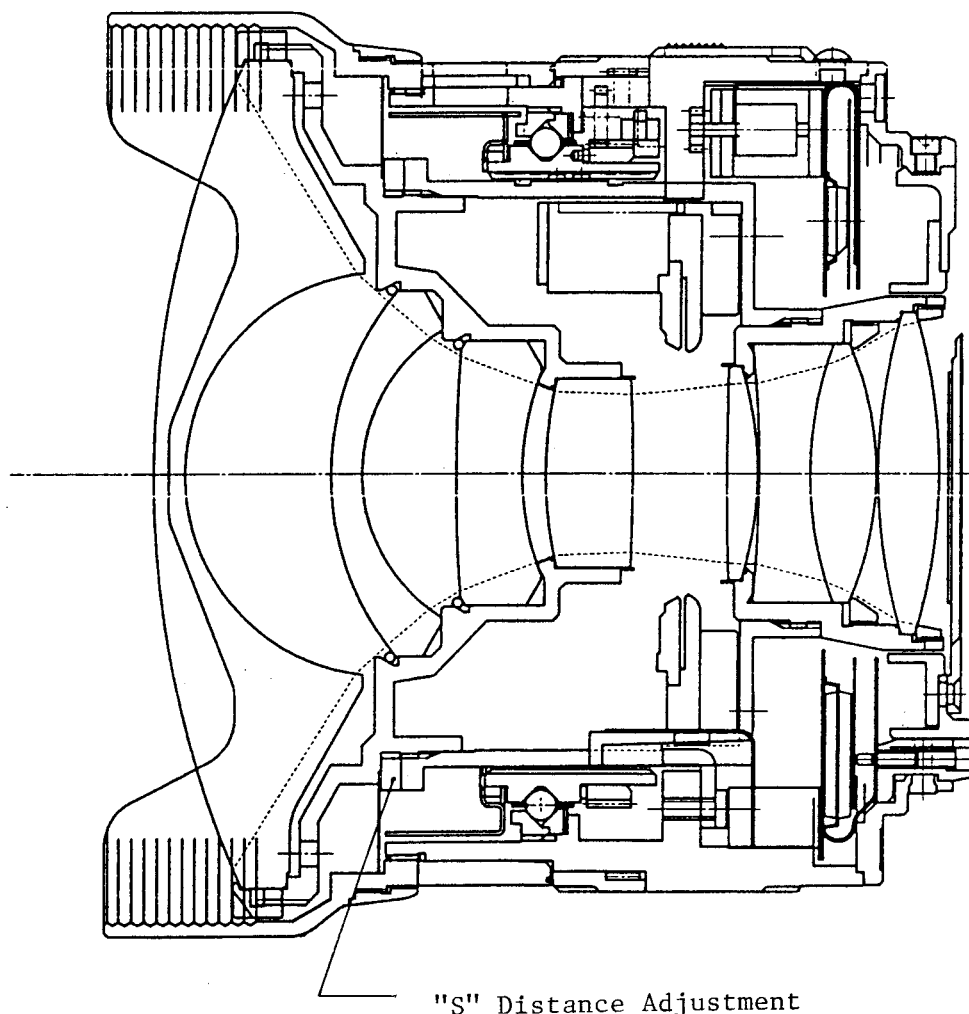


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NOTICE: For general information about this lens, see sections I, II, III, and IV of the EF50mm f/1.8 repair guide.

EF15mm f/2.8 Lens Expendables List

-ADHESIVES-

Part Number	Name	Remarks	Plastic Safe?
CY4-9301-000	Double faced tape	Always use new tape (New)	YES
CY9-8007-000	Aron Alpha	Instant Bond (Cyanoacrylate)	YES
CY9-8009-000	Arontite R	For staking screws	NO
CY9-8011-000	Screw-lock	For staking screws	YES
CY9-8015-000	Water-soluble bond	Light duty,	YES
CY9-8076-000	Vynlole 2200	General Purpose	YES

- LUBRICANTS -

Part Number	Name	Remarks	Plastic Safe?
CY9-8045-000	GE-C4	Helicoid & cam (metal OK)	YES
CY9-8086-000	FF-10	Helicoid & cam (New)	YES
CY9-8087-000	Lozoid 6308/31-F	Manual focusing ring (New)	YES

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.

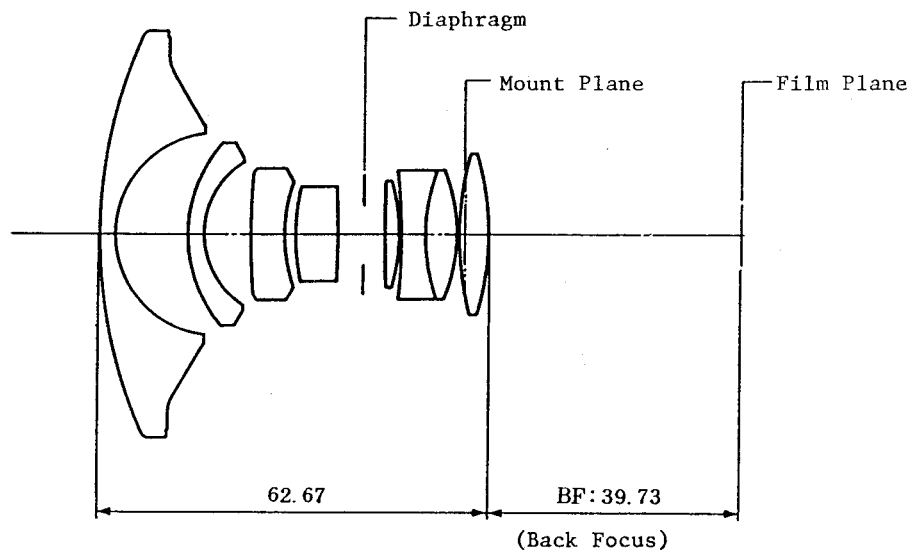
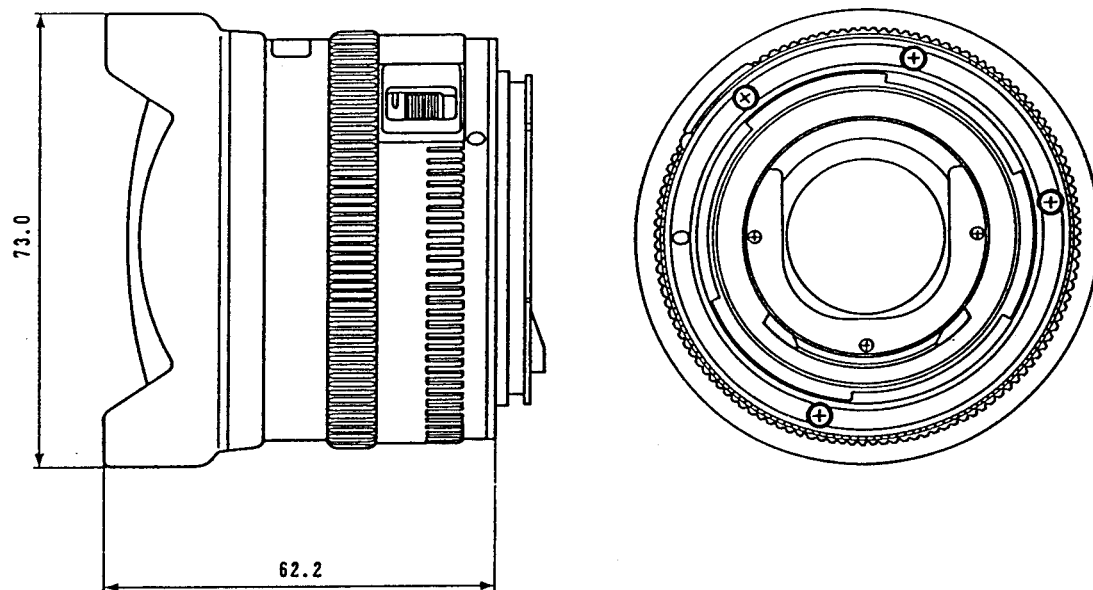
Features

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



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 gelitan filterscut 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

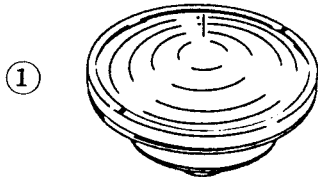
11-4 Dust cap: Common to all EF lenses (new)

12. Other: Maximum number of filters usable: one

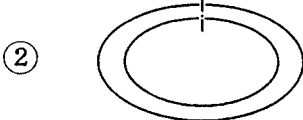
II. DISASSEMBLY & ASSEMBLY EF15mm f/2.8

1. EMD Unit Removal

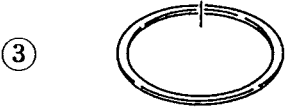
Unscrew (The assmeby collar may loosen.)



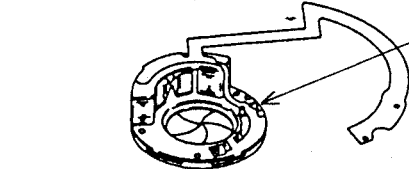
Dust Shield



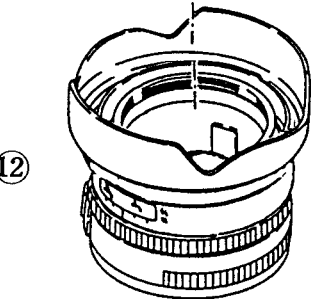
Lens element spacing "S" collar.



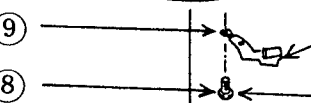
EMD Unit: Clean the maximum aperture switch, but DO NOT disturb the eccentric. (A factory tool is required to adjust it.)



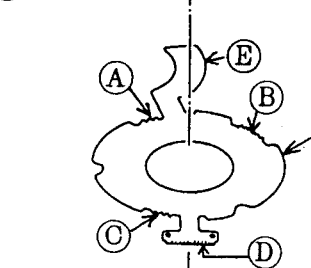
EMD Spacer (The same EMD unit is used in other lenses.)



(See Pg.6)



EMD Flex holder(Place flex in crook.)

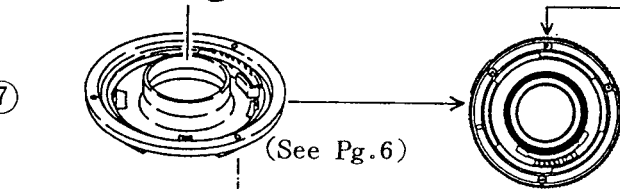


Stake head with screw-lock.

(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.

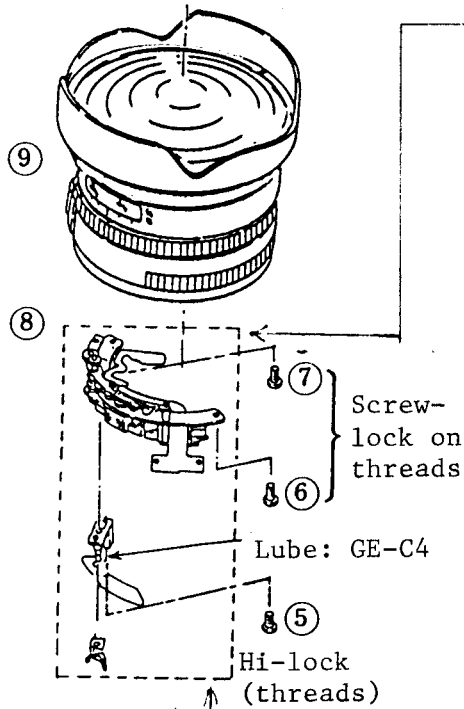


(4)×3

VI. DISASSEMBLY & ASSEMBLY EF15mm 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 the flex in the clockwise direction.
3. Lift [A] to remove.

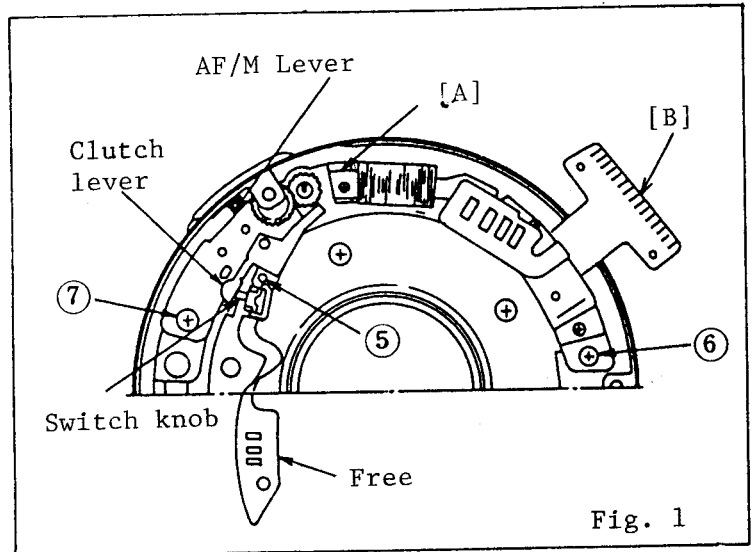
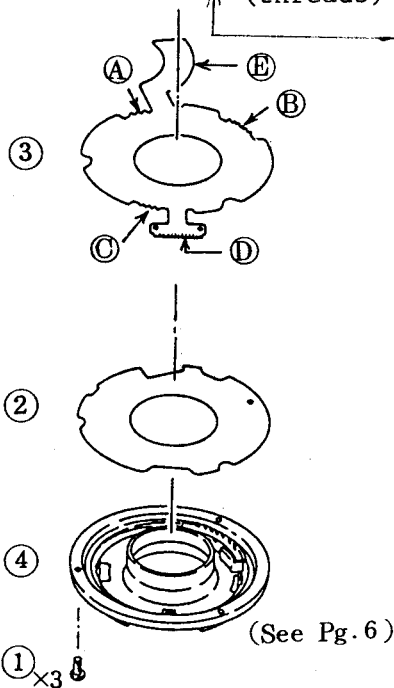


Fig. 1



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).

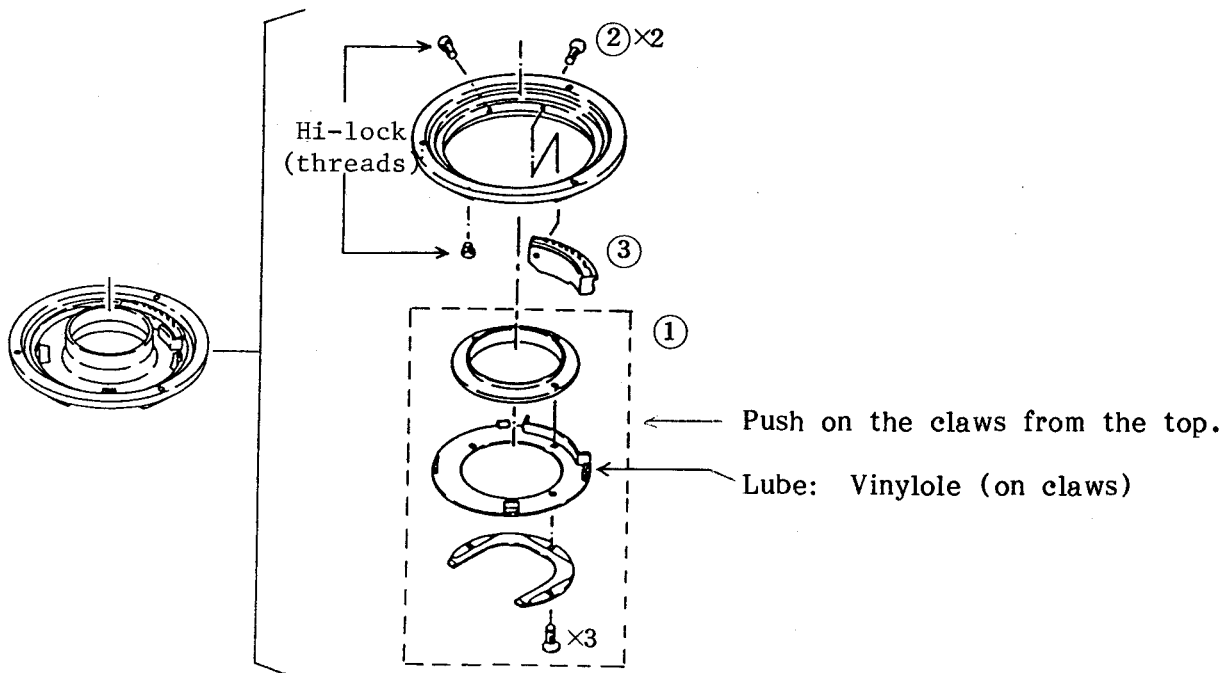
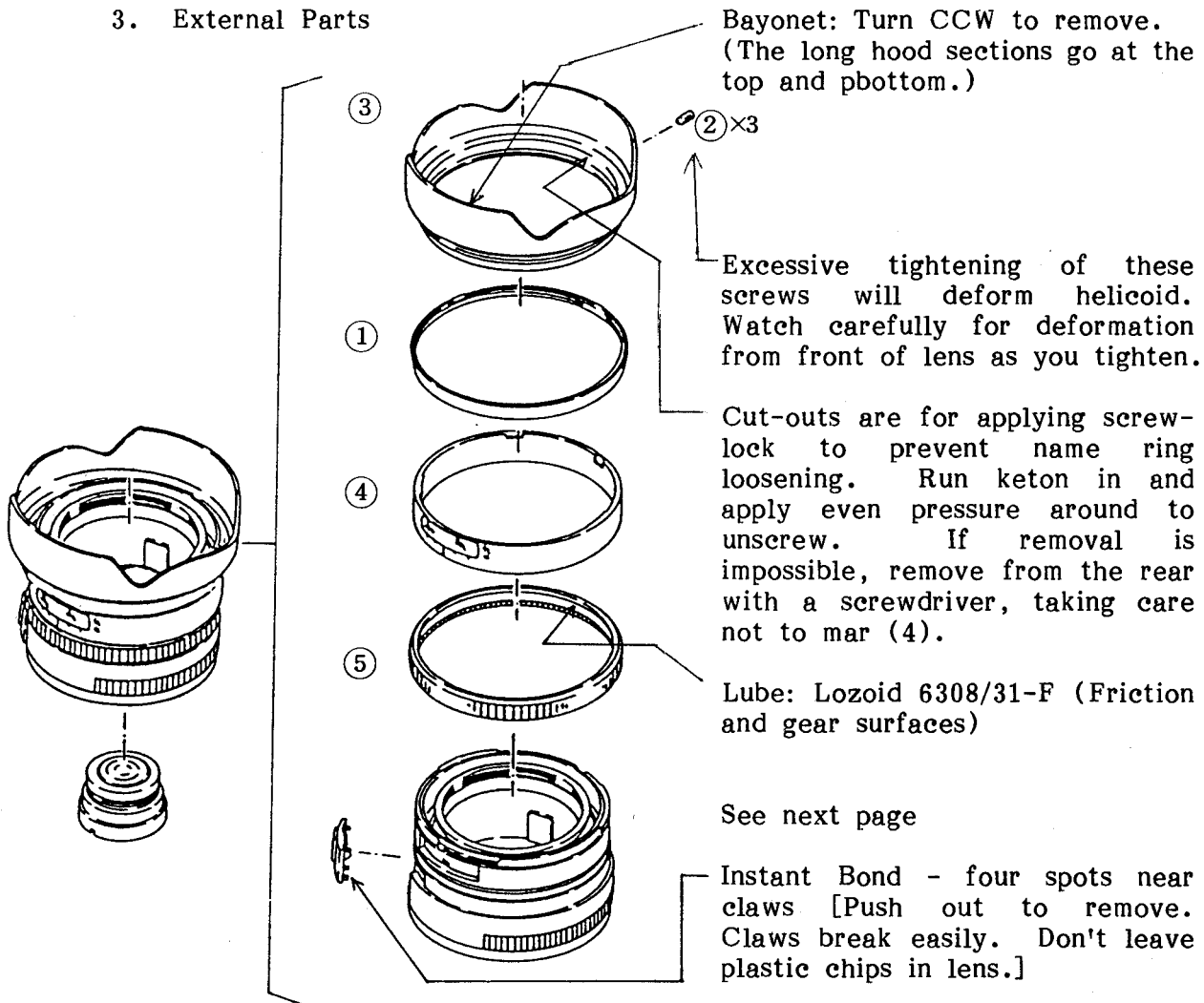
AFD Unit (8) Alignment

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

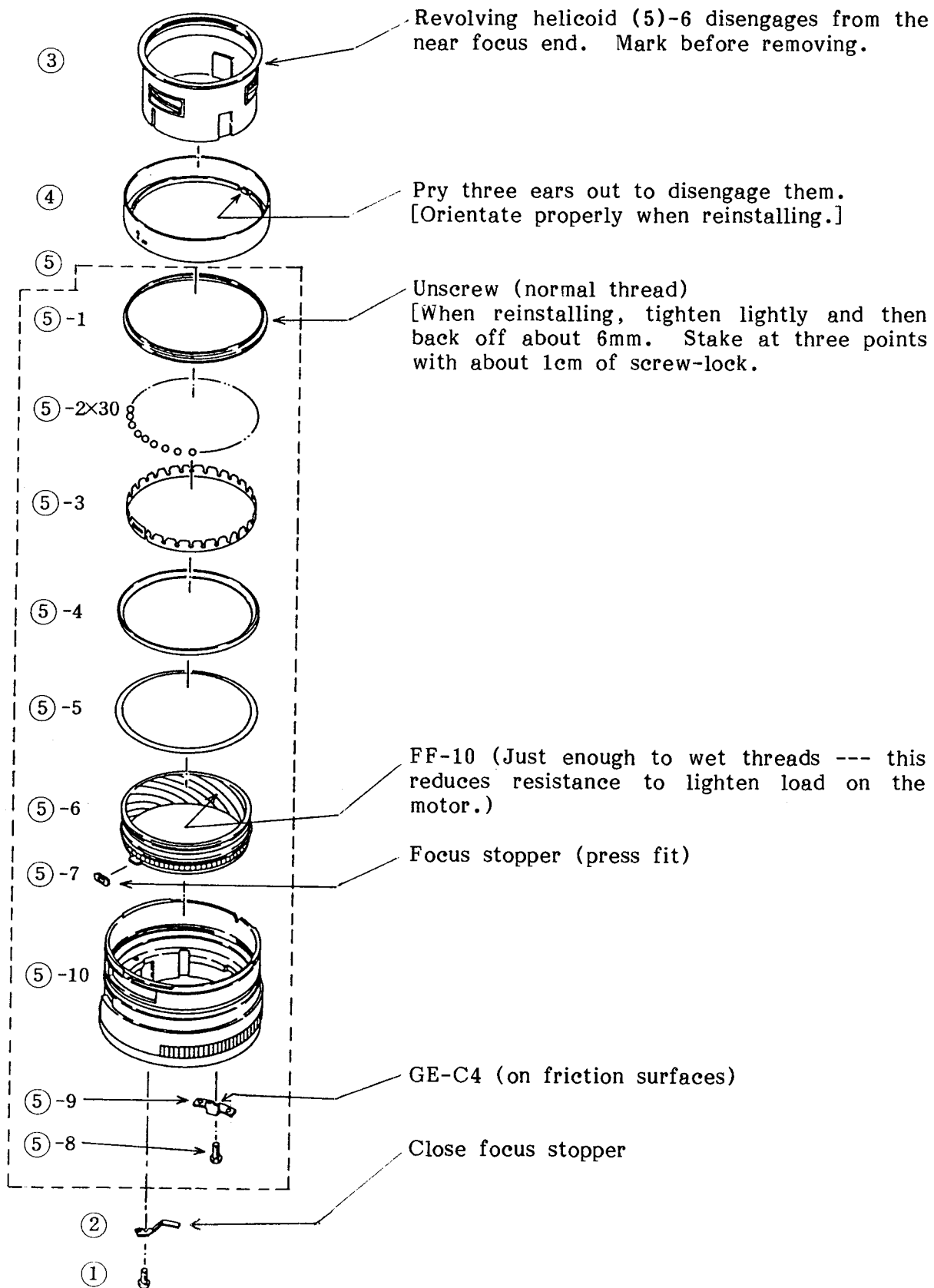
II. DISASSEMBLY & ASSEMBLY EF15mm f/2.8

3. External Parts



II. DISASSEMBLY & ASSEMBLY EF15mm f/2.8

4. Helicoid Disassembly



III. ADJUSTMENTS EF15mm f/2.8

1. Optical Element Spacing (S Distance) Adjustment

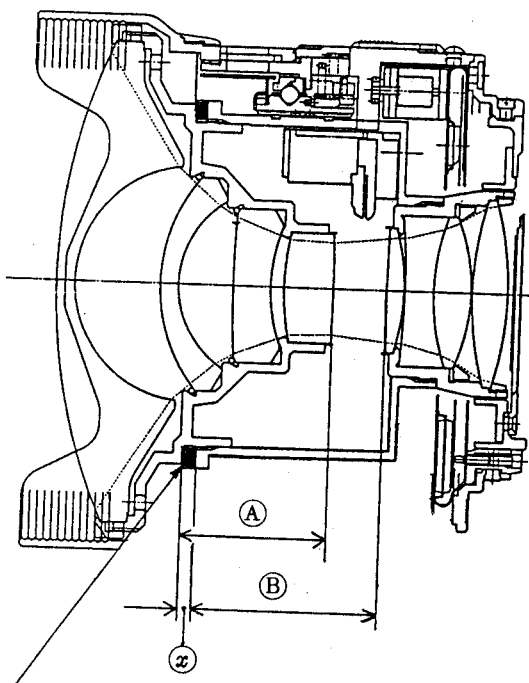
Standard: $7.48 \pm 0.03\text{mm}$ (G4-G5 spacing)
 Tester: Micro Tester (Height Gage)

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

	A	SIZE	A	SIZE
	1.45 mm	(145)	1.65 mm	(165)
	1.50 mm	(150)	1.70 mm	(170)
	1.55 mm	(155)	1.75 mm	(175)
	1.60 mm	(160)		

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 1 : Resolution Chart

Image Height (mm)	0	4	8	12	16	20
S		100	100	100	100	25
Axial	100					
M		100	40	25	40	40

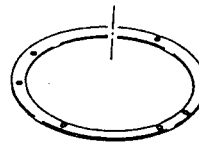
III. ADJUSTMENTS EF15mm f/2.8


2. Focus Adjustment

STANDARD: $\pm 0.03\text{mm}$

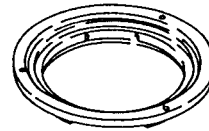
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Focus Washer (Service Parts)



	A	SIZE
	0.02 mm	(002)
	0.05 mm	(005)

Lens Mount (Service Parts)



	A	SIZE
	1.7 mm	(170)
	1.8 mm	(180)
	1.9 mm	(190)
	2.0 mm	(200)
	2.1 mm	(210)

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.

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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.

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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 $100f^2$ distant.

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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: $0.9T \leq t \leq 1.1T$

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.

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

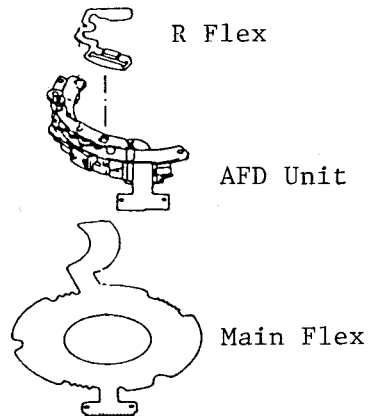


Fig. 1

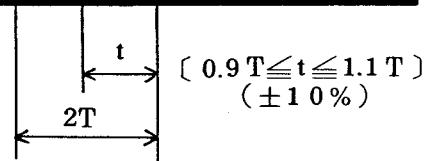
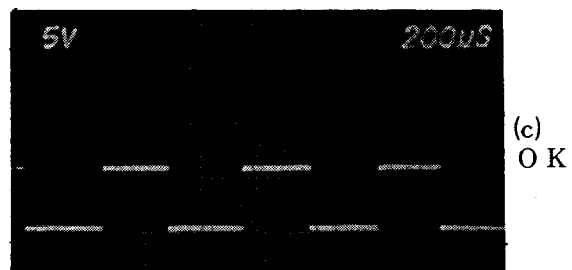
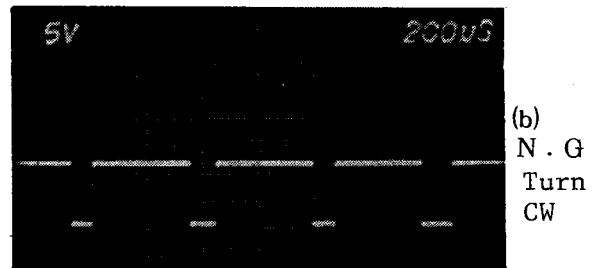
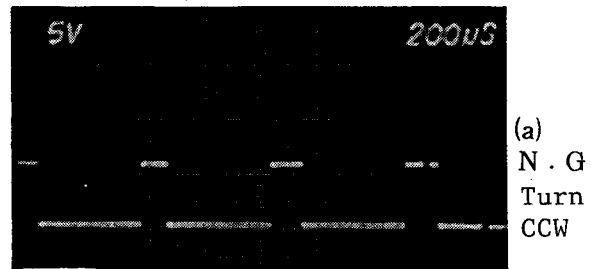


Fig. 3

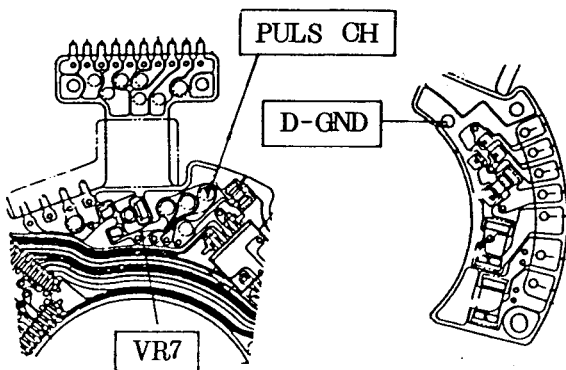


Fig. 2

III. ADJUSTMENTS EF15mm f/2.8

4. "Best Focus Adjustment" Service Policy

STANDARD: $\pm \frac{1}{4}Fc$

$F = f/\text{number}$

$c = 0.035\text{mm}$ (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 $\pm \frac{1}{4}Fc$.]

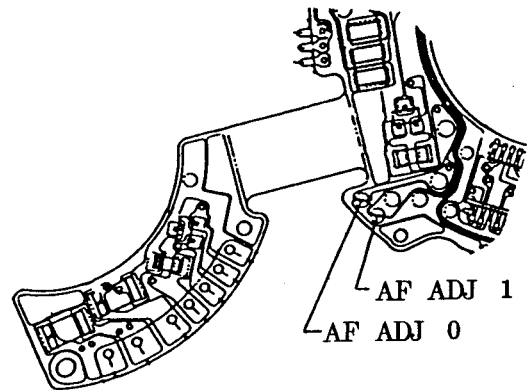
There is bound to be some discrepancy between the focus point determined by the autofocus system and the actual best focus point of the interchangeable lenses due to the inherent differences between the different lens types.

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

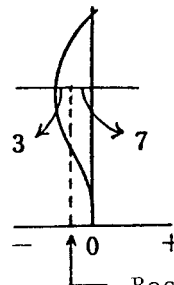


Best Focus Correction (Reference)

Correction	AF ADJ0	AF ADJ1
$-\frac{3}{4}Fc$	Closed	Open
$-\frac{1}{4}Fc$	Closed	Closed
$+\frac{1}{4}Fc$	Open	Open
$+\frac{3}{4}Fc$	Open	Closed

Correction varies with each lens.

Correction is set at 70% of maximum spherical aberration.



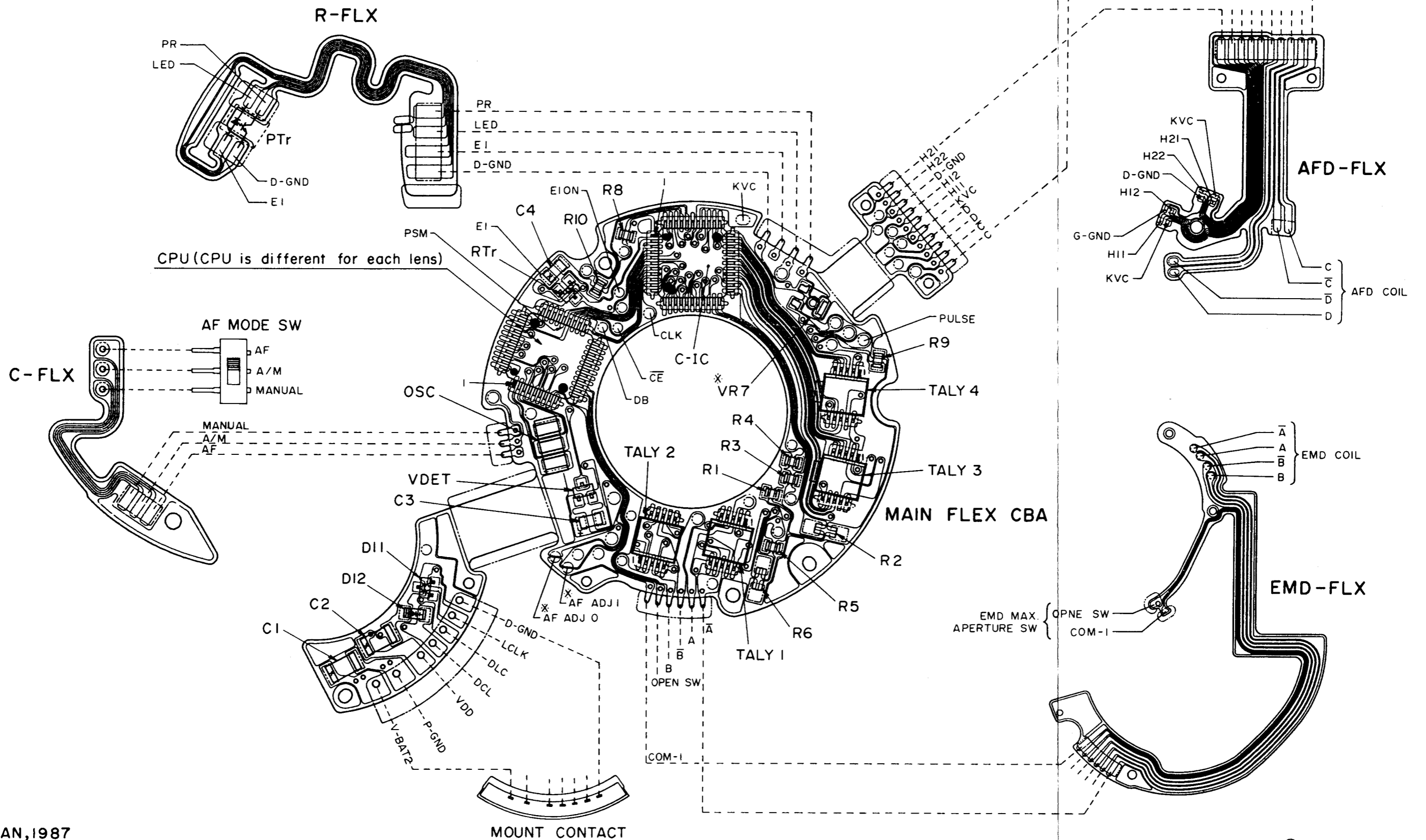
Best Focus

ELECTRICAL
DIAGRAMS

PCB DIAGRAM
CY8-1423-104-200

CANON LENS EF 50 mm 1:1.8
EF 28 mm 1:2.8
EF 15 mm 1:2.8

REF. NO. C21-6211
C21-5281
C21-5291



SCHEMATIC DIAGRAM
CY8-1623-101-200

CANON EF LENS

