

M51594AFP

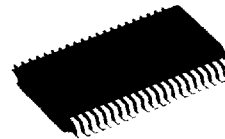
OPTICAL PICKUP SERVO CONTROL

DESCRIPTION

The M51594AFP is a semiconductor integrated circuit with built-in logic control, servo amp, and switches necessary to perform servo control of CD player optical pickups.

FEATURES

- Combination with preamplifier for optical pickup (M51595FP, M51567P, M51599FP, or M51598FP) makes it possible to form a pickup servo control system
- Single chip containing amp, switches, and logic controller necessary for servo control of optical pickup
- Built-in focus search circuit for automatic search up and down
- Built-in serial-to-parallel data converter to reduce microcomputer overload
- Adapts for any pickup by changing gain and frequency response of amplifiers with external components
- Built-in $V_{CC}/2$ generator to be capable of being driven by either dual or single power supply



Outline 42P2R-A

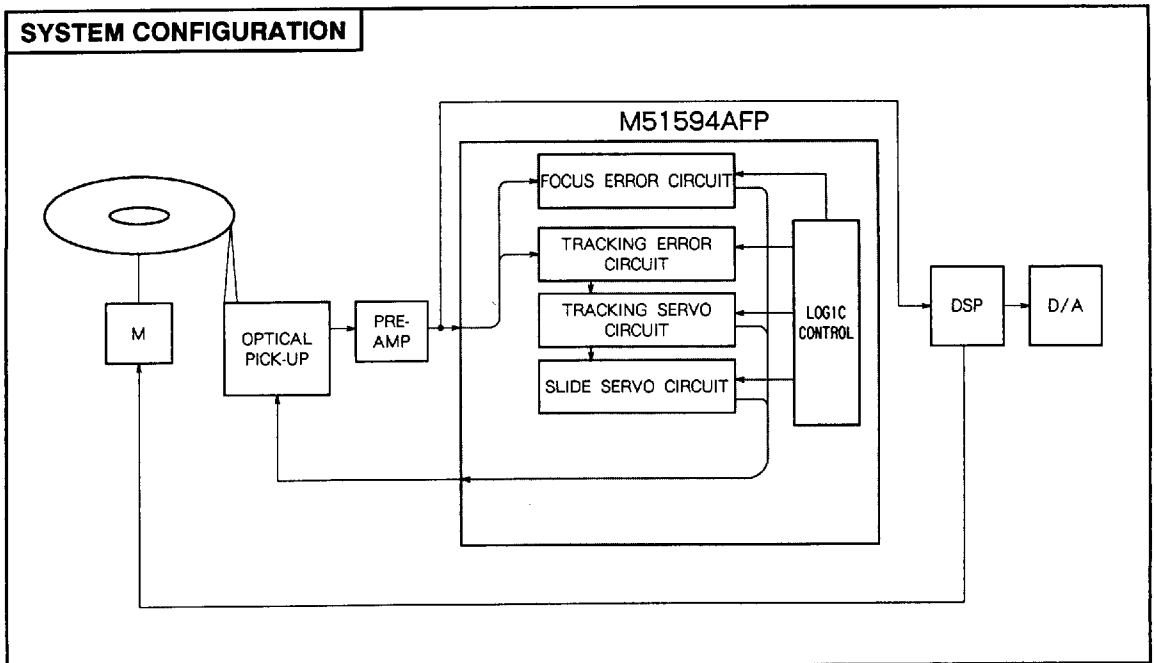
0.8mm pitch 450mil SSOP
(8.4mm × 17.5mm × 2.0mm)

RECOMMENDED OPERATING CONDITIONS

Supply voltage range..... V_{CC} , $V_{EE} = \pm 4.75 \sim \pm 5.25V$
or $V_{CC} = 4.75 \sim 5.25V$

Rated supply voltage
..... V_{CC} , $V_{EE} = \pm 5V$ (Split supply voltage)
or $V_{CC} = 5V$ (Single supply voltage)

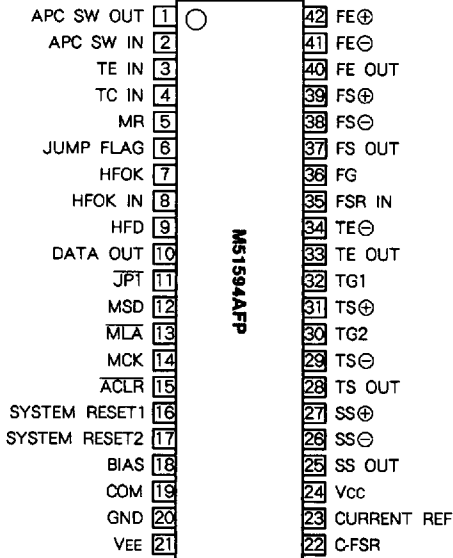
Rated power dissipation 70mW



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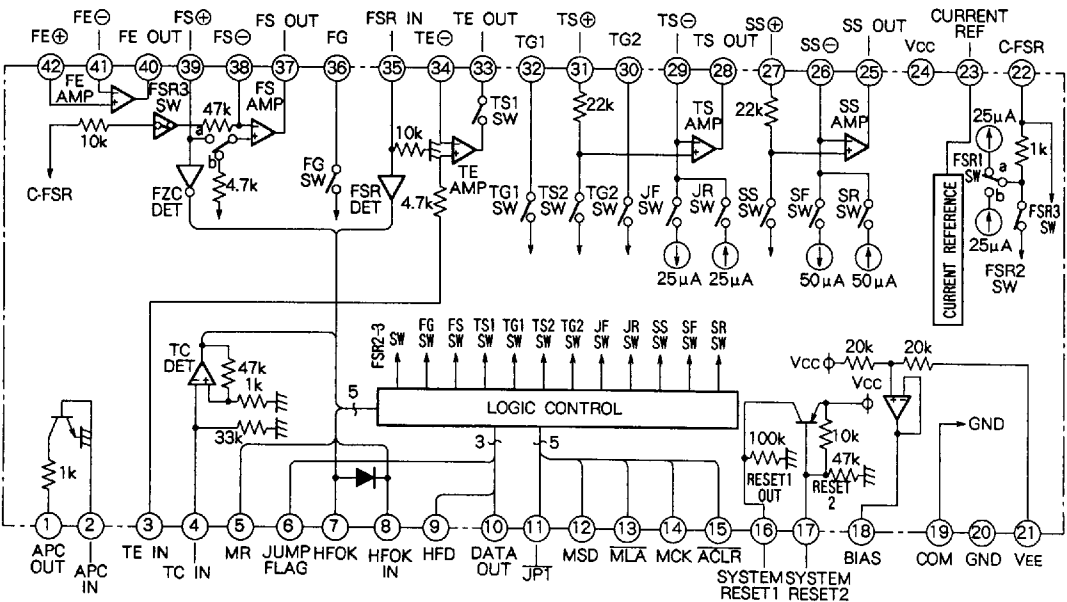
OPTICAL PICKUP SERVO CONTROL

PIN CONFIGURATION



Outline 42P2R-A

IC INTERNAL BLOCK DIAGRAM



Unit Resistance : Ω

PIN DESCRIPTION

Pin No.	Symbol	Block	I/O	Function
①	APC SW OUT	APC	0	APC SW control output
②	APC SW IN	APC	1	APC SW control input
③	TE IN	Pre Amp. Input	1	Tracking error signal input
④	TC IN	↑	1	Tracking cross signal input
⑤	MR	↑	1	Mirror detected signal input
⑥	JUMP FLAG	Microcomputer I/O	0	Outputs High under Jump function
⑦	HF OK	Pre Amp. Input	1	HF OK signal input
⑧	HFOK IN	Input	1	HF OK signal input
⑨	HFD	Output (DSP)	0	Outputs High, when HF OK Low
⑩	DATA OUT	↑	0	Inner condition output changed by command modes
⑪	JPT	↑	1	1 Track Jump control signal input (usually High)
⑫	MSD	↑	1	Serial data input (LSB first 8-bit data)
⑬	MLA	↑	1	Latch signal of serial data from microcomputer to servo IC
⑭	MCK	↑	1	Clock signal of serial data from microcomputer to the servo IC
⑮	ACLR	↑	1	All clear input (clear inner registers and flip-flops by Low signal)
⑯	SYSTEM RESET	RESET	0	Reset pulse output
⑰	SYSTEM RESET	RESET	1	Reset pulse width
⑱	BIAS	Regulated voltage	0	Outputs reference voltage ($\approx \frac{V_{CC}}{2}$ at signal supply voltage)
⑲	COM	↑	1	COMMON connects to GND at split supply voltage : to pin ⑱ at single supply voltage
⑳	GND	↑	1	GND
㉑	VEE	↑	1	Negative supply voltage. At single supply voltage connects to GND
㉒	C-FSR	Focus servo	-	Connects the external capacitor for setting time constant of Focus search
㉓	CURRENT REF	Regulated voltage	1	Connects the external resistance for deciding value of current
㉔	Vcc	Supply voltage	1	Positive supply voltage
㉕	SS OUT	Side servo	0	SS Amp. output
㉖	SS⊖	↑	1	SS Amp. negative input
㉗	SS⊕	↑	1	SS Amp. positive input
㉘	TS OUT	Tracking servo	0	TS Amp. output
㉙	TS⊖	↑	1	TS Amp. negative input
㉚	TS⊕	↑	1	TS Amp. positive input
㉛	TG1	↑	-	TG1 SW output
㉜	TE OUT	↑	0	TE Amp. output
㉝	TE⊖	↑	1	TE Amp. negative input
㉞	FSR IN	Focus servo	1	Focus search detector input
㉟	FG	↑	-	FG SW output
㊱	FS OUT	↑	0	FS Amp. output
㊲	FS⊖	↑	1	FS Amp. negative input
㊳	FS⊕	↑	1	FS Amp. positive input
㊴	FE OUT	↑	0	Focus error Amp. output
㊵	FE⊖	↑	1	Focus error Amp. negative input
㊶	FE⊕	↑	1	Focus error Amp. positive input

ABSOLUTE MAXIMUM RATINGS (Ta = 25 °C, unless otherwise noted)

Symbol	Parameter	Ratings	Unit
Vcc	Supply voltage	+ 6.5	V
VEE		- 6.5	V
Vi	Input voltage (absolute value)	Applied supply voltage+0.3	V
Vo	Output voltage (absolute value)	Applied supply voltage+0.3	V
Pd	Power dissipation	750	mW
Topr	Operating temperature	-20~+75	°C
Tstg	Storage temperature	-40~+125	°C

ELECTRICAL CHARACTERISTICS (Vcc = +5V, VEE = -5V, Ta = 25 °C, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
Icc	Circuit current	RESET	-	14	32	mA
IEE	Circuit current	RESET	-28	-12	-	mA
GFE	FE close loop voltage	f=1kHz, Vi = -10dBm	8	10	12	dB
VHFE	FE output voltage high	Vi = 2V, RL = 220 Ω	2.2	4	-	V
VLFE	FE output voltage low	Vi = -2V, RL = 220 Ω	-	-4	-2.2	V
GFS	FS close loop voltage gain	f=1kHz, Vi = 10dBm	20	22	24	dB
ATFS	FS SW attenuation	f=1kHz, Vi = 0dBm	-	-35	-25	dB
RONFG	FG SW on resistor	f=1kHz, Vi = 0dBm	-	100	300	Ω
VHFS	FS output voltage high	Vi = 1V, RL = 220 Ω	2.2	4	-	V
VLFS	FS output voltage low	Vi = -1V, RL = 220 Ω	-	-4	-2.2	V
VFSR+	FSR reference voltage ⊕	Note "FSR Detector Function"	0.40	0.45	0.50	V
VFSR-	FSR reference voltage ⊖	Note "FSR Detector Function"	-0.54	-0.49	-0.44	V
GTE	TE close loop voltage gain	f=1kHz, Vi = -10dBm	6.8	8.8	10.8	dB
GTS	TS close loop voltage gain	f=1kHz, Vi = -10dBm	7.8	9.8	11.8	dB
ATTS1	TS SW attenuation	f=1kHz, Vi = 0dBm	-	-50	-30	dB
ATTS2			-	-50	-30	dB
RONT1	TG1 SW on resistor	f=1kHz, Vi = 0dBm	-	50	300	Ω
RONT2	TG2 SW on resistor	f=1kHz, Vi = 0dBm	-	50	300	Ω
VHTS	TS output voltage high	Vi = 2V, RL = 220 Ω	2.2	4	-	V
VLTS	TS output voltage low	Vi = -2V, RL = 220 Ω	-	-4	-2.2	V
GSS	SS close loop voltage gain	f=1kHz, Vi = -10dBm	11.5	13.5	15.5	dB
ATSS	SS SW attenuation	f=1kHz, Vi = 0dBm	-	-54	-30	dB
VHSS	SS output voltage high	Vi = 2V, RL = 220 Ω	2.2	4	-	V
VLSS	SS output voltage low	Vi = -2V, RL = 220 Ω	-	-4	-2.2	V
VJF	JF output voltage	Note "TRACK Function"	1.1	1.4	1.7	V
VJR	JR output voltage	Note "TRACK Function"	-1.7	-1.4	-1.1	V
VSF	SF output voltage	Note "SLIDE Function"	2.2	2.8	3.4	V
VSR	SR output voltage	Note "SLIDE Function"	-3.4	-2.8	-2.2	V
VFCU+	FZC⊕ reference voltage	Note "FSR Detector Function"	0.26	0.29	0.32	V
VFCU-			-0.1	0	0.1	V
VFCD+	FZC⊖ reference voltage	Note "FSR Detector Function"	-0.1	0	0.1	V
VFCD-			-0.31	-0.28	-0.25	V
VTC+	TC reference voltage	Note "BRAKE A, BRAKE B Function"	0	0.1	0.2	V
VTC-			-0.2	-0.1	0	V
VHTE	TE output voltage high	Vi = 2V, RL = 47k Ω	3.5	4.2	-	V
VLTE	TE output voltage low	Vi = -2V, RL = 47k Ω	-	-4.2	-3.5	V
VosFS	FS output offset voltage	After up search	70	130	190	mV
VosFE	FE output offset voltage		-30	0	30	mV
VosTE	TE output offset voltage		-35	-10	15	mV
VosTS	TS output offset voltage		-5	20	45	mV
VosSS	SS output offset voltage		-30	0	30	mV
IFSRU	FSR output current		21	29	37	μA
IFSRD			-32	-25	-8	μA

* 0dBm = 775mVrms

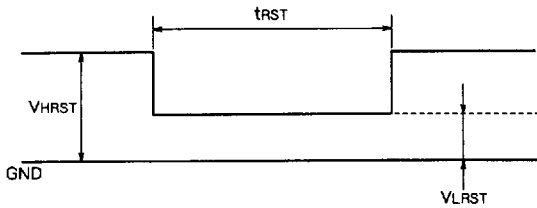
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OPTICAL PICKUP SERVO CONTROL

ELECTRICAL CHARACTERISTICS (cont.) ($V_{CC} = +5V$, $V_{EE} = -5V$, $T_a = 25^\circ C$, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V _{HSY}	SYSTEM RESET output voltage high	R _L = 20k Ω	4.0	4.9	-	V
V _{LSY}	SYSTEM RESET output voltage low	R _L = 20k Ω	-	0	0.2	V
I _{ALON}	APC SW "ON" output current		0.6	1.0	2.0	mA
I _{ALOF}	APC SW "OFF" output current		-10	0	10	μA

Note 1. Supply voltage turn on and pin ⑤ $\overline{ACL\bar{R}}$ input reset pulse and next all parameter measures.



$t_{RST} : 1 \mu s \text{ min}$
 $V_{HRST} : 2.5V \text{ min}$
 $V_{LRST} : 0.4V \text{ max}$

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OPTICAL PICKUP SERVO CONTROL

M51594AFP LOGIC CONTROL FUNCTION DESCRIPTION

1. Serial command function

The M51594AFP has a 8-bit shift register in the logic control block to convert serial data from microcomputer input through MSD pin ②, to internal switch commands.

(1) Data-Input function

Higher 4 bits of the 8-bit data (D7~D4) are used to select the command mode. Lower 4 bits (D3~D0) set the command state.

Once a command is set, it is held until a new command of the same command mode is input. If an other command mode is selected the command state will not change.

Table 1. Serial command function

X = 1 or 0

Mode Name	MSB				Data IN pin ② Input				Data Out pin ② Output
	Mode Select				Command State				
	D7	D6	D5	D4	D3	D2	D1	D0	
FOCUS	0	0	0	0	FS ON	FG	FSR EN	x	FS OK
TRACK1 { A B	0	0	0	1	x	BRAKE A	TG2	TG1	0
			1	0	x	BRAKE B			
TRACK2	0	0	1	0	TRACK		SLIDE		TC
SERVO OFF	0	1	x	x	x	x	x	x	0
STOP	1	1	x	x	x	x	x	x	0

Note 2. TRACK1 A and TRACK1 B at the same command mode.

TG2 and TG1 are set by both commands. BRAKE A or B are determined by selecting TRACK1 A or TRACK1 B.

3. Data out (pin ② output) is changed automatically when the command mode is selected.

4. The serial command 10XXXXXX is available of control M50422P/M50423FP/M50427FP (DSP LSI).

When this command input, the command state of M51594FP is not changed

Table 2. Command function

Command	Command mode	Data	Function			
FS ON	FOCUS	D3	1 ON 0 OFF	Focus search start → Focus on		
FG	↑	D2	1 CLOSE 0 OPEN	FG SW for changing focus gain is opened or closed		
FSR EN	↑	D1	1 INHIBIT 0 ENABLE	Inhibit automatic re-search of focus		
BRAKE A	TRACK1 A	D2	1 ON 0 OFF	Jump break action. TS2 SW is opened or closed		
BRAKE B	TRACK1 B	D2	1 ON 0 OFF	Jump break action. TS1 SW is opened or closed		
TG2	TRACK1	D1	1 OPEN 0 CLOSE	TG2 SW for changing TRACK gain is controlled		
TG1	TRACK1	D0	1 OPEN 0 CLOSE	TG1 SW for changing TRACK gain is controlled		
TRACK	TRACK2	D3 D2	0 0 TS OFF	Track servo off		
			0 1 TS ON		Track servo on	
			1 0 JF			Forward jump
			1 1 JR			
SLIDE	TRACK2	D1 D0	0 0 SS OFF	Slide servo off		
			0 1 SS ON		Slide servo on	
			1 0 SF			Forward slide
			1 1 SR			
-	SERVO OFF		Data of D0~D3 is reset to 0			
-	STOP		Data of D0~D3 is reset to 0			

SW states shown in Table 4

SW states shown in Table 5

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OPTICAL PICKUP SERVO CONTROL

SETTING CURRENT VALUE OF INTERNAL CURRENT SOURCES

(Focus search (FSR), Tracking servo (TS), Slide motor servo (SS))

Current value of internal current sources (FSR, TS, SS) is set by an external resistor connected between pin 23 and Vcc. (Resistance value : Rx)

If the current value of a current source (FSR, TS, SS) is IFSR, ITS, ISS)

$$I_{FSR} \approx \frac{1}{8} \cdot \frac{V_{CC} - V_{23}}{R_x}$$

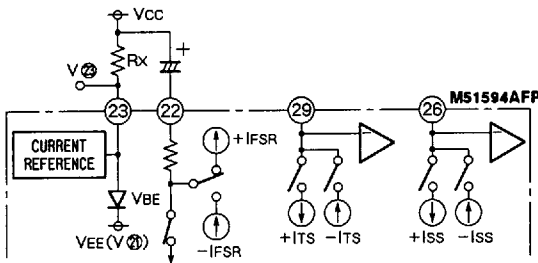
$$I_{TS} \approx \frac{1}{8} \cdot \frac{V_{CC} - V_{23}}{R_x}$$

$$I_{SS} \approx \frac{1}{4} \cdot \frac{V_{CC} - V_{23}}{R_x}$$

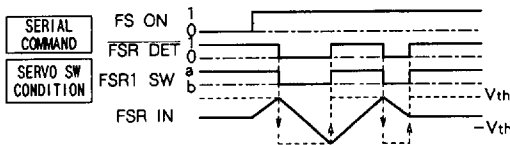
And if the voltage value of pin 22 is V22, the voltage value of pin 21,

$$V_{21} = V_{22} + V_{BE} \quad (V_{BE} \approx 0.7V)$$

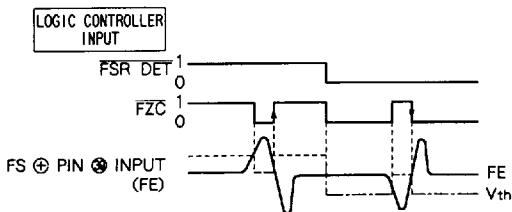
BLOCK DIAGRAM OF CURRENT SOURCES



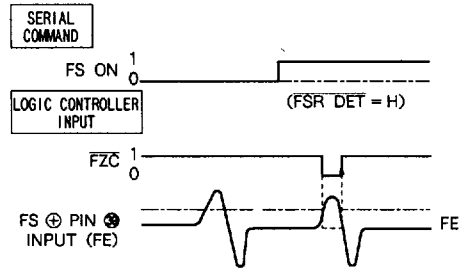
Timing chart of FSR det



Timing chart of FZC



FZC reset



FSR detector

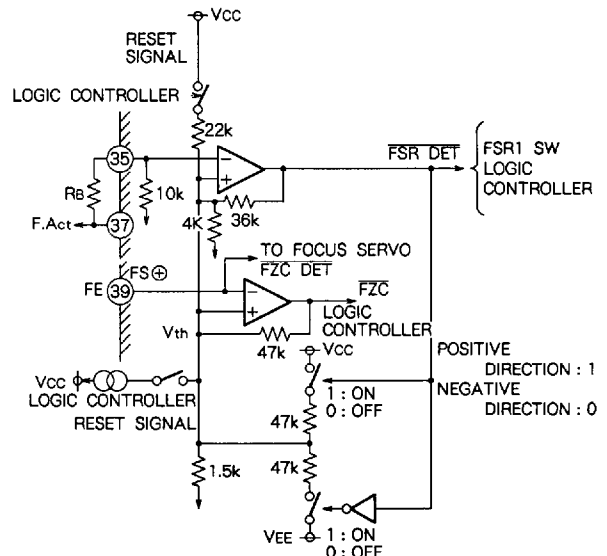
With external resistor (Ra) connected between FS OUT (pin 27) output and FSR IN (pin 39) input at FSR function,

- 1) FSR direction,
- 2) Threshold voltage polarity of FZC detector are automatically changed.

Focus search always starts from positive voltage side. The direction of FSR is changed by FSR 1 SW controlled by FSR DET signal.

INPUT		OUTPUT		
FSR IN level V _{IN}	FSR DET	FSR1 SW	At ±5V FZC V _{th}	
V _{IN} > V _{th}	0	b : Negative direction of FSR	Min	Max
V _{IN} < V _{th}	1	a : Positive direction of FSR	0V	0.30V

Equivalent circuit



(2) How to send serial data(MSD)

The serial command is executed by sending \overline{MLA} signal after sending LSB serial data.

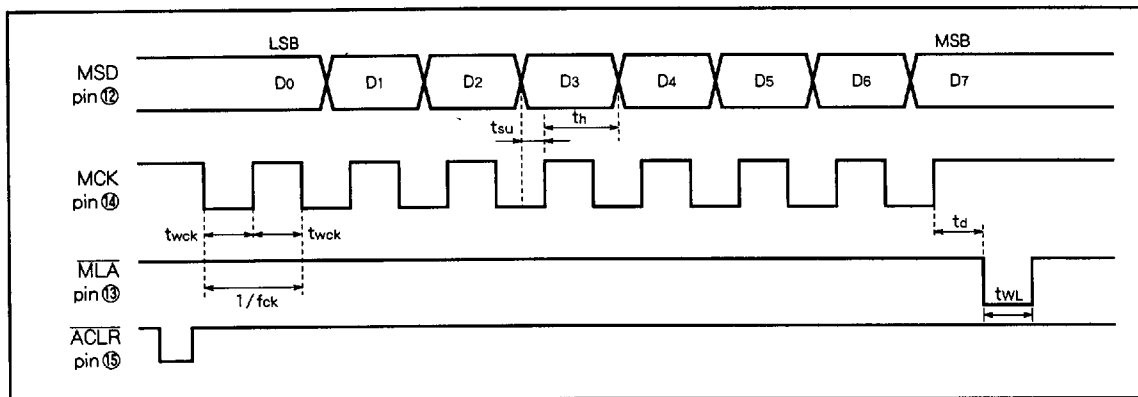


Fig. 1 Serial data input timing chart

2. BRAKE A, BRAKE B

When BRAKE A command or BRAKE B command is set to High (1), Jump brake operates.

This increases the ability to break after track jump

Jump brake action

- 1) When MR (pin 5) input) = 1, Track servo loop goes off at the edge of pulse output from TC Det.
- 2) When MR (pin 5) input) = 0, Track servo loop goes on at the edge of pulse output from TC Det.

Table 3. SW states at jump brake

INPUT MR \overline{TC}	OUTPUT	
	BRAKE A = 1 TS2 SW states	BRAKE B = 1 TS1 SW states
1	a (TRACK servo OFF)	b (TRACK servo OFF)
0	b (TRACK servo ON)	a (TRACK servo ON)

3. TRACK, SLIDE

Table 4. Track function

Command	INPUT Data		OUTPUT (SW state)			
	D3	D2	TS1 SW	TS2 SW	JF SW	JR SW
TS OFF	0	0	a (servo ON)	a (servo OFF)	b	b
TS ON	0	1	a (servo ON)	b (servo ON)	b	b
JF	1	0	b (servo OFF)	b (servo ON)	a (JF ON)	b
JR	1	1	b (servo OFF)	b (servo ON)	b	a (JR ON)

Table 5. Slide function

Command	INPUT		OUTPUT (SW state)		
	D ₁	D ₀	SS SW	SF SW	SR SW
SS OFF	0	0	a (servo OFF)	b	b
SS ON	0	1	b (servo ON)	b	b
SF	1	0	a (servo OFF)	a (SF ON)	b
SR	1	1	a (servo OFF)	b	a (SR ON)

4. Direct command function

JPT Input

At one track jump, \overline{JPT} signal allows two transmissions of serial data to selected and restrains the delay time of microcomputer.

JPT is usually high. After microcomputer catches the up signal of data out output (TC signal), if JPT goes down, the polarity of jump direction is automatically. (JF→JR, JR→JF)

After one track jump is finished (after period T₃), if JPT goes up, Jump ends and the states become TS ON and SS ON.

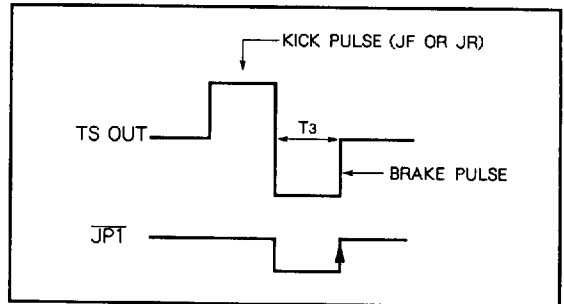


Fig. 2 JPT timing chart

Table 6. TRACK, SLIDE states by JPT Input

JPT (INPUT)	TRACK2 Mode (0010 D ₃ D ₂ D ₁ D ₀) (OUTPUT)							
	TRACK (D ₃ D ₂)				SLIDE (D ₁ D ₀)			
	00	01	10	11	00	01	10	11
1	TS OFF	TS ON	JF	JR	SS OFF	SS ON	SF	SR
0	TS OFF	TS ON	JR	JF	SS OFF	SS ON	SF	SR
↑	TS OFF	TS ON	TS ON	TS ON	SS ON	SS ON	SF	SR

Note 5. When command mode is TS OFF (001000XX, MSB first), even if JPT goes up, states do not become TS ON and SS ON.

6. Change to TS ON and SS ON after JPT goes up are held.

5. Logoc output function

(1) Data out

Data out output mode changes at each serial command mode.(shown in Table 1) It is decided by the last sent serial command.

Table 7. Data out output function

	Data Out output name	Serial Command Mode(INPUT)
(I)	FS OK	FOCUS (0000XXXX)
(II)	TC	TRACK2 (0010XXXX)

(I) FS OK

When HF OK (pin ⑦ input) was high and FS SW was closed (servo ON), FS OK is high.

(II) TC

TC pulse is produced by latching MR pulse with pulse edges of TC Det output (TC). At reset, TC is low.

Table 8. FS OK truth

INPUT		OUTPUT
HF OK	FS SW	FS OK
0	b (servo OFF)	0
1	b (servo OFF)	0
0	a (servo ON)	0
1	a (servo ON)	1

Note 7. While FS OK is low, TS2 SW and SS SW are opened regardless of the serial command.

Table 9. TC output

INPUT		OUTPUT
MR	TC	TC
1	↑ or ↓	1
0	↑ or ↓	0

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(2) $\overline{\text{HFD}}$ (HF defect)

Output is High when HF OK is Low.

(3) Jump flag

Jump flag terminal outputs ; High when serial command is TS OFF or JF or JR or BRAKE. Outputs is low at other times.

6. Focus error amp

This amp is auxiliary.

7. APC switch

The APC circuit supply is controlled by this switch.

8. System reset

This circuit generates the reset pulse at power-on.

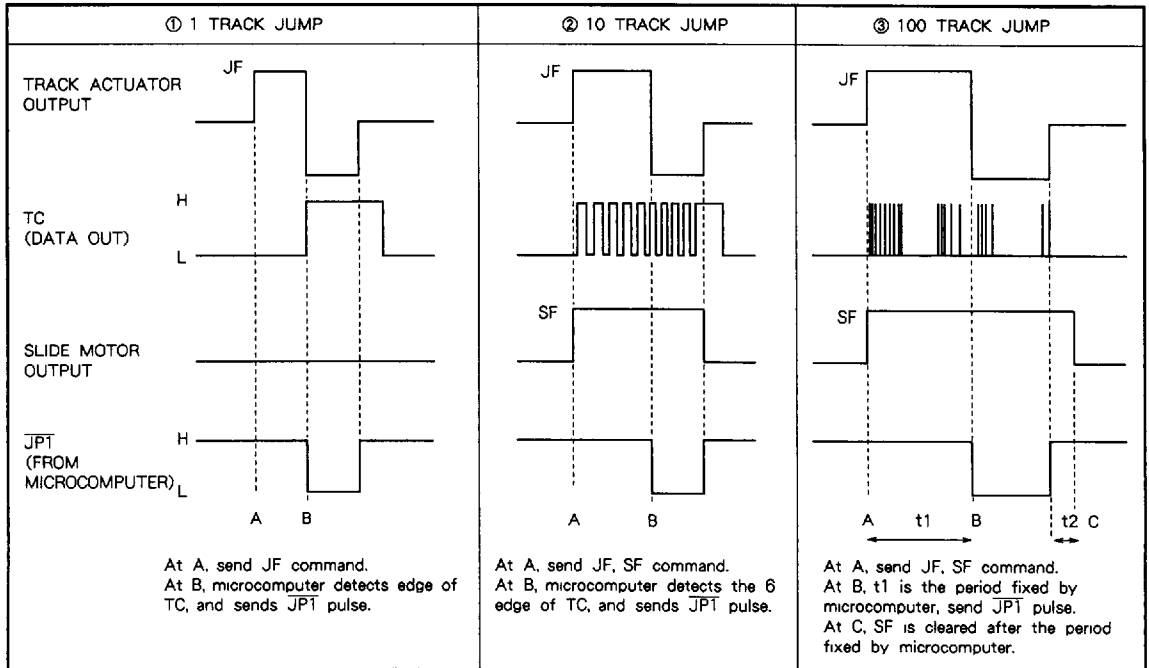
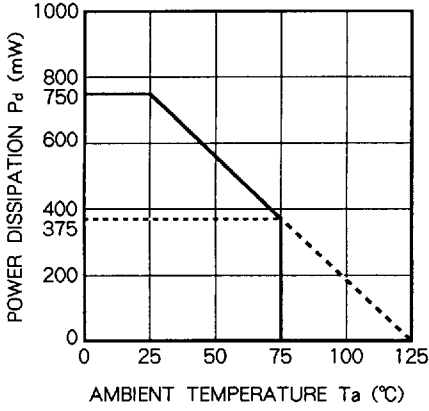


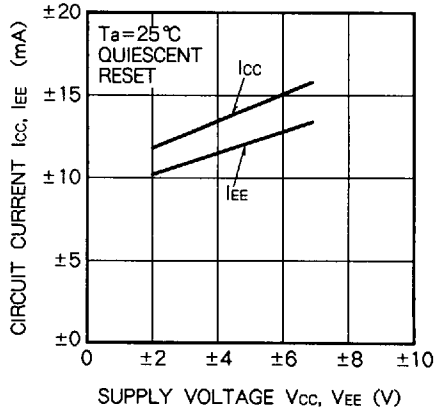
Fig. 3 Example for track jump timing. (Forward jump)

TYPICAL CHARACTERISTICS

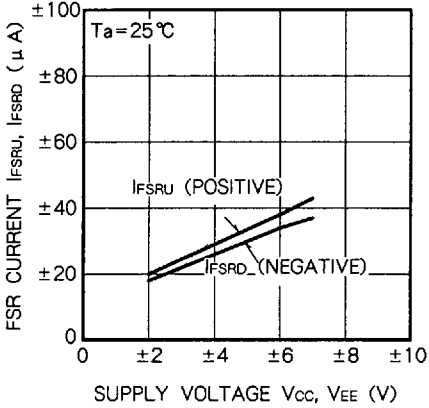
■ THERMAL DERATING
(MAXIMUM RATING)



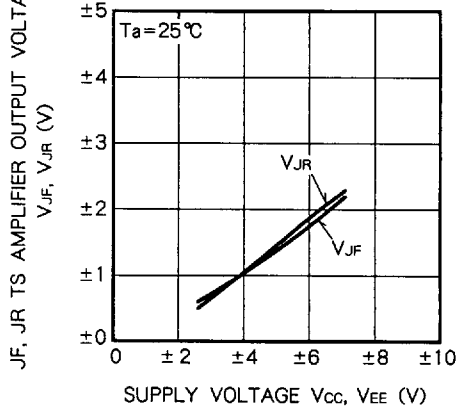
■ QUIESCENT CIRCUIT CURRENT
VS. SUPPLY VOLTAGE



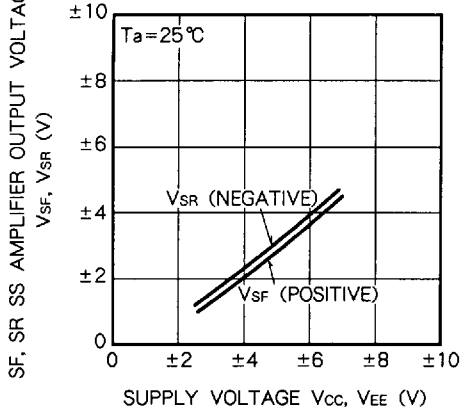
■ FSR CURRENT VS.
SUPPLY VOLTAGE



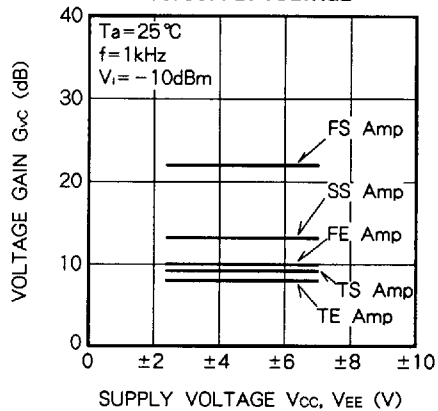
■ JF, JR, TS AMPLIFIER OUTPUT
VOLTAGE VS. SUPPLY VOLTAGE



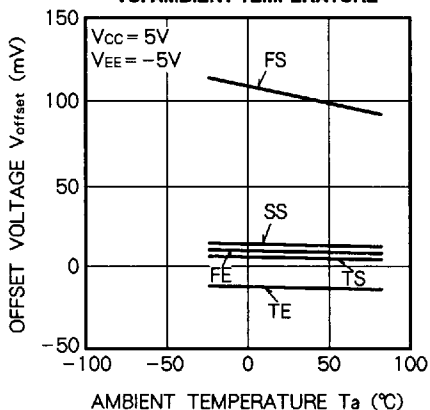
■ SF, SR SS AMPLIFIER OUTPUT
VOLTAGE VS. SUPPLY VOLTAGE



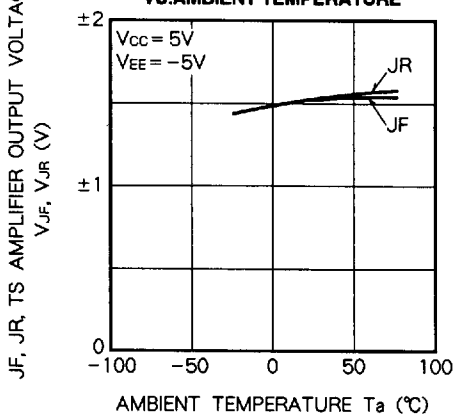
■ EACH AMPLIFIER VOLTAGE GAIN
VS. SUPPLY VOLTAGE



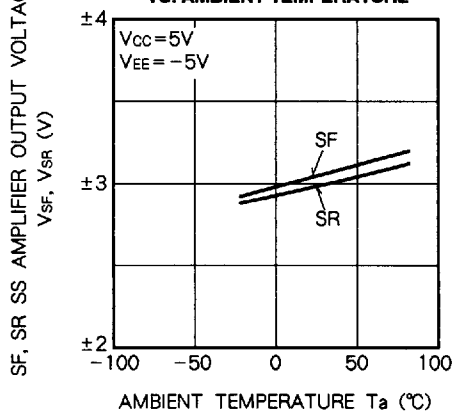
AMPLIFIER OFFSET VOLTAGES VS. AMBIENT TEMPERATURE



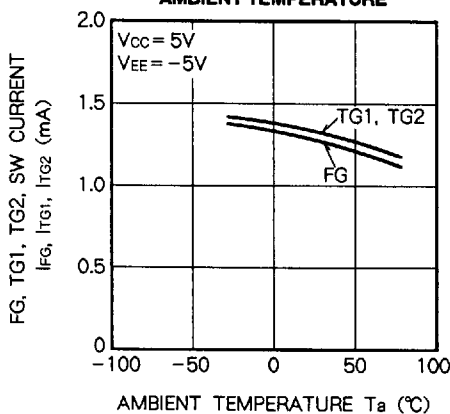
JF, JR, TS AMPLIFIER OUTPUT VOLTAGE VS. AMBIENT TEMPERATURE



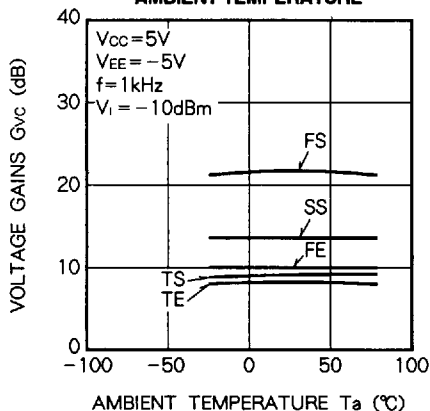
SF, SR SS AMPLIFIER OUTPUT VOLTAGE VS. AMBIENT TEMPERATURE



FG, TG1, TG2 CURRENT VS. AMBIENT TEMPERATURE



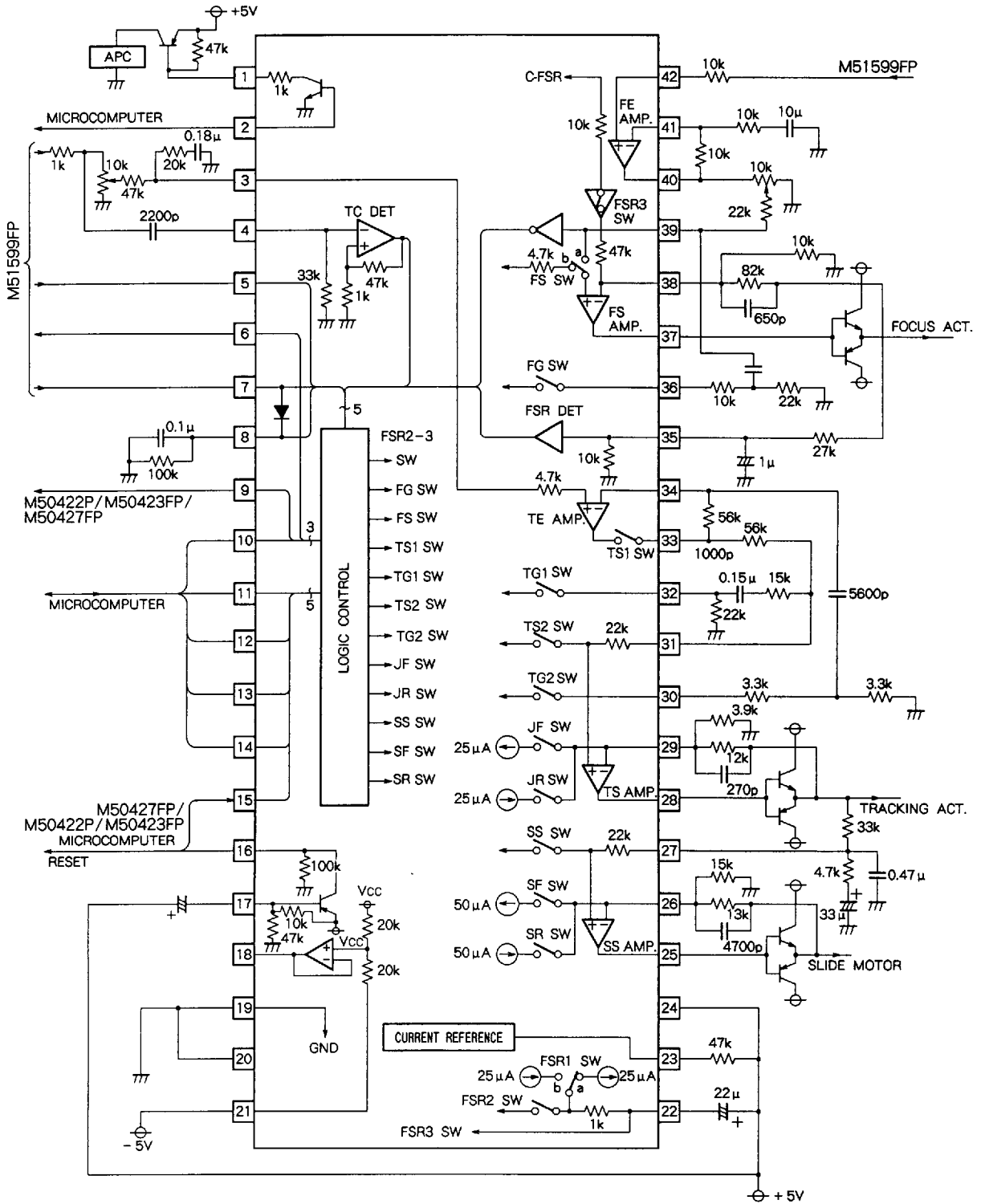
AMPLIFIER VOLTAGE GAINS VS. AMBIENT TEMPERATURE



M51594AFP

OPTICAL PICKUP SERVO CONTROL

APPLICATION EXAMPLE (V_{CC} = +5V, V_{EE} = -5V)



Units Resistance : Ω
Capacitance : F