Ordering number : ENN6125

Monolithic Linear IC

LA9251M

CD Player Analog Signal Processor (ASP)

Overview

The LA9251M is a servo signal-processing IC for CD players. In combination with a CD DSP such as the LC78626KE, it can implement a CD player with a minimal number of external components.

Functions

- I/V amplifier
- SLC
- FE
- Focus servo amplifier
- Spindle servo amplifier (with gain switching function)
- Focus detection (DRF and FZD)
- Defect detection
- RF amplifier with AGC
- APC
- TE (with variable gain and auto balance function)
- Tracking servo amplifier
- Sled servo amplifier (with turn-off function)
- Track detection (HFL, TES)
- Shock detection

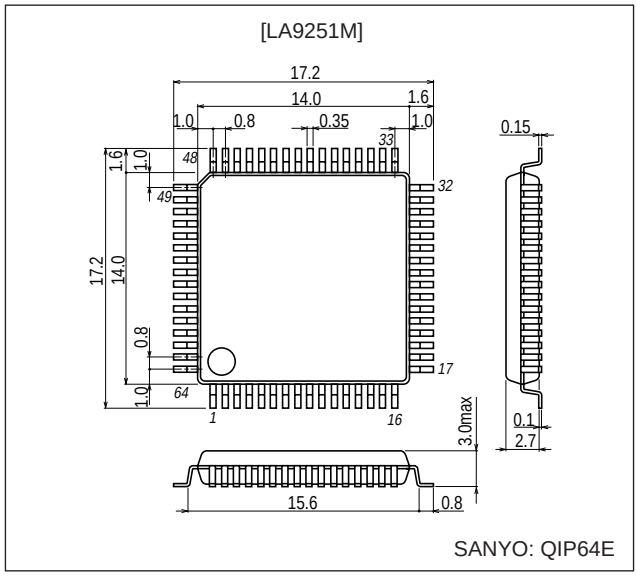
Features

- Low-voltage operation: 2.4 V (minimum)
- Low current drain: 15 mA (at V_{CC} = 3.0 V, typical)
- Built-in EF balance adjustment
- Built-in RF level AGC function
- RF level follower function for the tracking servo gain (with turn-off function)

Package Dimensions

unit: mm

3159-QIP64E



Specifications

Maximum Ratings at Ta = 25°C, with pin 46 tied to ground

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V_{CC} max	Pin 56	7	V
Allowable power dissipation	Pd max	Ta ≤ 75°C	200	mW
Operating temperature	Topr		–15 to +75	°C
Storage temperature	Tstg		–40 to +150	°C

SANYO Electric Co.,Ltd. Semiconductor Company

TOKYO OFFICE Tokyo Bldg., 1-10, 1 Chome, Ueno, Taito-ku, TOKYO, 110-8534 JAPAN

42800RM (OT) No. 6125-1/17

Operating Conditions at Ta = 25°C, with pin 46 tied to ground

Parameter	Symbol	Conditions	Ratings	Unit
Recommended supply voltage	V_{CC}		3	V
Allowable operating supply voltage range	V_{CC} op		2.4 to 5.5	V

Electrical Characteristics at Ta = 25°C, with pin 46 tied to ground, pin 56 = 3 V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Current drain	I_{CCO}	No input	8	14	21	mA
Reference voltage	V_{REF}	VR	1.2	1.5	1.8	V
[Interface]						
SLOFvth	SLOFvth	SLOF		0.8		V
SP8vth	SP8vth	SP8: 8 cm mode		0.8		V
EFBALvth	EFBALvth	EFBAL		2.3		V
FSTAvth	FSTAvth	ESTA		2.3		V
LASERvth	LASERvth	LASER		0.8		V
CLK	CLK	R = 390 kΩ, C = 0.1 µF	25	35	45	Hz
[RF Amplifier]						
RF no-signal voltage	RFo		0.75	1.00	1.25	V
Minimum gain	RF_Gmin	FIN1, FIN2: 1 MΩ-input, PH1 = 2 V, f = 200 kHz, RF		–15		dB
[Focus Amplifier]						
FDO gain	FD_G	FIN1, FIN2: 1 MΩ-input, FDO	3.5	5.0	6.5	dB
FDO offset	FDost	The difference from the reference voltage, servo on.	–340	0	+340	mV
F search voltage (high) 1	FS max1	FDO, FSS = GND		0.8		V
F search voltage (low) 1	FS min1	FDO, FSS = GND		–0.8		V
F search voltage (high) 2	FS max2	FDO, FSS = V_{CC}		0.8		V
F search voltage (low) 2	FS min2	FDO, FSS = V_{CC}		0		V
[Tracking Amplifier]						
TE gain max	TE_G max	f = 10 kHz, E: 1 MΩ-input, PH1 = 0.5 V, TGRF = open	–3.6	–3.0	–2.4	dB
TE gain min	TE_G min	f = 10 kHz, E: 1 MΩ-input, PH1 = 2 V, TGRF = open	–11.0	–9.0	–7.0	dB
TE-3dB	TEfc	E: 1 MΩ-input		70		kHz
TO gain	TO_G	TH → TO gain, THLD mode	10.0	12.0	14.0	dB
TGL offset	TGLost	Servo on, TGL = high, TO	–260	0	+260	mV
TGH offset	TGHost	TGL = low, the difference from the TGL offset, TO	–35	0	+35	mV
THLD offset	THDost	THLD mode, the difference from the TGL offset, TO	–35	0	+35	mV
Off 1 offset	OFF1ost	TOFF = High	–25	0	+25	mV
Balance range (high)	BAL-H	ΔGainE/F input, TB = 3 V, TBC = open		+35		dB
Balance range (low)	BAL-L	ΔGainE/F input, TB = 0 V, TBC = open		–35		dB
TGLvth	TGLvth		0.8	1.5	1.8	V
PH no-signal voltage	PHo	The difference from RFSM	–0.90	–0.65	–0.40	V
BH no-signal voltage	BHo10	The difference from RFSM	0.40	0.65	0.90	V
DRF detection voltage	DRFvth	At RFSM, the difference from VR	–0.50	–0.25	–0.10	V
DRF output voltage (high)	DRF-H		2.5	2.9		V
DRF output voltage (low)	DRF-L			0	0.5	V
FZD detection voltage 1	FZD1	FE, the difference from VR	0	0.2		V
FZD detection voltage 2	FZD2	FE, the difference from VR		0		V
HFL detection voltage	HFLvth	At RF, the difference from VR	–0.25	–0.10	–0.05	V
HFL output voltage (high)	HFL-H		2.5	2.9		V
HFL output voltage (low)	HFL-L			0	0.5	V
TES output voltage (low-high)	TES-LH	TESI, the difference from VR	–0.15	–0.10	–0.05	V
TES output voltage (high-low)	TES-HL	TESI, the difference from VR	0.05	0.10	0.15	V
TES output voltage (high)	TES-H		2.5	2.9		V
TES output voltage (low)	TES-L			0	0.5	V
JP output voltage (high)	JP-H	TJP = 3 V, at TO, the difference from TJP = 1.5 V	0.05	0.25	0.45	V

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Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
[Spindle Amplifier]						
Offset 12	SPD12ost	At SPD, the difference from VR, SP8 = 0 V: 12 cm mode	–40	0	+40	mV
Offset 8	SPD8ost	At SPD, the difference from VR, SP8 = 3 V: 8 cm mode	–40	0	+40	mV
Offset off	SPDof	At SPD, the difference from VR, SP8 = 3 V: 8 cm mode	–40	0	+40	mV
Output voltage H12	SPD-H12	The difference from offset 12, SP8 = 0 V, 12 cm mode, CLV = 3 V	0.35	0.50	0.65	V
Output voltage H8	SPD-H8	The difference from offset 8, SP8 = 3 V, 8 cm mode, CLV = 3 V	0.10	0.20	0.30	V
[Sled Amplifier]						
Offset SLD	SLDost	SLEQ = VR, the difference from VR	–80	0	+80	mV
Offset off	SLDof	SLOF = High	–40	0	+40	mV
SLC no-signal voltage	SLCo	SLC	1.0	1.5	2.0	V
Shock no-signal voltage	SCIo	SCI, the difference from VR	–40	0	+40	mV
Shock detection voltage (high)	SCIvthH	SCI, the difference from VR	90	140	190	mV
Shock detection voltage (low)	SCIvthL	SCI, the difference from VR	–190	–140	–90	mV
DEF detection voltage	DEFvth	The difference between the LF2 voltage when DEF is detected with RF = 1.9 V and the LF2 voltage when RF = 1.9 V.	0.20	0.35	0.50	V
DEF output voltage (high)	DEF-H		2.5	2.9		V
DEF output voltage (low)	DEF-L			0	0.5	V
APC reference voltage	LDS	The LDS voltage such that LDD = 1.5 V	120	170	220	mV
APC off voltage	LDDof	LDD	2.7	2.9		V

Pin Functions

Pin No.	Pin	Function
1	FIN2	Pickup photodiode (focus, RF) connection
2	FIN1	Pickup photodiode (focus, RF) connection
3	E	Pickup photodiode (tracking) connection
4	F	Pickup photodiode (tracking) connection
5	TB	TE signal DC component input. Pickup photodiode (tracking) connection
6	TE⁻	TE signal gain setting resistor connection. A resistor is connected between this pin and TE.
7	TE	TE signal output
8	TESI	TES comparator input. Takes the bandpass filtered TE signal as its input.
9	SCI	Shock detection input
10	TH	Tracking gain time constant setting
11	TA	TA amplifier output
12	TD⁻	In conjunction with the TD and VR pins, used to form the tracking phase compensation circuit constant
13	TD	Tracking phase compensation setting
14	JP	Track jump signal amplitude setting
15	TO	Tracking control signal output
16	(NC)	No connection
17	FD	Focusing control signal output
18	FD⁻	In conjunction with the FD and FA pins, used to form the focusing phase compensation circuit constant
19	FA	In conjunction with the FD- and FA- pins, used to form the focusing phase compensation circuit constant
20	FA⁻	In conjunction with the FA and FE pins, used to form the focusing phase compensation circuit constant
21	FE	FE signal output
22	FE⁻	FE signal gain setting resistor connection. A resistor is connected between this pin and FE.
23	SP	CLV pin input signal inverted output
24	SPG	Gain setting resistor connection (12 cm spindle mode)

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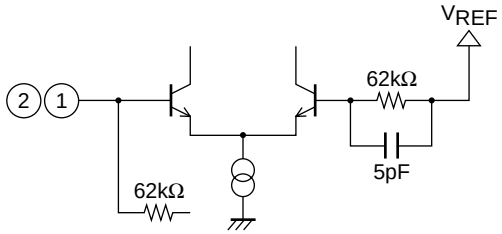
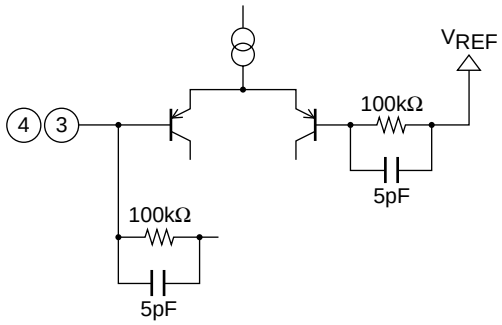
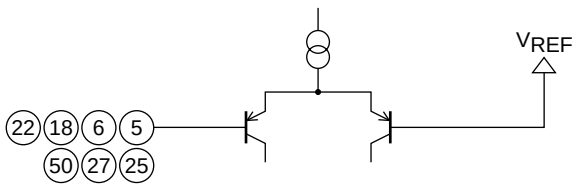
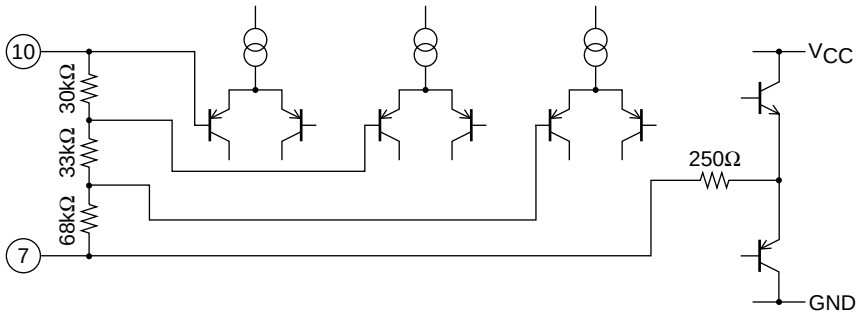
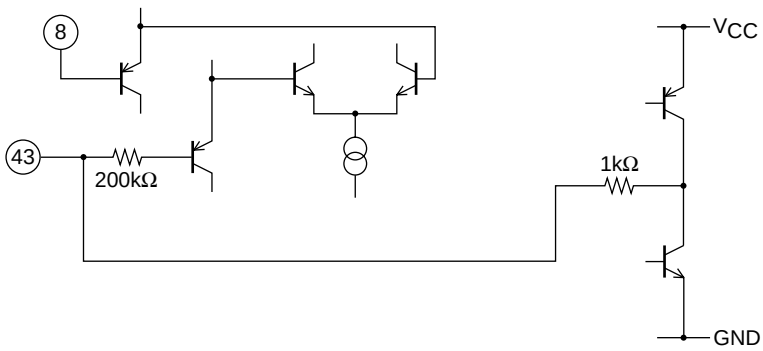
Pin No.	Pin	Function
25	SP−	In conjunction with the SPD pin, spindle phase compensation constant connection
26	SPD	Spindle control signal output
27	SLEQ	Sled phase compensation constant connection
28	SLD	Sled control signal output
29	SL−	Sled feed signal input from the microcontroller
30	SL+	Sled feed signal input from the microcontroller
31	OSC	Oscillator frequency setting
32	(NC)	No connection
33	SLOF	Sled servo off control input
34	TGRF	Tracking servo gain RF level follower function setting
35	SP8	Spindle 8 cm/12 cm mode switching control from the DSP
36	EFBAL	E/F balance adjustment signal input from the DSP
37	FSTA	Focus search control signal input from the DSP
38	LASER	Laser on/off control from the DSP
39	(NC)	No connection
40	TJP	Track jump signal input from the DSP
41	TGL	Tracking gain control signal input from the DSP
42	TOFF	Tracking off control signal input from the DSP
43	TES	TES signal output to the DSP
44	HFL	Output for the HFL signal that indicates whether the main beam is positioned over pits or mirror
45	CLV	CLV error signal input from the DSP
46	GND	GND
47	RF	RF output
48	RF−	In conjunction with the RF pin, sets the RF gain and sets the EFM 3T compensation constant
49	SLC	Output for control of the data slice level according to the DSP
50	SLI	Input for control of the data slice level according to the DSP
51	DEF	Disc defect detection output
52	DRF	RF level detection output
53	FSC	Focus search smoothing capacitor output
54	TBC	E/F balance variation range setting
55	FSS	Focus search mode setting
56	V_{CC}	V_{CC}
57	REFI	Reference voltage bypass capacitor connection
58	VR	Reference voltage output
59	LF2	Disc defect detection time constant setting
60	PH1	RF signal peak hold capacitor connection
61	BH1	RF signal bottom hold capacitor connection
62	LDD	APC circuit output
63	LDS	APC circuit input
64	(NC)	No connection

Pin Circuits

Pin No.	Pin	Internal equivalent circuit
1 2	FIN2 FIN1	
3 4	E F	
5 6 18 22 25 27 50	TB TE⁻ FD⁻ FE⁻ SP⁻ SLEQ SLI	
7 10	TE TH	
8 43	TESI TES	

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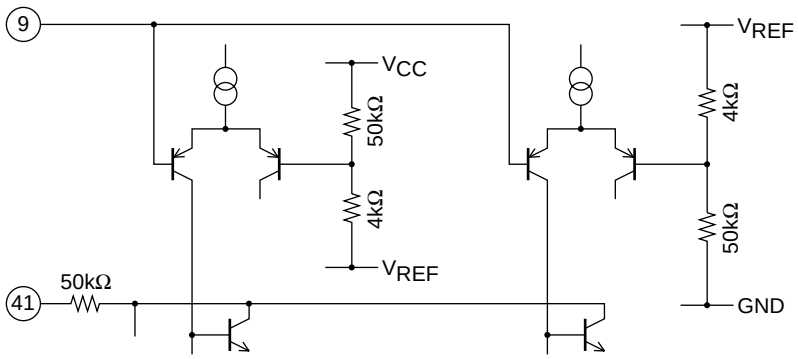
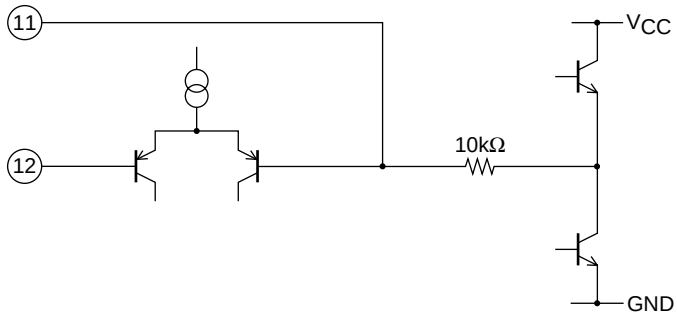
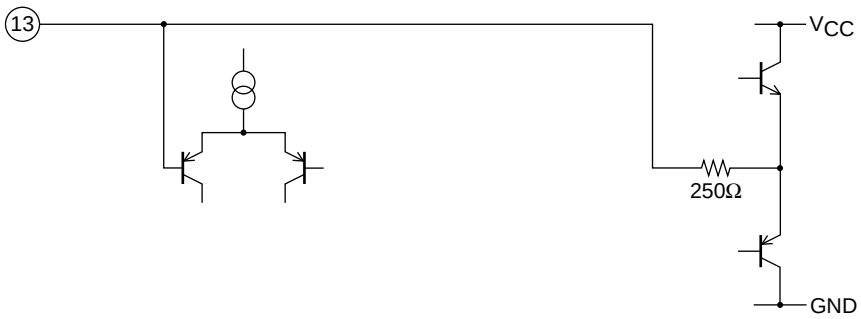
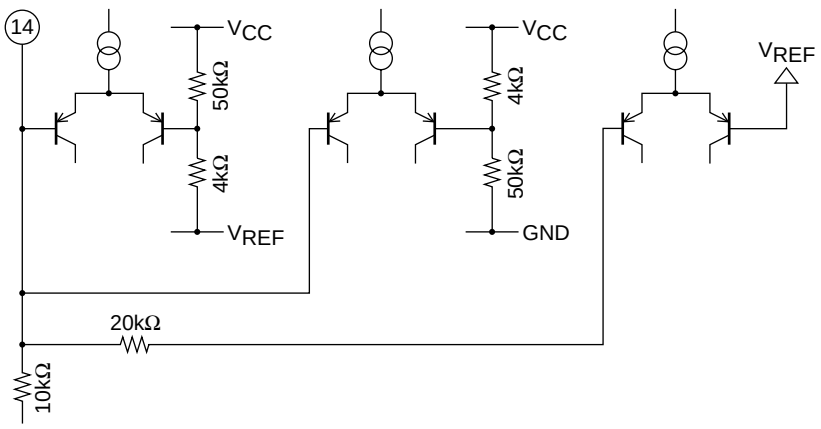
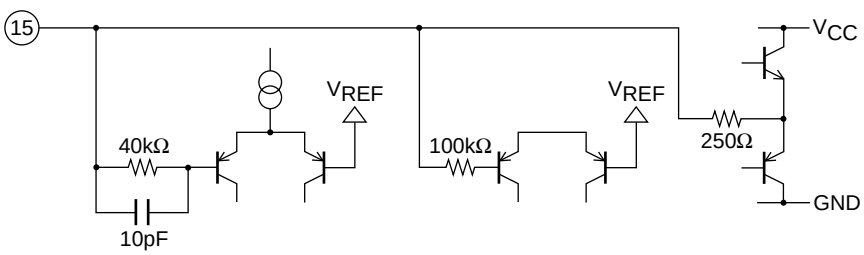
Pin No.	Pin	Internal equivalent circuit
9 41	SCI TGL	
11 12	TA TD–	
13	TD	
14	JP	
15	TO	

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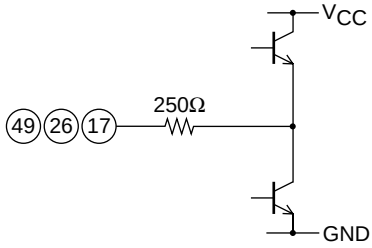
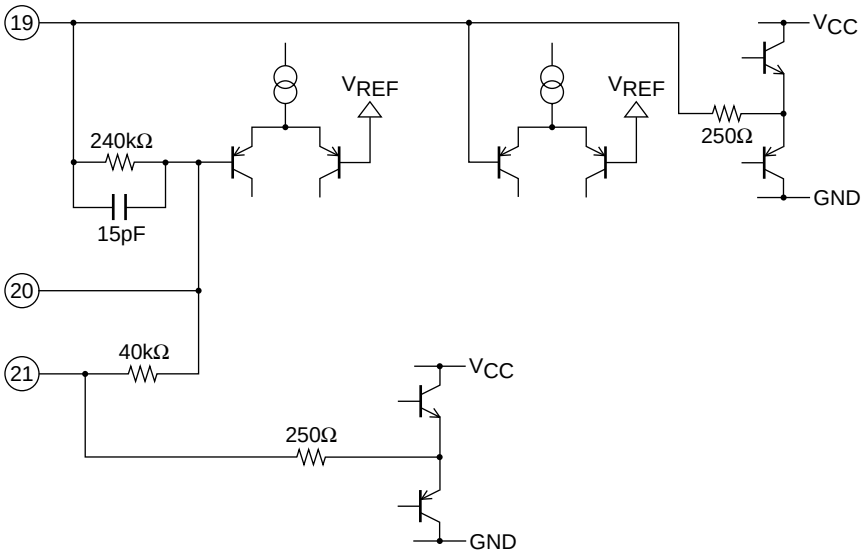
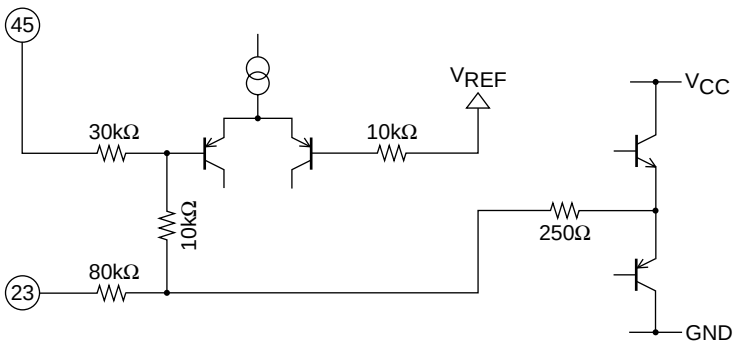
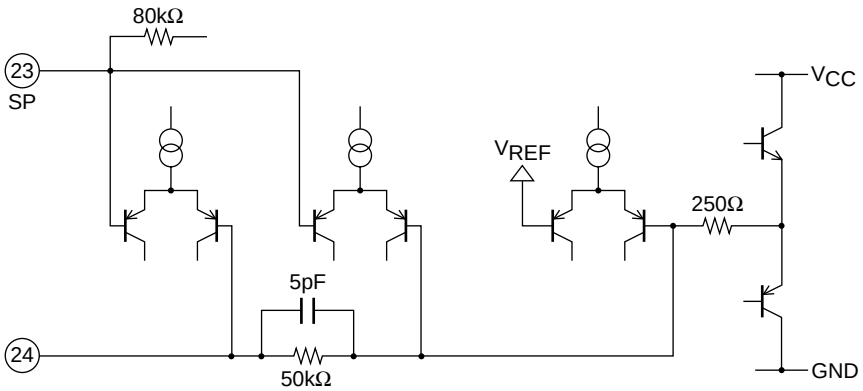
Pin No.	Pin	Internal equivalent circuit
17 26 49	FD SPD SLC	
19 20 21	FA FA⁻ FE	
23 45	SP CLV	
24	SPG	

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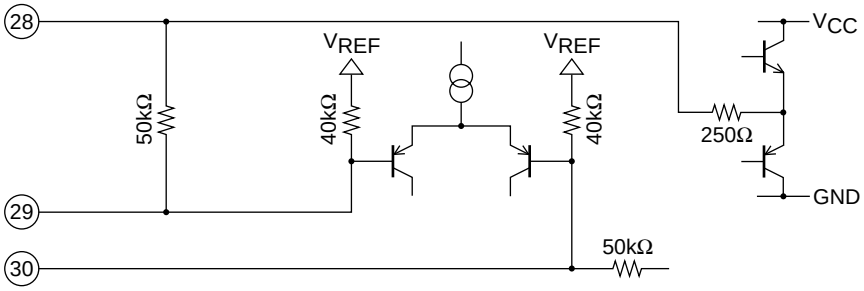
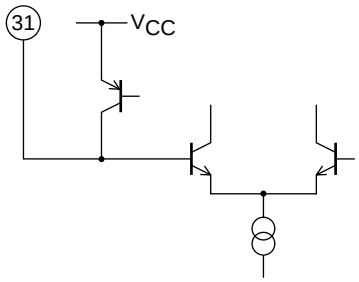
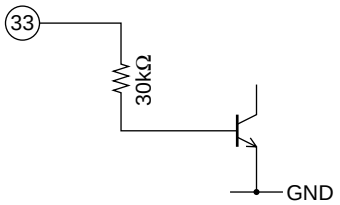
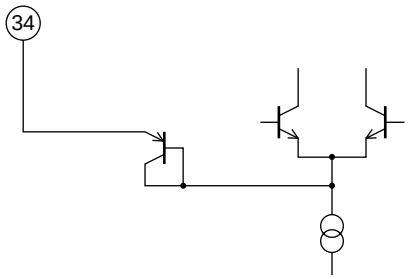
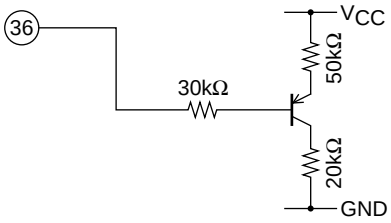
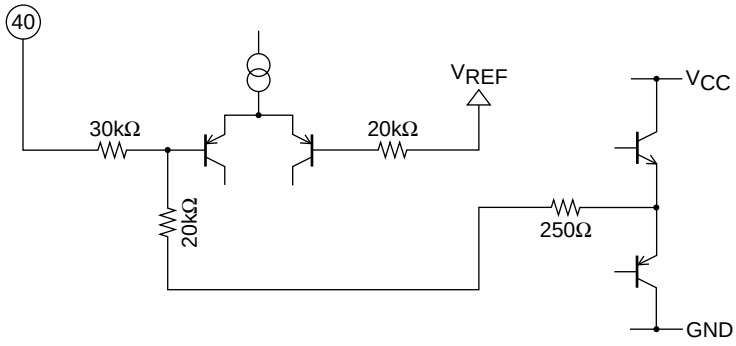
Pin No.	Pin	Internal equivalent circuit
28 29 30	SLD SL⁻ SL⁺	
31	OSC	
33 35 38	SLOF SP8 LASER	
34	TGRF	
36 37	EFBAL FSTA	
40	TJP	

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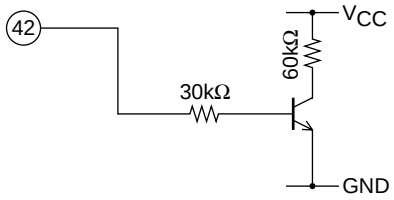
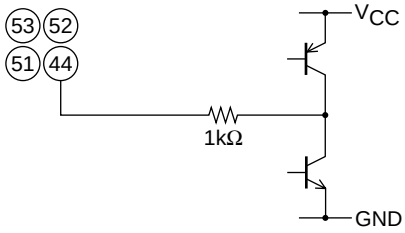
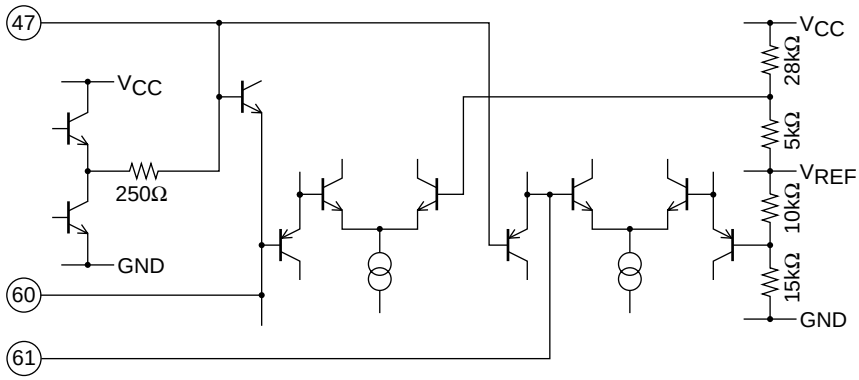
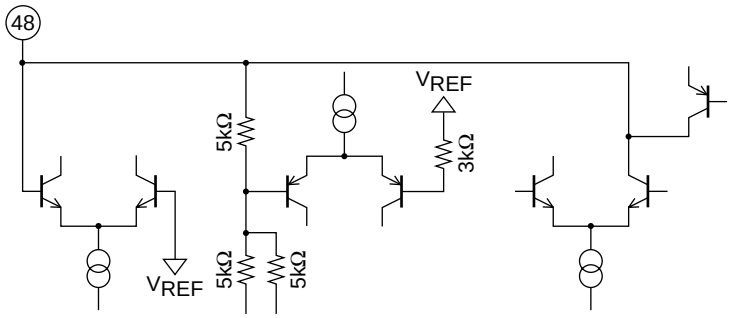
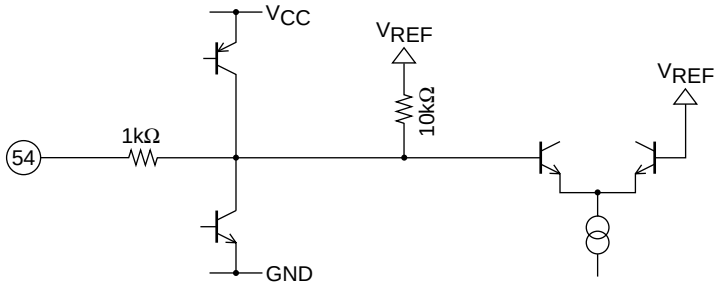
Pin No.	Pin	Internal equivalent circuit
42	TOFF	
44 51 52 53	HFL DEF DRF FSC	
47 60 61	RF PH1 BH1	
48	RF−	
54	TBC	

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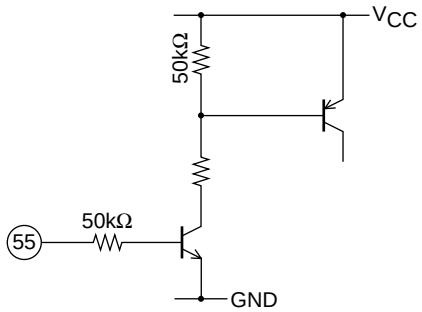
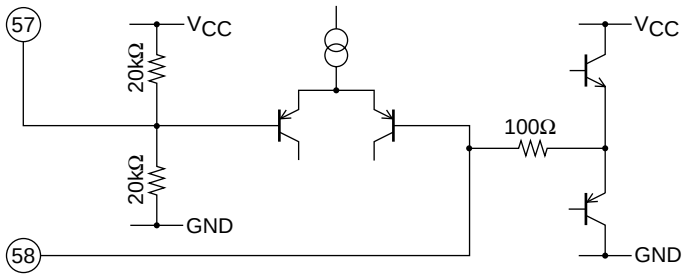
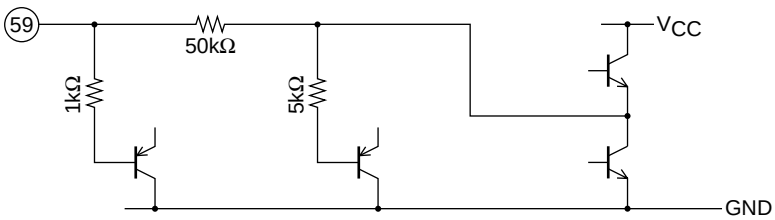
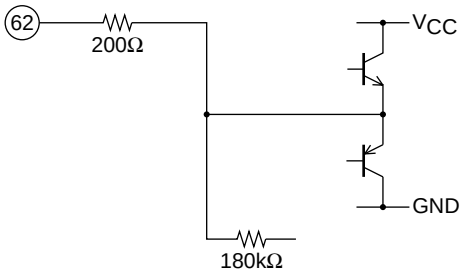
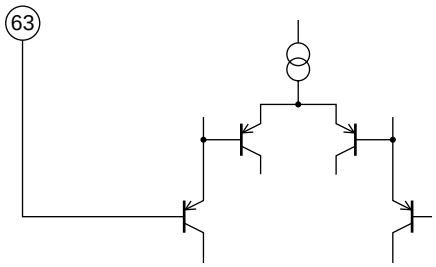
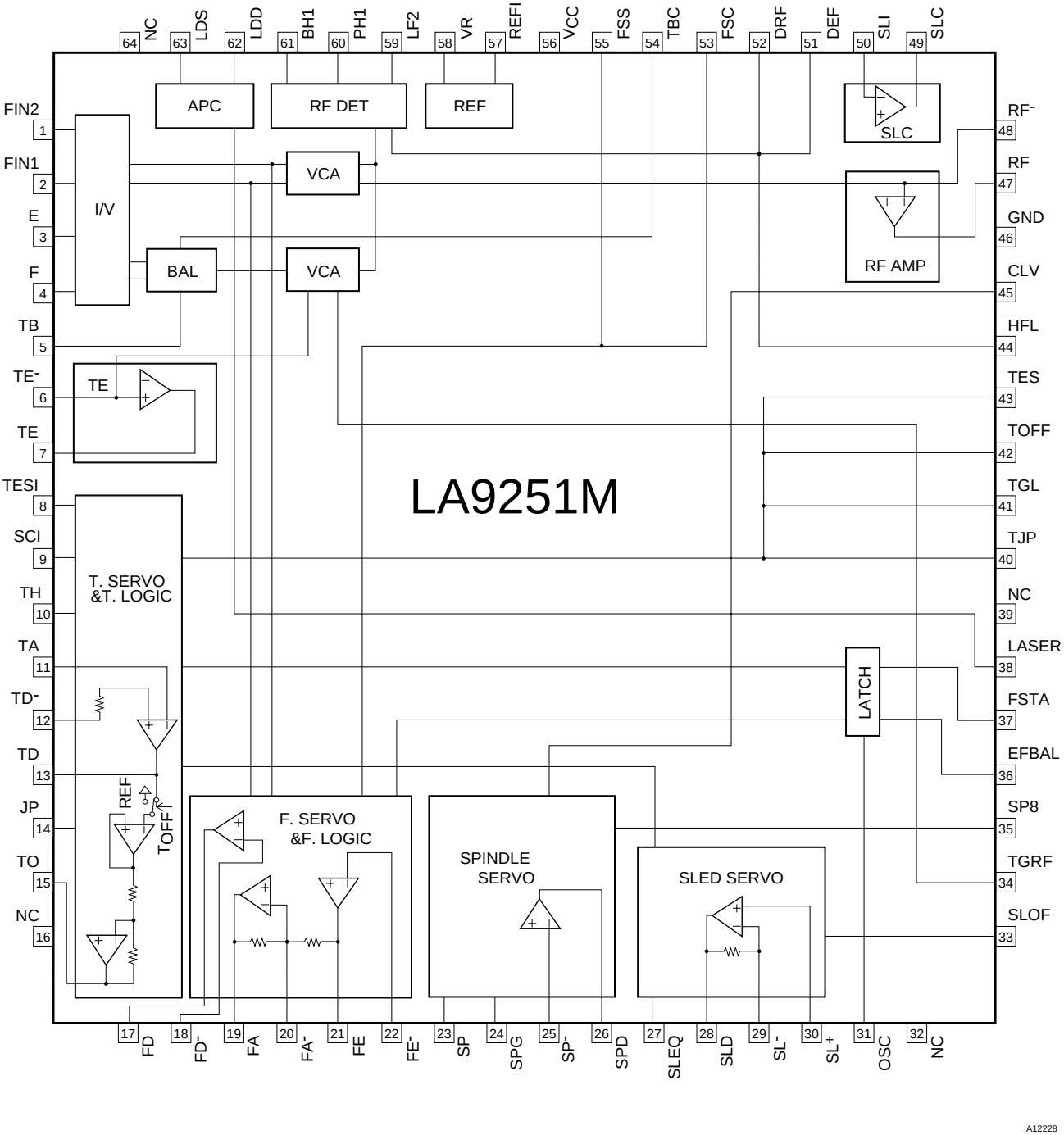
Pin No.	Pin	Internal equivalent circuit
55	FSS	
57 58	REFI VR	
59	LF2	
62	LDD	
63	LDS	

Equivalent Circuit



Operation

1. APC (Auto Laser Power Control)
   This circuit controls the laser power, turning the laser on and off (pin 38). The laser is turned on when the LASER pin is high.

2. RF amplifier (eye pattern output)
   The pickup photodiode output current input to FIN1 (pin 2) and FIN2 (pin 1) is I/V converted, passed through an AGC circuit, and output from the RFSUM amplifier RF pin (pin 47). The built-in AGC circuit has a variable range of about ±4 dB, and its time constant is set by the external capacitor connected to PH1 (pin 60). The EFM signal bottom level is also controlled, and the response is set by the external capacitor attached to PH1 (pin 60). The center gain for the AGC variable range is set by the value of the resistor between RF (pin 47) and RF- (pin 48). If required, these pins can also be used for EFM signal 3T compensation.

3. SLC (Slice Level Controller)
   Since the SLC circuit sets the duty of the EFM signal input to the DSP to 50%, the DC level is controlled by integrating the EFMO signal from the DSP.

4. Focus Servo
   The focus error signal is acquired by detecting the difference between (A + C) and (B + D) from the pickup and the result is output from FE (pin 21). The FE signal gain is set by the value of the resistor between FE and FE⁻ (pin 22). The FA amplifier is the pickup phase compensation amplifier, and its equalization curve is set by an external capacitor and resistor.
   The FD amplifier provides a phase compensation circuit and a focus search signal synthesis function.
   A focus search operation is started by switching FSTA (pin 37) from low to high. A ramp waveform is generated by an internal oscillator; this ramp completes in about 560 ms. We recommend holding FSTA (pin 37) high until another focus search is to be performed. Focus is detected (the focus zero cross state) from the focus error signal generated, in effect, by this waveform, and this turns the focus servo on. The ramp waveform amplitude is set by the value of the resistor between FD (pin 17) and FE⁻ (pin 18).
   Since FSC (pin 53) is used to smooth the focus search ramp waveform, a capacitor is connected between FSC and VR (pin 58). FSS (pin 55) switches the focus search mode; when FSS is shorted to VCC the circuit performs a + search with respect to the reference voltage VR, and when open or shorted to ground, it performs a ± search.

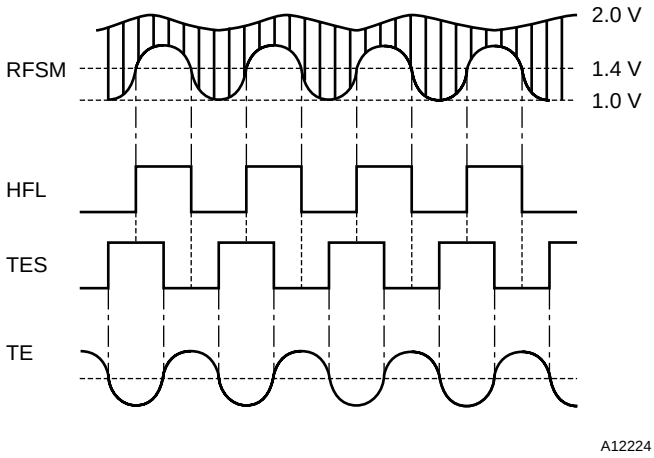
5. Tracking Servo
   The pickup photodiode output current input to E (pin 3) and F (pin 4) is I/V converted and passed first through a balance adjustment VCA circuit and then through a VCA circuit that performs gain following for the RF AGC circuit. The resulting signal is then output from TE (pin 7). The gain follower function can be turned off by setting TGRF (pin 34) high.
   The tracking error gain is set by the value of the resistor between TE⁻ (pin 6) and TE (pin 7).
   The TH amplifier detects either the JP signal or the TGL signal from the DSP, and functions to change the response characteristics of the servo according to the THLD signal generated internally. When a defect is detected, the circuit switches to THLD mode internally. Set DEF (pin 51) low to prevent this. Note that an external bandpass filter that extracts only the shock component from the tracking error signal is formed on SCI (pin 9), and that the gain is automatically increased if this signal is inserted.
   The TA output (pin 11) has an internal resistor so that a low-pass filter can be formed.
   The TD amplifier circuit is provided to perform servo loop phase compensation, and its characteristics are set by external RC components. This amplifier also provides a muting function, and the servo can be turned off by setting TOFF (pin 42) high.
   The TO amplifier provides a function for synthesizing JP pulses, and JP (pin 14) is used to set the JP pulse conditions.
   The E/F balance adjustment operation is started by switching EFBAL (pin 36) from low to high. After that, the adjustment operation is performed by a clock generated by an internal oscillator, and the adjustment completes in about 500 ms. We recommend holding EFBAL (pin 36) high until the next time an E/F balance operation is to be performed.

This adjustment operation must be performed over the disc pit area, not over the disc mirror area. Note that applications must take measures to assure that a stable TE signal is acquired so that track kick operations do not occur during the adjustment. (This includes sled feed commands from the microcontroller.)
The E/F balance adjustment precision and adjustment range can be set to be optimal for the pickup characteristics by the value of the resistor between TBC (pin 54) and the reference voltage, VR.

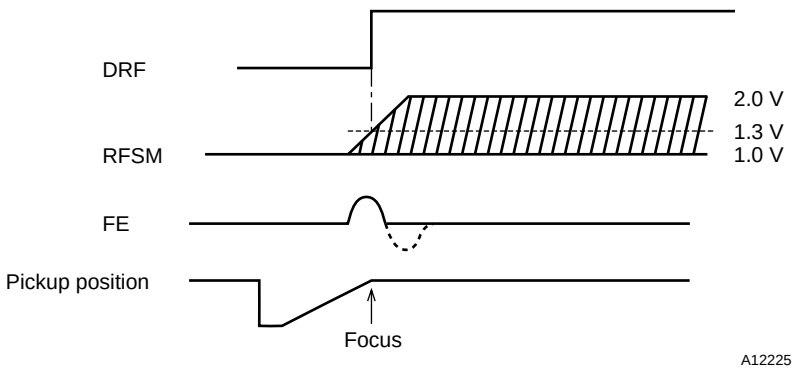
6. Sled Servo
The response characteristics are set at SLEQ (pin 27). The amplifier that follows SLEQ has a muting function, and the sled servo can be turned off by setting SLOF (pin 33) high.
Sled feed is performed in a current input form at SL− (pin 29) and SL+ (pin 30). In particular, a resistor is connected to a microcontroller output port and the feed gain is set by the value of that resistor.

7. Spindle Servo
A servo circuit that holds the disc at a constant linear velocity is formed by the internal servo circuit in conjunction with the DSP. A signal from the DSP is accepted by CLV (pin 45), and output from SPD (pin 26). The phase compensation characteristics are set by SP (pin 23), SP− (pin 25), and SPD. The 12 cm mode amplifier gain is set by a resistor connected between SPG (pin 24) and the reference voltage. In 8 cm mode, this amplifier is internally buffered and not affected by SPG. The circuit switches to 8 cm mode when SP8 (pin 35) is set high.

8. TES and HFL (Traversal signal)
The sub-beam signals from the pickup are connected to E (pin 3) and F (pin 4) so that HFL and TES have the phase relationship shown in the figure when the pickup moves from the outside towards the inside of the disc. The TES comparator has a hysteresis of about ±100 mV at the minus polarity of the comparator with respect to the TESI (pin 8) input. An external bandpass filter is formed so that only the required signal is extracted from the TE signal.

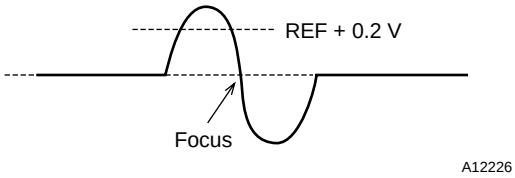


9. DRF (Optical level decision)
A peak hold operation is applied to the EFM signal (RF output) by a capacitor at PH1 (pin 60), and DRF goes high when the RF peak value exceeds about 1.3 V (when V_{CC} = 3.0 V). The PH1 capacitor is related to the settings of both the DRF detection time constant and the RF AGC response.



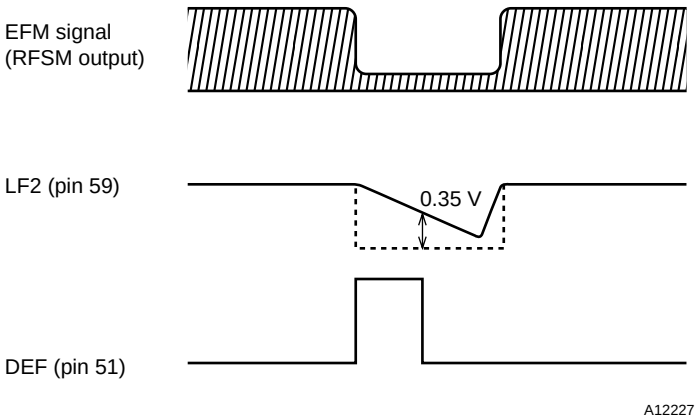
10. Focus Detection

The pickup is seen as being in focus when, after a VR + 0.2 V level is detected in the focus error signal S-curve, that S-curve next goes to the VR level.



11. Defect Detection

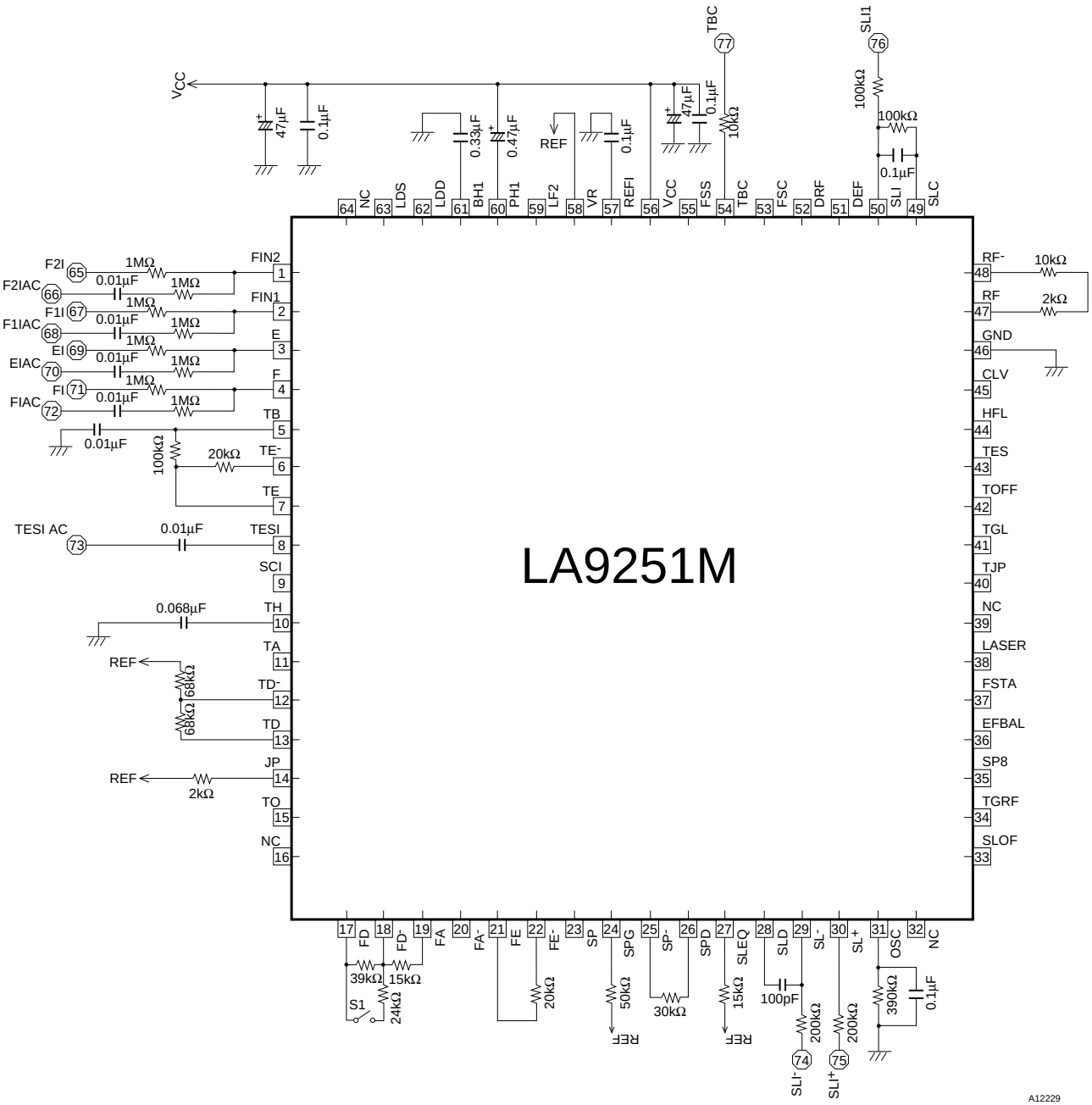
The mirror surface level is held by the capacitor on LF2 (pin 59), and DEF (pin 51) goes high if a drop in the EFM signal (RF output) exceeds about 0.35 V. When DEF goes high, the tracking servo goes to THLD mode. When a defect is detected applications can prevent the LA9251M from going to THLD mode either by setting DEF to low or by setting LF2 (pin 59) low and thus setting the LA9251M not to output DEF.



12. Oscillator Circuit

The oscillator frequency is set by the external RC circuit attached to OSC (pin 31). This oscillator frequency is used as the reference clock for focus search and E/F balance adjustment.

Test Circuit



Sample Application Circuit