



## LA9251M

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

| Parameter                                | Symbol             | Conditions | Ratings    | Unit |
|--|--------------------|------------|------------|------|
| Recommended supply voltage               | V <sub>CC</sub>    |            | 3          | V    |
| Allowable operating supply voltage range | V <sub>CC op</sub> |            | 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 <sub>CCO</sub>    | No input   | 8       | 14    | 21    | mA   |
| Reference voltage             | V <sub>REF</sub>    | 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          | RF <sub>o</sub>     |  | 0.75    | 1.00  | 1.25  | V    |
| Minimum gain                  | RF <sub>Gmin</sub>  | FIN1, FIN2: 1 MΩ-input, PH1 = 2 V, f = 200 kHz, RF   |         | -15   |       | dB   |
| [Focus Amplifier]             |                     |  |         |       |       |      |
| FDO gain                      | FD <sub>G</sub>     | FIN1, FIN2: 1 MΩ-input, FDO                          | 3.5     | 5.0   | 6.5   | dB   |
| FDO offset                    | FD <sub>ost</sub>   | 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 <sub>CC</sub>                           |         | 0.8   |       | V    |
| F search voltage (low) 2      | FS min2             | FDO, FSS = V <sub>CC</sub>                           |         | 0     |       | V    |
| [Tracking Amplifier]          |                     |  |         |       |       |      |
| TE gain max                   | TE <sub>G max</sub> | f = 10 kHz, E: 1 MΩ-input, PH1 = 0.5 V, TGRF = open  | -3.6    | -3.0  | -2.4  | dB   |
| TE gain min                   | TE <sub>G min</sub> | f = 10 kHz, E: 1 MΩ-input, PH1 = 2 V, TGRF = open    | -11.0   | -9.0  | -7.0  | dB   |
| TE-3dB                        | TE <sub>fc</sub>    | E: 1 MΩ-input  |         | 70    |       | kHz  |
| TO gain                       | TO <sub>G</sub>     | TH → TO gain, THLD mode                              | 10.0    | 12.0  | 14.0  | dB   |
| TGL offset                    | TGL <sub>ost</sub>  | Servo on, TGL = high, TO                             | -260    | 0     | +260  | mV   |
| TGH offset                    | TGH <sub>ost</sub>  | TGL = low, the difference from the TGL offset, TO    | -35     | 0     | +35   | mV   |
| THLD offset                   | THD <sub>ost</sub>  | THLD mode, the difference from the TGL offset, TO    | -35     | 0     | +35   | mV   |
| Off 1 offset                  | OFF1 <sub>ost</sub> | 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          | PH <sub>o</sub>     | The difference from RFSM                             | -0.90   | -0.65 | -0.40 | V    |
| BH no-signal voltage          | BH <sub>o10</sub>   | 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  |      |
| <b>[Spindle Amplifier]</b>     |          |  |         |      |      |      |
| 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    |
| <b>[Sled Amplifier]</b>        |          |  |         |      |      |      |
| 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 <sub>CC</sub> | V <sub>CC</sub>  |
| 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  |

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Pin Circuits

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

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| Pin No.  | Pin        | Internal equivalent circuit |
|----------|------------|-----------------------------|
| 9<br>41  | SCI<br>TGL |                             |
| 11<br>12 | TA<br>TD-  |                             |
| 13       | TD         |                             |
| 14       | JP         |                             |
| 15       | TO         |                             |

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| Pin No.        | Pin              | Internal equivalent circuit |
|----------------|------------------|-----------------------------|
| 17<br>26<br>49 | FD<br>SPD<br>SLC |                             |
| 19<br>20<br>21 | FA<br>FA-<br>FE  |                             |
| 23<br>45       | SP<br>CLV        |                             |
| 24             | SPG              |                             |

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

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

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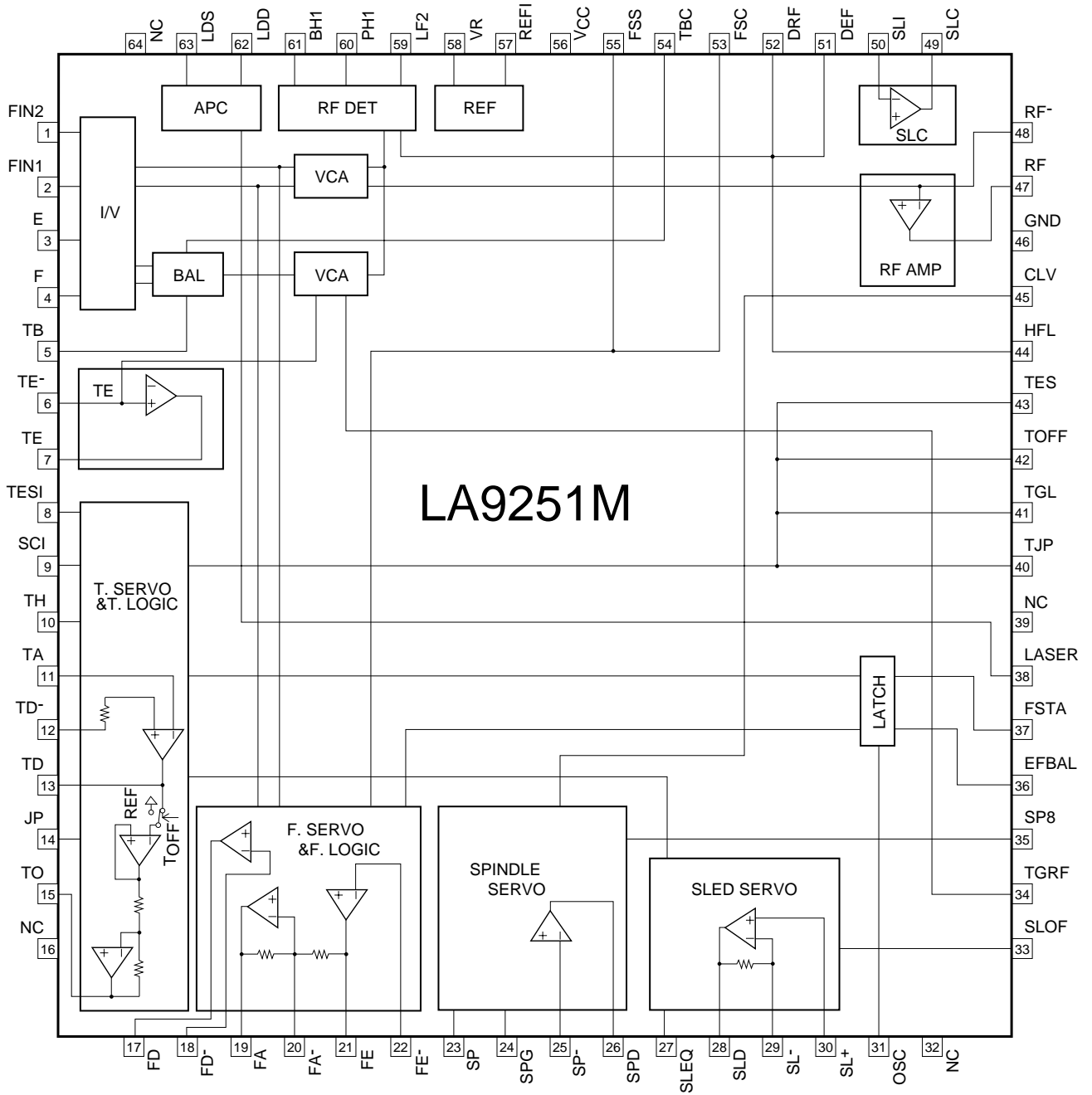
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| Pin No.  | Pin        | Internal equivalent circuit |
|----------|------------|-----------------------------|
| 55       | FSS        |                             |
| 57<br>58 | REFI<br>VR |                             |
| 59       | LF2        |                             |
| 62       | LDD        |                             |
| 63       | LDS        |                             |

LA9251M

Equivalent Circuit



A12228

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## 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  $\pm 4$  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  $\pm$  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.

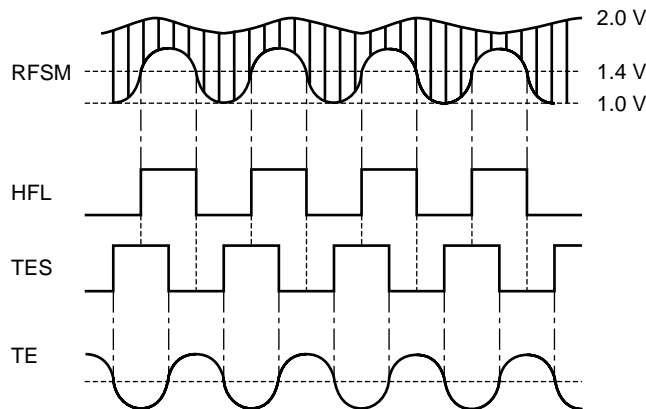
Sled feed is performed in a current input form at SL<sup>-</sup> (pin 29) and SL<sup>+</sup> (pin 30). In particular, a resistor is connected to a microcontroller output port and the feed gain is set by the value of that resistor.

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<sup>-</sup> (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)

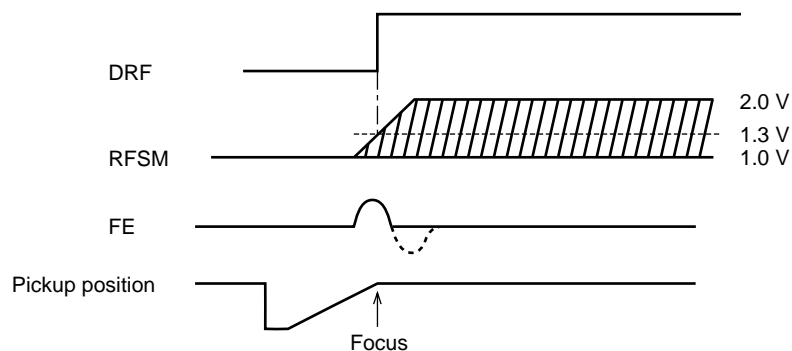
The sub-beam signals from the pickup are connected to E (pin 3) and F (pin 4) so that HFL and TES have the phase relationship shown in the figure when the pickup moves from the outside towards the inside of the disc. The TES comparator has a hysteresis of about  $\pm 100$  mV at the minus polarity of 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.



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9. DRF (Optical level decision)

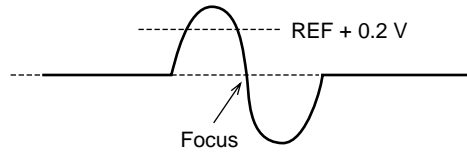
A peak hold operation is applied to the EFM signal (RF output) by a capacitor at PH1 (pin 60), and DRF goes high when the RF peak value exceeds about 1.3 V (when  $V_{CC} = 3.0$  V). The PH1 capacitor is related to the settings of both the DRF detection time constant and the RF AGC response.



A12225

10. Focus Detection

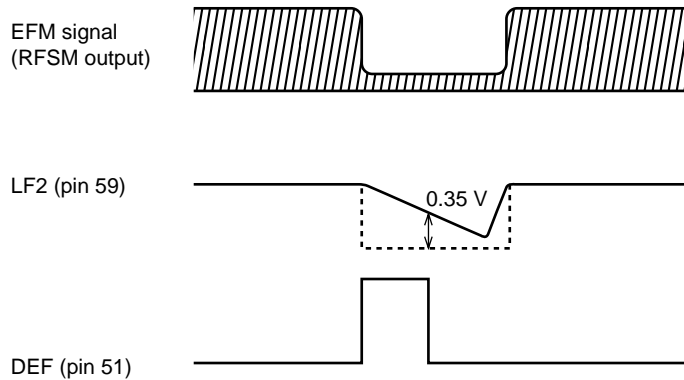
The pickup is seen as being in focus when, after a VR + 0.2 V level is detected in the focus error signal S-curve, that S-curve next goes to the VR level.



A12226

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.



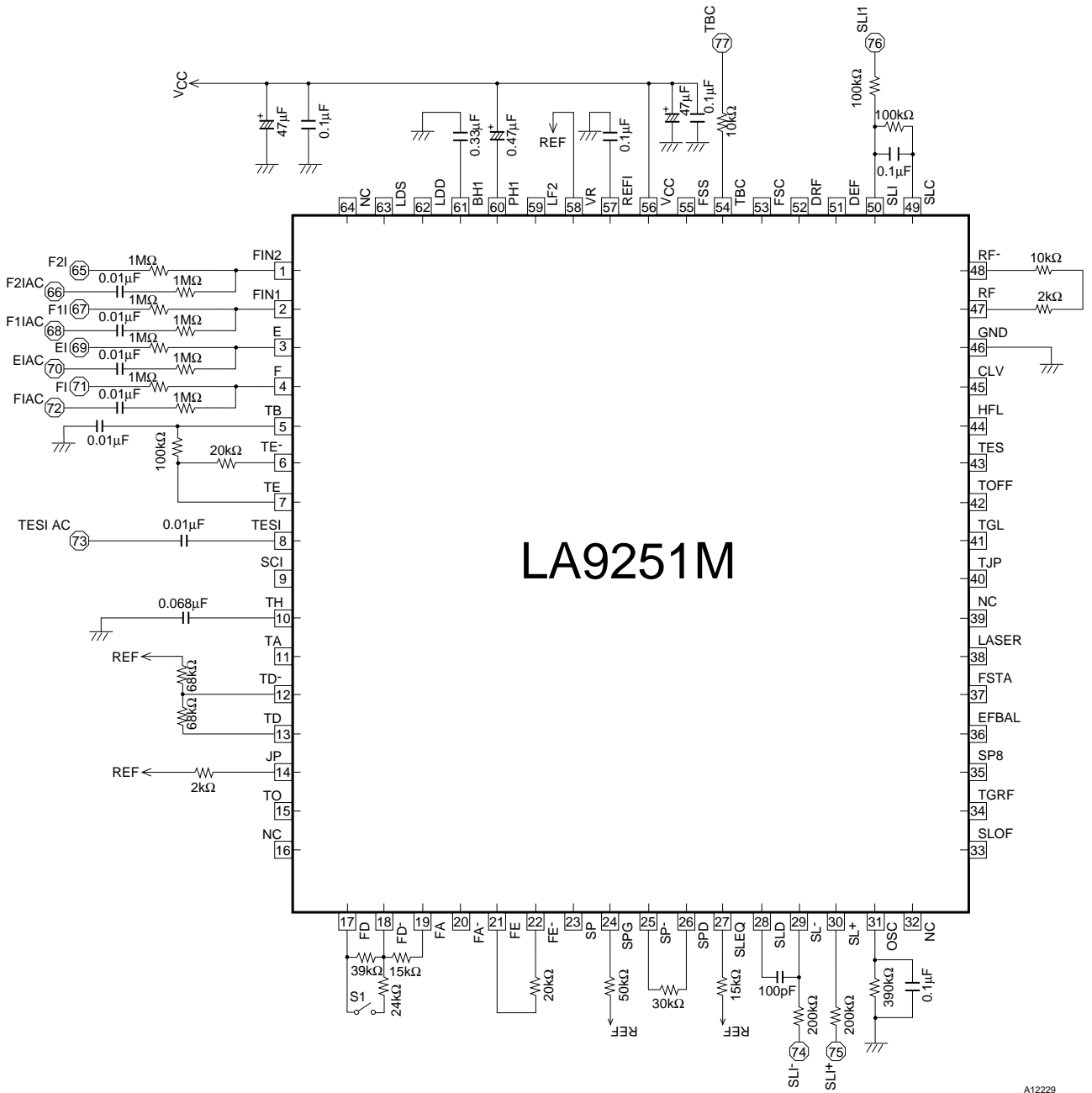
A12227

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.

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## Test Circuit



A12229





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