



LA9239T

48× CD-ROM Digital Servo RF IC

Overview

The LA9239T is a CD-ROM digital servo RF IC that supports high-speed CD-ROM drive replay of up to 48×. It also supports RW disks by featuring an on-chip servo VCA and gain switch.

Functions

- RF amplifier (with AGC)
- RF gain amplifier (supporting CD-RW disk replay)
- RF equalizer (7 modes)
- RF hold function
- PH/BH detection
- 3T extraction circuit
- FE amplifier (built-in balance adjustment VCA)
- TE amplifier (built-in balance adjustment VCA)
- servo signal VCA circuit
- APC circuit (with laser power-up function)
- sleep function

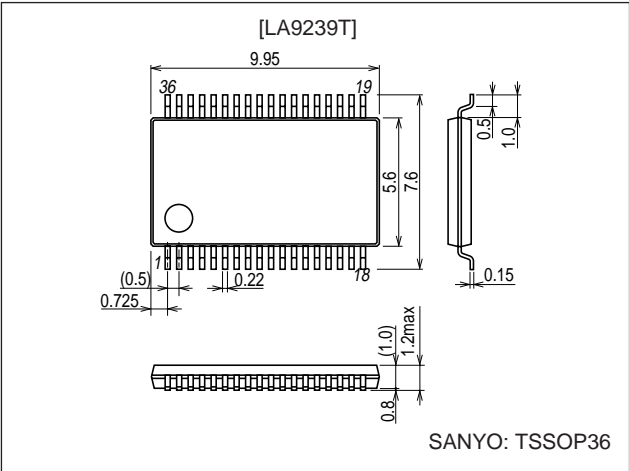
Features

The LA9239T is an IC that features on-chip functions for improved playability and an RF equalizer, resulting in superior performance and a reduced need for external components.

Package Dimensions

unit: mm

3253-TSSOP36



Specifications

Maximum Ratings at Ta = 25°C, Pins 4 and 31 = GND

| Parameter                    | Symbol              | Conditions | Ratings     | Unit |
|------------------------------|---------------------|------------|-------------|------|
| Maximum power supply voltage | V <sub>CC</sub> max |            | 7           | V    |
| Allowable power dissipation  | P <sub>d</sub> max  |            | 300         | mW   |
| Operating temperature        | T <sub>opr</sub>    |            | –25 to +70  | °C   |
| Storage temperature          | T <sub>stg</sub>    |            | –40 to +150 | °C   |

Operating Conditions at Ta = 25°C

| Parameter                         | Symbol             | Conditions | Ratings    | Unit |
|-----------------------------------|--------------------|------------|------------|------|
| Recommended power supply voltage  | V <sub>CC</sub>    |            | 5          | V    |
| Allowable operating voltage range | V <sub>CC</sub> op |            | 4.5 to 5.5 | V    |

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# LA9239T

## Operating Characteristics at Ta = 25°C, VCC (Pins 23, 34) = 5 V, GND (Pins 4, 31) = 0 V

| Parameter                    | Symbol           | Conditions  | Ratings |       |      | Unit |
|------------------------------|------------------|---|---------|-------|------|------|
|                              |                  |   | min     | typ   | max  |      |
| Current drain                | I <sub>CC</sub>  | No signal   | 18      | 30    | 42   | mA   |
| Current drain (during sleep) | I <sub>CCS</sub> | No signal, EQS = 0 V  | 2       | 6     | 10   | mA   |
| Reference voltage            | V <sub>ref</sub> |   | 2.3     | 2.5   | 2.7  | V    |
| Preamplifier offset          | RFAOost          | Difference with VR in RFA0  | -120    | 0     | +120 | mV   |
| RF no-signal voltage         | RFSM             | FIN1, FIN2 = VR   | 1.5     | 1.8   | 2.3  | V    |
| RF gain max                  | RFG1             | GHS = 0 V   | 19      | 21    | 23   | dB   |
| RF gain min                  | RFG2             | GHS = 0 V   | 4       | 6     | 8    | dB   |
| RF gain UP                   | RFGUP            | GHS = 5 V   | 12.5    | 14    | 15.5 | dB   |
| RFEQ normal                  | RFEQN            | RFSM difference when FIN1, 2: 350 mVp-p, f = 1 MHz and 350 mVp-p, f = 100 kHz, EQS = 5 V, BHC = 2.45 V, PHC = 2.8 V     | 1.5     | 3.5   | 5.5  | dB   |
| RFEQ CAV1                    | RFEQ1            | RFSM difference when FIN1, 2: 350 mVp-p, f = 2.4 MHz and 350 mVp-p, f = 100 kHz, EQS = 4.1 V, BHC = 2.45 V, PHC = 2.8 V | 1       | 3     | 5    | dB   |
| RFEQ CAV2                    | RFEQ2            | RFSM difference when FIN1, 2: 350 mVp-p, f = 4.4 MHz and 350 mVp-p, f = 100 kHz, EQS = 3.4 V, BHC = 2.45 V, PHC = 2.8 V | 1       | 3     | 5    | dB   |
| RFEQ CAV3                    | RFEQ3            | RFSM difference when FIN1, 2: 350 mVp-p, f = 6 MHz and 350 mVp-p, f = 100 kHz, EQS = 2.8 V, BHC = 2.45 V, PHC = 2.8 V   | 1       | 3     | 5    | dB   |
| RFEQ CAV4                    | RFEQ4            | RFSM difference when FIN1, 2: 350 mVp-p, f = 8 MHz and 350 mVp-p, f = 100 kHz, EQS = 2.2 V, BHC = 2.45 V, PHC = 2.8 V   | 1       | 3     | 5    | dB   |
| RFEQ CAV5                    | RFEQ5            | RFSM difference when FIN1, 2: 350 mVp-p, f = 12 MHz and 350 mVp-p, f = 100 kHz, EQS = 1.6 V, BHC = 2.45 V, PHC = 2.8 V  | 1       | 3     | 5    | dB   |
| RFEQ CAV6                    | RFEQ6            | RFSM difference when FIN1, 2: 350 mVp-p, f = 30 MHz and 350 mVp-p, f = 100 kHz, EQS = 0.9 V, BHC = 2.45 V, PHC = 2.8 V  | 0.5     | 2.5   | 4.5  | dB   |
| RF hold                      | RFHLD            | FIN1, 2: 700 mVp-p, f = 100 kHz, RHLD = 5 V   | -13.5   | -11   | -8.5 | dB   |
| PH                           | PH               | RFSM = 1.7 Vp-p   | 2.7     | 3.3   | 3.9  | V    |
| 3T extraction                | 3TON             | Difference with RFSM for 3TON = 5 V, PH   | -20     | -16.5 | -13  | dB   |
| BH                           | BH               | RFSM = 1.7 Vp-p   | 1.3     | 1.6   | 1.9  | V    |
| BH band switch               | BHH              | f = 100 kHz, RHH = 5 V  | 7       | 9     | 11   | dB   |
| REFL offset                  | REFLost          | Difference with VR for REFL   | -120    | 0     | +120 | mV   |
| REFL gain 1                  | REFL1            | FIN1 = Vin, FIN2 = VR, SGC = 2 V  | 9       | 11    | 13   | dB   |
| REFL gain 2                  | REFL2            | FIN1 = Vin, FIN2 = VR, SGC = 3 V  | 14.5    | 16.5  | 18.5 | dB   |
| FE offset                    | FEost            | Difference with VR for FE   | -120    | 0     | +120 | mV   |
| FE gain 1                    | FEG1             | FIN1 = Vin, FIN2 = VR, SGC = 2 V, FBAL = VR   | 5       | 7     | 9    | dB   |
| FE gain 2                    | FEG2             | FIN1 = Vin, FIN2 = VR, SGC = 3 V, FBAL = VR   | 10      | 12    | 14   | dB   |
| FE balance 1                 | FBAL1            | FIN1 = Vin, FIN2 = VR, SGC = VR, FBAL = 2 V   | 10.5    | 12.5  | 14.5 | dB   |
| FE balance 2                 | FBAL2            | FIN1 = Vin, FIN2 = VR, SGC = VR, FBAL = 3 V   | 7.5     | 9.5   | 11.5 | dB   |
| TE offset                    | TEost            | Difference with VR for TE   | -120    | 0     | +120 | mV   |
| TE gain 1                    | TEG1             | E = Vin, F = VR, SGC = 2 V, TBAL = VR   | 13.5    | 15.5  | 17.5 | dB   |
| TE gain 2                    | TEG2             | E = Vin, F = VR, SGC = 3 V, TBAL = VR   | 19      | 21    | 23   | dB   |
| TE balance 1                 | TBAL1            | E = Vin, F = VR, SGC = VR, TBAL = 2 V   | 20      | 22    | 24   | dB   |
| TE balance 2                 | TBAL2            | E = Vin, F = VR, SGC = VR, TBAL = 3 V   | 16      | 18    | 20   | dB   |
| TS offset                    | TSost            | Difference with VR for TS   | -120    | 0     | +120 | mV   |
| TS gain 1                    | TSG1             | GHS = 0 V, TBAL = VR  | 13      | 15    | 17   | dB   |
| TS gain 2                    | TSG2             | GHS = 5 V, TBAL = VR  | 25      | 27    | 29   | dB   |
| TS band 1                    | TSHL             | TE-TE- = 82 P, TSH = 0 V  | 16      | 20    | 24   | kHz  |
| TS band 2                    | TSHH             | TE-TE- = 82 P, TSH = 5 V  | 240     | 300   | 360  | kHz  |
| APC reference voltage 1      | LDSL             | LSD voltage for LDD = 3 V, LDON = 0 V   | 175     | 190   | 205  | mV   |
| APC reference voltage 2      | LDSH             | LSD voltage for LDD = 3 V, LDON = 5 V   | 215     | 230   | 245  | mV   |
| APC off voltage              | LDD              | LDON = VR   | 4       | 4.3   | 5    | V    |

## Explanation of Operation

### (1) RF amplifier

The RF signal is generated by inputting (A+C) from FIN2 (pin 8) and (B+D) from FIN1 (pin 7) and adding the two. The EFM signal is output from the RFSM (pin 33) via the preamplifier, gain switch, RFAGC circuit, and 3T compensation circuit. The RFSUM output D range is 1 to 4 V. 3T compensation can be done according to the band through the EQS (pin 18) control pin.

The gain switch enables replay of CD and CD-RW disks, and when GHS (pin 16) level is made Hi (CD-RW mode), a gain of 14 dB can be obtained. In the CD mode, the gain is 0 dB.

The on-chip AGC circuit has a variable range of  $\pm 6$  dB. The peak level controls the RFAGC level, and the bottom level controls the DC level of RF. The respective frequency response characteristics can be changed with the external capacitors connected to PHC (pin 2) and BHC (pin 1).

The response frequency is proportional to the capacitance of the PHC and BHC capacitors.

When a defect is detected in the DSP, AGC control can be changed to the hold status (by making RHLD (pin 32) Hi) to prevent the RF signal from becoming unstable.

### (2) Focus error amplifier

The focus error signal is generated by inputting (A+C) to FIN2 (pin 8) and (B+D) to FIN1 (pin 7), passing these signals through the focus balance adjustment VCA, and extracting the difference between the two ((B+D)-(A+C)). The FE signal is gain controlled by FE-VCA and output to FE (pin 28). The FE signal gain can be set with the resistor connected between FE and FE- (pin 29).

The focus balance adjustment VCA is controlled by FBAL (pin 21), and FE-VCA is controlled by SGC (pin 19). A gain of +12 dB for the FE signal gain is obtained in the RW mode by making the GS level Hi.

Note: The polarity of the FE output in relation to the FIN1 input is common-mode output.

### (3) Tracking error amplifier

The tracking error signal is generated through input to E (pin 9) and F (pin 10), passing the signals through the tracking balance adjustment VCA, and detecting their difference. The TE signal is gain controlled at TE-VCA and output from TE (pin 26). The TE signal gain can be set with the resistor connected between TE and TE- (pin 27). The tracking balance adjustment VCA is controlled by TBAL (pin 20), and TE-VCA is controlled by SGC (pin 19).

The TE signal for the TES comparator is output from TS (pin 23). The TS signal level must meet the TES comparator level in the DSP. Setting of this level is performed with the pickup output and the resistor between the E and F inputs. In the RW mode, a gain of +12 dB for TE and TS signal gain is obtained by making the GHS (pin 16) level Hi (same as for RF). An on-chip band switch is also provided to support high-speed seek for the TS signal, which is controlled with TSH (pin 22). The band can be set with the capacitance between TSS (pin 25) and TS.

Note: The polarity of the TE output in relation to the E input is inverted output, and the polarity of the TS output in relation to the E input is also inverted output.

### (4) APC (auto laser power control)

The APC controls the pickup laser power. Since CD-RW disks are also supported, a laser power-up (+20%) function is also provided. Laser ON/OFF and laser power-up control are performed with LDON (pin 15).

### (5) REFL detection (reflected light detection) and focus detection

The reflected light amount signal from the disk is added to the FIN1 and FIN2 inputs (A+B+C+D) and fetched. It is then gain controlled at REFL-VCA and output from REFL (pin 30) to the DSP. This output signal is used to control SGC (pin 19) to secure the D range of the servo signal in relation to disk irregularities. The amount of light is judged by the DSP and SGC control is performed. REFL-VCA is controlled by SGC. During RW replay, the REFL gain is increased by 12 dB (GHS = Hi).

The REFL signal is also used as a signal for focus detection.

Note: The polarity of the REFL output in relation to the FIN1 input is common-mode output.

## (6) BH (RF bottom hold signal)

The HFL (mirror) detection signal is generated at BH (pin 35), and HFL (mirror) is detected in the DSP. The DSP detects the track jump direction using the phase difference with TES. Moreover, this BH circuit has a band switching function that can be controlled with BHH (pin 17). (BHH = Hi for wide band)

## (7) PH (RF peak hold signal)

The RF peak hold signal used for defect detection is output from PH. The DSP performs defect detection judgments based on this signal. Since the EFM signal level is not necessarily stable due to the influence of the disk's reflection factor, consideration must be paid to using as reference the PH signal level measured when there are no scratches, for defect judgment. Moreover, the PH circuit performs constant settings during PH demodulation according to the speed. This is controlled along with the RF equalizer by the EQS (pin 18) control pin.

The system is designed so that, during focus balance adjustment, the peak and bottom levels of the 3T component are detected and output as the error signal. During focus balance adjustment, 3T is extracted and output from PH and BH by setting 3TON (pin 6) to Hi.

## (8) Sleep

The sleep status can be selected in order to reduce the current drain of the IC.

(Sleep is selected with EQS (pin 18) = GND.)

## Usage Note

The level of the signals input to FIN1 (pin 7), FIN2 (pin 8), E (pin 9), and F (pin 10) must be set so that it is higher than the reference voltage (VREF).

## Relationships between control pin voltages and operation modes

## 1. 3TON (pin 6)

Extracts 3T and performs focus balance adjustment.

| Mode  | Min   | Max   | Extraction Frequency |
|-------|-------|-------|----------------------|
| 3TON  | 3.0 V | 5.0 V | 10 MHz               |
| 3TOFF | 0 V   | 2.0 V | —                    |

## 2. LDON (pin 15)

Laser ON and laser power-up (20%) switch control

| Mode      | Min   | Max   | Laser | Power Up |
|-----------|-------|-------|-------|----------|
| PUPH      | 3.5 V | 5.0 V | ON    | Hi       |
| LDOF      | 2.0 V | 3.0 V | OFF   | Low      |
| LDON+PUPL | 0 V   | 1.5 V | ON    | Low      |

## 3. GHS (pin 16)

RF and TS gain-up (+14 dB) switch control

| Mode       | Min   | Max   | Gain Up |
|------------|-------|-------|---------|
| RW support | 3.0 V | 5.0 V | Hi      |
| CD support | 0 V   | 2.0 V | Low     |

## 4. BHH (pin 17)

Reduces the time constant during bottom hold when the access speed is slow.

| Mode                            | Min   | Max   | Band (fc) |
|---------------------------------|-------|-------|-----------|
| Hi (during normal operation)    | 3.0 V | 5.0 V | 450 kHz   |
| Low (when access speed is slow) | 0 V   | 2.0 V | 80 kHz    |

## 5. TSH (pin 22)

TS filter setting pin for TES signal

| TSH                   | Min   | Max   | TS Band                              |
|-----------------------|-------|-------|--------------------------------------|
| Hi (during seek)      | 3.0 V | 5.0 V | 300 kHz                              |
| Low (other than seek) | 0 V   | 2.0 V | 20 kHz (between pins 24 and 25: 80P) |

## 6. EQS (pin 18)

RF equalizer, PH detection time constant control (7 modes), and sleep switch control

PH time constant switching is done according to the equalizer switch.

| Mode   | Min   | Max   | +2 dB Boost Frequency | 11T Frequency   |
|--------|-------|-------|-----------------------|-----------------|
| Normal | 4.5 V | 5.0 V | Approx. 1.0 MHz       | Approx. 200 kHz |
| CAV1   | 3.9 V | 4.3 V | Approx. 2.4 MHz       | Approx. 2.4 MHz |
| CAV2   | 3.2 V | 3.6 V | Approx. 4.3 MHz       | Approx. 3.5 MHz |
| CAV3   | 2.6 V | 3.0 V | Approx. 6.0 MHz       | Approx. 3.9 MHz |
| CAV4   | 2.0 V | 2.4 V | Approx. 8.0 MHz       | Approx. 4.7 MHz |
| CAV5   | 1.4 V | 1.8 V | Approx. 11 MHz        | Approx. 5.9 MHz |
| CAV6   | 0.8 V | 1.2 V | Approx. 30 MHz        | Approx. 9.4 MHz |
| Sleep  | 0 V   | 0.5 V | —                     | —               |

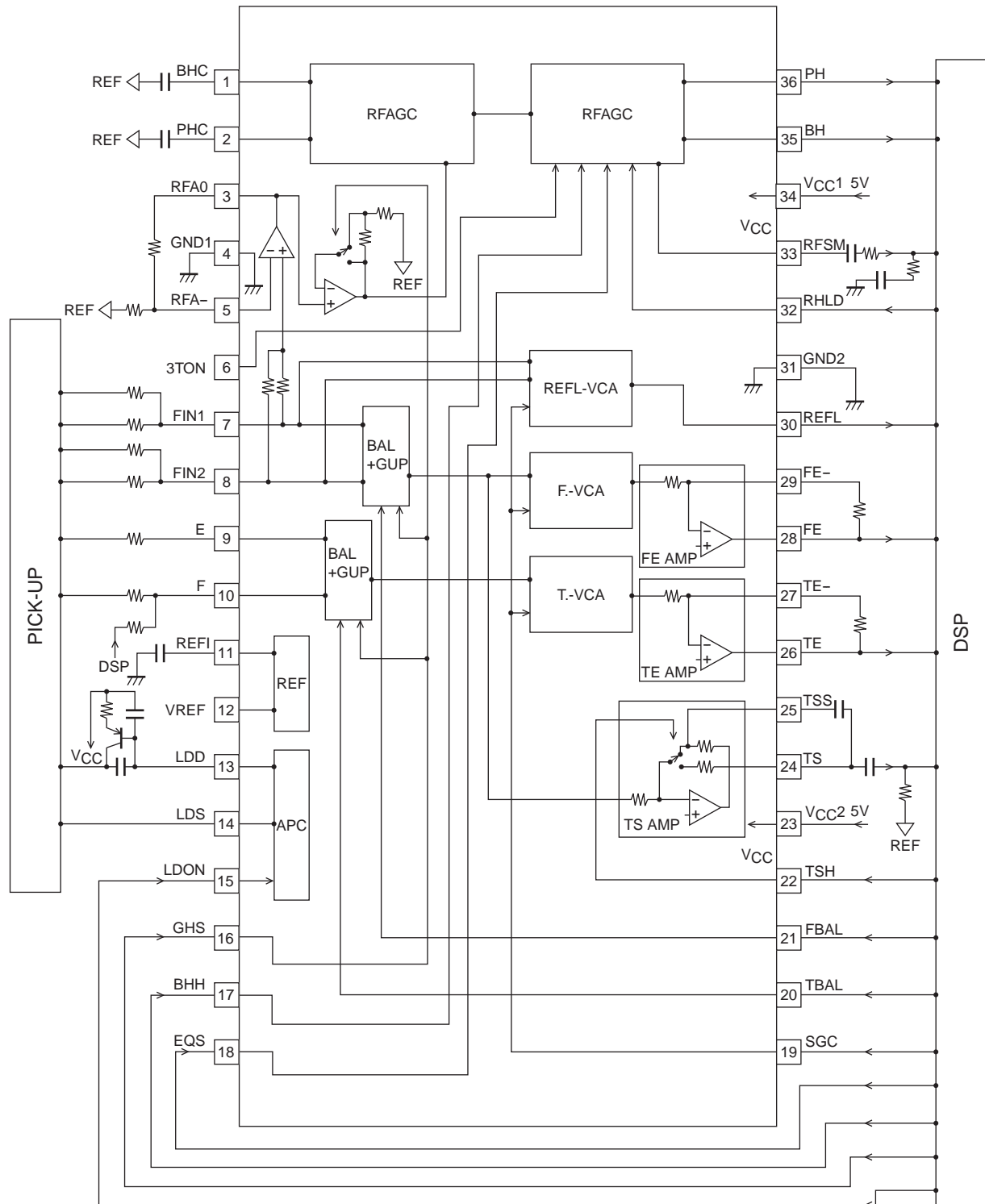
## 7. RHL D (pin 32)

| RHL D                         | Min   | Max   |
|-------------------------------|-------|-------|
| Hi (during defect detection)  | 3.0 V | 5.0 V |
| Low (during normal operation) | 0 V   | 2.0 V |

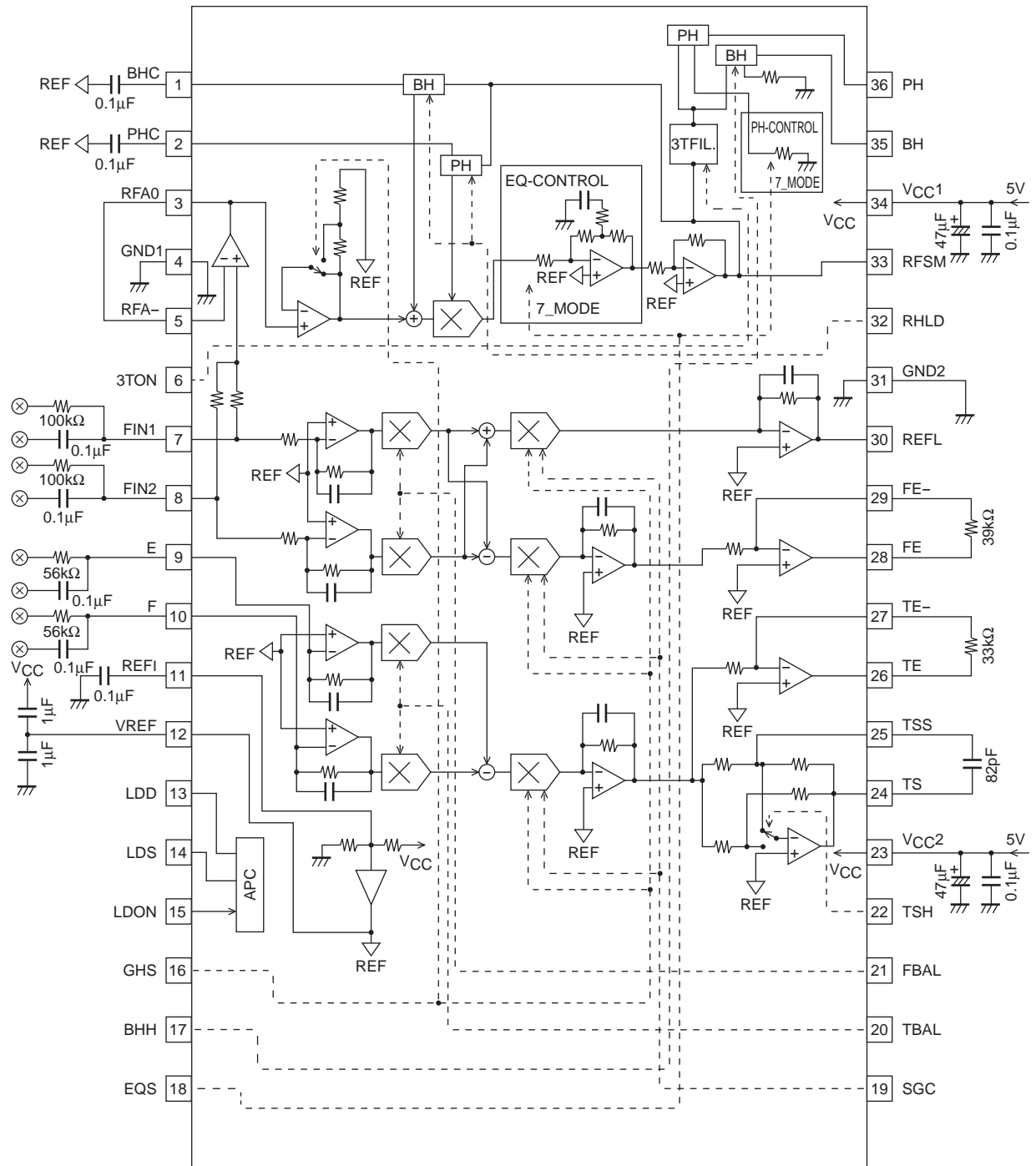
## Pin Description

| Pin No. | Pin Name | Description   |
|---------|----------|---|
| 1       | BHC      | Bottom hold capacitor connection pin for RF AGC detection   |
| 2       | PHC      | Peak hold capacitor connection pin for RF AGC detection   |
| 3       | RFAO     | RF preamplifier output pin  |
| 4       | GND1     | RF signal GND pin   |
| 5       | RFA–     | RF preamplifier minus input pin   |
| 6       | 3TON     | 3T extraction circuit control pin   |
| 7       | FIN1     | Pickup voltage output connection pin. The RF signal and mirror signal are generated by adding FIN1 to FIN2, and the FE signal is generated by subtracting FIN1 from FIN2. |
| 8       | FIN2     | Pickup voltage output connection pin  |
| 9       | E        | Pickup voltage output connection pin. The TE signal is generated by subtracting E from F.   |
| 10      | F        | Pickup voltage output connection pin  |
| 11      | REFI     | Reference voltage bus capacitor connection pin  |
| 12      | VREF     | Reference voltage output pin  |
| 13      | LDD      | APC circuit output pin  |
| 14      | LDS      | APC circuit input pin   |
| 15      | LDON     | Laser ON/OFF, laser power-up control pin  |
| 16      | GHS      | RF, TS signal gain switch pin (0 dB/+14 dB)   |
| 17      | BHH      | BH response switch pin  |
| 18      | EQS      | RF equalizer, PH detection control pin  |
| 19      | SGC      | Servo gain control pin (FE, TE, REFL signals)   |
| 20      | TBAL     | TE balance adjustment pin   |
| 21      | FBAL     | FE balance adjustment pin   |
| 22      | TSH      | TS signal band control pin  |
| 23      | VCC2     | Servo signal VCC pin  |
| 24      | TS       | TS signal (TES signal source) output pin (→ DSP)  |
| 25      | TSS      | TS signal band setting pin  |
| 26      | TE       | TE signal output pin (→ DSP)  |
| 27      | TE–      | TE signal gain setting pin  |
| 28      | FE       | FE signal output pin (→ DSP)  |
| 29      | FE–      | Servo signal GND pin  |
| 30      | REFL     | Reflection signal output pin (→ DSP)  |
| 31      | GND2     | Servo signal GND pin  |
| 32      | RHLD     | RF hold control pin   |
| 33      | RFSM     | EFM signal output pin (→ DSP)   |
| 34      | VCC1     | RF signal VCC pin   |
| 35      | BH       | RF bottom hold signal output pin (→ DSP)  |
| 36      | PH       | RF peak hold signal output pin (→ DSP)  |

## Block Diagram



## Test Circuit





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