# DATA SHEET

# TEA5757HL; TEA5759HL
## Self Tuned Radio (STR)

Product specification
File under Integrated Circuits, IC01
2000 Feb 02

Philips
Semiconductors

PHILIPS

## FEATURES

- The tuning system has an optimized IC partitioning both from application (omitting interferences) and flexibility (removable front panel option) point of view: the tuning synthesizer is on-chip with the radio
- The tuning quality is superior and requires no IF-counter for stop-detection; it is insensitive to ceramic filter tolerances
- In combination with the microcontroller, fast, low-power operation of preset mode, manual-search, auto-search and auto-store are possible
- The local (internal) controller function facilitates reduced and simplified microcontroller software
- The high integration level (radio and tuning synthesizer on one chip) means fewer external components with regard to the communication between the radio and the microcontroller (90% less components compared to the digital tuning application of a radio IC with external PLL tuning function) and a simple and small Printed-Circuit Board (PCB)
- There will be no application considerations for the tuning system, with regards to quality and high integration level, since there will be no external 110 MHz buffers, loop filter or false lock elimination
- The inherent FUZZY LOGIC behaviour of the Self Tuned Radio (STR), which mimics hand tuning and yields a potentially fast yet reliable tuning operation
- The level of the incoming signal at which the radio must lock is software programmable
- Two programmable ports
- FM-on/off port to control an external FM front-end
- High selectivity with distributed IF gain
- Soft mute
- Signal dependent stereo-blend
- High impedance MOSFET input on AM
- Wide supply voltage range of 2.5 to 12 V
- Low current consumption 18 mA at AM and FM (including tuning synthesizer)
- High input sensitivity
- Low output distortion
- Due to the new tuning concept, the tuning is independent of the channel spacing.

## GENERAL DESCRIPTION

The TEA5757HL; TEA5759HL is a 48-pin integrated AM/FM stereo radio circuit including a novel tuning concept. The radio part is based on the TEA5712.

The TEA5757HL is used in FM-standards in which the local oscillator frequency is above the radio frequency (e.g. european and american standards).

The TEA5759HL is the version in which the oscillator frequency is below the radio frequency (e.g. Japanese standard).

The new tuning concept combines the advantages of hand tuning with electronic facilities and features. User ‘intelligence’ is incorporated into the tuning algorithm and an improvement of the analog signal processing is used for the AFC function.

## ORDERING INFORMATION

| TYPE NUMBER | PACKAGE | | |
|---|---|---|---|
| | NAME | DESCRIPTION | VERSION |
| TEA5757HL | LQFP48 | plastic low profile quad flat package; 48 leads; body $7 \times 7 \times 1.4$ mm | SOT313-2 |
| TEA5759HL | LQFP48 | plastic low profile quad flat package; 48 leads; body $7 \times 7 \times 1.4$ mm | SOT313-2 |

## QUICK REFERENCE DATA

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $V_{CC1}$ | supply voltage | | 2.5 | – | 12 | V |
| $V_{CC2}$ | supply voltage for tuning | | – | – | 12 | V |
| $V_{tune}$ | tuning voltage | | 0.7 | – | $V_{CC2}$ – 0.75 | V |
| $I_{CC1}$ | supply current | AM mode | 12 | 15 | 18 | mA |
| | | FM mode | 13 | 16 | 19 | mA |
| $I_{DD}$ | supply current | AM mode | 2.8 | 3.3 | 3.7 | mA |
| | | FM mode | 2.4 | 2.7 | 3.0 | mA |
| $I_{CC2}$ | supply current for tuning in preset mode (band-end to band-end) | | – | – | 800 | µA |
| $T_{amb}$ | ambient temperature | | –15 | – | +60 | °C |
| **AM performance;** note 1 | | | | | | |
| $V_{11}$ | AF output voltage | $V_{i1}$ = 5 mV | 36 | 45 | 70 | mV |
| $V_{i1}$ | RF sensitivity input voltage | (S+N)/N = 26 dB | 40 | 55 | 70 | µV |
| THD | total harmonic distortion | $V_{i1}$ = 1 mV | – | 0.8 | 2.0 | % |
| **FM performance;** note 2 | | | | | | |
| $V_{11}$ | AF output voltage | $V_{i5}$ = 1 mV | 40 | 48 | 57 | mV |
| $V_{i5}$ | RF sensitivity input voltage | $V_{11}$ at –3 dB; $V_{11}$ is 0 dB at $V_{i5}$ = 1 mV | 0.4 | 1.2 | 3.8 | µV |
| THD | total harmonic distortion | IF filter SFE10.7MS3A20K-A | – | 0.3 | 0.8 | % |
| **MPX performance;** note 3 | | | | | | |
| $\alpha_{cs}$ | channel separation | | 26 | 30 | – | dB |

**Notes**

1. $V_{CC1}$ = 3 V; $V_{CC2}$ = 12 V; $V_{DDD}$ = 3 V; $f_i$ = 1 MHz; m = 0.3; $f_m$ = 1 kHz; measured in Fig.11 with S1 in position A; S2 in position B; unless otherwise specified.
2. $V_{CC1}$ = 3 V; $V_{CC2}$ = 12 V; $V_{DDD}$ = 3 V; $f_i$ = 100 MHz; $\Delta f_m$ = 22.5 kHz; $f_m$ = 1 kHz; measured in Fig.11 with S2 in position A; S3 in position A and S5 in position A; unless otherwise specified.
3. $V_{CC1}$ = 3 V; $V_{CC2}$ = 12 V; $V_{DDD}$ = 3 V; $V_{i3(L + R)}$ = 155 mV; $V_{pilot}$ = 15.5 mV; $f_i$ = 1 kHz; measured in Fig.11 with S2 in position B; S3 in position B; unless otherwise specified.

## BLOCK DIAGRAM

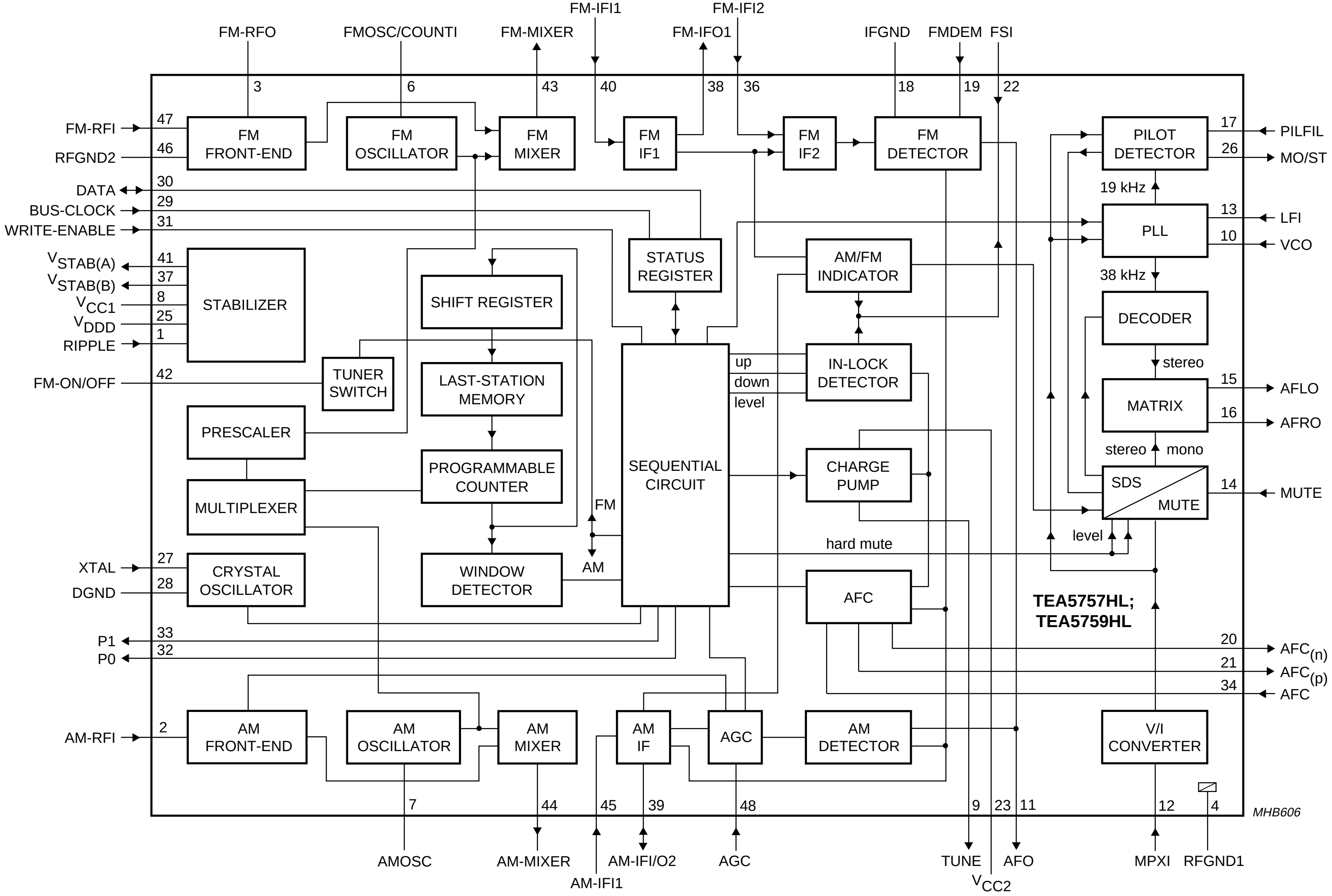



Fig.1 Block diagram.

## PINNING

| SYMBOL | PIN | DESCRIPTION |
|---|---|---|
| RIPPLE | 1 | ripple capacitor input |
| AM-RFI | 2 | AMRF input |
| FM-RFO | 3 | parallel tuned FMRF circuit to ground |
| RFGND1 | 4 | RF ground 1 and substrate |
| CGND | 5 | counter ground |
| FMOSC/COUNTI | 6 | parallel tuned FM-oscillator circuit to ground/counter input |
| AMOSC | 7 | parallel tuned AM-oscillator circuit to ground |
| $V_{CC1}$ | 8 | supply voltage |
| TUNE | 9 | tuning current output |
| VCO | 10 | voltage controlled oscillator input |
| AFO | 11 | AM/FM AF output (output impedance typical 5 kΩ) |
| MPXI | 12 | stereo decoder input (input impedance typical 150 kΩ) |
| LFI | 13 | loop filter input |
| MUTE | 14 | mute input |
| AFLO | 15 | left channel output (output impedance typical 4.3 kΩ) |
| AFRO | 16 | right channel output (output impedance typical 4.3 kΩ) |
| PILFIL | 17 | pilot detector filter input |
| IFGND | 18 | ground of IF, detector and MPX stage |
| FMDEM | 19 | ceramic discriminator input |
| $AFC_{(n)}$ | 20 | AFC negative output |
| $AFC_{(p)}$ | 21 | AFC positive output |
| FSI | 22 | field strength indicator |
| $V_{CC2}$ | 23 | supply voltage for tuning |
| n.c. | 24 | not connected |
| $V_{DDD}$ | 25 | digital supply voltage |
| MO/ST | 26 | mono/stereo and tuning indication output |
| XTAL | 27 | crystal input |
| DGND | 28 | digital ground |
| BUS-CLOCK | 29 | bus-clock input |
| DATA | 30 | bus data input/output |
| WRITE-ENABLE | 31 | bus write-enable input |
| P0 | 32 | programmable output port (P0) |
| P1 | 33 | programmable output port (P1) |
| AFC | 34 | 450 kHz LC circuit |
| n.c. | 35 | not connected |
| FM-IFI2 | 36 | FMIF input 2 (input impedance typical 330 Ω) |
| $V_{STAB(B)}$ | 37 | internal stabilized supply voltage (B) |
| FM-IFO1 | 38 | FMIF output 1 (output impedance typical 330 Ω) |
| AM-IFI/O2 | 39 | input/output to IF-Tank (IFT); output: current source |
| FM-IFI1 | 40 | FMIF input 1 (input impedance typical 330 Ω) |

| SYMBOL | PIN | DESCRIPTION |
|---|---|---|
| $V_{STAB(A)}$ | 41 | internal stabilized supply voltage (A) |
| FM-ON/OFF | 42 | FM ON/OFF port |
| FM-MIXER | 43 | ceramic filter output (output impedance typical 330 Ω) |
| AM-MIXER | 44 | open-collector output to IFT |
| AM-IFI1 | 45 | IFT or ceramic filter input (input impedance typical 3 kΩ) |
| RFGND2 | 46 | FMRF ground 2 |
| FM-RFI | 47 | FMRF aerial input (input impedance typical 40 Ω) |
| AGC | 48 | AGC capacitor input |

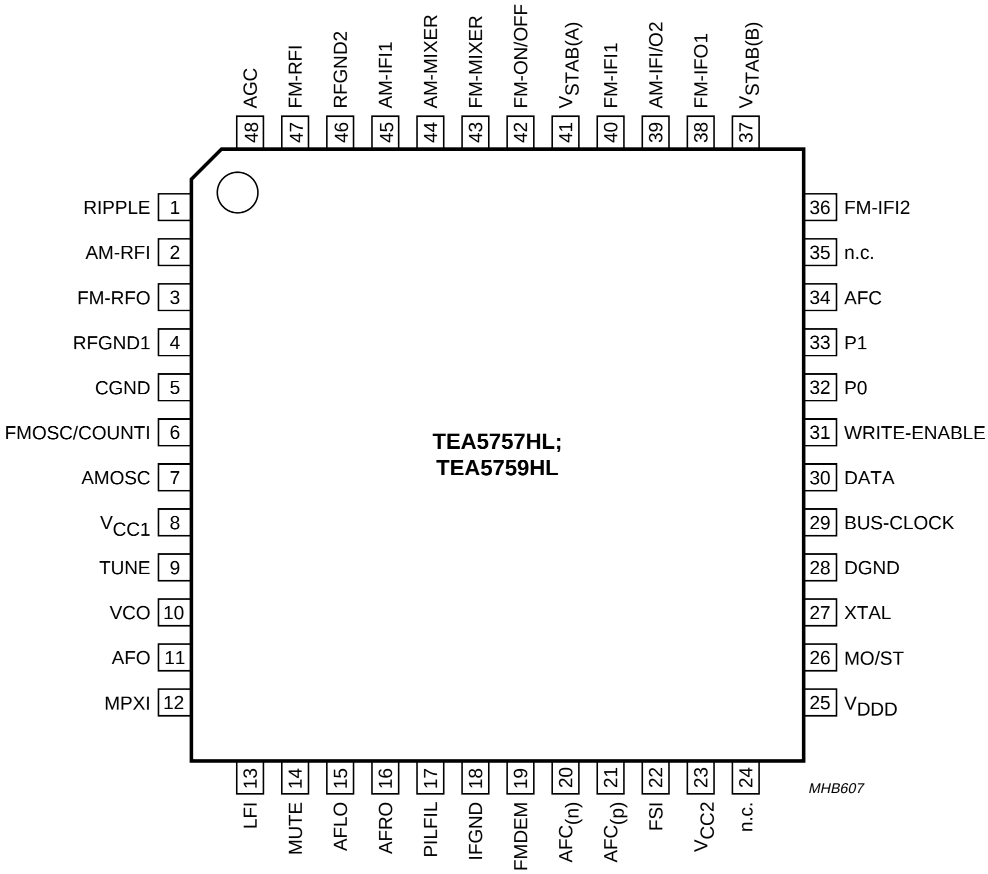



Fig.2 Pin configuration.

## FUNCTIONAL DESCRIPTION

The TEA5757HL; TEA5759HL is an integrated AM/FM stereo radio circuit including digital tuning and control functions.

### The radio

The AM circuit incorporates a double balanced mixer, a one-pin low-voltage oscillator (up to 30 MHz) and is designed for distributed selectivity.

The AM input is designed to be connected to the top of a tuned circuit. AGC controls the IF amplification and for large signals it lowers the input impedance of the AM front-end.

The first AM selectivity can be an IF-Tank (IFT) as well as an IFT combined with a ceramic filter; the second one is an IFT.

The FM circuit incorporates a tuned RF stage, a double balanced mixer, a one-pin oscillator and is designed for distributed IF ceramic filters. The FM quadrature detector uses a ceramic resonator.

The TEA5757HL; TEA5759HL can also be used with an external FM front-end circuit. The external front-end is activated by the FM-ON/OFF signal. The AFC circuit in the TEA5757HL; TEA5759HL provides a tuning voltage to drive the VCO of the external FM front-end. The frequency of the external VCO is counted in the Self Tuned Radio (STR) tuning system.

The PLL stereo decoder incorporates a signal dependent stereo-blend circuit and a soft-mute circuit.

### Tuning

The tuning concept of Self Tuned Radio (STR) is based on FUZZY LOGIC: it mimics hand tuning (hand tuning is a combination of coarse and fine tuning to the qualitatively best frequency position). As a consequence the tuning system is very fast.

The tuning algorithm, which is controlled by the sequential circuit (see Fig.1), is completely integrated; so there are only a few external components needed.

The bus and the microcontroller can be kept very simple. The bus only consists of three wires (BUS-CLOCK, DATA and WRITE-ENABLE). The microcontroller must basically give two instructions:

- Preset operation
- Search operation.

#### PRESET OPERATION

In preset mode, the microcontroller has to load information such as frequency band, frequency and mono/stereo. This information has to be sent via the bus to the STR.
The internal algorithm controls the tuning sequence as follows:

1. The information is loaded into a shift register, a last-station memory and the counter.
2. The Automatic Frequency Control (AFC) is switched off.
3. The counter starts counting the frequency and the tuning voltage is varied until the desired frequency roughly equals the real frequency.
4. The AFC is then switched on and the counter is switched off.
5. The real frequency is more precisely tuned to the desired frequency.

After the AFC has tuned the real frequency to the desired frequency an in-lock signal can be generated. In order to get a reliable in-lock signal, there are two parameters measured: the field strength and the S-curve. The field strength indicates the strength of the station and by looking at the S-curve the system can distinguish false in-locks from real in-locks (false in-locks occur on the wrong slope of the S-curve).

In the event of fading or pulling the in-lock signal becomes logic 0 and the synthesizer will be switched on again and the algorithm will be repeated.

#### SEARCH OPERATION

During a search operation, the only action the microcontroller has to take is: sending the desired band plus the direction and the search sensitivity level to the STR. The search operation is performed by the charge pump until an in-lock signal is generated (combination of measuring the field strength and the S-curve). The AFC then fine tunes to the station. The frequency belonging to the found station will be counted by the counter and written into the last-station memory and the shift register of the counter. At this time the frequency is available in the shift register and can be read by the microcontroller.
The microcontroller decides whether the frequency is within the desired frequency band. If so, this frequency can be stored under a preset and if not, a new search action should be started.

To ensure that the search function operates correctly under all conditions the following search sequence must be applied:

- Store the current frequency in the memory
- Issue the search command
- Wait for data valid and read the new frequency
- If the new frequency is the same as the stored frequency, issue a preset step (e.g. 50 kHz) and start the search sequence again.

TUNING CURRENTS FOR DIFFERENT CONDITIONS

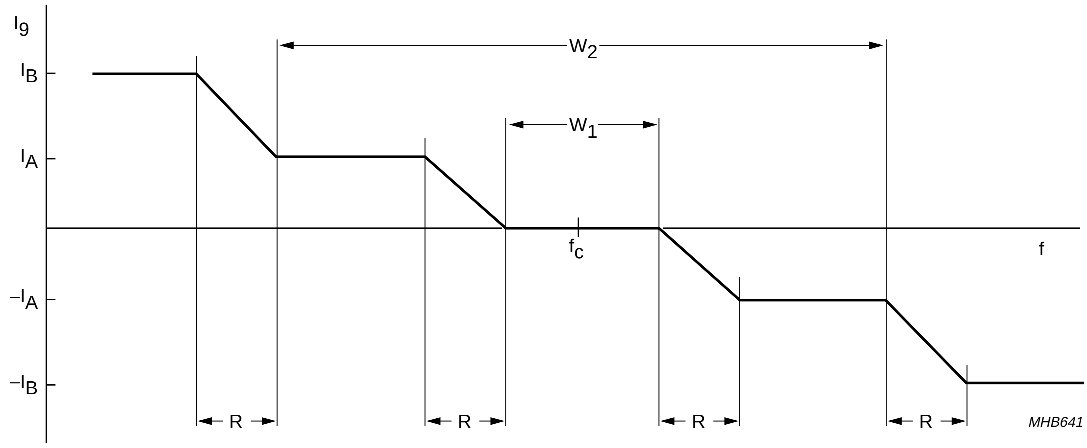



Fig.3 Tuning currents.

**Table 1** Tuning currents

| BAND SELECT | $W_1$ (kHz) | $W_2$ (kHz) | R (kHz) | $I_A$ (μA) | | | $I_B$ (μA) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| FM | 25 | 200 | 12.5 | 2 | 2.5 | 3 | 54 | 80 | 100 |
| MW | 3 | 64 | 1 | 2 | 2.5 | 3 | 54 | 80 | 100 |
| LW | 1 | 64 | 1 | 2 | 2.5 | 3 | 54 | 80 | 100 |
| SW | 1 | 64 | 1 | 0.4 | 0.5 | 0.7 | 12 | 16 | 20 |

### Description of the bus

The TEA5757HL; TEA5759HL radio has a bus which consists of three wires, as shown in Table 2.

**Table 2** Bus signals

| SIGNAL | DESCRIPTION | PIN |
|---|---|---|
| BUS-CLOCK | software driven clock input | 29 |
| DATA | data input/output | 30 |
| WRITE-ENABLE | write/read input | 31 |

These three signals, together with the mono/stereo pin (MO/ST; pin 26), communicate with the microcontroller. The mono/stereo indicator has two functions, which are controlled by the BUS-CLOCK, as shown in Table 3.

**Table 3** Bus-clock functions

| BUS-CLOCK | MO/ST (PIN 26) | RESULT |
|---|---|---|
| LOW | LOW | stereo |
| LOW | HIGH | mono |
| HIGH | LOW | tuned |
| HIGH | HIGH | not tuned |

The TEA5757HL; TEA5759HL has a 25-bit shift register; see Table 4 for an explanation of the shift register bits.

If in search mode no transmitter can be found, all frequency bits of the shift register are set to logic 0.

The bus protocol is illustrated in Figs 4 and 5.

**Table 4** Explanation of the shift register bits

| BIT | DESCRIPTION | LOGIC STATE | RESULT |
|---|---|---|---|
| S.24 (MSB) | search start/end | 0 | after a search when a station is found or after a preset |
| | | 1 | during the search action |
| D.23 | search up/down | 0 | indicates if the radio has to search down |
| | | 1 | indicates if the radio has to search up |
| M.22 | mono/stereo | 0 | stereo is allowed |
| | | 1 | mono is required (radio switched to forced mono) |
| B0.21 | band | see Table 5 | selects FM/MW/LW/SW band |
| B1.20 | band | see Table 5 | selects FM/MW/LW/SW band |
| P0.19 | port | note 1 | user programmable bits which e.g. can be used as band switch driver |
| P1.18 | port | note 1 | user programmable bits which e.g. can be used as band switch driver |
| S0.17 | search-level of station | see Table 6 | determines the locking field strength during an automatic search, automatic store or manual search |
| S1.16 | search-level of station | see Table 6 | determines the locking field strength during an automatic search, automatic store or manual search |
| 15 | dummy | – | buffer |
| F.14 to F.0 (LSB) | frequency | – | determine the tuning frequency of the radio; see Table 7 for the bit values |

**Note**

1. The output pins 32 and 33 can drive currents up to 5 mA; bits P0.19 and P1.18 control the output voltage of the control pins P0 (pin 32) and P1 (pin 33):
   a) Bit P0.19 LOW sets P0 (pin 32) to LOW.
   b) Bit P0.19 HIGH sets P0 (pin 32) to HIGH.
   c) Bit P1.18 LOW sets P1 (pin 33) to LOW.
   d) Bit P1.18 HIGH sets P1 (pin 33) to HIGH.

**Table 5** Truth table for bits B0.21 and B1.20

| B0.21 | B1.20 | BAND SELECT |
|---|---|---|
| 0 | 0 | FM(1) |
| 0 | 1 | MW |
| 1 | 0 | LW |
| 1 | 1 | SW |

**Note**

1. When FM is selected, the control output FM-ON/OFF (pin 42) is pulled to ground to switch-on the external FM front-end. Pin 42 is an open-collector pin with a series resistor R = 500 Ω.

**Table 6** Truth table for bits S1.16 and S0.17

| S1.16 | S0.17 | SIGNAL RECEPTION | | |
|---|---|---|---|---|
| | | FM IF INPUT (μV) | FM RF INPUT (μV) | AM RF INPUT (μV) |
| 0 | 0 | >50 | >5 | >28 |
| 0 | 1 | >100 | >10 | >40 |
| 1 | 0 | >300 | >30 | >63 |
| 1 | 1 | >1500 | >150 | >1000 |

**Table 7** Values for bits F.14 to F.0

| BIT | BIT VALUE | FM VALUE(1) (kHz) | AM VALUE(2) (kHz) |
|---|---|---|---|
| F.14 | $2^{14}$ | – | 16384 |
| F.13 | $2^{13}$ | 102400 | 8192 |
| F.12 | $2^{12}$ | 51200 | 4096 |
| F.11 | $2^{11}$ | 25600 | 2048 |
| F.10 | $2^{10}$ | 12800 | 1024 |
| F.9 | $2^{9}$ | 6400 | 512 |
| F.8 | $2^{8}$ | 3200 | 256 |
| F.7 | $2^{7}$ | 1600 | 128 |
| F.6 | $2^{6}$ | 800 | 64 |
| F.5 | $2^{5}$ | 400 | 32 |
| F.4 | $2^{4}$ | 200 | 16 |
| F.3 | $2^{3}$ | 100 | 8 |
| F.2 | $2^{2}$ | 50 | 4 |
| F.1 | $2^{1}$ | 25 | 2 |
| F.0 | $2^{0}$ | 12.5 | 1 |

**Notes**

1. FM value of the affected oscillators:
   a) FM VALUE = FMRF + FMIF (for TEA5757HL).
   b) FM VALUE = FMRF – FMIF (for TEA5759HL).
2. AM value of the affected oscillators:
   AM VALUE = AMRF + AMIF.

READING DATA

While WRITE-ENABLE is LOW data can be read by the microcontroller. At a rising edge of the BUS-CLOCK, data is shifted out of the register. This data is available from the point where the BUS-CLOCK is HIGH until the next rising edge of the BUS-CLOCK occurs (see Fig.4).

To read the entire shift register 24 clock pulses are necessary.

WRITING DATA

While WRITE-ENABLE is HIGH the microcontroller can transmit data to the TEA5757HL; TEA5759HL (hard mute is active). At a rising edge of the BUS-CLOCK, the register shifts and accepts one bit into LSB. At clock LOW the microcontroller writes data (see Fig.5).

To write the entire shift register 25 clock pulses are necessary.

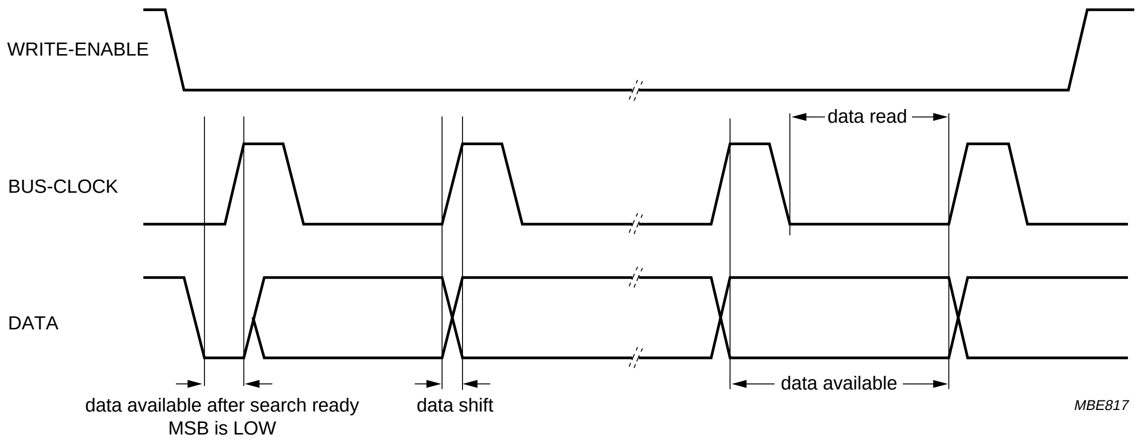



Fig.4 Read data.

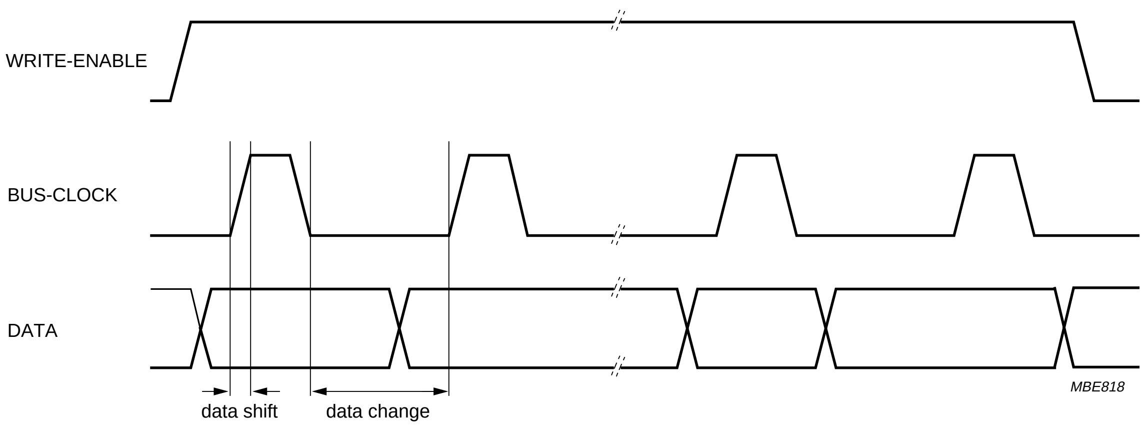



Fig.5 Write data.

BUS TIMING

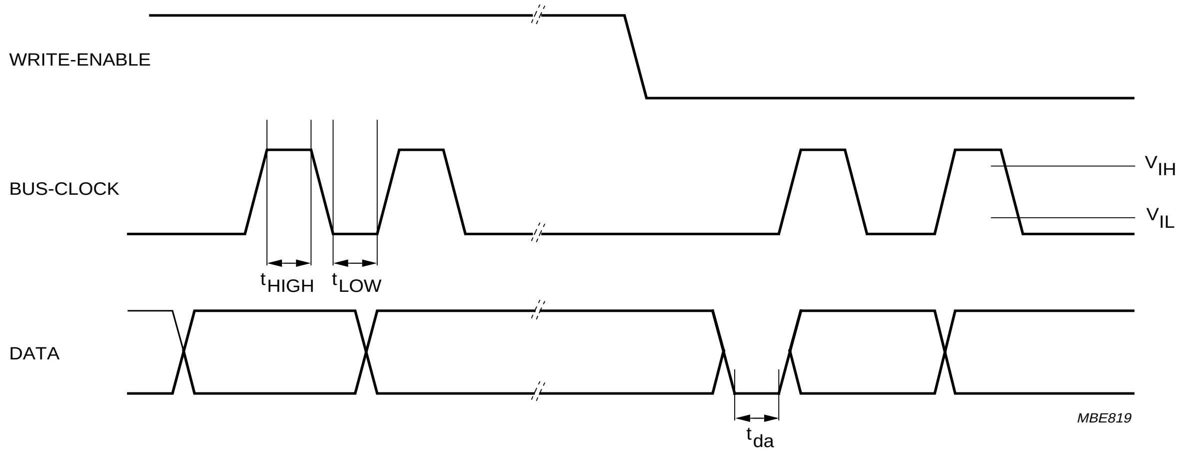



Fig.6 Bus timing.

**Table 8** Digital inputs

| SYMBOL | PARAMETER | CONDITIONS | MIN. | MAX. | UNIT |
|---|---|---|---|---|---|
| **Digital inputs** | | | | | |
| $V_{IH}$ | HIGH-level input voltage | | 1.4 | – | V |
| $V_{IL}$ | LOW-level input voltage | | – | 0.6 | V |
| **Digital outputs (open-collector)** | | | | | |
| $I_{OL}$ | LOW-level output current | | – | 1000 | μA |
| $V_{OL}$ | LOW-level output voltage | $I_{OL}$ = 600 μA | – | 0.6 | V |
| **Timing** | | | | | |
| $f_{clk}$ | clock input | | – | 300 | kHz |
| $t_{HIGH}$ | clock HIGH time | | 1.67 | – | μs |
| $t_{LOW}$ | clock LOW time | | 1.67 | – | μs |
| $t_{da}$ | shift register available after ‘search ready’ | | – | 14 | μs |

## LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

| SYMBOL | PARAMETER | CONDITIONS | MIN. | MAX. | UNIT |
|---|---|---|---|---|---|
| $V_{CC1}$ | supply voltage | | 0 | 13.2 | V |
| $P_{tot}$ | total power dissipation | $T_{amb}$ = 70 °C | – | 250 | mW |
| $T_{stg}$ | storage temperature | | –65 | +150 | °C |
| $T_{amb}$ | ambient temperature | | –15 | +60 | °C |
| $T_j$ | junction temperature | | –15 | +150 | °C |
| $V_{es}$ | electrostatic handling voltage for all pins | note 1 | – | ±200 | V |

**Note**

1. Charge device model; equivalent to discharging a 200 pF capacitor via a 0 Ω series resistor.

## THERMAL CHARACTERISTICS

| SYMBOL | PARAMETER | CONDITIONS | VALUE | UNIT |
|---|---|---|---|---|
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | in free air | 75 | K/W |

## CHARACTERISTICS

$V_{CC1}$ = 3 V; $T_{amb}$ = 25 °C; unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $V_{CC1}$ | supply voltage | | 2.5 | – | 12 | V |
| $V_{CC2}$ | supply voltage for tuning | | – | – | 12 | V |
| $V_{DDD}$ | supply voltage for digital part | | 2.5 | – | 12 | V |
| $V_{tune}$ | tuning voltage | | 0.7 | – | $V_{CC2}$ – 0.75 | V |
| $I_{CC2}$ | supply current for tuning in preset mode (band-end to band-end) | | – | – | 800 | µA |
| $f_{BUS-CLOCK(max)}$ | maximum BUS-CLOCK frequency | | – | – | 300 | kHz |
| $I_{CC1}$ | current consumption during acquisition of $V_{CC1}$ | AM mode | 12 | 15 | 18 | mA |
| | | FM mode | 12.5 | 15.5 | 18.5 | mA |
| $I_{DD}$ | current consumption during acquisition of $I_{DD}$ | AM mode | – | 4.8 | – | mA |
| | | FM mode | – | 5.5 | – | mA |
| $I_{CC1}$ | current consumption after acquisition of $V_{CC1}$ | AM mode | 12 | 15 | 18 | mA |
| | | FM mode | 13 | 16 | 19 | mA |
| $I_{DD}$ | current consumption after acquisition of $I_{DD}$ | AM mode | – | 3.3 | – | mA |
| | | FM mode | – | 2.7 | – | mA |
| $t_{search}$ | synthesizer auto-search time for empty band | FM mode | – | – | 10 | s |
| $t_{acq}$ | synthesizer preset acquisition time between two band limits | FM | – | 100 | – | ms |
| | | MW | – | 100 | – | ms |
| | | LW | – | 200 | – | ms |
| | | SW | – | 500[1] | – | ms |
| $f_{band}$ | frequency band range of the synthesizer | AM mode | 0.144 | – | 30 | MHz |
| | | FM mode | 50 | – | 150 | MHz |
| $\Delta f_{FM}$ | AFC inaccuracy of FM | note 2 | – | – | 1 | kHz |
| $\Delta f_{AM}$ | AFC inaccuracy of AM | | – | – | 100 | Hz |
| $I_{P0(sink)}$ | sink current of software programmable output P0 | $V_{32}$ = 3 V | 4 | 6 | – | mA |
| $I_{P1(sink)}$ | sink current of software programmable output P1 | $V_{33}$ = 3 V | 4 | 6 | – | mA |
| $I_{P0(source)}$ | source current of software programmable output P0 | $V_{32}$ = 0 V | 5 | 9 | – | mA |
| $I_{P1(source)}$ | source current of software programmable output P1 | $V_{33}$ = 0 V | 5 | 9 | – | mA |
| $I_{42(sink)}$ | sink current of FM-ON/OFF switch | FM ON | 4 | 6 | – | mA |

**Notes**

1. Depending on band.
2. In the application with external front-end the inaccuracy depends on the front-end.

**AM CHARACTERISTICS**

Input frequency $f_i$ = 1 MHz; m = 0.3; $f_m$ = 1 kHz; measured in test circuit at pin 11 (see Fig.11); S2 in position B; $V_{i1}$ measured at input of matching network at pin 2; matching network adjusted to maximum output voltage at low input level; $V_{i(n)}$ refers to test circuit (see Fig.11); $V_n$ refers to pin voltages; unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $V_{11}$ | AF output voltage | $V_{i1}$ = 5 mV | 36 | 45 | 70 | mV |
| | | $V_{i2}$ = 0.2 mV | 12 | 30 | 45 | mV |
| $V_{i1}$ | RF sensitivity input voltage | (S+N)/N = 26 dB | 40 | 55 | 70 | μV |
| $V_{il}$ | large signal voltage handling capacity | m = 0.8; THD ≤ 8% | 150 | 300 | – | mV |
| PSRR | power supply ripple rejection $\left(\frac{V_{11}}{\Delta V_8}\right)$ | $\Delta V_8$ = 100 mV (RMS); 100 Hz; $V_8$ = 3.0 V | – | –47 | – | dB |
| $I_i$ | input current (pin 2) | $V_{48}$ = 0.2 V | – | 0 | – | μA |
| $C_i$ | input capacitance (pin 2) | $V_{48}$ = 0.2 V | – | – | 4 | pF |
| $G_c$ | front-end conversion gain | $V_{48}$ = 0.2 V | 5 | 10 | 14 | dB |
| | | $V_{48}$ = 0.9 V | –26 | –14 | 0 | dB |
| (S+N)/N | signal plus noise-to-noise ratio | | – | 50 | – | dB |
| | | $V_{i2}$ = 0.32 mV | – | 32 | – | dB |
| THD | total harmonic distortion | $V_{i1}$ = 1 mV | – | 0.8 | 2.0 | % |
| $\alpha_{450}$ | IF suppression | $V_{11}$ = 30 mV | – | 56 | – | dB |
| $I_{22}$ | indicator current | $V_{i2}$ = 0 V; $V_{22}$ = 0 V | –60 | –50 | –40 | μA |
| | | $V_{i2}$ = 100 mV; $V_{22}$ = 0 V | –330 | –285 | –240 | μA |
| $I_{14}$ | muting current | S4 in position B; $V_{14}$ = 1.4 V; $V_{i2}$ = 100 mV | 12 | 16 | 20 | μA |

**FM CHARACTERISTICS**

Input frequency $f_i$ = 100 MHz; $\Delta f$ = 22.5 kHz; $f_m$ = 1 kHz; measured in test circuit (see Fig.11) at pin 11; S2 in position B; $V_{i(n)}$ refers to test circuit (see Fig.11); $V_n$ refers to pin voltages; unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $V_{11}$ | AF output voltage | $V_{i5}$ = 1 mV | 40 | 48 | 57 | mV |
| $V_{i5}$ | RF sensitivity input voltage | (S+N)/N = 26 dB | 1 | 2 | 3.8 | μV |
| | RF limiting sensitivity | $V_{11}$ at –3 dB; $V_{11}$ is 0 dB at $V_{i5}$ = 1 mV | 0.4 | 1.2 | 3.8 | μV |
| $V_{il}$ | large signal voltage handling capacity | THD ≤ 5% | – | 500 | – | mV |
| PSRR | power supply ripple rejection $\left(\frac{V_{11}}{\Delta V_8}\right)$ | $\Delta V_8$ = 100 mV (RMS); 100 Hz; $V_8$ = 3.0 V | –44 | – | – | dB |
| $G_c$ | front-end conversion gain $\left(\frac{V_{40}}{V_{i5}}\right)$ | | 12 | 18 | 22 | dB |
| (S+N)/N | signal plus noise-to-noise ratio | $V_{i5}$ = 2 μV | – | 26 | – | dB |
| | | $V_{i5}$ = 1 mV | – | 62 | – | dB |
| | | $V_{i4}$ = 30 μV | 33 | 38 | – | dB |
| | | $V_{i4}$ = 10 mV | 62 | – | – | dB |
| THD | total harmonic distortion | IF filter SFE10.7MS3A20K-A detector CDA10.7MG40-A | | | | |
| | | $\Delta f$ = 22.5 kHz | – | 0.3 | 0.8 | % |
| | | $\Delta f$ = 75 kHz | – | 1.5 | 3 | % |
| $I_{22}$ | indicator current | $V_{i4}$ = 0 V; $V_{22}$ = 0 V | –90 | –60 | –30 | μA |
| | | $V_{i4}$ = 100 mV; $V_{22}$ = 0 V | –330 | –285 | –240 | μA |
| $I_{14}$ | muting current | $V_{14}$ = 1.4 V; $V_{i2}$ = 0 mV | 3 | 4.5 | 6 | μA |
| | | $V_{14}$ = 1.4 V; $V_{i2}$ = 100 mV | 8 | 12 | 17 | μA |

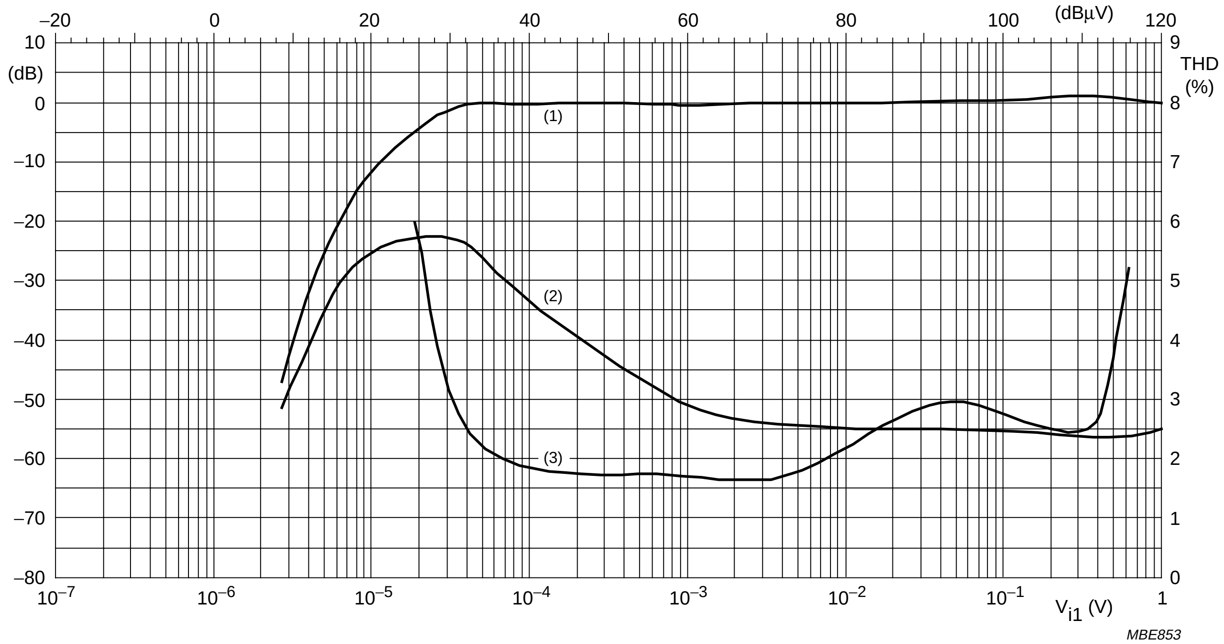
## STEREO DECODER CHARACTERISTICS

$V_{i3(L+R)}$ = 155 mV; $V_{pilot}$ = 15.5 mV; f = 1 kHz; apply unmodulated RF-signal of 100 mV to front-end to set radio to maximum channel separation; soft mute off (S4 in position A); unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $R_o$ | output resistance (pins 15 and 16) | | – | 4.3 | – | kΩ |
| $R_i$ | input resistance (pin 12) | | – | 180 | – | kΩ |
| $V_{15/16}$ | AF output voltage | | – | 160 | – | mV |
| $V_{pilot(s)}$ | switch to stereo | | – | 8 | 12 | mV |
| $V_{pilot(m)}$ | switch to mono | | 2 | 5 | – | mV |
| $\Delta f/f$ | capture range | $V_{pilot}$ = 15 mV | 3 | 4 | 8 | % |
| $V_{AF\text{-}L}/V_{i3}$ | MPX voltage gain | | –1.5 | – | +1.5 | dB |
| (S+N)/N | signal plus noise-to-noise ratio | $V_{pilot}$ = 15.5 mV (stereo) | – | 74 | – | dB |
| | | $V_{pilot}$ = 0 mV (mono) | – | 80 | – | dB |
| THD | total harmonic distortion | | – | 0.5 | 1.0 | % |
| $\alpha_{cs}$ | channel separation | | 26 | 30 | – | dB |
| $\alpha_{cub}$ | channel unbalance | | – | 0 | 1 | dB |
| $I_{26}$ | stereo indicator current | $V_{26} = V_{CC1}$; clock = LOW | | | | |
| | | $V_{pilot}$ = 15.5 mV | 600 | 800 | – | μA |
| | | $V_{pilot}$ = 0 mV | – | 15 | 30 | μA |
| $\alpha_{19}$ | carrier and harmonic suppression | 19 kHz (200 mV) = 0 dB | 27 | 32 | – | dB |
| $\alpha_{38}$ | | 38 kHz | 16 | 21 | – | dB |
| $\alpha$ | stereo-blend | $V_{i5}$ = 200 μV | 22 | 30 | – | dB |
| | | $V_{i5}$ = 20 μV | – | 1 | 2 | dB |
| mute(s) | soft mute depth | $V_{i5}$ = 3 μV; $V_{15} = V_{16}$ | –1 | 0 | – | dB |
| | | $V_{i5}$ = 1 μV; $V_{15} = V_{16}$ | –10 | –6 | – | dB |

**TUNING CHARACTERISTICS**

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $V_{FM(IF)}$ | FM IF voltage levels | $\alpha_{-3\ dB}$-point at $V_{i4}$ = 20 μV | | | | |
| | high (auto-store/search) | S0 = 1; S1 = 1 | 600 | 1500 | 5000 | μV |
| | medium (auto-store/search) | S0 = 0; S1 = 1 | 100 | 300 | 550 | μV |
| | low (auto-store/search) | S0 = 1; S1 = 0 | 40 | 100 | 200 | μV |
| | nominal (preset mode/tuning indication) | S0 = 0; S1 = 0 | 30 | 50 | 90 | μV |
| $V_{FM(RF)}$ | FM RF voltage levels | $\alpha_{-3\ dB}$-point at $V_{i5}$ = 2 μV | | | | |
| | high (auto-store/search) | S0 = 1; S1 = 1 | 60 | 150 | 500 | μV |
| | medium (auto-store/search) | S0 = 0; S1 = 1 | 10 | 30 | 55 | μV |
| | low (auto-store/search) | S0 = 1; S1 = 0 | 4 | 10 | 20 | μV |
| | nominal (preset mode/tuning indication) | S0 = 0; S1 = 0 | 3 | 5 | 9 | μV |
| $V_{AM}$ | AM voltage levels | $\alpha_{-3\ dB}$-point at $V_{i5}$ = 2 μV | | | | |
| | high (auto-store/search) | S0 = 1; S1 = 1 | 400 | 1000 | 2500 | μV |
| | medium (auto-store/search) | S0 = 0; S1 = 1 | 50 | 63 | 80 | μV |
| | low (auto-store/search) | S0 = 1; S1 = 0 | 32 | 40 | 50 | μV |
| | nominal (preset mode/tuning indication) | S0 = 0; S1 = 0 | 25 | 28 | 40 | μV |
| $V_{AFC(off)}$ | AFC voltage off mode | $\alpha_{-3\ dB}$-point at $V_{i5}$ = 2 μV | | | | |
| | | FM mode | – | 3 | – | μV |
| | | AM mode | – | 25 | – | μV |
| mute(h) | hard mute depth | WRITE-ENABLE = HIGH | – | 60 | – | dB |
| mute(p) | pull mute depth | | – | 15 | – | dB |
| $f_{max}$ | maximum frequency of FM prescaler | | – | 150 | – | MHz |
| $I_{26}$ | lock-in indicator current | $V_{26} = V_{CC1}$; clock = HIGH | | | | |
| | | tuning system locked | 1200 | 1800 | – | μA |
| | | tuning system not locked | – | 12 | 18 | μA |

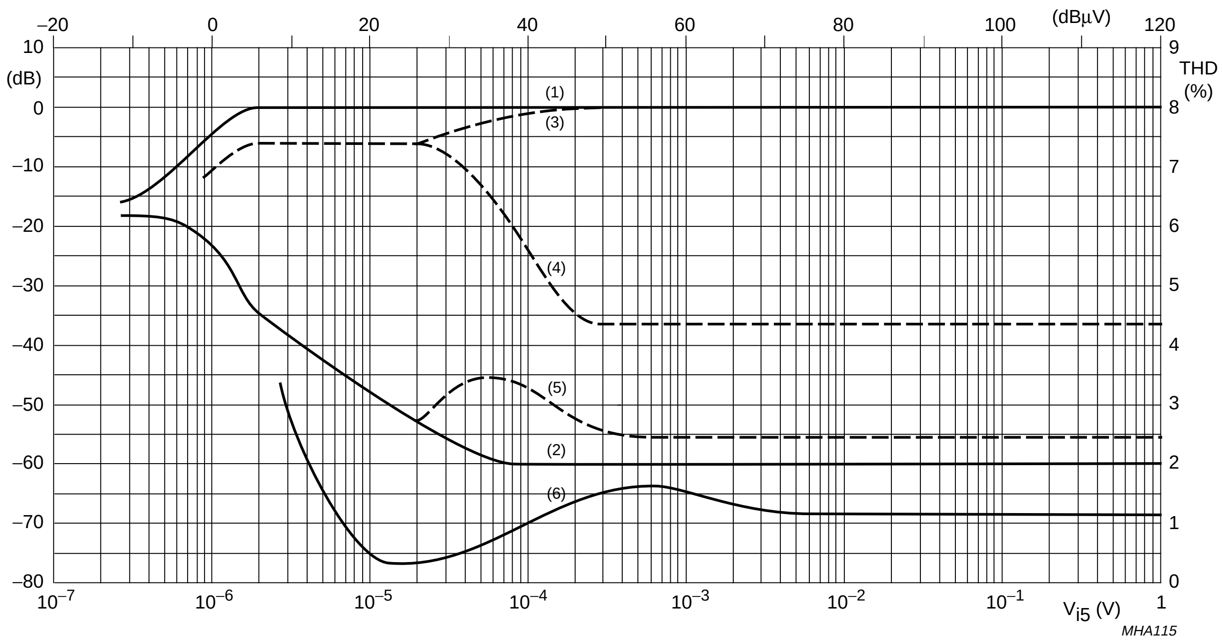



(1) Audio signal.

(2) Noise.

(3) Harmonic distortion.

Fig.7 AM mode.

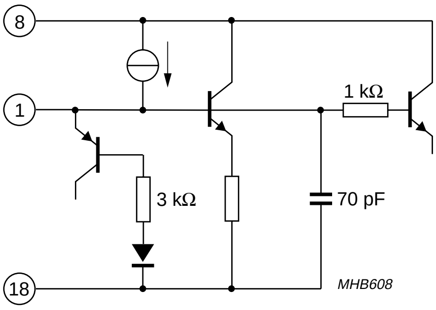
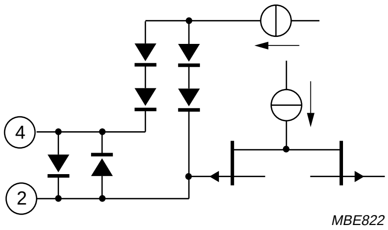
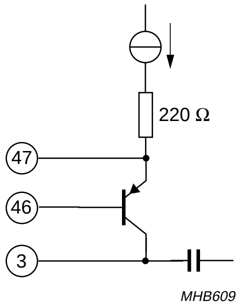
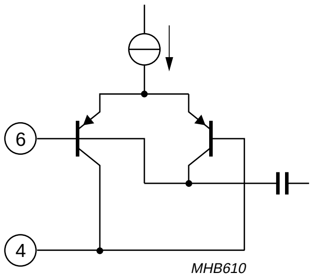


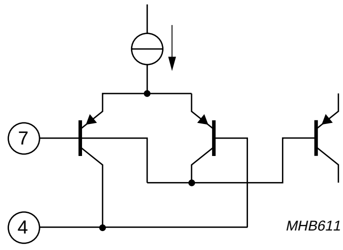
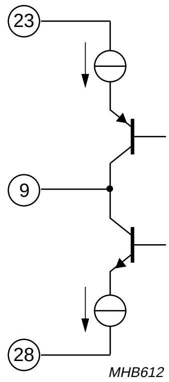
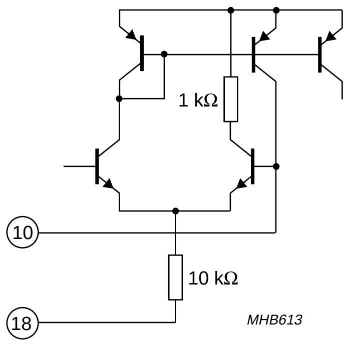
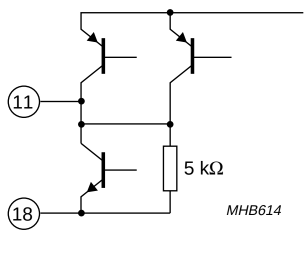

(1) Mono signal.
(2) Noise in mono mode.
(3) Left channel with modulation left.
(4) Right channel with modulation left.
(5) Noise in stereo mode.
(6) Total harmonic distortion $\Delta f$ = 75 kHz.

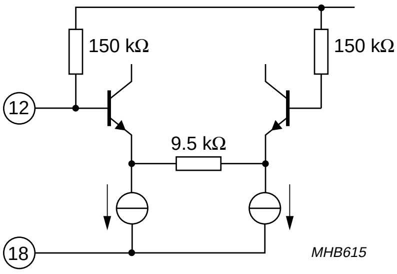
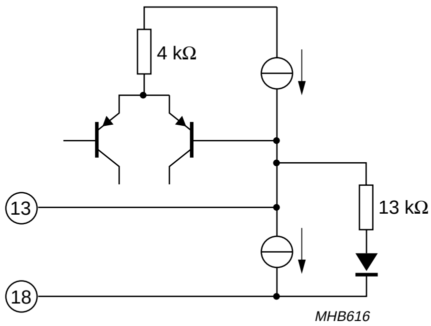
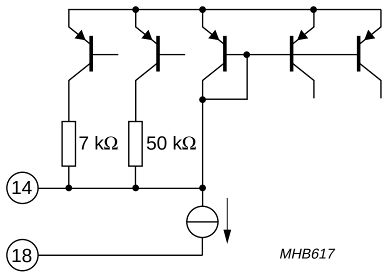
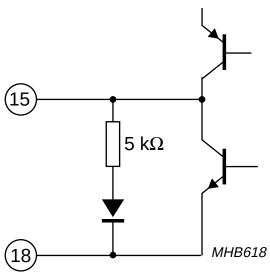
Fig.8 FM mode.

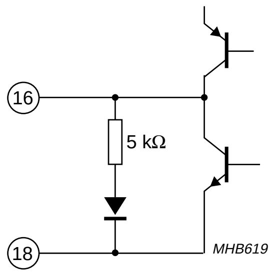
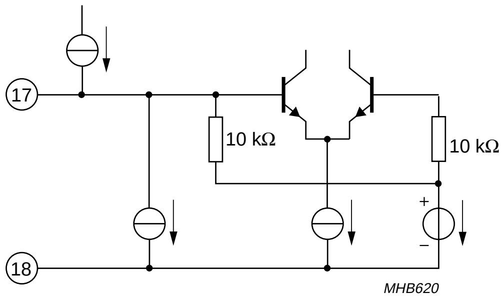
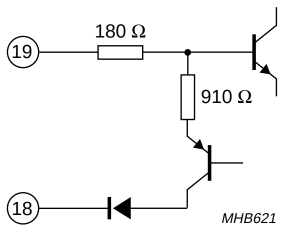
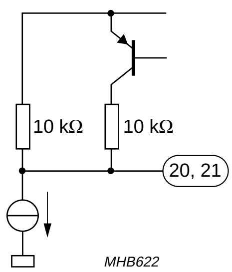
## INTERNAL CIRCUITRY

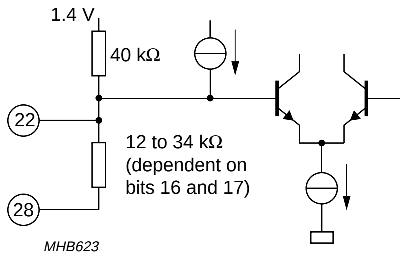
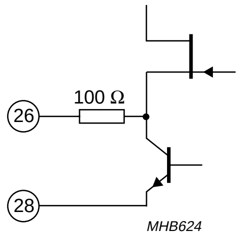
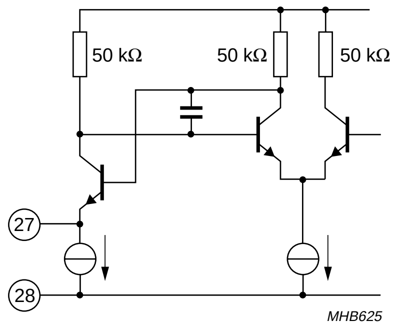
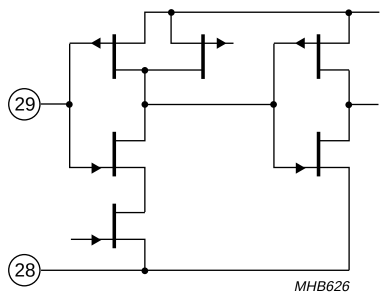
**Table 9** Equivalent pin circuits and pin voltages

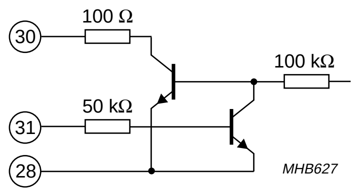
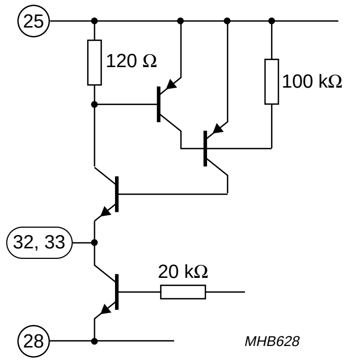
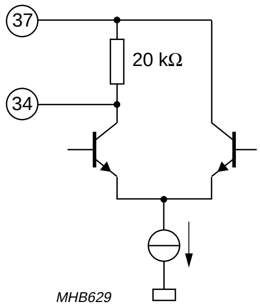
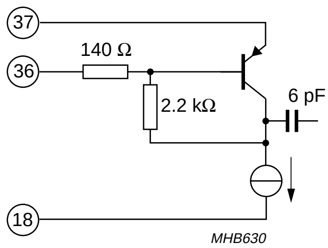
| PIN | SYMBOL | DC VOLTAGE (V) | | EQUIVALENT CIRCUIT |
|---|---|---|---|---|
| | | AM | FM | |
| 1 | RIPPLE | 2.1 | 2.1 |  |
| 2 | AM-RFI | 0 | 0 |  |
| 3 | FM-RFO | 0 | 0 |  |
| 4 | RFGND1 | – | – | |
| 5 | CGND | – | – | |
| 6 | FMOSC/<br>COUNTI | 0 | 0 |  |

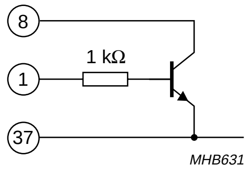
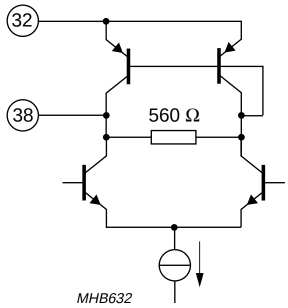
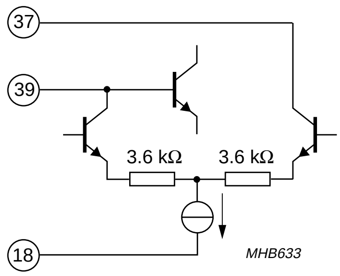
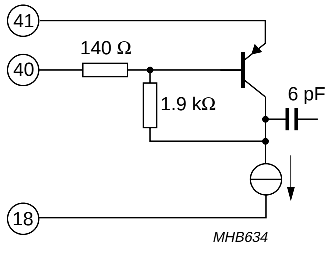
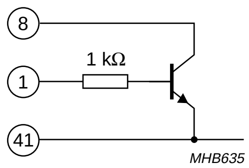
| PIN | SYMBOL | DC VOLTAGE (V) | | EQUIVALENT CIRCUIT |
|---|---|---|---|---|
| | | AM | FM | |
| 7 | AMOSC | 0 | 0 |  |
| 8 | $V_{CC1}$ | 3.0 | 3.0 | |
| 9 | TUNE | – | – |  |
| 10 | VCO | 1.3 | 0.95 |  |
| 11 | AFO | 0.6 | 0.7 |  |

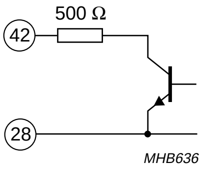
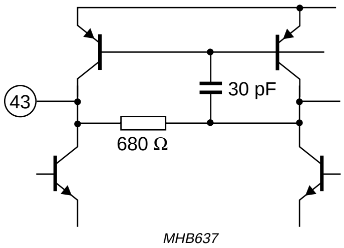
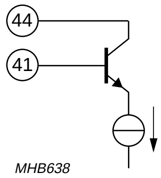
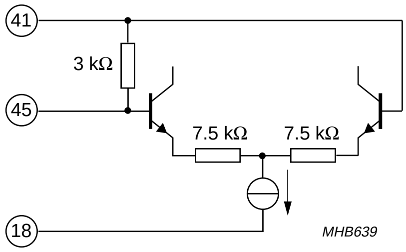
| PIN | SYMBOL | DC VOLTAGE (V) | | EQUIVALENT CIRCUIT |
|---|---|---|---|---|
| | | AM | FM | |
| 12 | MPXI | 1.23 | 1.23 |  |
| 13 | LFI | 0.1 | 0.8 |  |
| 14 | MUTE | 0.7 | 0.7 |  |
| 15 | AFLO | 0.65 | 0.65 |  |

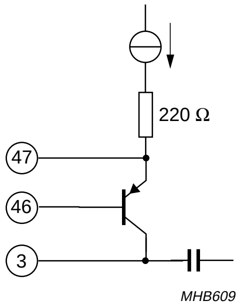
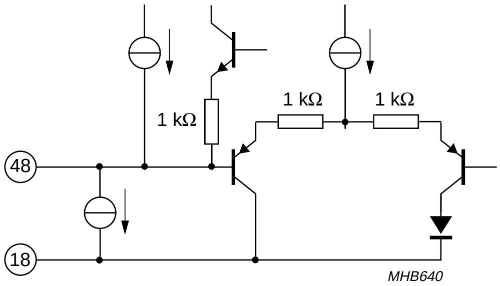
| PIN | SYMBOL | DC VOLTAGE (V) | | EQUIVALENT CIRCUIT |
|---|---|---|---|---|
| | | AM | FM | |
| 16 | AFRO | 0.65 | 0.65 |  |
| 17 | PILFIL | 0.95 | 0.95 |  |
| 18 | IFGND | – | – | |
| 19 | FMDEM | – | 1.0 |  |
| 20 | $AFC_{(n)}$ | – | – |  |
| 21 | $AFC_{(p)}$ | – | – | |

| PIN | SYMBOL | DC VOLTAGE (V) | | EQUIVALENT CIRCUIT |
|---|---|---|---|---|
| | | AM | FM | |
| 22 | FSI | – | – |  |
| 23 | $V_{CC2}$ | – | – | |
| 24 | n.c. | – | – | |
| 25 | $V_{DDD}$ | 3.0 | 3.0 | |
| 26 | MO/ST | – | – |  |
| 27 | XTAL | – | – |  |
| 28 | DGND | – | – | |
| 29 | BUS-CLOCK | – | – |  |

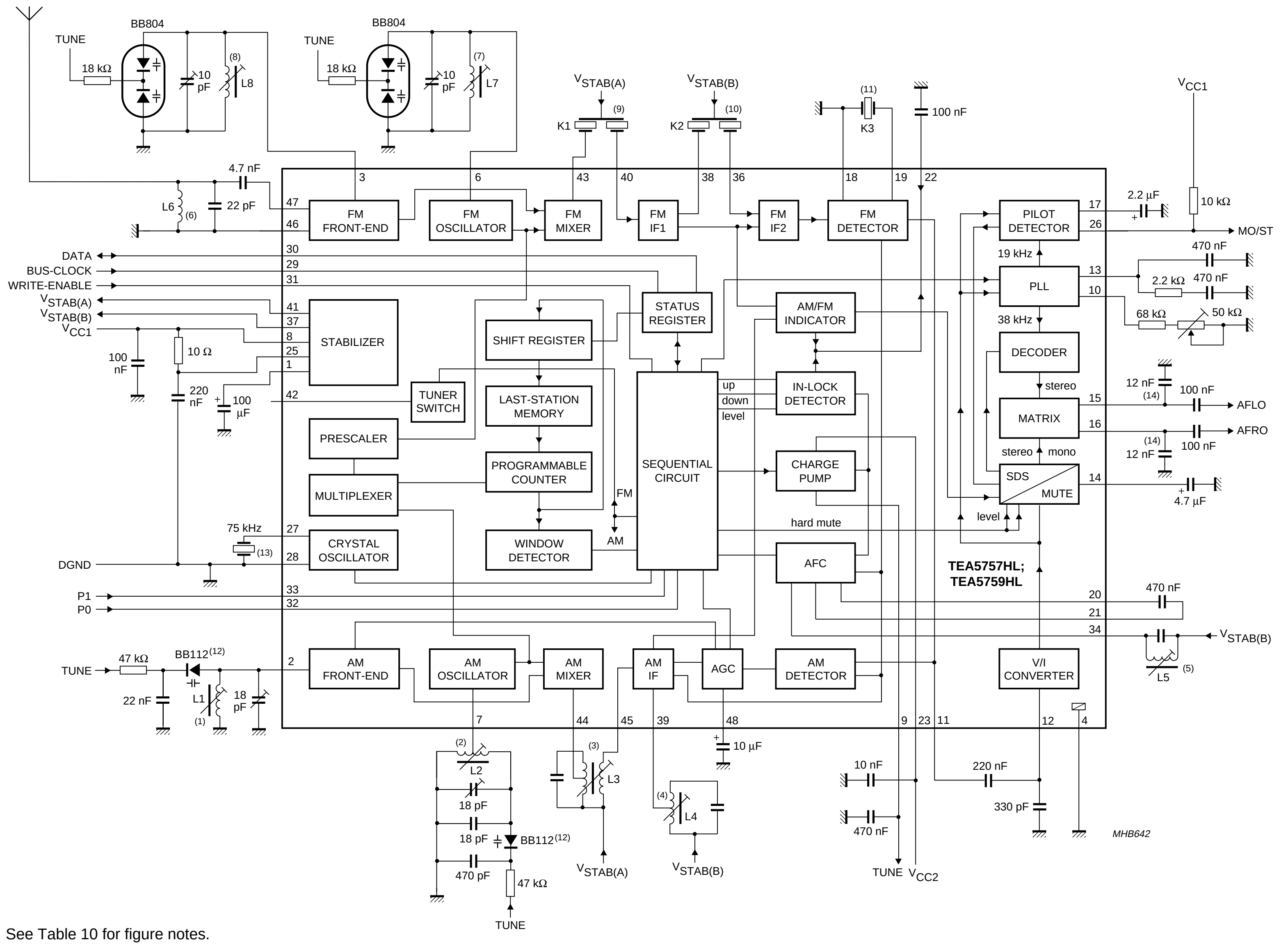
<table>
<tr><th rowspan="2">PIN</th><th rowspan="2">SYMBOL</th><th colspan="2">DC VOLTAGE (V)</th><th rowspan="2">EQUIVALENT CIRCUIT</th></tr>
<tr><th>AM</th><th>FM</th></tr>
<tr><td>30</td><td>DATA</td><td>–</td><td>–</td><td rowspan="2">
</td></tr>
<tr><td>31</td><td>WRITE-ENABLE</td><td>–</td><td>–</td></tr>
<tr><td>32</td><td>P0</td><td>–</td><td>–</td><td rowspan="2">
</td></tr>
<tr><td>33</td><td>P1</td><td>–</td><td>–</td></tr>
<tr><td>34</td><td>AFC</td><td>–</td><td>–</td><td>
</td></tr>
<tr><td>35</td><td>n.c.</td><td>–</td><td>–</td><td></td></tr>
<tr><td>36</td><td>FM-IF12</td><td>–</td><td>0.73</td><td>
</td></tr>
</table>

| PIN | SYMBOL | DC VOLTAGE (V) | | EQUIVALENT CIRCUIT |
|---|---|---|---|---|
| | | AM | FM | |
| 37 | $V_{STAB(B)}$ | 1.4 | 1.4 |  |
| 38 | FM-IFO1 | – | 0.69 |  |
| 39 | AM-IFI/O2 | 1.4 | 1.4 |  |
| 40 | FM-IFI1 | – | 0.73 |  |
| 41 | $V_{STAB(A)}$ | 1.4 | 1.4 |  |

| PIN | SYMBOL | DC VOLTAGE (V) | | EQUIVALENT CIRCUIT |
|---|---|---|---|---|
| | | AM | FM | |
| 42 | FM-ON/OFF | – | – |  |
| 43 | FM-MIXER | – | 1.0 |  |
| 44 | AM-MIXER | 1.4 | 1.4 |  |
| 45 | AM-IF1I | 1.4 | 1.4 |  |

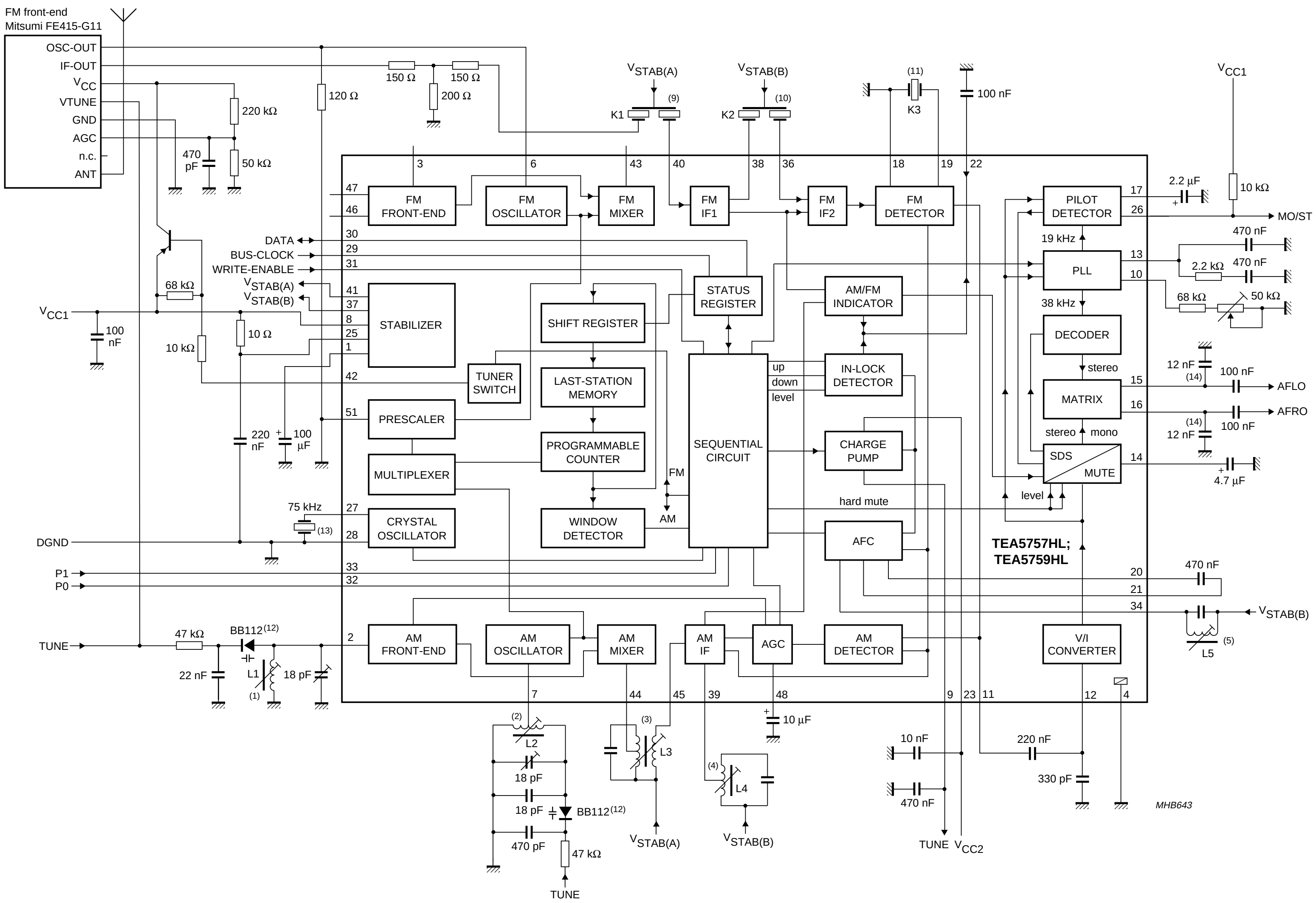
| PIN | SYMBOL | DC VOLTAGE (V) | | EQUIVALENT CIRCUIT |
|---|---|---|---|---|
| | | AM | FM | |
| 46 | RFGND2 | – | – | |
| 47 | FM-RFI | – | 0.73 |  |
| 48 | AGC | 0.1 | 0.7 |  |

## TEST AND APPLICATION INFORMATION



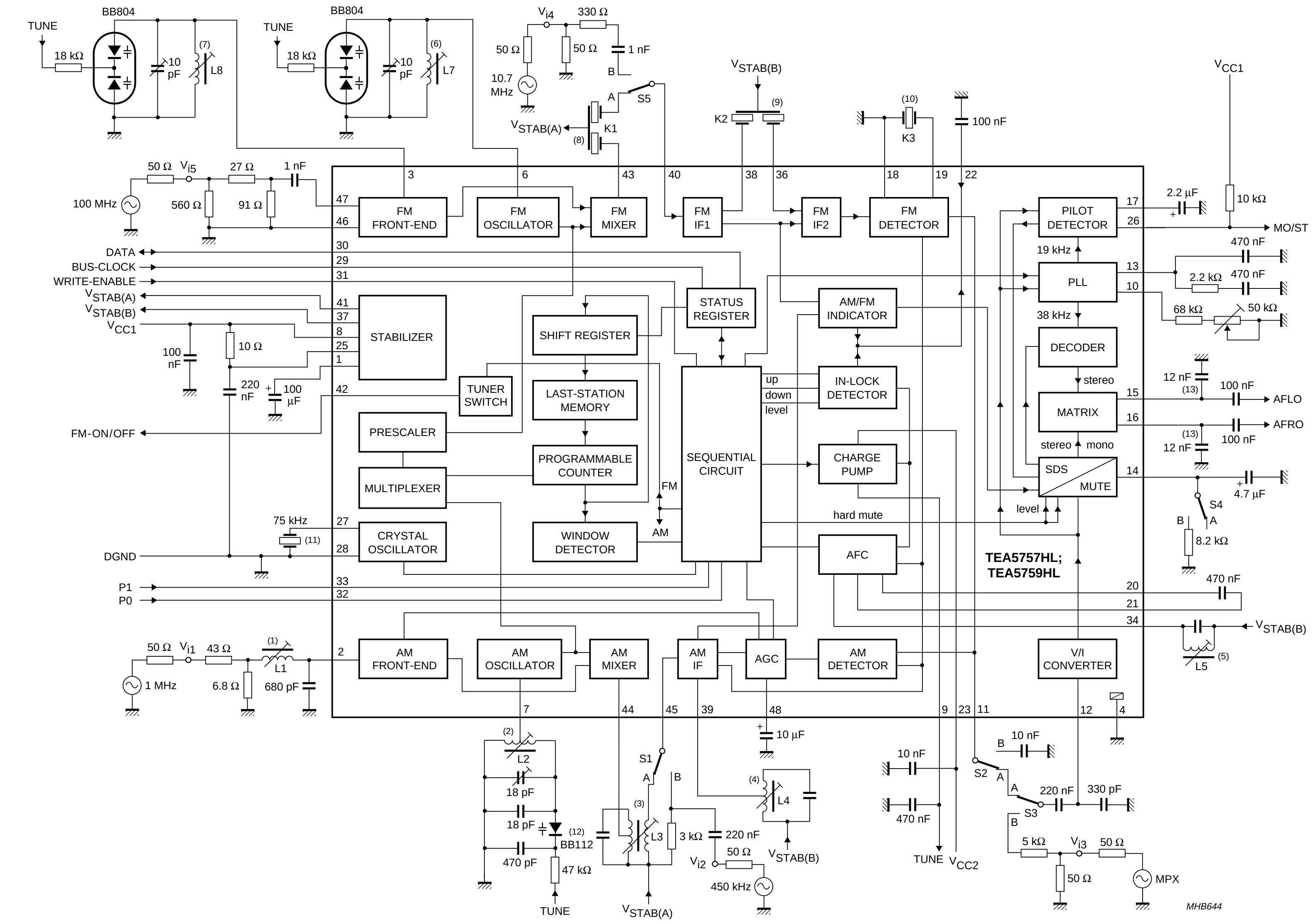

See Table 10 for figure notes.

Fig.9 Application diagram.




See Table 10 for figure notes.

Fig.10 Application diagram with external FM front-end.




See Table 10 for figure notes.

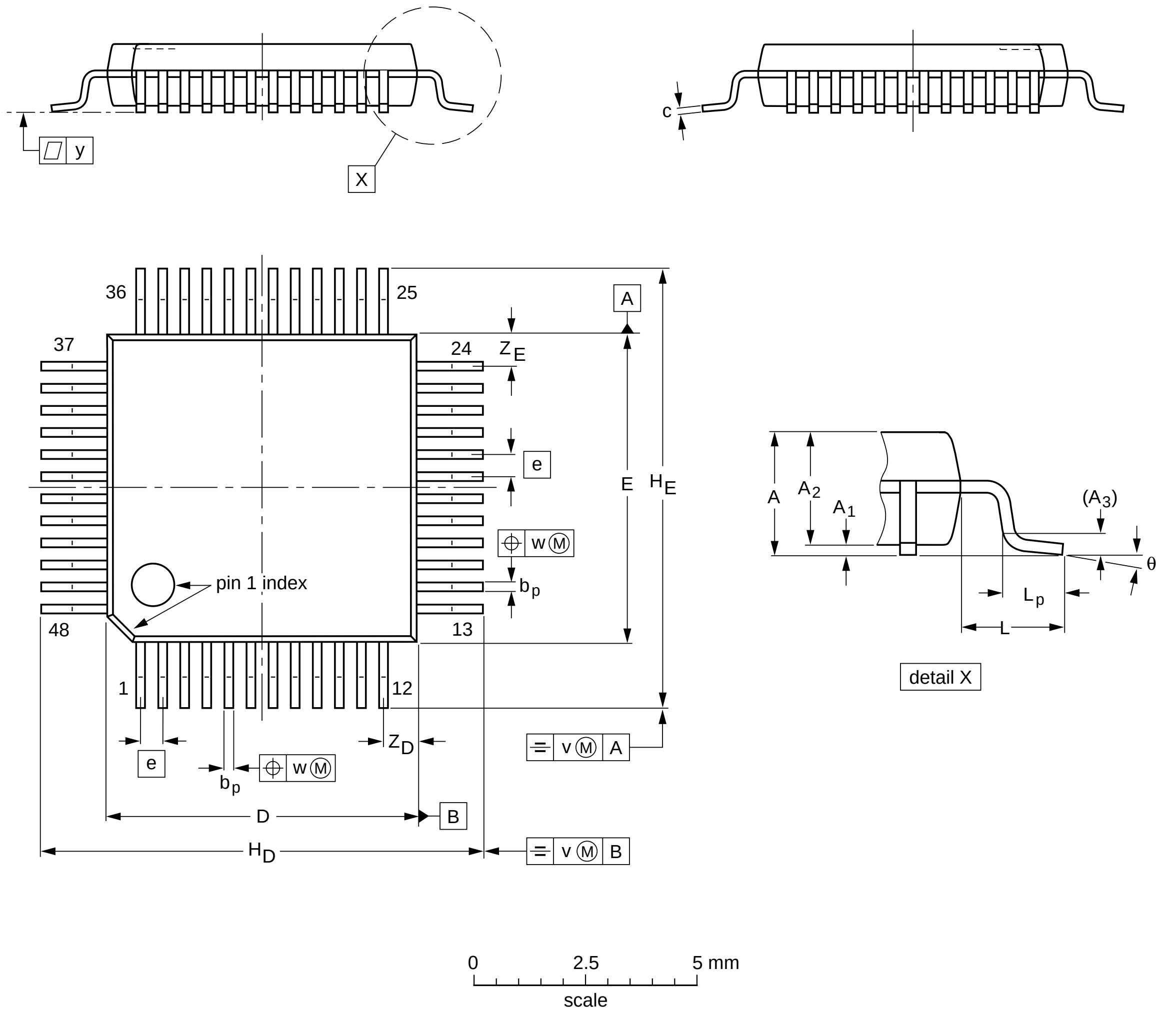
Fig.11 Test circuit.

**Table 10** Test and application components

| FIGURE NOTE | DESCRIPTION |
|---|---|
| **Application diagrams;** see Figs 9 and 10 | |
| 1 | L1 = 250 μH ferroceptor |
| 2 | L2 = 7P 7DRS-11459N, 110 μH at 796 kHz, Q = 80, TOKO |
| 3 | L3 = 7P A7MCS-11844N, C = 180 pF, Q = 90, TOKO |
| 4 | L4 = 7P A7MCS-11845Y, C = 180 pF, Q = 90, TOKO |
| 5 | L5 = 7P A7MCS-11845Y, C = 180 pF, Q = 90, TOKO |
| 6 | L6 = 60 nH |
| 7 | L7 = MC117E523FN-2000242, 38 pF ±3%, TOKO |
| 8 | L8 = MC117E523FN-2000242, 38 pF ±3%, TOKO |
| 9 | K1 = SFE10.7MS3, MURATA |
| 10 | K2 = SFE10.7MS3, MURATA |
| 11 | K3 = CDA10.7-MC40-A, MURATA |
| 12 | alternatively BB512, Siemens or KV1561A, TOKO |
| 13 | standard application: ±30 ppm at $T_{amb}$ = 25 °C<br>short wave application: ±20 ppm at $T_{amb}$ = 25 °C |
| 14 | de-emphasis time constant is 50 μs: $C_{deem}$ = 12 nF<br>de-emphasis time constant is 75 μs: $C_{deem}$ = 18 nF |
| **Test circuit;** see Fig.11 | |
| 1 | L1 = 22281-30091 |
| 2 | L2 = 7P 7DRS-11459N, 110 μH at 796 kHz, Q = 80, TOKO |
| 3 | L3 = 7P A7MCS-11844N, C = 180 pF, Q = 90, TOKO |
| 4 | L4 = 7P A7MCS-11845Y, C = 180 pF, Q = 90, TOKO |
| 5 | L5 = 7P A7MCS-11845Y, C = 180 pF, Q = 90, TOKO |
| 6 | L7 = MC117E523FN-2000242, 38 pF ±3%, TOKO |
| 7 | L8 = MC117E523FN-2000242, 38 pF ±3%, TOKO |
| 8 | K1 = SFE10.7MS3, MURATA |
| 9 | K2 = SFE10.7MS3, MURATA |
| 10 | K3 = CDA10.7-MG40-A, MURATA or CDACV10.7MG61-A, MURATA |
| 11 | standard application: ±30 ppm at $T_{amb}$ = 25 °C<br>short wave application: ±20 ppm at $T_{amb}$ = 25 °C |
| 12 | alternatively BB512, Siemens or KV1561A, TOKO |
| 13 | de-emphasis time constant is 50 μs: $C_{deem}$ = 12 nF<br>de-emphasis time constant is 75 μs: $C_{deem}$ = 18 nF |

## PACKAGE OUTLINE

**LQFP48: plastic low profile quad flat package; 48 leads; body 7 x 7 x 1.4 mm** **SOT313-2**




**DIMENSIONS (mm are the original dimensions)**

| UNIT | A max. | $A_1$ | $A_2$ | $A_3$ | $b_p$ | c | $D^{(1)}$ | $E^{(1)}$ | e | $H_D$ | $H_E$ | L | $L_p$ | v | w | y | $Z_D^{(1)}$ | $Z_E^{(1)}$ | θ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 1.60 | 0.20<br>0.05 | 1.45<br>1.35 | 0.25 | 0.27<br>0.17 | 0.18<br>0.12 | 7.1<br>6.9 | 7.1<br>6.9 | 0.5 | 9.15<br>8.85 | 9.15<br>8.85 | 1.0 | 0.75<br>0.45 | 0.2 | 0.12 | 0.1 | 0.95<br>0.55 | 0.95<br>0.55 | $7^o$<br>$0^o$ |

**Note**

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | EIAJ | | | |
| SOT313-2 | 136E05 | MS-026 | | | | ~~99-12-27~~<br>00-01-19 |

## SOLDERING

### Introduction to soldering surface mount packages

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"Data Handbook IC26; Integrated Circuit Packages"* (document order number 9398 652 90011).

There is no soldering method that is ideal for all surface mount IC packages. Wave soldering is not always suitable for surface mount ICs, or for printed-circuit boards with high population densities. In these situations reflow soldering is often used.

### Reflow soldering

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stencilling or pressure-syringe dispensing before package placement.

Several methods exist for reflowing; for example, infrared/convection heating in a conveyor type oven. Throughput times (preheating, soldering and cooling) vary between 100 and 200 seconds depending on heating method.

Typical reflow peak temperatures range from 215 to 250 °C. The top-surface temperature of the packages should preferable be kept below 230 °C.

### Wave soldering

Conventional single wave soldering is not recommended for surface mount devices (SMDs) or printed-circuit boards with a high component density, as solder bridging and non-wetting can present major problems.

To overcome these problems the double-wave soldering method was specifically developed.

If wave soldering is used the following conditions must be observed for optimal results:

- Use a double-wave soldering method comprising a turbulent wave with high upward pressure followed by a smooth laminar wave.
- For packages with leads on two sides and a pitch (e):
  - larger than or equal to 1.27 mm, the footprint longitudinal axis is **preferred** to be parallel to the transport direction of the printed-circuit board;
  - smaller than 1.27 mm, the footprint longitudinal axis **must** be parallel to the transport direction of the printed-circuit board.

  The footprint must incorporate solder thieves at the downstream end.
- For packages with leads on four sides, the footprint must be placed at a 45° angle to the transport direction of the printed-circuit board. The footprint must incorporate solder thieves downstream and at the side corners.

During placement and before soldering, the package must be fixed with a droplet of adhesive. The adhesive can be applied by screen printing, pin transfer or syringe dispensing. The package can be soldered after the adhesive is cured.

Typical dwell time is 4 seconds at 250 °C.
A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

### Manual soldering

Fix the component by first soldering two diagonally-opposite end leads. Use a low voltage (24 V or less) soldering iron applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C.

When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

**Suitability of surface mount IC packages for wave and reflow soldering methods**

| PACKAGE | SOLDERING METHOD | |
|---|---|---|
| | WAVE | REFLOW[1] |
| BGA, SQFP | not suitable | suitable |
| HLQFP, HSQFP, HSOP, HTSSOP, SMS | not suitable[2] | suitable |
| PLCC[3], SO, SOJ | suitable | suitable |
| LQFP, QFP, TQFP | not recommended[3][4] | suitable |
| SSOP, TSSOP, VSO | not recommended[5] | suitable |

**Notes**

1. All surface mount (SMD) packages are moisture sensitive. Depending upon the moisture content, the maximum temperature (with respect to time) and body size of the package, there is a risk that internal or external package cracks may occur due to vaporization of the moisture in them (the so called popcorn effect). For details, refer to the Drypack information in the *"Data Handbook IC26; Integrated Circuit Packages; Section: Packing Methods"*.
2. These packages are not suitable for wave soldering as a solder joint between the printed-circuit board and heatsink (at bottom version) can not be achieved, and as solder may stick to the heatsink (on top version).
3. If wave soldering is considered, then the package must be placed at a 45° angle to the solder wave direction. The package footprint must incorporate solder thieves downstream and at the side corners.
4. Wave soldering is only suitable for LQFP, TQFP and QFP packages with a pitch (e) equal to or larger than 0.8 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.65 mm.
5. Wave soldering is only suitable for SSOP and TSSOP packages with a pitch (e) equal to or larger than 0.65 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.5 mm.

## DEFINITIONS

| **Data sheet status** | |
|---|---|
| Objective specification | This data sheet contains target or goal specifications for product development. |
| Preliminary specification | This data sheet contains preliminary data; supplementary data may be published later. |
| Product specification | This data sheet contains final product specifications. |
| **Limiting values** | |
| Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability. | |
| **Application information** | |
| Where application information is given, it is advisory and does not form part of the specification. | |

## LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

**NOTES**

## NOTES

**NOTES**

# Philips Semiconductors – a worldwide company


**Argentina:** see South America

**Australia:** 3 Figtree Drive, HOMEBUSH, NSW 2140, Tel. +61 2 9704 8141, Fax. +61 2 9704 8139

**Austria:** Computerstr. 6, A-1101 WIEN, P.O. Box 213, Tel. +43 1 60 101 1248, Fax. +43 1 60 101 1210

**Belarus:** Hotel Minsk Business Center, Bld. 3, r. 1211, Volodarski Str. 6, 220050 MINSK, Tel. +375 172 20 0733, Fax. +375 172 20 0773

**Belgium:** see The Netherlands

**Brazil:** see South America

**Bulgaria:** Philips Bulgaria Ltd., Energoproject, 15th floor, 51 James Bourchier Blvd., 1407 SOFIA, Tel. +359 2 68 9211, Fax. +359 2 68 9102

**Canada:** PHILIPS SEMICONDUCTORS/COMPONENTS, Tel. +1 800 234 7381, Fax. +1 800 943 0087

**China/Hong Kong:** 501 Hong Kong Industrial Technology Centre, 72 Tat Chee Avenue, Kowloon Tong, HONG KONG, Tel. +852 2319 7888, Fax. +852 2319 7700

**Colombia:** see South America

**Czech Republic:** see Austria

**Denmark:** Sydhavnsgade 23, 1780 COPENHAGEN V, Tel. +45 33 29 3333, Fax. +45 33 29 3905

**Finland:** Sinikalliontie 3, FIN-02630 ESPOO, Tel. +358 9 615 800, Fax. +358 9 6158 0920

**France:** 51 Rue Carnot, BP317, 92156 SURESNES Cedex, Tel. +33 1 4099 6161, Fax. +33 1 4099 6427

**Germany:** Hammerbrookstraße 69, D-20097 HAMBURG, Tel. +49 40 2353 60, Fax. +49 40 2353 6300

**Hungary:** see Austria

**India:** Philips INDIA Ltd, Band Box Building, 2nd floor, 254-D, Dr. Annie Besant Road, Worli, MUMBAI 400 025, Tel. +91 22 493 8541, Fax. +91 22 493 0966

**Indonesia:** PT Philips Development Corporation, Semiconductors Division, Gedung Philips, Jl. Buncit Raya Kav.99-100, JAKARTA 12510, Tel. +62 21 794 0040 ext. 2501, Fax. +62 21 794 0080

**Ireland:** Newstead, Clonskeagh, DUBLIN 14, Tel. +353 1 7640 000, Fax. +353 1 7640 200

**Israel:** RAPAC Electronics, 7 Kehilat Saloniki St, PO Box 18053, TEL AVIV 61180, Tel. +972 3 645 0444, Fax. +972 3 649 1007

**Italy:** PHILIPS SEMICONDUCTORS, Via Casati, 23 - 20052 MONZA (MI), Tel. +39 039 203 6838, Fax +39 039 203 6800

**Japan:** Philips Bldg 13-37, Kohnan 2-chome, Minato-ku, TOKYO 108-8507, Tel. +81 3 3740 5130, Fax. +81 3 3740 5057

**Korea:** Philips House, 260-199 Itaewon-dong, Yongsan-ku, SEOUL, Tel. +82 2 709 1412, Fax. +82 2 709 1415

**Malaysia:** No. 76 Jalan Universiti, 46200 PETALING JAYA, SELANGOR, Tel. +60 3 750 5214, Fax. +60 3 757 4880

**Mexico:** 5900 Gateway East, Suite 200, EL PASO, TEXAS 79905, Tel. +9-5 800 234 7381, Fax +9-5 800 943 0087

**Middle East:** see Italy

**Netherlands:** Postbus 90050, 5600 PB EINDHOVEN, Bldg. VB, Tel. +31 40 27 82785, Fax. +31 40 27 88399

**New Zealand:** 2 Wagener Place, C.P.O. Box 1041, AUCKLAND, Tel. +64 9 849 4160, Fax. +64 9 849 7811

**Norway:** Box 1, Manglerud 0612, OSLO, Tel. +47 22 74 8000, Fax. +47 22 74 8341

**Pakistan:** see Singapore

**Philippines:** Philips Semiconductors Philippines Inc., 106 Valero St. Salcedo Village, P.O. Box 2108 MCC, MAKATI, Metro MANILA, Tel. +63 2 816 6380, Fax. +63 2 817 3474

**Poland**: Al.Jerozolimskie 195 B, 02-222 WARSAW, Tel. +48 22 5710 000, Fax. +48 22 5710 001

**Portugal:** see Spain

**Romania:** see Italy

**Russia:** Philips Russia, Ul. Usatcheva 35A, 119048 MOSCOW, Tel. +7 095 755 6918, Fax. +7 095 755 6919

**Singapore:** Lorong 1, Toa Payoh, SINGAPORE 319762, Tel. +65 350 2538, Fax. +65 251 6500

**Slovakia:** see Austria

**Slovenia:** see Italy

**South Africa:** S.A. PHILIPS Pty Ltd., 195-215 Main Road Martindale, 2092 JOHANNESBURG, P.O. Box 58088 Newville 2114, Tel. +27 11 471 5401, Fax. +27 11 471 5398

**South America:** Al. Vicente Pinzon, 173, 6th floor, 04547-130 SÃO PAULO, SP, Brazil, Tel. +55 11 821 2333, Fax. +55 11 821 2382

**Spain:** Balmes 22, 08007 BARCELONA, Tel. +34 93 301 6312, Fax. +34 93 301 4107

**Sweden:** Kottbygatan 7, Akalla, S-16485 STOCKHOLM, Tel. +46 8 5985 2000, Fax. +46 8 5985 2745

**Switzerland:** Allmendstrasse 140, CH-8027 ZÜRICH, Tel. +41 1 488 2741 Fax. +41 1 488 3263

**Taiwan:** Philips Semiconductors, 6F, No. 96, Chien Kuo N. Rd., Sec. 1, TAIPEI, Taiwan Tel. +886 2 2134 2886, Fax. +886 2 2134 2874

**Thailand:** PHILIPS ELECTRONICS (THAILAND) Ltd., 209/2 Sanpavuth-Bangna Road Prakanong, BANGKOK 10260, Tel. +66 2 745 4090, Fax. +66 2 398 0793

**Turkey:** Yukari Dudullu, Org. San. Blg., 2.Cad. Nr. 28 81260 Umraniye, ISTANBUL, Tel. +90 216 522 1500, Fax. +90 216 522 1813

**Ukraine**: PHILIPS UKRAINE, 4 Patrice Lumumba str., Building B, Floor 7, 252042 KIEV, Tel. +380 44 264 2776, Fax. +380 44 268 0461

**United Kingdom:** Philips Semiconductors Ltd., 276 Bath Road, Hayes, MIDDLESEX UB3 5BX, Tel. +44 208 730 5000, Fax. +44 208 754 8421

**United States:** 811 East Arques Avenue, SUNNYVALE, CA 94088-3409, Tel. +1 800 234 7381, Fax. +1 800 943 0087

**Uruguay:** see South America

**Vietnam:** see Singapore

**Yugoslavia:** PHILIPS, Trg N. Pasica 5/v, 11000 BEOGRAD, Tel. +381 11 3341 299, Fax.+381 11 3342 553

**For all other countries apply to:** Philips Semiconductors, International Marketing & Sales Communications, Building BE-p, P.O. Box 218, 5600 MD EINDHOVEN, The Netherlands, Fax. +31 40 27 24825

**Internet:** http://www.semiconductors.philips.com





Printed in The Netherlands 753503/01/pp40 Date of release: 2000 Feb 02 Document order number: 9397 750 06617


Let's make things better.

Philips Semiconductors

PHILIPS