

DATA SHEET



TDA6402; TDA6402A; TDA6403; TDA6403A

**5 V mixers/oscillators and
synthesizers for cable TV and VCR
2-band tuners**

Product specification
Supersedes data of 1998 Jul 28
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5 V mixers/oscillators and synthesizers for cable TV and VCR 2-band tuners

TDA6402; TDA6402A; TDA6403; TDA6403A

FEATURES

- Single-chip 5 V mixer/oscillator and synthesizer for cable TV and VCR tuners
- Synthesizer function compatible with existing TSA5526
- Universal bus protocol (I²C-bus or 3-wire bus)
 - Bus protocol for 18 or 19-bit transmission (3-wire bus)
 - Extra protocol for 27-bit transmission (test modes and features for 3-wire bus)
 - Address + 4 data bytes transmission (I²C-bus 'write' mode)
 - Address + 1 status byte (I²C-bus 'read' mode)
 - 4 independent I²C-bus addresses.
- 1 PNP buffer for UHF band selection (25 mA)
- 3 PNP buffers for general purpose, e.g. 2 VHF sub-bands, FM sound trap (25 mA)
- 33 V tuning voltage output
- In-lock detector
- 5-step A/D converter (3 bits in I²C-bus mode)
- 15-bit programmable divider
- Programmable reference divider ratio (512, 640 or 1024)
- Programmable charge pump current (60 or 280 μ A)
- Programmable automatic charge pump current switch
- Varicap drive disable
- Mixer/oscillator function compatible with existing TDA5732
- Balanced mixer with a common emitter input for VHF (single input)
- Balanced mixer with a common base input for UHF (balanced input)
- 2-pin common emitter oscillator for VHF
- 4-pin common emitter oscillator for UHF
- IF preamplifier with asymmetrical 75 Ω output impedance to drive a low-ohmic impedance (75 Ω)
- Low power
- Low radiation
- Small size
- The TDA6402A and TDA6403A differ from the TDA6402 and TDA6403 by the UHF port protocol in the I²C-bus mode (see Tables 3 and 4).



APPLICATIONS

- Cable tuners for TV and VCR (switched concept for VHF)
- Recommended RF bands for the USA: 55.25 to 133.25 MHz, 139.25 to 361.25 MHz and 367.25 to 801.25 MHz.

GENERAL DESCRIPTION

The TDA6402, TDA6402A, TDA6403 and TDA6403A are programmable 2-band mixers/oscillators and synthesizers intended for VHF/UHF cable tuners (see Fig.1).

The devices include two double balanced mixers and two oscillators for the VHF and UHF band respectively, an IF amplifier and a PLL synthesizer. The VHF band can be split-up into two sub-bands using a proper oscillator application and a switchable inductor. Two pins are available between the mixer output and the IF amplifier input to enable IF filtering for improved signal handling. Four PNP ports are provided. Band selection is provided by using pin PUHF. When PUHF is 'ON', the UHF mixer-oscillator is active and the VHF band is switched off. When PUHF is 'OFF', the VHF mixer-oscillator is active and the UHF band is 'OFF'. PVHFL and PVHFH are used to select the VHF sub-bands. FMST is a general purpose port, that can be used to switch an FM sound trap. When it is used, the sum of the collector currents has to be limited to 30 mA.

The synthesizer consists of a divide-by-eight prescaler, a 15-bit programmable divider, a crystal oscillator and its programmable reference divider and a phase/frequency detector combined with a charge pump which drives the tuning amplifier, including 33 V output (V33) at pin VT.

Depending on the reference divider ratio (512, 640 or 1024), the phase comparator operates at 7.8125 kHz, 6.25 kHz or 3.90625 kHz with a 4 MHz crystal.

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The device can be controlled according to the I²C-bus format or 3-wire bus format depending on the voltage applied to pin SW (see Table 2). In the 3-wire bus mode (SW = HIGH), pin LOCK/ADC is the LOCK output. The LOCK output is LOW when the PLL loop is locked. In the I²C-bus mode (SW = LOW), the lock detector bit FL is set to logic 1 when the loop is locked and is read on the SDA line (Status Byte; SB) during a READ operation in I²C-bus mode only. The Analog-to-Digital Converter (ADC) input is available on pin LOCK/ADC for digital AFC control in the I²C-bus mode only. The ADC code is read during a READ operation on the I²C-bus (see Table 11). In test mode, pin LOCK/ADC is used as a TEST output for f_{REF} and $\frac{1}{2}f_{DIV}$, in both I²C-bus mode and 3-wire bus mode (see Table 7).

When the automatic charge pump current switch mode is activated and when the loop is phase-locked, the charge pump current value is automatically switched to LOW. This action is taken to improve the carrier-to-noise ratio. The status of this feature can be read in the ACPS flag during a READ operation on the I²C-bus (see Table 9).

I²C-bus mode (SW = GND)

Five serial bytes (including address byte) are required to address the device, select the VCO frequency, program the four ports, set the charge pump current and set the reference divider ratio. The device has four independent I²C-bus addresses which can be selected by applying a specific voltage on input CE (see Table 6).

3-wire bus mode (SW = OPEN or VCC)

Data is transmitted to the devices during a HIGH-level on input CE (enable line). The device is compatible with 18-bit and 19-bit data formats, as shown in Figs 4 and 5. The first four bits are used to program the PNP ports and the remaining bits control the programmable divider. A 27-bit data format may also be used to set the charge pump current, the reference divider ratio and for test purposes (see Fig.6).

It is not allowed to address the devices with words whose length is different from 18, 19 or 27 bits.

Table 1 Data word length for 3-wire bus

| TYPE NUMBER | DATA WORD | REFERENCE DIVIDER ⁽¹⁾ | FREQUENCY STEP |
|--------------------------------------|-----------|----------------------------------|----------------|
| TDA6402; TDA6402A; TDA6403; TDA6403A | 18-bit | 512 | 62.50 kHz |
| TDA6402; TDA6402A; TDA6403; TDA6403A | 19-bit | 1024 | 31.25 kHz |
| TDA6402; TDA6402A; TDA6403; TDA6403A | 27-bit | programmable | programmable |

Note

- The selection of the reference divider is given by an automatic identification of the data word length. When the 27-bit format is used, the reference divider is controlled by RSA and RSB bits (see Table 8). More details are given in Chapter "PLL functional description", Section "3-wire bus mode (SW = OPEN or V_{CC})".

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QUICK REFERENCE DATA

Measured over full voltage and temperature ranges; unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---------------------|---|-------------------------|--------|------|--------|-------------------|
| V _{CC} | supply voltage | operating | 4.5 | 5 | 5.5 | V |
| I _{CC} | supply current | all PNP ports are 'OFF' | – | 71 | – | mA |
| f _{X TAL} | crystal oscillator input frequency | | 3.2 | 4.0 | 4.48 | MHz |
| I _{o(PNP)} | PNP port output current | note 1 | – | – | 30 | mA |
| P _{tot} | total power dissipation | note 2 | – | – | 490 | mW |
| T _{stg} | IC storage temperature | | –40 | – | +150 | °C |
| T _{amb} | ambient temperature | | –20 | – | +85 | °C |
| f _{RF} | RF frequency | VHF band | 55.25 | – | 361.25 | MHz |
| | | UHF band | 367.25 | – | 801.25 | MHz |
| G _V | voltage gain | VHF band | – | 19 | – | dB |
| | | UHF band | – | 29 | – | dB |
| NF | noise figure | VHF band | – | 8.5 | – | dB |
| | | UHF band | – | 9 | – | dB |
| V _o | output voltage causing 1% cross modulation in channel | VHF band | – | 108 | – | dB _μ V |
| | | UHF band | – | 108 | – | dB _μ V |

Notes

1. One buffer 'ON', I_o = 25 mA; two buffers 'ON', maximum sum of I_o = 30 mA.

2. The power dissipation is calculated as follows: $P_{tot} = V_{CC} \times (I_{CC} - I_o) + V_{CE(sat PNP)} \times I_o + \frac{\left(\frac{1}{2}V_{33}\right)^2}{22 \text{ k}\Omega}$

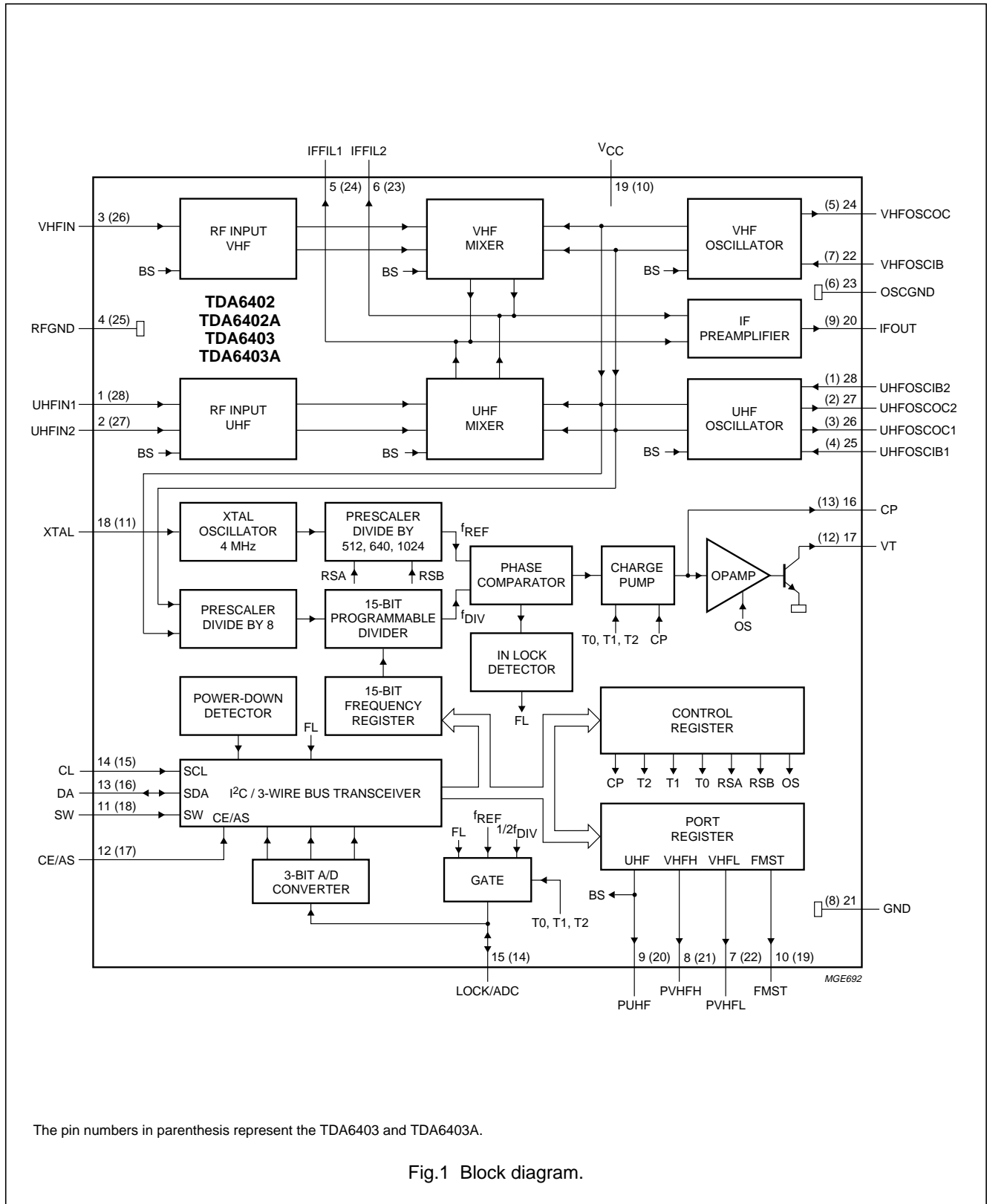
ORDERING INFORMATION

| TYPE NUMBER | PACKAGE | | |
|------------------------|---------|---|----------|
| | NAME | DESCRIPTION | VERSION |
| TDA6402M; TDA6402AM | SSOP28 | plastic shrink small outline package; 28 leads; body width 5.3 mm | SOT341-1 |
| TDA6403M; TDA6403AM | SSOP28 | plastic shrink small outline package; 28 leads; body width 5.3 mm | SOT341-1 |

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BLOCK DIAGRAM



The pin numbers in parenthesis represent the TDA6403 and TDA6403A.

Fig.1 Block diagram.

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PINNING

| SYMBOL | PIN | | DESCRIPTION |
|-----------------|----------------------|----------------------|--|
| | TDA6402; TDA6402A | TDA6403; TDA6403A | |
| UHFIN1 | 1 | 28 | UHF RF input 1 |
| UHFIN2 | 2 | 27 | UHF RF input 2 |
| VHFIN | 3 | 26 | VHF RF input |
| RFGND | 4 | 25 | RF ground |
| IFFIL1 | 5 | 24 | IF filter output 1 |
| IFFIL2 | 6 | 23 | IF filter output 2 |
| PVHFL | 7 | 22 | PNP port output, general purpose (e.g. VHF low sub-band) |
| PVHFH | 8 | 21 | PNP port output, general purpose (e.g. VHF high sub-band) |
| PUHF | 9 | 20 | PNP port output, UHF band |
| FMST | 10 | 19 | PNP port output, general purpose (e.g. FM sound trap) |
| SW | 11 | 18 | bus mode selection input (I ² C-bus/3-wire bus) |
| CE/AS | 12 | 17 | Chip Enable/Address Selection input |
| DA | 13 | 16 | serial data input/output |
| CL | 14 | 15 | serial clock input |
| LOCK/ADC | 15 | 14 | lock detector output (3-wire bus)/ADC input (I ² C-bus) |
| CP | 16 | 13 | charge pump output |
| VT | 17 | 12 | tuning voltage output |
| XTAL | 18 | 11 | crystal oscillator input |
| V _{CC} | 19 | 10 | supply voltage |
| IFOUT | 20 | 9 | IF output |
| GND | 21 | 8 | digital ground |
| VHFOSCIB | 22 | 7 | VHF oscillator input base |
| OSCGND | 23 | 6 | oscillator ground |
| VHFOSCOC | 24 | 5 | VHF oscillator output collector |
| UHFOSCIB1 | 25 | 4 | UHF oscillator input base 1 |
| UHFOSCOC1 | 26 | 3 | UHF oscillator output collector 1 |
| UHFOSCOC2 | 27 | 2 | UHF oscillator output collector 2 |
| UHFOSCIB2 | 28 | 1 | UHF oscillator input base 2 |

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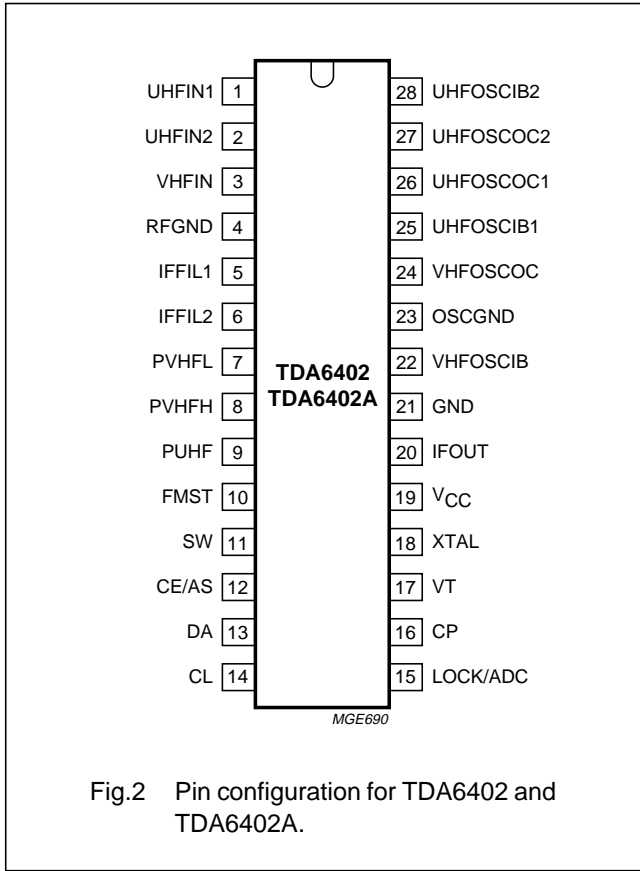


Fig.2 Pin configuration for TDA6402 and TDA6402A.

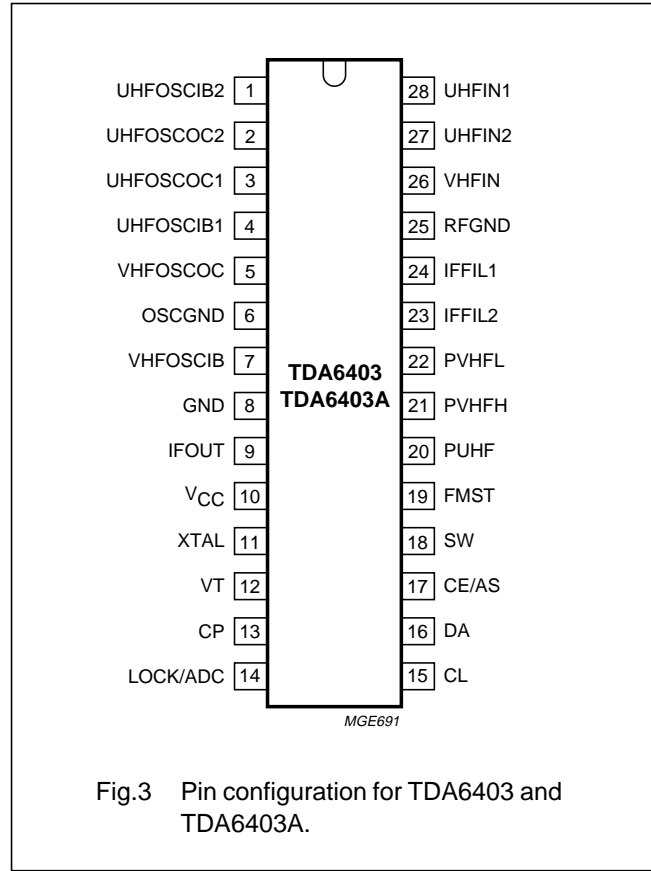


Fig.3 Pin configuration for TDA6403 and TDA6403A.

PLL FUNCTIONAL DESCRIPTION

The device is controlled via the I²C-bus or the 3-wire bus, depending on the voltage applied on the SW input. A HIGH-level on the SW input enables the 3-wire bus; CE/AS, DA and CL inputs are used as enable (CE), data

and clock inputs respectively. A LOW-level on SW input enables the I²C-bus; the CE/AS, DA and CL inputs are used as address selection (AS), SDA and SCL input respectively (see Table 2).

Table 2 Bus mode selection

| SYMBOL | PIN | | 3-WIRE BUS MODE | I ² C-BUS MODE |
|----------|----------------------|----------------------|--------------------|---------------------------|
| | TDA6402; TDA6402A | TDA6403; TDA6403A | | |
| SW | 11 | 18 | HIGH-level or OPEN | LOW-level or GND |
| CE/AS | 12 | 17 | enable input | address selection input |
| DA | 13 | 16 | data input | serial data input |
| CL | 14 | 15 | clock input | serial clock input |
| LOCK/ADC | 15 | 14 | LOCK/TEST output | ADC input/TEST output |

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I²C-bus mode (SW = GND)

WRITE MODE; R/W = 0 (see Tables 3 and 4)

Data bytes can be sent to the device after the address transmission (first byte). Four data bytes are needed to fully program the device. The bus transceiver has an auto-increment facility which permits the programming of the device within one single transmission (address + 4 data bytes).

The device can also be partially programmed providing that the first data byte following the address is divider byte 1 (DB1) or control byte (CB). The bits in the data bytes are defined in Tables 3 and 4. The first bit of the first data byte transmitted indicates whether frequency data (first bit = 0) or control and band-switch data (first bit = 1) will follow. Until an I²C-bus STOP command is sent by the

controller, additional data bytes can be entered without the need to re-address the device. The frequency register is loaded after the 8th clock pulse of the second divider byte (DB2), the control register is loaded after the 8th clock pulse of the control byte (CB) and the band-switch register is loaded after the 8th clock pulse of the band switch byte (BB).

I²C-BUS ADDRESS SELECTION

The module address contains programmable address bits (MA1 and MA0) which offer the possibility of having several synthesizers (up to 4) in one system by applying a specific voltage on the CE input. The relationship between MA1 and MA0 and the input voltage applied to the CE input is given in Table 6.

Table 3 I²C-bus data format, 'write' mode for the TDA6402 and TDA6403

| NAME | BYTE | BITS | | | | | | | | ACK |
|------------------|------|------|-----|-----|-----|------|------|-------|---------|-----|
| | | MSB | | | | LSB | | | | |
| Address byte | ADB | 1 | 1 | 0 | 0 | 0 | MA1 | MA0 | R/W = 0 | A |
| Divider byte 1 | DB1 | 0 | N14 | N13 | N12 | N11 | N10 | N9 | N8 | A |
| Divider byte 2 | DB2 | N7 | N6 | N5 | N4 | N3 | N2 | N1 | N0 | A |
| Control byte | CB | 1 | CP | T2 | T1 | T0 | RSA | RSB | OS | A |
| Band-switch byte | BB | X | X | X | X | FMST | PUHF | PVHFH | PVHFL | A |

Table 4 I²C-bus data format, 'write' mode for the TDA6402A and TDA6403A

| NAME | BYTE | BITS | | | | | | | | ACK |
|------------------|------|------|-----|-----|-----|------|------|-------|---------|-----|
| | | MSB | | | | LSB | | | | |
| Address byte | ADB | 1 | 1 | 0 | 0 | 0 | MA1 | MA0 | R/W = 0 | A |
| Divider byte 1 | DB1 | 0 | N14 | N13 | N12 | N11 | N10 | N9 | N8 | A |
| Divider byte 2 | DB2 | N7 | N6 | N5 | N4 | N3 | N2 | N1 | N0 | A |
| Control byte | CB | 1 | CP | T2 | T1 | T0 | RSA | RSB | OS | A |
| Band-switch byte | BB | X | X | X | X | PUHF | FMST | PVHFH | PVHFL | A |

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Table 5 Description of symbols used in Tables 3 and 4

| SYMBOL | DESCRIPTION |
|--------------------------|---|
| A | acknowledge |
| MA1, MA0 | programmable address bits (see Table 6) |
| N14 to N0 | programmable divider bits; $N = N14 \times 2^{14} + N13 \times 2^{13} + \dots + N1 \times 2^1 + N0$ |
| CP | charge pump current: CP = 0 = 60 μ A CP = 1 = 280 μ A (default) |
| T2, T1, T0 | test bits (see Table 7) |
| RSA, RSB | reference divider ratio select bits (see Table 8) |
| OS | tuning amplifier control bit: OS = 0; normal operation; tuning voltage is 'ON' (default) OS = 1; tuning voltage is 'OFF' (high-impedance) |
| PVHFL, PVHFH, PUHF, FMST | PNP ports control bits: bit = 0; buffer n is 'OFF' (default) bit = 1; buffer n is 'ON' |
| X | don't care |

Table 6 Address selection (I²C-bus mode)

| MA1 | MA0 | VOLTAGE APPLIED ON CE INPUT (SW = GND) |
|-----|-----|--|
| 0 | 0 | 0 V to $0.1 \times V_{CC}$ |
| 0 | 1 | open or $0.2 \times V_{CC}$ to $0.3 \times V_{CC}$ |
| 1 | 0 | $0.4 \times V_{CC}$ to $0.6 \times V_{CC}$ |
| 1 | 1 | $0.9 \times V_{CC}$ to $1.0 \times V_{CC}$ |

Table 7 Test modes

| T2 | T1 | T0 | TEST MODES |
|----|----|----|--|
| 0 | 0 | 0 | automatic charge pump switched off |
| 0 | 0 | 1 | automatic charge pump switched on (note 1) |
| 0 | 1 | X | charge pump is 'OFF' |
| 1 | 1 | 0 | charge pump is sinking current |
| 1 | 1 | 1 | charge pump is sourcing current |
| 1 | 0 | 0 | f_{REF} is available on pin LOCK/ADC (note 2) |
| 1 | 0 | 1 | $\frac{1}{2}f_{DIV}$ is available on pin LOCK/ADC (note 2) |

Notes

- This is the default mode at power-on reset.
- The ADC input cannot be used when these test modes are active; see Section "Read mode; R/W = 1 (see Table 9)" for more information.

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Table 8 Reference divider ratio select bits

| RSA | RSB | REFERENCE DIVIDER RATIO | FREQUENCY STEP (kHz) |
|------------------|-----|-------------------------|----------------------|
| X ⁽¹⁾ | 0 | 640 | 6.25 |
| 0 | 1 | 1024 | 3.90625 |
| 1 | 1 | 512 | 7.8125 |

Note

- X = don't care.

READ MODE; R/W = 1 (see Table 9)

Data can be read from the device by setting the R/W bit to logic 1. After the slave address has been recognized, the device generates an acknowledge pulse and the first data byte (status byte) is transferred on the SDA line (MSB first). Data is valid on the SDA line during a HIGH-level of the SCL clock signal. A second data byte can be read from the device if the microcontroller generates an acknowledge on the SDA line (master acknowledge). End of transmission will occur if no master acknowledge occurs. The device will then release the data line to allow the microcontroller to generate a STOP condition. The POR flag is set to logic 1 at power-on. The flag is reset when an end-of-data is detected by the device (end of a

READ sequence). Control of the loop is made possible with the in-lock flag FL which indicates when the loop is locked (FL = 1).

The automatic charge pump switch flag (ACPS) is LOW when the automatic charge pump switch mode is 'ON' and the loop is locked. In other conditions, ACPS = 1. When ACPS = 0, the charge pump current is forced to the LOW value.

A built-in ADC is available on LOCK/ADC pin (I²C-bus mode only). This converter can be used to apply AFC information to the microcontroller from the IF section of the television. The relationship between the bits A2, A1 and A0 is given in Table 11.

Table 9 Read data format

| NAME | BYTE | BITS | | | | | | | | ACK |
|--------------|------|--------------------|----|------|---|-----|-----|-----|---------|-----|
| | | MSB ⁽¹⁾ | | | | LSB | | | | |
| Address byte | ADB | 1 | 1 | 0 | 0 | 0 | MA1 | MA0 | R/W = 1 | A |
| Status byte | SB | POR | FL | ACPS | 1 | 1 | A2 | A1 | A0 | – |

Note

- MSB is transmitted first.

Table 10 Description of symbols used in Table 9

| SYMBOL | DESCRIPTION |
|------------|--|
| A | acknowledge |
| POR | power-on reset flag (POR = 1 at power-on) |
| FL | in-lock flag (FL = 1 when the loop is locked) |
| ACPS | automatic charge pump switch flag: ACPS = 0; active ACPS = 1; not active |
| A2, A1, A0 | digital outputs of the 5-level ADC |

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Table 11 A to D converter levels (note 1)

| A2 | A1 | A0 | VOLTAGE APPLIED ON ADC INPUT |
|----|----|----|--|
| 1 | 0 | 0 | $0.60 \times V_{CC}$ to $1.00 \times V_{CC}$ |
| 0 | 1 | 1 | $0.45 \times V_{CC}$ to $0.60 \times V_{CC}$ |
| 0 | 1 | 0 | $0.30 \times V_{CC}$ to $0.45 \times V_{CC}$ |
| 0 | 0 | 1 | $0.15 \times V_{CC}$ to $0.30 \times V_{CC}$ |
| 0 | 0 | 0 | 0 to $0.15 \times V_{CC}$ |

Note

1. Accuracy is $\pm 0.03 \times V_{CC}$.

POWER-ON RESET

Table 12 Default bits at power-on reset

| NAME | BYTE | BITS | | | | | | | |
|------------------|------|------|---|---|---|---|-----|-----|---|
| | | MSB | | | | | | LSB | |
| Address byte | ADB | 1 | 1 | 0 | 0 | 0 | MA1 | MA0 | X |
| Divider byte 1 | DB1 | 0 | X | X | X | X | X | X | X |
| Divider byte 2 | DB2 | X | X | X | X | X | X | X | X |
| Control byte | CB | 1 | 1 | 0 | 0 | 1 | X | 1 | 1 |
| Band switch byte | BB | X | X | X | X | 0 | 0 | 0 | 0 |

The power-on detection threshold voltage V_{POR} is set to $V_{CC} = 2$ V at room temperature. Below this threshold, the device is reset to the power-on state.

At power-on state, the charge pump current is set to 280 μ A, the tuning voltage output is disabled, the test bits T2, T1 and T0 are set to '001' (automatic charge pump switch 'ON') and RSB is set to logic 1.

PUHFL is 'OFF', which means that the UHF oscillator and the UHF mixer are switched off. Consequently, the VHF oscillator and the VHF mixer are switched on. PVHFL and PVHFH are 'OFF', which means that the VHF tank circuit is working in the VHF I sub-band. The tuning amplifier is switched off until the first transmission. In that case, the tank circuit in VHF I is supplied with the maximum tuning voltage. The oscillator is therefore working at the end of the VHF I sub-band.

3-wire bus mode (SW = OPEN or V_{CC})

During a HIGH-level on the CE input (enable line), the data is clocked into the data register at the HIGH-to-LOW transition of the clock. The first four bits control the PNP ports and are loaded into the internal band switch register on the 5th rising edge of the clock pulse. The frequency

bits are loaded into the frequency register at the HIGH-to-LOW transition of the chip enable line when an 18-bit or 19-bit data word is transmitted (see Figs 4 and 5).

When a 27-bit data word is transmitted, the frequency bits are loaded into the frequency register on the 20th rising edge of the clock pulse and the control bits at the HIGH-to-LOW transition of the chip enable line (see Fig.6). In this mode, the reference divider is given by the RSA and RSB bits (see Table 8). The test bits T2, T1 and T0, the charge pump bit CP, the ratio select bit RSB and the OS bit can only be selected or changed with a 27-bit transmission. They remain programmed if an 18-bit or 19-bit transmission occurs. Only RSA is controlled by the transmission length when the 18-bit or 19-bit format is used. When an 18-bit data word is transmitted, the most significant bit of the divider N14 is internally set to logic 0 and the RSA bit is set to logic 1. When a 19-bit data word is transmitted, the RSA bit is set to logic 0.

A data word of less than 18 bits will not affect the frequency register of the device. The definition of the bits is unchanged compared to I²C-bus mode.

It is not allowed to address the devices with words whose length is different from 18, 19 or 27 bits.

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POWER-ON RESET

The power-on detection threshold voltage V_{POR} is set to $V_{CC} = 2\text{ V}$ at room temperature. Below this threshold, the device is reset to the power-on state.

At power-on state, the charge pump current is set to $280\ \mu\text{A}$, the tuning voltage output is disabled, the test bits T2, T1 and T0 are set to '001' (automatic charge pump switch 'ON') and RSB is set to logic 1.

PUHF is 'OFF', which means that the UHF oscillator and the UHF mixer are switched off. Consequently, the VHF oscillator and the VHF mixer are switched on. PVHFL and

PVHFH are 'OFF', which means that the VHF tank circuit is working in the VHF I sub-band. The tuning amplifier is switched off until the first transmission. In that case, the tank circuit in VHF I is supplied with the maximum tuning voltage. The oscillator is therefore working at the end of the VHF I sub-band.

If the first sequence transmitted to the device has 18 or 19 bits, the reference divider ratio is set to 512 or 1024, depending on the sequence length.

If the sequence has 27 bits, the reference divider ratio is fixed by RSA and RSB bits (see Table 8).

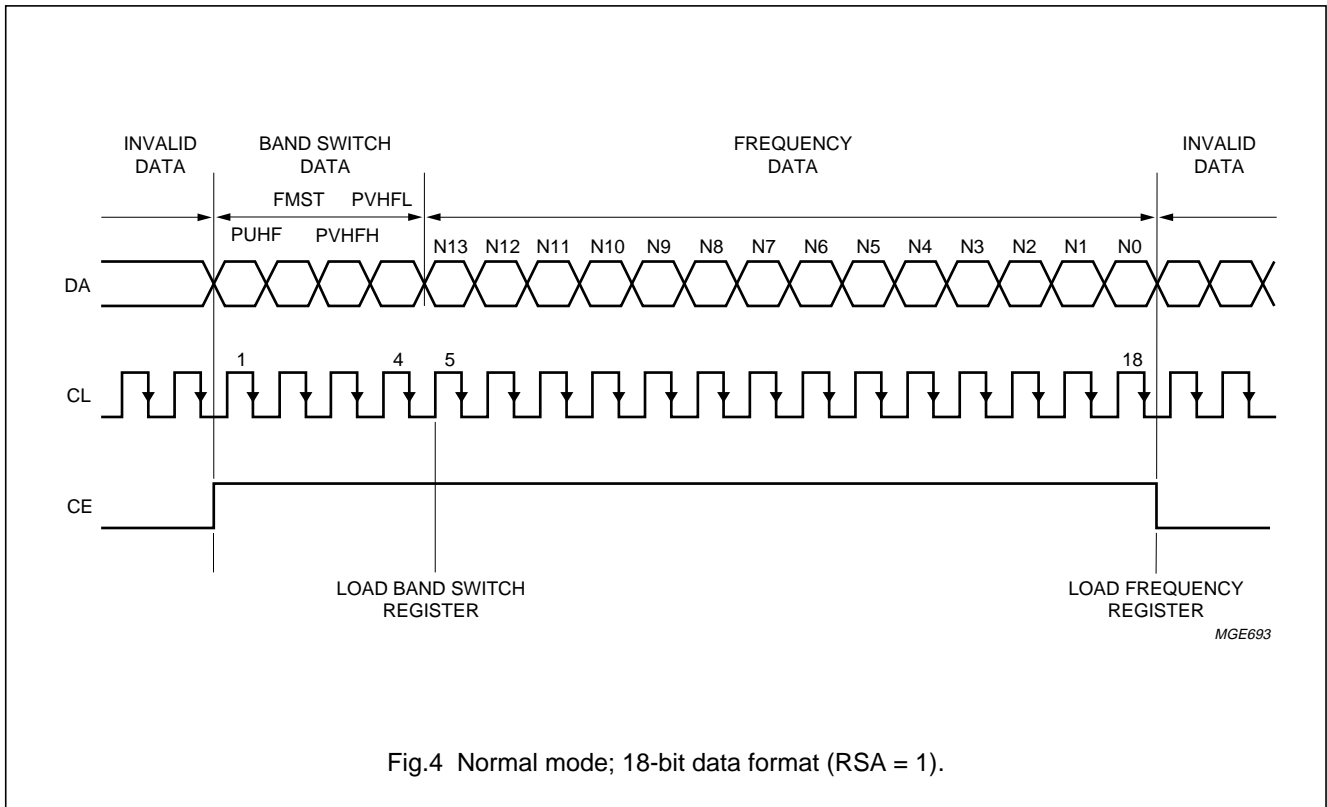


Fig.4 Normal mode; 18-bit data format (RSA = 1).

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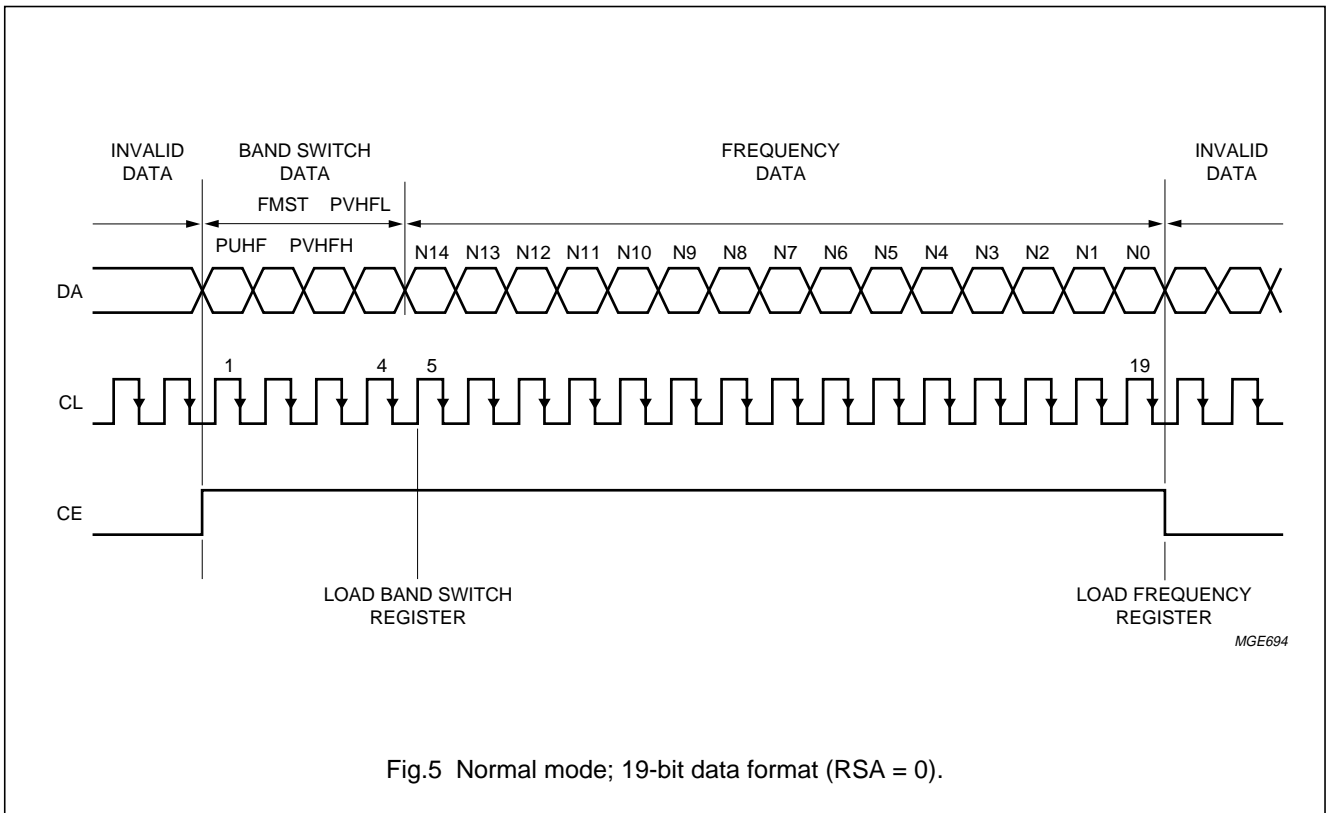


Fig.5 Normal mode; 19-bit data format (RSA = 0).

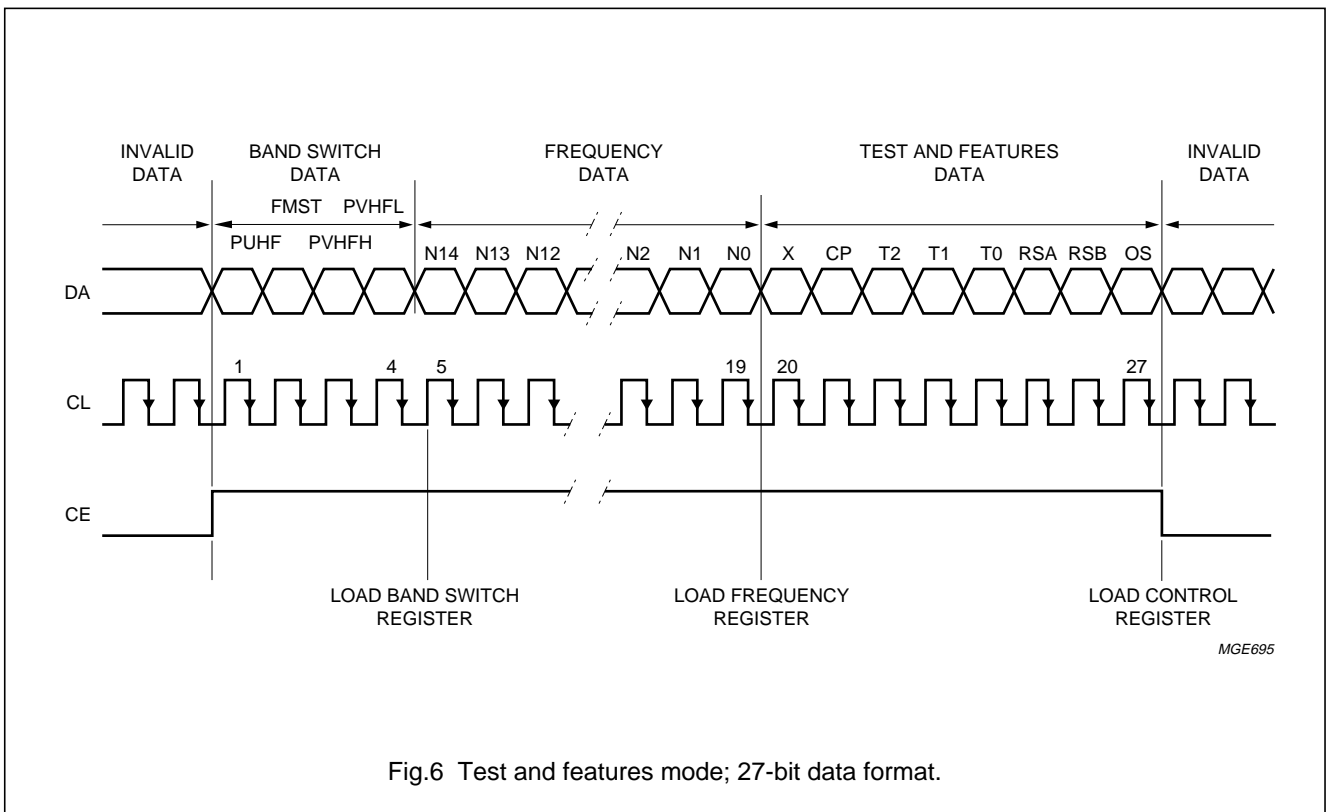


Fig.6 Test and features mode; 27-bit data format.

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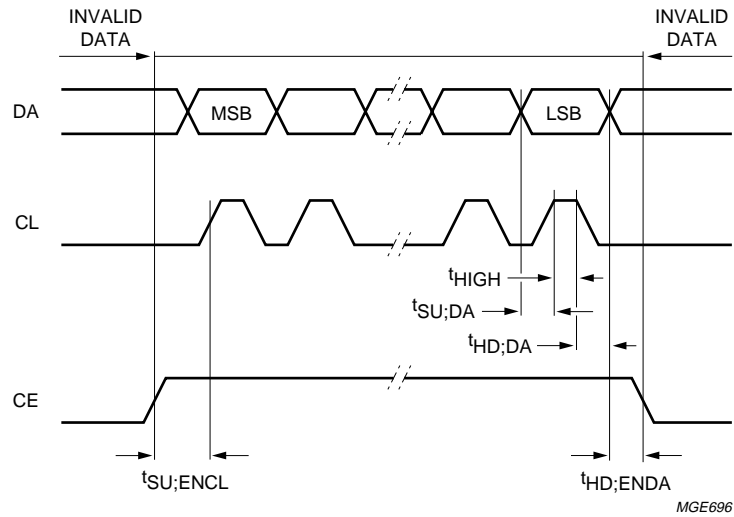


Fig.7 Timing diagram for 3-wire bus; DA, CL and CE.

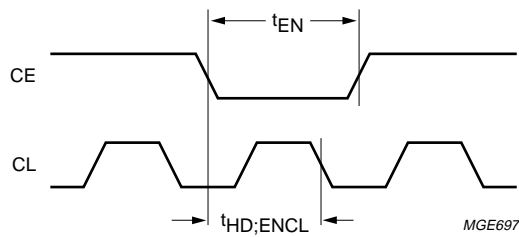


Fig.8 Timing diagram for 3-wire bus; CE and CL.

5 V mixers/oscillators and synthesizers for cable TV and VCR 2-band tuners

TDA6402; TDA6402A;
TDA6403; TDA6403A

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 60134) (note 1).

| SYMBOL | PIN | | PARAMETER | MIN. | MAX. | UNIT |
|-----------------------|----------------------|----------------------|--|------|------|------|
| | TDA6402; TDA6402A | TDA6403; TDA6403A | | | | |
| V _{CC} | 19 | 10 | DC supply voltage | -0.3 | +6 | V |
| | | | operating supply voltage | 4.5 | 5.5 | V |
| | | | OVS pulse is 1 second width and 1 A max. | - | 8 | V |
| V _{BSn} | 7 to 10 | 19 to 22 | PNP port output voltage | -0.3 | +6 | V |
| I _{BSn} | 7 to 10 | 19 to 22 | PNP port output current | -1 | +30 | mA |
| V _{CP} | 16 | 13 | charge pump output voltage | -0.3 | +6 | V |
| V _{SW} | 11 | 18 | bus mode selection input voltage | -0.3 | +6 | V |
| V _{VT} | 17 | 12 | tuning voltage output | -0.3 | +35 | V |
| V _{LOCK/ADC} | 15 | 14 | LOCK/ADC input/output voltage | -0.3 | +6 | V |
| V _{CL} | 14 | 15 | serial clock input voltage | -0.3 | +6 | V |
| V _{DA} | 13 | 16 | serial data input/output voltage | -0.3 | +6 | V |
| I _{DA} | 13 | 16 | data output current (I ² C-bus mode) | -1 | +10 | mA |
| V _{CE} | 12 | 17 | chip enable/address selection input voltage | -0.3 | +6 | V |
| V _{XTAL} | 18 | 11 | crystal input voltage | -0.3 | +6 | V |
| I _O | 1 to 6, 19 to 28 | 1 to 10, 23 to 28 | output current of each pin to ground | - | -10 | mA |
| t _{sc(max)} | - | - | maximum short-circuit time (all pins to V _{CC} and all pins to GND, OSCGND and RFGND) | - | 10 | s |
| T _{stg} | - | - | IC storage temperature | -40 | +150 | °C |
| T _{amb} | - | - | ambient temperature | -20 | +85 | °C |
| T _j | - | - | junction temperature | - | 150 | °C |

Note

- Maximum ratings can not be exceeded, not even momentarily without causing irreversible IC damage. Maximum ratings can not be accumulated.

THERMAL CHARACTERISTICS

| SYMBOL | PARAMETER | CONDITIONS | TYP. | UNIT |
|----------------------|---|-------------|------|------|
| R _{th(j-a)} | thermal resistance from junction to ambient | in free air | 90 | K/W |

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CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|--|---|--|------|------|----------|---------------|
| Supply | | | | | | |
| V_{CC} | supply voltage | | 4.5 | 5.0 | 5.5 | V |
| I_{CC} | supply current at $V_{CC} = 5\text{ V}$ | all PNP ports are 'OFF' | – | 71 | 78 | mA |
| | | one PNP port is 'ON'; sourcing 25 mA | – | 103 | 113 | mA |
| | | one PNP port is 'ON'; sourcing 25 mA and a second one is 'ON'; sourcing 5 mA | – | 111 | 122 | mA |
| PLL part ($V_{CC} = 4.5\text{ to }5.5\text{ V}$; $T_{amb} = -20\text{ to }+85\text{ }^{\circ}\text{C}$; unless otherwise specified) | | | | | | |
| FUNCTIONAL RANGE | | | | | | |
| V_{POR} | power-on reset supply voltage | below this supply voltage power-on reset becomes active | 1.5 | 2.0 | – | V |
| N | divider ratio | 15-bit frequency word | 256 | – | 32767 | |
| | | 14-bit frequency word | 256 | – | 16383 | |
| f_{XTAL} | crystal oscillator | $R_{XTAL} = 25\text{ to }300\text{ }\Omega$ | 3.2 | 4.0 | 4.48 | MHz |
| $ Z_{XTAL} $ | input impedance (absolute value) | $f_{XTAL} = 4\text{ MHz}$ | 600 | 1200 | – | Ω |
| PNP PORTS | | | | | | |
| $I_{BSn(off)}$ | leakage current | $V_{CC} = 5.5\text{ V}$; $V_{Pn} = 0\text{ V}$ | –10 | – | – | μA |
| $V_{BSn(sat)}$ | output saturation voltage | one buffer output is 'ON', sourcing 25 mA; $V_{Pn(sat)} = V_{CC} - V_{Pn}$ | – | 0.25 | 0.4 | V |
| LOCK OUTPUT IN 3-WIRE BUS MODE (PNP COLLECTOR OUT) | | | | | | |
| I_{UNLOCK} | output current when the PLL is out-of-lock | $V_{CC} = 5.5\text{ V}$; $V_{OUT} = 5.5\text{ V}$ | – | – | 100 | μA |
| V_{UNLOCK} | output saturation voltage when the PLL is out-of-lock | $I_{SOURCE} = 200\text{ }\mu\text{A}$; $V_{UNLOCK} = V_{CC} - V_{OUT}$ | – | 0.4 | 0.8 | V |
| V_{LOCK} | output voltage | the PLL is locked | – | 0.01 | 0.40 | V |
| ADC INPUT IN I ² C-BUS MODE | | | | | | |
| V_{ADC} | ADC input voltage | see Table 11 | 0 | – | V_{CC} | V |
| I_{ADCH} | HIGH-level input current | $V_{ADC} = V_{CC}$ | – | – | 10 | μA |
| I_{ADCL} | LOW-level input current | $V_{ADC} = 0\text{ V}$ | –10 | – | – | μA |
| SW INPUT (BUS MODE SELECTION) | | | | | | |
| V_{SWL} | LOW-level input voltage | | 0 | – | 1.5 | V |
| V_{SWH} | HIGH-level input voltage | | 3 | – | V_{CC} | V |
| I_{SWH} | HIGH-level input current | $V_{SW} = V_{CC}$ | – | – | 10 | μA |
| I_{SWL} | LOW-level input current | $V_{SW} = 0\text{ V}$ | –100 | – | – | μA |

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| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|--|------|------|------|------|
| CE/AS INPUT (CHIP ENABLE/ADDRESS SELECTION) | | | | | | |
| V _{CE/ASL} | LOW-level input voltage | | 0 | – | 1.5 | V |
| V _{CE/ASH} | HIGH-level input voltage | | 3 | – | 5.5 | V |
| I _{CE/ASH} | HIGH-level input current | V _{CE/AS} = 5.5 V | – | – | 10 | μA |
| I _{CE/ASL} | LOW-level input current | V _{CE/AS} = 0 V | –10 | – | – | μA |
| CL AND DA INPUTS | | | | | | |
| V _{CL/DAL} | LOW-level input voltage | | 0 | – | 1.5 | V |
| V _{CL/DAH} | HIGH-level input voltage | | 3 | – | 5.5 | V |
| I _{CL/DAH} | HIGH-level input current | V _{BUS} = 5.5 V; V _{CC} = 0 V | – | – | 10 | μA |
| | | V _{BUS} = 5.5 V; V _{CC} = 5.5 V | – | – | 10 | μA |
| I _{CL/DAL} | LOW-level input current | V _{BUS} = 1.5 V; V _{CC} = 0 V | – | – | 10 | μA |
| | | V _{BUS} = 0 V; V _{CC} = 5.5 V | –10 | – | – | μA |
| DA OUTPUT (I ² C-BUS MODE) | | | | | | |
| I _{DAH} | leakage current | V _{DA} = 5.5 V | – | – | 10 | μA |
| V _{DA} | output voltage | I _{DA} = 3 mA (sink current) | – | – | 0.4 | V |
| CLOCK FREQUENCY | | | | | | |
| f _{clk} | clock frequency | | – | 100 | 150 | kHz |
| CHARGE PUMP OUTPUT CP | | | | | | |
| I _{CPH} | HIGH-level input current (absolute value) | CP = 1 | – | 280 | – | μA |
| I _{CPL} | LOW-level input current (absolute value) | CP = 0 | – | 60 | – | μA |
| V _{CP} | output voltage | PLL is locked; T _{amb} = 25 °C | – | 1.95 | – | V |
| I _{CPleak} | off-state leakage current | T ₂ = 0; T ₁ = 1 | –15 | –0.5 | +15 | nA |
| TUNING VOLTAGE OUTPUT VT | | | | | | |
| I _{VTOFF} | leakage current when switched off | OS = 1; tuning supply = 33 V | – | – | 10 | μA |
| V _{VT} | output voltage when the loop is closed | OS = 0; T ₂ = 0; T ₁ = 0; T ₀ = 1; R _{LOAD} = 22 kΩ; tuning supply = 33 V | 0.2 | – | 32.7 | V |
| 3-WIRE BUS TIMING | | | | | | |
| t _{HIGH} | clock HIGH time | see Fig.7 | 2 | – | – | μs |
| t _{SU;DA} | data set-up time | see Fig.7 | 2 | – | – | μs |
| t _{HD;DA} | data hold time | see Fig.7 | 2 | – | – | μs |
| t _{SU;ENCL} | enable to clock set-up time | see Fig.7 | 10 | – | – | μs |
| t _{HD;ENDA} | enable to data hold time | see Fig.7 | 2 | – | – | μs |
| t _{EN} | enable time between two transmissions | see Fig.8 | 10 | – | – | μs |
| t _{HD;ENCL} | enable to clock active edge hold time | see Fig.8 | 6 | – | – | μs |

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TDA6403; TDA6403A

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|--|---|--------|------|--------|------------|
| Mixer/oscillator part ($V_{CC} = 5\text{ V}$) (measured in circuit of Fig.19; unless otherwise specified) | | | | | | |
| VHF MIXER (INCLUDING IF AMPLIFIER) | | | | | | |
| f_{RF} | RF frequency | note 1 | 55.25 | – | 361.25 | MHz |
| G_v | voltage gain | $f_{RF} = 57.5\text{ MHz}$; see Fig.12 | 16.5 | 19 | 21.5 | dB |
| | | $f_{RF} = 357.5\text{ MHz}$; see Fig.12 | 16.5 | 19 | 21.5 | dB |
| NF | noise figure | $f_{RF} = 50\text{ MHz}$; see Figs 13 and 14 | – | 8.5 | 9.5 | dB |
| | | $f_{RF} = 150\text{ MHz}$; see Figs 13 and 14 | – | 8.5 | 10.5 | dB |
| | | $f_{RF} = 300\text{ MHz}$; see Fig.14 | – | 9.5 | 12.5 | dB |
| V_o | output voltage causing 1% cross modulation in channel | $f_{RF} = 55.25\text{ MHz}$; see Fig.15 | 105 | 108 | – | dB μ V |
| | | $f_{RF} = 361.25\text{ MHz}$; see Fig.15 | 105 | 108 | – | dB μ V |
| V_i | input voltage causing pulling in channel (750 Hz) | $f_{RF} = 361.25\text{ MHz}$; note 2 | – | 83 | – | dB μ V |
| g_{os} | optimum source conductance for noise figure | $f_{RF} = 50\text{ MHz}$ | – | 0.7 | – | mS |
| | | $f_{RF} = 150\text{ MHz}$ | – | 0.9 | – | mS |
| | | $f_{RF} = 300\text{ MHz}$ | – | 1.5 | – | mS |
| g_i | input conductance | $f_{RF} = 55.25\text{ MHz}$; see Fig.9 | – | 0.25 | – | mS |
| | | $f_{RF} = 361.25\text{ MHz}$; see Fig.9 | – | 0.5 | – | mS |
| C_i | input capacitance | $f_{RF} = 57.5\text{ to }357.5\text{ MHz}$; see Fig.9 | – | 1.3 | – | pF |
| VHF OSCILLATOR; see Fig.19 | | | | | | |
| f_{OSC} | oscillator frequency | note 3 | 101 | – | 407 | MHz |
| $\Delta f_{OSC(V)}$ | oscillator frequency shift | $\Delta V_{CC} = 5\%$; note 4 | – | 20 | 120 | kHz |
| | | $\Delta V_{CC} = 10\%$; note 4 | – | 110 | – | kHz |
| $\Delta f_{OSC(T)}$ | oscillator frequency drift | $\Delta T = 25\text{ }^\circ\text{C}$; with compensation; note 5 | – | 1600 | 2700 | kHz |
| $\Delta f_{OSC(t)}$ | oscillator frequency drift | 5 s to 15 min after switch on; note 6 | – | 600 | 1100 | kHz |
| Φ_{OSC} | phase noise, carrier to noise sideband | $\pm 100\text{ kHz}$ frequency offset; worst case in the frequency range | – | 100 | – | dBc/Hz |
| RSC | ripple susceptibility of V_{CC} (peak-to-peak value) | $V_{CC} = 5\text{ V}$; worst case in the frequency range; ripple frequency 500 kHz; note 7 | 15 | 20 | – | mV |
| UHF MIXER (INCLUDING IF AMPLIFIER) | | | | | | |
| f_{RF} | RF frequency | note 1 | 367.25 | – | 801.25 | MHz |
| G_v | voltage gain | $f_{RF} = 369.5\text{ MHz}$; see Fig.16 | 26 | 29 | 32 | dB |
| | | $f_{RF} = 803.5\text{ MHz}$; see Fig.16 | 26 | 29 | 32 | dB |
| NF | noise figure (not corrected for image) | $f_{RF} = 369.5\text{ MHz}$; see Fig.17 | – | 9 | 11 | dB |
| | | $f_{RF} = 803.5\text{ MHz}$; see Fig.17 | – | 10 | 12 | dB |
| V_o | output voltage causing 1% cross modulation in channel | $f_{RF} = 367.25\text{ MHz}$; see Fig.18 | 105 | 108 | – | dB μ V |
| | | $f_{RF} = 801.25\text{ MHz}$; see Fig.18 | 105 | 108 | – | dB μ V |
| V_i | input voltage causing pulling in channel (750 Hz) | $f_{RF} = 801.25\text{ MHz}$; note 2 | – | 82 | – | dB μ V |

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| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|----------------------------|--|---|------|-------|------|------------|
| Z_i | input impedance ($R_S + j\omega L_S$) | R_S at $f_{RF} = 367.25$ MHz; see Fig.10 | – | 30 | – | Ω |
| | | R_S at $f_{RF} = 801.25$ MHz; see Fig.10 | – | 38 | – | Ω |
| | | L_S at $f_{RF} = 367.25$ MHz; see Fig.10 | – | 9 | – | nH |
| | | L_S at $f_{RF} = 801.25$ MHz; see Fig.10 | – | 6 | – | nH |
| UHF OSCILLATOR | | | | | | |
| f_{OSC} | oscillator frequency | note 3 | 413 | – | 847 | MHz |
| $\Delta f_{OSC(V)}$ | oscillator frequency shift | $\Delta V_{CC} = 5\%$; note 4 | – | 10 | 80 | kHz |
| | | $\Delta V_{CC} = 10\%$; note 4 | – | 300 | – | kHz |
| $\Delta f_{OSC(T)}$ | oscillator frequency drift | $\Delta T = 25$ °C; with compensation; note 5 | – | 2000 | 2700 | kHz |
| $\Delta f_{OSC(t)}$ | oscillator frequency drift | 5 s to 15 min after switching on; note 6 | – | 300 | 1300 | kHz |
| Φ_{OSC} | phase noise, carrier to noise sideband | ± 100 kHz frequency offset; worst case in the frequency range | – | 100 | – | dBc/Hz |
| RSC | ripple susceptibility of V_{CC} (peak-to-peak value) | $V_{CC} = 5$ V (worst case in the frequency range); ripple frequency 500 kHz; note 7 | 15 | 28 | – | mV |
| IF AMPLIFIER | | | | | | |
| S_{22} | output reflection coefficient | magnitude; see Fig.11 | – | –13.1 | – | dB |
| | | phase; see Fig.11 | – | 2.9 | – | deg |
| Z_o | output impedance ($R_S + j\omega L_S$) | R_S at 43.5 MHz; see Fig.11 | – | 75 | – | Ω |
| | | L_S at 43.5 MHz; see Fig.11 | – | 6.6 | – | nH |
| REJECTION AT THE IF OUTPUT | | | | | | |
| INT_{DIF} | level of divider interferences in the IF signal | note 8; worst case: channel C | – | 17 | – | dB μ V |
| $INTR_{XTAL}$ | crystal oscillator interferences rejection | $V_{IF} = 100$ dB μ V; worst case in the frequency range; note 9 | 60 | – | – | dBc |
| $INTR_{FREF}$ | reference frequency rejection | $V_{IF} = 100$ dB μ V; worst case in the frequency range; $f_{REF} = 7.8125$ kHz; note 10 | 50 | – | – | dBc |
| INT_{CH6} | channel 6 beat | $V_{RFpix} = V_{RFsnd} = 80$ dB μ V; note 11 | 57 | – | – | dBc |
| INT_{CHA-5} | channel A-5 beat | $V_{RFpix} = 80$ dB μ V; note 12 | 60 | – | – | dBc |

Notes

- The RF frequency range is defined by the oscillator frequency range and the intermediate frequency (IF).
- This is the level of the RF signal (100% amplitude modulated with 11.89 kHz) that causes a 750 Hz frequency deviation on the oscillator signal; it produces sidebands 30 dB below the level of the oscillator signal.
- Limits are related to the tank circuits used in Fig.19; frequency bands may be adjusted by the choice of external components.
- The frequency shift is defined as a change in oscillator frequency when the supply voltage varies from $V_{CC} = 5$ to 4.75 V (4.5 V) or from $V_{CC} = 5$ to 5.25 V (5.5 V). The oscillator is free running during this measurement.

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5. The frequency drift is defined as a change in oscillator frequency when the ambient temperature varies from $T_{amb} = 25$ to $50\text{ }^{\circ}\text{C}$ or from $T_{amb} = 25$ to $0\text{ }^{\circ}\text{C}$. The oscillator is free running during this measurement. The VHF drift value can be improved by adding a $10\text{ k}\Omega$ resistor between the VHFOSCOC pin and the V_{CC} . In that case the typical VHF drift value can be reduced to 900 kHz .
6. Switch-on drift is defined as the change in oscillator frequency between 5 s and 15 min after switch on. The oscillator is free running during this measurement.
7. The ripple susceptibility is measured for a 500 kHz ripple at the IF output using the measurement circuit of Fig.19; the level of the ripple signal is increased until a difference of 53.5 dB occurs between the IF carrier fixed at $100\text{ dB}\mu\text{V}$ and the sideband components.
8. This is the level of divider interferences close to the IF frequency. For example channel C: $f_{OSC} = 179\text{ MHz}$, $\frac{1}{4} f_{OSC} = 44.75\text{ MHz}$. Divider interference is measured with the Philips 37185 demonstration board in accordance with Fig.19. All ground pins are connected to a single ground plane under the IC. The VHFIN input must be left open (i.e. not connected to any load or cable); The UHFIN1 and UHFIN2 inputs are connected to a hybrid. The measured levels of divider interference are influenced by layout, grounding and port decoupling. The measurement results could vary by as much as 10 dB with respect to the specification.
9. Crystal oscillator interference means the 4 MHz sidebands caused by the crystal oscillator. The rejection has to be greater than 60 dB for an IF output signal of $100\text{ dB}\mu\text{V}$.
10. The reference frequency rejection is the level of reference frequency sidebands related to the sound sub-carrier. The rejection has to be greater than 50 dB for an IF output signal of $100\text{ dB}\mu\text{V}$.
11. Channel 6 beat is the interfering product of $f_{RFpix} + f_{RFsnd} - f_{OSC}$ of channel 6 at 42 MHz .
12. Channel A-5 beat is the interfering product of f_{RFpix} , f_{IF} and f_{OSC} of channel A-4; $f_{BEAT} = 45.5\text{ MHz}$. The possible mechanisms are: $f_{OSC} - 2 \times f_{IF}$ or $2 \times f_{RFpix} - f_{OSC}$. For the measurement $V_{RF} = 80\text{ dB}\mu\text{V}$.

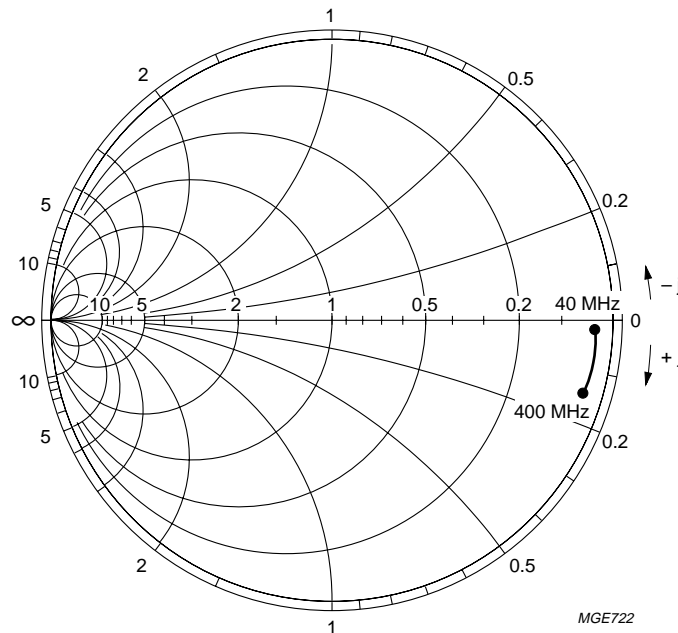


Fig.9 Input admittance (S_{11}) of the VHF mixer input (40 to 400 MHz); $Y_0 = 20\text{ mS}$.

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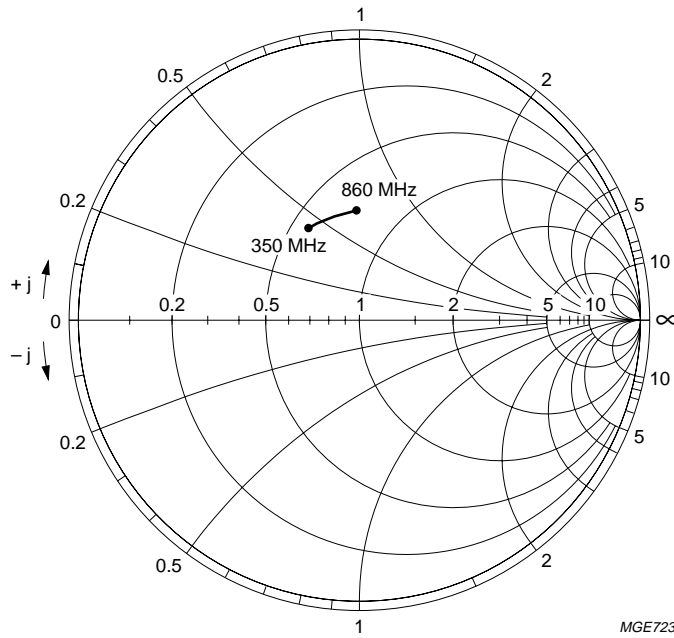


Fig.10 Input impedance (S_{11}) of the UHF mixer input (350 to 860 MHz); $Z_0 = 50 \Omega$.

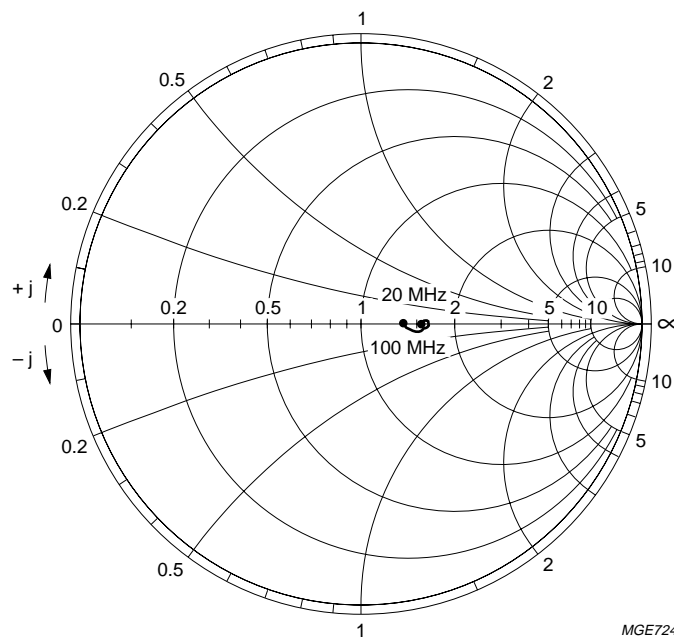
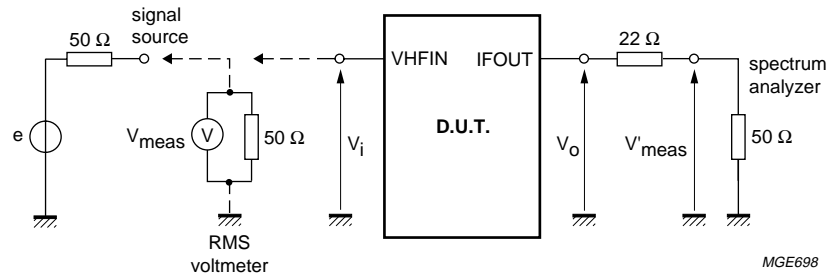


Fig.11 Output impedance (S_{22}) of the IF amplifier (20 to 60 MHz); $Z_0 = 50 \Omega$.

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TEST AND APPLICATION INFORMATION



MGE698

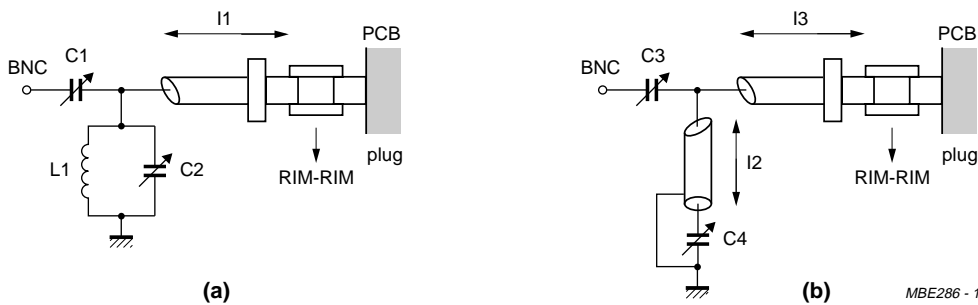
$$Z_i \gg 50 \Omega \Rightarrow V_i = 2 \times V_{meas} = 80 \text{ dB}\mu\text{V}$$

$$V_i = V_{meas} + 6 \text{ dB} = 80 \text{ dB}\mu\text{V}$$

$$V_o = V'_{meas} \times \frac{50 + 22}{50}$$

$$G_v = 20 \log \frac{V_o}{V_i}$$

Fig.12 Gain measurement in VHF band.



MBE286 - 1

(a) For $f_{RF} = 50 \text{ MHz}$:

mixer A frequency response measured = 57 MHz, loss = 0 dB

image suppression = 16 dB

C1 = 9 pF

C2 = 15 pF

L1 = 7 turns (\varnothing 5.5 mm, wire \varnothing = 0.5 mm)

l1 = semi rigid cable (RIM): 5 cm long

(semi rigid cable (RIM); 33 dB/100 m; 50 Ω ; 96 pF/m).

(b) For $f_{RF} = 150 \text{ MHz}$:

mixer A frequency response measured = 150.3 MHz, loss = 1.3 dB

image suppression = 13 dB

C3 = 5 pF

C4 = 25 pF

l2 = semi rigid cable (RIM): 30 cm long

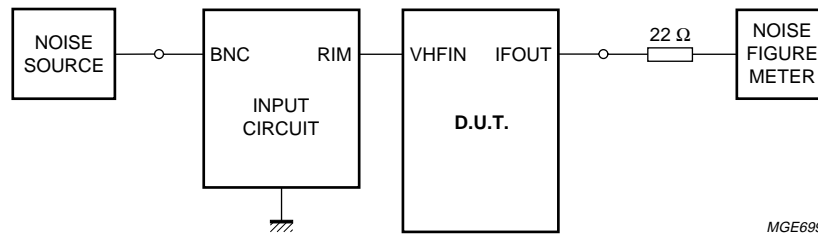
l3 = semi rigid cable (RIM): 5 cm long

(semi rigid cable (RIM); 33 dB/100 m; 50 Ω ; 96 pF/m).

Fig.13 Input circuit for optimum noise figure in VHF band.

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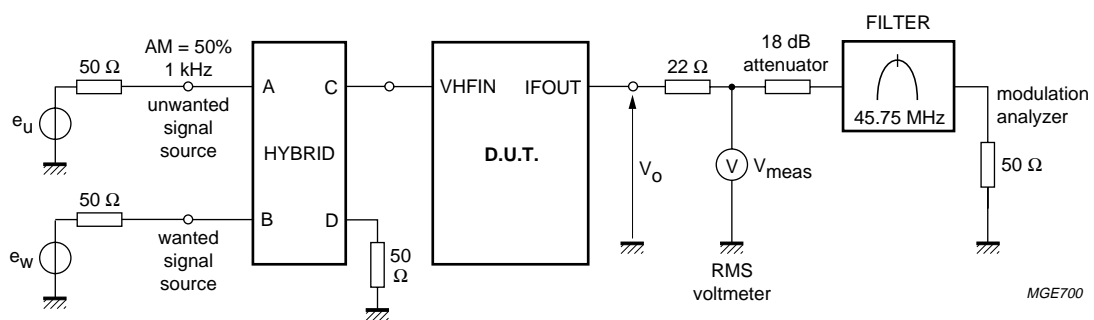
TDA6402; TDA6402A;
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MGE699

$NF = NF_{meas} - \text{loss (of input circuit) (dB)}$.

Fig.14 Noise figure (NF) measurement in VHF band.



MGE700

$$V_o = V_{meas} \times \frac{50 + 22}{50}$$

Wanted output signal at $f_{RFW} = 55.25$ (361.25) MHz; $V_{o(w)} = 100$ dB μ V.

Measuring the level of the unwanted output signal $V_{o(u)}$ causing 0.5% AM modulation in the wanted output signal; $f_{RFU} = 59.75$ (366.75) MHz.

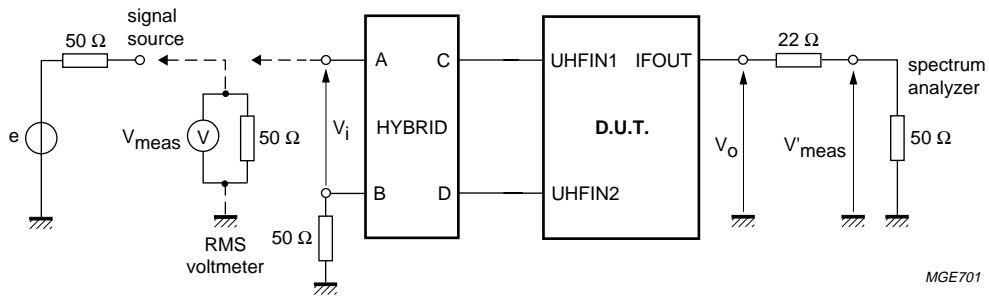
$f_{OSC} = 101$ (407) MHz.

Filter characteristics: $f_C = 45.75$ MHz, $f_{-3\text{dB(BW)}} = 1.4$ MHz, $f_{-30\text{dB(BW)}} = 3.1$ MHz.

Fig.15 Cross modulation measurement in VHF band.

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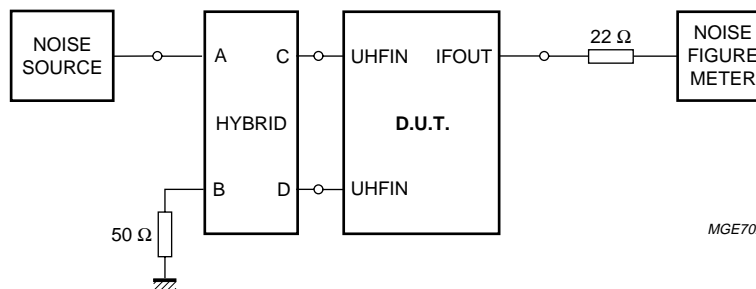
Loss (in hybrid) = 1 dB.

$V_i = V_{meas} - \text{loss (in hybrid)} = 70 \text{ dB}\mu\text{V}$.

$$V_o = V'_{meas} \times \frac{50 + 22}{50}$$

$$G_v = 20 \log \frac{V_o}{V_i}$$

Fig.16 Gain (G_v) measurement in UHF band.



MGE702

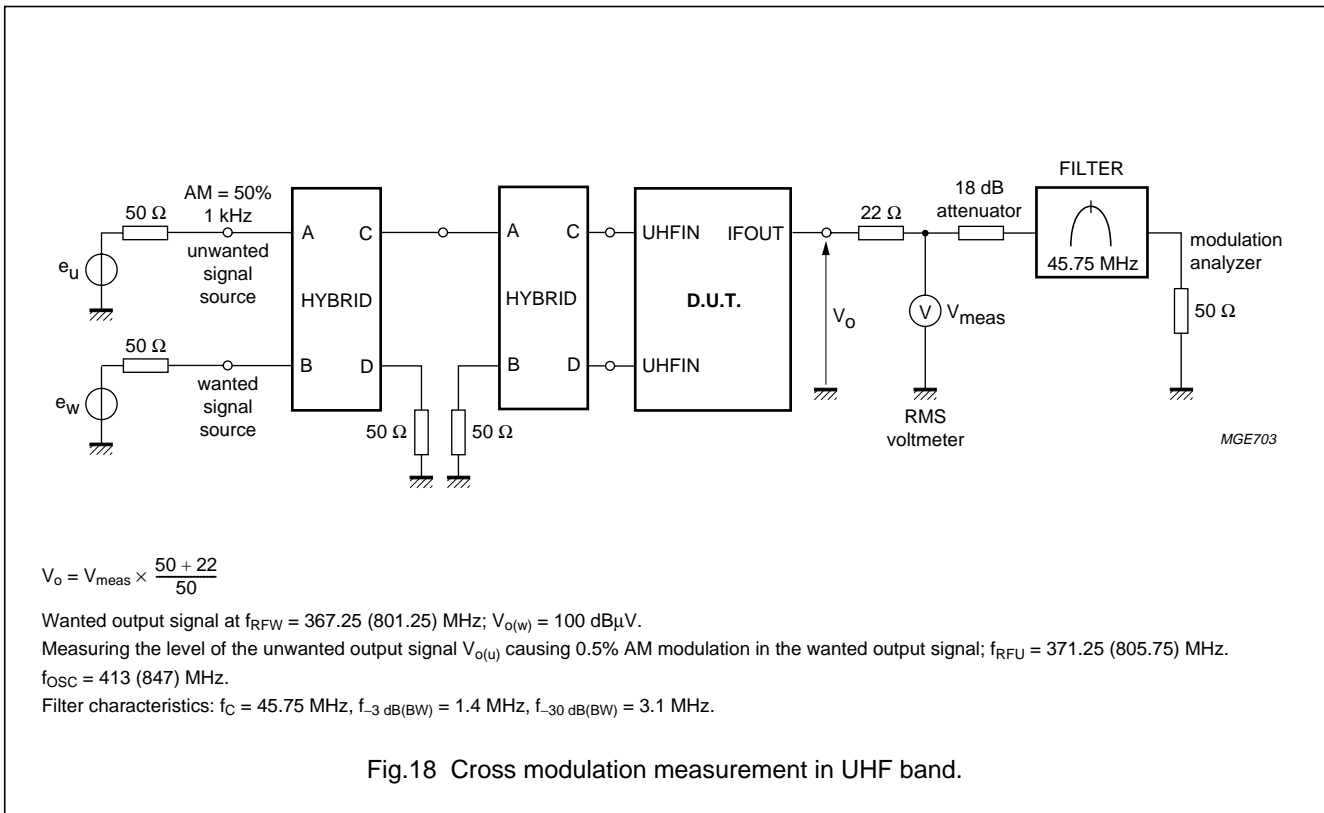
Loss (in hybrid) = 1 dB.

$NF = NF_{meas} - \text{loss (in hybrid)}$.

Fig.17 Noise figure (NF) measurement in bands UHF.

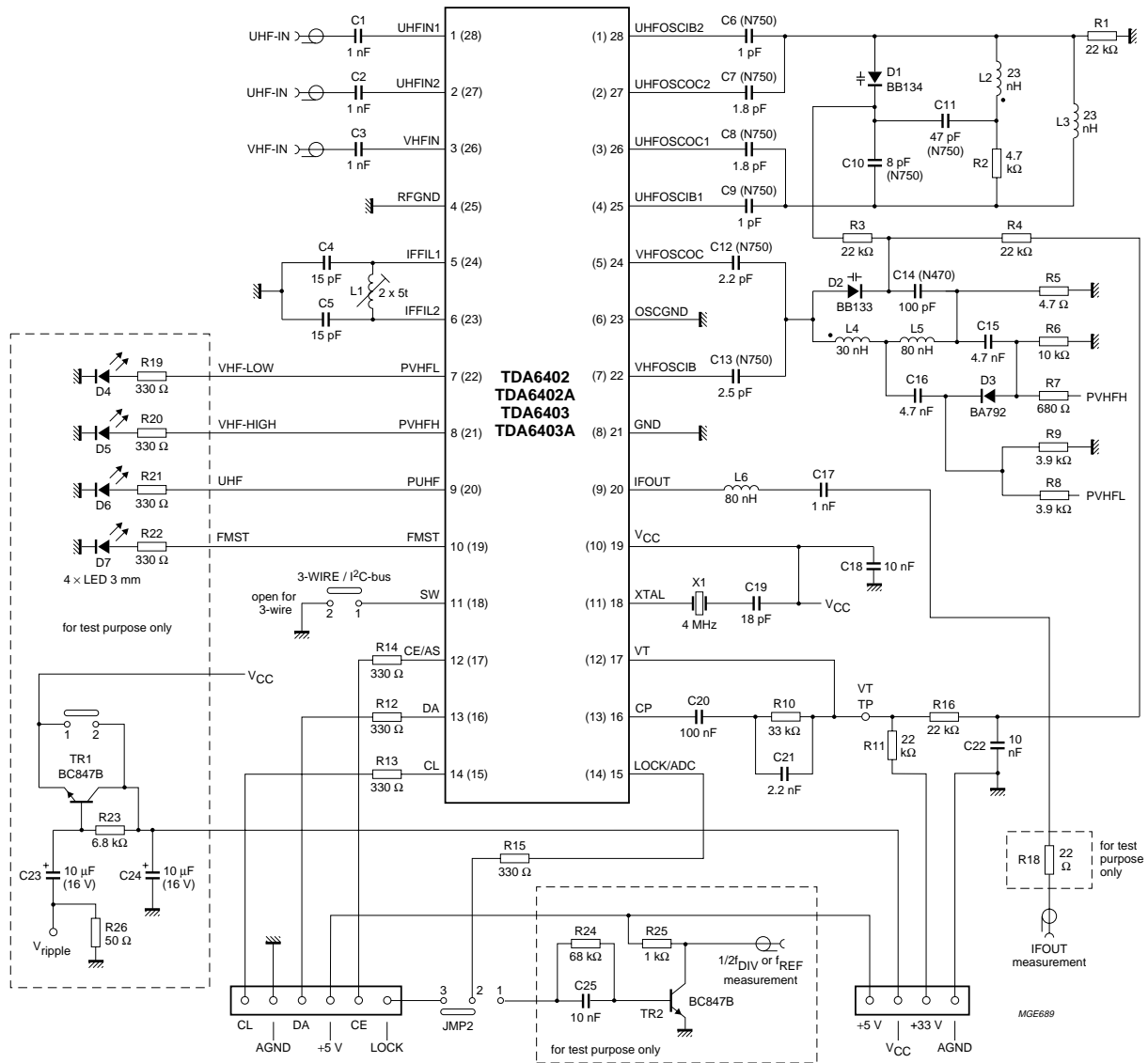
5 V mixers/oscillators and synthesizers for cable TV and VCR 2-band tuners

TDA6402; TDA6402A;
TDA6403; TDA6403A



5 V mixers/oscillators and synthesizers for cable TV and VCR 2-band tuners

TDA6402; TDA6402A; TDA6403; TDA6403A



The pin numbers in parenthesis represent the TDA6403 and TDA6403A.

Fig.19 Measurement circuit.

5 V mixers/oscillators and synthesizers for cable TV and VCR 2-band tuners

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TDA6403; TDA6403A

Component values for measurement circuit

Table 13 Capacitors (all SMD and NP0)

| COMPONENT | VALUE |
|-----------|---------------------------------|
| C1 | 1 nF |
| C2 | 1 nF |
| C3 | 1 nF |
| C4 | 15 pF |
| C5 | 15 pF |
| C6 | 1 pF (N750) |
| C7 | 1.8 pF (N750) |
| C8 | 1.8 pF (N750) |
| C9 | 1 pF (N750) |
| C10 | 8 pF (N750) |
| C11 | 47 pF (N750) |
| C12 | 2.2 pF (N750) |
| C13 | 2.7 pF (N750) |
| C14 | 100 pF (N470) |
| C15 | 4.7 nF |
| C16 | 4.7 nF |
| C17 | 1 nF |
| C18 | 10 nF |
| C19 | 18 pF |
| C20 | 100 nF |
| C21 | 2.2 nF |
| C22 | 10 nF |
| C23 | 10 μ F (16 V; electrolytic) |
| C24 | 10 μ F (16 V; electrolytic) |
| C25 | 10 nF |

Table 14 Resistors (all SMD)

| COMPONENT | VALUE |
|-----------|----------------|
| R1 | 22 k Ω |
| R2 | 4.7 k Ω |
| R3 | 22 k Ω |
| R4 | 22 k Ω |
| R5 | 4.7 Ω |
| R6 | 10 k Ω |
| R7 | 680 Ω |
| R8 | 3.9 k Ω |
| R9 | 3.9 k Ω |
| R10 | 33 k Ω |

| COMPONENT | VALUE |
|-----------|----------------|
| R11 | 22 k Ω |
| R12 | 330 Ω |
| R13 | 330 Ω |
| R14 | 330 Ω |
| R15 | 330 Ω |
| R16 | 22 k Ω |
| R18 | 22 Ω |
| R19 | 330 Ω |
| R20 | 330 Ω |
| R21 | 330 Ω |
| R22 | 330 Ω |
| R23 | 6.8 k Ω |
| R24 | 68 k Ω |
| R25 | 1 k Ω |
| R26 | 50 Ω |

Table 15 Diodes and ICs

| COMPONENT | VALUE |
|-----------|---|
| D1 | BB134 |
| D2 | BB133 |
| D3 | BA792 |
| IC | TDA6402; TDA6402A; TDA6403; TDA6403A |

Table 16 Coils (wire size 0.4 mm)

| COMPONENT | VALUE |
|-----------|-------|
| L2 | 23 nH |
| L3 | 23 nH |
| L4 | 30 nH |
| L5 | 80 nH |
| L6 | 80 nH |

Table 17 Transformer (note 1)

| COMPONENT | VALUE |
|-----------|--------------------|
| L1 | 2 \times 5 turns |

Note

- Coil type: TOKO 7kN; material: 113 kN; screw core: 03-0093; pot core: 04-0026.

5 V mixers/oscillators and synthesizers for cable TV and VCR 2-band tuners

TDA6402; TDA6402A;
TDA6403; TDA6403A

Table 18 Crystal

| COMPONENT | VALUE |
|-----------|-------|
| X1 | 4 MHz |

Table 19 Transistors

| COMPONENT | VALUE |
|-----------|--------|
| TR1 | BC847B |
| TR2 | BC847B |

Tuning amplifier

The tuning amplifier is capable of driving the varicap voltage without an external transistor. The tuning voltage output must be connected to an external load of 27 k Ω which is connected to the tuning voltage supply rail. The loop filter design depends on the oscillator characteristics and the selected reference frequency.

Crystal oscillator

The crystal oscillator uses a 4 MHz crystal connected in series with an 18 pF capacitor thereby operating in the series resonance mode. Connecting the oscillator to the supply voltage is preferred, but it can also be connected to ground.

Examples of I²C-bus sequences (SW = V_{CC}) for TDA6402 and TDA6403

Tables 20 to 24 show the various sequences where:

$$f_{\text{OSC}} = 100 \text{ MHz}$$

PVHFL = 'ON' to switch on VHF I

FMST is 'ON' to switch on an FM sound trap

$$I_{\text{CP}} = 280 \mu\text{A}$$

$$N = 512$$

$$f_{\text{XTAL}} = 4 \text{ MHz}$$

S = START

A = acknowledge

P = STOP.

For the complete sequence see Table 20 (sequence 1) or Table 21 (sequence 2).

Table 20 Complete sequence 1

| START | ADDRESS BYTE | | DIVIDER BYTE 1 | | DIVIDER BYTE 2 | | CONTROL BYTE | | BAND SWITCH BYTE | | STOP |
|-------|--------------|---|----------------|---|----------------|---|--------------|---|------------------|---|------|
| S | C2 | A | 06 | A | 40 | A | CE | A | 09 | A | P |

Table 21 Complete sequence 2

| START | ADDRESS BYTE | | CONTROL BYTE | | BAND SWITCH BYTE | | DIVIDER BYTE 1 | | DIVIDER BYTE 2 | | STOP |
|-------|--------------|---|--------------|---|------------------|---|----------------|---|----------------|---|------|
| S | C2 | A | CE | A | 09 | A | 06 | A | 40 | A | P |

Table 22 Divider bytes only sequence

| | | | | | | | |
|---|----|---|----|---|----|---|---|
| S | C2 | A | 06 | A | 40 | A | P |
|---|----|---|----|---|----|---|---|

Table 23 Control and band switch bytes only sequence

| | | | | | | | |
|---|----|---|----|---|----|---|---|
| S | C2 | A | CE | A | 09 | A | P |
|---|----|---|----|---|----|---|---|

Table 24 Control byte only sequence

| | | | | | |
|---|----|---|----|---|---|
| S | C2 | A | CE | A | P |
|---|----|---|----|---|---|

Table 25 Status byte acquisition

| | | | | | |
|---|----|---|-------------------|------------------|---|
| S | C3 | A | XX ⁽¹⁾ | X ⁽²⁾ | P |
|---|----|---|-------------------|------------------|---|

Notes

1. XX = Read status byte.
2. X = No acknowledge from the master means end of sequence.

5 V mixers/oscillators and synthesizers for cable TV and VCR 2-band tuners

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Table 26 Two status bytes acquisition

| | | | | | | | |
|---|----|---|-------------------|---|-------------------|------------------|---|
| S | C3 | A | XX ⁽¹⁾ | A | XX ⁽¹⁾ | X ⁽²⁾ | P |
|---|----|---|-------------------|---|-------------------|------------------|---|

Notes

1. XX = Read status byte.
2. X = No acknowledge from the master means end of sequence.

Other I²C-bus addresses may be selected by applying an appropriate voltage to the CE input.

Examples of 3-wire bus sequences (SW = OPEN)

Table 27 18-bit sequence (f_{OSC} = 800 MHz; PUHF = ON)

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

The reference divider is automatically set to 512 assuming that RSB has been set to logic 1 at power-on. If RSB has been set to logic 0, in a previous 27-bit sequence, the reference divider will still be set at 640. In that event, the 18-bit sequence has to be adapted to the 640 divider ratio.

Table 28 19-bit sequence (f_{OSC} = 650 MHz; PUHF = ON)

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

The reference divider is automatically set to 512 assuming that RSB has been set to logic 1 at power-on. If RSB has been set to logic 0 in a previous 27-bit sequence, the reference divider will still be set at 640. In that event, the 19-bit sequence has to be adapted to the 640 divider ratio.

Table 29 27-bit sequence (f_{OSC} = 750 MHz; PUHF = ON; N = 640; I_{CP} = 60 μA; no test function)

| | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

Table 30 19-bit sequence

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

This sequence will program f_{OSC} to 600 MHz in 50 kHz steps; I_{CP} remains at 60 μA.

Table 31 18-bit sequence

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

This sequence will program f_{OSC} to 600 MHz in 50 kHz steps; I_{CP} remains at 60 μA.

5 V mixers/oscillators and synthesizers for cable TV and VCR 2-band tuners

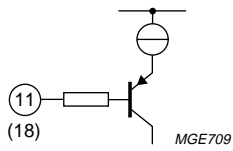
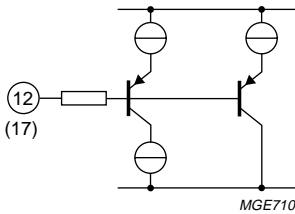
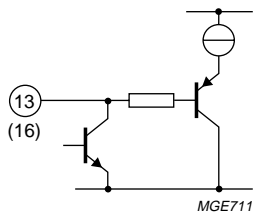
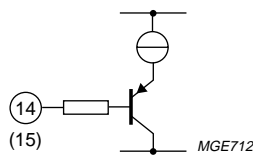
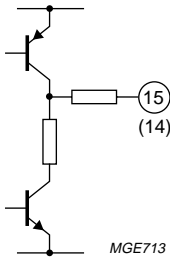
TDA6402; TDA6402A;
TDA6403; TDA6403A

INTERNAL PIN CONFIGURATION

| SYMBOL | PIN | | DESCRIPTION ⁽¹⁾ | AVERAGE DC VOLTAGE (V) (measured in Fig.19) | |
|--------|----------------------|----------------------|----------------------------|--|---------------------|
| | TDA6402; TDA6402A | TDA6403; TDA6403A | | VHF | UHF |
| UHFIN1 | 1 | 28 | <p>MGE704</p> | note 2 | 1.0 |
| UHFIN2 | 2 | 27 | | note 2 | 1.0 |
| VHFIN | 3 | 26 | <p>MGE705</p> | 1.8 | note 2 |
| RFGND | 4 | 25 | <p>MGE706</p> | 0.0 | 0.0 |
| IFFIL1 | 5 | 24 | <p>MGE617</p> | 3.6 | 3.6 |
| IFFIL2 | 6 | 23 | | 3.6 | 3.6 |
| PVHFL | 7 | 22 | <p>MGE708</p> | 0.0 or $(V_{CC} - V_{CE})$ | 0.0 |
| PVVFH | 8 | 21 | | $(V_{CC} - V_{CE})$ or 0.0 | 0.0 |
| PUHF | 9 | 20 | | 0.0 | $(V_{CC} - V_{CE})$ |
| FMST | 10 | 19 | | 0.0 or $(V_{CC} - V_{CE})$ | 0.0 |

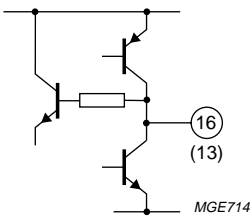
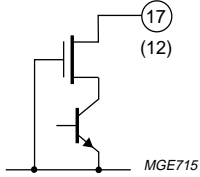
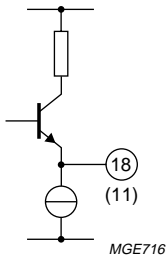
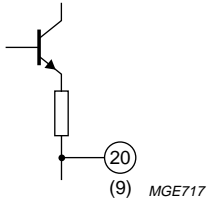
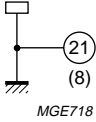
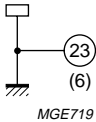
5 V mixers/oscillators and synthesizers for cable TV and VCR 2-band tuners

TDA6402; TDA6402A;
TDA6403; TDA6403A

| SYMBOL | PIN | | DESCRIPTION ⁽¹⁾ | AVERAGE DC VOLTAGE (V) (measured in Fig.19) | |
|----------|----------------------|----------------------|---|--|--------|
| | TDA6402; TDA6402A | TDA6403; TDA6403A | | VHF | UHF |
| SW | 11 | 18 |  | 5.0 | 5.0 |
| CE/AS | 12 | 17 |  | 1.25 | 1.25 |
| DA | 13 | 16 |  | note 2 | note 2 |
| CL | 14 | 15 |  | note 2 | note 2 |
| LOCK/ADC | 15 | 14 |  | 4.6 | 4.6 |

5 V mixers/oscillators and synthesizers for cable TV and VCR 2-band tuners

TDA6402; TDA6402A;
TDA6403; TDA6403A

| SYMBOL | PIN | | DESCRIPTION ⁽¹⁾ | AVERAGE DC VOLTAGE (V) (measured in Fig.19) | |
|-----------------|----------------------|----------------------|---|--|----------|
| | TDA6402; TDA6402A | TDA6403; TDA6403A | | VHF | UHF |
| CP | 16 | 13 |  | 1.9 | 1.9 |
| VT | 17 | 12 |  | V_{VT} | V_{VT} |
| XTAL | 18 | 11 |  | 3.4 | 3.4 |
| V _{CC} | 19 | 10 | supply voltage | 5.0 | 5.0 |
| IFOUT | 20 | 9 |  | 2.1 | 2.1 |
| GND | 21 | 8 |  | 0.0 | 0.0 |
| OSCGND | 23 | 6 |  | 0.0 | 0.0 |

5 V mixers/oscillators and synthesizers for cable TV and VCR 2-band tuners

TDA6402; TDA6402A;
TDA6403; TDA6403A

| SYMBOL | PIN | | DESCRIPTION ⁽¹⁾ | AVERAGE DC VOLTAGE (V) (measured in Fig.19) | |
|-----------|----------------------|----------------------|----------------------------|--|--------|
| | TDA6402; TDA6402A | TDA6403; TDA6403A | | VHF | UHF |
| VHFOSCIB | 22 | 7 | <p>MGE720</p> | 1.8 | note 2 |
| VHFOSCOC | 24 | 5 | | 3.0 | note 2 |
| UHFOSCIB1 | 25 | 4 | <p>MGK825</p> | note 2 | 1.9 |
| UHFOSCOC1 | 26 | 3 | | note 2 | 2.9 |
| UHFOSCOC2 | 27 | 2 | | note 2 | 2.9 |
| UHFOSCIB2 | 28 | 1 | | note 2 | 1.9 |

Notes

1. The pin numbers in parenthesis represent the TDA6403 and TDA6403A.
2. Not applicable.

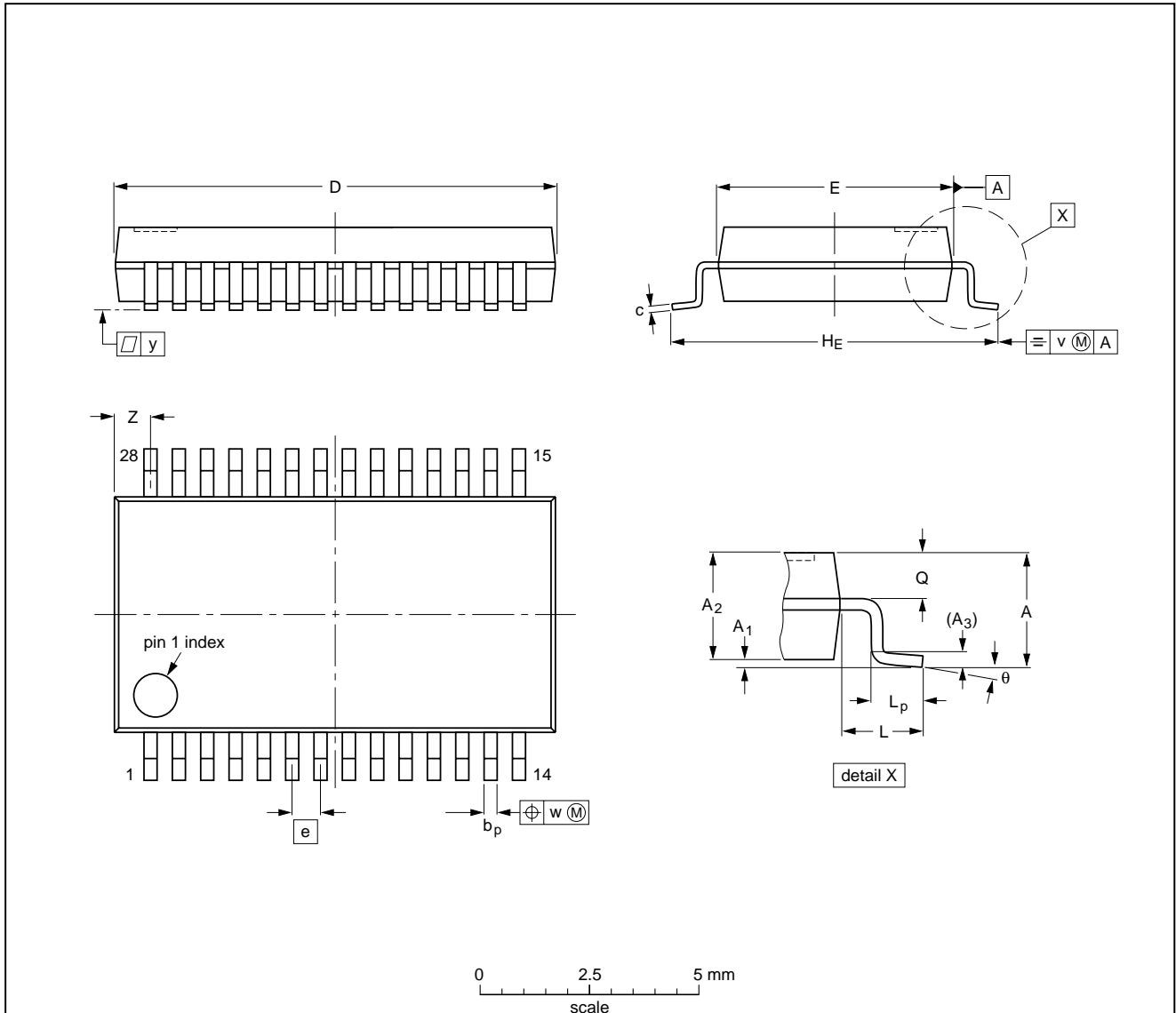
5 V mixers/oscillators and synthesizers for cable TV and VCR 2-band tuners

TDA6402; TDA6402A;
TDA6403; TDA6403A

PACKAGE OUTLINE

SSOP28: plastic shrink small outline package; 28 leads; body width 5.3 mm

SOT341-1



DIMENSIONS (mm are the original dimensions)

| UNIT | A max. | A ₁ | A ₂ | A ₃ | b _p | c | D ⁽¹⁾ | E ⁽¹⁾ | e | H _E | L | L _p | Q | v | w | y | Z ⁽¹⁾ | θ |
|------|--------|----------------|----------------|----------------|----------------|--------------|------------------|------------------|------|----------------|------|----------------|------------|-----|------|-----|------------------|----------|
| mm | 2.0 | 0.21 0.05 | 1.80 1.65 | 0.25 | 0.38 0.25 | 0.20 0.09 | 10.4 10.0 | 5.4 5.2 | 0.65 | 7.9 7.6 | 1.25 | 1.03 0.63 | 0.9 0.7 | 0.2 | 0.13 | 0.1 | 1.1 0.7 | 8° 0° |

Note

1. Plastic or metal protrusions of 0.20 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|-----------------|------------|--------|------|--|---------------------|----------------------|
| | IEC | JEDEC | EIAJ | | | |
| SOT341-1 | | MO-150 | | | | 95-02-04 99-12-27 |

5 V mixers/oscillators and synthesizers for cable TV and VCR 2-band tuners

TDA6402; TDA6402A;
TDA6403; TDA6403A

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 preferably 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.

5 V mixers/oscillators and synthesizers for
cable TV and VCR 2-band tuners

TDA6402; TDA6402A;
TDA6403; TDA6403A

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

| PACKAGE | SOLDERING METHOD | |
|--|-----------------------------------|-----------------------|
| | WAVE | REFLOW ⁽¹⁾ |
| BGA, LFBGA, SQFP, TFBGA | not suitable | suitable |
| HBCC, HLQFP, HSQFP, HSOP, HTQFP, 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.

5 V mixers/oscillators and synthesizers for
cable TV and VCR 2-band tuners

TDA6402; TDA6402A;
TDA6403; TDA6403A

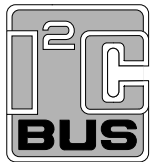
DEFINITIONS

| | |
|---|---|
| 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. | |

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Purchase of Philips I²C components conveys a license under the Philips' I²C patent to use the components in the I²C system provided the system conforms to the I²C specification defined by Philips. This specification can be ordered using the code 9398 393 40011.

5 V mixers/oscillators and synthesizers for
cable TV and VCR 2-band tuners

TDA6402; TDA6402A;
TDA6403; TDA6403A

NOTES

5 V mixers/oscillators and synthesizers for
cable TV and VCR 2-band tuners

TDA6402; TDA6402A;
TDA6403; TDA6403A

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,
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Internet: <http://www.semiconductors.philips.com>

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