

# DATA SHEET



## **TDA6402; TDA6402A; TDA6403; TDA6403A**

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

Product specification

2000 Jan 24

Supersedes data of 1998 Jul 28

File under Integrated Circuits, IC02

## 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 (I<sup>2</sup>C-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 (I<sup>2</sup>C-bus 'write' mode)
  - Address + 1 status byte (I<sup>2</sup>C-bus 'read' mode)
  - 4 independent I<sup>2</sup>C-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 I<sup>2</sup>C-bus mode)
- 15-bit programmable divider
- Programmable reference divider ratio (512, 640 or 1024)
- Programmable charge pump current (60 or 280  $\mu$ 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  $\Omega$  output impedance to drive a low-ohmic impedance (75  $\Omega$ )
- Low power
- Low radiation
- Small size
- The TDA6402A and TDA6403A differ from the TDA6402 and TDA6403 by the UHF port protocol in the I<sup>2</sup>C-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 I<sup>2</sup>C-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 I<sup>2</sup>C-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 I<sup>2</sup>C-bus mode only. The Analog-to-Digital Converter (ADC) input is available on pin LOCK/ADC for digital AFC control in the I<sup>2</sup>C-bus mode only. The ADC code is read during a READ operation on the I<sup>2</sup>C-bus (see Table 11). In test mode, pin LOCK/ADC is used as a TEST output for f<sub>REF</sub> and 1/2f<sub>DIV</sub>, in both I<sup>2</sup>C-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 I<sup>2</sup>C-bus (see Table 9).

### I<sup>2</sup>C-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 I<sup>2</sup>C-bus addresses which can be selected by applying a specific voltage on input CE (see Table 6).

### 3-wire bus mode (SW = OPEN or V<sub>CC</sub>)

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 <sup>(1)</sup>	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

1. 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<sub>CC</sub>)".

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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
$f_{XTAL}$	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	–	$\text{dB}\mu\text{V}$
		UHF band	–	108	–	$\text{dB}\mu\text{V}$

**Notes**

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

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

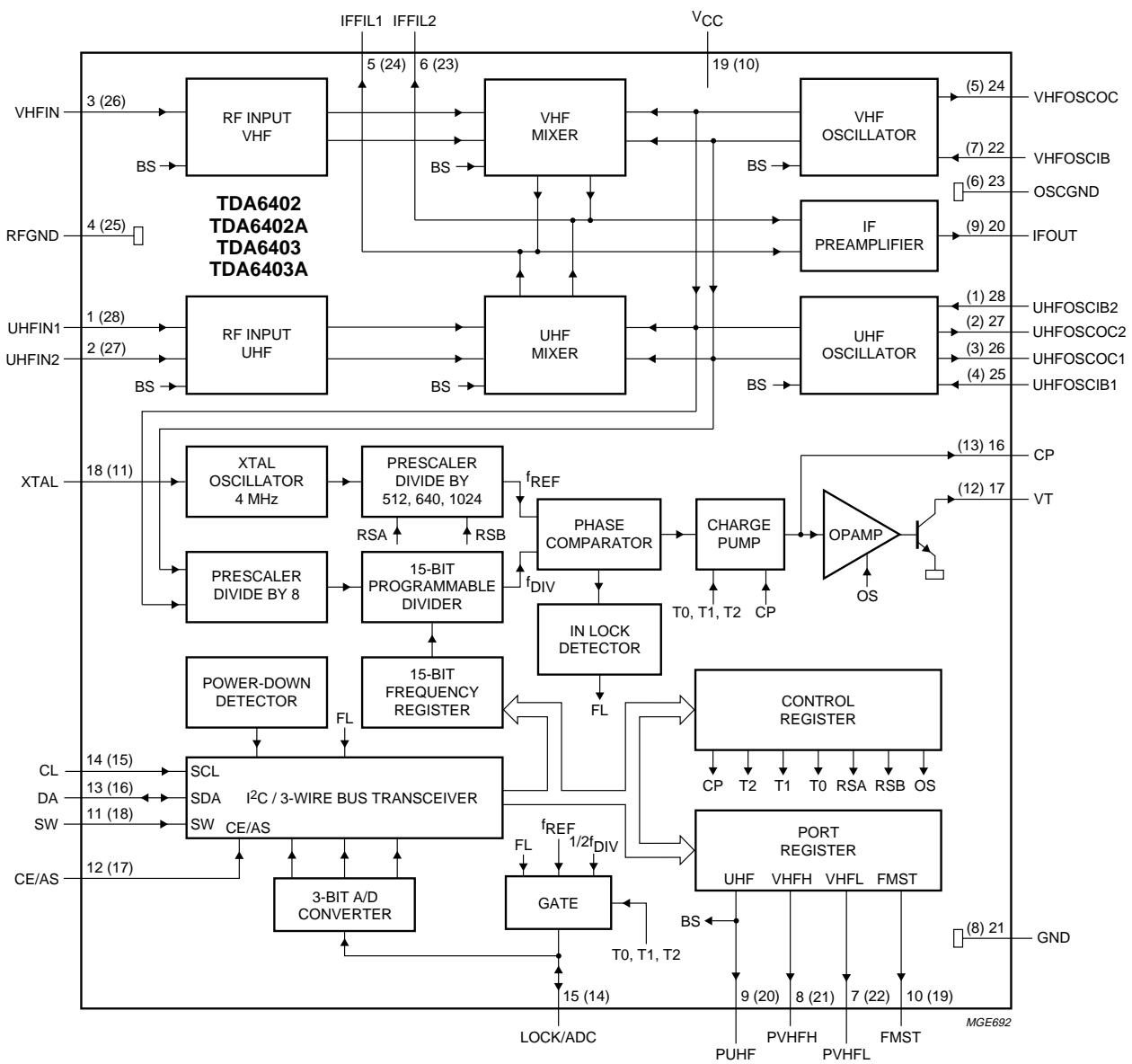
**ORDERING INFORMATION**

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 <sup>2</sup> 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 <sup>2</sup> C-bus)
CP	16	13	charge pump output
VT	17	12	tuning voltage output
XTAL	18	11	crystal oscillator input
V <sub>CC</sub>	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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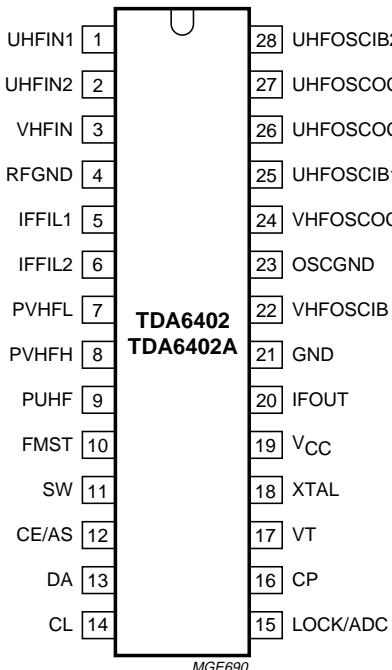


Fig.2 Pin configuration for TDA6402 and TDA6402A.

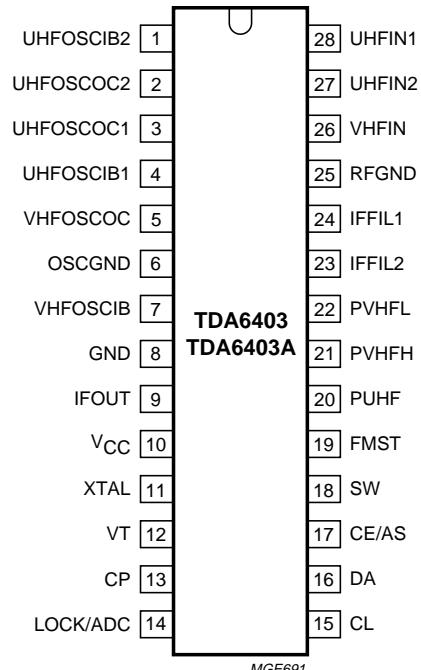


Fig.3 Pin configuration for TDA6403 and TDA6403A.

### PLL FUNCTIONAL DESCRIPTION

The device is controlled via the I<sup>2</sup>C-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 I<sup>2</sup>C-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 <sup>2</sup> 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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## I<sup>2</sup>C-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 I<sup>2</sup>C-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).

## I<sup>2</sup>C-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** I<sup>2</sup>C-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	<b>FMST</b>	<b>PUHF</b>	PVHFH	PVHFL	A

**Table 4** I<sup>2</sup>C-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 $\mu$ A CP = 1 = 280 $\mu$ 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 (I<sup>2</sup>C-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

1. This is the default mode at power-on reset.
2. 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

1. 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 (I<sup>2</sup>C-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 <sup>(1)</sup>						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

1. 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	X
Divider byte 2	DB2	X	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  $\mu$ 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.

### 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 I<sup>2</sup>C-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  $V_{CC} = 2$  V at room temperature. Below this threshold, the device is reset to the power-on state.

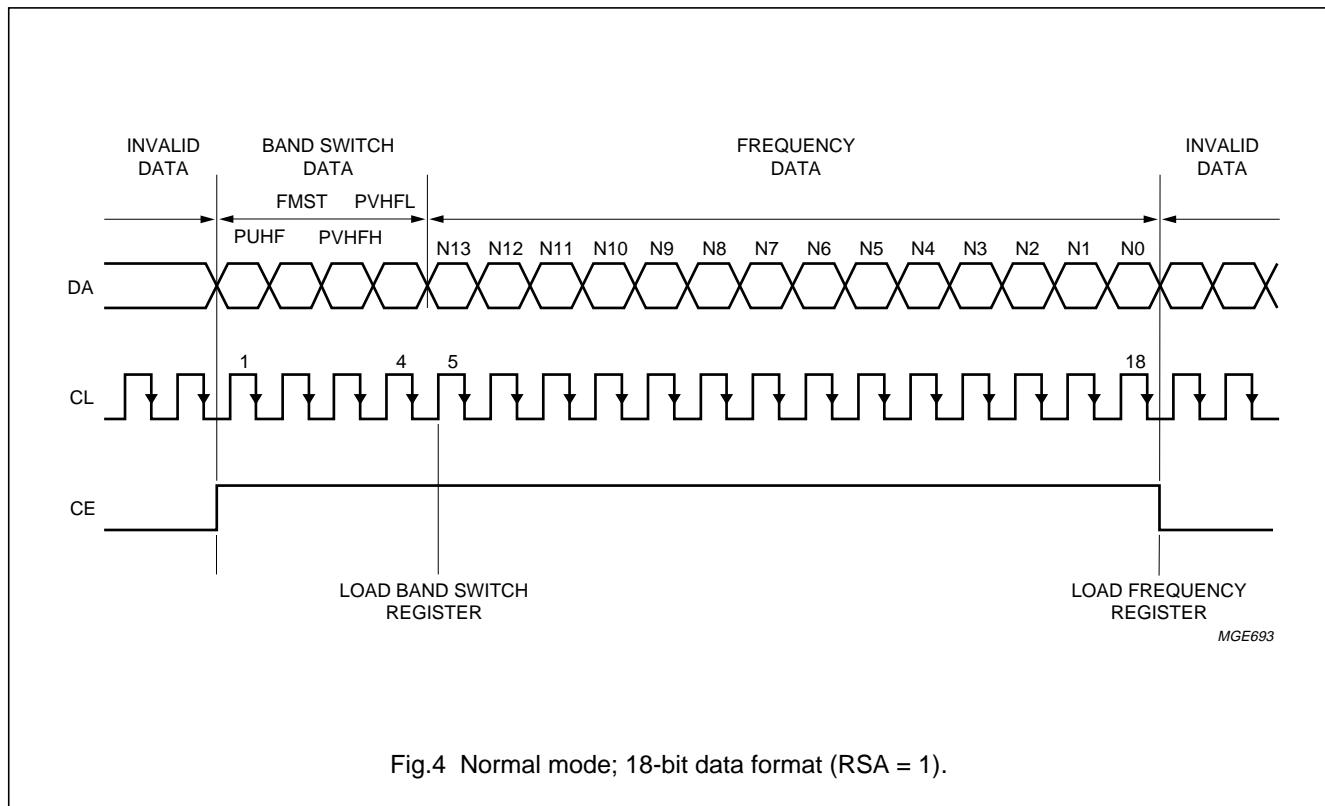
At power-on state, the charge pump current is set to 280  $\mu$ A, the tuning voltage output is disabled, the test bits T2, T1 and T0 are set to '001' (automatic charge pump switch 'ON') and RSB is set to logic 1.

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).



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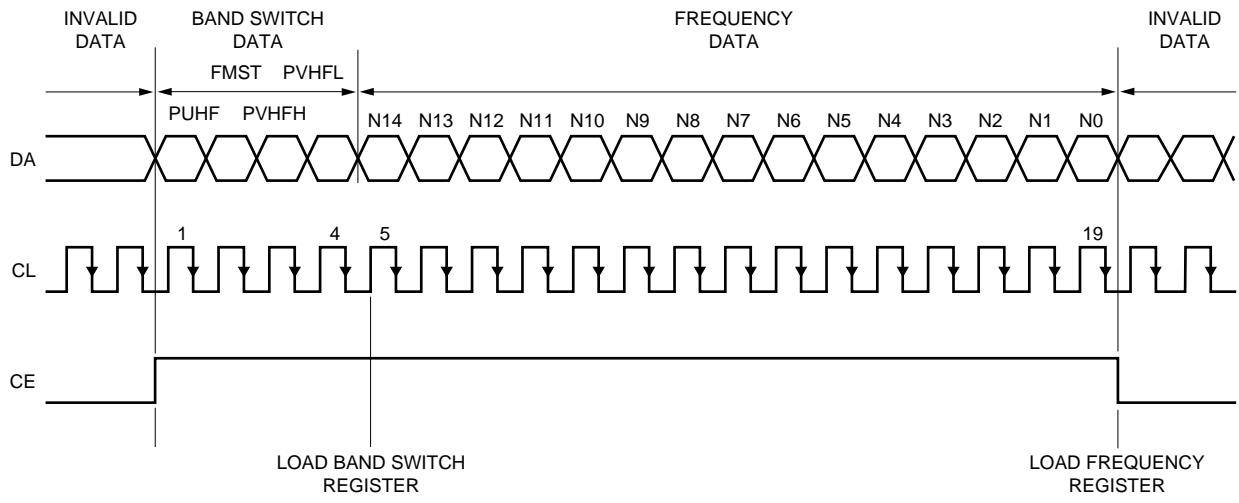


Fig.5 Normal mode; 19-bit data format (RSA = 0).

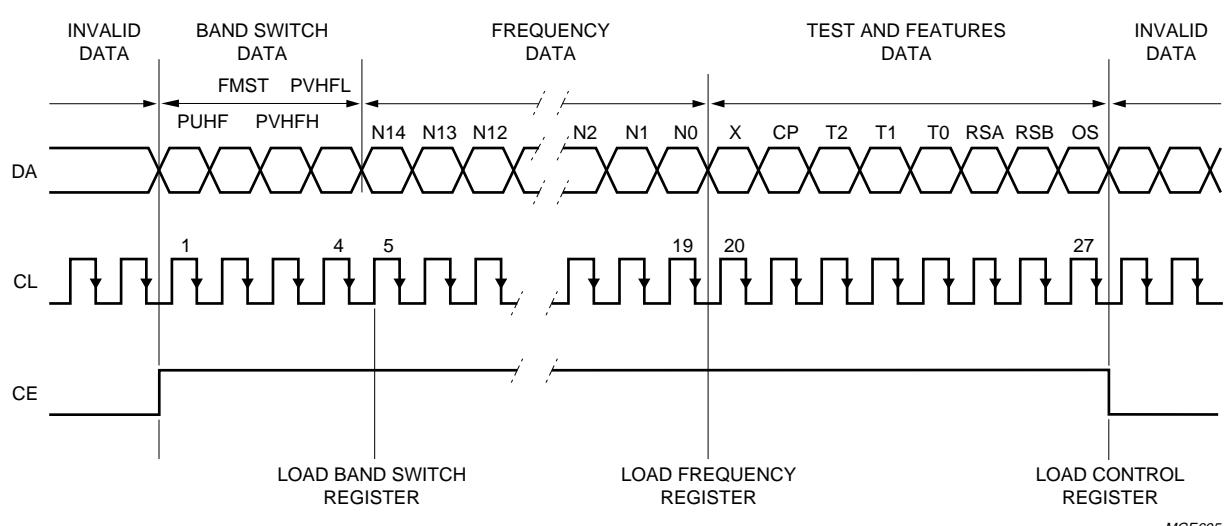


Fig.6 Test and features mode; 27-bit data format.

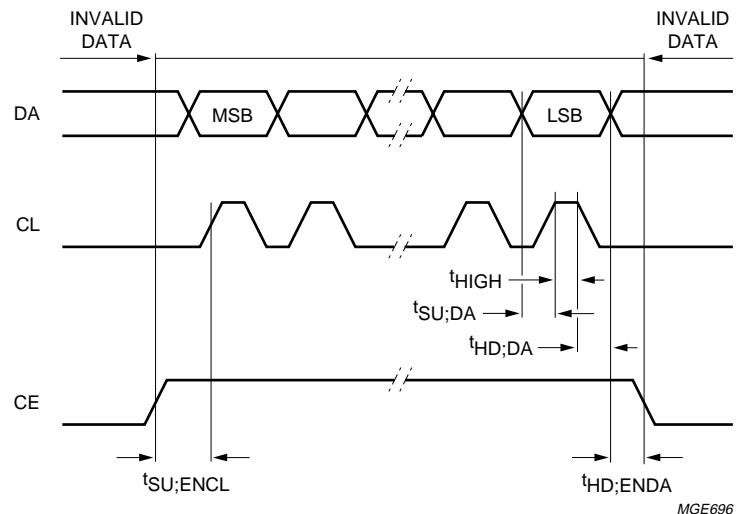
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Fig.7 Timing diagram for 3-wire bus; DA, CL and CE.

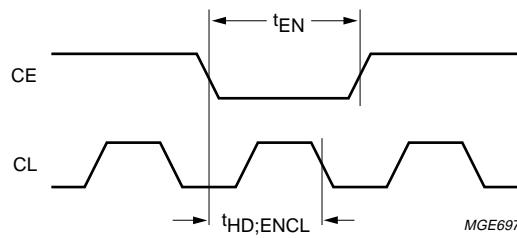


Fig.8 Timing diagram for 3-wire bus; CE and CL.

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**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 <sub>CC</sub>	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 <sub>BSn</sub>	7 to 10	19 to 22	PNP port output voltage	-0.3	+6	V
I <sub>BSn</sub>	7 to 10	19 to 22	PNP port output current	-1	+30	mA
V <sub>CP</sub>	16	13	charge pump output voltage	-0.3	+6	V
V <sub>SW</sub>	11	18	bus mode selection input voltage	-0.3	+6	V
V <sub>VT</sub>	17	12	tuning voltage output	-0.3	+35	V
V <sub>LOCK/ADC</sub>	15	14	LOCK/ADC input/output voltage	-0.3	+6	V
V <sub>CL</sub>	14	15	serial clock input voltage	-0.3	+6	V
V <sub>DA</sub>	13	16	serial data input/output voltage	-0.3	+6	V
I <sub>DA</sub>	13	16	data output current (I <sup>2</sup> C-bus mode)	-1	+10	mA
V <sub>CE</sub>	12	17	chip enable/address selection input voltage	-0.3	+6	V
V <sub>XTAL</sub>	18	11	crystal input voltage	-0.3	+6	V
I <sub>O</sub>	1 to 6, 19 to 28	1 to 10, 23 to 28	output current of each pin to ground	-	-10	mA
t <sub>sc(max)</sub>	-	-	maximum short-circuit time (all pins to V <sub>CC</sub> and all pins to GND, OSCGND and RFGND)	-	10	s
T <sub>stg</sub>	-	-	IC storage temperature	-40	+150	°C
T <sub>amb</sub>	-	-	ambient temperature	-20	+85	°C
T <sub>j</sub>	-	-	junction temperature	-	150	°C

**Note**

1. 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 <sub>th(j-a)</sub>	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	
<b>Supply</b>							
$V_{CC}$	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	
<b>PLL part (<math>V_{CC} = 4.5 \text{ to } 5.5 \text{ V}</math>; <math>T_{amb} = -20 \text{ to } +85 \text{ }^{\circ}\text{C}</math>; unless otherwise specified)</b>							
<b>FUNCTIONAL RANGE</b>							
$V_{POR}$	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	—	$\Omega$	
<b>PNP PORTS</b>							
$I_{BSn(off)}$	leakage current	$V_{CC} = 5.5 \text{ V}$ ; $V_{Pn} = 0 \text{ V}$	-10	—	—	$\mu\text{A}$	
$V_{BSn(sat)}$	output saturation voltage	one buffer output is 'ON', sourcing 25 mA; $V_{Pn(sat)} = V_{CC} - V_{Pn}$	—	0.25	0.4	V	
<b>LOCK OUTPUT IN 3-WIRE BUS MODE (PNP COLLECTOR OUT)</b>							
$I_{UNLOCK}$	output current when the PLL is out-of-lock	$V_{CC} = 5.5 \text{ V}$ ; $V_{OUT} = 5.5 \text{ V}$	—	—	100	$\mu\text{A}$	
$V_{UNLOCK}$	output saturation voltage when the PLL is out-of-lock	$I_{SOURCE} = 200 \mu\text{A}$ ; $V_{UNLOCK} = V_{CC} - V_{OUT}$	—	0.4	0.8	V	
$V_{LOCK}$	output voltage	the PLL is locked	—	0.01	0.40	V	
<b>ADC INPUT IN I<sup>2</sup>C-BUS MODE</b>							
$V_{ADC}$	ADC input voltage	see Table 11	0	—	$V_{CC}$	V	
$I_{ADCH}$	HIGH-level input current	$V_{ADC} = V_{CC}$	—	—	10	$\mu\text{A}$	
$I_{ADCL}$	LOW-level input current	$V_{ADC} = 0 \text{ V}$	-10	—	—	$\mu\text{A}$	
<b>SW INPUT (BUS MODE SELECTION)</b>							
$V_{SWL}$	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	$\mu\text{A}$	
$I_{SWL}$	LOW-level input current	$V_{SW} = 0 \text{ V}$	-100	—	—	$\mu\text{A}$	

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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	$V_{CE/AS} = 5.5 \text{ V}$	–	–	10	$\mu\text{A}$
$I_{CE/ASL}$	LOW-level input current	$V_{CE/AS} = 0 \text{ V}$	–10	–	–	$\mu\text{A}$
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	$V_{BUS} = 5.5 \text{ V}; V_{CC} = 0 \text{ V}$	–	–	10	$\mu\text{A}$
		$V_{BUS} = 5.5 \text{ V}; V_{CC} = 5.5 \text{ V}$	–	–	10	$\mu\text{A}$
$I_{CL/DAL}$	LOW-level input current	$V_{BUS} = 1.5 \text{ V}; V_{CC} = 0 \text{ V}$	–	–	10	$\mu\text{A}$
		$V_{BUS} = 0 \text{ V}; V_{CC} = 5.5 \text{ V}$	–10	–	–	$\mu\text{A}$
DA OUTPUT (I <sup>2</sup> C-BUS MODE)						
$I_{DAH}$	leakage current	$V_{DA} = 5.5 \text{ V}$	–	–	10	$\mu\text{A}$
$V_{DA}$	output voltage	$I_{DA} = 3 \text{ mA}$ (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	–	$\mu\text{A}$
$I_{CPL}$	LOW-level input current (absolute value)	$CP = 0$	–	60	–	$\mu\text{A}$
$V_{CP}$	output voltage	PLL is locked; $T_{amb} = 25 \text{ }^\circ\text{C}$	–	1.95	–	V
$I_{CPleak}$	off-state leakage current	$T2 = 0; T1 = 1$	–15	–0.5	+15	nA
TUNING VOLTAGE OUTPUT VT						
$I_{VTOFF}$	leakage current when switched off	$OS = 1$ ; tuning supply = 33 V	–	–	10	$\mu\text{A}$
$V_{VT}$	output voltage when the loop is closed	$OS = 0; T2 = 0; T1 = 0; T0 = 1;$ $R_{LOAD} = 22 \text{ k}\Omega$ ; tuning supply = 33 V	0.2	–	32.7	V
3-WIRE BUS TIMING						
$t_{HIGH}$	clock HIGH time	see Fig.7	2	–	–	$\mu\text{s}$
$t_{SU;DA}$	data set-up time	see Fig.7	2	–	–	$\mu\text{s}$
$t_{HD;DA}$	data hold time	see Fig.7	2	–	–	$\mu\text{s}$
$t_{SU;ENCL}$	enable to clock set-up time	see Fig.7	10	–	–	$\mu\text{s}$
$t_{HD;ENDA}$	enable to data hold time	see Fig.7	2	–	–	$\mu\text{s}$
$t_{EN}$	enable time between two transmissions	see Fig.8	10	–	–	$\mu\text{s}$
$t_{HD;ENCL}$	enable to clock active edge hold time	see Fig.8	6	–	–	$\mu\text{s}$

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SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Mixer/oscillator part (<math>V_{CC} = 5</math> V) (measured in circuit of Fig.19; unless otherwise specified)</b>						
<b>VHF MIXER (INCLUDING IF AMPLIFIER)</b>						
$f_{RF}$	RF frequency	note 1	55.25	—	361.25	MHz
$G_v$	voltage gain	$f_{RF} = 57.5$ MHz; see Fig.12	16.5	19	21.5	dB
		$f_{RF} = 357.5$ MHz; see Fig.12	16.5	19	21.5	dB
$NF$	noise figure	$f_{RF} = 50$ MHz; see Figs 13 and 14	—	8.5	9.5	dB
		$f_{RF} = 150$ MHz; see Figs 13 and 14	—	8.5	10.5	dB
		$f_{RF} = 300$ MHz; see Fig.14	—	9.5	12.5	dB
$V_o$	output voltage causing 1% cross modulation in channel	$f_{RF} = 55.25$ MHz; see Fig.15	105	108	—	$dB\mu V$
		$f_{RF} = 361.25$ MHz; see Fig.15	105	108	—	$dB\mu V$
$V_i$	input voltage causing pulling in channel (750 Hz)	$f_{RF} = 361.25$ MHz; note 2	—	83	—	$dB\mu V$
$g_{os}$	optimum source conductance for noise figure	$f_{RF} = 50$ MHz	—	0.7	—	mS
		$f_{RF} = 150$ MHz	—	0.9	—	mS
		$f_{RF} = 300$ MHz	—	1.5	—	mS
$g_i$	input conductance	$f_{RF} = 55.25$ MHz; see Fig.9	—	0.25	—	mS
		$f_{RF} = 361.25$ MHz; see Fig.9	—	0.5	—	mS
$C_i$	input capacitance	$f_{RF} = 57.5$ to $357.5$ MHz; see Fig.9	—	1.3	—	pF
<b>VHF OSCILLATOR; see Fig.19</b>						
$f_{osc}$	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	$\Delta T = 25$ °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
$\Phi_{osc}$	phase noise, carrier to noise sideband	$\pm 100$ 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	20	—	mV
<b>UHF MIXER (INCLUDING IF AMPLIFIER)</b>						
$f_{RF}$	RF frequency	note 1	367.25	—	801.25	MHz
$G_v$	voltage gain	$f_{RF} = 369.5$ MHz; see Fig.16	26	29	32	dB
		$f_{RF} = 803.5$ MHz; see Fig.16	26	29	32	dB
$NF$	noise figure (not corrected for image)	$f_{RF} = 369.5$ MHz; see Fig.17	—	9	11	dB
		$f_{RF} = 803.5$ MHz; see Fig.17	—	10	12	dB
$V_o$	output voltage causing 1% cross modulation in channel	$f_{RF} = 367.25$ MHz; see Fig.18	105	108	—	$dB\mu V$
		$f_{RF} = 801.25$ MHz; see Fig.18	105	108	—	$dB\mu V$
$V_i$	input voltage causing pulling in channel (750 Hz)	$f_{RF} = 801.25$ MHz; note 2	—	82	—	$dB\mu V$

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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	—	$\Omega$
		$R_S$ at $f_{RF} = 801.25$ MHz; see Fig.10	—	38	—	$\Omega$
		$L_S$ 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
$\Phi_{osc}$	phase noise, carrier to noise sideband	$\pm 100$ kHz frequency offset; worst case in the frequency range	—	100	—	dBc/Hz
$R_{SC}$	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	—	$\Omega$
		$L_S$ 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	—	$dB\mu V$
$INTR_{XTAL}$	crystal oscillator interferences rejection	$V_{IF} = 100$ $dB\mu V$ ; worst case in the frequency range; note 9	60	—	—	dBc
$INTR_{REF}$	reference frequency rejection	$V_{IF} = 100$ $dB\mu V$ ; worst case in the frequency range; $f_{REF} = 7.8125$ kHz; note 10	50	—	—	dBc
$INT_{CH6}$	channel 6 beat	$V_{RFpix} = V_{RFsnd} = 80$ $dB\mu V$ ; note 11	57	—	—	dBc
$INT_{CHA-5}$	channel A-5 beat	$V_{RFpix} = 80$ $dB\mu V$ ; note 12	60	—	—	dBc

## Notes

1. The RF frequency range is defined by the oscillator frequency range and the intermediate frequency (IF).
2. 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.
3. Limits are related to the tank circuits used in Fig.19; frequency bands may be adjusted by the choice of external components.
4. 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  $50$  °C or from  $T_{amb} = 25$  to  $0$  °C. The oscillator is free running during this measurement. The VHF drift value can be improved by adding a  $10$  kΩ 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  $100$  dBµV and the sideband components.
8. This is the level of divider interferences close to the IF frequency. For example channel C:  $f_{OSC} = 179$  MHz,  $\frac{1}{4}f_{OSC} = 44.75$  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  $100$  dBµV.
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  $100$  dBµV.
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;  $f_{BEAT} = 45.5$  MHz. The possible mechanisms are:  $f_{OSC} - 2 \times f_{IF}$  or  $2 \times f_{RFpix} - f_{OSC}$ . For the measurement  $V_{RF} = 80$  dBµV.

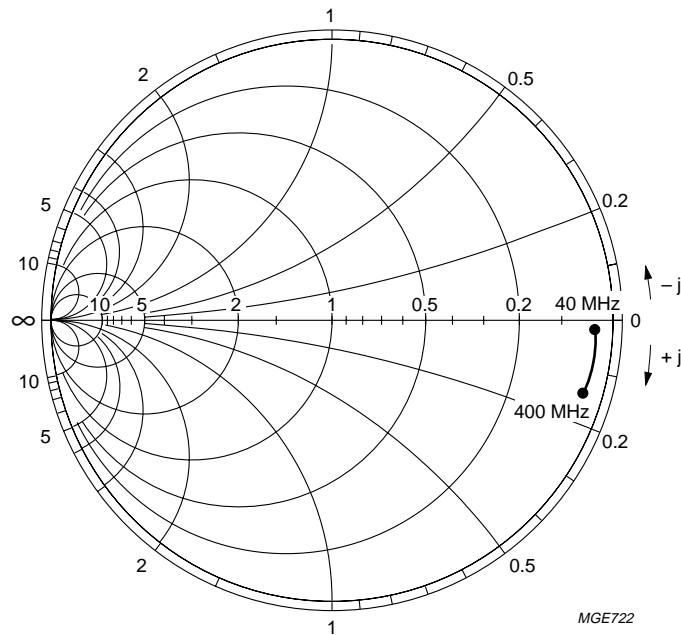
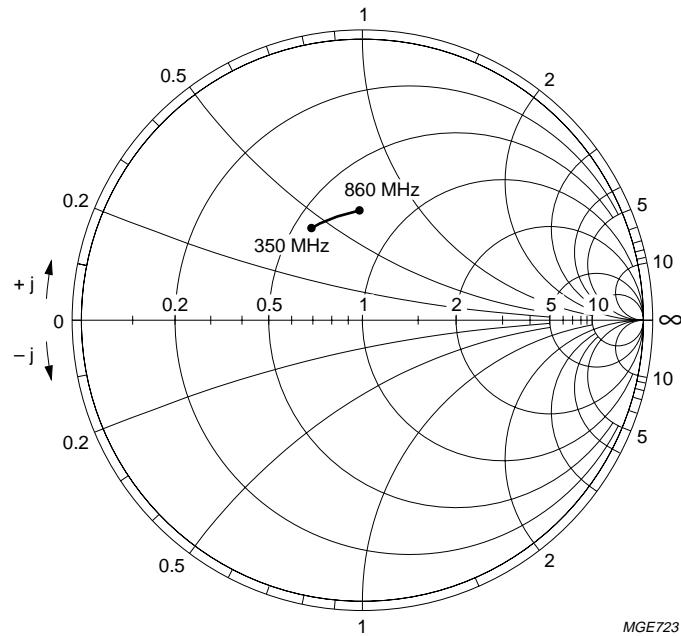
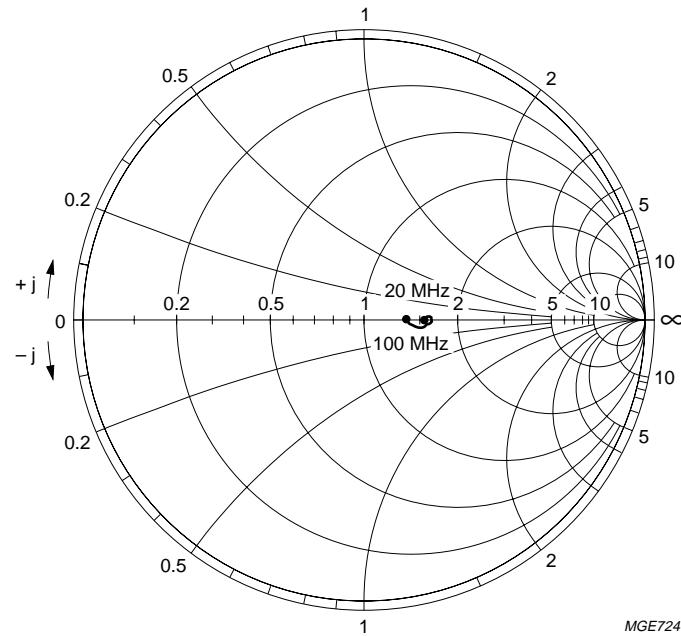


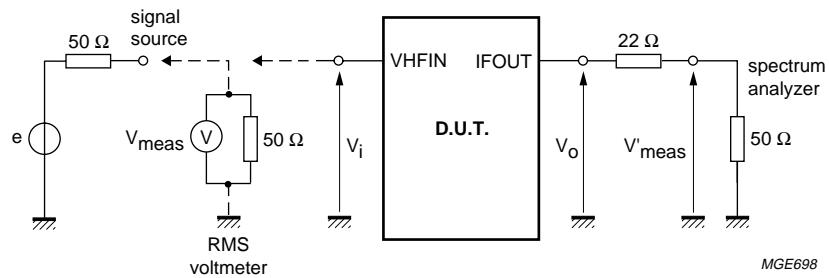
Fig.9 Input admittance ( $S_{11}$ ) of the VHF mixer input (40 to 400 MHz);  $Y_0 = 20$  mS.

**5 V mixers/oscillators and synthesizers for  
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### TEST AND APPLICATION INFORMATION



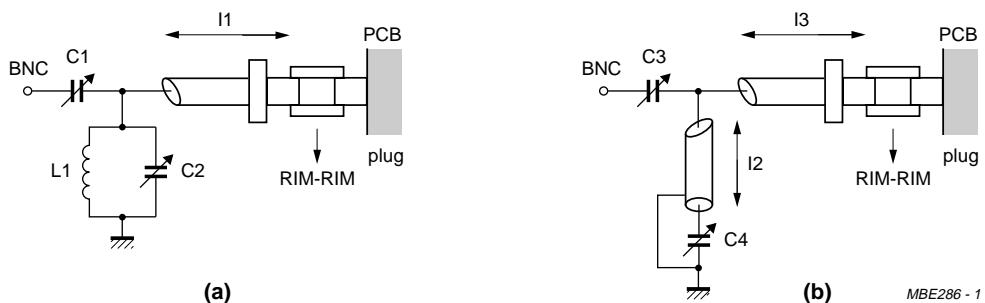
$$Z_i \gg 50 \Omega \Rightarrow V_i = 2 \times V_{\text{meas}} = 80 \text{ dB}\mu\text{V}.$$

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

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

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

Fig.12 Gain measurement in VHF band.



**(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

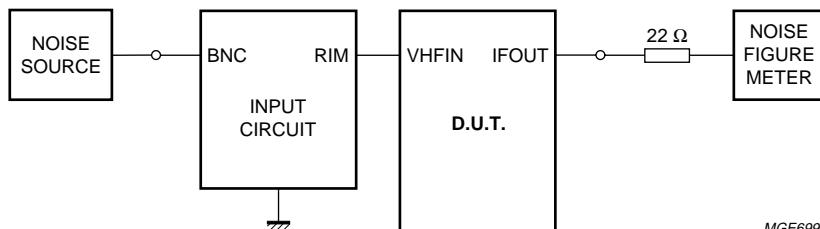
l3 = semi rigid cable (RIM): 5 cm long

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

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

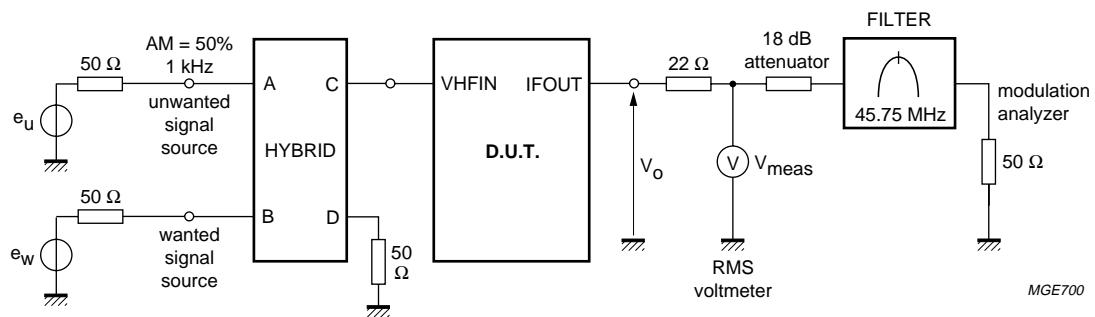
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$$NF = NF_{meas} - \text{loss (of input circuit)} \text{ (dB)}$$

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



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

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

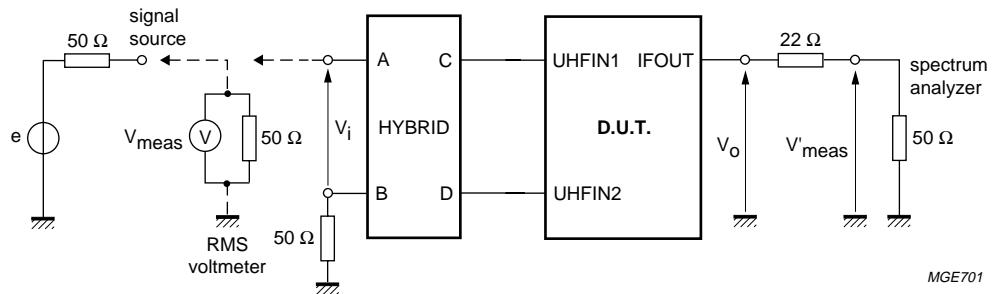
Measuring the level of the unwanted output signal  $V_{o(u)}$  causing 0.5% AM modulation in the wanted output signal;  $f_{RFU} = 59.75$  (366.75) MHz.  
 $f_{osc} = 101$  (407) MHz.

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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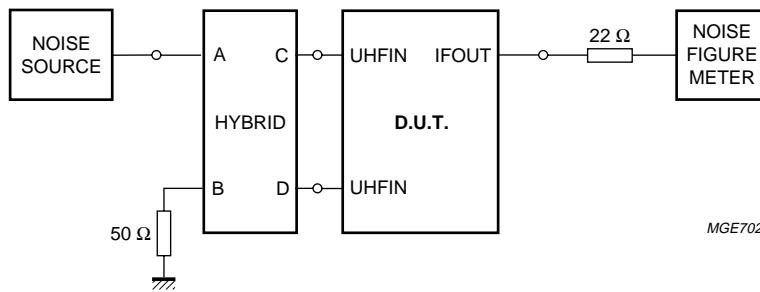
Loss (in hybrid) = 1 dB.

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

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

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

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



MGE702

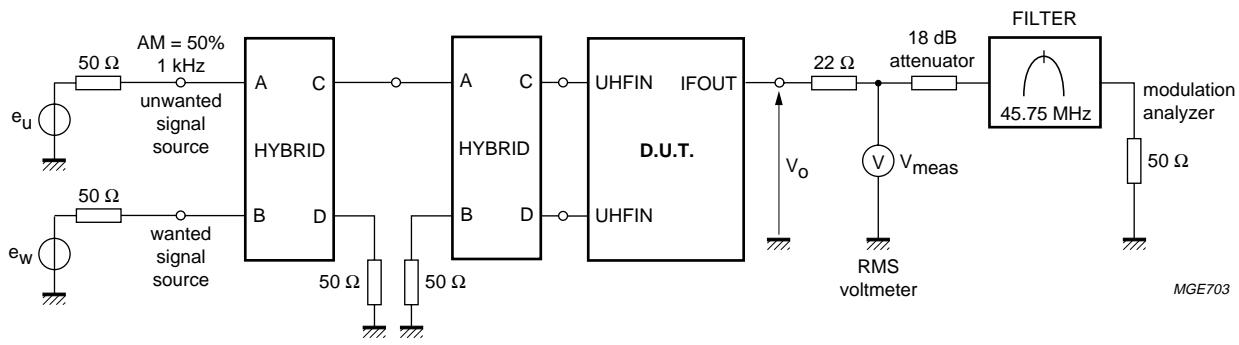
Loss (in hybrid) = 1 dB.

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

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



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

Wanted output signal at  $f_{\text{RFW}} = 367.25$  (801.25) MHz;  $V_{o(w)} = 100 \text{ dB}\mu\text{V}$ .

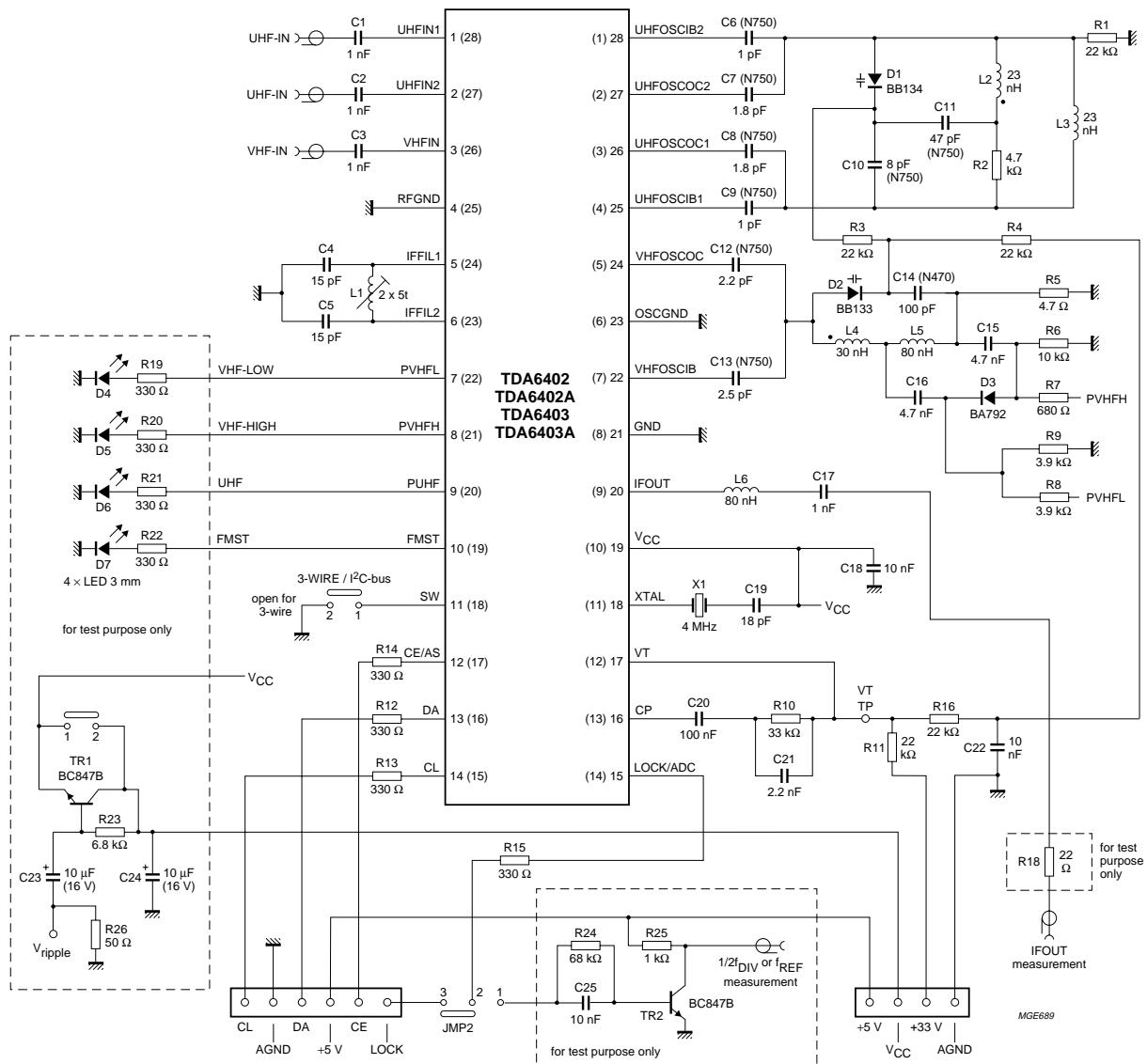
Measuring the level of the unwanted output signal  $V_{o(u)}$  causing 0.5% AM modulation in the wanted output signal;  $f_{\text{RFU}} = 371.25$  (805.75) MHz.  
 $f_{\text{osc}} = 413$  (847) MHz.

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

Fig.18 Cross modulation measurement in UHF band.

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

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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

TDA6402; TDA6402A;  
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 µF (16 V; electrolytic)
C24	10 µF (16 V; electrolytic)
C25	10 nF

**Table 14** Resistors (all SMD)

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

COMPONENT	VALUE
R11	22 kΩ
R12	330 Ω
R13	330 Ω
R14	330 Ω
R15	330 Ω
R16	22 kΩ
R18	22 Ω
R19	330 Ω
R20	330 Ω
R21	330 Ω
R22	330 Ω
R23	6.8 kΩ
R24	68 kΩ
R25	1 kΩ
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 × 5 turns

**Note**

1. 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

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**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 $\Omega$  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.

**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
---	----	---	----	---	---

### Examples of I<sup>2</sup>C-bus sequences (SW = V<sub>CC</sub>) for TDA6402 and TDA6403

Tables 20 to 24 show the various sequences where:

f<sub>osc</sub> = 100 MHz

PVHFL = 'ON' to switch on VHF I

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

I<sub>CP</sub> = 280  $\mu$ A

N = 512

f<sub>XTAL</sub> = 4 MHz

S = START

A = acknowledge

P = STOP.

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

**Table 25** Status byte acquisition

S	C3	A	XX <sup>(1)</sup>	X <sup>(2)</sup>	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  
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**Table 26** Two status bytes acquisition

S	C3	A	XX <sup>(1)</sup>	A	XX <sup>(1)</sup>	X <sup>(2)</sup>	P
---	----	---	-------------------	---	-------------------	------------------	---

**Notes**

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

Other I<sup>2</sup>C-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<sub>osc</sub> = 800 MHz; PUHF = ON)

1	0	0	0	1	1	0	0	1	0	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<sub>osc</sub> = 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<sub>osc</sub> = 750 MHz; PUHF = ON; N = 640; I<sub>CP</sub> = 60 µA; no test function)

1	0	0	0	0	1	1	1	0	1	0	1	0	0	1	1	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	0	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

This sequence will program f<sub>osc</sub> to 600 MHz in 50 kHz steps; I<sub>CP</sub> remains at 60 µA.

**Table 31** 18-bit sequence

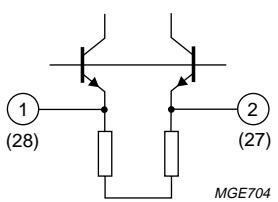
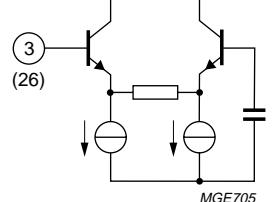
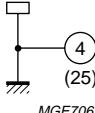
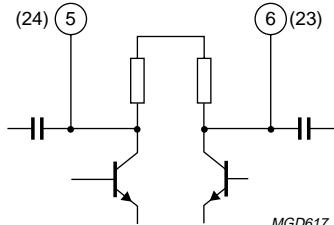
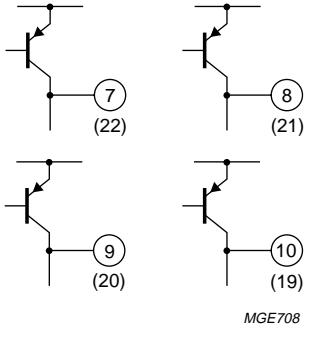
1	0	0	0	1	0	1	1	1	0	1	1	1	0	0	0	0	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

This sequence will program f<sub>osc</sub> to 600 MHz in 50 kHz steps; I<sub>CP</sub> remains at 60 µA.

5 V mixers/oscillators and synthesizers for  
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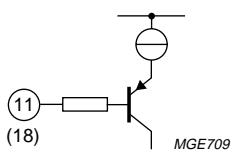
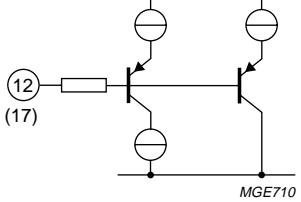
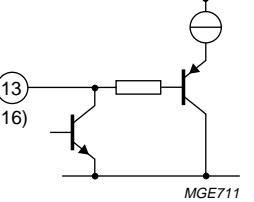
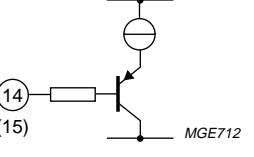
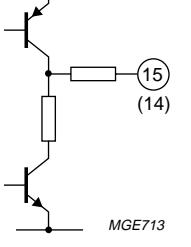
TDA6402; TDA6402A;  
TDA6403; TDA6403A

INTERNAL PIN CONFIGURATION

SYMBOL	PIN		DESCRIPTION <sup>(1)</sup>	AVERAGE DC VOLTAGE (V) (measured in Fig.19)	
	TDA6402; TDA6402A	TDA6403; TDA6403A		VHF	UHF
UHFIN1	1	28		note 2	1.0
UHFIN2	2	27		note 2	1.0
VHFIN	3	26		1.8	note 2
RFGND	4	25		0.0	0.0
IFFIL1	5	24		3.6	3.6
IFFIL2	6	23		3.6	3.6
PVHFL	7	22		0.0 or $(V_{CC} - V_{CE})$	0.0
PVHFH	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

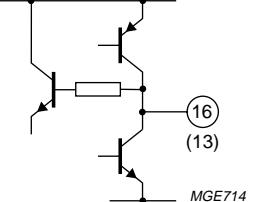
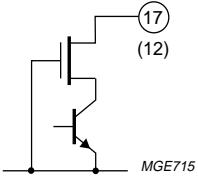
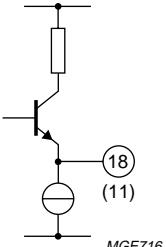
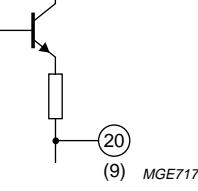
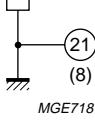
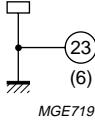
5 V mixers/oscillators and synthesizers for  
cable TV and VCR 2-band tuners

TDA6402; TDA6402A;  
TDA6403; TDA6403A

SYMBOL	PIN		DESCRIPTION <sup>(1)</sup>	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 <sup>(1)</sup>	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 tunersTDA6402; TDA6402A;  
TDA6403; TDA6403A

SYMBOL	PIN		DESCRIPTION <sup>(1)</sup>	AVERAGE DC VOLTAGE (V) (measured in Fig.19)	
	TDA6402; TDA6402A	TDA6403; TDA6403A		VHF	UHF
VHFOSCIB	22	7		1.8	note 2
VHFOSCOC	24	5		3.0	note 2
UHFOSCIB1	25	4		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.

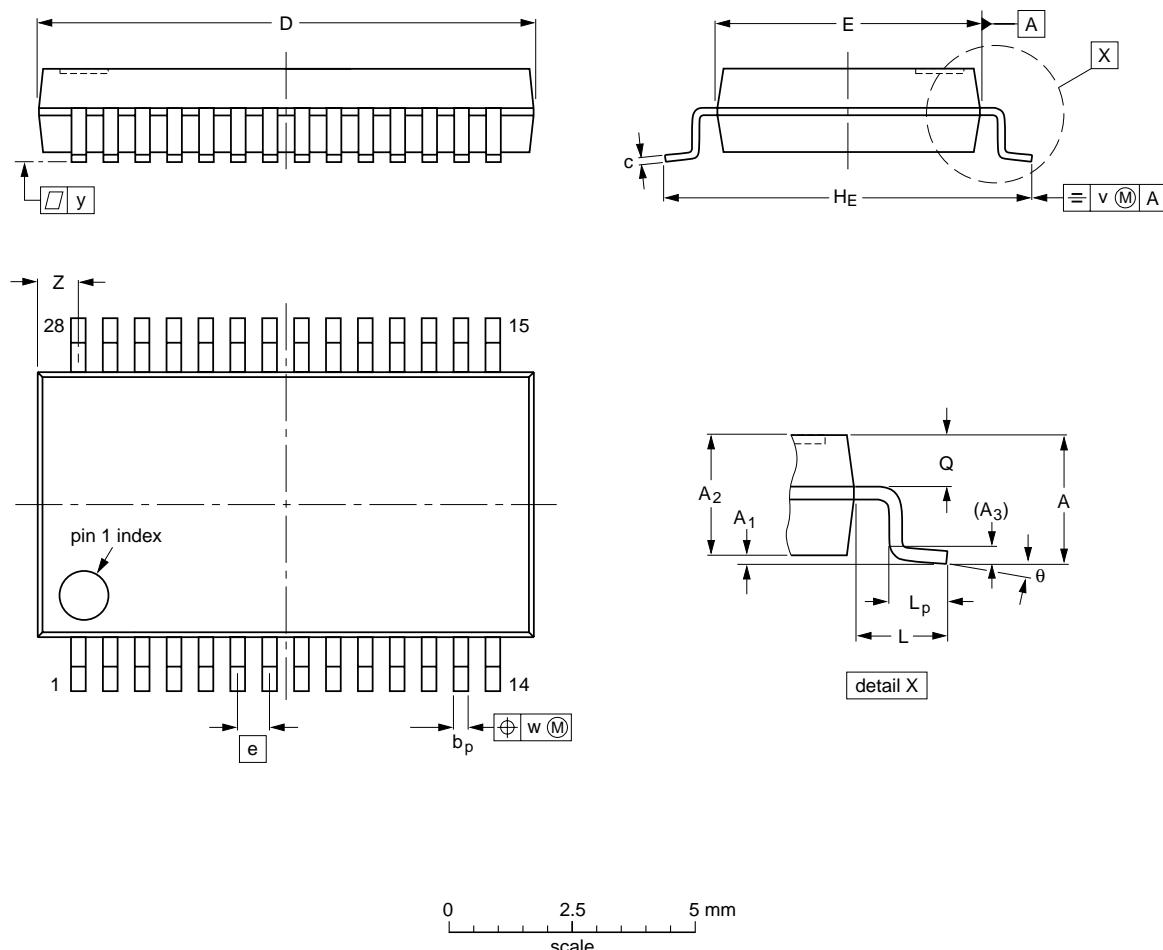
## 5 V mixers/oscillators and synthesizers for cable TV and VCR 2-band tuners

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 <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	z <sup>(1)</sup>	θ
mm	2.0 0.05	0.21 1.65	1.80	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 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.

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 <sup>(1)</sup>
BGA, LFBGA, SQFP, TFBGA	not suitable	suitable
HBCC, HLQFP, HSQFP, HSOP, HTQFP, HTSSOP, SMS	not suitable <sup>(2)</sup>	suitable
PLCC <sup>(3)</sup> , SO, SOJ	suitable	suitable
LQFP, QFP, TQFP	not recommended <sup>(3)(4)</sup>	suitable
SSOP, TSSOP, VSO	not recommended <sup>(5)</sup>	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

<b>Data sheet status</b>	
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.
<b>Limiting values</b>	
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.	
<b>Application information</b>	
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.

## PURCHASE OF PHILIPS I<sup>2</sup>C COMPONENTS



Purchase of Philips I<sup>2</sup>C components conveys a license under the Philips' I<sup>2</sup>C patent to use the components in the I<sup>2</sup>C system provided the system conforms to the I<sup>2</sup>C specification defined by Philips. This specification can be ordered using the code 9398 393 40011.

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

TDA6402; TDA6402A;  
TDA6403; TDA6403A

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**NOTES**

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

TDA6402; TDA6402A;  
TDA6403; TDA6403A

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**NOTES**

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