# SIEMENS

**VHF/UHF-Tuner IC**                                      **MTI 3006X**

**Bipolar IC**

## Features

- Few external components
- Frequency and amplitude-stable balanced oscillator for VHF (I and II) and UHF
- Mixer stages with optimized suppression of oscillator and input frequency at IF-output
- Mixer with low intermodulation if large input signals are applied
- Balanced mixer with wide dynamic range and low-impedance inputs
- Internal band switch
- Low-noise, internal reference voltage

**P-DSO-20-1**

| Type | Ordering Code | Package |
|------|---------------|---------|
| MTI 3006X | Q67000-A5152 | P-DSO-20-1 (SMD) |
| MTI 3006X | Q67006-A5152 | P-DSO-20-1 Tape & Reel (SMD) |

## Functional Description and Application

This integrated circuit permits the design of TV-tuners covering the entire frequency range from 48 … 900 MHz split into 2 parts with 3 frequency bands.
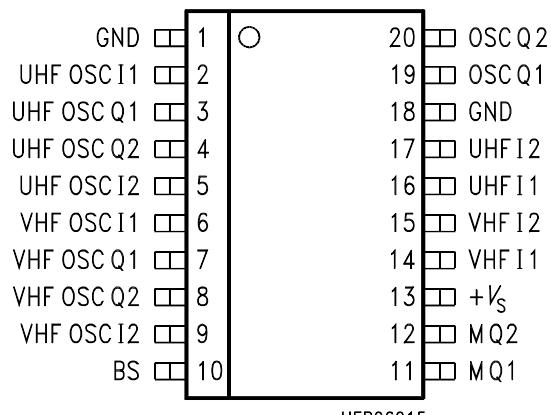
The application is suitable for all tuners in TV-and VCR-sets.

## Circuit Description

This IC includes 2 balanced mixers (double balanced mixer/ring mixer), two balanced oscillators for VHF (I and II) and UHF, a reference voltage source and band switch.

Filters between tuner input and IC separate the TV-frequency signal into two bands. The band switch ensures that only one band at a time is activated. In the activated band the signal passes a frontend stage with MOSFET-amplifier, a double-tuned bandpass filter and is then fed to the activated balanced mixer input of the IC which is a low-impedance stage for the VHF- and UHF-range, respectively.
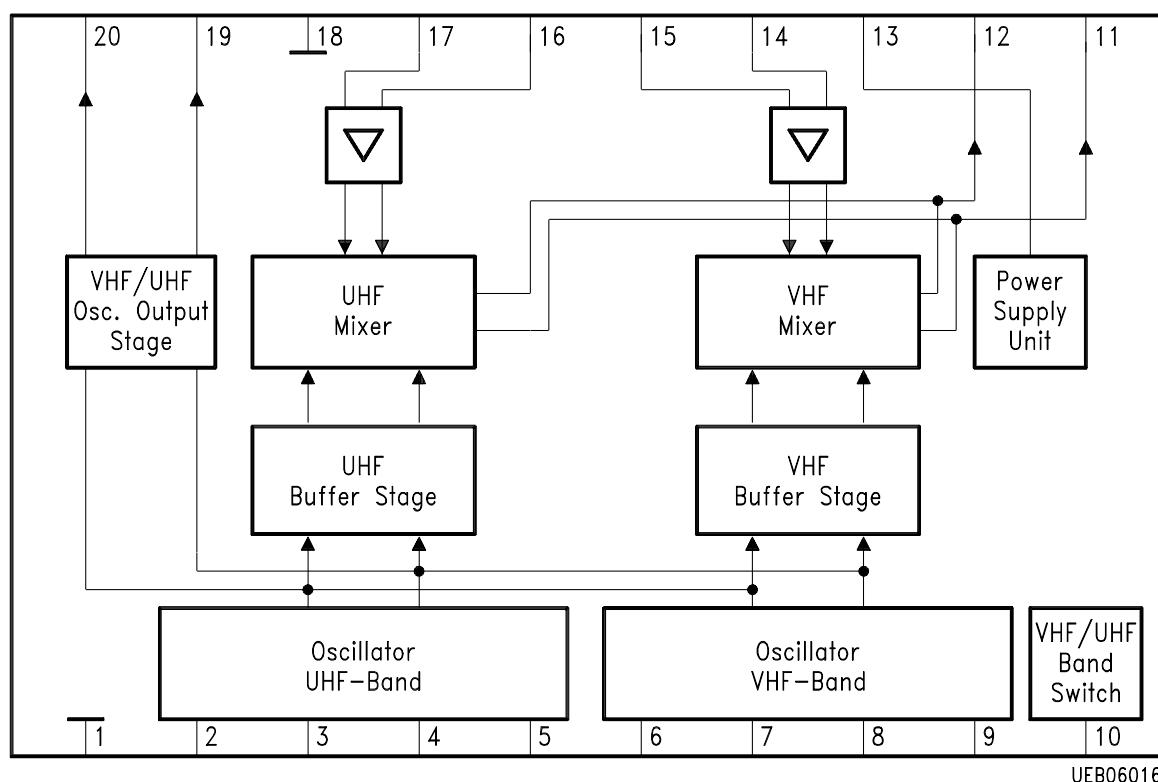
The input signal is mixed there with the oscillator signal from the activated oscillator section and fed to a common IF-stage for all bands.

## Pin Configuration
(top view)

```
        GND  ⊏⊐ 1   ○        20 ⊏⊐  OSC Q 2
   UHF OSC I1 ⊏⊐ 2            19 ⊏⊐  OSC Q 1
   UHF OSC Q1 ⊏⊐ 3            18 ⊏⊐  GND
   UHF OSC Q2 ⊏⊐ 4            17 ⊏⊐  UHF I 2
   UHF OSC I2 ⊏⊐ 5            16 ⊏⊐  UHF I 1
   VHF OSC I1 ⊏⊐ 6            15 ⊏⊐  VHF I 2
   VHF OSC Q1 ⊏⊐ 7            14 ⊏⊐  VHF I 1
   VHF OSC Q2 ⊏⊐ 8            13 ⊏⊐  +Vs
   VHF OSC I2 ⊏⊐ 9            12 ⊏⊐  M Q 2
         BS  ⊏⊐ 10           11 ⊏⊐  M Q 1
                   UEP06015
```

## Pin Definitions and Functions

| Pin No. | Symbol | Function |
|---------|--------|----------|
| 1 | GND | Ground |
| 2 | UHF Osc. Input 1 | UHF-oscillator amplifier, high-impedance base input, symmetrical to pin 5 |
| 3 | UHF Osc. Output 1 | UHF-oscillator amplifier, high-impedance collector output, symmetrical to pin 4 |

**Pin Definitions and Functions** (cont'd)

| Pin No. | Symbol | Function |
| --- | --- | --- |
| 4 | UHF Osc. Output 2 | UHF-oscillator amplifier, high-impedance collector output, symmetrical to pin 3 |
| 5 | UHF Osc. Input 2 | UHF-oscillator amplifier, high-impedance base input, symmetrical to pin 2 |
| 6 | VHF Osc. Input 1 | VHF-oscillator amplifier, high-impedance base input, symmetrical to pin 9 |
| 7 | VHF Osc. Output 1 | VHF-oscillator amplifier, high-impedance collector output, symmetrical to pin 8 |
| 8 | VHF Osc. Output 2 | VHF-oscillator amplifier, high-impedance collector output, symmetrical to pin 7 |
| 9 | VHF Osc. Input 2 | VHF-oscillator amplifier, high-impedance base input, symmetrical to pin 6 |
| 10 | Band Switching | VHF/UHF-band switching |
| 11 | Mixer Output 1 | Open collector mixer output, high-impedance, symmetrical to pin 12 |
| 12 | Mixer Output 2 | Open collector mixer output, high-impedance, symmetrical to pin 11 |
| 13 | + $V_S$ | Supply voltage |
| 14 | VHF Input 1 | VHF-mixer input low-impedance, symmetrical to pin 15 |
| 15 | VHF Input 2 | VHF-mixer input low-impedance, symmetrical to pin 14 |
| 16 | UHF Input 1 | UHF-mixer input low-impedance, symmetrical to pin 17 |
| 17 | UHF Input 2 | UHF-mixer input low-impedance, symmetrical to pin 16 |
| 18 | GND | Ground |
| 19 | Osc. Output 1 | VHF/UHF-oscillator signal output to PLL, symmetrical to pin 20 |
| 20 | Osc. Output 2 | VHF/UHF-oscillator signal output to PLL, symmetrical to pin 19 |

UEB06016

**Block Diagram**

## Absolute Maximum Ratings

$T_A$ = 0 to 70 °C

| Parameter | Symbol | Limit Values | | Unit |
|---|---|---|---|---|
| | | min. | max. | |
| Supply voltage | $V_{11, 12, 13}$ | – 0.3 | 14.5 | V |
| Switching voltage | $V_{10}$ | – 0.3 | $V_S$ | V |

According to the test circuit 1, only the provided circuitry can be connected to pins 1 to 9 and 14 to 20

| | | | | |
|---|---|---|---|---|
| Junction temperature | $T_j$ | | 150 | °C |
| Storage temperature | $T_{stg}$ | – 40 | 125 | °C |
| Thermal resistance | $R_{th}$ | | 125 | K/W |

## Operating Range

| | | | | |
|---|---|---|---|---|
| Supply voltage | $V_S$ | 10 | 13.2 | V |
| VHF-mixer input frequency range | $f_{VHF}$ | 30 | 500 | MHz |
| UHF-mixer input frequency range | $f_{UHF}$ | 30 | 900 | MHz |
| VHF-oscillator frequency range | $f_{OVHF}$ | 30 | 500 | MHz |
| UHF-oscillator frequency range | $f_{OUHF}$ | 30 | 900 | MHz |
| Ambient temperature | $T_A$ | 0 | 70 | °C |

## AC/DC Characteristics

$T_A = 25\ °C;\ V_S = 12\ V$

| Parameter | Symbol | Limit Values | | | Unit | Test Condition | Test Circuit |
|---|---|---|---|---|---|---|---|
| | | min. | typ. | max. | | | |
| Current consumption | $I_{13}$ | 20 | 28 | 36 | mA | $V_{10} > 1.6\ V$ | 1 |
| Oscillator output impedance | $R_{19,\,20}$ $C_{19,\,20}$ | | 200 2 | | $\Omega$ pF | Parallel equivalent circuit Parallel equivalent circuit | 2 2 |
| Mixer output impedance | $R_{11,\,12}$ $C_{11,\,12}$ | | 10 2 | | k$\Omega$ pF | Parallel equivalent circuit Parallel equivalent circuit | 2 2 |

**VHF-Circuit Section**

| Parameter | Symbol | Limit Values | | | Unit | Test Condition | Test Circuit |
|---|---|---|---|---|---|---|---|
| | | min. | typ. | max. | | | |
| Switching voltage | $V_{10}$ | 1.6 | | 2.3 | V | | 1 |
| Switching current | $I_{10}$ | | 10 | 30 | µA | $V_{10} = 2.1\ V$ | 1 |
| Oscillator frequency range | $f_{\text{VHF I}}$ $f_{\text{VHF II}}$ | 80 140 | | 170 450 | MHz MHz | $V_d = 0 \dots 28\ V$ $V_d = 0 \dots 28\ V$ | 1 |
| Oscillator drift | $\Delta f_{\text{VHF}}$ $\Delta f_{\text{VHF}}$ $\Delta f_{\text{VHF}}$ | | | 200 400 200 | kHz kHz kHz | $V_S = 12\ V \pm 10\ \%$ $\Delta T = 25\ °C$ $t = 5$ s to 15 min. after switching on | 1 1 1 |
| Oscillator level | $V_{19,\,20}$ | $-\,17$ | $-\,14$ | $-\,11$ | dBm | voltage on 50 $\Omega$ | 1 |
| Harmonic wave ratio | $a_{\text{H}}$ | 10 | 15 | | dB | | 1 |
| Crosstalk $f_{\text{in}}$/LO | $V_{14/15}$ | 150 | 1000 | | mVrms | max. input level for 10-dB distance $f_{\text{in}}$/LO | 1 |
| Mixer gain | $G_{\text{VHF}}$ | 11 | 14 | 17 | dB | | 1 |
| Mixer noise figure | $F_{\text{VHF I}}$ $F_{\text{VHF II}}$ | | 6.5 7.5 | 11 11 | dB dB | VHF 1; DSB VHF 2; DSB | 1 |
| Mixer input impedance | $R_{14/15}$ $L_{14/15}$ | | 25 10 | | $\Omega$ nH | serial equivalent circuit serial equivalent circuit | 1 1 |

## AC/DC Characteristics (cont'd)

$T_A = 25\ °C;\ V_S = 12\ V$

| Parameter | Symbol | Limit Values | | | Unit | Test Condition | Test Circuit |
|---|---|---|---|---|---|---|---|
| | | min. | typ. | max. | | | |

**VHF-Circuit Section** (cont'd)
**(Design Hints only)**

| Parameter | Symbol | min. | typ. | max. | Unit | Test Condition | Test Circuit |
|---|---|---|---|---|---|---|---|
| IF-suppression | $a_{IF}$ | | 20 | | dB | $V_{14/15} = 80\ dB\mu V$ | 1 |
| IM2 | $a_{IM2}$ | 60 | 70 | | dB | $f_D = 50\ MHz$ $f_U = 100.5\ MHz$ | 3 |
| | $a_{IM2}$ | 60 | 67 | | dB | $f_D = 200\ MHz$ $f_U = 400.5\ MHz$ | 3 |
| IM3 | $a_{IM3}$ | 60 | 65 | | dB | $f_D = 100\ MHz$ $f_{U1} = 150\ MHz$ $f_{U2} = 160\ MHz$ | 4 |
| | $a_{IM3}$ | 60 | 64 | | dB | $f_D = 200\ MHz$ $f_{U1} = 250\ MHz$ $f_{U2} = 260\ MHz$ | 4 |
| N + 5 pulling | $a_{N+5}$ | 50 | 60 | | dB | $f_D = 50\ MHz$ | 5 |
| | $a_{N+5}$ | 50 | 60 | | dB | $f_D = 200\ MHz$ | 5 |

**UHF-Circuit Section**

| Parameter | Symbol | min. | typ. | max. | Unit | Test Condition | Test Circuit |
|---|---|---|---|---|---|---|---|
| Switching voltage | $V_{10}$ | 3.2 | | $\leq V_S$ | V | | 1 |
| Switching current | $I_{10}$ | | 60 | 300 | µA | $V_{10} = V_S$ | 1 |
| Oscillator frequency range | $f_{UHF}$ | 440 | | 900 | MHz | $V_d = 0 \dots 28\ V$ | 1 |
| Oscillator drift | $\Delta f_{UHF}$ $\Delta f_{UHF}$ $\Delta f_{UHF}$ | | | 400 800 200 | kHz kHz kHz | $V_S = 12\ V \pm 10\ \%$ $\Delta T = 25\ °C$ $t = 5\ s$ to 15 min. after switching on | 1 1 1 |
| Oscillator level | $V_{19,\,20}$ | − 22 | − 17 | − 13 | dBm | voltage on 50 Ω | 1 |
| Harmonic wave ratio | $a_H$ | 10 | 20 | | dB | | 1 |
| Crosstalk $f_{in}$/LO | $V_{16/17}$ | 150 | 1000 | | mVrms | max. input level for 10-dB distance $f_{in}$/LO | 1 |
| Mixer gain | $G_{UHF}$ | 11 | 14 | 17 | dB | | 1 |
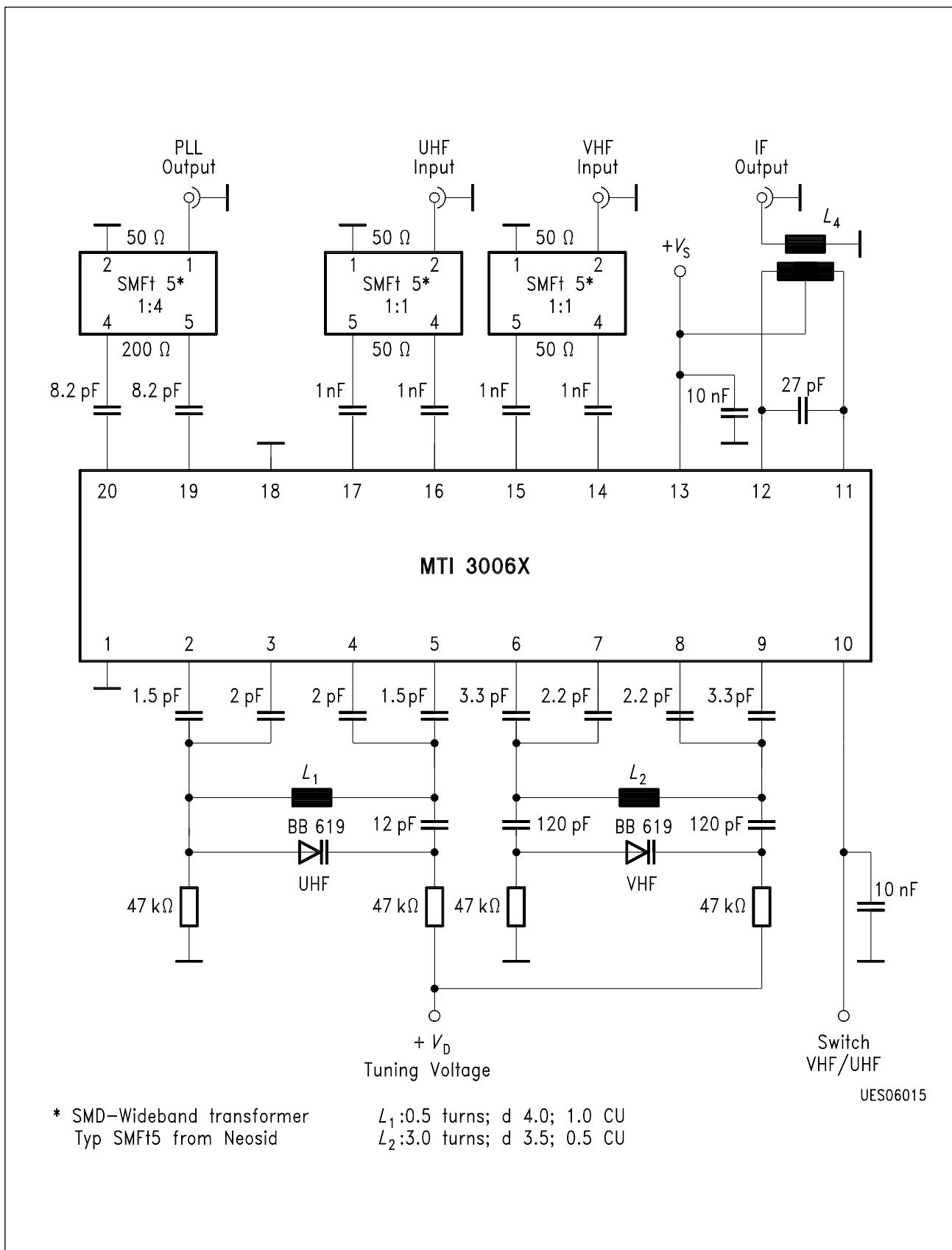
## AC/DC Characteristics  (cont'd)

$T_A = 25\ °C;\ V_S = 12\ V$
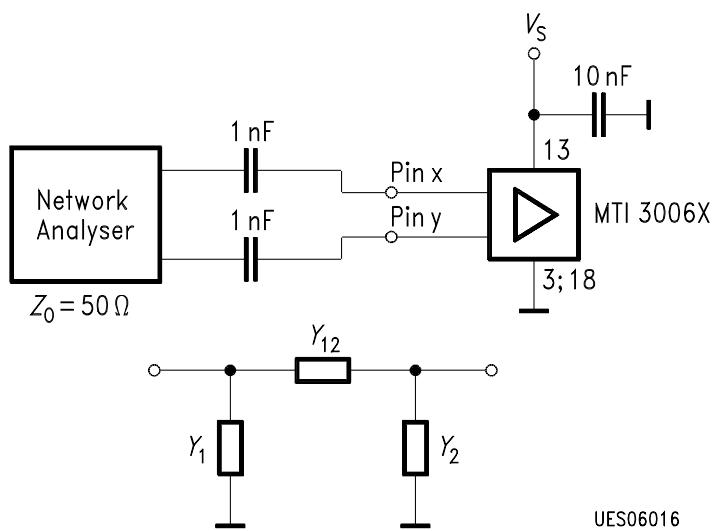
| Parameter | Symbol | Limit Values | | | Unit | Test Condition | Test Circuit |
|---|---|---|---|---|---|---|---|
| | | min. | typ. | max. | | | |
| Mixer noise figure | $F_{UHF}$ | | 8 | 12 | dB | DSB | 1 |
| Mixer input impedance | $R_{16/17}$ $L_{16/17}$ | | 25 10 | | $\Omega$ nH | serial equivalent circuit serial equivalent circuit | 2 2 |

**UHF-Circuit Section** (cont'd)
**(Design Hints only)**

| IF-suppression | $a_{ZF}$ | | 20 | | dB | $V_{16/17} = 80\ dB\mu V$ | 1 |
|---|---|---|---|---|---|---|---|
| IM2 | $a_{IM2}$ | 60 | 61 | | dB | $f_D = 400\ MHz$ $f_U = 800.5\ MHz$ | 3 |
| IM3 | $a_{IM3}$ | 60 | 66 | | dB | $f_D = 600\ MHz$ $f_{U1} = 650\ MHz$ $f_{U2} = 660\ MHz$ | 4 |
| | $a_{IM3}$ | 60 | 70 | | dB | $f_D = 850\ MHz$ $f_{U1} = 800\ MHz$ $f_{U2} = 790\ MHz$ | 4 |
| N + 5 pulling | $a_{N+5}$ $a_{N+5}$ | 50 50 | 60 60 | | dB dB | $f_D = 500\ MHz$ $f_D = 800\ MHz$ | 5 5 |

PLL

UHF
Input

VHF
Input

$L_4$

50 Ω
50 Ω
50 Ω

2   SMFt 5*   1
1:4
4    5

1   SMFt 5*   2
1:1
5    4

1   SMFt 5*   2
1:1
5    4

$+V_S$

200 Ω
50 Ω
50 Ω

8.2 pF   8.2 pF
1 nF   1 nF
1 nF   1 nF

10 nF
27 pF

| 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 |
|----|----|----|----|----|----|----|----|----|----|

**MTI 3006X**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|----|

1.5 pF   2 pF   2 pF   1.5 pF   3.3 pF   2.2 pF   2.2 pF   3.3 pF

$L_1$

BB 619

$L_2$

BB 619

12 pF

120 pF   120 pF

UHF

VHF

47 kΩ

47 kΩ   47 kΩ

47 kΩ

10 nF

$+V_D$
Tuning Voltage

Switch
VHF/UHF

UES06015

\* SMD−Wideband transformer    $L_1$ : 0.5 turns; d 4.0; 1.0 CU
Typ SMFt5 from Neosid    $L_2$ : 3.0 turns; d 3.5; 0.5 CU

## Test Circuit 1

Measurment of the 4−pole matrix
S11, S12, S21, S22 and calculation of the
π−equivalent circuit, which follows from that
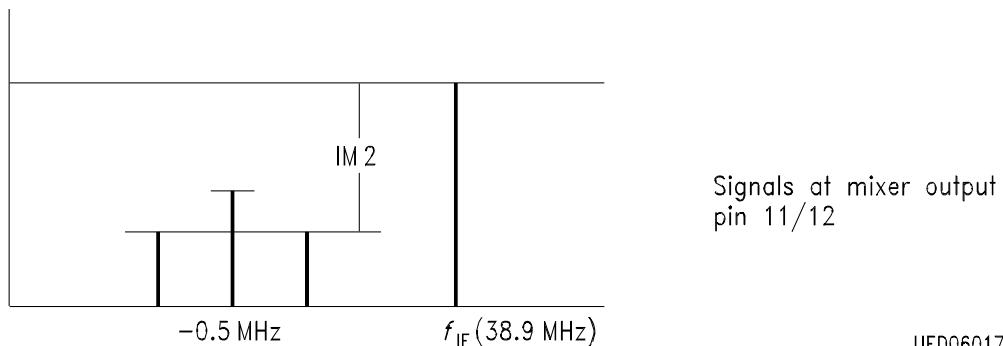
**Test Circuit 2**

| Test Point | Test Frequency in MHz | Pin x | Pin y |
|---|---|---|---|
| Oscillator output impedance | 100 | 19 | 20 |
| Mixer input impedance VHF | 100 | 14 | 15 |
| Mixer input impedance UHF | 600 | 17 | 18 |
| Mixer output impedance VHF/UHF | 100/600 | 11 | 12 |

80 dB   $\mu$V

8 dB

Signals at mixer input
pin 14/15 or 16/17

$f_D$        $f_U$

| $f_D$ | 50 | 200 | 400 | MHz |
|---|---|---|---|---|
| $f_U$ | 100.5 | 400.5 | 800.5 | MHz ; $f_{mod} = 50$ kHz ; AM = 80% |

IM 2

Signals at mixer output
pin 11/12

$-0.5$ MHz        $f_{IF}$ (38.9 MHz)
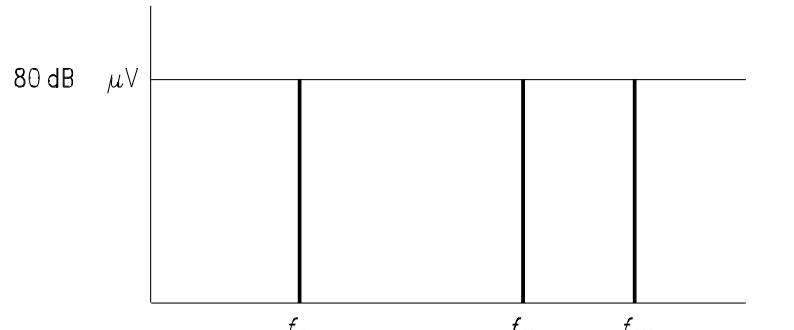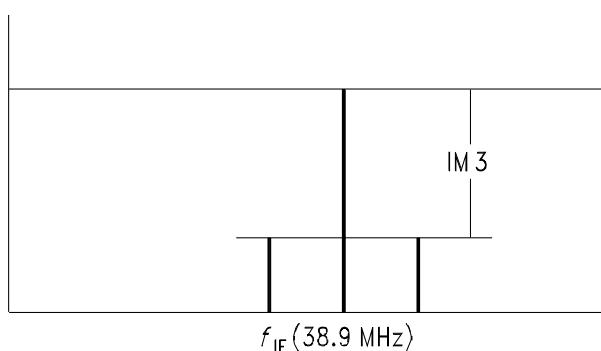
UED06017

**Test Circuit 3**
**IM2 ($f_U - f_D$) Transfer to $f_{IF}$**

80 dB  μV

Signals at mixer input
pin 14/15 or 16/17

$f_D$    $f_{U1}$    $f_{U2}$

| $f_D$ | 100 | 200 | 400 | 600 | 850 | MHz |
| $f_{U1}$ | 150 | 250 | 450 | 650 | 800 | MHz |
| $f_{U2}$ | 160 | 260 | 460 | 660 | 790 | MHz |

IM 3

Signals at mixer output
pin 11/12

$f_{IF}$ (38.9 MHz)
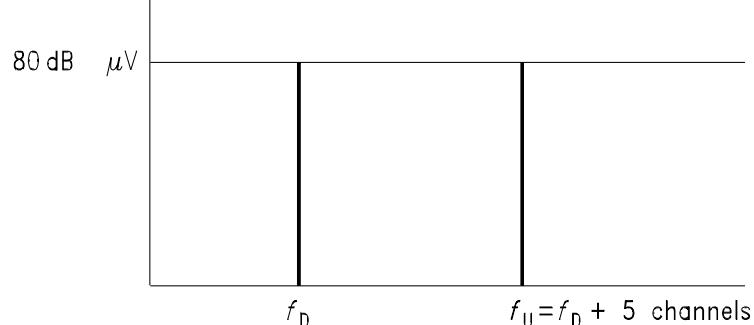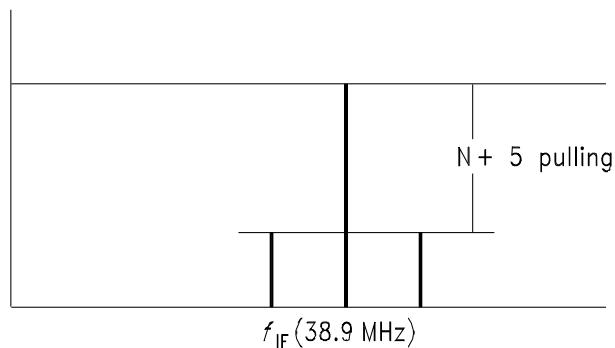
UED06018

**Test Circuit 4**
**IM3 ($f_{U2} - f_{U1}$) Transfer to $f_{IF} \pm (f_{U2} - f_{U1}$)**

80 dB   $\mu$V

$f_D$       $f_U = f_D$ + 5 channels

Signals at mixer input
pin 14/15 or 16/17

N + 5 pulling

Signals at mixer output
pin 11/12

$f_{IF}$ (38.9 MHz)
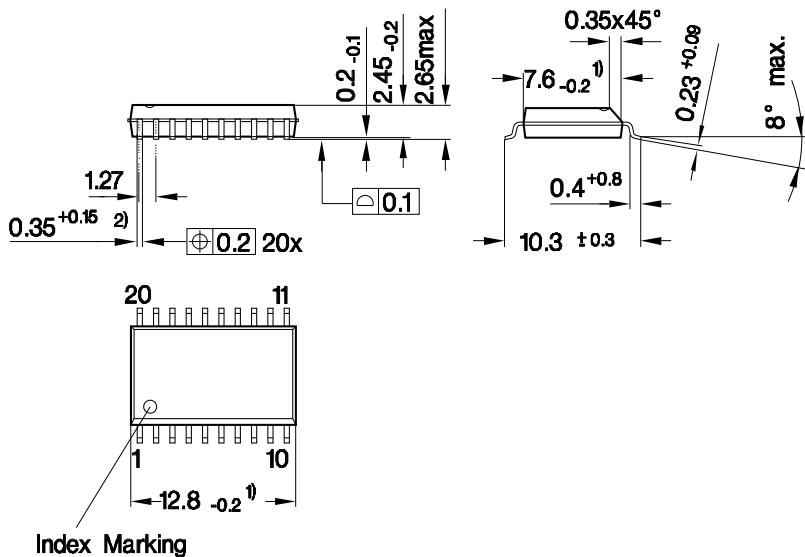
UED06019

**Test Circuit 5**
**N + 5 Pulling**

## Package Outline

**Plastic Package, P-DSO-20-1 (SMD)**
(Plastic Dual Small Outline Package)



Index Marking

1) Does not include plastic or metal protrusion of 0.15 max. per side
2) Does not include dambar protrusion of 0.05 max. per side

GPS05094

**Sorts of Packing**
Package outlines for tubes, trays etc. are contained in our
Data Book "Package Information"

SMD = Surface Mounted Device

Dimensions in mm