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# Wireless Components

TV Mixer-Oscillator-PLL

TUA 6010XS Version 1.0

Specification August 1999

preliminary

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## Product Info

### General Description

The **TUA 6010XS** device combines a digitally programmable phase locked loop (PLL), with a mixer-oscillator block including two balanced mixers and oscillators for use in TV tuners.

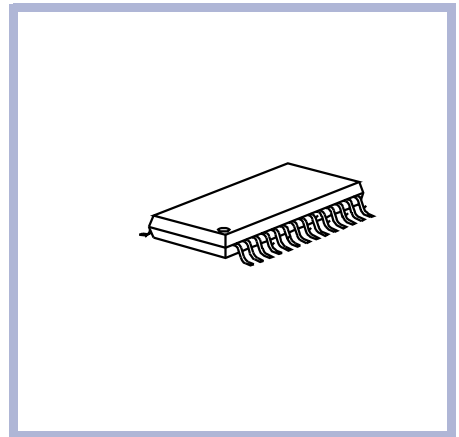
### Features

- PLL with short lock-in time; no asynchronous divider stage
- Fast I<sup>2</sup>C bus mode possible
- 4 programmable chip addresses
- Short pull-in time for quick channel access and optimized loop stability
- 3 high-current switch outputs
- 2 TTL inputs
- 5-level A/D converter
- Lock-in flag
- Power-down flag
- Few external components
- Frequency and amplitude-stable balanced oscillator for the VHF, HYPER and UHF frequency range
- Optimum decoupling of input frequency from oscillator

### Application

- The IC is suitable for all tuners in TV- and VCR-sets or cable set-top receivers for analog TV and Digital Video Broadcasting.

### Package



- Double balanced mixer with wide dynamic range and low-impedance inputs for the VHF, HYPER and UHF frequency range
- Internal band switch
- Internal low-noise reference voltage source
- Package TSSOP 28
- Full ESD protection

### Ordering Information

Type	Ordering Code	Package
TUA 6010 XS	Q67007-A5211	P-TSSOP-28-1

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# 2 Product Description

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## 2.1 Overview

The **TUA 6010XS** device combines a digitally programmable phase locked loop (PLL), with a mixer-oscillator block including two balanced mixers and oscillators for use in TV tuners.

The PLL block with four hard-switched chip addresses forms a digitally programmable phase locked loop. With a 4 MHz quartz crystal, the PLL permits precise setting of the frequency of the tuner oscillator up to 900 MHz in increments of 62.5 kHz. The tuning process is controlled by a microprocessor via an I<sup>2</sup>C bus. The device has three output ports, which all can also be used as input ports (two TTL inputs and one A/D converter input). A flag is set when the loop is locked. The input ports and lock flag can be read by the processor via the I<sup>2</sup>C bus. The mixer-oscillator block includes two balanced mixers (double balanced mixer with low-impedance input), two frequency and amplitude-stable balanced oscillators for VHF, HYPER and UHF, a low-noise reference voltage source and a band switch.

## 2.2 Features

- PLL with short lock-in time; no asynchronous divider stage
- Fast I<sup>2</sup>C bus mode possible
- 4 programmable chip addresses
- Short pull-in time for quick channel access and optimized loop stability
- 3 high-current switch outputs
- 2 TTL inputs
- 5-level A/D converter
- Lock-in flag
- Power-down flag
- Few external components
- Frequency and amplitude-stable balanced oscillator for the VHF, HYPER and UHF frequency range
- Optimum decoupling of input frequency from oscillator
- Double balanced mixer with wide dynamic range and low-impedance inputs for the VHF, HYPER and UHF frequency range
- Internal band switch
- Internal low-noise reference voltage source
- Package TSSOP 28
- Full ESD protection

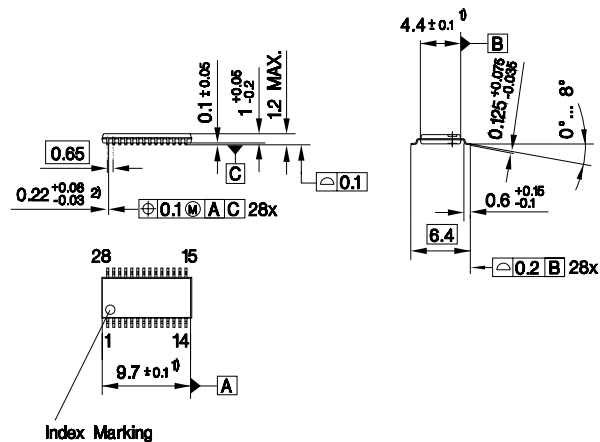
## 2.3 Application

- The IC is suitable for all tuners in TV- and VCR-sets or cable set-top receivers for analog TV and Digital Video Broadcasting.

## 2.4 Package Outlines

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P-TSSOP-28-1



Index Marking

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

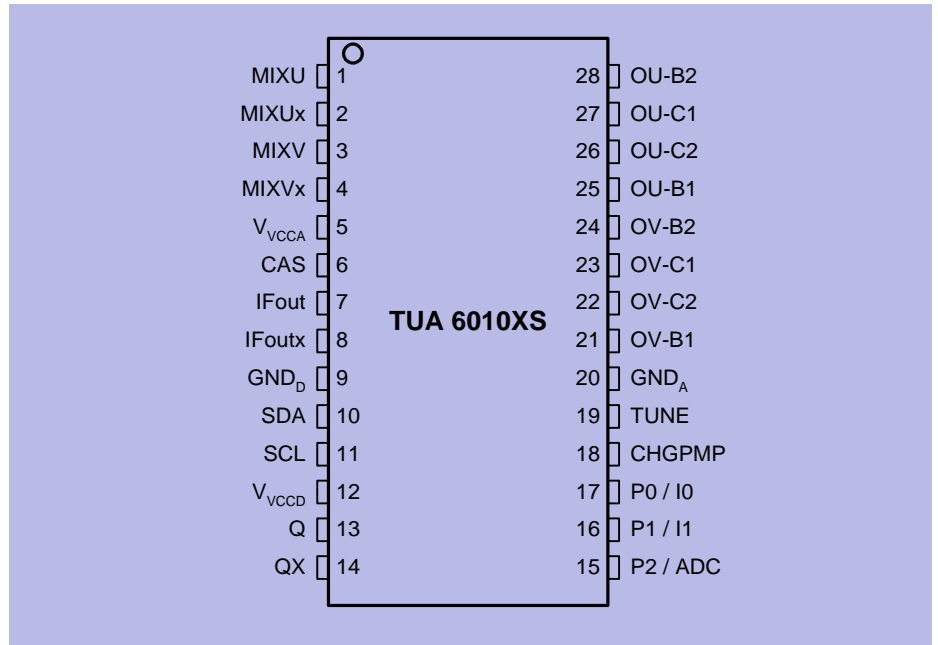
# 3 Functional Description

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### 3.1 Pin Configuration

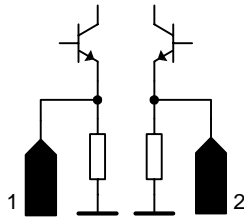
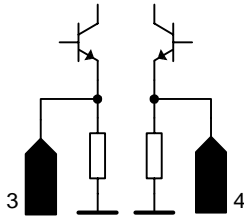
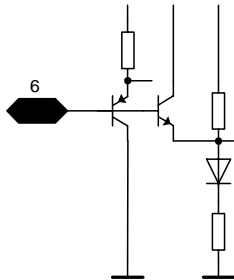
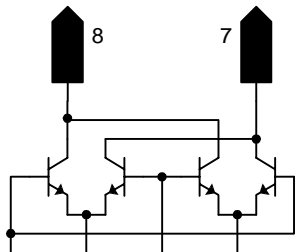


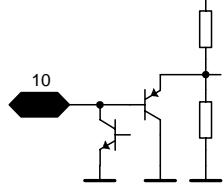
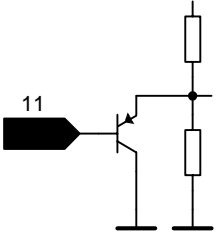
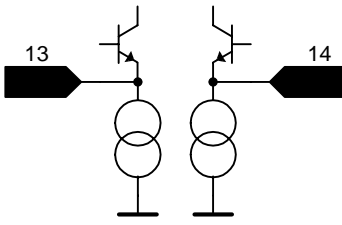
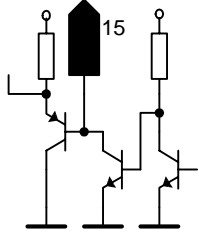
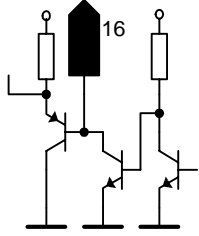
Pin\_config.wmf

Figure 3-1 Pin Configuration

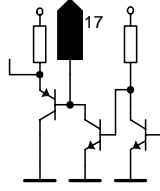
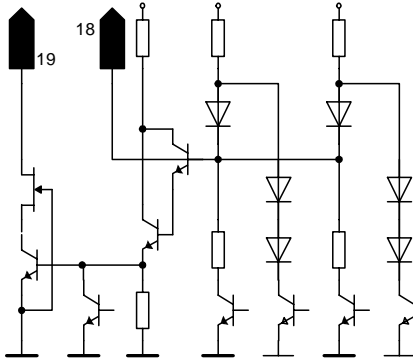
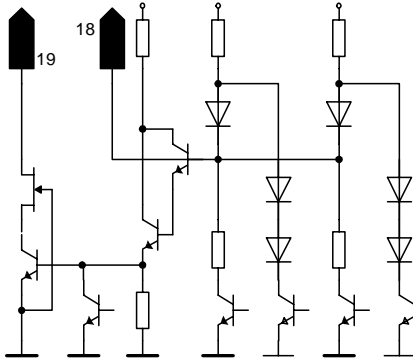
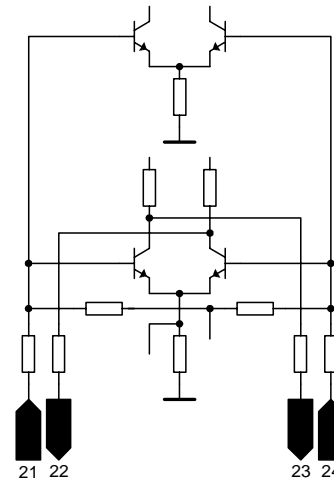
### 3.2 Pin Definition and Function

Table 3-1 Pin Definition and Function

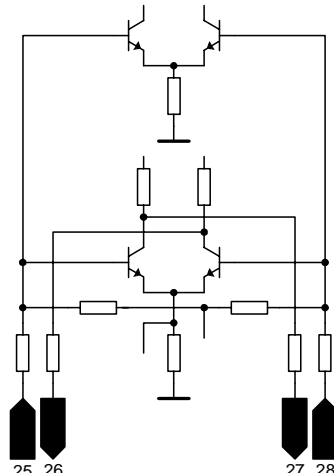
Pin No.	Symbol		Function
1	MIXU		UHF mixer input, low-impedance, symmetrical to MIXUx
2	MIXUx		UHF mixer input, low-impedance, symmetrical to MIXU
3	MIXV		VHF or HYPER mixer input, low-impedance, symmetrical to MIXVx
4	MIXVx		VHF or HYPER mixer input, low-impedance, symmetrical to MIXV
5	V <sub>VCCA</sub>		Positive supply voltage for analog block
6	CAS		Chip address select
7	IFout		Open collector mixer output, high-impedance, symmetrical to IFoutx
8	IFoutx		Inverse open collector mixer output, high-impedance, symmetrical to IFout
9	GND <sub>D</sub>		Digital Ground

10	SDA		Data input/output for the I <sup>2</sup> C bus
11	SCL		Clock input for the I <sup>2</sup> C bus
12	V <sub>VCCD</sub>		Positive supply voltage for digital block (PLL)
13	Q		4 MHz low-impedance crystal oscillator input
14	Qx		Inverse 4 MHz low-impedance crystal oscillator input
15	P2/ADC		Port output / ADC input
16	P1/I1		Port output / TTL input

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17	P0/I0		Port output / TTL input
18	CHGPMP		Charge pump output / loop filter
19	TUNE		VCO tuning voltage output
20	GND <sub>A</sub>		Analog Ground
21	OV-B1		VHF oscillator amplifier, high-impedance base input, symmetrical to OV-B2
22	OV-C2		VHF oscillator amplifier, high-impedance collector output, symmetrical to OV-C1
23	OV-C1		VHF oscillator amplifier, high-impedance collector output, symmetrical to OV-C2
24	OV-B2		VHF oscillator amplifier, high-impedance base input, symmetrical to OV-B1

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25	OU-B1		UHF oscillator amplifier, high-impedance base input, symmetrical to OU-B2
26	OU-C2		UHF oscillator amplifier, high-impedance collector output, symmetrical to OU-C1
27	OU-C1		UHF oscillator amplifier, high-impedance collector output, symmetrical to OU-C2
28	OU-B2		UHF oscillator amplifier, high-impedance base input, symmetrical to OU-B1

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### 3.3 Block Diagram

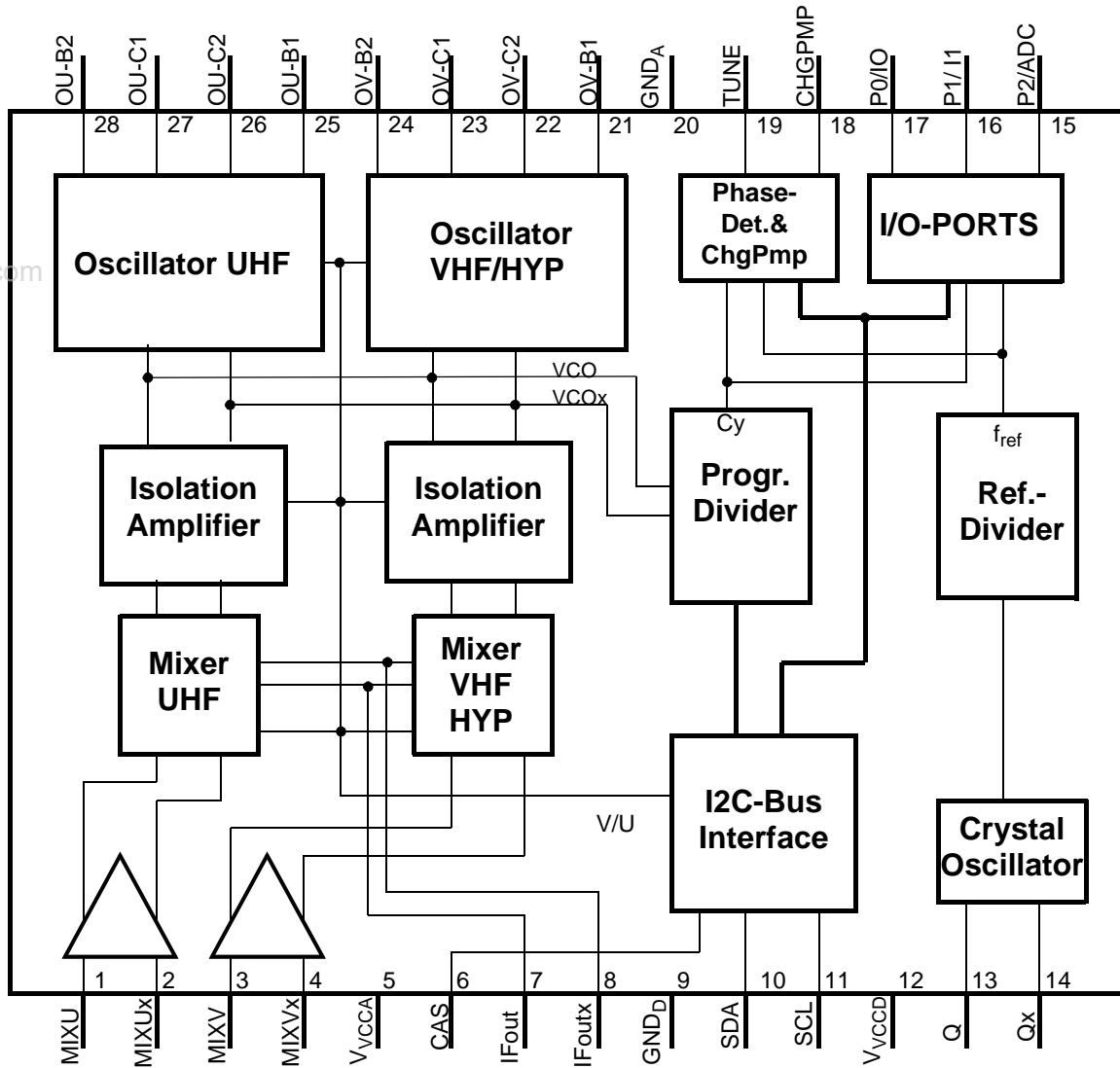


Figure 3-2 Block Diagram

## 3.4 Circuit Description

### 3.4.1 Mixer-Oscillator block

The mixer oscillator section includes two balanced mixers (double balanced mixer), two balanced oscillators for VHF and/or HYPER and UHF, a reference voltage source and a band switch.

Filters between tuner input and IC separate the TV frequency signals into two bands. The band switch ensures that only one mixer-oscillator block at a time is activated. In the activated band the signal passes a frontend stage with MOS-FET amplifier, a double-tuned bandpass filter and is then fed to the balanced mixer input of the IC which has a low-impedance input.

The input signal is mixed there with the on chip oscillator signal from the activated oscillator section.

### 3.4.2 PLL block

The mixer-oscillator signal VCO/VCOx is internally DC-coupled as a differential signal at the programmable divider inputs. The signal subsequently passes through a programmable divider with ratio  $N = 256$  through 32767 and is then compared in a digital frequency / phase detector to a reference frequency  $f_{ref} = 62.5$  kHz.

This frequency is derived from a balanced, low-impedance 4 MHz crystal oscillator (pin Q, Qx) divided by  $Q = 64$ .

The phase detector has two outputs UP and DOWN that drive two current sources I+ and I- of a charge pump. If the negative edge of the divided VCO signal appears prior to the negative edge of the reference signal, the I+ current source pulses for the duration of the phase difference. In the reverse case the I- current source pulses. If the two signals are in phase, the charge pump output (CHGPMP) goes into the high-impedance state (PLL is locked). An active low-pass filter integrates the current pulses to generate the tuning voltage for the VCO (internal amplifier, external pullup resistor at TUNE and external RC circuitry). The charge pump output is also switched into the high-impedance state when the control bit T0 = 1. Here it should be noted, however, that the tuning voltage can alter over a long period in the high-impedance state as a result of self-discharge in the peripheral circuitry. TUNE may be switched off by the control bit OS to allow external adjustments.

When the VCO is not working the PLL locks to a tuning voltage of 33V.

By means of control bit 5I the pump current can be switched between two values by software. This programmability permits alteration of the control response of the PLL in the locked-in state. In this way different VCO gains can be compensated, for example.

The software-switched ports P0, P1, P2 are general-purpose open-collector outputs. The test bit T1 = 1, switches the test signals  $f_{ref}$  (4 MHz / 64) and  $C_y$  (divided input signal) to P0 and P1 respectively. P0, P1, P2 are bidirectional.

The lock detector resets the lock flag FL when the width of the charge pump current pulses is greater than the period of the crystal oscillator (i.e. 250 ns). Hence, when FL = 1, the maximum deviation of the input frequency from the programmed frequency is given by

$$\Delta f = \pm I_P (K_{VCO} / f_Q) (C_1 + C_2) / (C_1 C_2)$$

where  $I_P$  is the charge pump current,  $K_{VCO}$  the VCO gain,  $f_Q$  the crystal oscillator frequency and  $C_1$ ,  $C_2$  the capacitances in the loop filter (see application circuit). As the charge pump pulses at 62.5 kHz (=  $f_{ref}$ ), it takes a maximum of 16  $\mu$ s for FL to be reset after the loop has lost lock state.

Once FL has been reset, it is set only if the charge pump pulse width is less than 250 ns for eight consecutive  $f_{ref}$  periods. Therefore it takes between 128 and 144  $\mu$ s for FL to be set after the loop regains lock.

### 3.4.3 I<sup>2</sup>C-Bus Interface

Data is exchanged between the processor and the PLL via the I<sup>2</sup>C bus. The clock is generated by the processor (input SCL), while pin SDA functions as an input or output depending on the direction of the data (open collector, external pull-up resistor). Both inputs have hysteresis and a low-pass characteristic, which enhance the noise immunity of the I<sup>2</sup>C bus.

The data from the processor pass through an I<sup>2</sup>C bus controller. Depending on their function the data are subsequently stored in registers. If the bus is free, both lines will be in the marking state (SDA, SCL are HIGH). Each telegram begins with the start condition and ends with the stop condition. Start condition: SDA goes LOW, while SCL remains HIGH. Stop condition: SDA goes HIGH while SCL remains HIGH. All further information transfer takes place during SCL = LOW, and the data is forwarded to the control logic on the positive clock edge.

The table 1 "bit allocation" should be referred to the following description. All telegrams are transmitted byte-by-byte, followed by a ninth clock pulse, during which the control logic returns the SDA line to LOW (acknowledge condition). The first byte is comprised of seven address bits. These are used by the processor to select the PLL from several peripheral components (chip select). The LSB bit (R/W) determines whether data are written into (R/W = 0) or read from (R/W = 1) the PLL.

In the data portion of the telegram during a WRITE operation, the MSB bit of the first or third data byte determines whether a divider ratio or control information is to follow. In each case the second byte of the same data type has to follow the first byte.

If the address byte indicates a READ operation, the PLL generates an acknowledge and then shifts out the status byte onto the SDA line. If the processor generates an acknowledge, a further status byte is output; otherwise the data line



is released to allow the processor to generate a stop condition. The status word consists of two bits from the TTL input ports, three bits from the A/D converter, the lock flag and the power-on flag.

Four different chip addresses can be set by appropriate connection of pin CAS (see table 2 "address selection").

When the supply voltage is applied, a power-on reset circuit prevents the PLL from setting the SDA line to LOW, which would block the bus. The power-on reset flag POR is set at power-on and when  $V_{VCCD}$  goes below 3.2 V. It will be reset at the end of a READ operation.

# 4 Applications

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### 4.1 Application Circuit

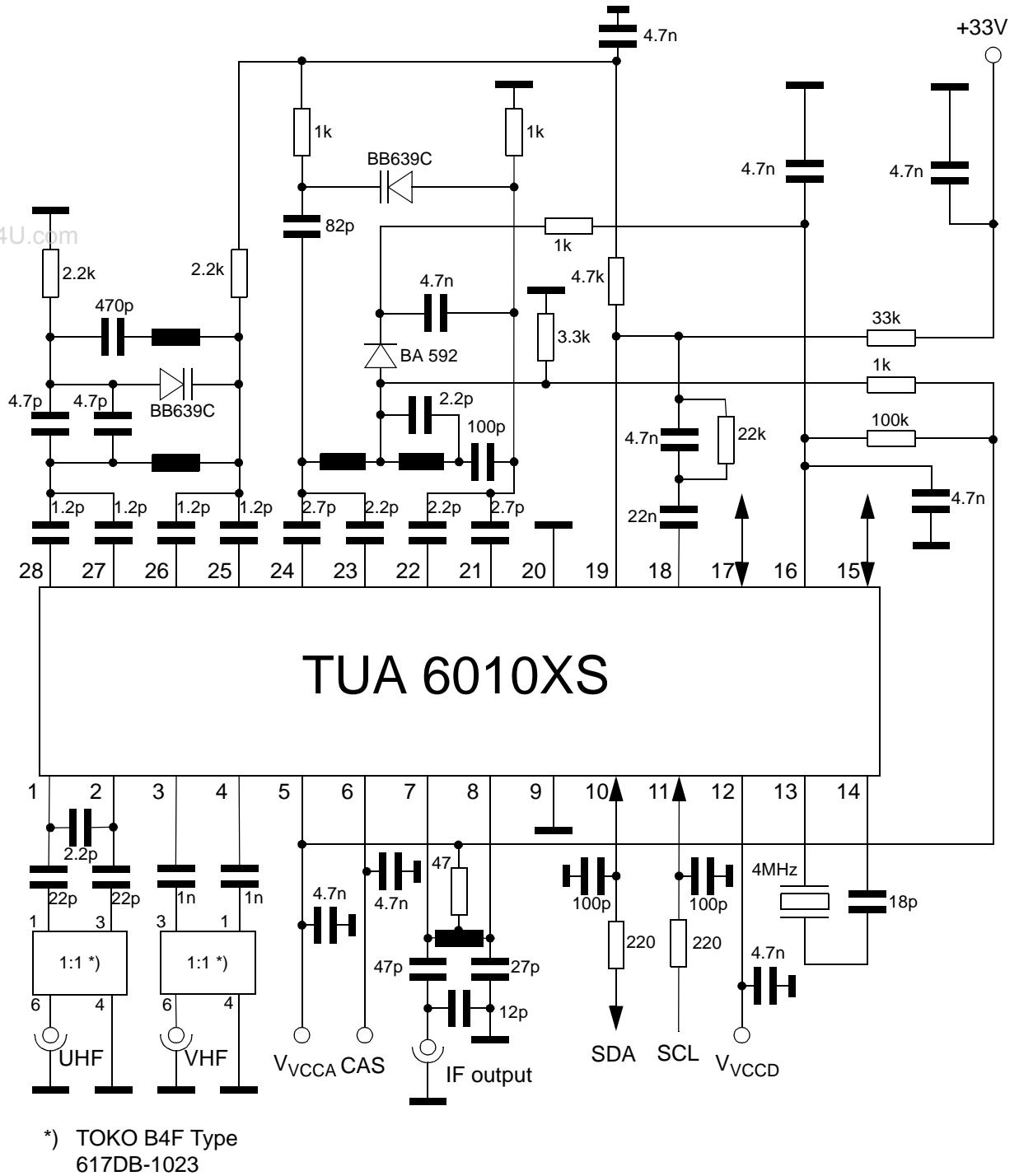


Figure 4-1 Evaluation Board

## **4.2 Hints**

See separate available **Application Note TUA 6010XS**.

# 5 Reference

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## 5.1 Electrical Data

### 5.1.1 Absolute Maximum Ratings

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**WARNING**

The maximum ratings may not be exceeded under any circumstances, not even momentarily and individually, as permanent damage to the IC will result.

**Table 5-1 Absolute Maximum Ratings, Ambient temperature  $T_{AMB} = -20^{\circ}\text{C} \dots +80^{\circ}\text{C}$** 

Parameter	Symbol	Limit Values		Unit	Remarks
		min	max		
<b>PLL</b>					
Supply voltage	$V_{VCCD}$	-0.3	+6	V	
CHGPMP	$V_{CHGPMP}$ $I_{CHGPMP}$	-0.3	1	V mA	
Crystal oscillator pins Q, Qx	$V_Q$ $I_Q$	-5	$V_{VCCD}$	V mA	
Bus input/output SDA Bus output current SDA	$V_{SDA}$ $I_{SDA(L)}$	-0.3	+6 5	V mA	
Bus input SCL	$V_{SCL}$	-0.3	+6	V	
Port outputs P0, P1, P2	$V_P$	-0.3	+13	V	
Chip address switch CAS	$V_{CAS}$	-0.3	$V_{VCCD}$	V	
VCO tuning output (loop filter)	$V_{TUNE}$	-0.3	+35	V	
Bus output SDA	$I_{SDAL}$	-1	5	mA	open collector
Port outputs P0, P1, P2	$I_{P(L)}$	-1	15	mA	open collector
Total port output current	$\Sigma I_{P(L)}$		20	mA	$t_{max} = 0,1 \text{ sec. at } 6 \text{ V}$
Junction temperature	$T_J$		+125	$^{\circ}\text{C}$	
Storage temperature	$T_{Stg}$	-40	+125	$^{\circ}\text{C}$	
Thermal resistance (junction to ambient)	$R_{thSA}$		130	K/W	

**Table 5-1 Absolute Maximum Ratings, Ambient temperature  $T_{AMB} = -20^{\circ}\text{C} \dots +80^{\circ}\text{C}$  (continued)**

Parameter	Symbol	Limit Values		Unit	Remarks
		min	max		
<b>Mixer-Oscillator</b>					
Supply voltage	$V_{VCCA}$	-0.3	+6	V	
Mix inputs VHF/UHF	$V_{MIX\ V/U}$ $I_{MIX\ V/U}$	-5	2 6	V mA	
VCO base voltage	$V_{OU-B/OV-B}$	-0.3	3	V	
VCO collector voltage	$V_{OU-C/OV-C}$		$V_{VCCA}$	V	
IF output	$V_{IFout}$ $V_{IFoutx}$		6	V	

All values are referred to ground (pin), unless stated otherwise.

Currents with a positive sign flows into the pin and currents with a negative sign flows out of pin.

**ESD-Protection\***

all pins unless otherwise specified	$V_{ESD}$	-1	1	kV	
Mixer inputs MIXU / MIXV	$V_{ESD\ MIX}$	-500	500	V	Pin 1, 2, 3, 4
Mixer outputs IFout / IFoutx	$V_{ESD\ IF}$	-500	500	V	Pin 7, 8
Ports	$V_{ESD\ P}$	-500	500	V	Pin 15, 16, 17
Charge pump	$V_{ESD\ CP}$	-500	500	V	Pin 18

\*according to MIL STD 883D, method 3015.7 and EOS/ESD assn. standard S5.1 - 1993

### 5.1.2 Operating Range

Within the operational range the IC operates as described in the circuit description. The AC / DC characteristic limits are not guaranteed.

**Table 5-2 Operating Range**

Parameter	Symbol	Limit Values		Unit	Test Conditions	L	Item
		min	max				
Supply voltage	$V_{VCCD}$	+4.5	+5.5	V			
Supply voltage	$V_{VCCA}$	+4.5	+5.5	V			
Mixer output voltage	$V_{IFout}$ $V_{IFoutx}$	+4.5	+5.5	V	open collector		
Programmable divider factor	N	256	32767				
VHF Mixer input frequency range	$f_{MIXV}$	30	500	MHz			
UHF Mixer input frequency range	$f_{MIXU}$	400	900	MHz			
VHF Oscillator frequency range	$f_{OV}$	30	500	MHz			
UHF Oscillator frequency range	$f_{OU}$	400	900	MHz			
Ambient temperature	$T_{amb}$	-20	+80	$^{\circ}\text{C}$			

### 5.1.3 AC/DC Characteristics

**Table 5-3 AC/DC Characteristics with  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ,  $V_{VCCA} = 5\text{ V}$ ,  $V_{VCCD} = 5\text{ V}$** 

	Symbol	Limit Values			Unit	Test Conditions	L	Item
		min	typ	max				
<b>Digital Unit</b>								
<b>PLL</b>								<b>1.1</b>
Supply current	$I_{VCCD}$	19	24	29	mA	$V_{VCCD} = 5\text{ V}$		
<b>Crystal oscillator connections Q, Qx</b>								
Crystal frequency	$f_Q$	3.2	4.0	4.8	MHz	series resonance		
Crystal resistance	$R_Q$	10		100	$\Omega$	series resonance		
Oscillation frequency	$f_Q$	3,99975	4,000	4,00025	MHz	$f_Q = 4\text{ MHz}$		
Input impedance	$Z_Q$	-600	-750	-900	$\Omega$	$f_Q = 4\text{ MHz}$		
Margin from 1st (fundamental) to 2nd and 3rd harmonics	$a_H$	20			dB	$f_Q = 4\text{ MHz}$		
<b>Charge pump output CHGPMP</b>								
HIGH output current	$I_{CPH}$	$\pm 90$	$\pm 220$	$\pm 300$	$\mu\text{A}$	$5I = 1, V_{CP} = 2\text{ V}$		
LOW output current	$I_{CPL}$	$\pm 22$	$\pm 50$	$\pm 75$	$\mu\text{A}$	$5I = 0, V_{CP} = 2\text{ V}$		
Tristate current	$I_{CPZ}$		+1		nA	$T0 = 1, V_{CP} = 2\text{ V}$		
Output voltage	$V_{CP}$	1.0		2.5	V	locked		
<b>Drive output TUNE (open collector)</b>								
HIGH output current	$I_{TH}$			10	$\mu\text{A}$	$V_{TH} = 33\text{ V}, T0 = 1$		
LOW output voltage	$V_{TL}$			0.5	V	$I_{TL} = 1.0\text{ mA}$		
<b>I<sup>2</sup>C-Bus</b>								<b>1.2</b>
<b>Bus inputs SCL, SDA</b>								
HIGH input voltage	$V_{IH}$	3		5.5	V			
LOW input voltage	$V_{IL}$	0		1.5	V			
HIGH input current	$I_{IH}$			10	$\mu\text{A}$	$V_{IH} = V_S$		
LOW input current	$I_{IL}$	-10			$\mu\text{A}$	$V_{IL} = 0\text{ V}$		
<b>Bus output SDA (open collector)</b>								
HIGH output current	$I_{OH}$			10	$\mu\text{A}$	$V_{OH} = 5.5\text{ V}$		
LOW output voltage	$V_{OL}$			0.4	V	$I_{OL} = 3\text{ mA}$		
<b>Edge speed SCL, SDA</b>								
Rise time	$t_r$			300	ns			
Fall time	$t_f$			300	ns			



**Table 5-3 AC/DC Characteristics with  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ,  $V_{VCCA} = 5\text{ V}$ ,  $V_{VCCD} = 5\text{ V}$  (Continued)**

	Symbol	Limit Values			Unit	Test Conditions	L	Item
		min	typ	max				
<b>Clock timing SCL</b>								
Frequency	$f_{SCL}$	0		400	kHz			
HIGH pulse width	$t_H$	0.6			$\mu\text{s}$			
LOW pulse width	$t_L$	1.3			$\mu\text{s}$			
<b>Start condition</b>								
Set-up time	$t_{susta}$	0.6			$\mu\text{s}$			
Hold time	$t_{hsta}$	0.6			$\mu\text{s}$			
<b>Stop condition</b>								
Set up time	$t_{susto}$	0.6			$\mu\text{s}$			
Bus free	$t_{buf}$	1.3			$\mu\text{s}$			
<b>Data transfer</b>								
Set-up time	$t_{sudat}$	0.1			$\mu\text{s}$			
Hold time	$t_{hdat}$	0			$\mu\text{s}$			
Input hysteresis SCL, SDA <sup>(1)</sup>	$V_{hys}$		200		mV			
Pulse width of spikes which are suppressed	$t_{sp}$	0		50	ns			
Capacitive load for each bus line	$C_L$			400	pF			
<b>Port outputs P0, P1, P2 (open collector)</b>								
HIGH output current	$I_{POH}$			1	$\mu\text{A}$	$V_{POH} = 5\text{ V}$		
LOW output voltage	$V_{POL}$			0.5	V	$I_{POL} = 15\text{ mA}$		
<b>TTL port inputs P0, P1</b>								
HIGH input voltage	$V_{PIH}$	2.7			V			
LOW input voltage	$V_{PIL}$			0.8	V			
HIGH input current	$I_{PIH}$			10	$\mu\text{A}$	$V_{PIH} = 13.5\text{ V}$		
LOW input current	$I_{PIL}$	-10			$\mu\text{A}$	$V_{PIL} = 0\text{ V}$		
<b>ADC port input P2</b>								
HIGH input current	$I_{ADCH}$			10	$\mu\text{A}$			
LOW input current	$I_{ADCL}$	-10			$\mu\text{A}$			
<b>Address selection input CAS</b>								
HIGH input current	$I_{CASH}$			50	$\mu\text{A}$	$V_{CASH} = 5\text{ V}$		
LOW input current	$I_{CASL}$	-50			$\mu\text{A}$	$V_{CASL} = 0\text{ V}$		

**Table 5-3 AC/DC Characteristics with  $T_{amb} = 25\text{ °C}$ ,  $V_{VCCA} = 5\text{ V}$ ,  $V_{VCCD} = 5\text{ V}$  (Continued)**

	Symbol	Limit Values			Unit	Test Conditions	L	Item
		min	typ	max				
<b>Analog Unit</b>								
<b>Mixer-Oscillator</b>								<b>2.1</b>
Current consumption	$I_{VCCA}$	11	15	19	mA	Bit V/U = Low		
	$I_{VCCA}$	14	18	22	mA	Bit V/U = High		
Mixer current	$I_{IF-V/IF-U}$	4	6	8	mA			
Mixer output impedance	$R_{IFout,IFoutx}$		20		k $\Omega$	Parallel equivalent circuit, $f_{IF} = 38,9\text{ MHz}$		
	$C_{IFout,IFoutx}$		0.5		pF	Parallel equivalent circuit, $f_{IF} = 38,9\text{ MHz}$		
<b>VHF and Hyper Band Section</b>								<b>2.2</b>
Oscillator frequency range	$f_{OscV}$	80		170	MHz	$V_d = 0,5..28\text{ V}$ ; VHF		
	$f_{OscH}$	140		450	MHz	$V_d = 0,5..28\text{ V}$ ; HYP		
Oscillator drift	$\Delta f_{OscV}$			400	kHz	$V_S = 5\text{ V} \pm 10\%$		
	$\Delta f_{OscV}$			500	kHz	$\Delta T = 25\text{ °C}$		
	$\Delta f_{OscV}$			100	kHz	$t = 5\text{ s}$ up to 15 min after switching on		
Oscillator pulling	$V_{MIXV}$	100	108		dB $\mu$ V	$\Delta f = 10\text{ kHz}$ in channel E2		
	$V_{MIXV}$	100	108		dB $\mu$ V	$\Delta f = 10\text{ kHz}$ in channel S10		
	$V_{MIXV}$	80	88		dB $\mu$ V	$\Delta f_{int} = E2 + N + 5 - 1\text{ MHz}$		
	$V_{MIXV}$	80	88		dB $\mu$ V	$\Delta f_{int} = S10 + N + 5 - 1\text{ MHz}$		
Oscillator phase noise	$L(fm)_{VH F}$	-80	-86		dBc/Hz	$f_m = 10\text{ kHz}$ , application circuit		
Mixer gain	$G_{MixV}$	11	14	17	dB			
Mixer noise figure	$F_{MixV}$		5	8	dB	Channel E2 (DSB)		
	$F_{MixV}$		5	8	dB	Channel 10 (DSB)		
Crosstalk $f_{in/LO}$	$V_{MixV}$	150	1000		mV $_{rms}$	max. input level for 10 dB distance $f_{in/LO}$		

**Table 5-3 AC/DC Characteristics with  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ,  $V_{VCCA} = 5\text{ V}$ ,  $V_{VCCD} = 5\text{ V}$  (Continued)**

	Symbol	Limit Values			Unit	Test Conditions	L	Item
		min	typ	max				
Mixer input impedance	$R_{MixV}$		20		W	serial equivalent circuit, $f_{MixV} = 300\text{ MHz}$		
	$L_{MixV}$		10		nH	serial equivalent circuit, $f_{MixV} = 300\text{ MHz}$		
IF suppression	$a_{IF}$		20		dB	$V_{MixB} = 80\text{ dB}\mu\text{V}$		
<b>UHF Section</b>								<b>2.3</b>
Oscillator frequency range	$f_{OscU}$	440		900	MHz	$V_t = 0,5...28\text{ V}$		
Oscillator drift	$\Delta f_{OscU}$			400	kHz	$V_S = 5\text{ V}\pm 10\%$		
	$\Delta f_{OscU}$			800	kHz	$\Delta T = 25\text{ }^{\circ}\text{C}$		
	$\Delta f_{OscU}$			100	kHz	$t = 5\text{ s}$ up to 15 min after switching on		
Oscillator pulling	$V_{MIXU}$	100	108		dB $\mu\text{V}$	$\Delta f = 10\text{ kHz}$ in channel E21		
	$V_{MIXU}$	100	108		dB $\mu\text{V}$	$\Delta f = 10\text{ kHz}$ in channel E68		
	$V_{MIXU}$	80	88		dB $\mu\text{V}$	$\Delta f_{int} = E21 + N + 5 - 1\text{ MHz}$		
	$V_{MIXU}$	80	88		dB $\mu\text{V}$	$\Delta f_{int} = E68 + N + 5 - 1\text{ MHz}$		
Oscillator phase noise	$L(fm)_{UH}$ F	-80	-86		dBc/Hz	$f_m = 10\text{ kHz}$ , application circuit		
Mixer gain	$G_{MixU}$	11	14	17	dB			
Mixer noise figure	$F_{MixU}$		6	9	dB	Channel E21 (DSB)		
			7	10	dB	Channel E68 (DSB)		
Crosstalk $f_{in}/LO$	$V_{MixU}$	150	1000		mV $_{rms}$	max. input level for 10 dB distance $f_{in}/LO$		
Mixer input impedance	$R_{MixU}$		20		W	serial equivalent circuit, $f_{MixU} = 600\text{ MHz}$		
	$L_{MixU}$		10		nH	serial equivalent circuit, $f_{MixU} = 600\text{ MHz}$		
IF suppression	$a_{IF}$		20		dB	$V_{MixB} = 80\text{ dB}\mu\text{V}$		

■ This value is only guaranteed in lab.

## 5.2 Bit Allocation Read / Write

**Table 5-4**

Byte	MSB*)	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	LSB	Ack	Remarks
<b>Write Data</b>										
Address Byte	1	1	0	0	0	MA1	MA0	0	A	
Progr. Divider Byte 1	0	n14	n13	n12	n11	n10	n9	n8	A	
Progr. Divider Byte 2	n7	n6	n5	n4	n3	n2	n1	n0	A	
Control Byte 1	1	5I	T1	T0	1	1	1	OS	A	
Control Byte 2	V/U	x	x	x	x	P2	P1	P0	A	
<b>Read Data</b>										
Address Byte	1	1	0	0	0	MA1	MA0	1	A	
Status Byte	POR	FL	x	I1	I0	A2	A1	A0	A	

\*) MSB shifted first.

### Divider ratio:

$$N = 16384 \times n14 + 8192 \times n13 + 4096 \times n12 + 2048 \times n11 + 1024 \times n10 + 512 \times n9 + 256 \times n8 + 128 \times n7 + 64 \times n6 + 32 \times n5 + 16 \times n4 + 8 \times n3 + 4 \times n2 + 2 \times n1 + n0$$

### Control Bytes:

#### ■ Ports P0, P1, P2:

P0...P2=1 open-collector output is active  
 P0...P2=0 open-collector output is inactive, TTL-inputs I1, I0 and ADC available

#### ■ Bandswitch V/U:

V/U=1 switch to OSC/MIX UHF  
 V/U=0 switch to OSC/MIX VHF

#### ■ Pump current 5I:

5I=1 high PD output current  
 5I=0 low PD output current

#### ■ Disabling tuning voltage OS:

OS=1 disables TUNE  
 OS=0 enables TUNE

**Status Byte:**

- Power On Reset flag POR:

flag is set at power-on and reset at the end of READ operation

- PLL lock flag FL:

flag is set to 1 when loop is locked

- TTL-inputs I1, I0:

input data from pins P1/I1, P0/I0

- ADC bits A2,A1,A0:

digital outputs of the 5-level ADC

**Table 5-5 Address Selection**

Voltage at CAS	MA1	MA0
$(0...0.1) * V_{CC}$	0	0
open circuit	0	1
$(0.4...0.6) * V_{CC}$	1	0
$(0.9...1) * V_{CC}$	1	1

**Table 5-6 Test Modes**

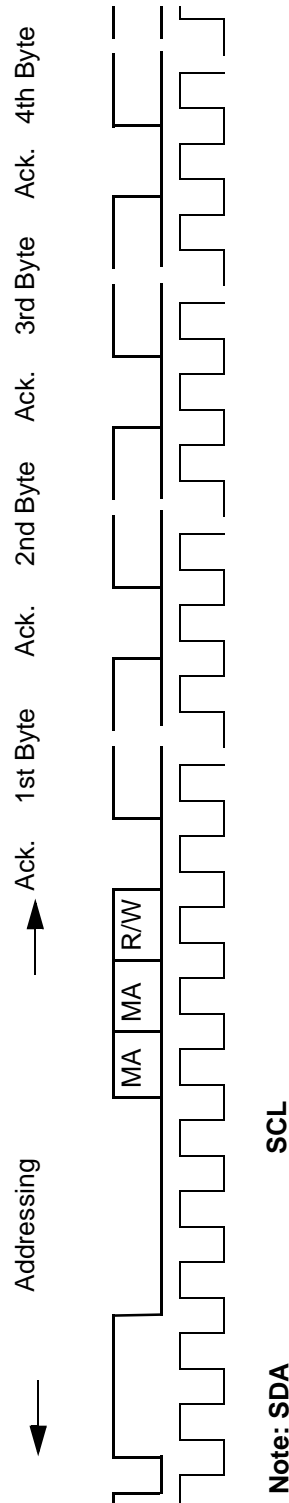
Test mode	T1	T0
Normal operation	0	0
P1 = Cy output, P0 = $f_{ref}$ output	1	0
Charge pump output, CHGPMP is in high-impedance state	0	1
TTL-inputs I1/I0 are Cy/ $f_{ref}$ inputs of phase detector	1	1

**Table 5-7 A/D Converter Levels**

Voltage at P2 / ADC	A2	A1	A0
$(0...0.15) * V_{CC}$	0	0	0
$(0.15...0.3) * V_{CC}$	0	0	1
$(0.3...0.45) * V_{CC}$	0	1	0
$(0.45...0.6) * V_{CC}$	0	1	1
$(0.6...1) * V_{CC}$	1	0	0

### 5.3 I<sup>2</sup>C Bus Timing Diagram

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**Telegram examples:**

- Start-Addr-DR1-DR2-CW1-CW2-Stop
- Start-Addr-CW1-CW2-DR1-DR2-Stop
- Start-Addr-DR1-DR2-Stop
- Start-Addr-CW1-CW2-Stop

- Start = start condition
- Addr = address byte
- DR1 = prog. divider byte 1
- DR2 = prog. divider byte 2
- CW1 = control byte 1
- CW2 = control byte 2
- Stop = stop condition

### 5.4 Test Circuits

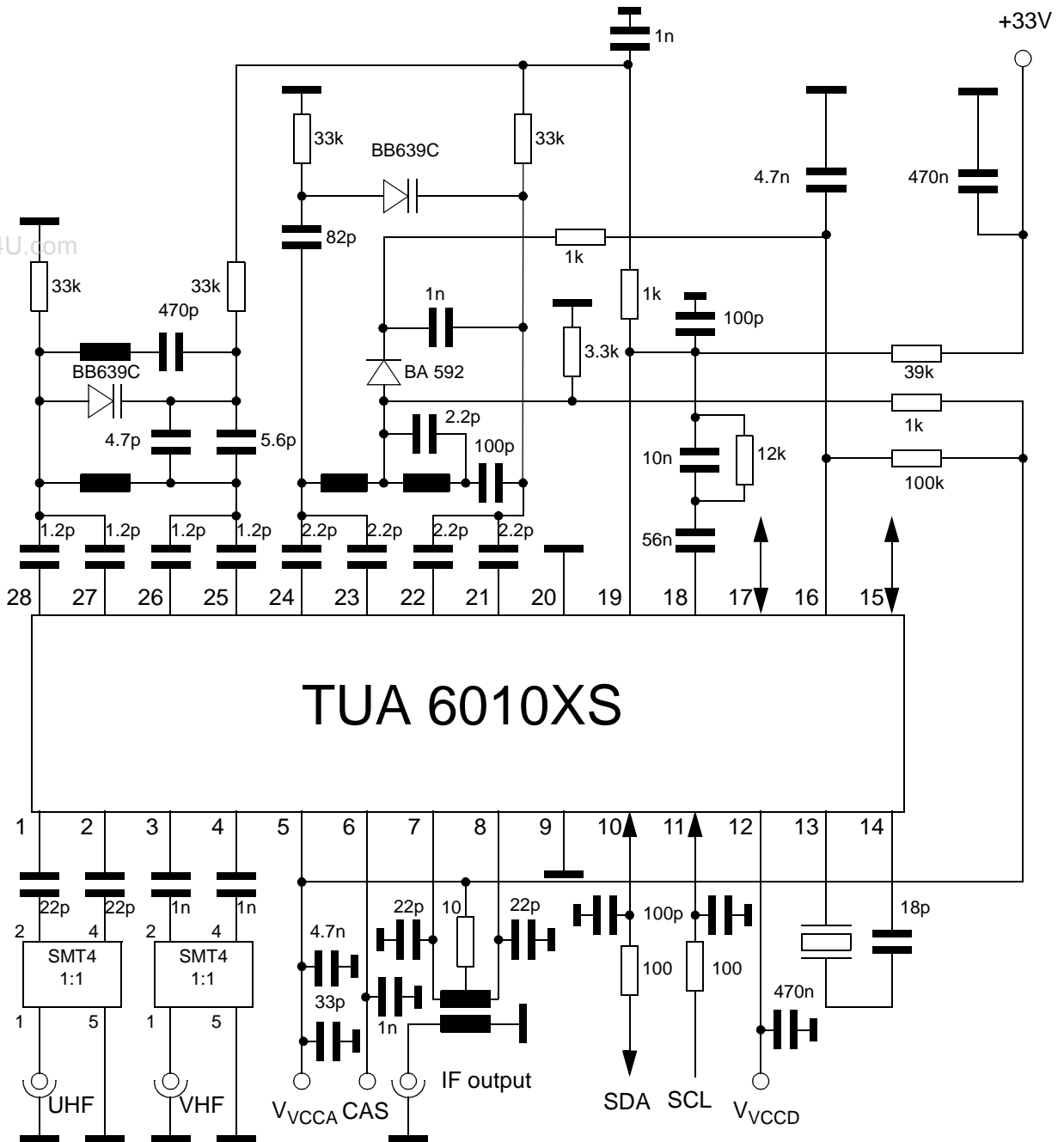


Figure 5-1 DC and RF Parameter Measurement

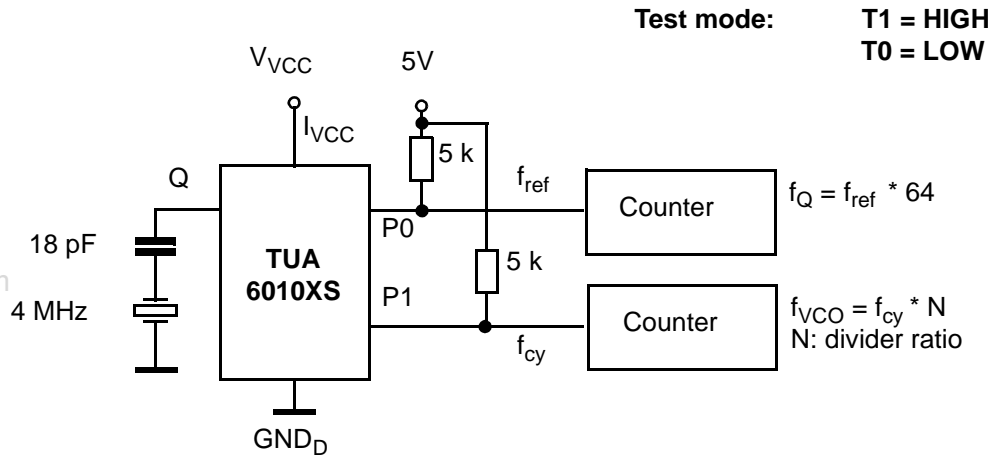


Figure 5-2 Measurement of Crystal Oscillator Frequency