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The SP5024 is a programming variant of the SP5510 allowing the design of one tuner with either I<sup>2</sup>C bus or 3-wire bus format depending on which device is inserted. The SP5024, when used with a TV varicap tuner, forms a complete phase locked loop tuning system. The circuit consists of a divide-by-8 prescaler with its own preamplifier and a 15 bit programmable divider controlled by a serially - loaded data register. Four open-collector outputs, each independently programmable, are included. The device has two modes of operation selected by the 'mode selected input'. In mode 1 the comparison frequency is 7.8125kHz and the programmable divider MSB is bypassed; mode 2 comparison frequency is 6.25kHz. The comparison frequencies are both obtained from a 4MHz crystal controlled on-chip oscillator. The comparator has a charge pump output with an output amplifier stage around which feedback may be applied. Only one external transistor is required for varicap line driving.

### FEATURES

- Complete 1.3GHz Single Chip System
- Dual Standard 50kHz or 62.5kHz Step Size
- Low Power Consumption (5V 40mA)
- Programming Compatible with Toshiba TD6380 and TD6381 \*
- Pin Compatible with SP5510 \*
- Low Radiation
- Varactor Drive Amplifier Disable
- Charge Pump Disable
- Single Port 18/19 Bit Serial Data Entry
- Four Controllable Outputs
- ESD Protection †

\* See notes on pin compatibility

† Normal ESD handling procedures should be observed

### APPLICATIONS

- Satellite TV When Combined With SP4902 2.5GHz Prescaler
- Cable Tuning Systems
- VCRs

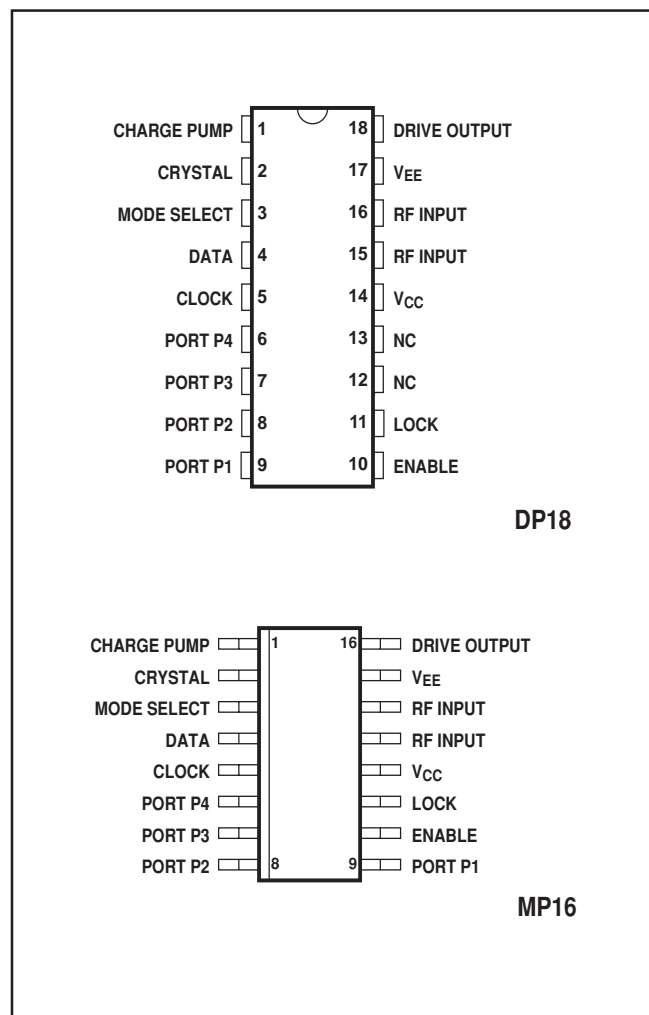


Fig. 1 Pin connections – top view

### ORDERING INFORMATION

- SP5024 DP - (18-lead plastic package)
- SP5024S MP - (16-lead miniature plastic package)

**ELECTRICAL CHARACTERISTICS**

$T_{amb} = -20^{\circ}\text{C}$  to  $+80^{\circ}\text{C}$ ,  $V_{CC} = +4.5\text{V}$  to  $+5.5\text{V}$ . Reference frequency = 4MHz. Pin numbers refer to SP5024 (DP package). These characteristics are guaranteed by either production test or design. They apply within the specified ambient temperature and supply voltage unless otherwise stated.

Characteristic	Symbol	Pin	Value			Units	Conditions
			Min.	Typ.	Max.		
Supply current	$I_{CC}$	14		40	55	mA	$V_{CC} = 5\text{V}$
Prescaler input voltage		15,16	12.5		300	mV <sub>RMS</sub>	50MHz to 1GHz sinewave
Prescaler input voltage		15, 16	30		300	mV <sub>RMS</sub>	1.3GHz, see Fig. 5
Prescaler input impedance		15,16		50		$\Omega$	
Input capacitance				2		pF	
High level input voltage		4,5,10	3		$V_{CC}$	V	
High level input voltage		3	4		$V_{CC}$	V	
Low level input voltage		3,4,5,10	0		0.6	V	
High level input current		4,5,10			1	$\mu\text{A}$	$V_{IN} = 5.5\text{V}, V_{CC} = 5.5\text{V}$
Low level input current		5			5	$\mu\text{A}$	$V_{IN} = 0\text{V}, V_{CC} = 5.5\text{V}$
Low level input current		4,10			-250	$\mu\text{A}$	$V_{IN} = 0\text{V}, V_{CC} = 5.5\text{V}$
High level input current		3			150	$\mu\text{A}$	$V_{IN} = 5.5\text{V}, V_{CC} = 5.5\text{V}$
Low level input current		3			-1	$\mu\text{A}$	$V_{IN} = 0\text{V}, V_{CC} = 5.5\text{V}$
Clock input hysteresis		5		0.4		V	
Clock rate		5			0.5	MHz	
Data set up time	$t_2$	4	300			ns	See Fig. 3
Data hold time	$t_3$	4	600			ns	See Fig. 3
Enable set up time	$t_1$	10	300			ns	See Fig. 3
Enable hold time	$t_5$	10	600			ns	See Fig. 3
Clock-to-enable time	$t_4$	10	300			ns	See Fig. 4
Charge pump output current		1		$\pm 150$		$\mu\text{A}$	V pin 1 = 2.0V
Charge pump output leakage current		1			$\pm 5$	nA	V pin 1 = 2.0V
Drift due to leakage					5	mV/s	At collector of external varicap drive transistor
Charge pump drive output current		18	1			mA	V pin 18 = 0.7V
Charge pump amplifier gain				6400			Pin 18 Current 100 $\mu\text{A}$
Oscillator temperature stability					2	ppm/ $^{\circ}\text{C}$	
Oscillator stability with supply voltage					2	ppm/V	
Recommended crystal series resistance			10		200	$\Omega$	"Parallel resonant" crystal
Crystal oscillator drive level		2		40		mV p-p	
Crystal oscillator source impedance		2		-400		$\Omega$	Nominal spread = $\pm 15\%$

**ELECTRICAL CHARACTERISTICS (continued)**

Characteristic	Symbol	Pin	Value			Units	Conditions
			Min.	Typ.	Max.		
Port and Lock sink current		6 - 9, 11	10			mA	$V_{OUT} = 0.7V$
Port leakage current		6-9			10	$\mu A$	$V_{OUT} = 13.2V$
Lock leakage current		11			10	$\mu A$	$V_{OUT} = V_{CC}$
Varactor Drive Amp Disable		10	-350			$\mu A$	$V_{IN} = <0V$
Charge Pump Disable		4	-350			$\mu A$	$V_{IN} = <0V$

**ABSOLUTE MAXIMUM RATINGS**

All voltages are referred to  $V_{EE} = 0V$

Parameter	Pin SP5024	Pin SP5024 S	Value		Units	Conditions
			Min.	Max.		
Supply voltage	14	12	-0.3	-6	V	
Prescaler inputs	15, 16	13, 14		2.5	Vp-p	
Output ports	6-9	6-9	-0.3	14	V	Port in off state
			-0.3	6	V	Port in on state
Total port output current	6-9	6-9		50	mA	
Prescaler DC offset	15, 16	13, 14	-0.3	$V_{CC}+0.3$	V	
Loop amplifier DC offset	1, 18	1, 16	-0.3	$V_{CC}+0.3$	V	
Crystal oscillator DC offset	2	2	-0.3	$V_{CC}+0.3$	V	
Data bus inputs	4, 5, 10	4, 5, 10	-0.7	$V_{CC}+0.3$	V	With $V_{CC}$ applied
Storage temperature			-55	+125	$^{\circ}C$	
Junction temperature				+150	$^{\circ}C$	
DP 18 thermal resistance, chip-to-ambient				78	$^{\circ}C/W$	
DP 18 thermal resistance, chip-to-case				24	$^{\circ}C/W$	
MP 16 thermal resistance, chip-to-ambient				111	$^{\circ}C/W$	
MP 16 thermal resistance, chip-to-case				41	$^{\circ}C/W$	
Power consumption at 5V				275	mW	All ports off

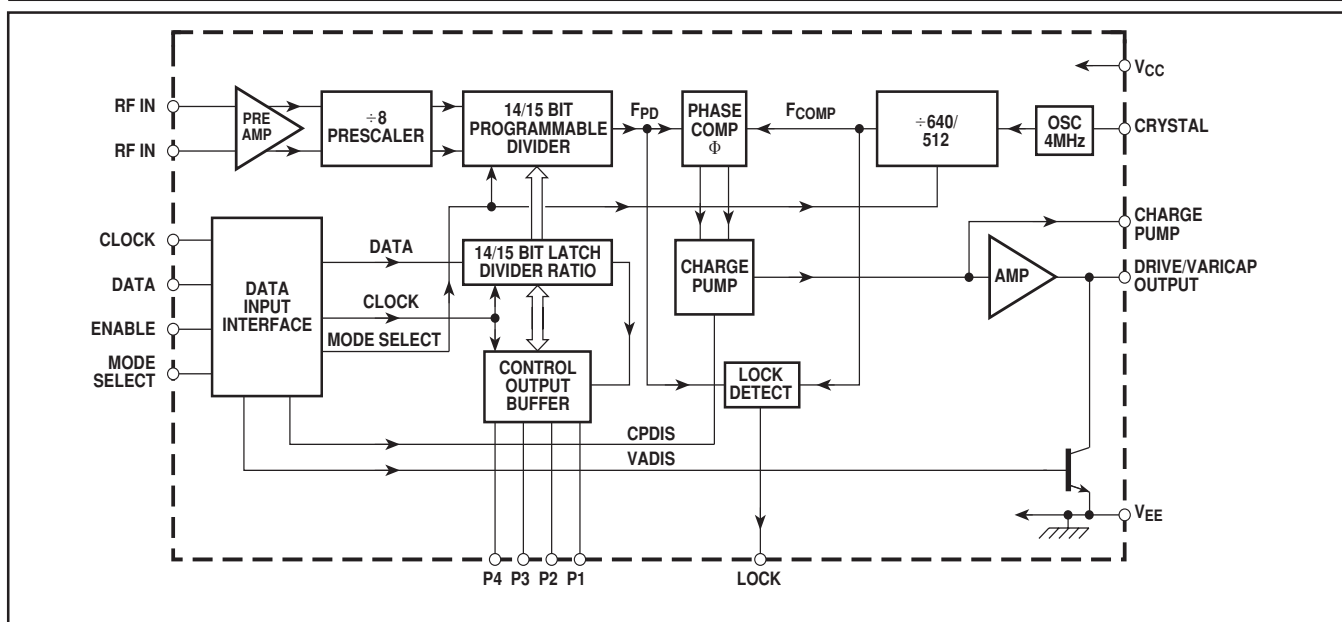


Fig.2 Block diagram

**FUNCTIONAL DESCRIPTION**

The SP5024 contains all the elements necessary, with the exception of reference crystal, loop filter and external high voltage transistor, to control a voltage controlled local oscillator, so forming a PLL frequency synthesised source.

The system is controlled by a microprocessor via a standard data, clock, enable, three-wire data bus. The data load normally consists of a single word, which contains the frequency and port information, and is only transferred to the internal data shift register during an enable high period. The clock input is disabled during enable low periods. New data words are only accepted by the internal data buffers from the shift register on a negative transition of the enable, so giving improved fine tune facility for digital AFC etc.

The data sequence and timing follows the format shown in Fig. 3.

The frequency is set by loading the programmable divider with the required 14/15 bit divisor word. The output of this divider,  $F_{PD}$ , is fed to the phase comparator where it is compared in phase and frequency domain to the internally generated comparison frequency,  $F_{COMP}$ .

The  $F_{COMP}$  is obtained by dividing the output of an on-chip crystal controlled oscillator. The crystal frequency used is generally 4MHz, which gives an  $F_{COMP}$  of 6.25kHz/7.8125kHz and, when multiplied back up to the synthesised LO, gives a minimum step size of 50kHz/62.5kHz, respectively.

The programmable divider is preceded by an input RF preamplifier and high speed, low radiation prescaler. The preamplifier is arranged to be self oscillating, so giving excellent input sensitivity. The input sensitivity and impedance are shown in Figs. 5 and 7, respectively.

The SP5024 contains an improved lock detect circuit which generates a flag when the loop has attained lock. 'Out of lock' is indicated by high impedance state.

The SP5024 contains 4 general purpose open collector outputs, ports P1-P4, which are capable of sinking at least 10mA. These outputs are set by the remaining four bits within the normal data word.

**PIN COMPATIBILITY**

The SP5024 may be used in SP5510 applications which require 3-wire bus as opposed to I<sup>2</sup>C bus data format. In SP5510 applications where the reference crystal is connected to pin 3, a small modification is required to ground the crystal as shown in Fig. 4.

Appropriate connections to the mode select input (pin 3) must also be made.

In mode 1 (pin 3 'HIGH') the SP5024 is programming and step size compatible with the Toshiba TD6380, and in mode 2 (pin 3 'LOW') it is compatible with the TD6381. In both modes a 4MHz crystal is used to derive  $F_{COMP}$ , unlike the TD6381 which requires a 3.2MHz crystal.

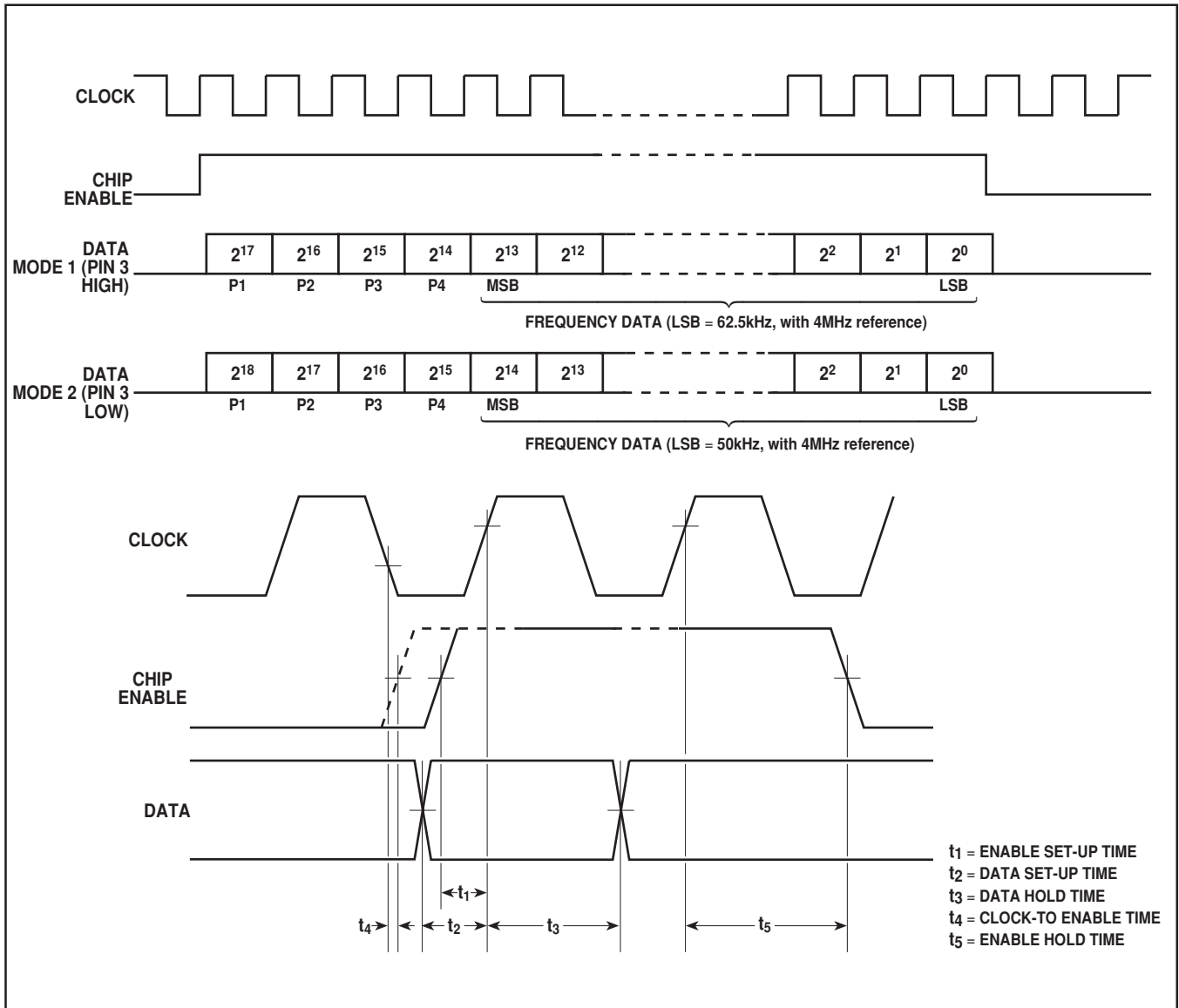


Fig. 3 Data format and timing

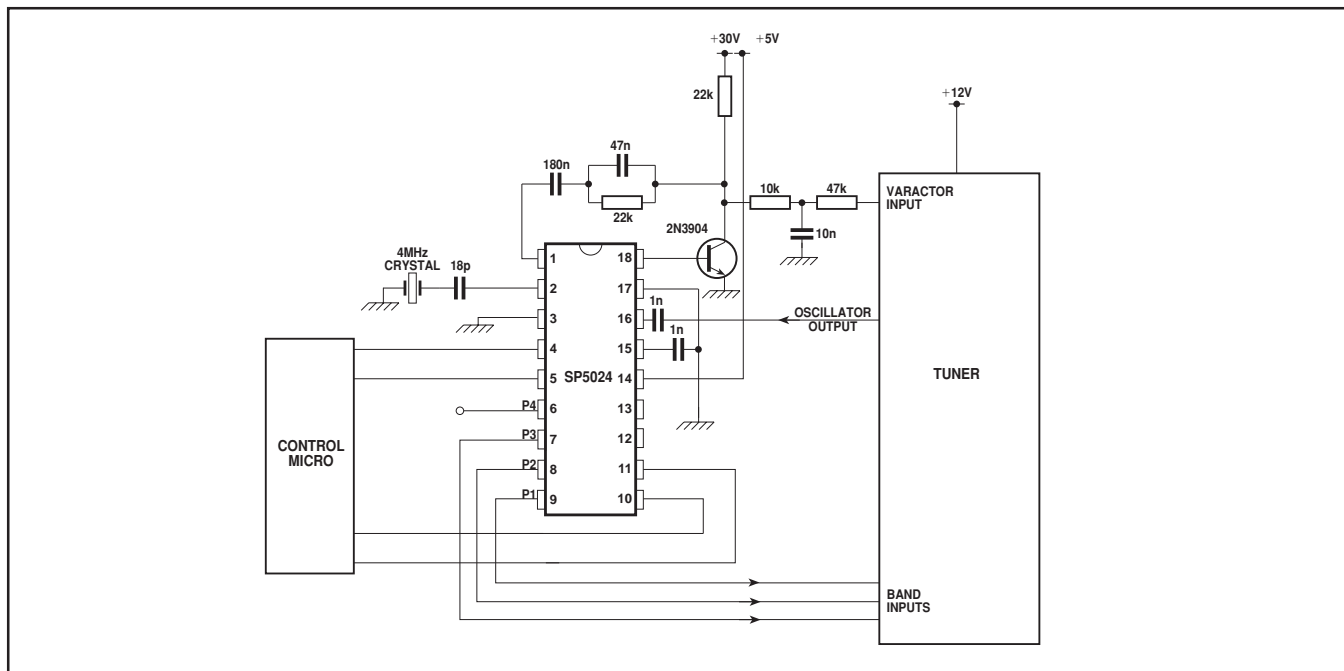


Fig. 4 Typical application ( $F_{STEP} = 50kHz$ )

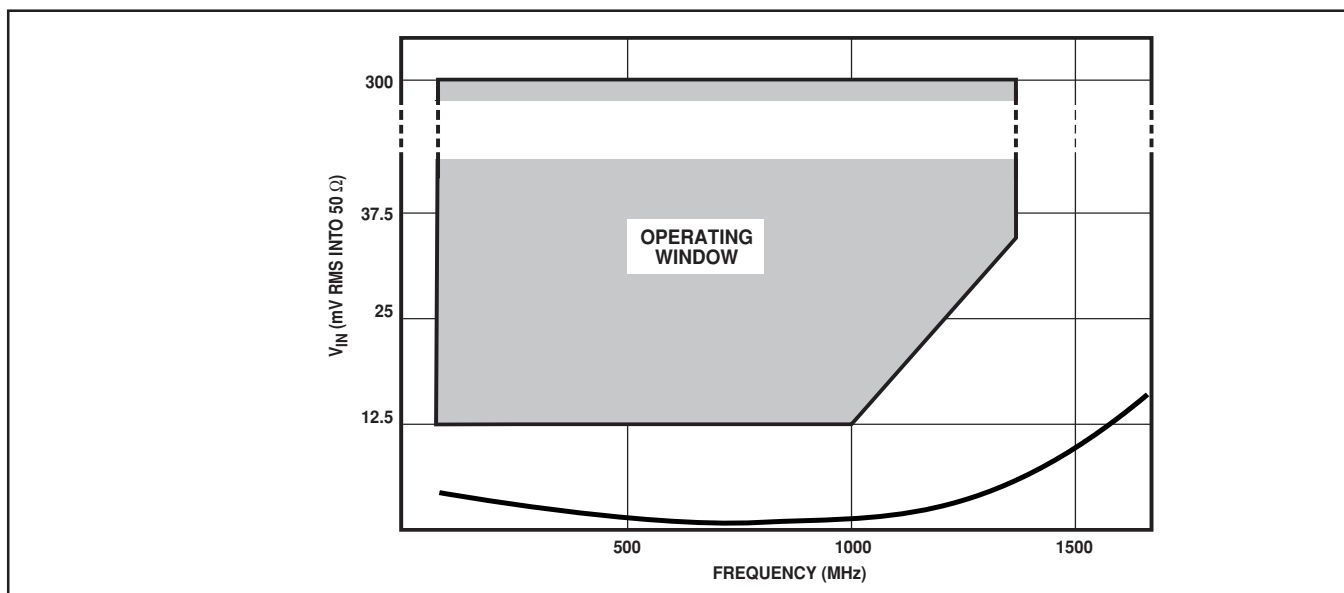


Fig. 5 Typical input sensitivity

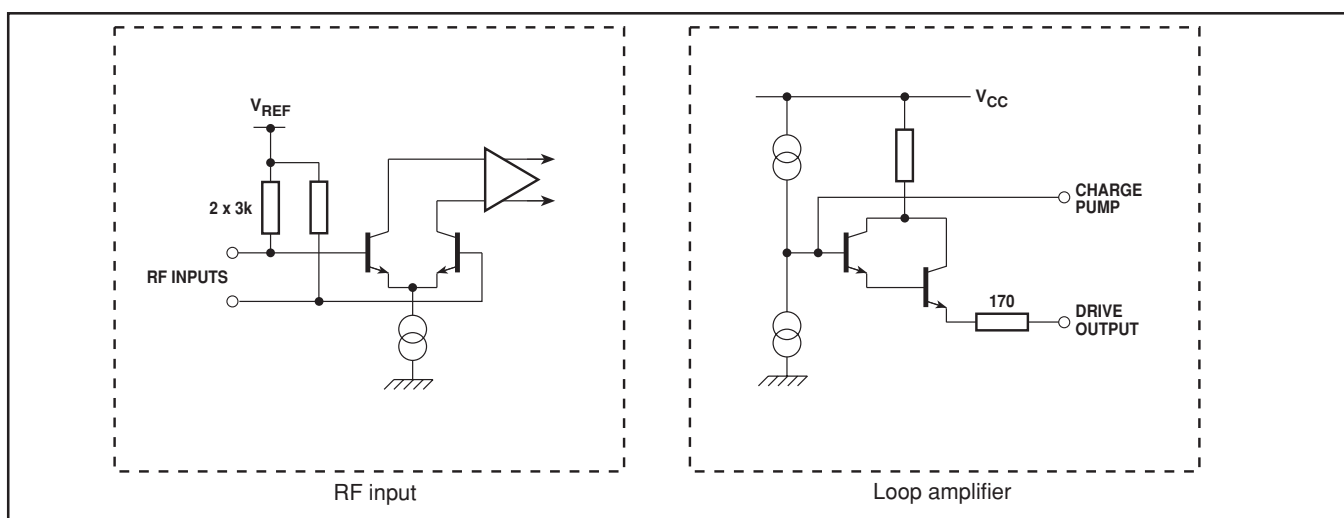


Fig.6a Input/Output interface circuits

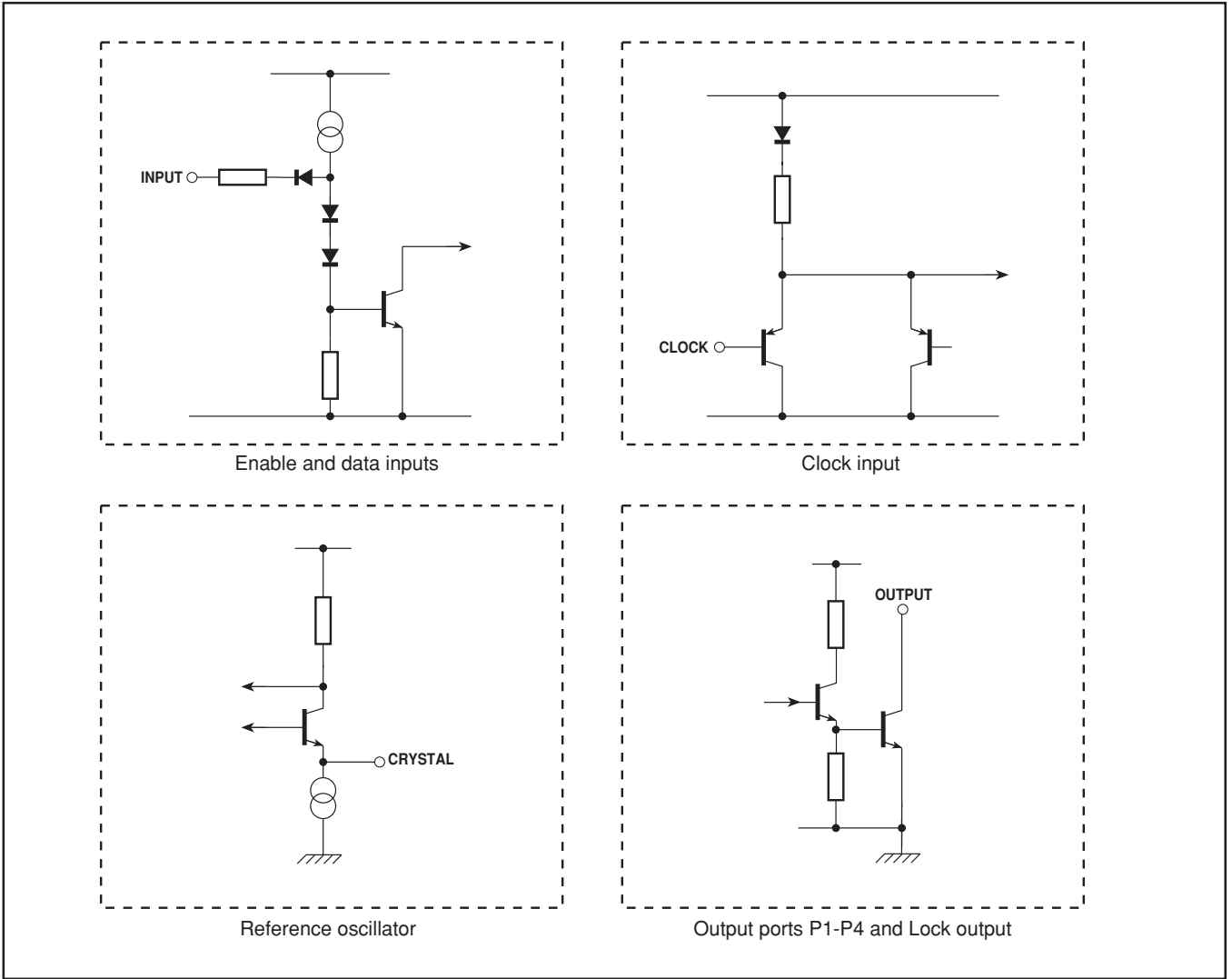


Fig.6b Input/Output interface circuits

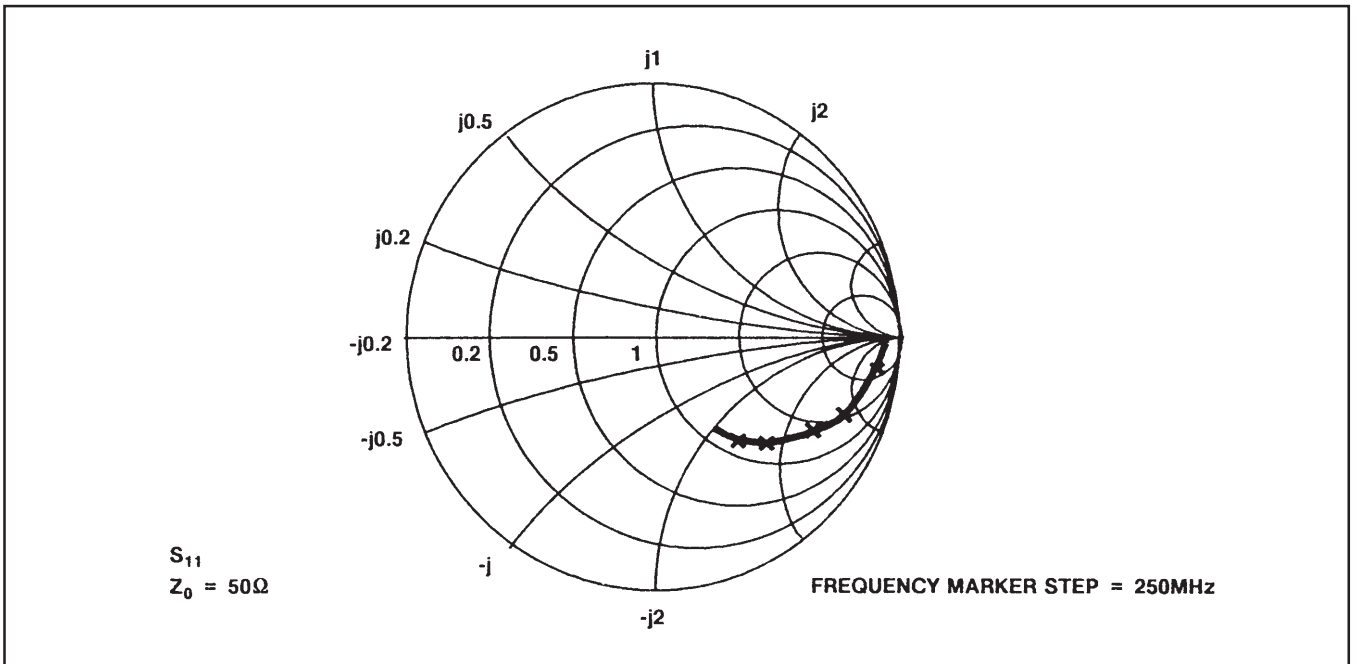


Fig.7 Typical input impedance



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