U2780B-AFP

Frequency Synthesizer

for UHF telecommunication systems, e.g. cellular radio and cordless telephone

Description / Technology

The programmable frequency synthesizer IC U2780B for µP controlled application is realized with a high speed BIPOLAR technology which is very suitable for combinations of fast ECL logic and low current I^2C logic. The benefits are high input sensitivity in connection with low power consumption and therefore small packages (SSO-20).

This feature makes the device very suitable for cordless phones and handheld cellular radio sets up to 1.1 GHz.

The IC is controlled by a 3-wire-bus with the inputs for Clock, Data and Enable for programming the scaling factors of the programmable counter, the reference counter and the prescaler.

A TCXO can be connected to the oscillator input (OSCin) as an alternative solution to the common crystal reference oscillator. In that case the oscillator output (OSCout) should be left open.

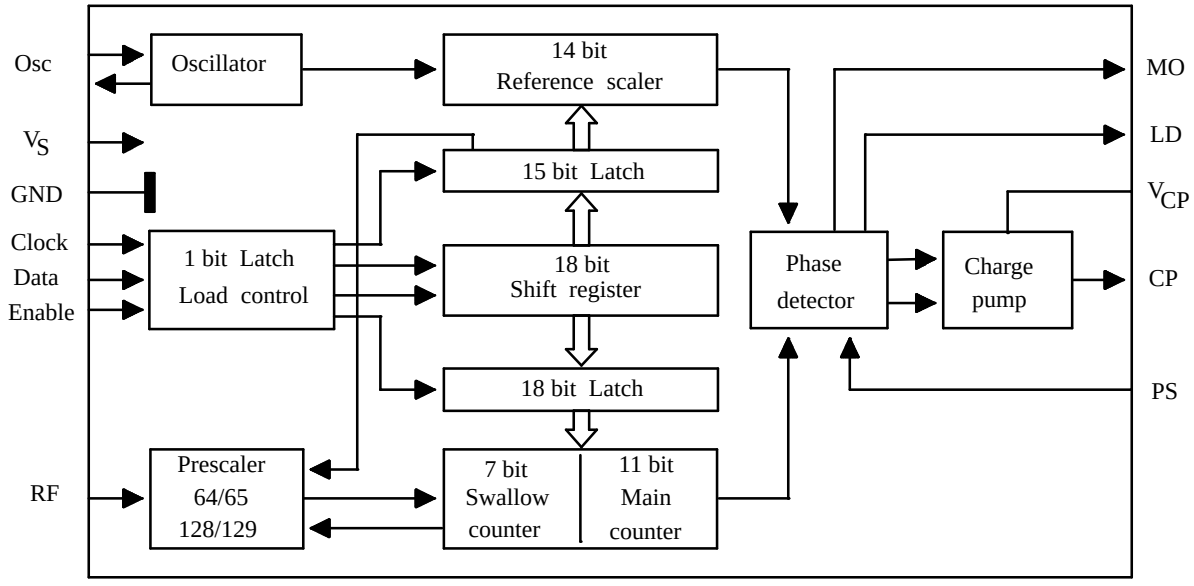
The charge pump output operates as a switch with limited max. current. The requirements of the PLL loop can be determinated by the external low pass filter.

The phase characteristic of the phase detector is convertible and so matchable to different frequency / tuning voltage characteristics.

Features

- Very low current consumption (typ. 3 V/7.5 mA)
- Supply voltage range 2.7 V – 5.5 V
- Max. input frequency 1.1 GHz
- Programmable prescaler 64/65 or 128/129
- Controlled by 3-wire-bus with f_{clock} up to 500 kHz
- Status output for PLL lock/unlock condition
- Very fast phase detector
- SO-16 as well as SSO-20 package
- ESD protection in accordance with MIL-STD. 883 method 3015 class 2

Block Diagram / Applications



93 7785 e

Pin Description – SO-16

Pin	Symbol	Function
1	OSC in n.c.	Oscillator input Not connected
2	OSC out	Oscillator output
3	Vcp	Charge pump supply voltage
4	V_s	Supply voltage
5	CP	Charge pump output
6	GND	Ground
7	LD n.c.	Lock-detector output Not connected
8	RF in	VCO input
9	Clock n.c.	3-wire-bus clock Not connected
10	Data	3-wire-bus data
11	Enable	3-wire-bus enable
12	PS	Phase inverting input
13	n.c.	Not connected
14	M out	Monitor output for f_p and f_r
15	n.c. (PCP) n.c.	Not connected Not connected
16	n.c. (PCR)	Not connected

Pin Description – SSO-20

Pin	Symbol	Function
1 2	OSC in n.c.	Oscillator input Not connected
3	OSC out	Oscillator output
4	Vcp	Charge pump supply voltage
5	V_s	Supply voltage
6	CP	Charge pump output
7	GND	Ground
8 9	LD n.c.	Lock-detector output Not connected
10	RF in	VCO input
11 12	Clock n.c.	3-wire-bus clock Not connected
13	Data	3-wire-bus data
14	Enable	3-wire-bus enable
15	PS	Phase inverting input
16	n.c.	Not connected
17	M out	Monitor output for f_p and f_r
18 19	n.c. (PCP) n.c.	Not connected Not connected
20	n.c. (PCR)	Not connected

Absolute Maximum Ratings

Parameters		Symbol	Value	Unit
Supply voltage		V_S	–0.3 to 6	V
RF input		V_{RF}	V_S	V
Oscillator input voltage		V_{OscI}	1	V
Oscillator output voltage		V_{OscO}	1.5	V
Bus input voltage		V_{BUS}	6	V
Phase select input voltage		V_{PS}	6	V
Charge pump input voltage		V_{CP}	6	V
Ambient temperature		T_{amb}	–40 to 85	°C
Storage temperature		T_{stg}	–40 to 125	°C
Thermal resistance junction-ambient	SO-16 SSO-20	R_{thJA}	110 140	K/W
Operating range				
Supply voltage		V_S	2.7 to 5.5	V
Ambient temperature		T_{amb}	–40 to 80	°C

Electrical Characteristics

T_{amb} = 25°C, V_S = 2.7 to 5.5 V, unless otherwise specified.

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
DC Supply						
Supply voltage	1	V_s	2.7		5.5	V
Supply current	V_s = 3 V	I_s		7.5		mA
Supply voltage CP		V_{CP}	V_s		5.5	V
Supply current CP	V_{CP} = 5 V, PLL	I_{CP}		1		µA
RF input						
Input voltage f_i = 200 to 1100 MHz	R_s = 50 Ω *) R_s = 50 Ω *)	V_{imin} V_{imax}		20 200		mV_{RM} mV_{RMSS}
Frequency range		f_{imin} f_{imax}	 1100	50 1250		MHz MHz
Scaling factor prescaler		S_{PSC}		64/128		
Scaling factors main counter		S_M	2		2047	
Scaling factors swallow counter		S_S	0		127	
Reference oscillator						
Input voltage	R_s = 50 Ω *) R_s = 50 Ω *)	V_{imin} V_{imax}		20 200		mV_{RMS} mV_{RMS}
Frequency range		f_{imin} f_{imax}		0,1 16		MHz MHz
Scaling factor reference counter		S_R	4		16383	
3-wire bus (Clock, Data, Enable) and PS						
High-input voltage		V_{iH}	1.5	0.9		V
Low-input voltage		V_{iL}	0		0.4	V
High-input current		I_{iH}			5	µA
Low-input current		I_{iL}	–5			µA
Monitor output (emitter follower)						
High-output voltage	V_s = 3 V	V_{iH}	2.1	2.2		V
Low-output voltage	I_{MO} = 0.5 mA	V_{iL}		1.8	1.9	V
Charge pump output						
Source current	V_{CP} = 5 V	I_{source}		–1		mA
Sink current		I_{sink}		1		mA
Leakage current	V_{CP} = 5 V	I_{leak}		±5		nA
Lock detector output (open collector)						
Saturation voltage	I_{LD} = 1 mA	V_{sat}		0.2	0.4	V
Cut-off current	V_{LD} = 5 V	I_{cut}			1	µA

*) RMS voltage at 50 Ω

Functional Description

Reference and programmable counter can be programmed by the 3-wire bus (Clock, Data and Enable). The Data Signal is transferred bit by bit during the rising edge into the shift register, starting with the MSB-bit. As soon as the enable signal is in high condition the contents of the shift register will be taken over either into the 15 bit reference counter latch (C = H) or into the 18 bit latch of the programmable counter (C = L).

Reference Counter (15-bit shift register)

LSB															MSB
C	R0	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	PSC

C: Control bit High

PSC: Prescaler scaling factor bit: High – 64/65
Low – 128/129
S_{PSC} = 64 or 128

R_0 to R_{13}:
These bits are setting the reference counter S_R
$S_R = R_0*2^0 + R_1*2^1 +$ to $+ R_{12}*2^{12} + R_{13}*2^{13}$
allowed scaling factors for S_R: 2 to 16383

Programmable Counter (18bit shift register)

LSB																		MSB
C	S0	S1	S2	S3	S4	S5	S6	M0	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10

C: Control bit Low

S_0 to S_6:
These bits are setting the swallow counter S_S.
$S_S = S_0*2^0 + S_1*2^1 + ... + S_5*2^5 + S_6*2^6$
allowed scaling factors for S_S: 0 to 127, $S_S < S_M$

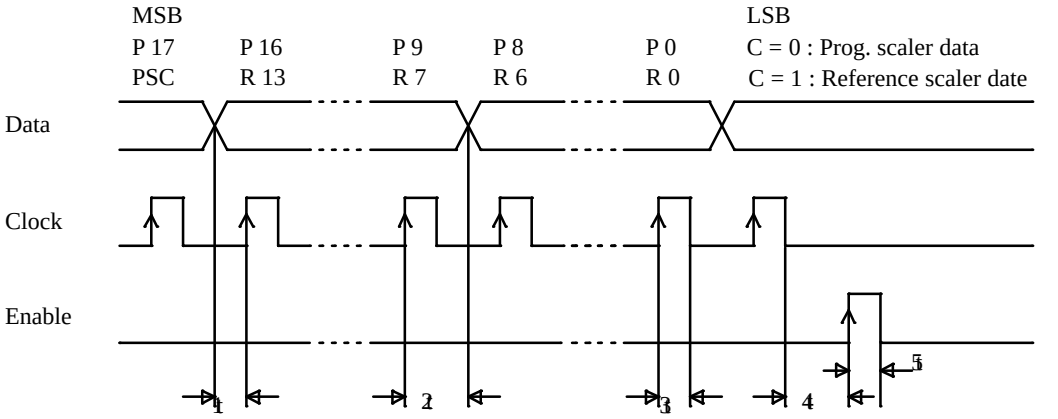
M0 to M10:
These bits are setting the main counter S_M.
$S_M = M_0*2^0 + M_1*2^1 + ... + M_9*2^9 + M_{10}*2^{10}$
allowed scaling factors for S_M: 2 to 2047

Total scaling factor S_P of the programmable counter
$S_P = (S_{PSC}*S_M) + S_S$ Condition: $S_S < S_M$

VCO-Frequency

$f_{VCO} = ((S_{PSC}*S_M) + S_S) * f_{RefOsc} / S_R$

Timing 3-Wire-Bus



All times t1 ... t5 > = 1

93 7787 e

Phase Detector Polarity

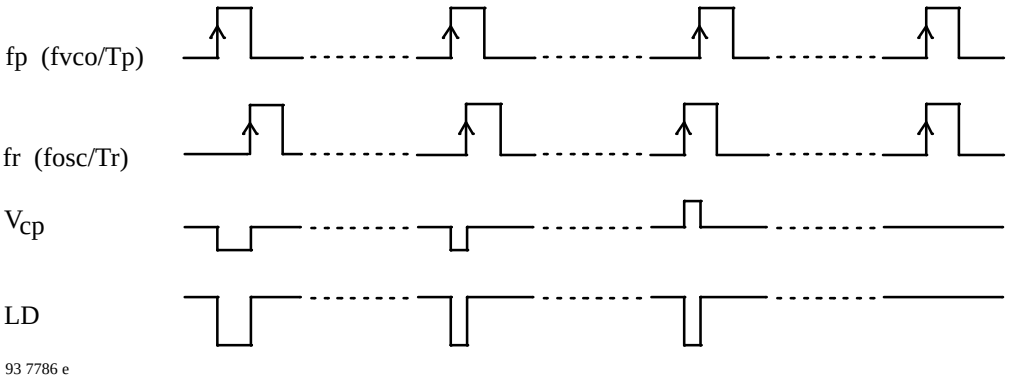
The polarity of the phase detector can be changed with the PS input. Depending on the PS input level the charge pump current will also be inverted. The monitor output signal MO (emitter follower output with ECL level) will be switched over from f_P to f_R simultaneously.

	PS = High or Open		PS = Low	
	CP	MO	CP	MO
$f_R > f_P$	I_{sink}	f_R	I_{source}	f_P
$f_R < f_P$	I_{source}	f_R	I_{sink}	f_P
$f_R = f_P$	0	f_R	0	f_P

Depending on the VCO frequency versus tuning voltage characteristic the PS input has to be programmed as follows:

For increasing tuning voltage and increasing frequency: PS = High or open
decreasing frequency: PS = Low.

Pulse Diagram Phase and Lock Detector

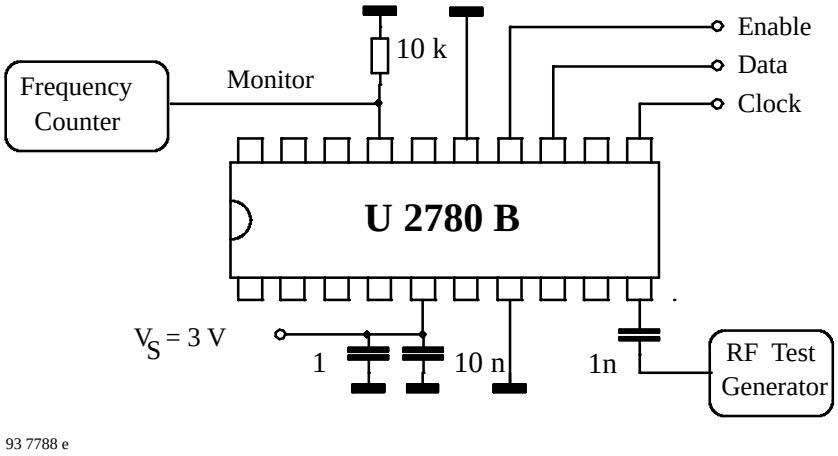


93 7786 e

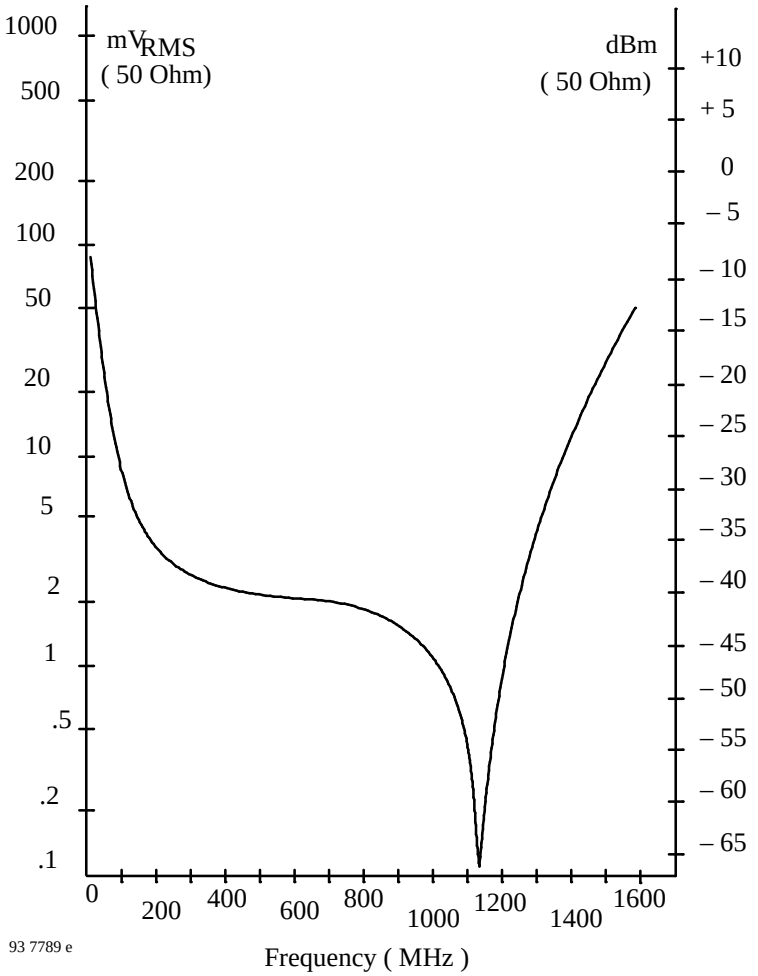
The LD output is in unlocked condition at low level and the pulse width is in reference to the phase respectively frequency difference at the phase detector. If the phase detector output pulses are smaller than 100 ns the LD output goes high and indicates “lock” condition.

Test Circuit

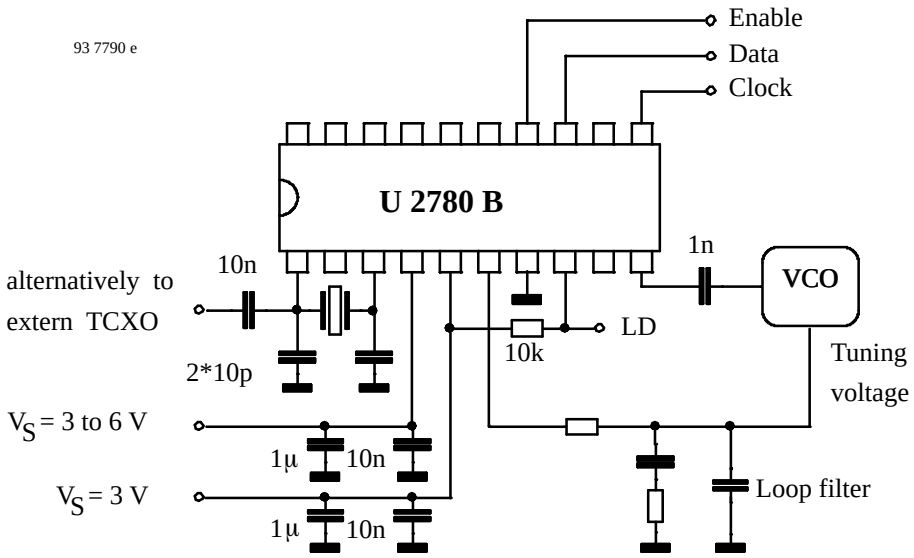
Input sensitivity



Typical Input Sensitivity

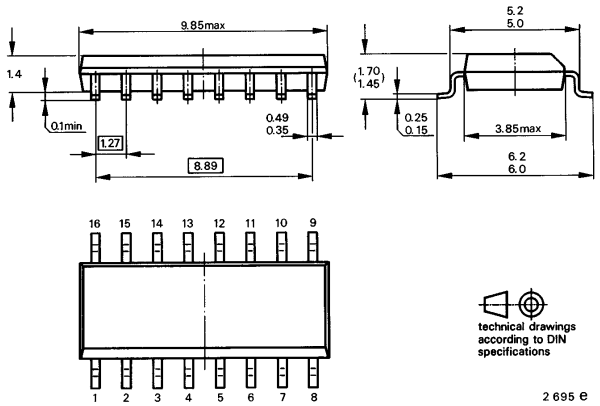


Application Circuit

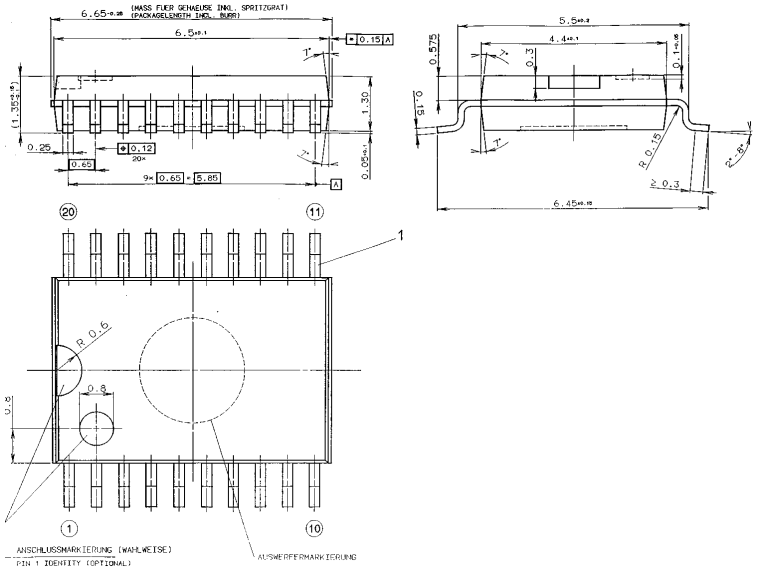


Dimensions in mm

Package: SO-16 (U 2780 B-AFP)



Package: SSO-20 (U 2780 B-AFS)



Ozone Depleting Substances Policy Statement

It is the policy of **TEMIC TELEFUNKEN microelectronic GmbH** to

1. Meet all present and future national and international statutory requirements.

2. Regularly and continuously improve the performance of our products, processes, distribution and operating systems with respect to their impact on the health and safety of our employees and the public, as well as their impact on the environment.

It is particular concern to control or eliminate releases of those substances into the atmosphere which are known as ozone depleting substances (ODSs).

The Montreal Protocol (1987) and its London Amendments (1990) intend to severely restrict the use of ODSs and forbid their use within the next ten years. Various national and international initiatives are pressing for an earlier ban on these substances.

TEMIC TELEFUNKEN microelectronic GmbH semiconductor division has been able to use its policy of continuous improvements to eliminate the use of ODSs listed in the following documents.

1. Annex A, B and list of transitional substances of the Montreal Protocol and the London Amendments respectively

2. Class I and II ozone depleting substances in the Clean Air Act Amendments of 1990 by the Environmental Protection Agency (EPA) in the USA

3. Council Decision 88/540/EEC and 91/690/EEC Annex A, B and C (transitional substances) respectively.

TEMIC can certify that our semiconductors are not manufactured with ozone depleting substances and do not contain such substances.

TEMIC TELEFUNKEN microelectronic GmbH, P.O.B. 3535, D-74025 Heilbronn, Germany
Telephone: 49 (0)7131 67 2831, Fax number: 49 (0)7131 67 2423