

FEATURES

- 12 parallel GPS signal processing channels
- 4000 time/frequency search bins
- Acquisition sensitivity better than -140dBm
- Tracking sensitivity better than -147dBm
- Compatible with available GPS RF front-end
- 3.3V Power Supply
- 0.35um CMOS technology
- 64-pin TQFP package
- Operating temperature form -40°C to $+85^{\circ}\text{C}$

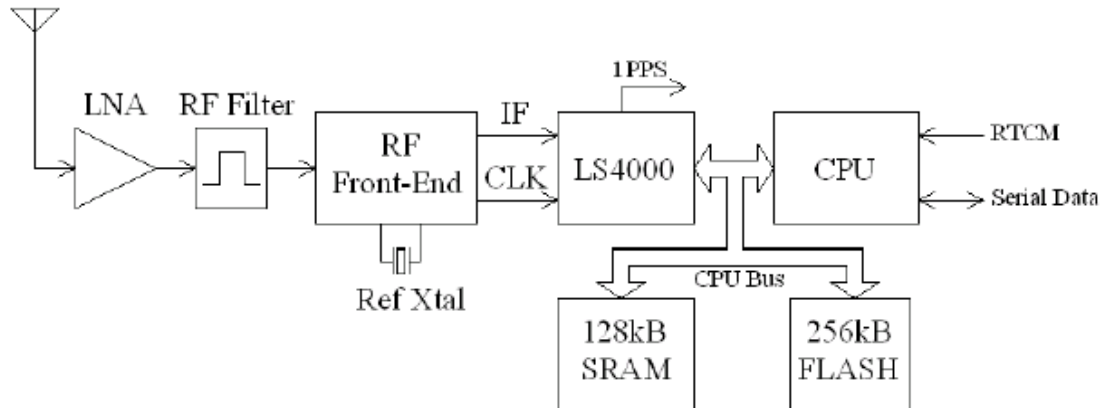
DESCRIPTION

The LS4000 is a 12 channel C/A code baseband correlation processor for use with GPS receivers. It contains 12 parallel correlation channels, and a dedicated high performance signal parameter search engine to achieve very fast signal lock-on to all visible satellites at power-up and reacquisition. The sensitivity-enhanced architecture allows positioning in severe environments such as under foliage and urban canyons.

To lower power consumption, the LS4000 allows unused tracking channels and the signal parameter search engine to be disabled individually.

The LS4000 works with available GPS RF front-ends such as SiGe SE4100, Nemerix NJ1006, and NEC uPB1007K.

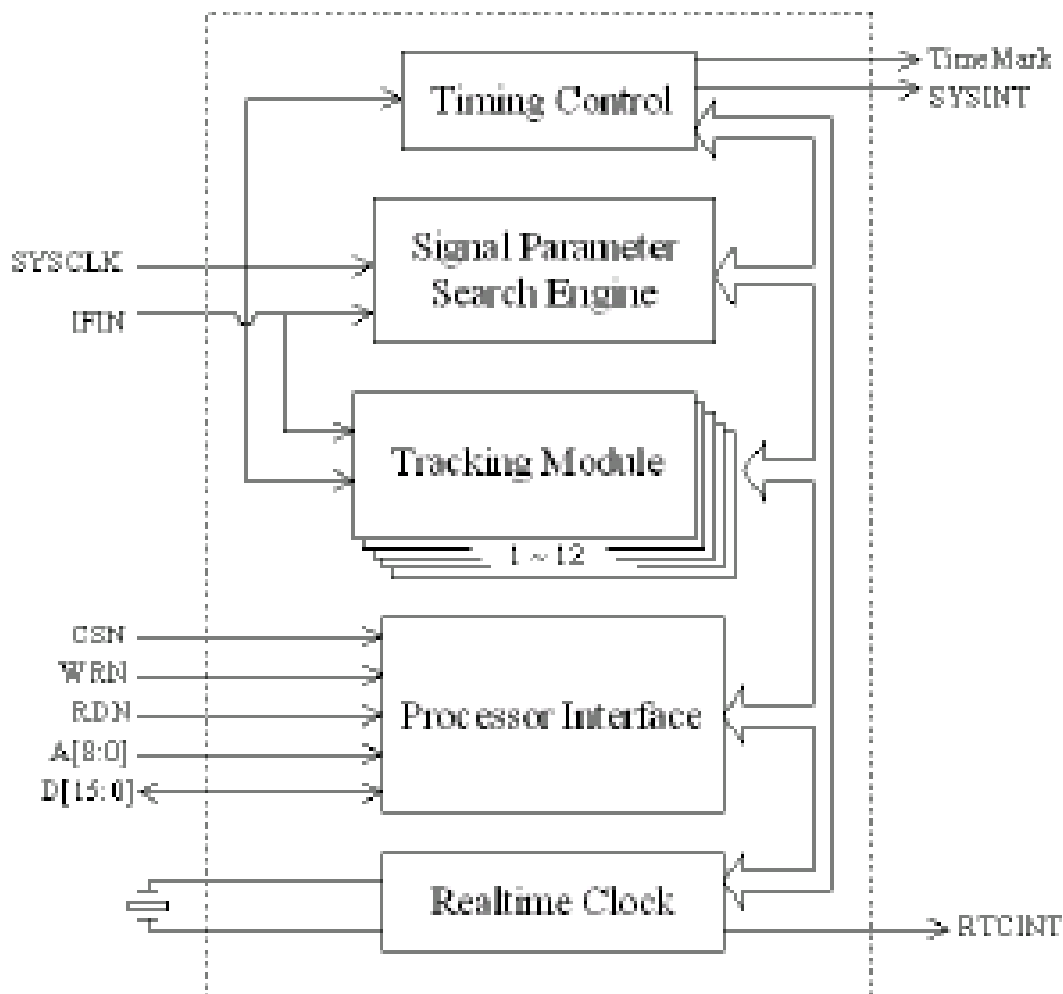
The LS4000 has 16-bit data bus interface, compatible with most available 16bit or 32bit processors.



GPS Receiver Using LS4000

FUNCTIONAL OVERVIEW

LS4000 Functional Blocks



The LS4000 GPS receiver base-band implements the necessary hardware for efficient acquiring and tracking of GPS signals. Main functional units of the hardware are: Signal Parameter Search Engine, 12 Tracking Modules, Timing Generator, and Real-time Clock. The functional units are under the control of an external processor, running the LocSense GPS decoding firmware. To lower power consumption, system clock to the unused Tracking Modules or the Signal Parameter Search Engine may be disabled individually.

Signal Parameter Search Engine

The signal parameter search engine efficiently performs 2-dimensional search of the C/A code phase and carrier offset frequency. At its maximum speed, 2million pairs of (code-phase, frequency-offset) hypothesis are tested each second, equivalent to 83% the speed of a conventional 12-channel 48-serial-correlator base-band

design. For acquisition of weak signal, programmable coherent integration and incoherent integration are applied to enhance signal detection capability.

Tracking Modules

The Tracking Modules may perform signal acquisition sequentially then close the loop after signal is detected, under control of the GPS decoding firmware. Or it may function directly in a closed-loop tracking mode, using the initial code phase and carrier offset information provided by the Signal Parameter Search Engine; which sets it in the pull-in range of the code and carrier phase-lock loops. The Tracking Modules tracks the signal continuously, generating pseudo-range and delta-range equivalent measurements at programmable interval.

Timing Control

The Timing Control unit generates processor interrupt at a programmable interval. Internal state of the tracking modules, including C/A code phase, code NCO phase, carrier NCO phase, carrier cycle count, and epoch count are latched for readout. The external processor then uses these data for closed-loop control, data bit decoding, and generate PVT solution.

Realtime Clock

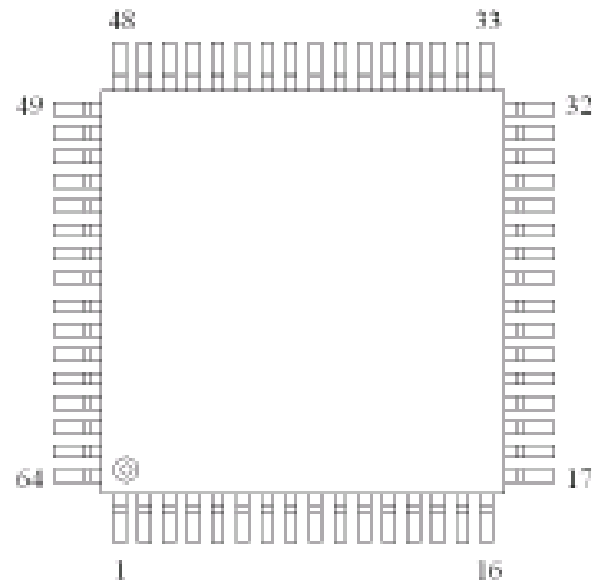
The Realtime Clock provides a continuous running clock function, to help speed up initial signal acquisition upon power-up. It requires a 32.768kHz crystal, and has separate power pin to be connected to backup supply, such that it may continue to function while the chip is powered down.

GPS PERFORMANCE

Combined with compatible GPS RF front-end and the LocSense GPS firmware, the following performance are achieved:

Accuracy	Position	10m autonomous 5m WAAS 3m DGPS	Sensitivity	Acquisition	better than -140dBm	
	Velocity	0.1m/sec stand-alone 0.05m/sec DGPS		Tracking	better than -147dBm	
	Time	+/-500nsec				
TTFB	Hot-Start	< 5sec	Reacquisition		< 1sec	
	Warm Start	< 35sec		Dynamics		< 4G
	Cold Start	< 45sec			Operating Limit	Altitude
		Velocity	500m/sec			

PIN DESCRIPTION



Pin Number	Signal Name	Type	Description
1	RTC_OSCI	I	Real-time clock oscillator coil input
2	RTC_OSCEO	O	Real-time clock oscillator coil output
3	NC		No connection
4	CSN	I	Active-low chip select
5	A0	I	Address input bit-0
6	A1	I	Address input bit-1
7	A2	I	Address input bit-2
8	A3	I	Address input bit-3
9	VCC		System power, 3.3V
10	GND		System ground
11	A4	I	Address input bit-4
12	A5	I	Address input bit-5
13	A6	I	Address input bit-6
14	A7	I	Address input bit-7
15	A8	I	Address input bit-8
16	SIGNAL	I	IF signal input
17	SYCLK	I	System clock input, 16.38767MHz
18	NC		
19	NC		
20	NC		
21	VCC		System power, 3.3V
22	GND		System ground
23	IFCLK	O	SIGNAL or SYCLK output
24	NC		
25	NC		
26	RSTN	I	Active-low hardware reset
27	VCC		System power, 3.3V
28	GND		System ground

29	TMRK	O	One pulse per second time mark
30	BWRSTN	I	Active-low software reset
31	RDN	I	Active-low read strobe
32	WRN	I	Active-low write strobe
33	D15	I/O	Bidirectional data bus bit-15
34	D7	I/O	Bidirectional data bus bit-7
35	D14	I/O	Bidirectional data bus bit-14
36	D6	I/O	Bidirectional data bus bit-6
37	VCC		System power, 3.3V
38	GND		System ground
39	D13	I/O	Bidirectional data bus bit-13
40	D5	I/O	Bidirectional data bus bit-5
41	D12	I/O	Bidirectional data bus bit-12
42	D4	I/O	Bidirectional data bus bit-4
43	VCC		System power, 3.3V
44	GND		System ground
45	D11	I/O	Bidirectional data bus bit-11
46	D3	I/O	Bidirectional data bus bit-3
47	D10	I/O	Bidirectional data bus bit-10
48	D2	I/O	Bidirectional data bus bit-2
49	D9	I/O	Bidirectional data bus bit-9
50	D1	I/O	Bidirectional data bus bit-1
51	D8	I/O	Bidirectional data bus bit-8
52	D0	I/O	Bidirectional data bus bit-0
53	VCC		System power, 3.3V
54	GND		System ground
55	NC		
56	NC		
57	NC		
58	NC		
59	NC		
60	YSINT	O	System Interrupt
61	VCC		System power, 3.3V
62	VCC		RTC power.
63	GND		RTC ground
64	RTCINT	O	RTC Interrupt

ABSOLUTE MAXIMUM RATING

Symbol	Parameter	Rating	Unit
VCC	Supply Voltage	-0.3 to 3.9	V
VIN	Input Voltage	-0.3 to VCC+0.3	V
VOUT	Output Voltage	-0.3 to VCC+0.3	V
Tstg	Storage Temperature	-40 to 150	°C

RECOMMENDED OPERATING CONDITIONS

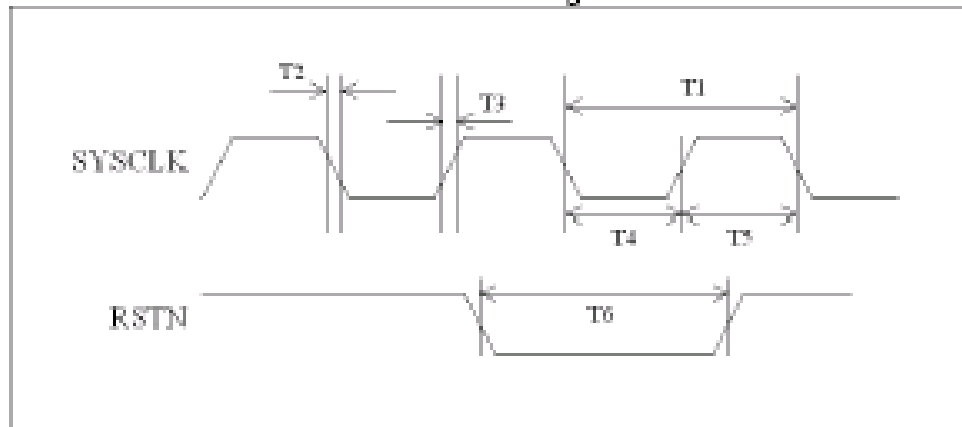
Symbol	Min	Typ	Max	Unit
VCC	3.0	3.3	3.6	V
VIN	0	3.3	3.6	V
TJ	-40	25	125	°C

DC CHARACTERISTICS

Parameter	Min	Typ	Max	Unit
VCC Power Supply	3.0	3.3	3.6	V
V _{IL} Input Low Voltage			0.3*VCC	V
V _{IH} Input High Voltage	0.7*VCC			V
V _{OL} Output Low Voltage			0.44	V
V _{OIH} Output High Voltage	2.4			V

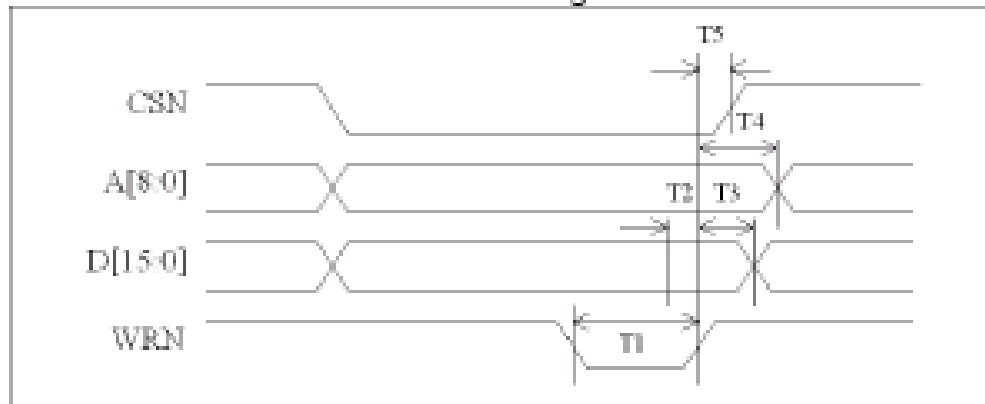
AC CHARACTERISTICS

Reset Timing



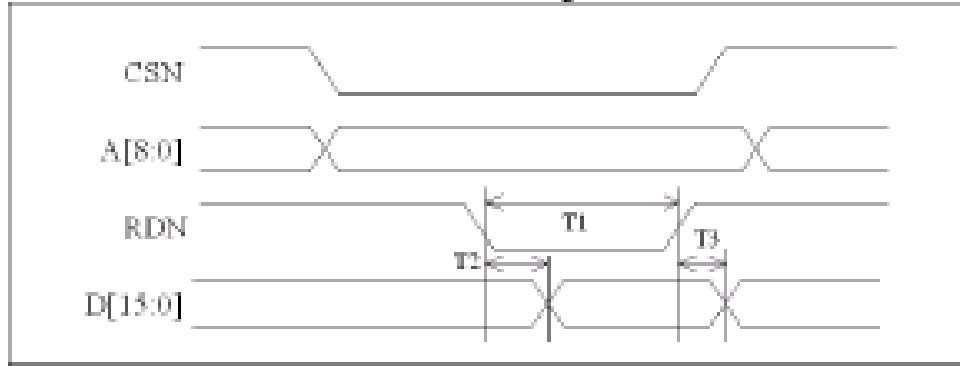
Symbol	Parameter	Min	Max	Unit
T1	Clock Period	$1/(16.384 \pm 1\%/MHz + 1\text{ppm})$	$1/(16.384 \pm 1\%/MHz + 1\text{ppm})$	sec
T2	Rise Time		10	ns
T3	Fall Time		10	ns
T4	Clock Pulse Width High Period	15		ns
T5	Clock Pulse Width Low Period	15		ns
T6	Reset Duration	150		ns

Write Timing



Symbol	Parameter	Min	Max	Unit
T1	Write Strobe Pulse Width	15		ns
T2	Data Setup Time	10		ns
T3	Data Hold Time	5		ns
T4	Address Hold Time	5		ns
T5	Chip Select Hold Time	0		ns

Read Timing



Symbol	Parameter	Min	Max	Unit
T1	Read Strobe Pulse Width	15		ns
T2	Data Valid Time	7		ns
T3	Data Hold Time		5	ns

PACKAGE DETAILS

