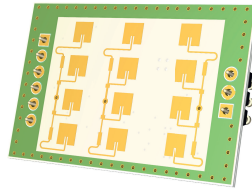


K-LC7

radar transceiver



Features

- Small and low cost 24 GHz transceiver
- Two Rx Antennas for angle measurement
- I/Q IF outputs
- Fully integrated low phase noise VCO
- Built in temperature compensation circuit for VCO stabilization
- Wide power supply range from 3.2 to 5.5V
- 3 × 4 patch antenna with 80°/34° beam aperture
- Available as SMT or THT type

Applications

- Direction sensitive movement detection
- Security systems
- Home automation
- Indoor and outdoor lighting control applications
- Object speed measurement systems
- Ranging detection of moving objects using FSK
- Industrial sensors

Description

The K-LC7 is a small and low cost radar module which allows angle measurements. The module is operating in the 24.0 GHz to 24.25 GHz ISM band and it has a built in low phase noise VCO, which makes the module suitable for FSK or FMCW applications. The internal temperature compensating circuit keeps the output frequency stable over a wide temperature range.

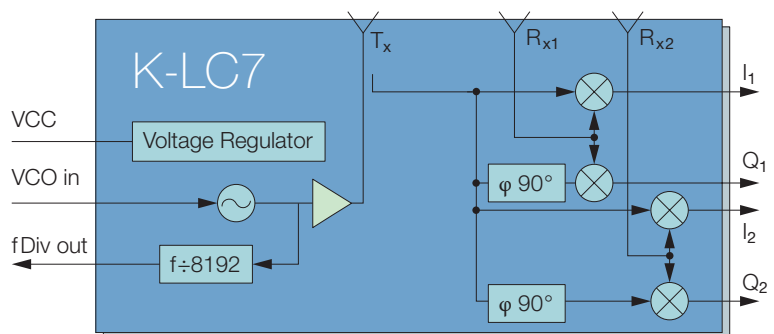
IF outputs I and Q allow movement direction detection and high performance signal processing.

The sensor has a 3x4 patch radar frontend with an asymmetrical beam. The built-in voltage regulator covers a wide power supply range from 3.2 to 5.5V. The module provides a frequency divided output which can be used to measure the output frequency of the VCO.

The K-LC7 is offered as SMD or THT type. The SMD-Type can be mounted using standard pick and place machines and is compatible with Reflow solder process.

Block Diagram

Figure 1: K-LC7 block diagram



Characteristics

Parameter	Conditions/Notes	Symbol	Min	Typ	Max	Unit
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Operating conditions

Supply voltage		V _{CC}	3.2		5.5	V
Supply current		I _{CC}		75		mA
VCO input voltage		U _{VCO}	0		5	V
VCO pin resistance	Driving voltage source Note 1	R _{VCO}		120		kΩ
Operating temperature		T _{St}	-20		85	°C
Storage temperature		T _{op}	-20		105	°C

Transmitter

Transmitter frequency	V _{CO} pin left open, Tamb = -20 °C .. +85 °C	f _{TX}	24	24.125	24.25	GHz
Frequency drift vs. temperature	V _{CC} = 5V, -20°C .. +85°C Note 2	Δ f _{TX}		0.1		MHz/°C
Frequency tuning range		Δ f _{VCO}	200	250	350	MHz
VCO sensitivity		S _{VCO}		80		MHz/V
VCO Modulation Bandwidth	Δf = 20MHz	B _{VCO}		100		kHz
Output power	EIRP	P _{TX}		12		dBm
Output power deviation	Full V _{CO} tuning range	Δ P _{TX}			+/-1	dBm
Spurious emissions	According to ETSI 300 440	P _{Spur}		-30		dBm
Turn-on time	Until oscillator stable, Δ f _{TX} < 5MHz	t _{ON}		1		μs

Receiver

Mixer conversion loss	f _{IF} = 1 kHz, IF load = 1 kΩ	D _{mixer1}		-6		dB
Antenna gain	f _{IF} = 20 MHz, IF load = 50 Ω	D _{mixer2}		-11		dB
	f _{TX} = 24.125 GHz	G _{Ant}		8.6		dBi
Receiver sensitivity	f _{IF} = 500 Hz, B = 1 kHz, R _{IF} = 1 kΩ, S/N = 6 dB	P _{RX}		-96		dBm
Overall sensitivity	f _{IF} = 500 Hz, B = 1 kHz, R _{IF} = 1 kΩ, S/N = 6 dB	D _{system}		-108		dBc

Antenna

Horizontal -3 dB beamwidth	E-Plane	W _φ		80		°
Vertical -3 dB beamwidth	H-Plane	W _θ		34		°
Horiz. sidelobe suppression		D _φ	-12	-20		dB
Vertical sidelobe suppression		D _θ	-12	-20		dB

IF output

IF output resistance		R _{IF}		50		Ω
IF frequency range	-3 dB Bandwidth, IF load = 50 Ω	f _{IF}	0		50	MHz
IF noise power	f _{IF} = 500 Hz, IF load = 50 Ω	P _{IFnoise1}		-134		dBm/Hz
	f _{IF} = 1 MHz, IF load = 50 Ω	P _{IFnoise2}		-164		dBm/Hz
IF noise voltage	f _{IF} = 500 Hz, IF load = 1 kΩ	U _{IFnoise1}		-147		dBm/Hz
	f _{IF} = 500 Hz, IF load = 1 kΩ	U _{IFnoise1}		45		nV/√Hz
IF output offset voltage	Full VCO range, no object in range	U _{IF}	-200		200	mV
I/Q amplitude balance	f _{IF} = 500 Hz, U _{IF} = 1 mVpp	Δ U _{IF}		3		dB
I/Q phase shift	f _{IF} = 1 Hz ... 20 kHz	φ	80	90	100	°
Supply rejection	Rejection supply pins to IF output	D _{Supply}		25		dB

Frequency divider output

Prescaler division factor		X _{div}		8192		
Divider output frequency		F _{div}		2.94		MHz
Divider output voltage	Load = 1 kΩ	U _{div}		1.5		Vpp

Body

Weight				5		g
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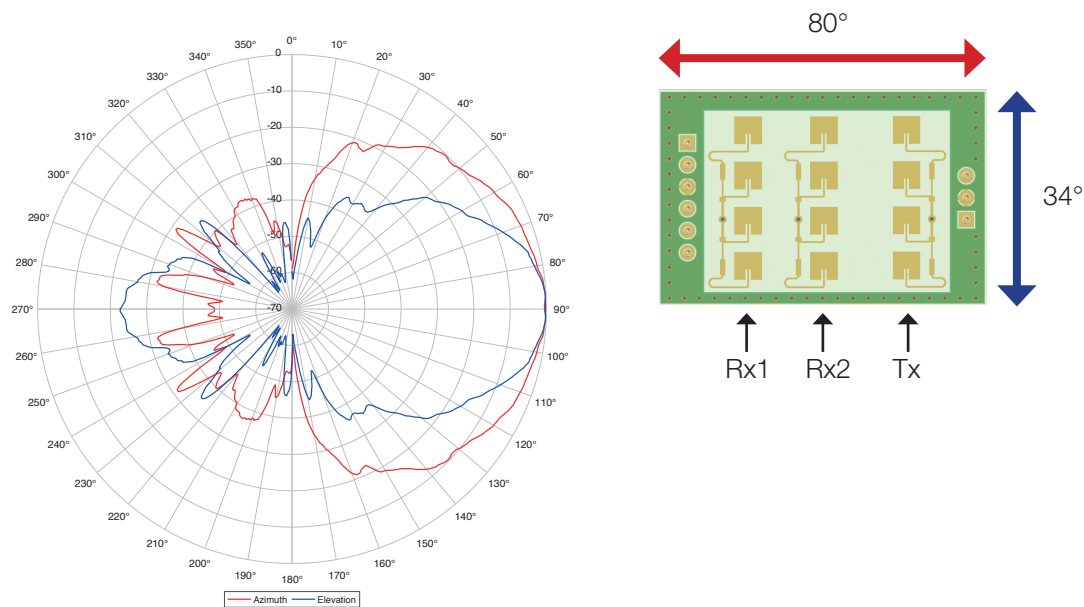
Note 1 The VCO input has an internal voltage source with approximately 1.2VDC.

Note 2 Transmit frequency stays within 24.000 to 24.250GHz over the specified temperature range when the VCO pin is left open.

Antenna System Diagram

This diagram shows module sensitivity in both azimuth and elevation directions. It incorporates the transmitter and receiver antenna characteristics.

Figure 2: Antenna characteristics



Pin Configuration and Functions

Table 1: Pin function description

Pin No.	Type	Name	Description	Typical Value
X1,1	Supply	Vcc	Power supply	+3.2 to +5.5V
X1,2	Ground	GND	Ground	–
X1,3	Digital out	fDiv_out	Frequency divider output ($f_{TX} / 8192$)	–
X2,1	Analog out	Out_I1	IF I (In-Phase) of Antenna Rx1	Load 1 kOhm
X2,2	Analog out	Out_Q1	IF Q (Quadrature) of Antenna Rx1	Load 1 kOhm
X2,3	Ground	GND	Ground	–
X2,4	Analog out	Out_Q2	IF Q (Quadrature) of Antenna Rx2	Load 1 kOhm
X2,5	Analog out	Out_I2	IF I (In-Phase) of Antenna Rx2	Load 1 kOhm
X2,6	Analog in	VCO_In	Voltage controlled oscillator input	0 to +5V

Outline Dimensions

Figure 3: Outline dimensions K-LC7 (SMD-Type)

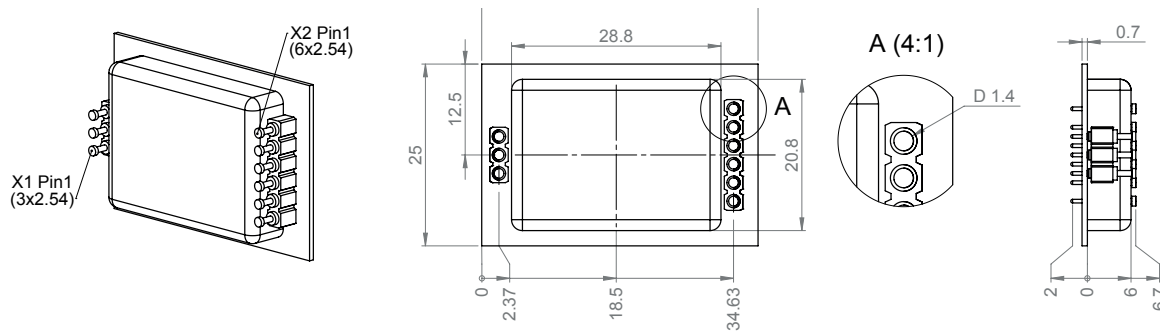


Figure 4: Outline dimensions K-LC7 (THT-Type)

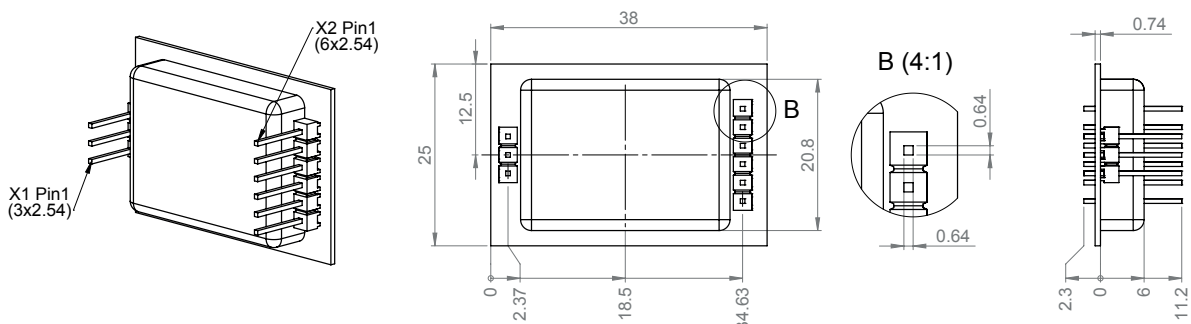
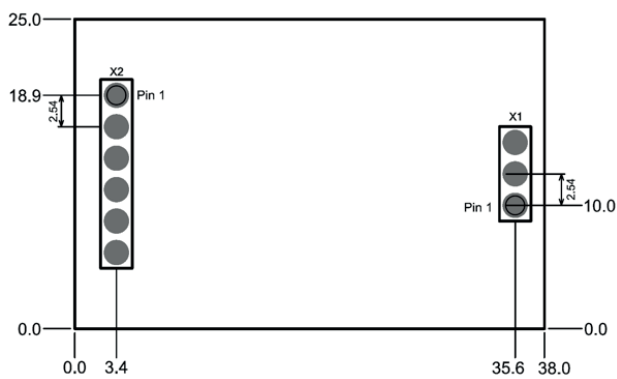


Figure 5: Footprint recommendation for SMD-Type



Top view

Pads: Round d = 2mm

All dimensions in (mm)

Ordering Information

The ordering number consists of different parts with the structure below.

Figure 6: Ordering number structure

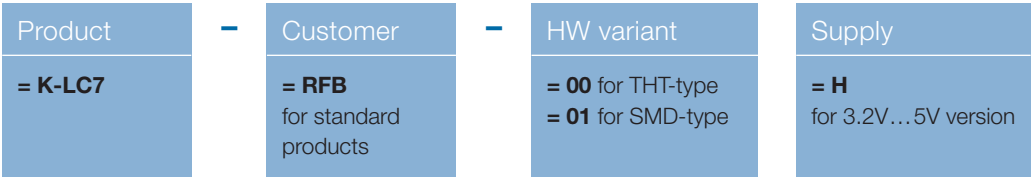


Table 2: Available ordering numbers

Ordering number	Description
K-LC7-RFB-00H	Standard K-LC7 THT-type
K-LC7-RFB-01H	Standard K-LC7 SMD-type

Revision History

02/2018 – Revision A: Initial Version

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