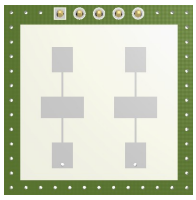
K-LC5 RADAR TRANSCEIVER

Datasheet

Features

- 24 GHz short range transceiver
- Beam aperture 80°/34°
- Pin-compatible with K-LC2
- 150 MHz typical sweep rate
- High sensitive LNA receiver
- More than double K-LC2 sensitivity
- I/Q IF outputs
- Low cost design
- Compact size: 25mm x 25mm x 6mm



K-LC5 actual size

Applications

- Security systems
- Directional object speed measurement systems
- Directional movement detectors
- Ranging of moving objects
- Industrial sensors

Description

K-LC5 is an extended range dual channel Doppler Radar module with an asymmetrical beam for short distance sensors. It is ideally suited for person movement sensors.
Dual IF I and Q allow movement direction detection and high performance signal processing. FM input allows FSK ranging applications.

An extremely slim construction with only 6mm depth gives you maximum flexibility in your equipment design.
Powerful starterkits with signal conditioning and visualization are also available. (see www.rfbeam.ch Download Section)

Blockdiagram

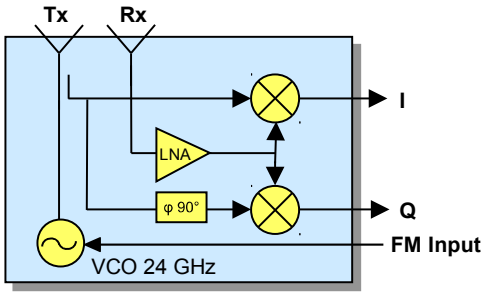


Fig. 1: K-LC5 Blockdiagram

Characteristics

Parameter	Conditions / Notes	Symbol	Min	Typ	Max	Unit
Operating conditions						
Supply voltage		V_{cc}	4.75	5.0	5.25	V
Supply current		I_{cc}		50	65	mA
VCO input voltage		U_{vco}	-0.5		2.0	V
VCO pin resistance	Driving voltage source Note 1	R_{vco}		570		Ω
Operating temperature		T_{op}	-20		+80	°C
Storage temperature		T_{st}	-20		+80	°C
Transmitter						
Transmitter frequency	T_{amb}=-20°C .. +60°C	f_{TX}	24.050	24.150	24.250	GHz
Frequency drift vs temp.	V_{cc}=5.0V, -20°C .. +60°C Note 2	Δf_{TX}		-1.0		MHz/°C
Frequency tuning range		Δf_{vco}		150		MHz
VCO sensitivity		S_{vco}		-80		MHz/V
VCO Modulation Bandwidth		B_{VCO}		3		MHz
Output power	EIRP	P_{TX}	+12	+15	+19	dBm
Turn-on Time	Until oscillator stable Δf_{TX} < 5MHz			1	1.5	µs
Spurious emission	According to ETSI 300 440	P_{spur}			-30	dBm
Receiver						
Antenna gain	F_{TX}=24.125GHz Note 3	G_{Ant}		8.6		dBi
LNA gain	F_{RX}=24.125GHz	G_{LNA}		10		dB
Mixer Conversion loss	f_{IF} =1kHz, IF load 1k	D_{mixer}		-9		dB
Receiver sensitivity	f_{IF} =500Hz, B=1kHz, S/N=6dB, RLOAD	P_{RX}		-103		dBm
Overall sensitivity	f_{IF} =500Hz, B=1kHz, S/N=6dB	D_{system}		-118		dBc
IF output						
IF output impedance		R_{IF}		50		Ω
I/Q amplitude balance	f_{IF} =500Hz	ΔU_{IF}		3		dB
I/Q phase shift	f_{IF} =500Hz	φ	80	90	100	°
IF frequency range	-3dB Bandwidth	f_{IF}	0		50	MHz
IF noise voltage	f_{IF} =500Hz	$U_{IFnoise}$		45		nV/√Hz
	f_{IF} =500Hz	$U_{IFnoise}$		-147		dBV/Hz
IF output offset voltage		U_{os}	-0.2		+0.2	V
Supply rejection	Rejection supply pins to outputs, 500Hz	D_{supply}		-25		dB
Antenna						
Horizontal -3dB beamwidth	E-Plane	W_{φ}		80		°
Vertical -3dB beamwidth	H-Plane	W_{θ}		34		°
Horiz. sidelobe suppression		D_{φ}	-12	-20		dB
Vert. sidelobe suppression		D_{θ}	-12	-20		dB
Body						
Outline Dimensions	connector left unconnected			25 x 25 x 6		mm^3
Weight				4		g
Connector				5		pins

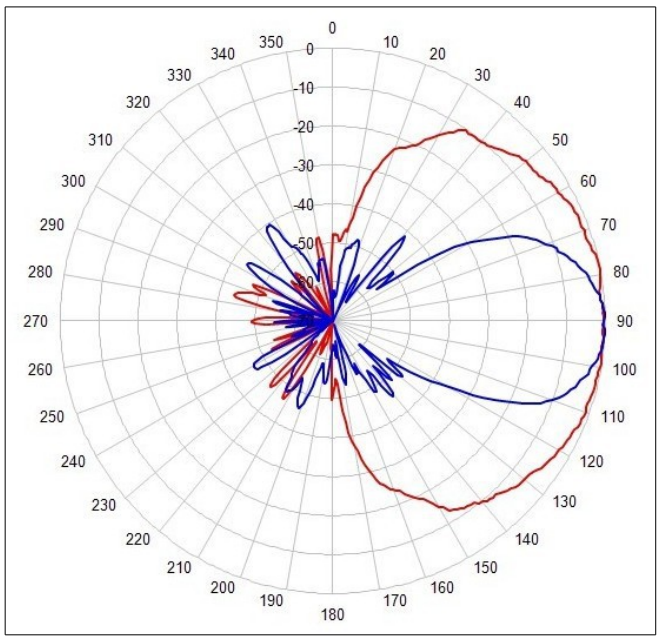
Note 1 The VCO input has an internal voltage source with approx. 0.9VDC. For driving this pin it is necessary to source and sink current

Note 2 Transmit frequency stays within 24.050 to 24.250GHz over the specified temperature

Note 3 Theoretical value, given by design

Antenna System Diagram

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



Azimuth 34° , Elevation 80°
At IF output voltage -6dB
(corresponds to -3dB Tx power)

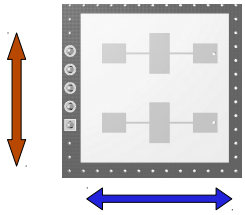


Fig. 2: Antenna system diagram (logarithmic scale)

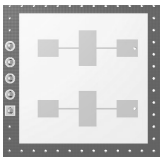
Pin Configuration

K-LC5		
Pin	**Description**	**Typical use**
1	IF output Q	1k load
2	VCC	5V supply
3	IF output I	1k load
4	GND	0V supply
5	VCO In	Open = f_0

K-LC5-v2		
Pin	**Description**	**Typical use**
1	IF output Q	1k load
2	VCC	5V supply
3	IF output I	1k load
4	GND	0V supply
5	IF output Q	tied to pin 1

Please note:
K-LC5-v2 does not include a VCO.
Pin 1 and 5 are tied together

Pin 1



Do not touch open connector pins. RFbeam K-LC5 radar module is susceptible to electrical discharge as long as it is not placed in the circuit.

Outline Dimensions

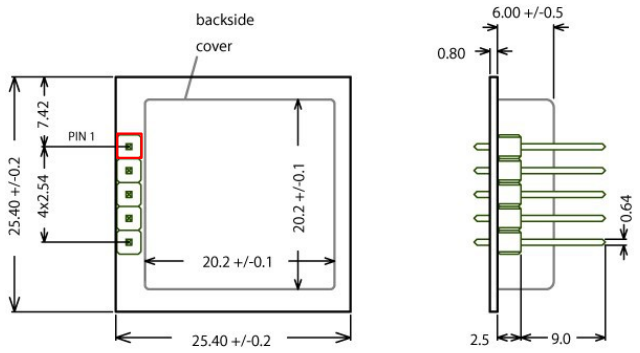


Fig. 3: Mechanical dimensions

Application Notes

Sensitivity and Maximum Range

The values indicated here are intended to give you a 'feeling' of the attainable detection range with this module. It is not possible to define an exact RCS (radar cross section) value of real objects because reflectivity depends on many parameters. The RCS variations however influence the maximum range only by $\sqrt[4]{\sigma}$.

Maximum range for Doppler movement depends mainly on:		
- Module sensitivity	S:	-118dBc (@1kHz IF Bandwidth)
- Carrier frequency	f_0:	24.125GHz
- Radar cross section RCS ("reflectivity") of the object	$\sigma^{1)}$:	$1m^2$ approx. for a moving person $>50m^2$ for a moving car

note [1)] RCS indications are very inaccurate and may vary by factors of 10 and more.

The famous "Radar Equation" may be reduced for our K-band module to the following relation:

$$r = 0.0167 \cdot 10^{\frac{-s}{40}} \cdot \sqrt[4]{\sigma}$$

Using this formula, you get an indicative detection range of
- > 15 meters for a moving person
- > 40 meters for a moving car

Please note, that range values also highly depend on the performance of signal processing, environment conditions (i.e. rain, fog), housing of the module and other factors.

By reducing IF amplifier bandwidth, detection range can be enhanced. With BW=250Hz instead of 1kHz, sensitivity will raise by 6dB to -124dBc. Maximum range will then become 21m.

You may achieve maximum range of more than 30m when using high resolution AD-converters and selective FFT algorithms.

Datasheet Revision History

Version	Date	Changes
1.0	25-April-2012	initial release
2.0	06 Sep-2012	K-LC5 standard contains a VCO. K-LC5-v2 does not contain a VCO