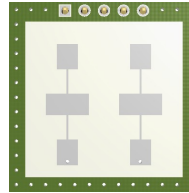


## Features

- 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
- 3 Pin version K-LC5\_V2 available
- Compact size: 25mm x 25mm x 6mm



## 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](http://www.rfbeam.ch) Download Section)

## Blockdiagram

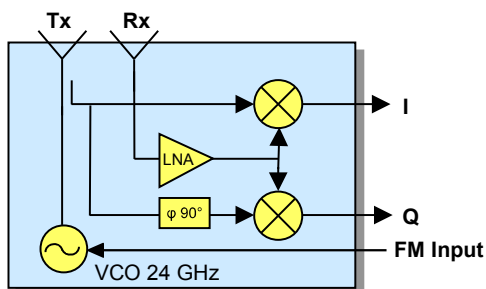


Fig. 1: K-LC5 Blockdiagram (FM input not present on K-LC5\_V2)

## K-LC5 RADAR TRANSCEIVER

## Datasheet

## Characteristics

Parameter	Conditions / Notes	Symbol	Min	Typ	Max	Unit
<b>Operating conditions</b>						
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 <sup>Note 1</sup>	$R_{vco}$		570		$\Omega$
Operating temperature		$T_{op}$	-20		+80	$^{\circ}\text{C}$
Storage temperature		$T_{st}$	-20		+80	$^{\circ}\text{C}$
<b>Transmitter</b>						
Transmitter frequency	$T_{amb} = -20^{\circ}\text{C} \dots +60^{\circ}\text{C}$	$f_{TX}$	24.050	24.150	24.250	GHz
Frequency drift vs temp.	$V_{cc} = 5.0\text{V}$ , $-20^{\circ}\text{C} \dots +60^{\circ}\text{C}$ <sup>Note 2</sup>	$\Delta f_{TX}$		-1.0		MHz/ $^{\circ}\text{C}$
Frequency tuning range		$\Delta f_{vco}$		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 $\Delta f_{TX} < 5\text{MHz}$			1	1.5	$\mu\text{s}$
Spurious emission	According to ETSI 300 440	$P_{spur}$			-30	dBm
<b>Receiver</b>						
Antenna gain	$F_{TX} = 24.125\text{GHz}$ <sup>Note 3</sup>	$G_{Ant}$		8.6		dBi
LNA gain	$F_{RX} = 24.125\text{GHz}$	$G_{LNA}$		10		dB
Mixer Conversion loss	$f_{IF} = 1\text{kHz}$ , IF load 1k	$D_{mixer}$		-9		dB
Receiver sensitivity	$f_{IF} = 500\text{Hz}$ , $B = 1\text{kHz}$ , $S/N = 6\text{dB}$ , $R_{LOAD}$	$P_{RX}$		-103		dBm
Overall sensitivity	$f_{IF} = 500\text{Hz}$ , $B = 1\text{kHz}$ , $S/N = 6\text{dB}$	$D_{system}$		-118		dBc
<b>IF output</b>						
IF output impedance		$R_{IF}$		50		$\Omega$
I/Q amplitude balance	$f_{IF} = 500\text{Hz}$	$\Delta U_{IF}$		3		dB
I/Q phase shift	$f_{IF} = 500\text{Hz}$	$\varphi$	80	90	100	$^{\circ}$
IF frequency range	-3dB Bandwidth	$f_{IF}$	0		50	MHz
IF noise voltage	$f_{IF} = 500\text{Hz}$	$U_{IFnoise}$		45		nV/ $\sqrt{\text{Hz}}$
	$f_{IF} = 500\text{Hz}$	$U_{IFnoise}$		-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
<b>Antenna</b>						
Horizontal -3dB beamwidth	E-Plane	$W_{\theta}$		80		$^{\circ}$
Vertical -3dB beamwidth	H-Plane	$W_{\theta}$		34		$^{\circ}$
Horiz. sidelobe suppression		$D_{\theta}$	-12	-20		dB
Vert. sidelobe suppression		$D_{\theta}$	-12	-20		dB
<b>Body</b>						
Outline Dimensions	connector left unconnected			25 x 25 x 6		mm <sup>3</sup>
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

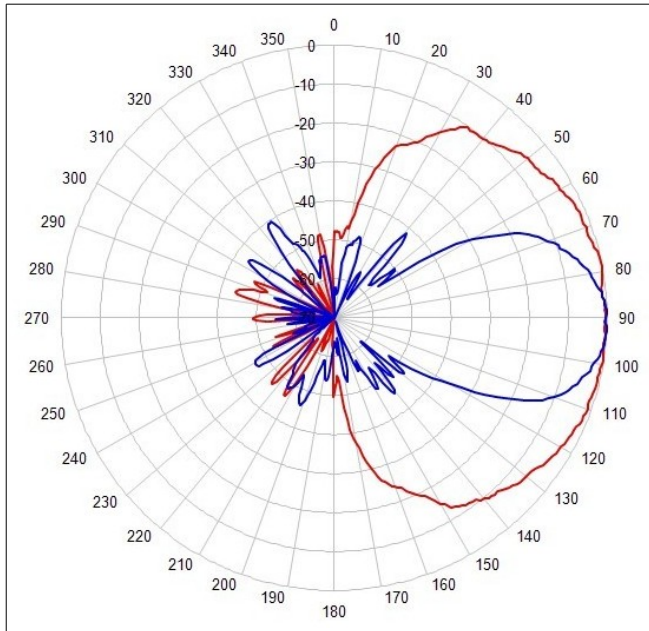
Note 2 Transmit frequency stays within 24.050 to 24.250GHz over the specified temperature

Note 3 Theoretical value, given by design

K-LC5 RADAR TRANSCEIVER

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)

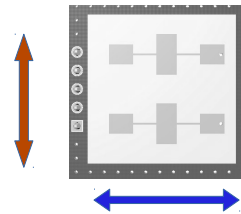
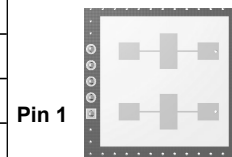


Fig. 2: Antenna system diagram (logarithmic scale)

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

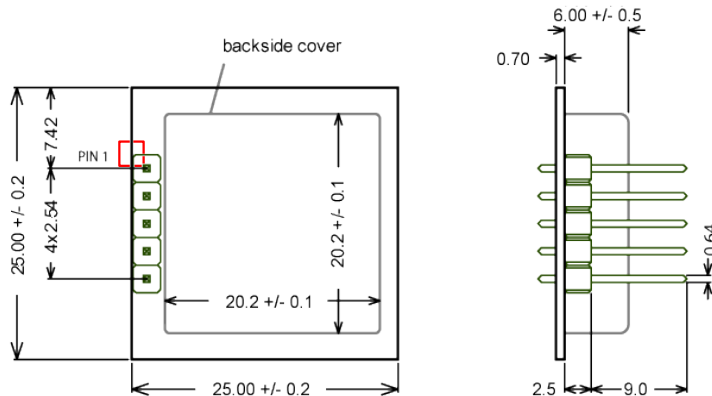


**Please note:**  
K-LC5\_V2 does not include a VCO.  
Pin 1 and 5 are tied together



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



All Dimensions in mm; values are typical unless otherwise specified

**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 <sup>2</sup> approx. for a moving person<br>>50m <sup>2</sup> for a moving car |

note <sup>1)</sup> 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
- > 60 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.

**EC-Declaration of Conformity**

This product complies with the essential requirements of the RED Directive 2014/53/EU, and can be used in all countries within Europe.

**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
2.1	24-Aug-2017	New module picture page 1, Directive 2014/53/EUR and full address added
2.2	25-Oct-2017	New module picture page 1, typing error in address corrected
2.3	02-Nov-2018	Outer Outline Dimensions corrected and corrected the part number of the K-LC5_V2

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