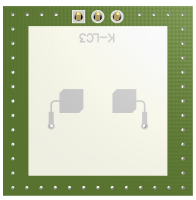
K-LC3 RADAR TRANSCEIVER

Datasheet

Features

- 24 GHz K-band miniature transceiver
- 3.3V Version K-LC3_V2 available
- Dual 1 patch circular polarized antenna
- Single balanced mixer with 50MHz bandwidth
- Wide beam aperture 138°/132°
- 10dBm EIRP output power
- 25x25mm^2 surface, <6mm thickness
- Low cost design



K-LC3 Actual Size

Applications

- Lowcost general purpose movement detectors
- Security systems
- Ceiling and wall mount surveillance system
- Industrial sensors

Description

K-LC3 is a 2 patch Doppler module with a nearly symmetrical wide beam for low cost short distance applications.
Its typical applications are movement sensors for security, lighting and building automation applications This module may be an alternative or a complementary sensor for infrared PIR or AIR systems thanks to its outstanding per-formance/cost ratio.

The module is extremely small and lightweight. With an IF bandwidth from DC to 50MHz it opens many new applications.
The unique RFbeam circular polarized antenna forms allows much wider acquisition fields than the traditional linear polarized patch antenna.
A powerful starterkit with signal conditioning and visualization is available from RFbeam. Find more informations on www.rfbeam.ch.

Blockdiagram

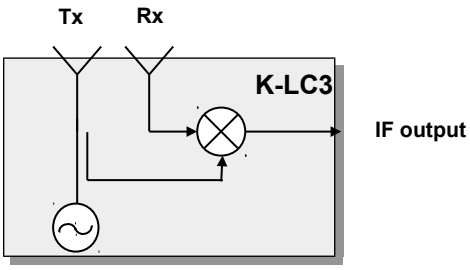


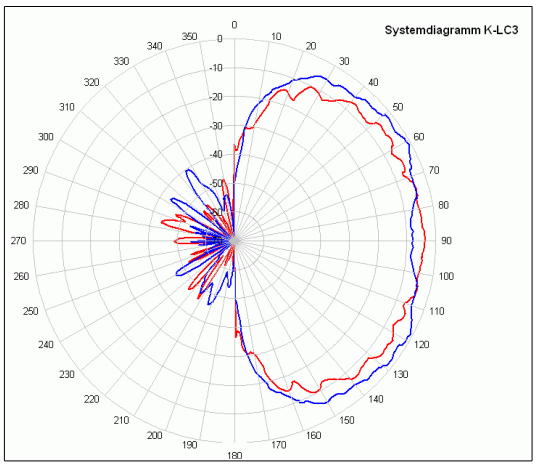
Fig. 1: Block diagram

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}		35	45	mA
Operating temperature		T_{op}	-20		+60	°C
Storage temperature		T_{st}	-20		+80	°C
Transmitter						
Transmitter frequency	T_{amb}=-20°C .. +60°C	f_{TX}	24.150	24.200	24.250	GHz
Frequency drift vs temperature	V_{cc}=5.0V, -20°C .. +60°C Note 1	Δf_{TX}		-0.9		MHz/°C
Output power	EIRP	P_{TX}	+7	+10	+13	dBm
Spurious emission	According to ETSI 300 440	P_{spur}			-30	dBm
Turn-on time	Until oscillator stable, Δf_{TX} < 5MHz	t_{on}		1		µs
Receiver						
Mixer Conversion loss	f_{IF} = 1kHz, IF load = 1kΩ	D_{mixer1}		-6		dB
	f_{IF} = 20MHz, IF load = 50Ω	D_{mixer2}		-11		dB
Antenna Gain	F_{TX}=24.125GHz Note 2	G_{Ant}		4.8		dB
Receiver sensitivity	f_{IF} =500Hz,B=1kHz,R_{IF} =1kΩ,S/N=6dB	P_{RX1}		-95		dBm
	f_{IF} =1MHz,B=20MHz,R_{IF} =50Ω,S/N=6dB	P_{RX1}		-83		dBm
Overall sensitivity	f_{IF} =500Hz,B=1kHz,R_{IF} =1kΩ,S/N=6dB	D_{system}		-105		dBc
IF output						
IF resistance		R_{IF}		50		Ω
IF frequency range	-3dB Bandwidth, IF load = 50Ω	f_{IF}	0		50	MHz
IF noise power	f_{IF} =500Hz, IF load = 50Ω	$P_{IFnoise1}$		-137		dBm/Hz
	f_{IF} =1MHz, IF load = 50Ω	$P_{IFnoise2}$		-164		dBm/Hz
IF noise voltage	f_{IF} =500Hz, IF load = 1kΩ	$U_{IFnoise1}$		-150		dBV/Hz
	f_{IF} =500Hz, IF load = 1kΩ	$U_{IFnoise1}$		31		nV/√Hz
IF output offset voltage	no object in range	U_{IF}	10		200	mV
Supply rejection	Rejection supply pins to IF output	D_{supply}		26		dB
Antenna						
Antenna type	Right hand circular polarized	RHCP				
Horizontal -3dB beamwidth	E-Plane	W_{φ}		138		°
Vertical -3dB beamwidth	H-Plane	W_{ϑ}		132		°
Horiz. sidelobe suppression		D_{φ}		-12		dB
Vertical sidelobe suppression		D_{ϑ}		-12		dB
Body						
Outline Dimensions				25*25*6		mm^3
Weight				4.5		g
Connector	3pin single row jumper					

Note 1 Transmit frequency stays within 24.150 to 24.250GHz over the specified temperature range
Note 2 Theoretical value, given by Design

Antenna System Diagram

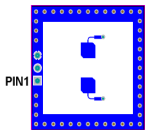


This diagram shows module sensitivity in both azimuth and elevation directions. It incorporates both transmitter and receiver antenna characteristics.

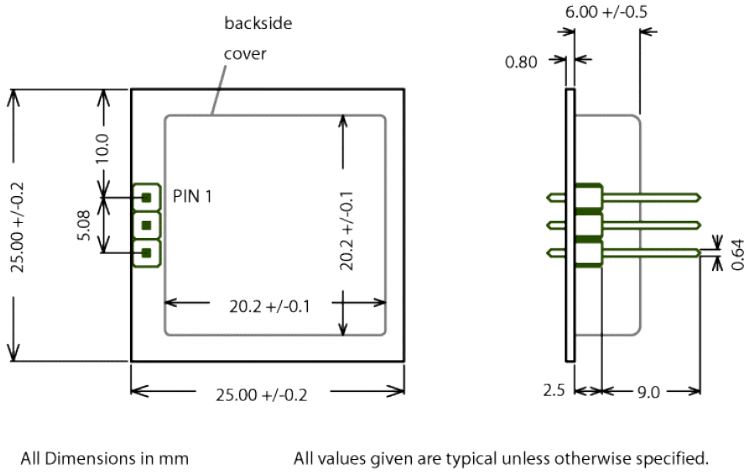
Fig. 2: System diagram

Pin Configuration

Pin	Description	Typical Value
1	VCC	5VDC supply
2	IF output	load 1kOhm
3	GND	ground



Outline Dimensions



All Dimensions in mm All values given are typical unless otherwise specified.

Fig. 3: Mechanical data

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:	-105dBc (@0.5kHz 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
- 7 meters for a moving person.
- > 15 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.
For simple detection purposes (security applications e.g.) without the need of speed measurements, range may be enhanced by further reducing the IF bandwidth. With 250Hz bandwidth and a simple comparator, we get already a 12m frontal detection range.

Datasheet Revision History

Version	Date	Changes
0.1	07-Apr-2009	initial release
1.0	18-Mar-2011	Typical transmit frequency = 24.200; range 24.150 .. 24.250 over temp.
1.1	02-Nov-2018	Changed footer to new address