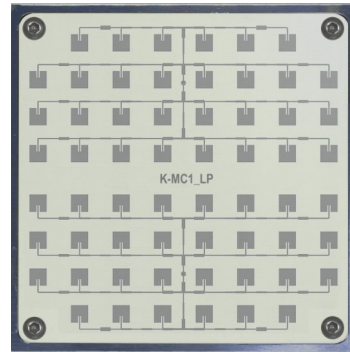


K-MC1_LP RADAR TRANSCEIVER

Datasheet

Features

- LOW CURRENT 24 GHz short range transceiver
- 8mA @ 3.3V at same performance as K-MC1
- 3.3V ... 5V supply
- Less than 30mW power consumption
- High sensitivity, with integrated RF/IF amplifier
- Dual 30 patch antenna
- Buffered I/Q IF outputs
- Beam aperture 25°/12°
- Slim 6mm thickness construction



Applications

- Battery operated equipment
- Traffic supervision
- Object speed measurement systems
- Industrial sensors

Description

K-MC1_LP is a low current, doppler module with an asymmetrical narrow beam for long distance sensors. It is ideally suited for traffic applications.

This module includes a RF low noise amplifier and two 42dB IF pre-amplifiers for both I and Q channels. The need for external analogue electronics will be significantly reduced by this feature.

K-MC1_LP needs 10 times less current than our standard K-MC1 sensor and works from 3.3V or 5V power supplies.

An extremely slim construction with only 6mm depth gives you maximum flexibility in your equipment design.

Powerful starter kits with signal conditioning and visualization are available.

Blockdiagram

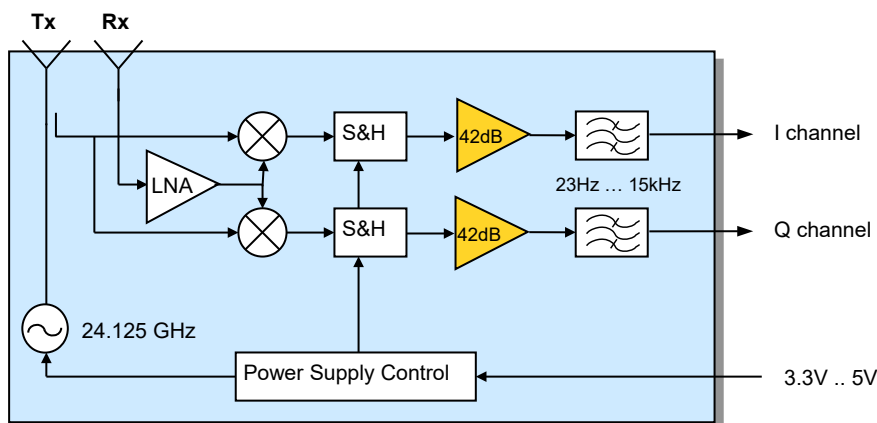


Fig. 1: K-MC1_LP Blockdiagram

K-MC1_LP RADAR TRANSCEIVER

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Characteristics

Parameter	Conditions / Notes	Symbol	Min	Typ	Max	Unit
Operating conditions						
Supply voltage		V_{cc}	3.15		6.0	V
Supply current	Module enabled (Pin 1 = V_{IL})	I_{cc}		7.5	9	mA
Operating temperature		T_{op}	-20		+80	°C
Storage temperature		T_{st}	-20		+80	°C
Transmitter						
Transmitter frequency	$U_{VCO}=5V$, $T_{amb}=-20^{\circ}C \dots +80^{\circ}C$	f_{TX}	24.050	24.150	24.250	GHz
Frequency drift vs temp.	$V_{cc}=5.0V$, $-20^{\circ}C \dots +80^{\circ}C$ Note 1	Δf_{TX}		-1.0		MHz/°C
Output power	EIRP peak power	P_{TX}	+16	+18	+20	dBm
Transmitter duty cycle	internally generated	d		1		%
Spurious emission	According to ETSI 300 440	P_{spur}			-30	dBm
Receiver						
Antenna gain	$F_{TX}=24.125GHz$ Note 2	G_{Ant}		18.5		dBi
LNA gain	$F_{RX}=24.125GHz$	G_{LNA}		10		dB
Mixer Conversion loss	$f_{IF}=500Hz$	D_{mixer}		-1		dB
Receiver sensitivity	$f_{IF}=500Hz$, $B=1kHz$, $S/N=6dB$	P_{RX}		-122		dBm
Overall sensitivity	$f_{IF}=500Hz$, $B=1kHz$, $S/N=6dB$	D_{system}		-140		dBc
IF output						
IF output impedance		R_{IF_AC}		100		Ω
IF Amplifier gain		G_{IF_AC}		42		dB
I/Q amplitude balance	$f_{IF}=500Hz$, $U_{IF}=100mV_{pp}$	ΔU_{IF}		0		dB
I/Q phase shift	$f_{IF}=500Hz$, $U_{IF}=100mV_{pp}$	φ	80	90	100	°
IF frequency range	-3dB Bandwidth	f_{IF_AC}	23		15k	Hz
Spurious signals	Internal regulator @ 100kHz	V_{sp}			0.3	mVrms
IF noise voltage	$f_{IF}=1kHz$	$U_{IFnoise}$		35		$\mu V/\sqrt{Hz}$
	$f_{IF}=1kHz$	$U_{IFnoise}$		-89		dBV/Hz
IF output offset voltage	$V_{cc}=5V$, AC outputs	U_{os_AC}	1.0	1.5	2.0	V
Supply rejection	Rejection supply pins to AC outputs, 500Hz	D_{supply}		-24		dB
Antenna						
Horizontal -3dB beamwidth	E-Plane	W_{φ}		12		°
Vertical -3dB beamwidth	H-Plane	W_{θ}		25		°
Horiz. sidelobe suppression		D_{φ}		-20		dB
Vert. sidelobe suppression		D_{θ}		-18		dB
Body						
Outline Dimensions	connector left unconnected			65*65*6		mm ³
Weight				50		g
Connector	Module side: AMP X-338069-8			8		pins

Note 1 Transmit frequency stays within 24.050 to 24.250GHz over the specified temperature range

Note 2 Theoretical value, given by Design

K-MC1_LP RADAR TRANSCEIVER

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Antenna System Diagram

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

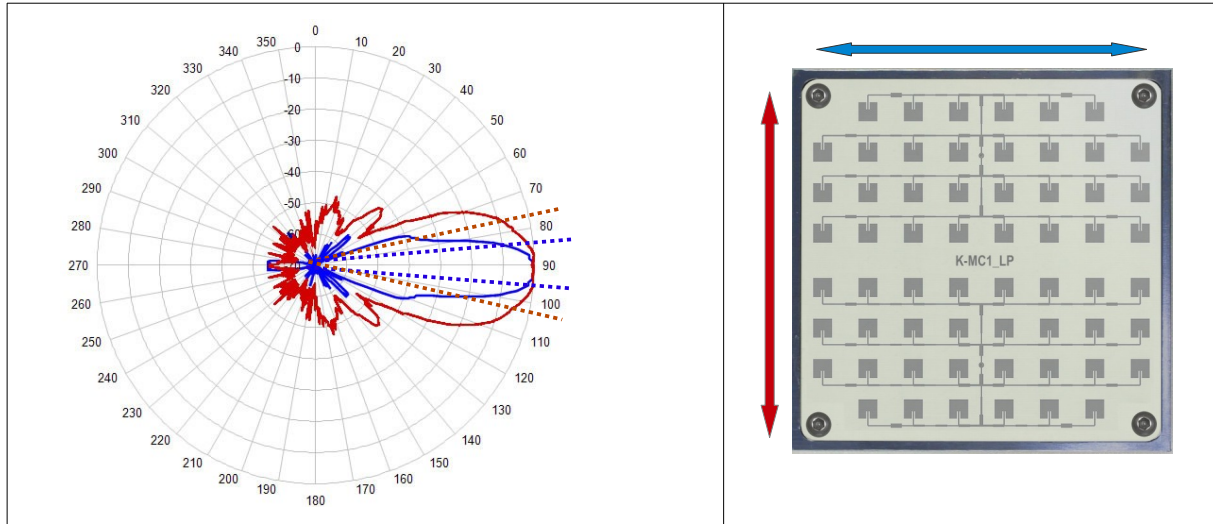
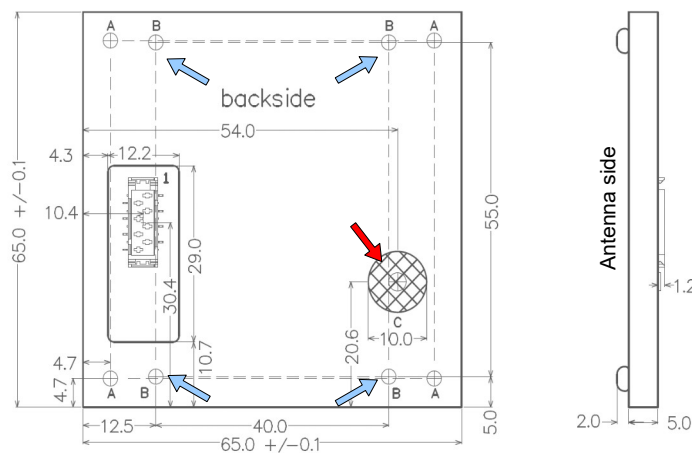


Fig. 2: Antenna system diagram

Pin Configuration

Pin	Description	Typical Value
1	nc	
2	VCC	3.3V..5V supply
3	GND	0V supply
4	IF output Q	
5	IF output I	
6	nc	
7	nc	
8	nc	

Outline Dimensions



Mounting instruction

Mount from back side using thread marked with **B**:
M2.5 screws, screw depth < 3.5mm

Keep out zone **C** (tuning screw)

K-MC1_LP modules must not be used without screws in A.

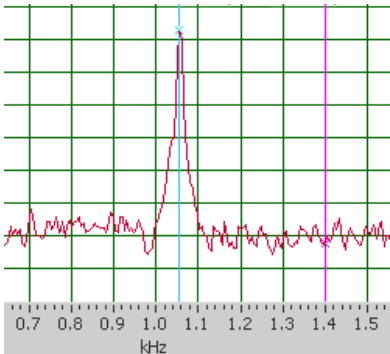
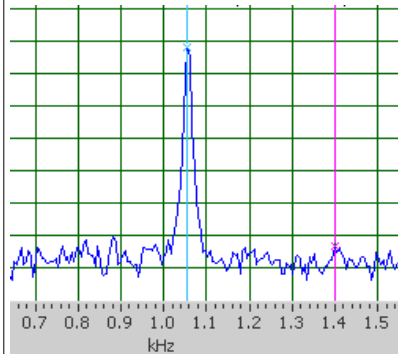
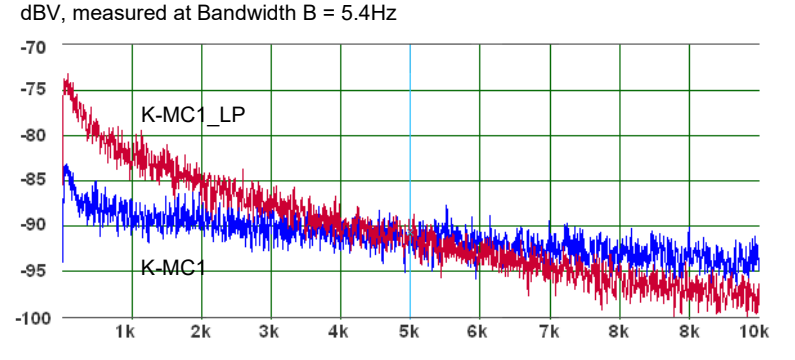
Fig. 3: Mechanical dimensions

K-MC1_LP RADAR TRANSCEIVER

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Application Notes

Main Differences K-MC1_LP vs K-MC1

	K-MC1_LP	K-MC1
Current consumption (typ.)	7.5mA	70mA
Supply Voltage	3.15V ... 6V	4.75V ... 5.25V
VCO Input (FMCW, FSK)	not available	yes
IF highspped DC output	not available	yes
IF output DC offset (typ.)	1.5V	2.5V
RSW rapid sleep wakeup	not available, not necessary	yes (sleep current typ 7mA)
Sensitivity (typical)	-140dBc	-141dBc
IF noise voltage (typ. @1kHz)	- 91dBV/Hz	-96dBV/Hz
SNR Signal-to-noise ratio same signal for comparison K-MC1_LP has similar sensitivity as K-MC1 despite the higher noise level.	 5dB/div → SNR = 32dB	 5dB/div → SNR = 33dB
Worst case 1/f Noise comparison Low current technology of K-MC1_LP requires high sensitive mixer diodes in order to get same sensitivity as K-MC1. Higher 1/f noise is caused by these diodes and by aliasing of internal switching noise. Please note, that higher K-MC1_LP noise does not significantly affect the SNR (signal-to-noise ratio). See diagrams above for SNR.	dBV, measured at Bandwidth B = 5.4Hz  K-MC1 sample with minimal noise floor and K-MC1_LP sample with high noise floor	

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:	-140dBc (@1kHz IF Bandwidth)
- Carrier frequency	f ₀ :	24.125GHz
- Radar cross section RCS ("reflectivity") of the object	σ ¹⁾ :	1m ² approx. for a moving person >50m ² for a moving car

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

> 50 meters for a moving person

> 140 meters for a moving car

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

Integrators Information

Installation Instruction

Mechanical enclosure

It is possible to hide the sensor behind a so called radome (short for radar dome) to protect it from environmental influences or to simply integrate it in the case of the end product. A radar sensor can see through different types of plastic and glass of any colour as long as it is not metallized. This allows for a very flexible design of the housing as long as the rules below are observed.

- Cover must not be metallic.
- No plastic coating with colors containing metallic or carbon particles.
- Distance between cover and front of Radar sensor $\geq 6.2\text{mm}$
- Best cover material is Polycarbonat or ABS
- Best cover thickness is 3-4mm
- Vibrations of the Radar antenna relatively to the cover should be avoided, because this generates signals that can trigger the output
- The cover material can act as a lens and focus or disperse the transmitted waves. Use a constant material thickness within the area used for transmission to minimize the effect of the radome to the radiated antenna pattern.

Note

Detailed information about the calculation and thickness for different cover materials can be found in the application note "AN-03-Radome".

United States (FCC) and Canada (ISED)

This module has been granted modular approval for fixed and/or mobile applications. The modular approval allows the end user to integrate the module into a finished product without obtaining subsequent and separate FCC/ISED approvals for intentional radiation, provided no changes or modifications are made to the module circuitry. Changes or modifications could void the user's authority to operate the equipment. The end user must comply with all of the instructions provided by the Grantee, which indicate installation and/or operating conditions necessary for compliance. The finished product is required to comply with all applicable FCC/ISED equipment authorizations regulations, requirements and equipment functions not associated with the transmitter module portion.

Note

Modification to this product will void the users' authority to operate this equipment.

Warning

The OEM integrator is responsible for the final compliance of the end product with this integrated modular approved transmitter module. This includes measurements with the RF module integrated and activated as defined in KDB 996369 and if applicable appropriate equipment authorizations as defined in §15.101.

Labelling and user information requirements

If the label of the module is not visible from the outside of the end product, it must include the following texts on the label of the host product:

FCC: Contains FCC ID: 2ASYV-K-MC1LP
ISED: Contains IC: 24358-KMC1LP

In addition to marking the product with the appropriate ID's, the end product shall bear the following statement in a conspicuous location on the label or alternatively in the user manual:

This device complies with Part 15 of the FCC Rules and with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

RF Exposure

This module is approved for installation into fixed and/or mobile host platforms and must not be co-located or operating in conjunction with any other antenna or transmitter except in accordance with FCC/ISED multi-transmitter guidelines. End users must be provided with transmitter operating conditions for satisfying RF Exposure compliance.

Europe (CE-RED)

This module is a Radio Equipment Directive assessed radio module that is CE compliant and have been manufactured and tested with the intention of being integrated into a final product.

According to the RED every final product that includes a radio module is also a radio product which falls under the scope of the RED. This means that OEM and host manufacturers are ultimately responsible for the compliance of the host and the module. The final product must be reassessed against all of the essential requirements of the RED before it can be placed on the EU market. This includes reassessing the module for compliance against the following RED articles:

- Article 3.1(a): Health and safety
- Article 3.1(b): Electromagnetic compatibility (EMC)
- Article 3.2: Efficient use of radio spectrum (RF)

The RED knows different conformity assessment procedures to show compliance against the essential requirements (See RED Guide, chapter 2.6b). As long as the radio module can show compliance to Article 3.2 by the use of a harmonized standard, which is listed in the official journal of the EU (OJEU), it is not necessary to do an EU type examination for the final radio product by a notified body. In this case it is possible to demonstrate conformity according to the essential requirements of the RED by using Module A (Annex II of the RED), which allows to show conformity by internal production control.

Note

As long as a harmonized standard listed in the OJEU can be used to demonstrate conformity in accordance with Article 3.2 of the RED, it is possible to carry out the CE certification in self-declaration without the involvement of a notified body.

The K-MC1_LP shows compliance against the Article 3.2 by the use of the standard EN 300 440 which is a harmonized standard listed in the OJEU, what gives the possibility to show conformity by internal production control.

An OEM integrator can show compliance to article 3.1(a) and 3.1(b) for the final product by doing internal or external tests and following the Module A (Annex II of the RED) assessment procedure. To show compliance against article 3.2 it is possible to reuse the assessment of the K-MC1_LP as long as it is the only radio module in the final product or if the integrator can guarantee that only one radio module is operating at the same time. Test reports of the K-MC1_LP are available on request.

Note

The ETSI guide EG 203 367 provides detailed guidance on the application of harmonized standards to multi-radio and combined equipment to demonstrate conformity.

RF Exposure Information (MPE)

This device has been tested and meets applicable limits for Radio Frequency (RF) exposure. A detailed calculation to show compliance to the RED Article 3.1(a) is available on request.

Simplified DoC Statement

Hereby, RFbeam Microwave GmbH declares that the radio equipment type K-MC1_LP is in compliance with Directive 2014/53/EU. The declaration of conformity may be consulted at www.rfbeam.ch.

Datasheet Revision History

Version	Date	Changes
0.9	12-Nov-2013	preliminary release
1.0	02-Nov-2018	Changed footer to new address
1.1	21-Feb-2020	Added chapter integrators information
1.2	31-May-2021	Corrected IF bandwidth, amplifier gain and block diagram

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