FMCW Base Module

The FMCW base module of the SkyRadar Modular Radar Training System provides a fully operational close and near range radar. The abbreviation FMCW stands for Frequency-modulated continuous-wave radar.

Description

The FMCW radar operates with one antenna (array/horn) and provides applications as FMCW mode, Doppler, etc. The FreeScopes software allows for comfortable control of the system, providing multiple ways of visualization such as FMCW Fast Fourier Transform, Doppler, IF Signals or the VCO Ramp. The software also provides calculation and visualization for the Synthetic Aperture Radar extension.

Features

- Operating Modes (enabled in the hardware)
    - FMCW
    - Doppler
    - Moving Target Indication (MTI)
- Scopes (enabled through FreeScopes)
    - A-Scope
    - B-Scope
    - Plan-Position-Indicator (PPI)
- Amplification
    - Amplification of raw signal (IQ signal) at receiver
    - Amplification of filtered signal in the scopes
- Filters and Signal Treatment
    - Sensitivity Time Control (STC)
    - Signal Threshold and Limiter
    - Range Calibration and Extension
    - Cutting out selections of the signal range
    - Moving Target Detection and Indication

Topics

The FMCW Base Module can be applied to experiment on the following subjects (selection):

- Experiments on FMCW, Doppler
- Experiments on A-Scope, B-Scope and Plan-Position-Indicator (PPI)
- Calibrating a radar using amplification, filters and settings
- Experiments in a fixed position as well as through panning and rotation (rotary tripod required)
- Experiments on amplification of source as well as of the signals
- Clutter processing e.g., through Sensitive Time Control (STC)
- Radar Cross Section (RCS) analysis allowing for an understanding of the varying detectability of objects based on material, absolute and relative size, reflection angle, distance and strength of the signal.
- Allows analyzing performance and false alarm tolerances through adjustment of the sensitivity.
- Adjustable decision threshold allowing for experiments on background noise.
- And much more.

Parts

The FMCW Base Module consists of:

- one (1) mounted horn antenna (standard version) or array antenna (all other versions)
- one (1) base unit, including
    - one (1) digital signal processing unit (DSP)
    - one (1) transceiver
    - one (1) motor control unit (only activated when rotary unit is added)
- one (1) cable set.

Prerequisites

- Computer with latest HTML5 enabled browser. Current versions of Chrome, Firefox, MS Internet explorer, Opera and Safari are able to read HTML5.
- SkyRadar FreeScopes (comes free with the FMCW Base Unit).

Extensions

- SkyRadar Rotary Tripod (recommended)
- SkyRadar Parabolic Reflector (recommended)
- SkyRadar Cloud Server (recommended)
- SkyRadar Target Tracker (comes free with the base module)
- SkyRadar Security
- SkyRadar Target Subsystems
- Vessel
- Quadcopter
- SkyRadar ADS-B Experimenter

Detailed Description

At the heart of the system is an FMCW transceiver. A variable trigger wave allows to generate also a Frequency Shift Key Mode. In addition, the transceiver can operate in Doppler mode. The transmitter can emit very short pulses through the antenna and monitor the reflected pulses. The pulses are reflected of fixed objects (buildings, trees…) and moving objects (cars, people…) which pass the antenna beam. The FMCW Base Module provides the opportunity to study Doppler effects.

The signals are digitally processed using a Digital Signal Processor (DSP), data is visualized through the analysis and visualization software SkyRadar FreeScopes.

The system comes the four configurations standard (up to 50 m), extended (up to 150 m), extreme (up to 450 m) and superhet (beyond 1000 m). The standard version comes with a horn antenna, extended, extreme and superhet version are equipped with an array antenna. All versions can be complemented with a parabolic reflector which helps bundling the beam.

- Active radar, designed for perfectly save indoors and outside operation in close and near range (transmitter output power significantly lower as such of a mobile phone)
- The following operating modes can be technically enabled in the hardware
  - FMCW
  - Doppler

General Features

- Antenna
  - Standard: Planar Antenna or Horn Antenna, Extended / Extreme / Superhet: Planar Antenna
  - Default operation 24 GHz
- Powerful and fast radar image processor.
- All measurements are performed in near-to real time. No sub-sampling or substitution techniques.
- Optimized for detection of real targets in a 3-dimensional space within laboratories or outside , remote controlled remote controlled aircrafts. No limiting target table or rail system required.
- Extendable with rotary tripod, parabolic reflector, linear conveyor for SAR operations
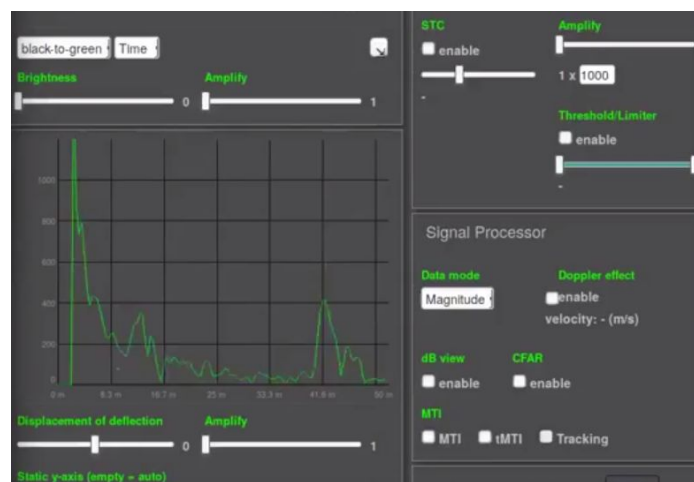
System Features

Power Requirements	12V, 5V
Output Density at the antenna	-18 dbm / 63 mW
Maximum Range with parabolic reflector	more than 100 m / 400 m / 1000 m / 1500 m
Sampling Rate	125 kS/s / 2 channels
Dimensions	with array antenna: 230mm x 270mm x 100mm, with horn antenna: 230mm x 270mm x ~170mm
Net Weight	1.00 - 2.00 kg

Model	Standard	Extended	Extreme	Superhet
Range	short	extended	medium	far
Resolution at 180 MHz Bandwidth	83 cm	83 cm	83 cm	83 cm
at a distance of	50 m	150 m	450 m	> 1000 m
Range	24 m (persons) 50 m (cars)	56 m (persons) 150 m (cars)	120 m (persons) 450 m (cars)	200 m (persons) 1 km (cars)
Minimum Distance	1,5 m	1,5 m	1,5 m	1,5 m
Antenna	Planar/Horn	Planar	Planar	Planar

Transmitter Features

Supply Voltage	12V
Supply Current	300 mA
Operating Temperature	-20 … + 60 °C

Table: General operative characteristics of the Transceiver

	min.	typ.	max.
Carrier Frequency	24 Ghz	24,125 GHz	24,250 Ghz
Transmitter Output Power:	16 dBm	18 dBm	20 dBm
At IF, output voltage of		-6 dB	
Tx Power		-3 dB	

Table : Operative characteristics of the Transmitter

Receiver Features

Antenna Gain	+ 17 dBi
Sensitivty	– 91 dBm
Overall Sensitivity	- 106 dBc

Table : Operative characteristics of the Receiver (subsection of the

Transceiver)