Dragonfly Datasheet

Draft Revision 0.5 – 2025-07-03

1. Overview

“Dragonfly” is a millimeter-wave beamformer featuring an onboard 8×8 antenna array. It integrates a beamformer (ADMV48281), an up/down converter (ADMV1128A), and a local oscillator (ADF4372). Dragonfly serves as an evaluation platform for system-level beamforming algorithm development. Each ADMV48281 supports 8 TDD channels, and four such beamformers are implemented on a single board. A total of 64 patch antenna elements are implemented on the board, all configured for single polarization. This setup is optimized for fundamental beam steering evaluation and algorithm development. (Note: Dual polarization can be designed in the future upon customer request.) Up to four Dragonfly units can be tiled together to form a 64×64 array, enabling a 256-channel massive MIMO configuration. Dragonfly requires an IF input centered at 3.5 GHz with a maximum bandwidth of 400 MHz. All parameters, including the beamforming index, can be configured via a high-speed SPI interface.

2. Features

Table 1. Features.

Antenna element	64 (8x8)
Polarization	Single (V)
RF frequency	27.8-29.1GHz
Duplexing	TDD
TX EIRP	46dBm
Beam range	±45°
Beam step	2°
RX gain	30dB
Reference clock	122.88MHz
IF frequency	3.5GHz

IF bandwidth	±200MHz
IF input power (TX)	-10dBm
IF output power (RX)	-20dBm
Control interface	SPI (LVDS)
SPI clock frequency	Max. 100MHz
Power-in	DC12V
Current consumption	2.5A
Power-out for fun	DC12V
Size	120mm x 140mm
Status	Production

Note: Dragonfly is optimized for the private 5G band (28.2–29.1 GHz) in Japan. Support for other bands (e.g., 39GHz) and V/H dual pollination antenna can be custom designed upon request.

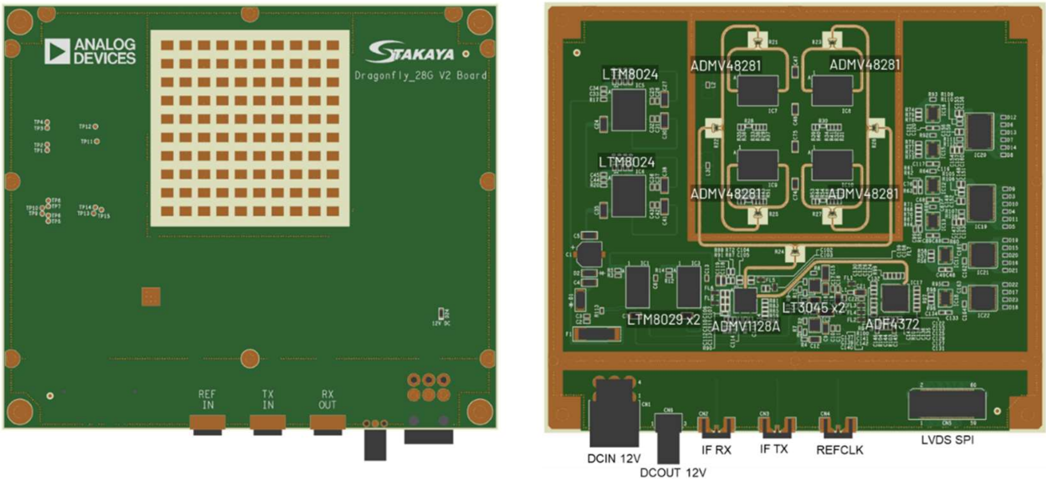

Figure 1. PCB module image.

Dragonfly SDK is provided by IDAS Co., where Dragonfly PAAM is integrated with a heatsink and shield case, as shown in Figure 2 and Figure 3. A stand frame can also be provided to allow flexible positioning. Refer to the SDK section for detailed specifications.

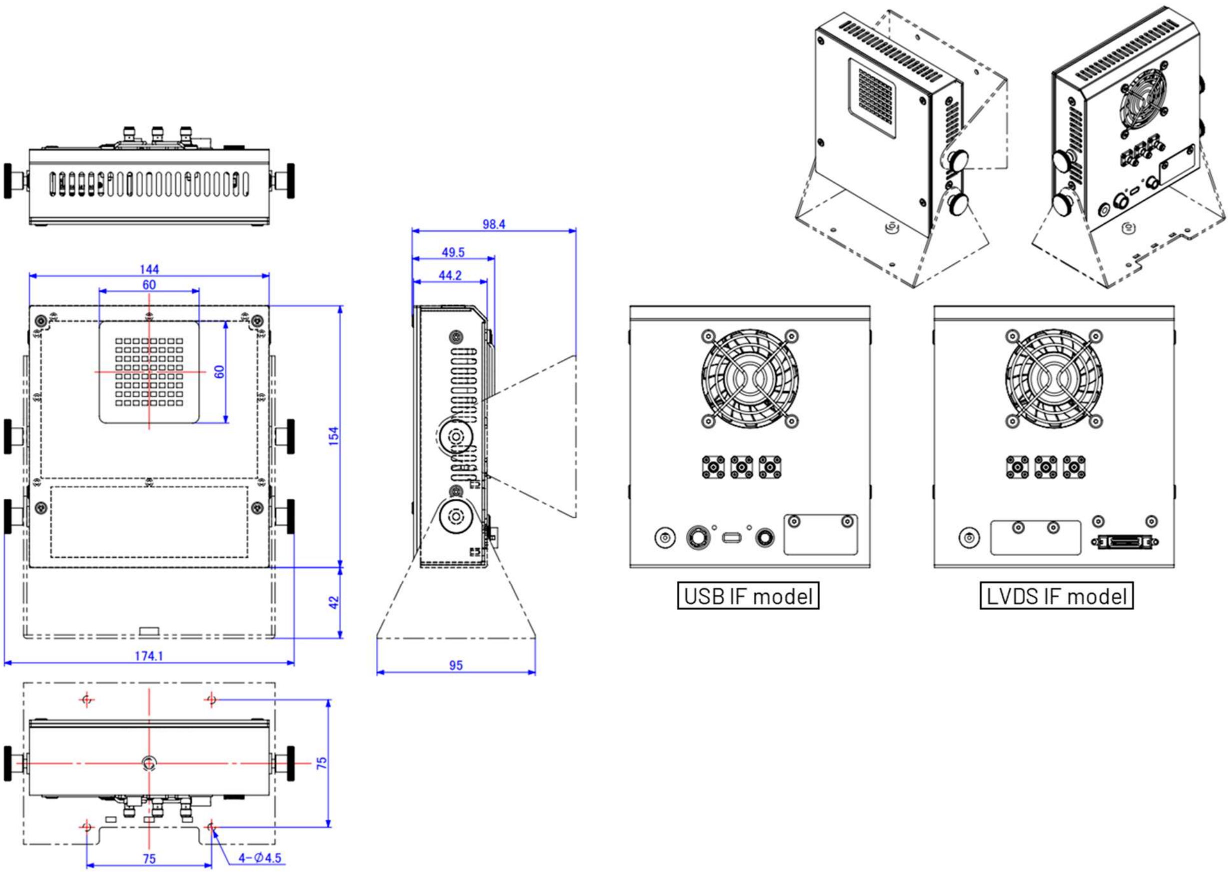

Figure 2 Dragonfly SDK

Figure 3 Dragonfly SDK (image)

3. Block Diagram

Dragonfly integrates all functions of a phased array antenna module, including an optimized power tree using low-noise power components. Figure 4 illustrates the block diagram with key active components.

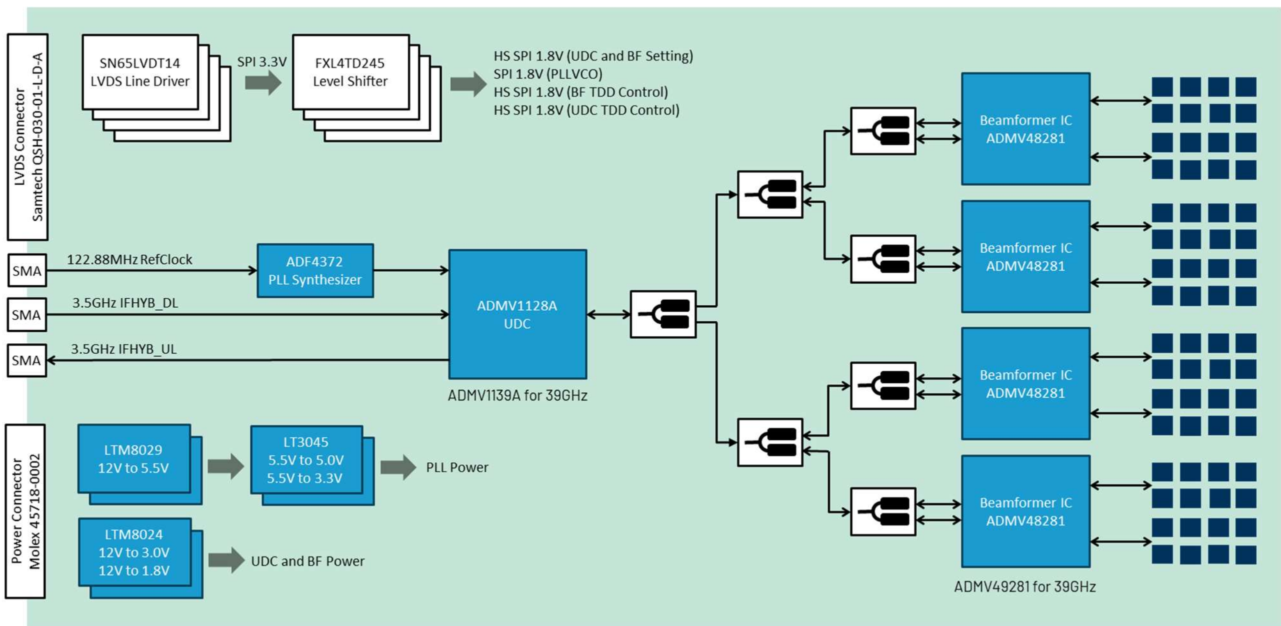

Figure 2. Block diagram.

4. Electrical Specification

Table 2. RF Transmit Specifications

Parameter	Test Condition	Min	Typ	Max	Unit
RF Frequency Range		27.8		29.1	GHz
Operating Temperature			+25		°C
Antenna elements	8x8 rectangle array	-	64	-	-
EIRP	CW		46		dBm
Polarization	V pol. single	-	V	-	-
Beam Steering Angle	Azimuth & Elevation		±45		Deg.
Beam Steering Step	Azimuth & Elevation		2		Deg.
Output P1dB	@Antenna output		50		dBm
Output IP3	@Antenna output		60		dBm
Gain	Per single channel		20		dB
Total Gain Control Range	Ctrl. UDC	-25		5	dB
Gain Step			0.5/1		dB
Gain Step Error			0.5		dB
Phase Step			0.56		Deg.
Phase Step Error			0.36		Deg.
Input Return Loss			-15		dB
Output Return Loss	Antenna output		-		dB
Noise Figure			15		dB
Power Consumption Per Channel			tbd		
Power at 3% EVM			tbd		

Table 3. IF Transmit Specifications (IF Input to Dragonfly).

Parameter	Test Condition	Min	Typ	Max	Unit
IF Frequency Range			3.5		GHz
IF Bandwidth				±200	MHz
IF Input Power				-10	dBm

Table 4. Transmit Power Detector Specifications.

Parameter	Test Condition	Min	Typ	Max	Unit
Output Power Range (EIRP)	Per single antenna	-7		+13	dBm
Power Detector Range	Per single BFIC output	0		+20	dBm
Power Detector Accuracy			±1		dB
Resolution			8		bits

Table 5. RF Receive Specifications.

Parameter	Test Condition	Min	Typ	Max	Unit
RF Frequency Range		27.8		29.1	GHz
RF Input Range				-40	dBm
Operating Temperature			+25		°C
Antenna elements	8x8 rectangle array	-	64	-	-
Polarization	V pol. single	-	V	-	-
Beam Steering Angle	Azimuth & Elevation		±45		Deg.
Beam Steering Step	Azimuth & Elevation		2		Deg.
Single-Channel Noise Figure	Include ANT Gain and Feeder loss		22		dB
Input P1dB		-	-	-	
Input IP3			-10		dBm
Gain (Electrical Gain)	64ch, from ANT input		30		dB
Coherent Gain		-	-	-	dB
Single Channel Gain			12		dB
Total Gain Dynamic Range	Ctrl. UDC	-15		5	dB
Gain Step			1		dB
Gain Step Error			0.5		dB
Phase Step			0.56		Deg.
Phase Step Error			0.36		Deg.
Input Return Loss	Antenna Input	-	-	-	dB
Output Return Loss			15		dB
Power Consumption Per Channel					
Maximum Overload Power					

Table 6. IF Receive Specifications (IF Output from Dragonfly).

Parameter	Test Condition	Min	Typ	Max	Unit
IF Frequency Range			3.5		GHz
IF Bandwidth				±200	MHz
IF Output Power				-20	dBm

Table 7. Local Oscillator Specifications.

Parameter	Test Condition	Min	Typ	Max	Unit
Local Frequency Range	Low side LO	12.15		12.8	GHz
VCO Fundamental Frequency Range	2x Multiplier	6.075		6.4	GHz
Reference Frequency		-	122.88	-	MHz
Reference Frequency Input Range	Single 50ohm	-4		10	dBm

Loop Bandwidth			200		KHz
Phase Noise	At 1MHz offset		-124		dBc/Hz

Table 8. Temperature Sensor Specifications

Parameter	Test Condition	Min	Typ	Max	Unit
Temperature Range		-40		+125	°C
Accuracy			±5		°C
Resolution			8		bits

Table 9. SPI Control Specifications (BF, UDC and LO PLL).

Parameter	Test Condition	Min	Typ	Max	Unit
SCLK Frequency (UDC and BFIC)				100	MHz
SCLK Frequency (PLL)				50	MHz

Table 10. DC Power Specifications.

Parameter	Test Condition	Min	Typ	Max	Unit
Supply Voltage (input)			12		V
Current Consumption	TX		2.5		A
Current Consumption	RX				A
Power Out Voltage (for Fun)			12		V
Power Out Current (for Fun)			tbd		

5. Dragonfly System Development Kit (option)

The SDK (System Development Kit) is available for quick evaluation, and it supports the flexible setup with full transparency (no black-box components). Dragonfly SDK consists of the following equipment (Table 11), and IDAQS Co. provides SDK, and they support system integration on demand. The SDK supports two types of interfaces to control Dragonfly as USB interface model and LVDS interface model (Table 12). Basically, USB models limit the response speed for dynamic beam switching while LVDS model support fully high-speed beam switching under 5G-NR TDD operation. To control Dragonfly, MATLAB reference code can be shared for all Dragonfly users.

Table 11. Dragonfly SDK

Equipment	Supplier
Dragonfly (only PAAM)	ADI (Japan), Macnica, S-Takaya or IDAQS
Dragonfly SDK (inc. PAAM)	IDAQS
Reference MATLAB source code	ADI (Japan) or IDAQS
ZCU102 (option)	AMD
EVAL-AD9988/AD9081 (option)	ADI

SDP-LVDS Interposer board + Cable (option)	IDAQS
SD Card Image for ZCU102 Peta Linux (option)	IDAQS

Table. 12 SDK model (supplied by IDAQS)

Model name	DFLY28G-B	DFLY28G-U	DFLY28G-L
Interface	USB2.0 (SPI 15MHz)	LVDS (SPI 50MHz)	Only PAAM board

Figure. 5 illustrates the backplane of DFLY28G-U and DFLY28G-L. DFY28G-U equips USB-C connector for PAAM configuration and DFLY28G-L has LVDS connector where differential SPI and GPIO signals are there.

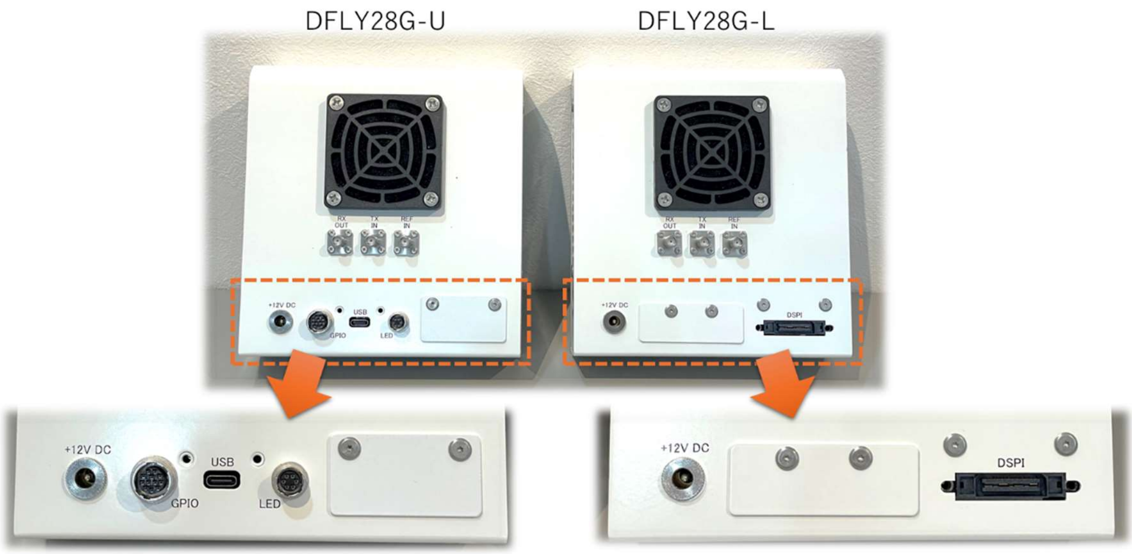

Figure. 5 SDK models

The Dragonfly SDK supports flexible configurations for both fundamental phased array RF testing and FR2 5G-NR signal transmission. Additionally, low-level PHY signals can be accessed for various types of signal processing, such as research and development of ISAC (Integrated Sensing and Communication) systems.

Figure 6 illustrates a basic setup for testing Dragonfly in TX mode. In this configuration, IF signals are generated by a signal generator (SG), and Dragonfly transmits 28 GHz signals over the air to a spectrum analyzer (SA). The SA receives the RF signals via a horn antenna. Dragonfly requires a 122.88 MHz reference clock. A host PC controls all Dragonfly configurations, including beam index selection, via USB. MATLAB reference code is provided and is available for all Dragonfly users.

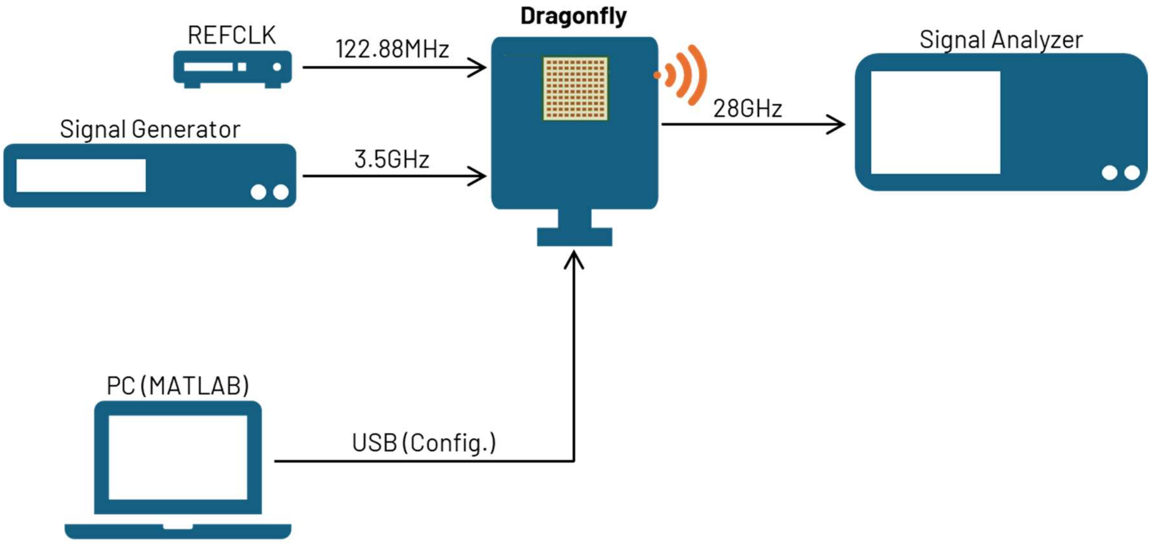

Figure 6. SDK setup for TX test.

Figure 7 illustrates an alternative TX setup for Dragonfly, where MxFE and FPGA boards are used in place of the signal generator (SG) shown in Figure 6. The host PC controls Dragonfly via USB while IF signal waveforms are generated by ZCU102 and MxFE boards with communication between the PC and ZCU102 established over Ethernet. The provided MATLAB reference code supports this setup as well as the Figure 6 setup case.

In this configuration, the MxFE functions as the analog front end (AFE) of the SDR system, allowing any type of modulated waveform to be generated and fed into Dragonfly. For example, a 5G FR2 waveform with 256QAM modulation, 120 kHz subcarrier spacing (SCS), 400 MHz bandwidth, and 125 µs symbol duration can be transmitted. The spectrum analyzer (SA) must also be capable of analyzing 5G waveforms in this setup.

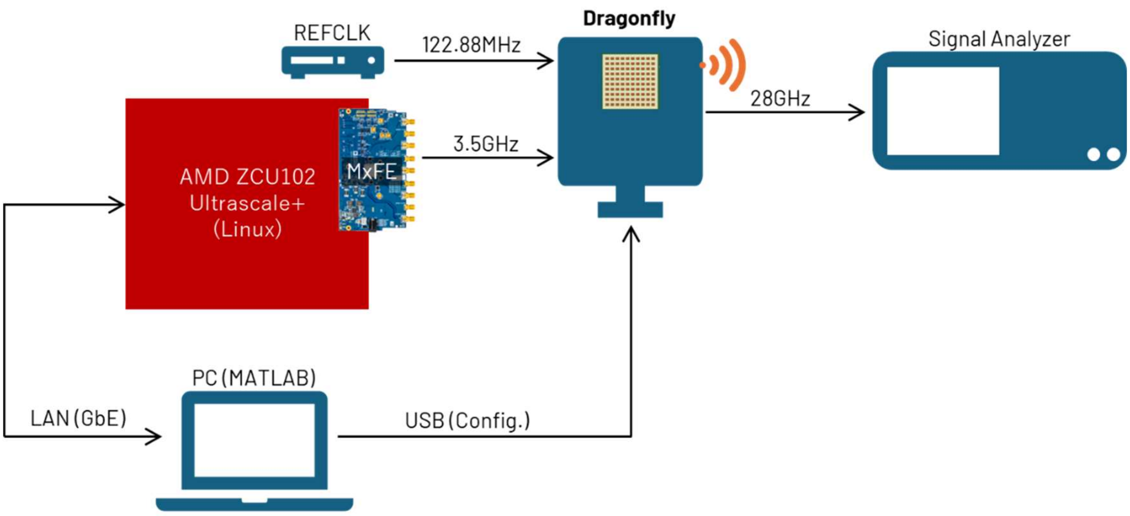

Figure 7. SDK setup for TX test.

Figure 8 illustrates the Dragonfly setup in RX mode, where Dragonfly receives a 28 GHz RF waveform from a signal generator (SG) over the air. The received signal is down converted to a 3.5 GHz IF waveform, which is then analyzed by the spectrum analyzer (SA).

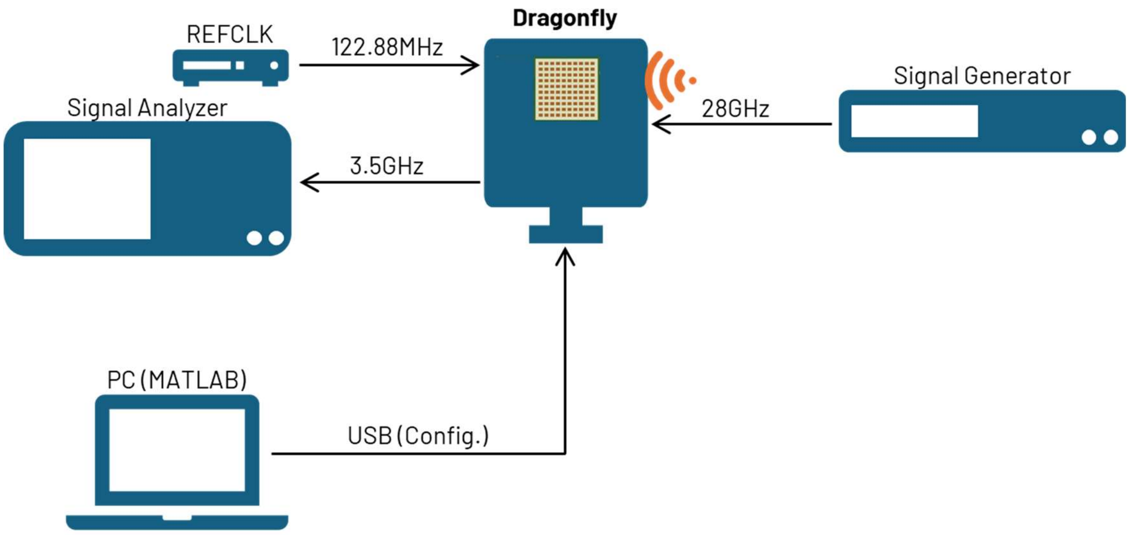

Figure 9 shows an alternative setup in which MxFE and FPGA boards are used in place of the SA. This setup is suitable for handling FR2 5G waveforms, and the SG must be capable of generating FR2 5G waveforms accordingly as well as Figure 7 setup case.

Figure 8. SDK setup for RX test.

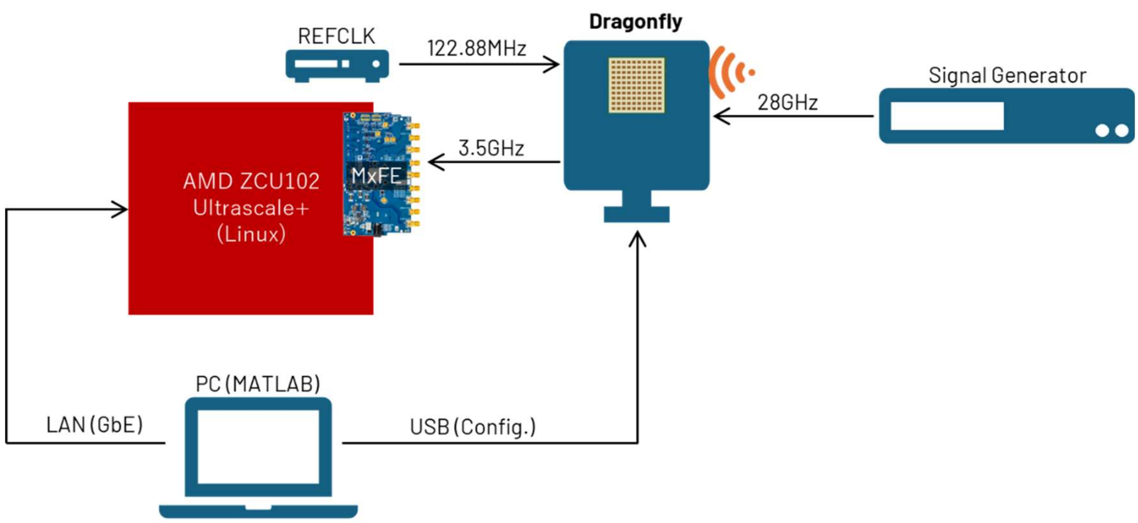

Figure 9. SDK setup for RX test.

Basically, Dragonfly SDK supports fundamental PAAM functionality where beams are not switched dynamically with respect to TDD operation i.e., based on 5G-NR symbol duration. To support the feature communication waveform e.g., 5G-NR waveform and beam control must be synchronized. Dragonfly can support the setup to support TDD operation alternatively as illustrated by Figure 10. IDAQS can support you for system level integration on the demand and they can integrates 5G end to end system with OAI (Open-Air-Interface) 5G.

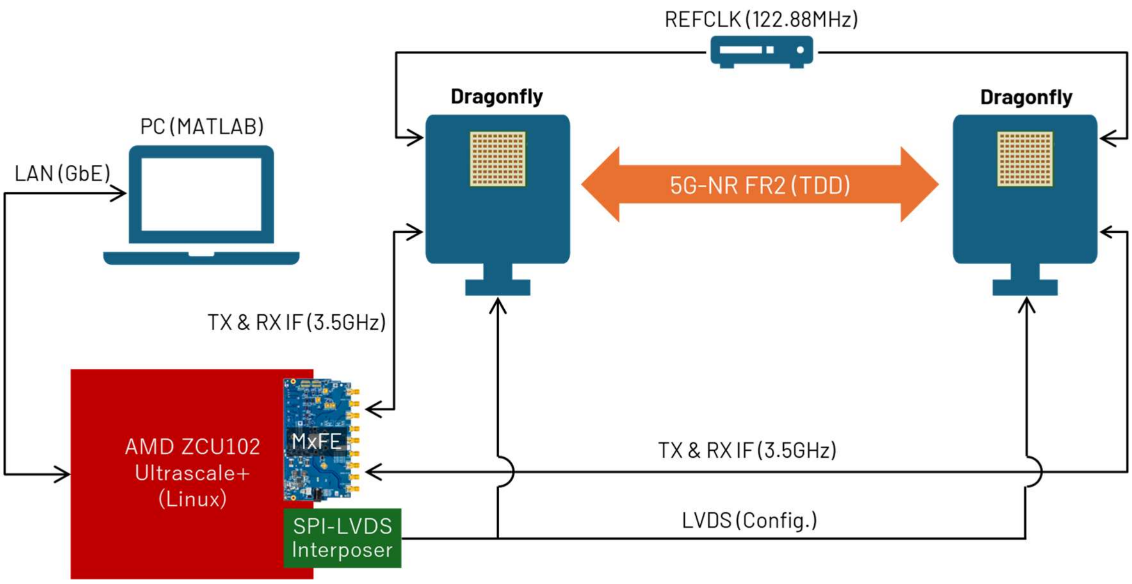

Figure. 10 TDD system setup

6. Reference Software (MATLAB)

For Dragonfly uses, reference software can be shared for evaluation purposes, which is MATLAB source code. The software can do the following functionalities.

- Initializing
- Phase calibration
- Beam pattern measurement with beam scan
- Beam index setting (bypass mode and beam pointer mode)
- TX/RX switching for TDD operation

Note: Since information of a few MMIC on Dragonfly board is under NDA but not under public. If a Dragonfly user does not have NDA with ADI, then MATLAB code may be encrypted as P-code manner.

The MATLAB code required the following toolbox under 2024b version, and the user must install the toolbox to use the reference code.

- Control System Toolbox
- Signal Processing Toolbox

7. Reference Documents

For hardware setting and operation, refer to the following documents to understand the control sequences. Some documents may be shared under NDA; please contact ADI for access.

- ADMV48281 Datasheet
- ADMV48281-EVALZ User Guide
- ADMV48281 Programming Reference Manual
- ADMV1128A Datasheet
- ADF4372 Datasheet