Singapore Amazing Flying Machine Competition 2022

Category C2/C3
Challenge Booklet 2022

Organised by:

DSO NATIONAL LABORATORIES

SCIENCE CENTRE singapore

Supported by:

MINDEF SINGAPORE

Partners:

DSTA Defence Science & Technology Agency

THE AIR FORCE ABOVE ALL

ST Engineering Aerospace

SINGAPORE POLYTECHNIC | SP

NYP NANYANG POLYTECHNIC

REPUBLIC POLYTECHNIC DISCOVER. TRANSFORM. ACHIEVE.

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

NUS National University of Singapore

SINGAPORE YOUTH FLYING CLUB Takes You To Greater Heights

FLIGHTSCIENCE AERO LABORATORIES

JUST FLY IT

SAFMC 2022 CAT C2/C3 CHALLENGE BOOKLET CHANGE LOG

Version	Release Date	Description
1.0	22 Nov 2022	Official Challenge Booklet Release

SAFMC 2022 COMPETITION SCHEDULE

Date*	Event	Platform/Venue
7-18 March 2022	Pre-Challenge Submission	Email
16-23 March 2022	Presentation	Teleconference
4-14 April 2022	Category Challenges	Singapore Expo
16 April 2022	Awards Presentation Ceremony	Singapore Expo

* The competition schedule is subject to changes in accordance with the latest MOE guidelines for COVID-19. Any changes will be updated on the SAFMC Website and Facebook. Registered participants will be informed via their registered email address.

CONTENTS

SINGAPORE AMAZING FLYING MACHINE COMPETITION 2022

1. INTRODUCTION

In celebration of DSO National Laboratories' (DSO) 50th Anniversary in 2022, SAFMC is enhanced in both challenges and prizes [CAT D & E] to allow students to push the boundaries of innovation by designing and creating extraordinary flying machines. The event is organised by DSO and Science Centre Singapore, and supported by Ministry of Defence (MINDEF). Open to all schools and participants, this annual competition promises a fun-filled learning journey with special talks, workshops and live demonstrations.

2. CATEGORIES

CATEGORY A – PAPER PLANES *(Primary Schools)*
Each team should consist of TWO (2) to THREE (3) members.
Design and fold paper planes to achieve the longest, farthest or most unique flight.

CATEGORY B – UNPOWERED GLIDERS *(Secondary Schools / Integrated Programme)*
Each team should consist of TWO (2) to FIVE (5) members.
Category B will be open to a maximum number of 150 registered teams.
Design and build small unpowered bungee-launched gliders to achieve the farthest and most precise flight

CATEGORY C – RADIO CONTROL FLIGHT / FIRST PERSON VIEW (FPV) FLIGHT (NOVICE, ADVANCED)
Category C1: Radio Control Flight - Fixed Wing *(Secondary Schools / Integrated Programme / Junior Colleges / Institute of Technical Education)*
Each team should consist of TWO (2) to FIVE (5) members.
Design and build a small remote-controlled fixed-wing air platform to navigate an obstacle course.

Category C2: FPV Flight – Novice *(All Schools)*
Each team should consist of ONE (1) to TWO (2) members.

Bring, or design and build, a ducted (shielded propeller) FPV drone to compete in an obstacle course.

Category C3: FPV Flight – Advanced *(All Schools)*

Each team should consist of ONE (1) member.

Bring, or design and build, an FPV drone to compete in an obstacle course.

[ENHANCED] CATEGORY D – SEMI-AUTONOMOUS / AUTONOMOUS

(Polytechnics / Universities)

Category D1: Semi-Autonomous

Each team should consist of TWO (2) to FIVE (5) members.

Design and build up to three semi-autonomous small air platforms, controlled using wearables, to perform a multitude of tasks in an indoor course.

Category D2: Autonomous

Each team should consist of TWO (2) to FIVE (5) members.

Design and build three autonomous small air platforms to collaboratively perform a multitude of tasks in an indoor course.

[ENHANCED] CATEGORY E – SWARM *(Open to Public)*

Each team should consist of TWO (2) to TEN (10) members.

Bring, or design and build, a swarm of TEN (10) to TWENTY-FIVE (25) drones to compete in an obstacle course.

3.   GENERAL SAFMC 2022 RULES

- **The deadline for registration is 18 February 2022.**

- Participants registered under a school must be a full-time student at the point of competition.

- Home-schooled participants and teams consisting of participants from different schools should be registered as "Independent teams".

- Participants will be notified upon successful registration within two weeks of the registration deadline. The decisions made by the SAFMC organising committee are <u>final</u>, and are subjected to the competition schedule and availability of logistics support.

- Each person can only participate in one team within a category. However, the person can participate as a member in different categories, i.e. a person can be a member of a team in Category B and another team in Category C but the person <u>cannot</u> be a member for two teams in Category B.

- Teams are allowed to take part in categories <u>beyond</u> the specified educational level, i.e. Primary school students are allowed to take part in Category B, C, D or E. Secondary school students are allowed to take part in Category C, D or E.

- Participants of Category C1 are also eligible to register for either Category C2 or C3 but not both.

- Participants of Category C2 are not eligible to participate in Category C3 and vice versa.

- Participants of Category D1 are also eligible to participate in Category D2 and vice versa.

- Members and family members of the organising committee are not allowed to participate in the SAFMC.

- The organisers reserve the right to amend the rules and regulations. In the event of changes, all teams will be informed at least **FOUR (4)** weeks prior to the start of the competition.

- Prizes will be issued to the Team Manager.

- A safety perimeter net will be set up at the competition field for Categories B, C, D, and E. There will be a top net approximately **EIGHT (8) meters** above the ground, which will limit the maximum flight altitude of flying machines. During the challenge attempts, teams are strongly encouraged to fly their aircraft away from the netting to avoid accidental entanglement.

- The organisers of SAFMC 2022 will not be held responsible for any damage to or the loss of any flying machine(s) throughout the entire competition.

- Participants are responsible for the safe flying of their flying machine(s) for the duration of the entire competition. The organisers reserve the right to ground the flying machine(s) of any team at any point in the competition.

- For queries regarding the competition, please send an email with the title stating the category in question *(e.g.: [CAT C2] - Clarification about task locations)* to the following email address: SAFMC@science.edu.sg

4. <u>FORMAT OF COMPETITION</u>

Once the teams have confirmed their registration for the competition, they are expected to commence on meeting the various competition requirements. *Category C2 and C3 do not require presentation and proof of flight videos.*

The top team from each category will be presented with the Championship Award at the SAFMC 2022 Awards Presentation Ceremony.

4.1 CHALLENGE

The competition will be conducted in accordance with Safe Management Measures (SMM) guidelines, which will be announced closer to the competition.

For the Challenge, teams are to design and build, or bring and fly their flying machines to overcome various challenges for the different SAFMC categories. *The full use of Commercial off-the-shelf (COTS) products are allowed for C2 and C3.*

On the Competition Day, tables will be provided within the main competition hall for teams to work on their flying machines. Alternatively, teams may be assigned a designated area instead.

Teams should expect the following during the course of the competition:

- Only registered team members of the participating teams can enter the playing field and team booths/holding areas.
- Teams are expected to fully comply with safety rules. Failure to comply with safety rules after the initial warning will result in immediate disqualification and potential blacklisting from the competition. The organiser will also not be responsible for any injures or mishaps if any participant has disregarded the safety rules.

- No trials will be allowed in the flying area unless specified by the officials.

- The participants will acknowledge that there will be variations in environmental conditions between teams, despite best efforts to control them

- For all Category C, D, and E participants, all aircraft and their transmitting devices must be presented to SAFMC officials for inspection upon arrival.

- For all Category C, D, and E participants, no video transmitting devices, including spares, should be powered on in the competition hall unless specified by the officials. Teams may request from the Chief Referee or the Category Technical Chairperson to perform power-on checks.

- Additional rules and regulations specific to Category C2/C3 are detailed in Sections 8 and 9. Participants will acknowledge that they have read the rules.

5. CATEGORY C2 / C3 AWARDS

All scoring decisions made by the judges are **final**. For arbitrary cases, the organising committee will have the **final** say.

CATEGORY C2 (NOVICE)				
Awards	**Medals**	**Trophy**	**Cash Prize**	**Remarks**
Cat C2 Championship Award - 1st Place	✓	✓	$ 180.00	Only 1st to 3rd Place will receive both medals and cash prizes
Cat C2 2nd Place	✓		$ 160.00	
Cat C2 3rd Place	✓		$ 140.00	
Awards	**Prize(s)**	**Awards**		**Prize(s)**
Cat C2 4th Place	$130.00	Cat C2 11th Place		$60.00
Cat C2 5th Place	$120.00	Cat C2 12th Place		$50.00
Cat C2 6th Place	$110.00	Cat C2 13th Place		$45.00
Cat C2 7th Place	$100.00	Cat C2 14th Place		$40.00
Cat C2 8th Place	$90.00	Cat C2 15th Place		$35.00

Cat C2 9th Place	$80.00	**Best Lap Bonus**	$35.00
Cat C2 10th Place	$70.00		

CATEGORY C3 (ADVANCE)				
Awards	**Medals**	**Trophy**	**Cash Prize**	**Remarks**
Cat C3 Championship Award - 1st Place	✓	✓	$ 600.00	Only <u>1st to 3rd Place</u> will receive both medals and cash prizes
Cat C3 2nd Place	✓		$ 500.00	
Cat C3 3rd Place	✓		$ 400.00	
Awards	**Prize(s)**	**Awards**		**Prize(s)**
Cat C3 4th Place	$350.00	Cat C3 7th Place		$200.00
Cat C3 5th Place	$300.00	Cat C3 8th Place		$150.00
Cat C3 6th Place	$250.00	**Best Qualifier Bonus**		$150.00

6. <u>CATEGORY C2 / C3: FPV RC DRONE FLIGHT CHALLENGE</u>

The pilot is expected to fly and maneuver a multi-rotor aircraft through first-person view (FPV) remote control and guide the craft through a series of air gates in a pre-defined course.

It is recommended that those new to FPV flying to participate in the C2 category as opposed to C3, as the latter involves more powerful and complicated drones that requires more experience.

COMPETITION CATEGORIES

• <u>Category C2 (Novice)</u> – This category is perfect for beginner FPV drone pilots to hone their skills and gain experience in a competitive context. The course is designed to be easily navigated by the junior pilot while still providing a high-paced and fun challenge.

- Category C3 (Advance) – This category tests the skill of the more advanced FPV drone pilot. With a course designed to be more technical, it is sure to stretch the abilities of the pilot while providing a fun challenge.
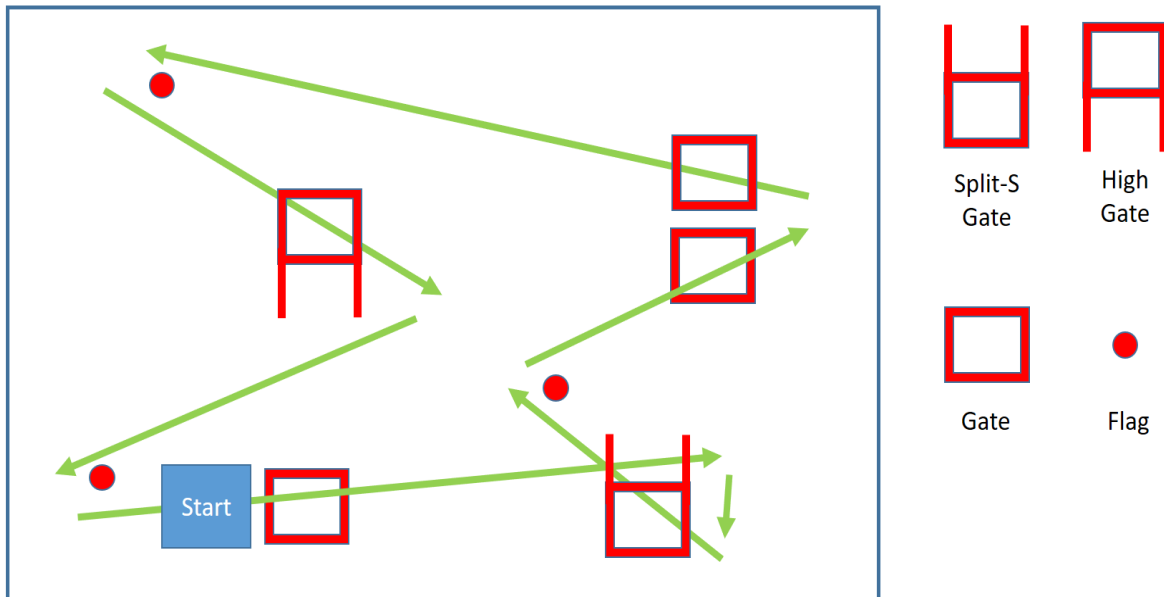
You may wish to refer to *Section 12*, which highlights some of the useful resources for participants who are new to FPV flying. Be sure to check our website regularly for updates on useful workshops catering to this category!

7. COMPETITION SETUP

The figures below show the course layouts for the two categories.
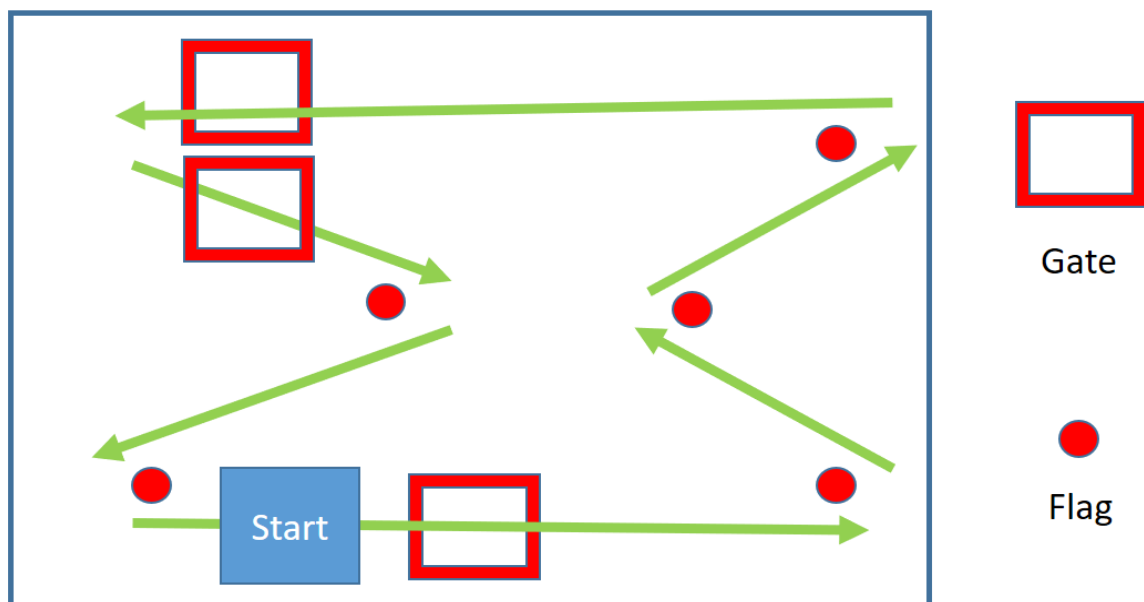
Course Layout for Category C2 (Novice)

Course Layout for Category C3 (Advance)

7.1 RACE COURSE SAFETY

a. The Race Course will be cordoned off to ensure safety.

b. No individuals, except for safety officials will be allowed within the Race Course when any multi-rotor is in flight.

c. Pilots will only take-off and land at the designated take-off/landing area.

d. Flying will only take place at designated timings as decided by the Race Director or their designees.

e. Retrieval of downed aircraft shall only be done by safety officials after flying has ceased.

f. All pilots will fly the same pre-defined course for both the controlled practice and mission runs.

g. No form of flying will take place outside the cordoned area.

h. Pilots operating their aircraft during their runs will only do so from the designated Pilot Area.

i. Human traffic areas will be cordoned off accordingly to manage flow.

j. Appropriate safety signs, fire mitigating aids and any necessary safety aids will be set-up within these areas.

8. <u>COMPETITION ARRANGEMENT</u>

Pilots should expect the following during the competition day:

8.1 PRE-RACE ADMINISTRATION & INSPECTION

a. All pilots shall go to the Reporting Point for allocation of their pit area as well as the competition schedule detailing their timings for their runs for the day.

b. At the allocated competition schedule, the pilot shall report to the Inspection Point. A Technical Inspector will check the aircraft as well as any associated peripherals for competition worthiness and potential violations.

c. The Race Director or their designees may disqualify or demand the appropriate rectification measures for any aircraft which, in his or her opinion, not safe in terms of materials, workmanship, radio installation, radio function, design details or evidence of damage.

8.2 CONTROLLED PRACTICE

a. There will be at least **THREE (3)** controlled practice sessions.

b. Pilots will be given **TWO (2)** minutes to practice and familiarise themselves with the course during each practice run.

c. Pilots will not be given additional time should they fail to complete their intended run, i.e. crashing out.

d. Pilots will report for their controlled practice runs as per the detailed competition schedule. Failure to report timely for any of the runs will result in the forfeiture of that particular run.

e. No lap timings from these practice runs will be considered for the eventual rankings.

f. No open self-practice is allowed at any time.

g. No Pilot will be allowed to power on their VTX at the pit area.

h. All decisions during the course of the runs by the Race Director or their designees will be final.

8.3 MISSION (C2) / QUALIFYING (C3) RUNS

a. There will be **THREE (3)** mission / qualifying runs.

b. Pilots will be given **TWO (2)** minutes to clock the most number of laps. A valid lap will require the pilot to navigate their aircraft through all air gates to be counted as one.

c. Pilots will report for their mission runs as per the detailed competition schedule. Failure to report timely for the any of the runs will result in the forfeiture of that particular run.

d. Lap counts and timings from these runs will count towards the determination of the final rankings.

e. All decisions made during the course of the runs by the Race Director or their designees will be final.

8.4 FINALS (KNOCK-OUT FOR C3 ONLY)

a. There will be **THREE (3)** rounds of final runs, i.e. Quarter-Finals (Top 16), Semi-Finals (Top 8), and Finals (Top 4).

b. Pilots will be given **TWO (2)** minutes to clock the most number of laps. A valid lap will require the pilot to navigate their aircraft through all air gates to be counted as one.

c. Pilots will report for their mission runs as per the detailed competition schedule. Failure to report timely for the any of the runs will result in the forfeiture of that particular run.

d. Top 2 finishers per detail will move on to the next round while the bottom 2 pilots from that detail will be eliminated.

e. All decisions made during the course of the runs by the Race Director or their designees will be **final**.

9. RULES AND REGULATIONS

9.1 GENERAL GUIDELINES

a. Pilots shall follow ALL instructions from the Race Director or their designees.

b. All flying areas will be out of bounds while flying is undergoing.

c. Retrieval of aircraft can only be done upon the end of each run and when it has been powered down.

d. Pilots are only allowed to fly at designated areas and during designated times.

e. Pilots are to start and end their runs at the designated landing/take-off areas.

f. Pilots must be seated at the designated piloting area.

g. Pilots can only power up their aircraft/video transmitters during their runs. No powering up of aircraft/video transmitters are permitted at the pit area.

9.2 KEY OFFICIALS

a. The Race Director and their designees will have absolute authority in all decisions regarding disputes or situations requiring immediate controls.

b. The Technical Inspector will be responsible for all preflight inspections to ensure the competition worthiness of all participating aircraft.

c. Course Safety Officer will be stationed to manage the flying zone as well as provide support for downed aircraft.

9.3 AIRCRAFT SPECIFICATIONS

Participants are allowed to bring along either their homebuilt platforms or commercial off-the-shelf (COTS) platforms to the competition. Modifications to COTS platforms are also allowed. The racing platform must conform to the following specifications.

	C2 – Novice	**C3 - Advance**
Frame	Ducted	No Restrictions
Motor	Brushed / Brushless	Brushless
Propellers	Diameter < 45mm	Diameter < 85mm
Weight	< 80g (with LiPo)	< 200g (with LiPo)
Battery	Max 2s LiPo	No Restrictions
VTX (5.6Ghz)	25mW	

9.4 AIR GATE SPECIFICATIONS

All air gates shall be no smaller than 1m (width) by 1m (height). It will be square in shape with the above-mentioned dimensions. All high gates/split s-gates shall be at least 1m above the floor.

9.5 FREQUENCY MANAGEMENT

No broadcasting of video is allowed unless consent is given by the Race Director. Pilots found to be broadcasting video when they are not supposed will be given a first warning and are subjected to disqualification for subsequent infractions as this will affect pilots currently flying.

Race-band frequencies (R1 to R8) will be preassigned. Pilots will only be given opportunities to change their frequencies at the Race Director's discretion.

10. RACE FORMAT & RULES

10.1 CATEGORY C2 - MOST LAPS WINS

a. No qualifying rounds

b. THREE (3) controlled practice rounds (more if time allows)

c. THREE (3) mission runs

d. Fixed time: TWO (2) minutes per run.

e. Only valid/completed laps are counted.

f. Finish last lap after timer sounds and count if finished

g. Best run out of THREE (3) mission runs.

h. Winner has most laps from the best run out of his or her THREE (3) mission runs.

i. Ties are determined by the fastest time for the best run.

10.2 CATEGORY C3 – QUALIFIERS & KNOCK-OUT SYSTEM

a. THREE (3) controlled practice rounds (more if time allows)

b. THREE (3) qualifying runs

c. Top 16 move to Christmas tree knock-out rounds.

d. Fixed time: TWO (2) minutes per run.

e. Only valid/completed laps are counted.

f. Finish last lap after timer sounds and count if finished

g. Best pilot in the final FOUR (4) wins.

h. Winner has most laps from the best run out during the final run.

i. Ties are determined by the fastest time for the best run.

10.3 SCORING FOR GATES OR FLAGS

a. Pilots must go back and fly thorough missed gates or flags. Flags extend indefinitely into space but it is advised that pilots navigate near the flag so that judges can accurately assess the turn.

b. The opening of a gate is defined as the interior perimeter of the opening that is perpendicular to the race line. The aircraft needs to breach this front plane for it to count as a pass.

c. Missing one or more gates or flags will invalidate the count of that particular lap towards the overall lap count.

10.4 BEFORE THE START OF A RUN

a. All aircraft must be staged with the propellers parallel to the ground during the staging period. During arming period, pilots may angle their aircraft in preparation of launch but falling off or tipping over will be charged as a false start.

b. A pilot may notify the Race Director before the start of the run if he or she is unable to start, i.e. due to aircraft damage. The Race Director will then exercise discretion to either delay the start of the run by up to TWO (2) minutes or move the pilot to another run. All decisions made are final.

c. A pilot will need to be ready for his or her run by the stipulated timings. Failure to do so will result in the forfeiture of the run.

10.5 STARTING A RACE

a. False starts results in a restart or a ONE (1) lap penalty at the Race Director's discretion.

b. If the aircraft fails to takes off, it is deemed that the pilot is out of the particular run and not eligible for a re-run.

c. Crashing into aircraft will result in the pilot being taken out of the race with no re-run permissible.

d. The Race Director will exercise discretion for "Loss of video" scenarios to determine if a re-run is necessary.

e. Contact or crash just before the timing or start/finish gate will result in a restart or re-run as decided by the Race Director.

f. The Race Director has full authority to decide for other scenarios not stipulated above.

10.6 DURING A RUN

a. In the event of a collapsed obstacle or situations affecting part of the course, the Race Director will make a decision.

b. The Race Director will make a decision for incidents or disputes arising during the course of a run.

11. TECHNICAL RULES & REGULATIONS

11.1 REMOTE CONTROL (R/C) RADIO

Based on the Singapore Spectrum Management Handbook (Chapter 7, Issue 1 Rev 2.9, July 2017) from Infocomm Media Development Authority (IMDA) Singapore for short range devices, the following R/C frequency ranges are allocated for R/C cameras / toys / miscellaneous devices:

- 26.96 – 27.28 MHz ≤ 100mW Effective Radiation Power (ERP)

- 34.995 – 35.225 MHz ≤ 100mW ERP

- 40.665 – 40.695 MHz ≤ 500mW ERP

- 40.77 – 40.83 MHz ≤ 500mW ERP

- 72.13 – 72.21 MHz ≤ 500mW ERP

The following R/C frequency ranges are allocated for R/C aircraft and gliders:

- 26.96 - 27.28 MHz ≤ 500mW ERP
- 29.700 - 30.000 MHz ≤ 500mW ERP

The organiser understands the proliferation of 2.4 GHz R/C systems and will allow its use for this competition. However, the organiser shall bear no responsibilities for any loss of control of flying machine due to radio frequency interference. The team is advised to conduct a radio control range check prior to flight.

In any mode of flight, the team must be able to demonstrate the failsafe capability in their R/C transmitter. All electric motors should come to a complete stop when failsafe is activated **AND** when there is a loss of link between the R/C transmitter and the R/C receiver on the aircraft. Please refer to Point 2.7 in Section 8.2 for details on the failsafe check.

Please refer to the Singapore Spectrum Management Handbook on IMDA website for more details on the spectrum allocation and for the latest approved range of frequencies.

12. AVAILABLE RESOURCES

Indoor RC Racing Quads Suitable For SAFMC Cat C2 (Novice).

Basic Quad (Mass participation and learning the basics. Can be upgraded for FPV racing in Cat C2)

	Description	Price	Sellers	Remarks
1	Eachine E010 Quad	$19.00 $38.00	BangGood (Online) Hobby Square LLP (Local)	Quad w/ Basic Tx
2	Eachine E011 Quad	$23.00 $50.00	BangGood (Online) Popular Bookstore (Local)	Quad w/ Basic TX * 7mm motor
3	JJRC H36 Quad	$17.00	GearBest (Online)	Quad w/ Basic Tx
4	Furybee F36 Quad	$17.00	GearBest (Online)	Quad w/ Basic Tx
5	Blade Inductrix RTF Quad	$100.00	Radio Control Sports (Local)	Quad w/ Basic Spectrum Tx

FPV Racing peripherals (Equipment upgrade for FPV racing in Cat C2)

	Description	Price	Sellers	Remarks
1	Eachine E010C Quad with Cam/Vtx	$51.00	BangGood (Online)	Quad w/ Basic Tx
2	Eachine TX02 Cam/Vtx	$26.00	BangGood (Online)	Cam/Vtx
3	Turbowing Cam/Vtx	$27.00	BangGood (Online)	Cam/Vtx
4	Furibee F05 Cam/Vtx	$30.00	GearBest (Online)	Cam/Vtx
5	Furibee VR01 Goggle	$73.00	GearBest (Online)	Box goggle
6	Eachine VR006 Goggle	$84.00	BangGood (Online)	Box goggle
7	Eachine EV800D Goggle	$126.00	BangGood (Online)	Box goggle
8	Furibee FB100 Goggle	$162.00	GearBest (Online)	Semi pro goggle
9	Eachine EV100 Goggle	$223.00	BangGood (Online)	Semi pro goggle
10	Aomway Commander V1 Goggle	$483.00	BangGood (Online)	Pro goggle
11	Fatshark Dominator V3 goggle	$502.00	BangGood (Online)	Pro goggle
12	Fatshark Dominator HD3 goggle	$696.00	BangGood (Online)	Pro goggle
13	Flysky FSi6 Transmitter	$53.00	BangGood (Online)	Hobby grade Tx
14	iRangeX iRX6 Multi Module	$12.00	BangGood (Online)	For pairing FSi6 with Eachine and JJRC drones

Complete Racing Quad (Complete package for FPV racing in Cat C2)

	Description	Price	Sellers	Remarks
1	Eachine E013	$92.00	BangGood (Online)	W/ VR006 Box goggle
2	Blade Inductrix FPV RTF	$250.00	Radio Control Sports (Local)	W/ 4.3" monitor screen

Disclaimer: All approximate prices indicated correct as at 3 October 2017 and meant to serve as a guide (exclusive of shipping where applicable).

1) Sample Quad with basic Transmitter (Tx) – Entry level mass participation.

2) Sample Quad with Hobby Grade Tx and Multi module – Upgrade to hobby level.

3) Sample Quad with Hobby grade Tx, Multi module, Cam/Vtx, Goggle and Monitor screen – Basic requirements for SAFMC Cat C2 competition.

Notes:

1) Recommendations based on getting the most number of participants by selection of entry level equipment with the lowest cost, student will learn to fly line-of-sight (LOS).

2) Upgrading of their entry level equipment is possible and recommended if the student wants to progress into FPV phase, Hobby grade equipment allows more precise control and a more robust Radio Frequency link between the Quad and Tx (Pilot).

3) With the addition of a Cam/Vtx, Goggle or Monitor, the student will have the basic equipment for participation in SAFMC Cat C2 event. It is assumed that these students are handy with a soldering iron and willing to research and/or google for instructions on how to put the upgrades together.