Inspection Quick Reference

Formerly known as the “Legal and Illegal Parts List”

Revision History		
Revision	Date	Description
1	10/25/2024	2024-25 Initial Release

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Using this document

This document is intended to be used as an Inspector Quick Reference for use during inspection, and should contain materials to aid an inspector during inspection. This document is not intended to replace the Competition Manual, nor should this document be used to wholesale duplicate rules contained within the Competition Manual (else there be multiple "sources of truth"). This document is a work in progress – suggestions for adding information to this Quick Reference can be sent to: ddiaz@firstinspires.org but please understand the value of keeping this document "quick."

Motors

This is a list of the legal motors in *FIRST* Tech Challenge with representative pictures for easy reference. Remember any transmission or gearbox is allowed to be used with a motor.

 AndyMark NeveRest 12V DC	 AndyMark NeveRest Hex 12V DC	 goBILDA YellowJacket 12V DC
 Modern Robotics/MATRIX 12V DC	 REV Robotics HD Hex 12V DC	 REV Robotics Core Hex 12V DC
 Studica Robotics Maverick 12V DC	 Tetrix MAX DC 12V Motor	 Tetrix MAX TorqueNADO 12V DC

Servos

Unit Conversions

Common unit conversions used on many servos used in *FIRST* Tech Challenge. Use this to perform back-of-napkin comparisons with the Maximum Mechanical Power table.

Speed (no-load)

sec/60°	RPM	rad/sec
0.04	250.0001	26.17994
0.06	166.6667	17.45329
0.08	125	13.08997
0.1	100	10.47198
0.12	83.33336	8.726646
0.14	71.4286	7.479983
0.16	62.50002	6.544985
0.18	55.55558	5.817764
0.2	50.00002	5.235988
0.22	45.45456	4.759989
0.24	41.66668	4.363323
0.26	38.46155	4.027683

Torque (max)

kg-cm	oz-in	N-m
5	69.43693	0.490333
10	138.8739	0.980665
15	208.3108	1.470998
20	277.7477	1.96133
25	347.1847	2.451663
30	416.6216	2.941995
35	486.0585	3.432328
40	555.4955	3.92266
45	624.9324	4.412993
50	694.3693	4.903325
55	763.8063	5.393658
60	833.2432	5.88399

Online Servo Maximum Mechanical Power Calculator QR Code (LINK)

Maximum Mechanical Power

Maximum Mechanical Power @6V = 0.25 x No-Load Speed (rad/sec) x Torque (N-m)

The below table uses standard units (used by Servo mfg) and provides maximum mechanical power in Watts (at 6V or greater). Use this table as a lookup when an online calculator is not available.

Table 0-1: Max Mechanical Power (Watts) of Servos given Speed and Torque

		Speed (*sec per 60 degrees*)											
		0.04	0.06	0.08	0.10	0.12	0.14	0.16	0.18	0.20	0.22	0.24	0.26
Torque (*kg-cm*)	5	3.21	2.14	1.60	1.28	1.07	0.92	0.80	0.71	0.64	0.58	0.53	0.49
	10	6.42	4.28	3.21	2.57	2.14	1.83	1.60	1.43	1.28	1.17	1.07	0.99
	15	9.63	6.42	4.81	3.85	3.21	2.75	2.41	2.14	1.93	1.75	1.60	1.48
	20	12.84	8.56	6.42	5.13	4.28	3.67	3.21	2.85	2.57	2.33	2.14	1.97
	25	16.05	10.70	8.02	6.42	5.35	4.58	4.01	3.57	3.21	2.92	2.67	2.47
	30	19.26	12.84	9.63	7.70	6.42	5.50	4.81	4.28	3.85	3.50	3.21	2.96
	35	22.46	14.98	11.23	8.99	7.49	6.42	5.62	4.99	4.49	4.08	3.74	3.46
	40	25.67	17.12	12.84	10.27	8.56	7.34	6.42	5.71	5.13	4.67	4.28	3.95
	45	28.88	19.26	14.44	11.55	9.63	8.25	7.22	6.42	5.78	5.25	4.81	4.44
	50	32.09	21.39	16.05	12.84	10.70	9.17	8.02	7.13	6.42	5.83	5.35	4.94

Pre-Verified Servos

This list comprises pre-verified servos commonly used in *FIRST* Tech Challenge. Teams must provide manufacturer's documentation for servos not on this list in order to be allowed to use them in competition (per R502). *Servos must be 8W or less* maximum mechanical power at 6V, and have *4A or less* Max Stall Current at 6V (or greater).

Servo Name	Manufacturer	SKU	Volts	Speed (s/60°)	Torque (kg-cm)	Stall Current (A)	Max Power (Watts)
AGFRC Sub-Micro Servo Motor	AGFRC	B13DLM	6	0.13	3.8	2.2	0.75
High Torque Programmable Servo	AndyMark	am-4954	6	0.2	22	1.7	2.82
High Speed Programmable Servo	AndyMark	am-4955	6	0.05	7	2.7	3.59
Micro Servo SG90	AndyMark	am-4343	6	0.1	2.5	0.65	0.64
Axon Micro+	Axon Robotics	Axon Micro+	6	0.075	7.8	2.2	2.67
Axon MAX+	Axon Robotics	Axon MAX+	6	0.115	34	4	7.59
Axon MINI+	Axon Robotics	Axon MINI+	6	0.09	25	3.8	7.13
DSSERVO DS3225	DSSERVO	DS3225	6.8	0.14	28	2.9	5.13
DSSERVO DS3225MG	DSSERVO	DS3225MG	6.8	0.13	25	2.9	4.94
DSSERVO DS3235	DSSERVO	DS3235	6	0.12	32	2.1	6.85
DSSERVO DS3235MG	DSSERVO	DS3235MG	6	0.12	32	2.1	6.85
DSSERVO DS3240	DSSERVO	DS3240	6.8	0.17	45	3.9	6.8
DSSERVO DS3240MG	DSSERVO	DS3240MG	6.8	0.17	45	3.9	6.8
FEETECH Digital Giant Servo	FEETECH	FT5335M-FB	6	0.2	35	4	4.49
2000 Series Dual Mode Servo (25-2, Torque)	goBILDA	2000-0025-0002	6	0.2	21.6	2.5	2.77
2000 Series Dual Mode Servo (25-3, Speed)	goBILDA	2000-0025-0003	6	0.09	9.3	2.5	2.65
2000 Series Dual Mode Servo (25-4, Super Speed)	goBILDA	2000-0025-0004	6	0.043	4.7	2.5	2.81
HiTec HSR-M9382TH Servo	HiTec	HSR-M9382TH	6	0.17	34	2.7	5.13
Super Servo Plus	Melonbotics	Super Servo Plus	6	0.01	2.3	3.9	5.9
Miuzei Digital Servo 20Kg	Miuzei	DS3218	6.8	0.14	21.5	2.5	3.94
Tetrix MAX (HiTec HS-485HB)	Pitsco	39197	6	0.18	6	1.2	0.86
PLEX Speed Brushless	PLEX Robotics	PLEX Speed	6	0.067	18	3.9	6.90
PLEX Torque Brushless	PLEX Robotics	PLEX Torque	6	0.095	28	3.9	7.57
REV Smart Servo	REV Robotics	REV-41-1097	6	0.14	13.5	2	2.48
Multi-Mode Smart Servo 200 - FAST	Studica	75007	6	0.046	5	2.7	2.79
Multi-Mode Smart Servo	Studica	75002	6	0.2	21.6	1.8	2.77
Swyft Robotics Speed Servo	Swyft Robotics	SR-Servo-01	6	0.062	19	2.7	7.87
Swyft Robotics Balance Servo	Swyft Robotics	SR-Servo-02	6	0.092	27.3	2.7	7.53
Swyft Robotics Torque Servo	Swyft Robotics	SR-Servo-03	6	0.112	33.5	2.7	7.68
TIANCONGRC TD-8125MG 360	TIANCONGRC	TD-8125MG	7.2	0.14	26.8	3.4	4.91

Servo Name	Manufacturer	SKU	Volts	Speed (s/60°)	Torque (kg-cm)	Stall Current (A)	Max Power (Watts)
MG90S Micro Servo	Tower Pro, …	MG90S	6	0.08	2.2	0.4	0.71
MG995 X-Large Servo	Tower Pro, …	MG995	6	0.16	11	1.2	1.77
MG996R X-Large Servo	Tower Pro, …	MG996R	6	0.15	11	1.4	1.88

Pre-Verified Linear Servos

This list comprises pre-verified linear servos commonly used in *FIRST* Tech Challenge. Teams must provide manufacturer's documentation for servos not on this list in order to be allowed to use them in competition (per R502). Linear Servos must have *1A or less* Max Stall Current at 6V.

Linear Servo Name	Manufacturer	SKU	Volts	Stall Current (A)
Actuonix Micro Linear Servo	Actuonix	P8-100-252-12-R	6	0.45
Hitec Linear Servo	Hitec	HLS12-3050-6V, HLS12-30100-6V, HLS12-30210-6V, HLS12-30380-6V, HLS12-5050-6V, HLS12-50100-6V, HLS12-50380-6V, HLS12-10050-6V, HLS12-100100-6V, HLS12-100210-6V, HLS12-100380-6V	6	0.5
Studica Linear Servo RC Actuator	Studica	75010, 75011, 75012, 75013, 75014, 75015	6	1

Known Illegal Servos

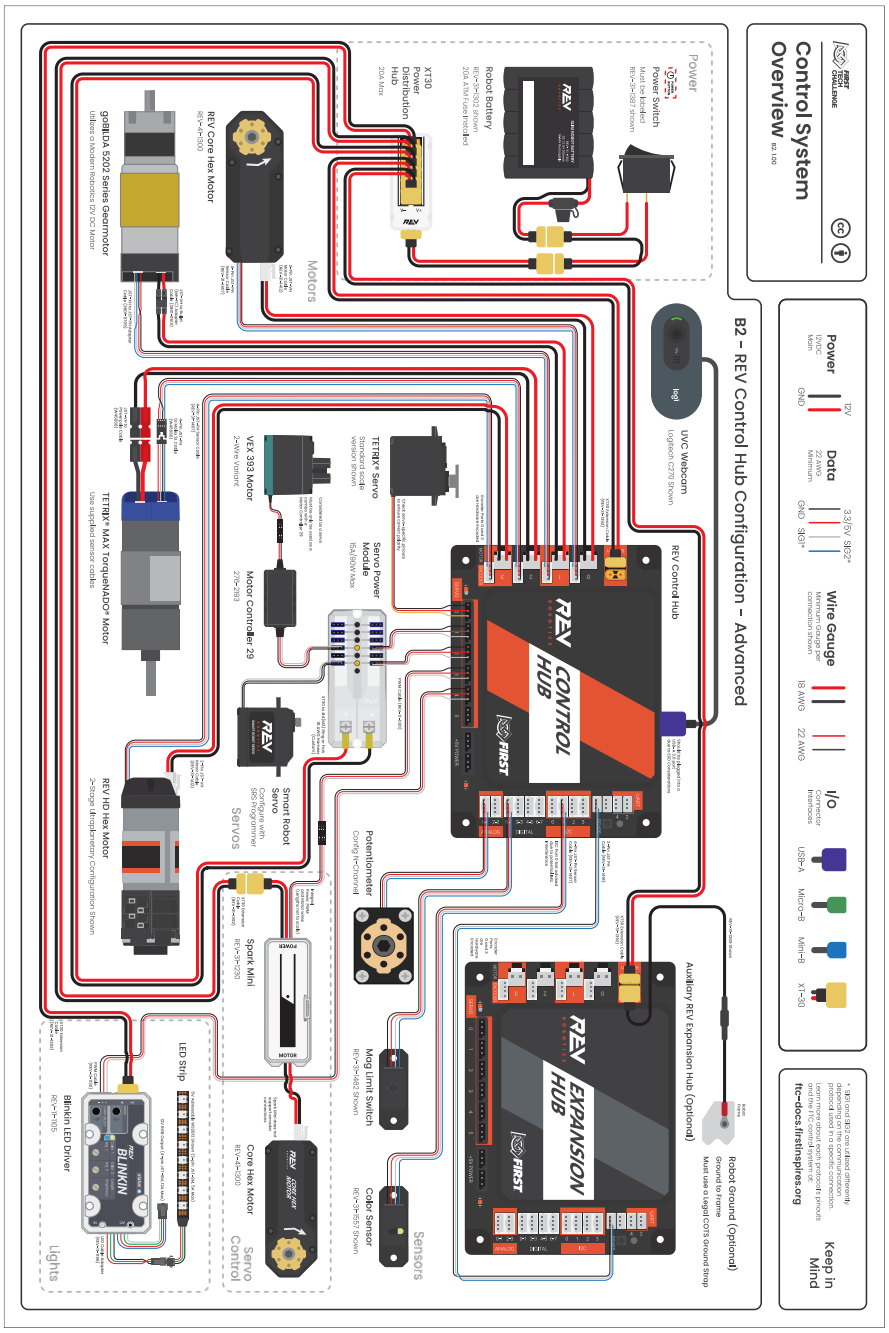
This list highlights servos known to be illegal – those who have a Maximum Stall Current or Maximum Mechanical Power that exceeds the maximum allowed ratings. Not all illegal servos will be in this list, only a few of the commonly found/seen ones or those that have been used in past seasons.

Servo Name	Manufacturer	SKU	Volts	Speed (s/60°)	Torque (kg-cm)	Stall Current (A)	Max Power (Watts)
DSSERVO DS3225PRO	DSSERVO	DS3225PRO	6	0.09	30	4.2	8.56
Hitec HS-805BB Monster Resin	Hitec	HS-805BB	6	0.14	24.7	6.0	4.53
Smraza 45KG Coreless Torque	Smraza	SC55-NA	6	0.12	39	2.4	8.34

Wiring Guides

Robot Controller

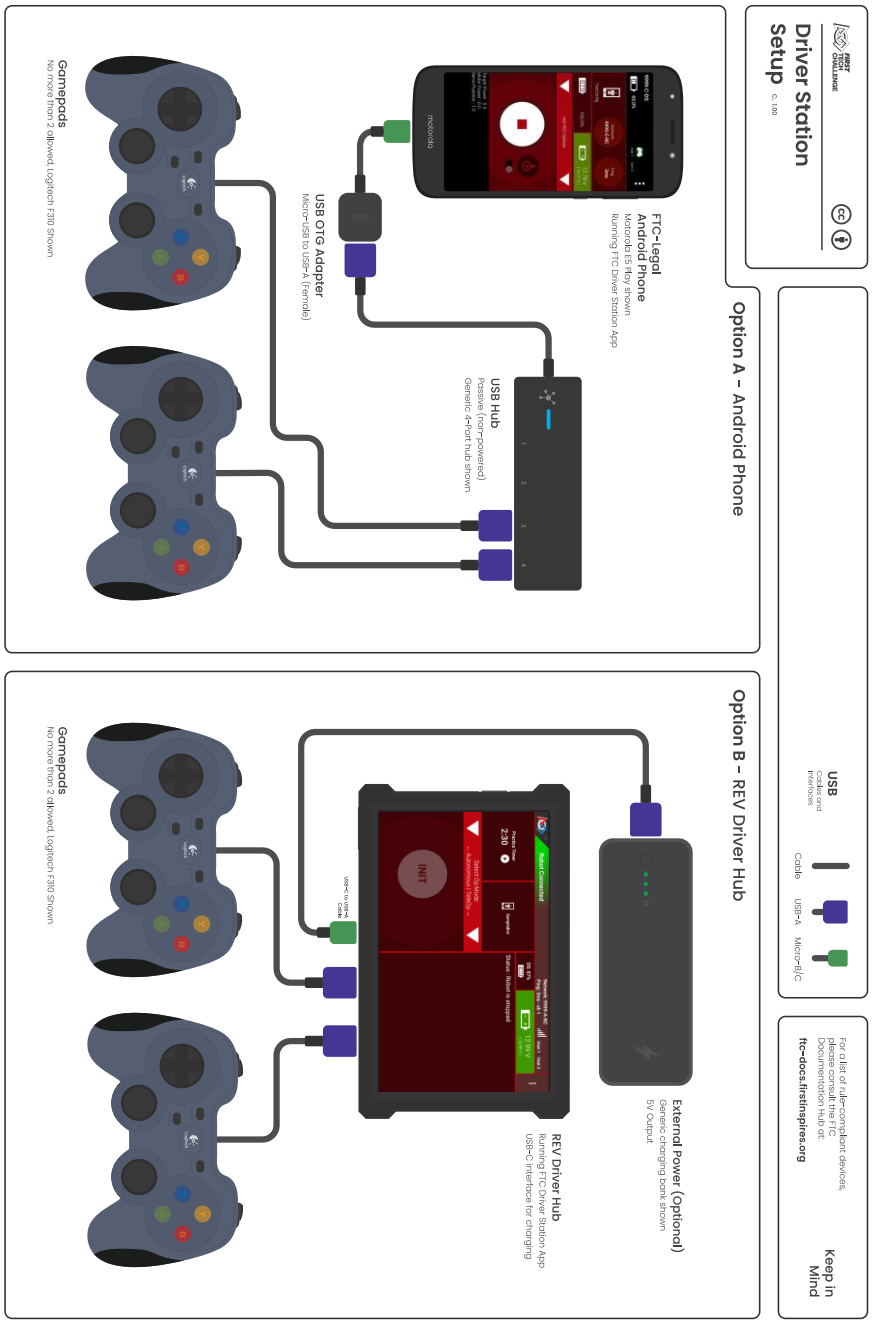
Below is the “Advanced” REV Control Hub sample wiring diagram. This is just a sample of the ways in which electronics can be connected to the REV Control Hub. To see additional Robot Controller wiring diagrams or a high-resolution version of this wiring diagram use the QR code/link on the right.



Simple and Advanced Robot Wiring Diagrams *(REV Control Hub and Android SmartPhone)* (LINK)

Driver Station

Below are the Driver Station wiring diagrams. This is just a sample of the ways in which electronics can be connected to create a Driver Station, consult the Competition Manual for the full descriptions of what is allowed and what isn't. To see a high-resolution version of this wiring diagram use the QR code/link on the right.



REV Driver Hub and Android Smartphone Driver Station Wiring Diagrams (LINK)

Illegal Electronics

This section is intended to list commonly asked-about electronics that are illegal for use in *FIRST* Tech Challenge. This is absolutely NOT a comprehensive list and should NOT in any way be used to determine if a given device is legal or illegal unless it is specifically mentioned here. If the device is not listed here, and there are questions about the legality of the device, consult the Competition Manual or the FTC Q&A platform. Unofficial compatibility questions can also be discussed in the FTC Community forum.

Illegal Servo Power or Servo Signal Adjusters

Devices that generate or alter servo signals cannot be used to control servos, servos can only be controlled by core power regulating devices (REV Control Hub, REV Expansion Hub, REV Servo Hub). Be aware that allowed servo power modules (like the REV Servo Power Module or Studica Servo Power Block) are signal pass-through devices. Some devices are also illegal because they're not compatible with the FTC Electronics – generally because they do not regulate incoming power – or are of a "protected class" (actuators, actuator controllers, actuator power modules, USB devices, robot controllers, smartphones, electrical grounding devices, and so on) and are not approved for use. Servo controlling devices that are illegal include:

		
goBILDA Servo Travel Tuner ***(ILLEGAL)***	goBILDA Servo Power Distribution Board (8 Channel) ***(ILLEGAL)***	goBILDA 4-Channel Servo Extension via CAT6 ***(ILLEGAL)***