**LFEV-Y5**

v0.4

**Lafayette College: Electrical and Computer Engineering**

Acceptance Test Plan: v0.4

Greg Flynn

This document outlines all of the tests required to deliver LFEV-Y5. The plan is presented as an overview with the ATP number next to the test. This refers to the document that describes the test procedure. The requirements are from the SoW for 2017

08

**Fall**

Table of Contents

[ATP overviews 3](#_Toc478917032)

[Compliance Matrix 6](#_Toc478917033)

[Deliverables 8](#_Toc478917034)

[D000 8](#_Toc478917035)

[D001 8](#_Toc478917036)

[D002 8](#_Toc478917037)

[D003 8](#_Toc478917038)

[D004 8](#_Toc478917039)

[D005 8](#_Toc478917040)

[D007 9](#_Toc478917041)

[D008 9](#_Toc478917042)

[D009 9](#_Toc478917043)

[D010 9](#_Toc478917044)

[D012 9](#_Toc478917045)

[D013 9](#_Toc478917046)

[D014 9](#_Toc478917047)

[Waived or modified requirements and questions 10](#_Toc478917048)

[ATP-01 checklist 10](#_Toc478917049)

[ATP-02 checklist 10](#_Toc478917050)

[ATP-03 checklist 11](#_Toc478917051)

[ATP-04 checklist 11](#_Toc478917052)

[ATP-07 checklist 12](#_Toc478917053)

[ATP-09 checklist 12](#_Toc478917054)

[ATP-11 checklist 13](#_Toc478917055)

[ATP-12 checklist 14](#_Toc478917056)

[ATP-13 checklist 14](#_Toc478917057)

[ATP-14 checklist 14](#_Toc478917058)

# ATP overviews

None of these tests can be viewed as completed until appropriate documentation has been uploaded to the webpage.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Item | Item description | Demonstrated Requirements | Successful Test Criteria | Verification Method |
| ATP-01 | Accumulator integration | R001a  R001c  R001d  R001e  R002a  R002c  R004a (TSV part)  R005a  R005b (Manual) | Packs power motor and all telemetry is recorded by VSCADA. Control by using the throttle.  Verify by accelerating and looking at dash, pack screens, and log files remotely | Test |
| ATP-02 | Charging  Accumulator and GLV | R001b  R001g  R002b  R002h  R003a(4-7) | Packs charge by the charging port and open the safety loop  VSCADA reacts correctly  Verify by looking at the dash  GLV battery can be charged | Test |
| ATP-03 | CAN Bus link | R002a  R002c  R002d  R002e  R002f  R002g  R002j  R002k  R003a(8)  R003d  R004a (CAN Bus part)  R005a (CAN Bus part)  R005c (CAN Bus part)  R007c  R007d | DAQ by VSCADA of TSI, GLV, TSV, Cooling. Verify by looking at cell phone and looking at dash and remote computer in each mode of VSCADA | Test |
| ATP-04 | Safety loop | R001g  R002b  R002c  R002d  R002k  R002m  R003b  R003c  R003d  R004a (Safety loop part)  R005c (IMD fault)  R007b | Fault by:  Crashing  BRB  IMD  Cooling  VSCADA limit  Pack fault  Throttle fault  Brake fault  User defined limit (warn)  User defined limit (halt)  Pack charging  Verify by looking at the dash, the remote computer and the cellphone | Test |
| ~~ATP-05~~ | ~~Cruise Control~~ | ~~R002l~~  ~~R005b (Software)~~ | ~~Motor can maintain desired speed~~  ~~Verify by checking motor speed compared to target~~ | ~~Test~~ |
| ~~ATP-06~~ | ~~24h endurance test~~ | ~~GPR006~~ | ~~At the end of all other tests leave the car running for 24h~~ | ~~Test~~ |
| ATP-07 | Shutdown | R002k  R002i | VSCADA works after unexpected GLV shutdown  All hardware in safe state  Packs stop powering motor with GLV shutdown  TSI works after unexpected TSV shutdown | Test |
| ATP-08 | GLV grounding | R003a(2) | Ensure that there is only 1 connection between ground and chassis ground | Inspection |
| ATP-09 | Documentation | GRP001 | Complete and accurate documentation | Inspection |
| ATP-10 | Hazmat | GPR004 | No hazardous materials used | Analysis |
| ATP-11 | Safety practice | GPR005 | Good practice used for safety | Inspection |
| ATP-12 | Maintainability | GPR007 | Ensure that the project is maintainable | Analysis |
| ATP-13 | Demonstration | GPR011 | Have a video and demo setup | Inspection |
| ATP-14 | Disposal | GPR012 | Dispose of all materials as required | Inspection |

# Compliance Matrix

All requirements should also have a QA by each subsystem before integration.

|  |  |
| --- | --- |
| Requirement | Test(s) to demonstrate acceptance |
| R001a | ATP-01 |
| R001b | ATP-02 OR https://sites.lafayette.edu/ece492-sp16/files/2016/05/QAR001b.pdf |
| R001c | ATP-01 |
| R001d | ATP-01 |
| R001e | ATP-01 |
| R001f | https://sites.lafayette.edu/ece492-sp16/files/2016/05/QAR001e.pdf |
| R001g | ATP-02 |
| R002a | ATP-01 or ATP-03 |
| R002b | ATP-02 |
| R002c | ATP-01 OR ATP-03 OR ATP-04 |
| R002d | ATP-01 OR ATP-03 OR ATP-04 |
| R002e | ATP-03 |
| R002f | ATP-03 |
| R002g | ATP-03 |
| R002h | ATP-02 OR ATP-03 |
| R002i | ATP-02 |
| R002j | ATP-03 |
| R002k | ATP-03 |
| R002l | Waived |
| R002m | ATP-04 |
| R003a(1) | Any ATP |
| R003a(2) | ATP-08 |
| R003a(3) | QA by GLV |
| R003a(4) | ATP-02 |
| R003a(5) | ATP-02 |
| R003a(5) | ATP-02 |
| R003a(6) | ATP-02 |
| R003a(7) | ATP-02 |
| R003a(8) | ATP-03 |
| R003b | ATP-04 |
| R003c | QA by GLV |
| R003d | ATP-03 |
| R004a | ATP-01 AND ATP-03 AND ATP-04 |
| R004b | QA by Interconnect |
| R005a | ATP-01 AND ATP-03 |
| R005b | ATP-01 AND ATP-07 |
| R005c | ATP-04 |
| R005d | QA by TSI |
| R006 | Any ATP |
| R007a | QA by Cooling |
| R007b | ATP-04 |
| R007c | ATP-03 |
| R007d | ATP-03 |
| R007e | Waived |
| R007f | QA by Cooling |
| R007g | QA by Cooling |
| GPR001 | ATP-09 |
| GPR003 | Waived |
| GPR004 | ATP-10 |
| GPR005 | ATP-11 |
| GPR006 | ATP-06 and ATP-11 |
| GRP007 | ATP-12 |
| GPR008 | ATP-09 |
| GPR011 | ATP-13 |
| GPR012 | ATP-14 |

# Deliverables

## D000

Completed

## D001

Completed

## D002

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| System | Getting started | FAQ | Functions and controls | Troubleshooting calibration and maintenance |
| TSI |  |  |  |  |
| TSV |  |  |  |  |
| GLV |  |  |  |  |
| Cooling |  |  |  |  |
| VSCADA |  |  |  |  |
| Dyno room |  |  |  |  |

## D003

|  |  |
| --- | --- |
| Check | Completed |
| Final report of all documents |  |
| 3x DVD presented (or flash drive) |  |
| DVD artwork |  |

Maintenance manual

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| System | Maintenance | Calibration | Schematics | ICDs | FSM |
| TSI |  |  |  |  |  |
| TSV |  |  |  |  |  |
| GLV |  |  |  |  |  |
| Cool |  |  |  |  |  |
| VSCADA |  |  |  |  |  |

## D004

|  |  |
| --- | --- |
| Check | Completed |
| Compliance matrix |  |
| Forms present |  |

## D005

|  |  |
| --- | --- |
| Check | Completed |
| All tests included |  |
| Test date for all tests |  |
| Photos as required |  |
| Tester named |  |
| Witness signature if available |  |
| Test results |  |
| Submitted to website |  |

## D007

|  |  |
| --- | --- |
| Check | Completed |
| All documents as portable static documents (PDF/TXT/XML) |  |
| Original version present |  |
| Links to any cloud storage |  |

## D008

|  |  |
| --- | --- |
| Check | Completed |
| GPR006 |  |
| GPR007 |  |
| GPR008 |  |
| GPR011 |  |
| D010 |  |
| Video for D009 | Waived |
| Video of GPR011 |  |
| Delivered per GPR012 |  |
| Any other items disposed per GPR012 |  |

## D009

Waived

## D010

|  |  |
| --- | --- |
| Check | Completed |
| Poster dimensions 47"x35" |  |
| QR code to webpage |  |
| Web link present |  |

## D012

Completed

## D013

|  |  |
| --- | --- |
| Check | Completed |
| Table for all purchases |  |
| Summary based on team |  |
| Summary based on week |  |

## D014

|  |  |
| --- | --- |
| Check | Completed |
| Status letter submitted |  |
| WBS delivered |  |

# Waived or modified requirements and questions

|  |  |
| --- | --- |
| Requirement | Reason |
| R003a(4) | Cannot tell if GLV is from the battery or 24VDC |
| R002h | Cannot tell if GLV is from the battery or 24VDC |
| R007e | Waived |
| R005d | We’ve changed the switches |
| R002l | Waived |
| GPR003 | Waived |
| D009 | Waived |

# ATP-01 checklist

|  |  |
| --- | --- |
| Test | Pass |
| Packs can deliver 200A through TSI to the motor according to current sensor on HV cable |  |
| Voltage measured at TSVMP is as expected |  |
| Throttle controls RPM |  |
| Throttle implausibility causes exit of drive mode |  |
| Two moves required to enter drive mode |  |
| Throttle and brake together prevent drive mode from starting |  |
| Throttle and brake together exit drive mode |  |
| TSAL lights come on when HV present outside packs |  |
| TSEL lights come on when AIRS closed |  |
| RTDS come on for 1-3 seconds when drive mode entered |  |
| HV present light comes on when HV present |  |
| Packs display telemetry on screen |  |
| VSCADA can set the throttle |  |
| VSCADA can set the valve on the dyno |  |

Pass count: /14

# ATP-02 checklist

|  |  |
| --- | --- |
| Test | Pass |
| Safety loop opens when charging |  |
| Dash board shows that packs are charging |  |
| Packs can be left charging after they are full |  |
| GLV battery can be charged |  |
| GLV battery can be left charging after it is full |  |

Pass count: /5

# ATP-03 checklist

|  |  |  |  |
| --- | --- | --- | --- |
| Test | Seen by VSCADA | Seen by Remote | Seen by Cell |
| Cell Temperature |  |  |  |
| Cell Voltage |  |  |  |
| Pack Current |  |  |  |
| Pack SoC |  |  |  |
| Pack Status |  |  |  |
| Pack Voltage |  |  |  |
| GLV Voltage |  |  |  |
| GLV SoC |  |  |  |
| GLV Current |  |  |  |
| GLV Temperature |  |  |  |
| Safety loop status |  |  |  |
| RPM gauge (Dyno) |  |  |  |
| Strain gauge |  |  |  |
| Throttle position |  |  |  |
| Brake status |  |  |  |
| IMD status |  |  |  |
| FWD/REV status |  |  |  |
| Precharge status |  |  |  |
| MC temp |  |  |  |
| MC current |  |  |  |
| Cooling temp in |  |  |  |
| Cooling flow |  |  |  |
| Cooling temp out |  |  |  |
| TSI temp |  |  |  |
| Speed |  |  |  |
| Safety loop status |  |  |  |

Pass count: /78

# ATP-04 checklist

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Fault | Safety loop trip | Seen on VSCADA | Seen on Remote | Seen on Cell |
| Driver resettable BRB |  |  |  |  |
| Non driver resettable BRB |  |  |  |  |
| Crash protection |  |  |  |  |
| Over temperature cooling |  |  |  |  |
| Under flow cooling |  |  |  |  |
| IMD fault |  |  |  |  |
| Cell overtemp |  |  |  |  |
| Cell overcurrent |  |  |  |  |
| Cell overvoltage |  |  |  |  |
| Cell undervoltage |  |  |  |  |
| Brake overtravel |  |  |  |  |
| VSCADA defined violation |  |  |  |  |

Pass count: /48

# ATP-07 checklist

|  |  |
| --- | --- |
| Test | Pass |
| VSCADA powers up with no user input |  |
| GLV shutdown prevents TSV being present at TSVMP |  |
| TSVMS shutdown prevents TSV being present at TSVMP |  |
| VSCADA has recorded data up to the shutdown |  |
| TSVMS shutdown while under load does not create any issues |  |
|  |  |

Pass count: /5

# ATP-09 checklist

Each document:

|  |  |
| --- | --- |
| Check | Pass |
| Unique part number |  |
| Document delivered to instructor |  |
| Document uploaded to website |  |
| Units defined on diagram clearly |  |
| Have a complete BOM with document if required |  |
| Part number on title block |  |
| Part number on file name |  |
| Part number on fabricated object |  |
| Lafayette Electrical and Computer Engineering marked |  |
| The BOM has parts that are purchasable with 1 alternative or justification why 1 supplier is acceptable |  |

Pass count: /10

# ATP-11 checklist

For each wire:

|  |  |
| --- | --- |
| Check | Pass |
| Wires correctly color coded |  |
| Cable labeled with gauge/max temperature/max voltage |  |
| Cable labeled with reference designator |  |

Pass count: /3

For each indicator and button:

|  |  |
| --- | --- |
| Check | Pass |
| Clear indicator of function |  |

Pass count: /1

For each PCB:

|  |  |
| --- | --- |
| Check | Pass |
| Silkscreens marking reference designators |  |
| Silkscreens marking power and critical signals |  |
| Silkscreen showing Lafayette College, Made in USA, Electrical and Computer Engineering, part number |  |
| Space for serial number |  |
| Bottom copper has part number and rev |  |

Pass count: /5

For each fuse

|  |  |
| --- | --- |
| Check | Pass |
| UL listed socket as a holder |  |
| 5 spares |  |
| Easy to access |  |

Pass count: /3

For enclosures

|  |  |
| --- | --- |
| Check | Pass |
| Access panel present |  |
| Pilot lights and indicators present |  |
| All interconnect cables have at least 1 return signal |  |
| PCBs are not mounted directly to enclosure |  |
| Enclosures are grounded if they are conductive |  |
| Labeled internally and externally |  |

Pass count: /6

For every part that dissipates >25mV (0.025W). (Basically every part)

|  |  |
| --- | --- |
| Check | Pass |
| Overrated to +50% maximum expected power dissipation |  |
| No temperature rise to >40C above ambient |  |
| Overrated to +25% maximum expected voltage |  |
| MTBF analysis completed |  |

Pass count: /4

# ATP-12 checklist

For software

|  |  |
| --- | --- |
| Check | Pass |
| Version controlled |  |
| Can startup with no input from the user |  |
| Have an install script (.exe/make/RPM) |  |
| Configurable without requiring a recompile |  |
| Data stored in a well-supported format |  |
| Any files that grow should be automatically trimmed |  |
| A procedure for backing up data |  |
| Passwords should be avoided |  |
| If a port is needed it should enumerate automatically |  |

Pass count: /9

For hardware

|  |  |
| --- | --- |
| Check | Pass |
| Recommended list of spare hardware |  |
| Basic troubleshooting guidelines for a beginner |  |
| Advance troubleshooting for an expert |  |
| A beginner can diagnose a simple problem (loose connector) |  |
| An expert can diagnose a complex problem (TBA) |  |

Pass count: /5

# ATP-13 checklist

|  |  |
| --- | --- |
| Check | Pass |
| 320p video supplied |  |
| 640p video supplied |  |
| Video ~5min in length |  |
| Slideshow of final project |  |
| Demonstration of final project |  |
| Standalone self-contained display provided |  |

Pass count: /6

# ATP-14 checklist

|  |  |
| --- | --- |
| Check | Pass |
| All materials stored in the same room |  |
| Webpage updated to a final version |  |

Pass count: /2

|  |  |  |  |
| --- | --- | --- | --- |
| ***The following is for REFERENCE ONLY with regards to demonstration requirements. All of this can be completed in the dyno room*** | | | |
| *Torque Control:* | | | |
| Demo |  | ~~2.1.1~~ | ~~Torque control sensor actuated by a right foot pedal~~ |
| Demo | ~~2.1.2~~ | ~~Foot pedal returns to original position when not actuated and has positive stops to protect sensor~~ |
| Demo | 2.2.1 | All plausibility detections schemes must detect and shutdown torque production within 1 second of the errors first occurrence or loss of communication. |
| Demo | 2.2.2 | Teams must be prepared to demonstrate error detection at Electrical Tech Inspection. Unplugging a connector is an  acceptable method of demonstration |
| *Safety Circuit/Shutdown* | | | |
| Demo |  | 5.8.1 | The brake over-travel switch shuts down the tractive system |
| Demo | 5.8.2 | The brake over-travel switch is not driver-resettable |
| Demo | 5.1.6 | Check that motor spins freely when TS is deactivated. |
| Demo | 1.2.7 | The GLV system must be energized in order to activate the tractive system. If the GLV system shut down, the tractive system must de-activate immediately. |
| Demo | 4.7.6  4.7.6  4.7.7 | The team can remove the HVD in under 10 seconds, from the ready-to-drive condition, without the use of tools |
| Demo | 4.8.1 | The driver can make the car ready to drive without assistance. For AMS, IMD, or other inaccessible shutdown circuit opens, the driver alone cannot make the car ready-to-drive. |
| Demo | 4.8.1 | The driver must be able to re-activate or reset the tractive system from within the cockpit without the assistance of any other person except for situations in which the AMS or IMD have shut down |
| Demo | 4.8.2 | At least one action in addition to enabling the shutdown circuits is required to set the car to ready-to-drive mode. A start button shall not be such that it can inadvertently be left in the “on” position. |
| Demo | 4.9.1 | The pre-charge is disabled by an opened shutdown circuit. |
| Demo | 4.9.5 | Pre-Charge circuit must operate regardless of the sequence of operation used to energize the vehicle (i.e. restarting after automatic shutdown of safety circuit |
| Demo | 5.1.7  5.1.8 | Shutdown circuit operates to state diagram in the FSM (Figure 1 - FSM for TSI) |
| *AMS* | | | |
| Demo |  | 3.7.8 | AMS disables all electrical systems, disables TSV drive system, and opens AIRs until manually reset by other than driver. |
| Demo | 3.7.10 | Does AMS trip at level documented in ESF? |
| *IMD* | | | |
| Demo |  | 5.1.5 | The driver must not be able to re-activate the tractive system from within the car in case of an AMS or IMD fault.  Wireless reset shutdown circuit is not permitted |
| Demo | 5.9.5 | TS remains inactive until manually reset by other than the driver (IMD Fault). Driver must not be able to reset an  IMD fault from within the car. |
| Demo | 5.9.6  5.9.7 | A red indicator light in the cockpit indicates IMD status. It is visible in bright sunlight, and marked "IMD" or "GFD". |
|  | 7.1 | The IMD test is passed if the IMD shuts down the tractive system within 30 seconds at a fault resistance of 250 ohm/volt (50% below the response value) - Note: Proper wiring proven through successful testing of the IMD |
| Demo |  | IMD test. Shuts down HV? Latches off? Labeled cockpit light? |
| Demo | 7.2 | The insulation resistance between the tractive system and control system ground will be measured during Electrical  Tech Inspection. The available measurement voltages are 250 V and 500 V. All cars with a maximum nominal operation voltage below 500 V will be measured with the next available voltage level. For example, a 175 V system will be measured with 250 V; a 300 V system will be measured with 500 V etc. |
| Demo |  | The measured insulation resistance is >= 500 ohm/volt related to the maximum nominal tractive system operation voltage |



Figure 1 - FSM for TSI

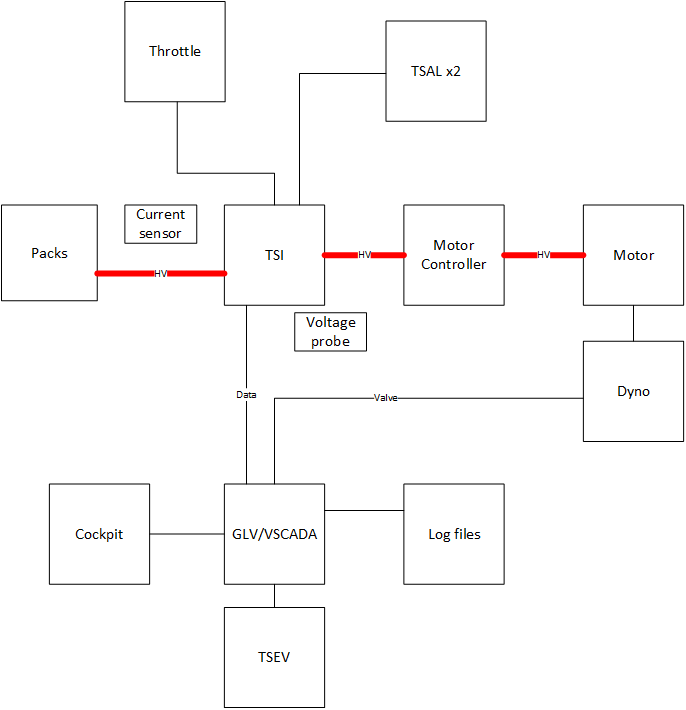


Figure - ATP-01 block diagram

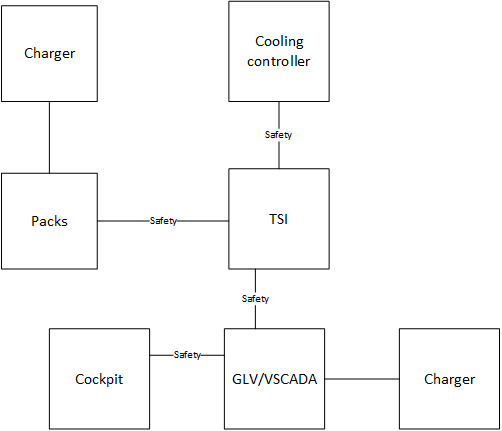


Figure - ATP-02 block diagram

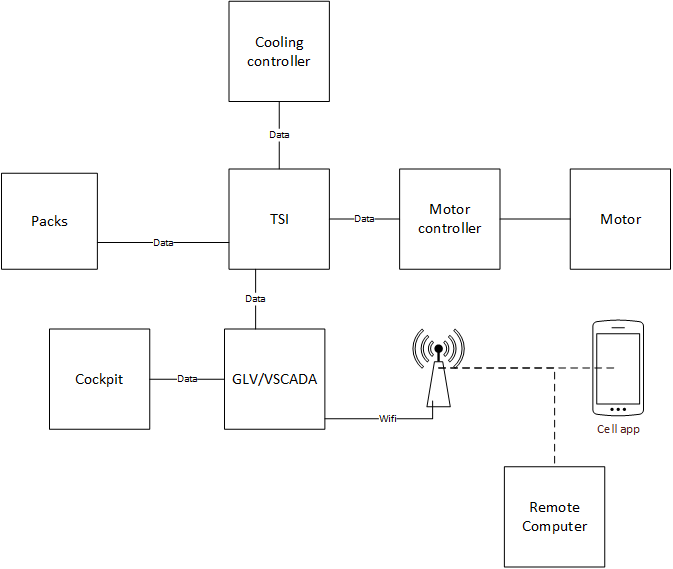


Figure - ATP-03 block diagram

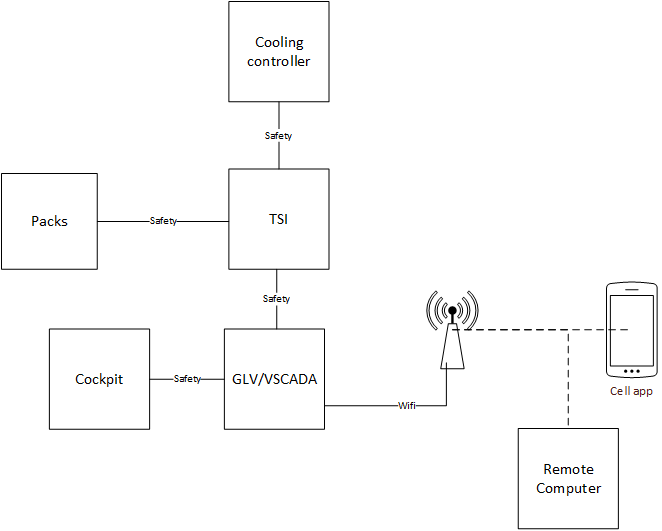


Figure - ATP-04 block diagram