

# Contactor's Control Board

Reliability Study – kick-off meeting

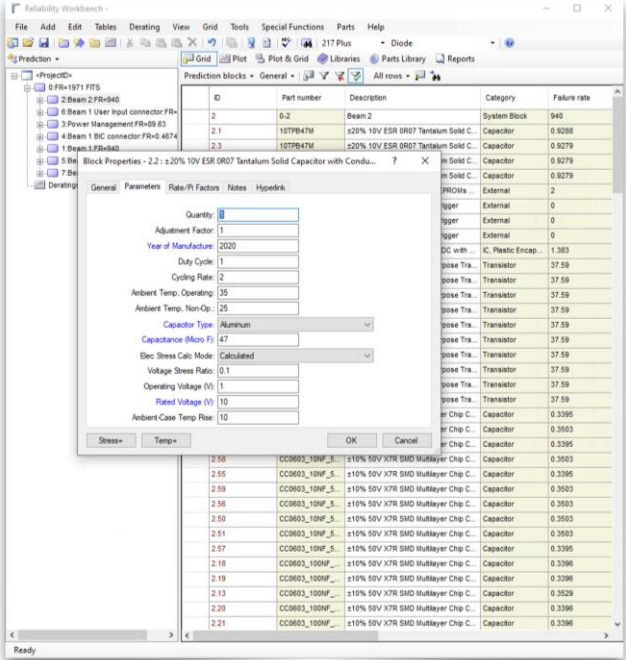
# Component-level FMECA

## Failure rates, modes & end-effects

### Component failure modelling

- Use library of component failure models, parametrized by mission profile and operating conditions

**Outcomes:**  
 Template of all component failure modes and estimation of their likelihood.



### End-effects assignment

- Together with expert, assign system-level effect of each component failure mode

**Outcomes:**  
 Establishing probability for each failure end-effect (on system level).

ID	Alt	Description	PartNumber	Category	Page	Failure Mode	Failure	End Effect TSU1	End Effect TSU2
1	3.1	C1 SMD Multilayer Chip Ceramic Capacitor	CC0603_100NF_50V_10%_X7R	Capacitor	U_JTAG_and_Flash_2	Open	6	0.0214	No effect
2	3.1	C1 SMD Multilayer Chip Ceramic Capacitor	CC0603_100NF_50V_10%_X7R	Capacitor	U_JTAG_and_Flash_2	Parameter change	61	0.218	No effect
3	3.1	C1 SMD Multilayer Chip Ceramic Capacitor	CC0603_100NF_50V_10%_X7R	Capacitor	U_JTAG_and_Flash_2	Short	30	0.0214	No effect
4	7.2	C10 SMD Multilayer Chip Ceramic Capacitor	CC0603_4.7UF_16V_10%_X5R	Capacitor	U_DDR_4	Open	6	0.0678	No effect
5	7.2	C10 SMD Multilayer Chip Ceramic Capacitor	CC0603_4.7UF_16V_10%_X5R	Capacitor	U_DDR_4	Parameter change	61	0.6891	Async beam dump
6	7.2	C10 SMD Multilayer Chip Ceramic Capacitor	CC0603_4.7UF_16V_10%_X5R	Capacitor	U_DDR_4	Short	30	0.3389	Async beam dump
7	0.2	C100 SMD Multilayer Chip Ceramic Capacitor	CC0603_100NF_50V_10%_X7R	Capacitor	U_FPGA_0	Open	6	0.0214	No effect
8	0.2	C100 SMD Multilayer Chip Ceramic Capacitor	CC0603_100NF_50V_10%_X7R	Capacitor	U_FPGA_0	Parameter change	61	0.218	Async beam dump
9	0.2	C100 SMD Multilayer Chip Ceramic Capacitor	CC0603_100NF_50V_10%_X7R	Capacitor	U_FPGA_0	Short	30	0.1072	Async beam dump
10	5.3	C101 SMD Multilayer Chip Ceramic Capacitor	CC0603_100NF_50V_10%_X7R	Capacitor	U_TSU2TSU_B	Open	6	0.0214	No effect
11	5.3	C101 SMD Multilayer Chip Ceramic Capacitor	CC0603_100NF_50V_10%_X7R	Capacitor	U_TSU2TSU_B	Parameter change	61	0.218	Async beam dump
12	5.3	C101 SMD Multilayer Chip Ceramic Capacitor	CC0603_100NF_50V_10%_X7R	Capacitor	U_TSU2TSU_B	Short	30	0.1072	Async beam dump
13	5.4	C102 SMD Multilayer Chip Ceramic Capacitor	CC0603_100NF_50V_10%_X7R	Capacitor	U_TSU2TSU_B	Open	6	0.0214	No effect
14	5.4	C102 SMD Multilayer Chip Ceramic Capacitor	CC0603_100NF_50V_10%_X7R	Capacitor	U_TSU2TSU_B	Parameter change	61	0.218	No effect
15	5.4	C102 SMD Multilayer Chip Ceramic Capacitor	CC0603_100NF_50V_10%_X7R	Capacitor	U_TSU2TSU_B	Short	30	0.1072	Async beam dump
16	5.5	C103 SMD Multilayer Chip Ceramic Capacitor	CC0603_100NF_50V_10%_X7R	Capacitor	U_TSU2TSU_B	Open	6	0.0242	No effect
17	5.5	C103 SMD Multilayer Chip Ceramic Capacitor	CC0603_100NF_50V_10%_X7R	Capacitor	U_TSU2TSU_B	Parameter change	61	0.2457	No effect
18	5.5	C103 SMD Multilayer Chip Ceramic Capacitor	CC0603_100NF_50V_10%_X7R	Capacitor	U_TSU2TSU_B	Short	30	0.1208	Async beam dump
19	5.6	C104 SMD Multilayer Chip Ceramic Capacitor	CC0603_100NF_50V_10%_X7R	Capacitor	U_TSU2TSU_B	Open	6	0.0242	No effect
20	5.6	C104 SMD Multilayer Chip Ceramic Capacitor	CC0603_100NF_50V_10%_X7R	Capacitor	U_TSU2TSU_B	Parameter change	61	0.2457	No effect

This considers only the first order failures, components being used according to specifications and defined operating scenarios & during useful life.

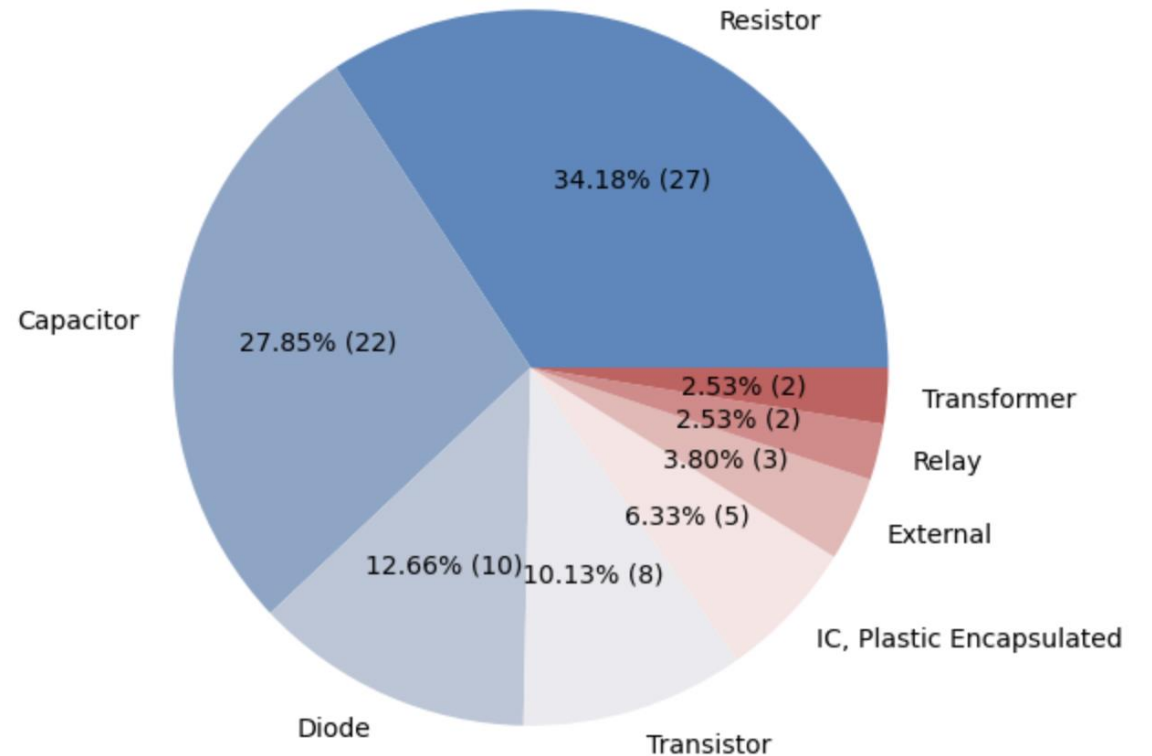
# General statistics

- Initial prediction of 891 FITS\*
- Only two design pages:
  - Input, Driving and Feedback – 471 FITS
  - Powering – 420 FITS
- Total of 80 components
  - 62% are resistors and capacitors
  - 22% diodes, transistors
  - 5 ICs, 2 relays and 2 transformers
  - 3 uncategorized components
    - Fuse – 20 FITS each

\* FITS – number of failures in  $10^9$  hours.

## Number of components in categories

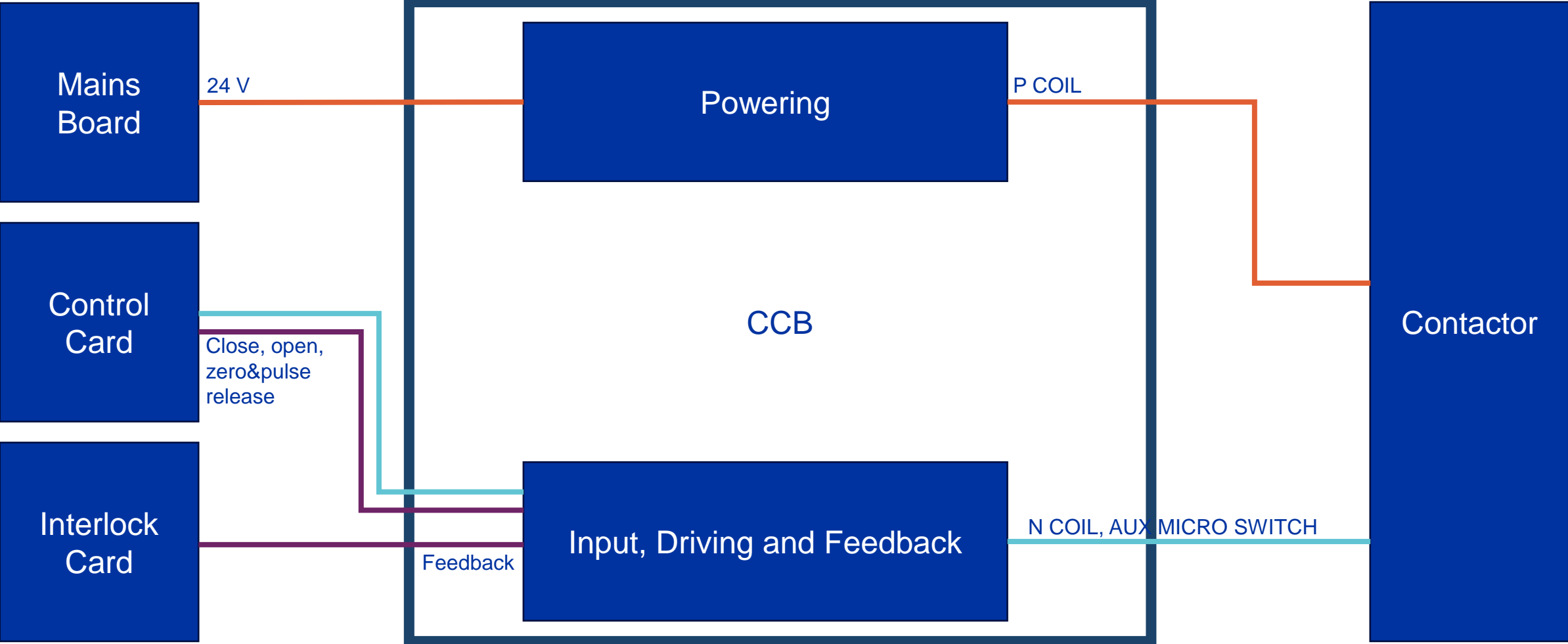
Total number of components: 79



# Mission profile & other assumptions

- **Operating temperature: 35°C.**
- **Non-operating temperature: 25°C.**
- **Default component parameters:**
  - Year of manufacture: 2020
  - Ambient case rise (where applicable): 10°C.
  - Duty cycle: 1 (i.e., always on).
  - Cycling rate 2 (i.e., two power cycles in a year).
- **Relative humidity: 0.5**
- Parts assumed to be used within their ratings, no modifications made to quality and process factors (217Plus standard assumed).

# Functional Context



# Special components

- Miniature High Capacity Relays, SPST – 80 FITS
- Gate Driver – Transistor?
- NPN/PNP General Purpose transistors vs OptiMOS Power MOSFET and PNP Complementary Silicon Power Transistor
- Two analog optocouplers
- Power Metal Strip, High Power
- Professional MELF Resistor
- Aluminium Electrolytic Capacitor, High Reliability for Switching Power Supplies
- Encapsulated Transformer and Moulded Transformer

# Other problems

- **How many instances of the CCB will be deployed? What is the criticality of a single contactor not opening?**
  - There seems to be three contactor relays in series – can it be considered triple redundancy?
- **End-effects assignment**



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# Other problems

- **Galvanic isolation:**
  - matters of insulation degradation, thermal stress and other environmental factors,
  - mitigation: through design (creepage, clearance, layout), materials, inspections; also conformal coatings, sealing
    - [How to Meet the Higher Isolation Creepage & Clearance Needs in Automotive Applications](#)
- **How many instances of the CCB will be deployed? What is the criticality of a single contactor not opening?**
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- **End-effects assignment**