More.

Turn That Great Design
into a Powerful Solution

DEUBLIN®

Slip Rings
Electrical Theory & Testing

Electrical Theory / Diagrams - EMI
Final Tests – Product validation

Giorgio Balugani
Mainz, 24 & 25 January 2018

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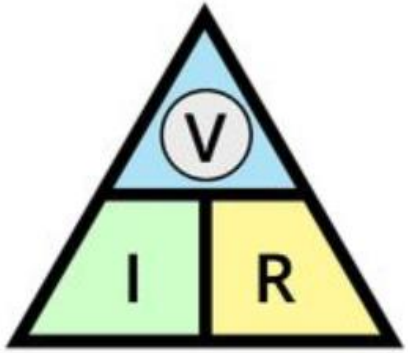
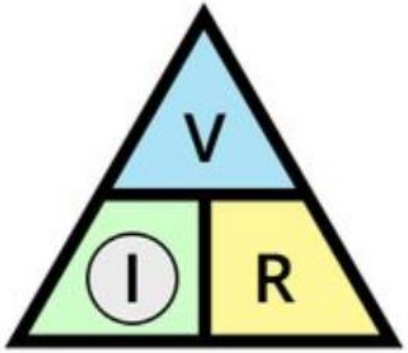
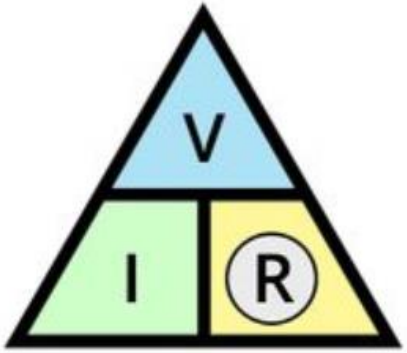
Electrical Theory: Ohm's law



$$V = I \times R$$



$$I = \frac{V}{R}$$



$$R = \frac{V}{R}$$

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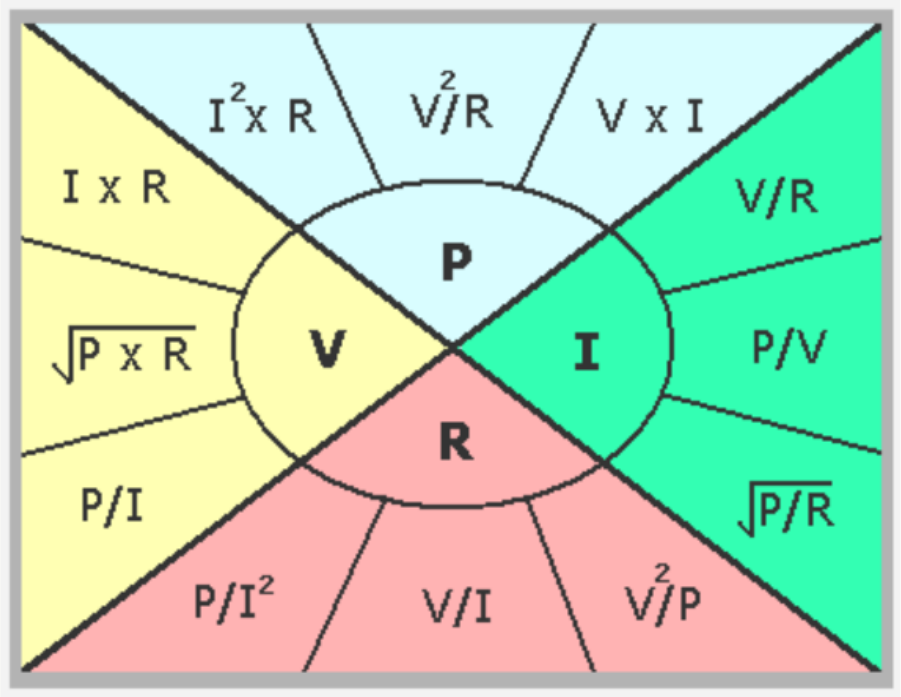
Electrical Theory: Electrical Power

$$P = I * V = \frac{V}{R} * V = \frac{V^2}{R}$$

Why power is so important?

Often, instead of current values, we know only the power value and the main voltage…

Electrical Theory: Ohm's with power



Voltage (V)

Ohm's Law: V = I x R
In terms of power: $V = \sqrt{P x R}$, V = P ÷ I

Current (I)

Ohm's Law: I = V ÷ R
In terms of power: I = P ÷ V, $I = \sqrt{P \div R}$

Resistance (R)

Ohm's Law: R = V ÷ I
In terms of power: $R = P \div I^2$, $R = V^2 \div P$

Power (P)

$P = I^2 x R$, $P = V^2 \div R$, P = V x I

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Electrical Theory: Wire size

He wire we use two ways to identify the wire size:

- AWG (American Wire Gauge)
- Square mm [mm^2]

Both are valid, nevertheless in EU we commonly use the square mm type

Just for information, the relation between both surfaces :

$$A_n = \frac{\pi}{4} d_n^2 = 0.000019635\ \text{inch}^2 \times 92^{\frac{36-n}{19.5}} = 0.012668\ \text{mm}^2 \times 92^{\frac{36-n}{19.5}} \ ,$$

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Electrical Theory: Wire insulation

AWG Number	Ø [Inch]	Ø [mm]	Ø [mm²]	Polyethylene Neoprene Polyurethane Polyvinylchloride (Semi-Rigid) 80° C	Polypropylene Polyethylene (High Density) 90° C	Polyvinylchloride PVC (Irradiated) Nylon 105° C	Kynar (135° C) Polyethylene (Crosslinked) Thermoplastic Elastomers 125° C	Kapton/Teflon PTFE Silicone 200° C
2/0 = 00	0.365	9.26	67.4		283		355	370
1/0 = 0	0.325	8.25	53.5		245		305	325
1	0.289	7.35	42.4		211		265	280
2	0.258	6.54	33.6	170	180	200	225	240
3	0.229	5.83	26.7		158			
4	0.204	5.19	21.1	125	135	145	170	180
5	0.182	4.62	16.8		118			
6	0.162	4.11	13.3	95	100	105	125	135
7	0.144	3.66	10.5		89			
8	0.128	3.26	8.36	65	70	75	90	100
9	0.114	2.91	6.63		64			
10	0.102	2.59	5.26	47	55	58	70	75

Usually we use

PVC wire insulation to have a better safety factor and higher reliability

This allows to reach

rated current values @ 105°C

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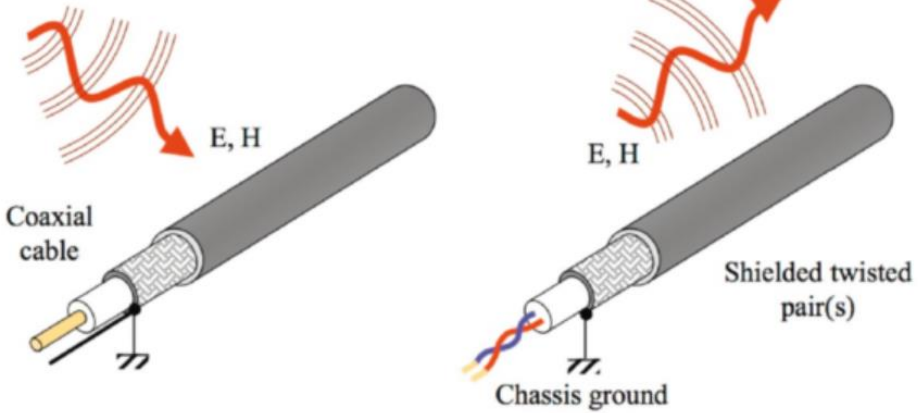
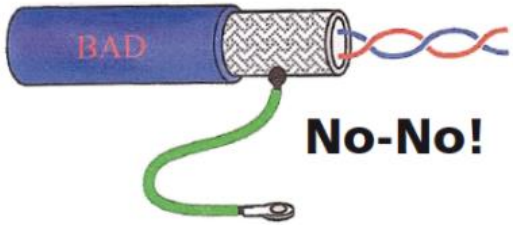
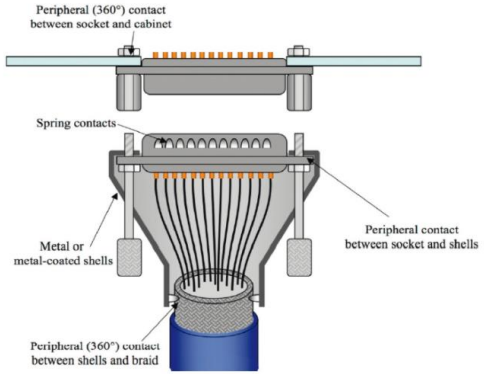
Electrical Theory: Why shielding?







Although any conductor(s) slipped in a metallic sheat can be labelled as ”shielded”, there are two basic types of shielded cables: coaxial cables and shielded pairs or multipairs. Both types reduce the interference received.

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Electrical Theory: Series Circuits

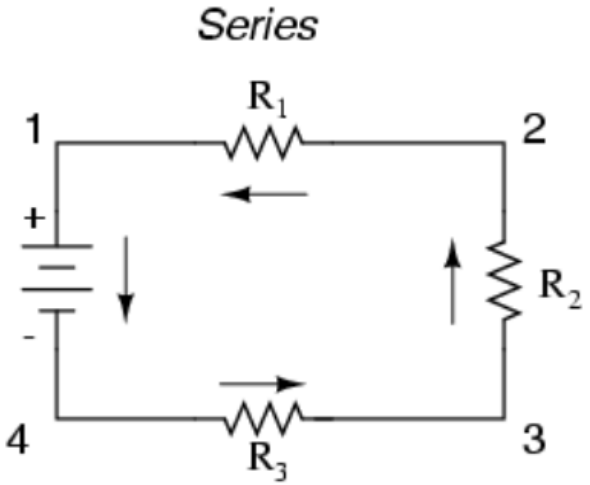
With simple series circuits, all components are connected end-to-end to form only one path for electrons to flow through the circuit:

Series Circuits:

Voltage drops add to equal total voltage.

All components share the same (equal) current.

Resistances add to equal total resistance.



$$R_{equivalent} = R_1 + R_2 + R_3 + \ldots$$

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Electrical Theory: Series Circuits

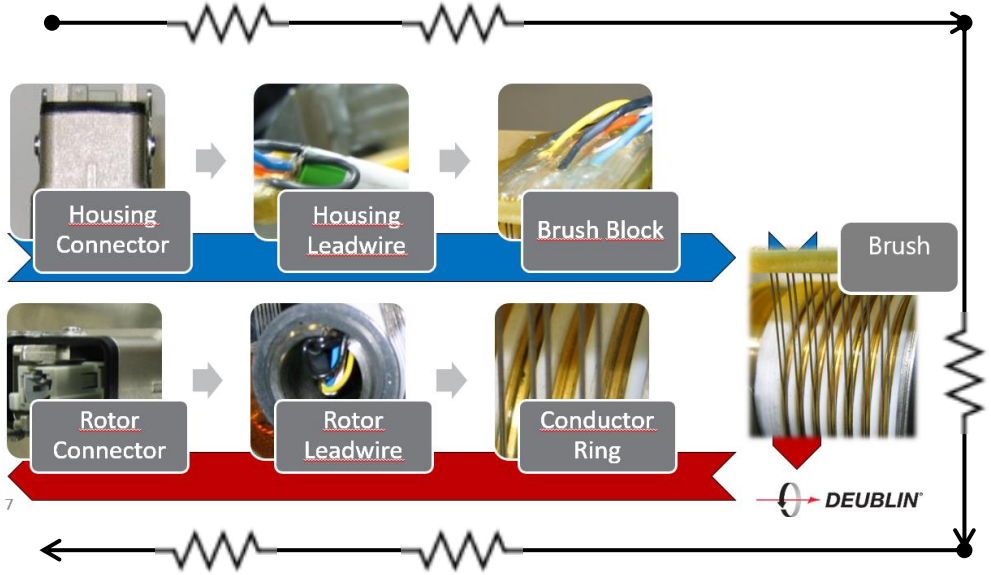
Series Circuits:

What does it means on Deublin Slip Rings?

$$R_{equivalent} = R_1 + R_2 + R_3 + \ldots$$

Slip Rings:

Each connection add a resistance across the path



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Electrical Theory: Parallel Circuits

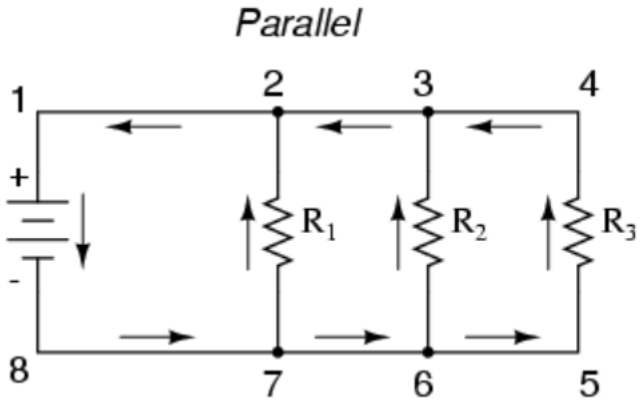
With simple parallel circuits, all components are connected between the same two sets of electrically common points, creating multiple paths for electrons to flow from one end of the battery to the other:

Parallel Circuits:

All components share the same (equal) voltage.

Branch currents add to equal total current.

Resistances diminish to equal total resistance.



$$\frac{1}{R_{equivalent}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

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Electrical Theory: Parallel Circuits

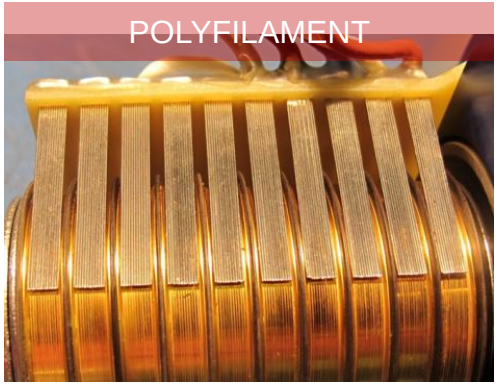
Parallel Circuits:

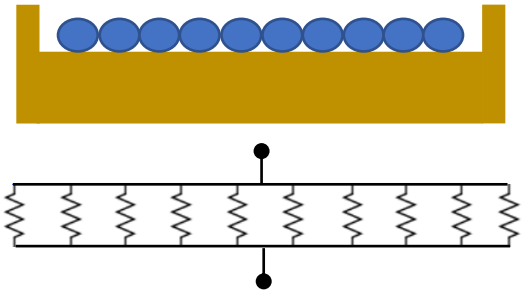
What does it means on Deublin Slip Rings?

$$\frac{1}{R_{equivalent}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

Slip Rings:

Multiple connections means lower contact resistance on conductor rings





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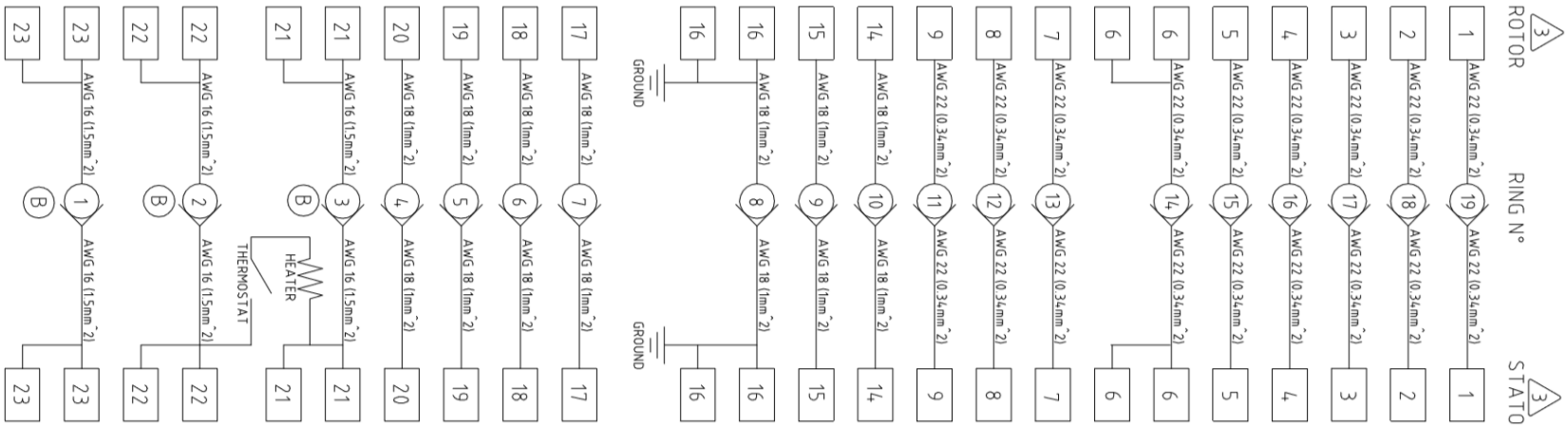
Deublin drawings: Electrical Diagram



Deublin drawings: Operating Parameters

SLIP RING OPERATING PARAMETERS							
ROTOR POSITION	STATOR POSITION	CHANNELS	MAX. VOLTAGE	CONTINUOUS CURRENT	MAX. CURRENT	MAX. TEMPERATURE	MAX. SPEED
1	1	19	30VDC	1A	-	-30° / +80° C	30 RPM
2	2	18	30VDC	1A	-		
3	3	17	30VDC	1A	-		
4	4	16	30VDC	1A	-		
5	5	15	30VDC	1A	-		
6	6	14	30VDC	1A	-		
6	6						
7	7	13	30VDC	1A	-		
8	8	12	30VDC	1A	-		
9	9	11	30VDC	1A	-		
14	14	10	290VAC	6A	9A		
15	15	9	290VAC	6A	9A		
16	16	8	GROUND	8A	9A		
16	16						
17	17	7	290VAC	6A	9A		
18	18	6	290VAC	6A	9A		
19	19	5	290VAC	4A	9A		
20	20	4	290VAC	4A	9A		
21	21	3	290VAC	8A	9A		
21	21						
22	22	2	290VAC	8A	9A		
22	22						
23	23	1	290VAC	8A	9A		
23	23						

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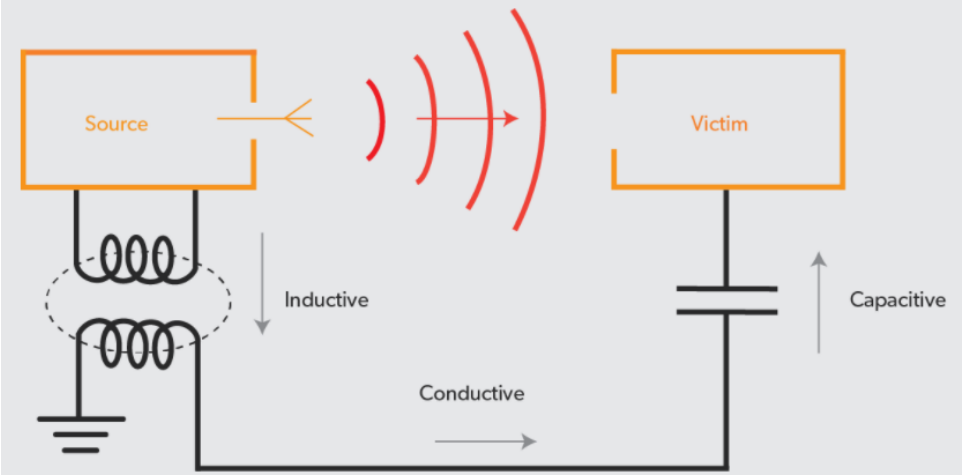
Disturbances: EMI

Electromagnetic interference is abbreviated as EMI. EMI is the disturbance which is unintentionally generated by an external source that effects the electrical circuit by electromagnetic induction, electrostatic coupling or conduction. This is a particular problem with sensitive equipment where transmission signals may be corrupted or distorted.



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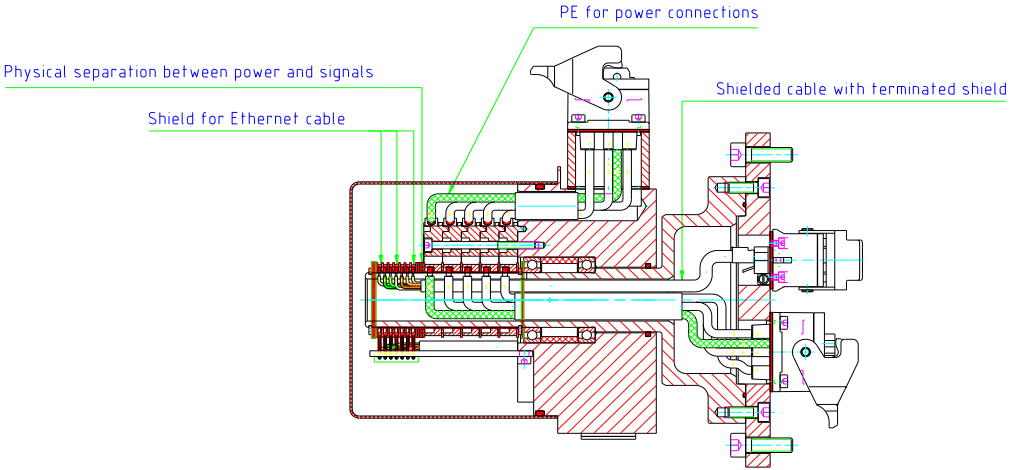
Disturbances: EMI

- Ethernet cables must be shielded and the shield terminated to ground.
- Ring and brush of the slip ring is placed to help isolate the signals from other noise (power or other signals).
- Power rings and brushes are positioned with the case ground used to separate the power channels from the signal channels.
- Physical separation is added to reduce coupling between power and signals.



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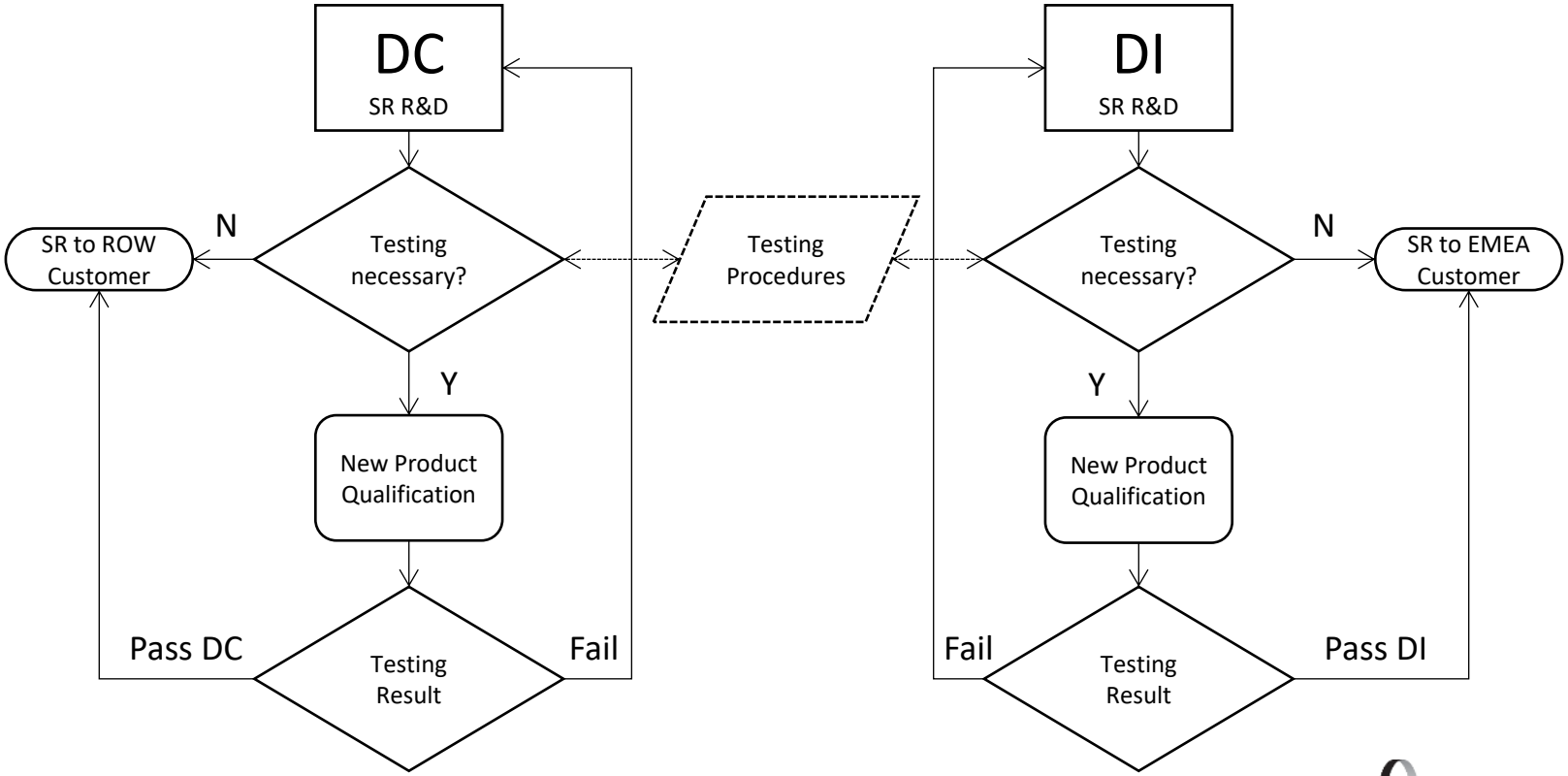
Testing: Deublin Approach



Testing: Deublin Approach

Testing: what's the difference between end of line test and evaluation testing?

End of line Test:

Those tests carried out on product out-of-production, before shipping

EvaluationTesting:

Those tests carried out on prototypes, for validation purposes, before Start Of Production (SOP)

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Testing: Deublin Facility

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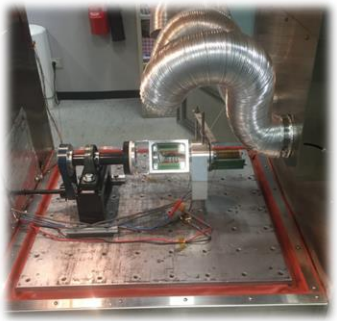
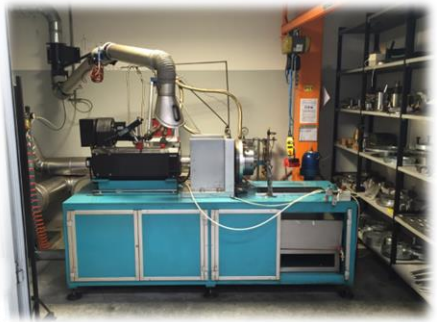
Testing: Deublin Capability

In Deublin Italiana we can manage more than 30 different tests according with operating instructions.

Example of testing capability:

- Endurance Test
- Noise Test
- Stress check with strain gauges
- Current, voltage, resistance check
- Vibration
- HALT (Higly Accelerated Life Test)



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Thank You!

Questions?

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