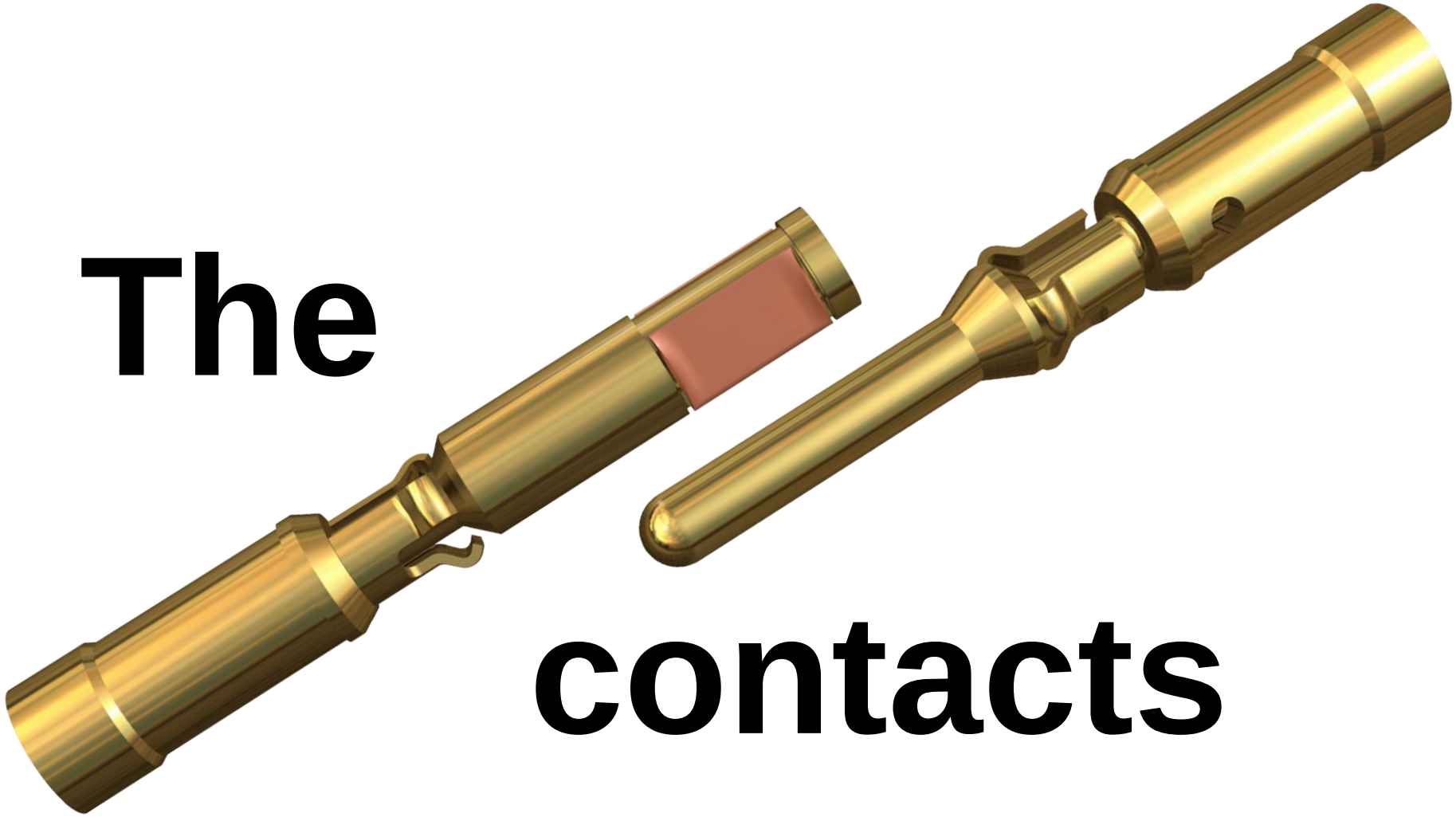
Positronic®

THE SCIENCE OF CERTAINTY

Efficiency considerations in Power Connectors for Space-Flight applications

WHAT DEFINES THE EFFICIENCY OF AN ELECTRICAL CONNECTOR?

The contacts



Range of resistance values of electrical contacts

contact size	Spec Values Typical mΩ	Low mΩ	Ultra-Low mΩ
22	5	3	1.5
20	5	3	1
16	3	1.6	0.7
12	2	1	0.4
8	1	0.6	0.35

Power loss at contact interface = $I^2 R$

a direct function of contact resistance

What technical elements could be optimized in order to obtain an ULTRA-LOW Resistance electrical contact?

1. Utilize high conductivity materials
2. Increase the electrical contact surface area
3. Optimize the force between the areas in contact

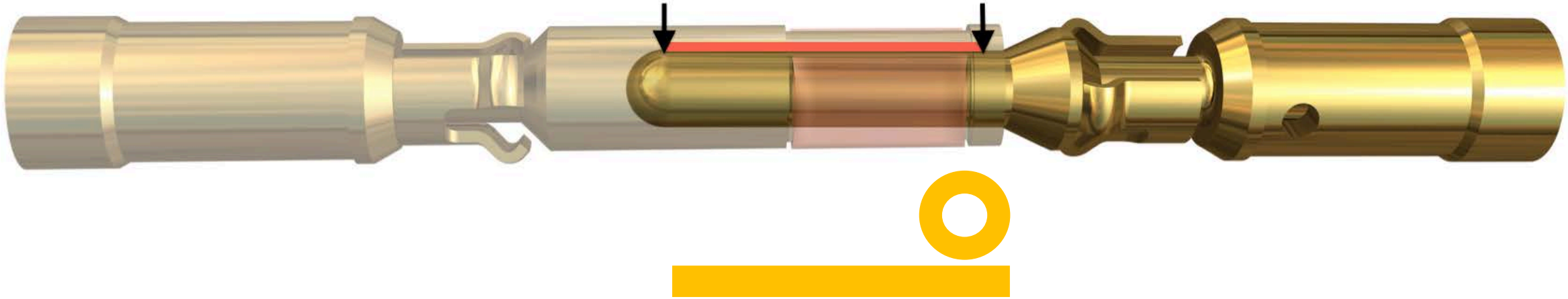
1 Utilize high conductivity materials

International Annealed Copper Standard

Material by Copper Alloy number	Conductivity (%IACS)	Description
pure Copper C10400, C10500	100.0	pure copper in various conditions generally not used for contact manufacturing
C14300	96.00	high copper content alloy generally not used for contact manufacturing
C14700-O61	95.00	high copper content alloy generally not used for contact manufacturing
C14* **	93.00	high copper content alloy possible to use for contacts manufacturing with difficult machinability
1.25% Phos. Bronze	48.00	commonly used in manufacturing Mil/EN3155 grade female contacts
Bronze-commercial leaded	42.00	commonly used in manufacturing Mil/EN3155 grade female contacts
Brass	18.00 to 37.00	commonly used in manufacturing Mil/EN3155 grade male contacts
Beryllium Copper	17.00 to 21.00	very commonly used in manufacturing stamped and formed contacts

2 Increase the electrical contact surface area

PosiBand = External Pressure Element
FULLY SEPARATES MECHANICAL ACTION FROM ELECTRICAL ACTION

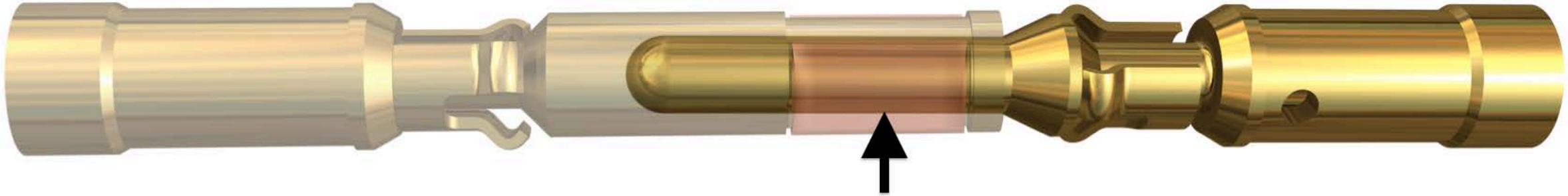


Wipe line is longer than the inner perimeter of the female contact face

3 Optimize the force between the areas in contact

PosiBand = External Pressure Element

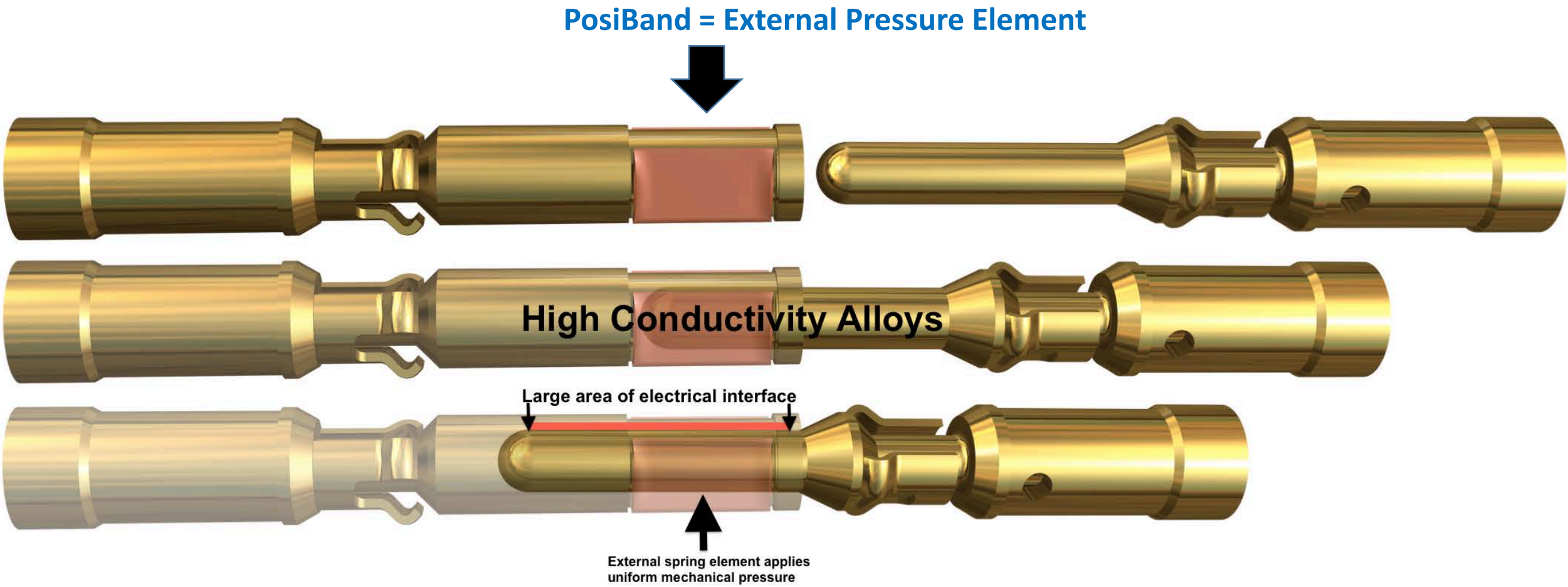
FULLY SEPARATES MECHANICAL ACTION FROM ELECTRICAL ACTION



Optimized interface normal force

THE SCIENCE
OF **CERTAINTY**

Anatomy of the Ultra-Low Resistance contact



Comparing efficiency impact between: typical, low and ultra-low, interface resistance on size 12 power contacts

contact size	Typical mΩ	Low mΩ	Ultra-Low mΩ
22	5	3	1.5
20	5	3	1
16	3	1.6	0.7
12	2	1	0.4
8	1	0.6	0.35

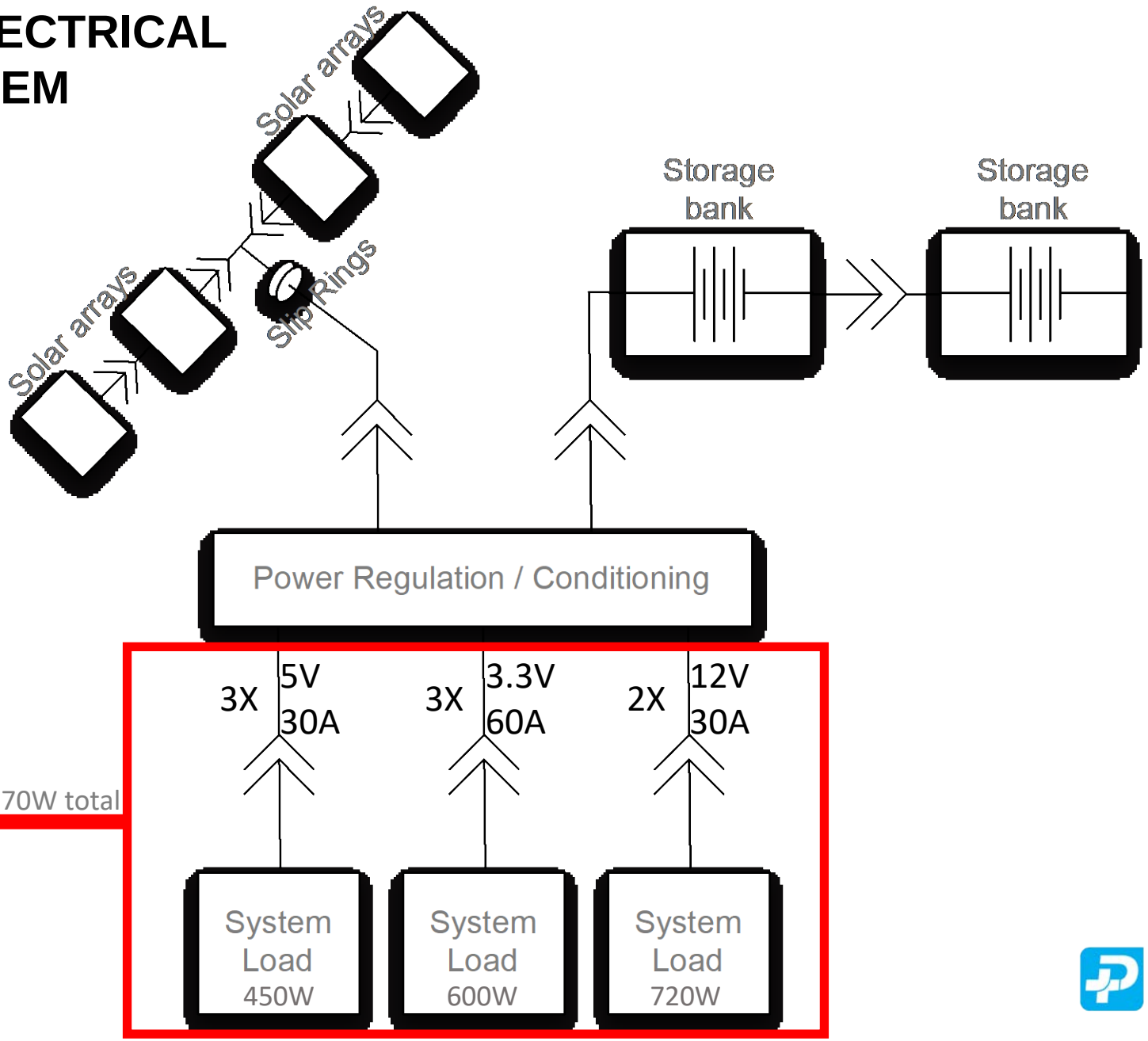
Power loss at contact interface = I^2R

THE SCIENCE OF **CERTAINTY**

SIMPLIFIED DIAGRAM OF ELECTRICAL POWER DISTRIBUTION SYSTEM IN A TELECOM SATELLITE

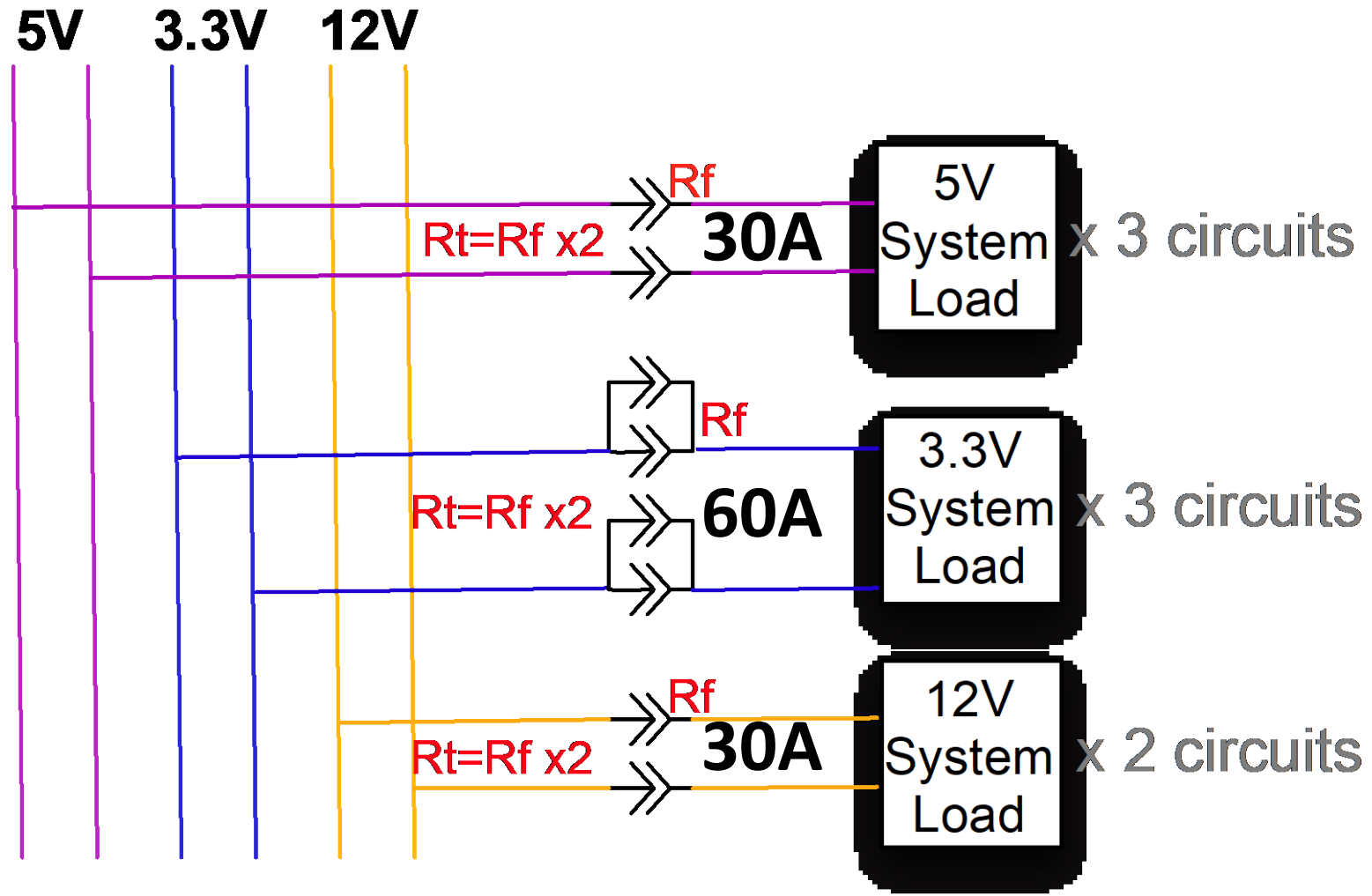
Application example:

- System Power Rating = 3200W
- **60 Amps** on 50V bus (all systems)
- **30 Amps** to **60Amps** on Multiple System Loads



THE SCIENCE OF **CERTAINTY**

1770W TOTAL SYSTEM LOADS - EQUIVALENT CIRCUIT DIAGRAM:



POWER LOSS COMPARISON TABLE:

CIRCUIT	Rf	Rt	Circuit Current	Instant P loss	Nr. of circuits	POWER LOSS	
5V	2mΩ	4mΩ	30A	3.6W	3	10.8W	**Spec/Max allowable resistance**
3.3V	1mΩ	2mΩ	60A	7.2W	3	21.6W	
12V	2mΩ	4mΩ	30A	3.6W	2	7.2W	
TOTAL INSTANT POWER LOSS						**39.6W**	
5V	1mΩ	2mΩ	30A	1.8W	3	5.4W	**Low contact resistance**
3.3V	0.5mΩ	1mΩ	60A	3.6W	3	10.8W	
12V	1mΩ	2mΩ	30A	1.8W	2	3.6W	
TOTAL INSTANT POWER LOSS						**19.8W**	
5V	0.4mΩ	0.8mΩ	30A	0.72W	3	2.16W	**Ultra-low contact resistance**
3.3V	0.2mΩ	0.4mΩ	60A	1.44W	3	4.32W	
12V	0.4mΩ	0.8mΩ	30A	0.72W	2	1.44W	
TOTAL INSTANT POWER LOSS						**7.92W**	

POWER LOSS IN TIME:

CIRCUIT	DURATION OF TIME FOR 1kWhr LOSS	LOSS IN 1 MONTH OPERATION	LOSS IN 1 YEAR OPERATION	LOSS IN LIFETIME OPERATION (avg 6.5 yrs)
Typical R CONTACTS	25 hours	28.5 kWhrs	347 kWhrs	2.3 MWhrs
LOW R CONTACTS	50 hours	14.2 kWhrs	173 kWhrs	1.1 MWhrs
ULTRA-LOW R CONTACTS	126 hours	5.7 kWhrs	69 kWhrs	448 kWhrs

FACT:

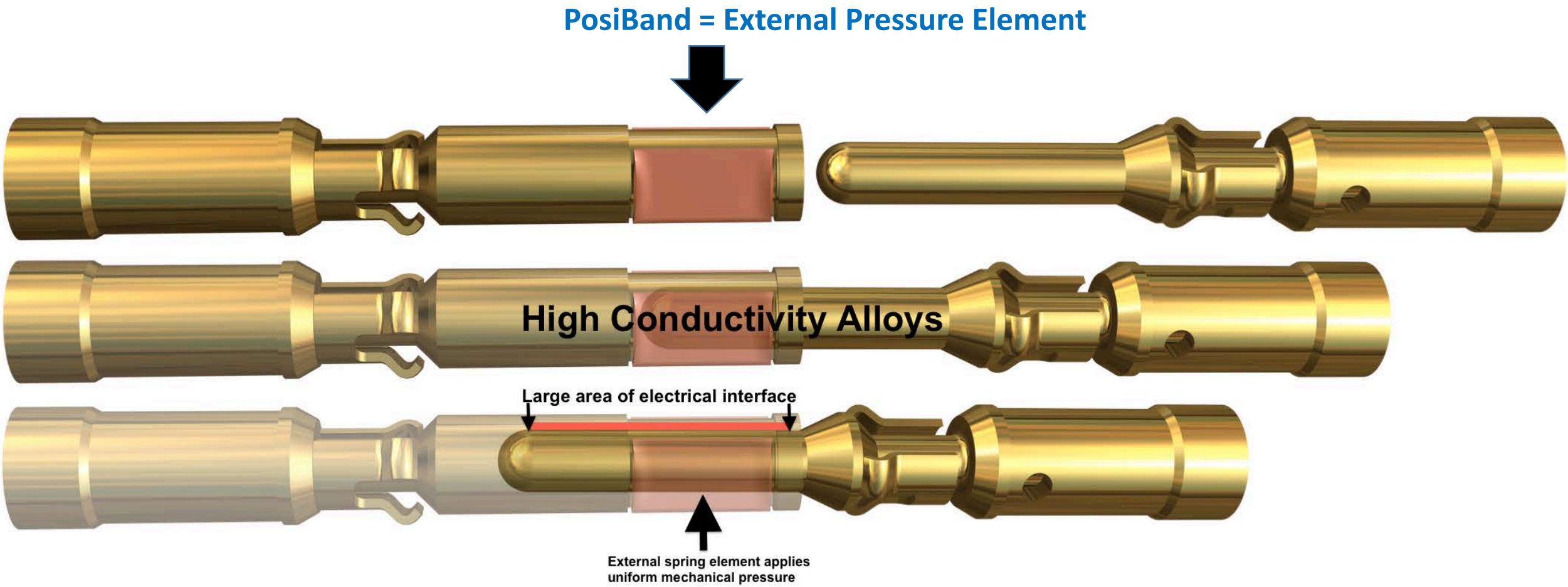
The Power System set is the heaviest equipment component in any satellite!

Increasing efficiency in every single component allows proportional decrease of system ratings which results in reducing the overall weight of the system.

REMEMBER:

ULTRA-LOW RESISTANCE POWER CONTACTS HELP MAXIMIZE EFFICIENCY IN A POWER DISTRIBUTION SYSTEM

— Anatomy of the Ultra-Low Resistance contact



THE SCIENCE
OF **CERTAINTY**

Positronic®

THE SCIENCE OF CERTAINTY

THANK YOU