The products described herein have not been fully tested to ensure conformance to the requirements below. Tyco Electronics makes no representation or warranty, express or implied, that the products will comply with these requirements. Further, Tyco Electronics may change these requirements, based on the results of additional testing and evaluation. Contact Tyco Electronics engineering for further details.

1. SCOPE

1.1. Content

This document covers the performances, tests and quality requirements of a family of modular rectangular connectors designed for aerospace applications. This product line meets dimensional and general requirements of connectors series 2 per EN 4165. This family of connectors offers the following features:

1.1.1 Contacts

The applicable contacts (signal, power, coaxial…) are per EN 3155-002. They are derived from contacts per MIL-C39029 and are inter-mateable with them.

1.1.2 Shell housings:

There are two housing shell sizes (accepting 2 or 4 modules respectively), stackable, aluminum alloy, black nickel plated (class F)
Versions with grounding fingers enhancing the shell to shell continuity are available. The coupling system is a central screw, with a spring loaded mechanism preventing screw loosening under vibrations. In fully mated position, a shell to shell bottoming between plug and receptacle is provided.
The plug contains the coupling screw and the receptacle the coupling nut.
A central keying mechanism offers 36 polarization options.
The connector mating sequence is as follows:

- Face to face positioning
- Keyways polarization guide
- Central thread coupling
- Grounding-shielding continuity
- Electrical contact
- Sealed interface compression
- Metal to metal shell bottoming

1.1.3 Modules:

The modules accept crimp or PCB solder contacts, sizes 22, 20, 16, and 12, possibly mixed, depending on the particular arrangements. The female modules accept female contacts. The male modules accept male contacts.
Male or female modules can be mixed in plug or receptacle housings. The modules are rear mounted in the shell housings. Four polarizing options are available (coded A,B,C,D) as well as one universal module (coded N) , mountable in any shell housing cavity.

1.2. Materials and construction:

- Contacts: High performance-high conductivity copper alloy, gold plated over nickel
- Plug and receptacle shells (metallic version): aluminium alloy, nickel plated, black.
- RFI fingers: beryllium copper, nickel plated over copper (on selected versions only)
- EMI gasket: conductive fluoro-silicone elastomer.
- Hardware: Stainless steel, passivated or beryllium copper, nickel plated.
- Modules: Glass-filled PEI UL94V0, per ATS 1000 001 AND FAA 1988 requirements.
- All seals and grommets: fluoro-silicone elastomer.

2. QUALIFICATION

When test are performed on subject product line, procedures specified in EN 4165 series specifications shall be used. All inspections shall be performed using applicable inspection plan and product drawing.

3. APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent specified herein.
Unless otherwise specified, the latest edition of the document is applicable.

3.1 Standard documents :

prEN4165-001 2008-09 Aerospace series. Connectors, electrical, rectangular, modular – Operating temperature 175 °C continuous – Part 001: Technical specification.

EN 4165-002, Aerospace series. Connectors, electrical, rectangular, modular – Operating temperature 175 °C continuous – Part 002: Specification of performance and contact arrangements.

EN 4165-020, Aerospace series. Connectors, electrical, rectangular, modular – Operating temperature 175 °C continuous – Part 020: Coupling system keyway for receptacle.

EN 2591, Aerospace series. Elements of electrical and optical connection – Test methods.

EN 3155-002, Aerospace series. Electrical contacts used in elements of connection – Part 002: List and utilization of contacts·

EN 3197, Aerospace series. Installation of aircraft electrical and optical interconnection systems.

EN 2424, Aerospace series. Marking of aerospace products.

MIL-C-39029/56 Contacts, electrical connector, socket, crimp removable (For MIL-24038, MIL-C- 38999, SERIES I, II, III, and IV connector)
MIL-C-39029/58 Contacts, electrical connector, pin, crimp removable (For MIL-24038, MIL-C 38999, SERIES I, II, III, and IV, and MIL-C-55302/69 and MIL-C-83733 connectors)

3.2 Tyco Electronics documents:

3.2.1. Application specification: 114-15111

3.2.2. Drawings:

Receptacle, stackable, 2 cavity, series 2:	1577885
Receptacle, stackable, 4 cavity, series 2:	1577883
Key, receptacle :	1577941
Plug, grounding, 2 cavities, series 2:	1577924
Plug, grounding, 4 cavities, series 2:	1577927
Plug, 2 cavities, series 2:	1577942
Plug, 4 cavities, series 2:	1577943
Key plug:	1577910
Modules 20-22 (20 contacts # 22):	1577698, 1577699, 1577851, 1577852
Modules 12-20 (12 contacts # 20):	1577853, 1577854, 1577132, 1577133
Modules 08-16 (8 contacts # 16):	1577725, 1577726, 1577859, 1577860
Modules 04-12 (4 contacts # 12):	1577732, 1577733, 1577857, 1577858
Modules 99-01 (6#16 contacts+5#22 contacts):	1577849, 1577850, 1577855, 1577856

4. REQUIREMENTS

Operating temperature range:

Minimum temperature: -55C
Maximum temperature: +175°C continuous (contact de-rating applicable)

4.1. PERFORMANCES-ELECTRICAL

4.1.1. Contact resistance:

4.1.1.1 Low level (Ambient temperature)

Wire size	Max. initial (mΩ)	Max. after tests (mΩ)
16	5	6
20	9	11
22	15	17
24	20	23
26	31	38

4.1.1.2. Rated current (Ambient temperature)

Contact size		Size of conductors standard cables		Outer diameter of cables (mm)		Current per contact (A)
Contact	Barrel	Aecma code	AWG	min.	Max.	
22	22	004	22	0,71	1,37	5
		002	24			3
		001	26			2
20	20	006	20	0,85	2,11	7,5
		004	22			5
		002	24			3
20	18	010	18	0,85	2,11	7,5
		006	20			7,5
		004	22			5
		002	24			3
16	16	012	16	1,31	2,62	13
		010	18			10
		006	20			7,5
16	14	020	16	1,63	2,62	13
		012	18			10
		010	20			7,5
12	12	030	12	1,90	3,70	23
		020	14			13

4.1.2. Electrical continuity at microvolt level:
Applicable to coaxial contacts only

4.1.3. Housing shell electrical continuity:
1 m Ω max. initial
2 m Ω after test

4.1.4. Insulation resistance:
5000 MΩ min. (ambient temperature- unmated connectors)
1000 MΩ min.(after tests - mated connectors)
100 MΩ min. after 1000 h at 175°C

4.1.5. Voltage proof:
Sea level: 1 500 V rms (1300V for contact size 22) mated and un-mated
Altitude 30 000 m (1,1 KPa): 1000 V rms (mated)

4.1.6. Electrical overload:

Contact size	Current (A)	Duration (s)
22	10	40
	50	0,6
20	15	40
	75	0,6
16	26	40
	130	0,6
12	46	40
	230	0,6

4.1.7. Surface transfer impedance (max)

1 Kz	1Mhz	10Mhz	100Mhz
5 mΩ	10 mΩ	20 mΩ	150 mΩ

4.1.8. Shielding effectiveness:
Attenuation: 50 db min. @ 100 Mhz - 30 db min. @ 1 Ghz (metal shells)

4.1.9. Lightning strike, current and voltage pulse:
10 KA - 1600V, 10 pulses, waveform 1

4.1.10. Discontinuity of contact in the microsecond range:
Standard contacts: 1 µs Max.
Coax contacts: 100 ns Max.

4.2 PERFORMANCES (MECHANICAL)

4.2.1. Mechanical endurance:
Plug / Receptacle: 500 mating and un-mating operations
5 cycles per Minute

4.2.2. Shock:
Method A - Severity 100- One shock each way for each direction (total 6 shocks)

4.2.3. Sinusoidal and random vibrations:
Method A
5Hz to 3 kHz- 20 g-1 octave per minute :4 hours per axis.
Method B Level E figure 2 and table 1: 1 h per axis

4.2.4. Transverse load: (external bending moment)
50 Nm (2 and 4 cavity housings)

4.2.5. Durability of contact retention system and seals: (maintenance aging)
10 cycles of contact insertion-removal

4.2.6. Mating and un-mating forces:

Housing size	Coupling torque (N.m)	Un-coupling torque (N.m)		Over-tightening torque (N.m)
		Min.	Max.	
2 modules	1,1	0,77	1,7	3
4 modules	1,3	0,91	2,2	3

Housing size	Min. rotation torque (un-coupling) (N.m)
2 modules	0,01
4 modules	0,01

4.2.7. Contact retention in insert:
Preload : 1 daN

Contact size	Axial load (N)
22	44
20	67
16	110
12	110
08	110

0,3 mm displacement Max. during and after application of load.

4.2.8. Insert retention in housing:
254 N load applied to front face of module-No contact mounted.
0,2 mm Max. displacement during and after application of load

4.2.9 Contact insertion and extraction forces:

Contact size	Maximum force (N)	
	Insertion	Extraction
22	68	45
20	68	45
16	68	45
12	68	45

4.2.10. Holding force of grounding spring system:

Housing size	Axial Force (N) Black nickel finish	
	Min.	Max.
2 cavity	5	10
4 cavity	10	20

4.2.11. Stability of male contacts in insert:

Contact size	Applied Force (N)	Max. deflection permitted (mm)
22	12	0,76
20	24	1,37
16	49	1,91
12	49	1,91

4.2.12. Mechanical strength of rear accessories:
100 N

4.2.13. Use of application tools:
Force to be applied on tool: 13 N Max.

4.2.14. Magnetic permeability:
< 2

4.4 PERFORMANCES-ENVIRONMENTAL
4.4.1. Endurance at temperature:
175 °C - 1000 h under load

4.4.2. Climatic sequence:
Connectors mated
Min. temperature: -55°C
Max. temperature: +175°C

4.4.3. Cold/low pressure and damp heat:
5 cycles - Minimum temperature (-55°C +-2°C)

4.4.4. Rapid change of temperature:
-55°C +175°C (Connectors mated)

4.4.5. Mould growth:
28 days

4.4.6 Salt mist:

96H (Black nickel plated metal shell housings) as follows:
50 cycles mating and un-mating: - rate five cycles/min.
96 h of exposure to the salt mist: (mated condition)
200 cycles mating and un-mating - rate ≤ five cycles/min.

4.4.7. Sand and dust:
Wind velocity: 3,5 m/s

4.4.8. Air leakage:
Applicable only to modules with a peripheral seal

4.4.9. Immersion at low air pressure:
1,1 kPa

4.4.10. Fluid resistance: see table below

Fluid		Immersion		Stoving Temp. °C	Number of cycles
Category	References per EN 3909	Duration Min.	Temp. °C		
Fuel	2	5	$+2_{0}$	25	85	7
Mineral hydraulic fluid	5	15	$+5_{0}$	85	100	5
Synthetic hydraulic fluid	3	15	$+5_{0}$	85	100	5
Mineral lubricant	7	15	$+5_{0}$	120	125	5
Synthetic lubricant	9	15	$+5_{0}$	150	125	5
Cleaning products	11	15	$+5_{0}$	25	25	5
	12					5
	13	5	$+2_{0}$			2
De-icing fluid	15	15	$+5_{0}$	50	100	5
Extinguishing fluid	17	15	$+5_{0}$	15	25	5
Cooling fluid	19	15	$+5_{0}$	50	25	5

4.4.11. Flammability:
Connectors mated - 30 seconds-Flame temperature 955°C.

5. TEST REQUIREMENTS AND PROCEDURE

5.1. Samples required for qualification
The test samples shall be randomly taken from production batches.
The minimum amount of samples required for qualification shall be per table 1.

Note: The test EN2591-306 in not part of a group, and shall be performed on the materials used or components made from each material used. If the materials used comply with group 1 of MIL-HDBK-454A, requirement 4, the test EN2591-306 shall not be performed.

5.1.1. Wires
The cables used shall be per EN 2267-002. The wire length shall be adapted to the test.

5.1.2 Accessories
For group 6, the following accessories shall be used:

- Shielded plug accessories EN4165-F14P2 with round chimneys per EN4165F15

- Shielded plug accessories EN4165-F14P4 with round chimneys per EN4165F15

- Shielded receptacle accessories EN4165-F14R2 with round chimneys per EN4165F15

- Shielded plug accessories EN4165-F14R4 with round chimneys per EN4165F15

For the other groups, cable clamps EN4165F13A2 and EN4165F13A2 shall be used when applicable.

5.2. Preparation of samples
One half of the modules of a group shall be wired with wires whose gauge shall be the minimum gauge accepted by the contact, and the other half with wires of the maximum gauge accepted by the contact, except for test 314, where min and max wires shall be uniformly distributed in the modules.

5.3 Qualification test groups
The tests shall be organized in groups per table 2.

5.4 Test details and requirements
The tests shall be carried out per table 3.

6. RE-QUALIFICATION
Periodicicity: 3 years per EN4165-001

The requalification shall be implemented per table 4.

TABLE 1
Sampling and definition of test specimen

Test group Nr	Minimum number of complete specimens (receptacle, plug and accessories if necessary)	
	Shells with 2 modules	Shells with 4 modules
0	One complete untested specimen of each shell size , from groups 1 to 6	
1	1	1
2	1	1
3	1 per fluid	
4	1	1
5	1	1
6	1 without module	1 without module
7	1	1

TABLE 2 Qualification test groups

Designation of the test	EN 2591-	Remarks
Group 0		
Visual examination	101	
Examination of dimensions and mass	102	
Magnetic permeability	513	
Mating and un-mating forces	408	
Insert retention in housing (axial)	410	
Measurement of insulation resistance	206	
Voltage proof test	207	Normal air pressure
Visual examination	101	
Group 1		
Measurement of insulation resistance	206	
Voltage proof test	207	Normal air pressure
Housing (shell) electrical continuity	205	
Salt mist	307	96 h
Visual examination	101	
Measurement of insulation resistance	206	
Voltage proof test	207	Normal air pressure
Housing (shell) electrical continuity	205	
Mating and un-mating forces	408	
Visual examination	101	
Group 2		
Housing (shell) electrical continuity	205	
Shock	402	
Sinusoidal and random vibration	403	Ambient temperature
Cold/low pressure and damp heat	303	
Contact resistance at rated current	202	
Measurement of insulation resistance	206	
Voltage proof test	207	Normal air pressure
Mechanical strength of rear accessories	420	Applicable for qualification of rear accessories
Mating and un-mating forces	408	
Visual examination	101	
Group 3		
Contact retention in insert	409	
Fluid resistance	315	
Housing (shell) electrical continuity	205	
Measurement of insulation resistance	206	Ambient temperature
Mating and un-mating forces	408	
Contact retention in insert	409	
Insert retention in housing (axial) 410	410	
Visual examination	101	

TABLE 2 (Continued) Qualification test groups

Designation of the test	EN 2591-	Remarks
Group 4		
Electrical overload	210	After test, crimp contacts shall be replaced
Measurement of insulation resistance	206	Ambient temperature
Voltage proof test	207	After test
Contact resistance - Low level	201	
Contact resistance at rated current	202	
Endurance at temperature	301	
Contact resistance - Low level	201	
Visual examination	101	
Flammability	317	
Visual examination	101	
Group 5		
Contact insertion and extraction forces	412	
Durability of contact retention system and seals (Maintenance ageing)	407	
Contact retention in insert	409	
Rapid change of temperature	305	
Mating and unmating forces	408	
Measurement of insulation resistance	206	Ambient temperature
Voltage proof test	207	
Immersion at low air pressure	314	
Interfacial sealing	324	
Insert retention in housing (axial)	410	
Visual examination	101	
Group 6		
Holding force of grounding spring system	413	
Mechanical endurance	406	
Housing (shell) electrical continuity	205	
Shielding effectiveness	IEC 61526	From 100 MHz to 1 GHz
Surface transfer impedance	212	From 1 KHz to 100 MHz
Lighting strike, current and voltage pulse	214	
Mating and unmating forces	408	
Housing (shell) electrical continuity	205	
Visual examination	101	

TABLE 2 (Continued) Qualification test groups

Designation of the test	EN 2591-	Remarks
Group 7		
Stability of male contacts in insert	419	Test a minimum of 3 contacts per size
Visual examination	101	Visual examination

TABLE 3 Qualification tests

<table>
<tr><th>EN 2591-</th><th>Designation of the test</th><th>Details</th></tr>
<tr><td>101</td><td>Visual examination</td><td>Initial examination; examination of connectors, housing, module loose parts (contacts, etc.)
Details to be examined: identification, appearance, markings, surface finish. Final examination: no loosening of parts, crack, excessive wear or detached part shall be observed.</td></tr>
<tr><td>102</td><td>Examination of dimensions and mass</td><td>Dimensions and mass specified in EN4165 series. The use of metrology reports supplied by the quality organization is acceptable.</td></tr>
<tr><td>201</td><td>Contact resistance - Low level</td><td>Test applicable to contact defined by the standards for contacts specified in EN 4165-002.
<table>
<tr><th>Number N of contacts of the same size per mated pair</th><th>Minimum percentage to measure</th></tr>
<tr><td>N <= 5</td><td>100%</td></tr>
<tr><td>5<N<= 60</td><td>50%</td></tr>
<tr><td>60<N<= 130</td><td>25%</td></tr>
<tr><td>N>130</td><td>10%</td></tr>
</table>
<table>
<tr><th>Contact size</th><th>Max contact resistance - initial (mΩ)</th><th>Max contact resistance after tests (mΩ)</th></tr>
<tr><td>22</td><td>8</td><td>11</td></tr>
<tr><td>20</td><td>5</td><td>7</td></tr>
</table></td></tr>
<tr><td>202</td><td>Contact resistance at rated current</td><td>Test applicable to contact defined by the standards for contacts specified in EN 4165-002.
<table>
<tr><th>Number N of contacts of the same size per mated pair</th><th>Minimum percentage to measure</th></tr>
<tr><td>N <= 5</td><td>100%</td></tr>
<tr><td>5<N<= 60</td><td>50%</td></tr>
<tr><td>60<N<= 130</td><td>25%</td></tr>
<tr><td>N>130</td><td>10%</td></tr>
</table>
<table>
<tr><th>Contact size</th><th>Current (A)</th><th>Max contact resistance initial (mΩ)</th><th>Max contact resistance after tests (mΩ)</th></tr>
<tr><td>22</td><td>5</td><td>8</td><td>11</td></tr>
<tr><td>20</td><td>7,5</td><td>5</td><td>7</td></tr>
<tr><td>16</td><td>13</td><td>3</td><td>5</td></tr>
<tr><td>12</td><td>23</td><td>2</td><td>3</td></tr>
</table></td></tr>
</table>

TABLE 3 (Continued) Qualification tests

<table>
<tr><th>EN 2591-</th><th>Designation of the test</th><th>Details</th></tr>
<tr><td>204</td><td>Discontinuity of contacts in the microsecond range</td><td>Duration of micro-discontinuity:
Standard contacts: : 1 µs

Method B Test time: throughout the duration of tests EN 2591 -402, EN 2591 -403 and EN 2591-301, method B
The minimum numbers of contacts to measure shall be per table below.

<table>
<tr><th>Number N of contacts of the same size per mated pair</th><th>Minimum percentage to measure</th></tr>
<tr><td>N <= 5</td><td>100%</td></tr>
<tr><td>5<N<= 60</td><td>50%</td></tr>
<tr><td>60<N<= 130</td><td>25%</td></tr>
<tr><td>N>130</td><td>10%</td></tr>
</table>
</td></tr>
<tr><td>205</td><td>Housing (shell) electrical continuity</td><td>Measuring points: on the rear of the receptacle and plug, by contact point.

a) between mated connectors. Maximum resistance:
Initial: 1 mΩ. After test: 2 mΩ

b) Between end of chimney of plug accessory and the flange of receptacle:
Initial: 2 mΩ. After test: 5 mΩ</td></tr>
<tr><td>206</td><td>Measurement of insulation resistance</td><td>Method A Minimum insulation resistance:

- at ambient temperature: 5 000 MΩ (unmated connectors)
- after tests EN 2591 -314, and during EN 2591 -324: 1 000 MΩ (mated connectors)
- after tests EN 2591 -315: 1 000 MΩ (unmated connectors) except conductive fluids
- during tests EN 2591-301: 100 MΩ (mated connectors).</td></tr>
<tr><td>207</td><td>Voltage proof test</td><td>Method A, connectors mated and un-mated except after test EN 2591-314, where they shall be mated. For tests at low pressure, voltage is applied after 30 min at the pressure indicated.
Voltage value: If connectors are not mated, follow EN 3197.

<table>
<tr><th rowspan="2">Max. Leakage current</th><th rowspan="2">Pressure</th><th colspan="2">Connectors</th></tr>
<tr><th>Mated
V r.m.s.</th><th>Un-mated
V r.m.s.</th></tr>
<tr><td rowspan="2">2 mA</td><td>Sea level</td><td>(size 22) 1300
(other)1500</td><td>(size 22) 1300
(other) 1500</td></tr>
<tr><td>1,1 kPa</td><td>1000</td><td>N/A</td></tr>
</table>
</td></tr>
</table>

TABLE 3 (Continued) Qualification tests

<table>
<tr><th>EN 2591-</th><th>Designation of the test</th><th>Details</th></tr>
<tr><td>210</td><td>Electrical overload</td><td>
<table>
<tr><th>Contact size</th><th>Current (A)</th><th>Duration (s)</th></tr>
<tr><td rowspan="2">22</td><td>10</td><td>40</td></tr>
<tr><td>50</td><td>0,6</td></tr>
<tr><td rowspan="2">20</td><td>15</td><td>40</td></tr>
<tr><td>75</td><td>0,6</td></tr>
<tr><td rowspan="2">16</td><td>26</td><td>40</td></tr>
<tr><td>130</td><td>0,6</td></tr>
<tr><td rowspan="2">12</td><td>46</td><td>40</td></tr>
<tr><td>230</td><td>0,6</td></tr>
</table>
</td></tr>
<tr><td>212</td><td>Surface transfer impedance</td><td>Initial and after tests connector mated with accessories
<table>
<tr><th>1 Kz</th><th>1Mhz</th><th>10Mhz</th><th>100Mhz</th></tr>
<tr><td>5 mΩ</td><td>10 mΩ</td><td>20 mΩ</td><td>150 mΩ</td></tr>
</table>
</td></tr>
<tr><td>IEC 61726</td><td>Shielding effectiveness from 100 MHz to 1 GHz</td><td>Initial and after tests connector mated with accessories
<table>
<tr><th>Frequency
MHz</th><th>Minimum attenuation
(dB)</th></tr>
<tr><td>100
200
300
400
800
1 000</td><td>50
45
45
40
35
30</td></tr>
</table>
</td></tr>
<tr><td>214</td><td>Lightning strike, current and voltage pulse</td><td>10 KA – 1 600 Volts – 10 pulses wave form 1</td></tr>
<tr><td>216</td><td>Engagement of contacts</td><td>Not applicable</td></tr>
<tr><td>301</td><td>Endurance at temperature</td><td>Method B, contacts under mechanical load.
Temperature: 175 °C
Duration: 1 000 h</td></tr>
<tr><td>302</td><td>Climatic sequence</td><td>Not Applicable</td></tr>
<tr><td>303</td><td>Cold/low pressure and damp heat</td><td>Connectors mated 5 cycles. Minimum temperature: (– 55 ± 2) °C</td></tr>
<tr><td>305</td><td>Rapid change of temperature</td><td>Connectors mated
T_A = 175°C $^{0}_{+5}$ °C T_B = -55°C $^{0}_{-5}$ °C</td></tr>
<tr><td>306</td><td>Mould growth</td><td>Method A
Duration:
28 d Growth 0
No prior washing No surface etching</td></tr>
</table>

TABLE 3 (Continued) Qualification tests

<table>
<tr><th>EN 2591-</th><th>Designation of the test</th><th>Details</th></tr>
<tr><td>307</td><td>Salt mist</td><td>The connectors shall be suspended in the test chamber with non - metallic cords, so that no accumulation of condensed saline solution can occur.
The connectors shall be: – subjected to 50 cycles of mating and un-mating at a rate five cycles/min; – exposed to the salt mist: mated for 96h – subjected to 200 mating and un-mating cycles at the rate ≤ five cycles/min.</td></tr>
<tr><td>308</td><td>Sand and dust</td><td>Not applicable to black nickel metal versions. (series F)</td></tr>
<tr><td>314</td><td>Immersion at low air pressure</td><td>Pressure 1,1 kPa</td></tr>
<tr><td>315</td><td>Fluid resistance</td><td>For types of fluids, number of cycles, temperature and duration of immersion and temperature for the third phase: see table 4</td></tr>
<tr><td>317</td><td>Flammability</td><td>Test applicable. Connectors mated. Method A</td></tr>
<tr><td>324</td><td>Interfacial sealing</td><td>Pressure 1,1 kPa.</td></tr>
<tr><td>402</td><td>Shocks</td><td>Method A
Receptacle is front mounted on panel with screw (coupling torque: 0,15/0,20 daN, severity 100
Number of shocks: one each way for each of the three directions (six shocks in total).</td></tr>
<tr><td>403</td><td>Sinusoidal and random vibration</td><td>Same mounting configuration as EN 2591-402
Headers mounted to vibration fixture and mated
Method A
Frequency range: 5 Hz to 3 000 Hz
Acceleration: 20 g
1 octave per minute
Duration: 4 h /axe
Method B
Figure 2 and Table 1, level E
Duration: 1 h/axis</td></tr>
<tr><td>404</td><td>Transverse load (external bending moment)</td><td>Bending moment:
Connector is tested in worst case position (horizontal or vertical)
Force is applied along y axis of the connector.
<table>
<tr><th>Housing (shell) size</th><th>Torque N.m rear plug</th><th>Torque N.m Rear accessory (body extremity)</th></tr>
<tr><td>2 cavity</td><td>50</td><td>15</td></tr>
<tr><td>4 cavity</td><td>50</td><td>15</td></tr>
</table></td></tr>
<tr><td>406</td><td>Mechanical endurance</td><td>Number of mating and un-mating operations: 500
Max rate: five cycles/min.</td></tr>
<tr><td>407</td><td>Durability of contact retention system and seals (Maintenance ageing)</td><td></td></tr>
</table>

TABLE 3 (Continued) Qualification tests

<table>
<tr><th>EN 2591-</th><th>Designation of the test</th><th>Details</th></tr>
<tr><td>408</td><td>Mating and un-mating forces</td><td>Samples mounted on test fixture.
Screw plug: Method A
a) mating and un-mating of pairs of connectors
Mating and un-mating of pairs of connectors
Apply, on the coupling screw, the coupling torque indicated in the table. Then check that the connectors are at the mechanical stop. Measure the uncoupling torque of the coupling screw. This torque shall be within the limits indicated in the table. Pre-couple the connectors and apply the over-tightening torque indicated in the table to the coupling screw.
<table>
<tr><th rowspan="2">Housing (shell) size</th><th rowspan="2">Coupling torque N.m</th><th colspan="2">Un-coupling torque N.m</th><th>Over-tightening torque N.m</th></tr>
<tr><th>min</th><th>max</th><th>max</th></tr>
<tr><td>2 cavity</td><td>1,1</td><td>0,77</td><td>1,7</td><td>3</td></tr>
<tr><td>4 cavity</td><td>1,3</td><td>0,91</td><td>2,2</td><td>3</td></tr>
</table>
b) Checking the self locking system on the plugs only. The rotation torque of the coupling device, in the uncoupling direction, shall be according the table below during a full 360° rotation
<table>
<tr><th>Housing (shell) size</th><th>Rotation torque (un-coupling direction) N.m min</th></tr>
<tr><td>2 cavity</td><td>0,01</td></tr>
<tr><td>4 cavity</td><td>0,01</td></tr>
</table></td></tr>
<tr><td>409</td><td>Contact retention in insert</td><td>Preload: 1 daN
<table>
<tr><th>Contact size</th><th>Axial load (N)</th><th>Number of contacts tested</th></tr>
<tr><td>22</td><td>44</td><td>50 %</td></tr>
<tr><td>20</td><td>67</td><td>50 %</td></tr>
<tr><td>16</td><td>110</td><td>50 %</td></tr>
<tr><td>12</td><td>110</td><td>100 %</td></tr>
</table>
Displacement < 0,3 mm during and after application of the load.</td></tr>
</table>

TABLE 3 (Continued) Qualification tests

<table>
<tr><th>EN 2591-</th><th>Designation of the test</th><th>Details</th></tr>
<tr><td>410</td><td>Insert retention in housing (axial)</td><td>Connectors not fitted with contacts. Test applicable to of the female modules only, if the retention mechanisms and the materials are the same on male and female modules.
Force applied: 25,4 daN to the front surface of the module by a steel fixture.
Displacement: 0,2 mm max. during and after application of the load.</td></tr>
<tr><td>412</td><td>Contact extraction and insertion forces</td><td>
<table>
<tr><th>Contact size</th><th colspan="2">Maximum force (N)</th></tr>
<tr><th></th><th>Insertion</th><th>Extraction</th></tr>
<tr><td>22</td><td>68</td><td>45</td></tr>
<tr><td>20</td><td>68</td><td>45</td></tr>
<tr><td>16</td><td>68</td><td>45</td></tr>
<tr><td>12</td><td>68</td><td>45</td></tr>
</table>
</td></tr>
<tr><td>413</td><td>Holding force of grounding spring system</td><td>
<table>
<tr><th>Housing (shell) size</th><th colspan="2">Axial force (N)</th></tr>
<tr><th></th><th>Min (N)</th><th>Max (N)</th></tr>
<tr><td>2 cavity</td><td>5</td><td>10</td></tr>
<tr><td>4 cavity</td><td>10</td><td>20</td></tr>
</table>
</td></tr>
<tr><td>419</td><td>Stability of male contacts in inserts</td><td>
<table>
<tr><th>Contact size</th><th>Permitted deflection (mm)</th><th>Force (daN)</th></tr>
<tr><td>22</td><td>0,76</td><td>1,2</td></tr>
<tr><td>20</td><td>1,37</td><td>2,4</td></tr>
<tr><td>16</td><td>1,91</td><td>4,9</td></tr>
<tr><td>12</td><td>1,91</td><td>4,9</td></tr>
</table>
</td></tr>
<tr><td>513</td><td>Magnetic permeability</td><td>< 2</td></tr>
</table>

TABLE 4 Requalification tests

Designation of the test	Test number per EN2591
Group 1	
Visual examination	101
Examination of dimensions and mass	102
Voltage proof test	207
Contact resistance at rated current	202
Housing (shell) electrical continuity	205
Cold/low pressure and damp heat	303
Housing (shell) electrical continuity	205
Measurement of insulation resistance	206
Mating and un-mating forces	408
Mechanical endurance	406
Salt mist	307
Measurement of insulation resistance	206
Group 2	
Visual examination	101
Examination of dimensions and mass	102
Contact resistance at rated current	202
Endurance at temperature	301
Mating and un-mating forces	408
Measurement of insulation resistance	206

HISTORY OF REVISIONS

Rev 2 - Nov 2 2009 - Major update:

Restricted document scope to shells, metal, stackable, black nickel plated.
Restricted document scope to contacts size 22, 20, 16, 12.
Restricted document scope to un-sealed modules 20-22, 12-20, 08-16, 04-12, 99-01
Aligned requirements and tests with changes introduced in prEN 4165-001 2008-09
Added details of groups, test sequence, and test conditions.
Added test 419 in group 7.
Numerous editorial changes and clarifications.
Added history of revisions.