Plasma Control Technologies

Service Bulletin-56

Vacuum Capacitor Life Time

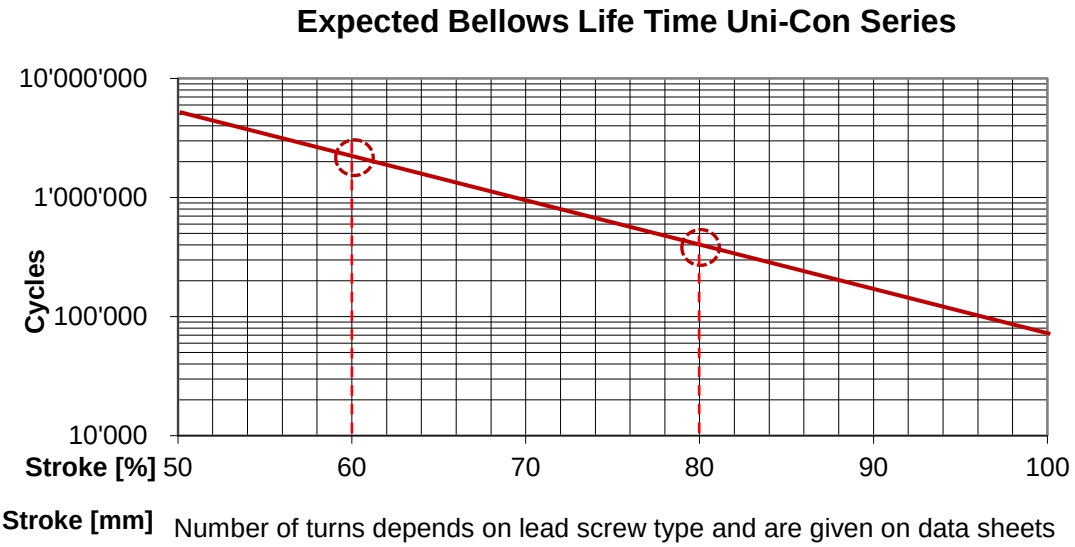
Life time of Variable Vacuum Capacitors

Although COMET capacitors are produced with best selected materials and fabrication processes there are limits based on movable parts which are necessary to adjust variable vacuum capacitors. One is the bellows and the other is the drive system with the nut and the lead-screw, which allows a precise and fine adjusting of the capacitance over the coupled motor drive. COMET's product portfolio has been developed over several decades and therefore different designs with different kinds of bellows and drive systems are available or still in use.

Bellows Life Time

Dominating factor is the used capacitance range but also the design and used type of bellows. The graph "expected bellows life time" is available for all Semicon types. It shows on the X-axis the used capacitance range in % and on the Y-axis the number of expected life cycles. **Important:** These curves are valid only for the specified nominal C-range of each capacitor. The range below Cmin nominal is not recommended, as the life time will be reduced, if the capacitor will be used in this area.

Fig. 1: *Typical graph "Expected bellows life time" Uni-Con Series.*



Number of turns depends on lead screw type and are given on data sheets

The values are based on centered stroke i.e. 60% stroke starts from 20% and ends at 80% (or 80% stroke starts from 10% and ends at 90%, respectively) of the nominal Crange, given on the data sheet. Corresponding values of different capacitors Series are listed in table on page 2.

Example:	CVUN-1000AC/5-BAJA; used Crange from 260 – 745pF
C-curve data from Data-Sheet:	260pF = 2 turns; 745pF = 8 turns
(See page 5, 6)	-> Δ= 6 turns = 54% of nominal stroke (11.1 turns)
	Expected bellows life time: ~3'700k cycles

Expected bellows life time depends on the capacitor Series

Capacitors-Series	Expected life cycles at 80% of nom Crange	Expected life cycles at 60% of nom Crange
Basic-Con	270k	1’300k
Uni-Con	400k	2’200k
Smart-Con	500k	2’500k
Uni-Select	400k	1’200k
Uni-Select (J)	700k	3’400k
Power-Con	300k	1’500k
Hexa-Con	2’100k	10’500k
Maxi-Con	300k	1’500k
Maxi-Con (J)	1’800k	9’300k
Hiper-Con	250k	1’250k
Supra-Con	250k	1’250k
Broadcast and other Series	Information available on request	

(J) Improved bellows (see type designation)

The values above are valid for centered strokes. Decentered strokes towards Cmin will reduce the life cycles, on some types significantly. Detailed information is available on request.

Drive System Life Time
Variable vacuum capacitors are available most of all with rotational drive system including nut and lead-screw but also as push-pull types on demand. There are different drive systems available which has been designed to meet increased requirement from the industry, like speed and number of turns. The domination factor influencing the life time is the required torque.

Torque of Drive System
The necessary torque to tune a variable capacitor depends first of all on the bellows diameter and therefore on capacitor series but less on used threads type of lead-screw. Large water cooled variable capacitors have in addition to the vacuum force also the water pressure which will increase the axial force and therefore also the necessary torque. COMET specifies the maximum torque in the data sheet which considers a safety margin. Torque values of typical Semiconductor types are specified with 0.3Nm although it is often 0.15Nm when the product is delivered. **Important:** The maximum applied torque towards mechanical end-stop at Cmin positions should not exceed twice the specified torque, to prevent damages on the drive system.

Overview of most used drive systems and expected Life cycle time

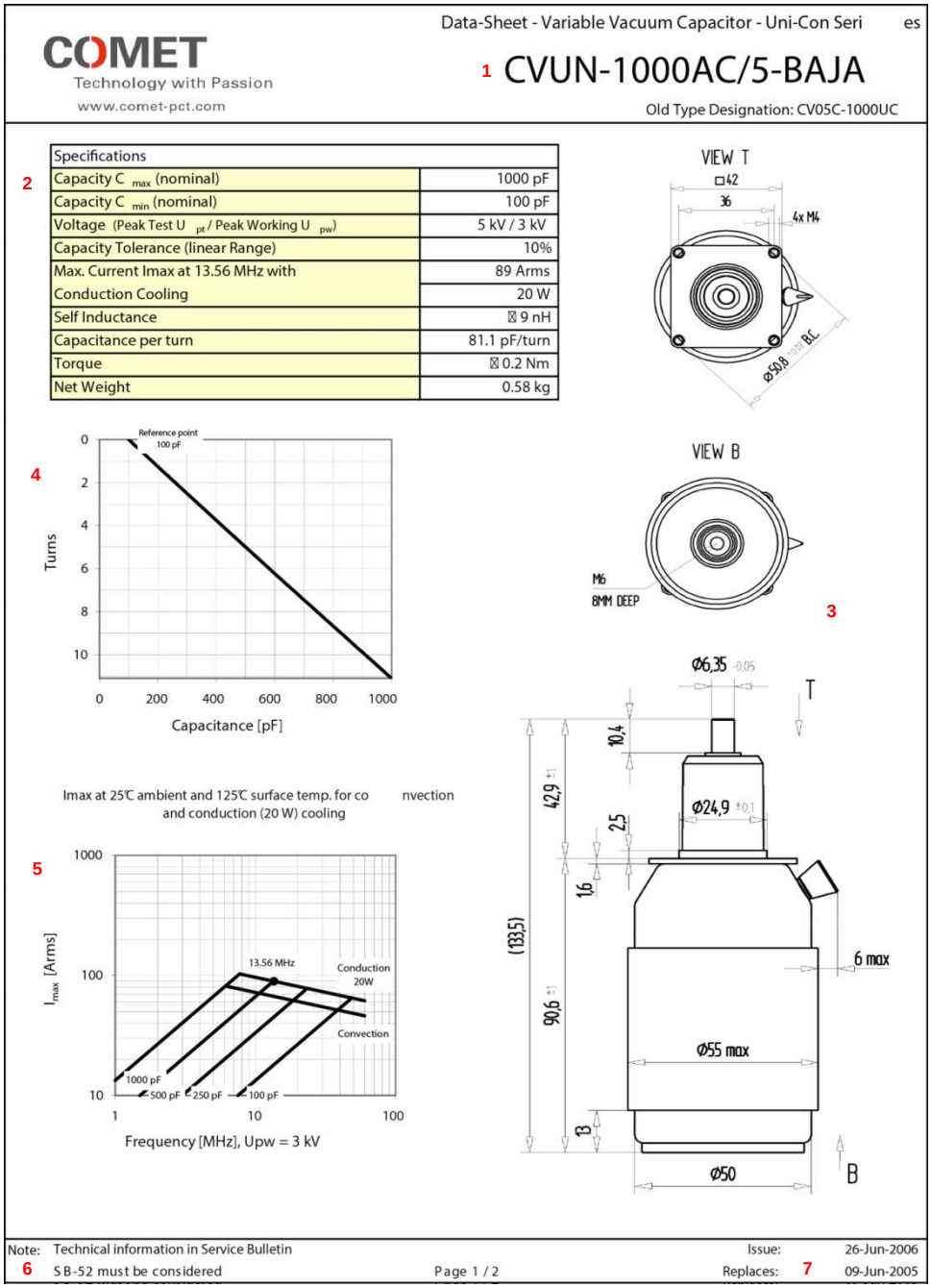
Drive System		Drive System and Letter Code of Lead-Screw Feature			expected life time [Mio. of turns] max speed [RPM]			
Series	Letter Code	**Standard** -	**A-coated** A	**B-coated** B	**Hybrid A RoHS C**	**Hybrid B RoHS D**	**RoHS K**	**RoHS A L**
					Ultra-Life			
Basic-Con	**Torque [Nm]** ≤ 0.15	2 – 4 Mio 360 RPM	5 – 10 Mio 600 RPM					
Uni-Con	≤ 0.20		5 – 10 Mio 600 RPM					50 – 100 Mio 1200 RPM
Smart-Con	≤ 0.20							40 – 80 Mio. 1200 RPM
Uni-Select	≤ 0.20						30 – 60 Mio. 1200 RPM	50 – 100 Mio 1200 RPM
Power-Con	≤ 0.40	1 – 2 Mio 360 RPM	3 – 6 Mio 600 RPM	5-10 Mio 600 RPM	25 – 50 Mio 600 RPM			25 – 50 Mio 600 RPM
Hexa-Con	≤ 0.40		3 – 6 Mio 360 RPM	5-10 Mio 600 RPM	25 – 50 Mio 600 RPM	50 – 100 Mio 1200 RPM		
Maxi-Con	≤ 0.60		2 – 4 Mio 360 RPM		10 – 20 Mio 600 RPM			
Hiper-Con	≤ 0.80			2 – 4 Mio 360 RPM		5 – 10 Mio 600 RPM		
Supra-Con	≤ 0.80					5 – 10 Mio 600 RPM		
Other Series:		Information available on request						
Other configuration:		Available on request						

Number of life cyles can be calculated based on number of turns per one full cycle forth and back.

Example: CVUN-1000AC/5-BAJA; used Crange from 260 – 745pF
C-curve data from Data-Sheet: 260pF = 2 turns; 745pF = 8 turns
(See page 5, 6) -> Δ= 6 turns which corresponds to 12 turns of full cycle
Letter Code = A Expected number of turns = 5 – 10 Mio turns
Expected life time: ~ 450 - 900k cycles

The life time could be extended by factor 10 if the drive system “RoHS A” with letter code L would be used. Considering the life time of bellows also, the life time limiting factor can be determined and finally the total expected life time of a variable capacitor.

How to read a Data-Sheet (1)



1 Type designation; In case an old type designation exists, it is noted below the current type designation

2 Table with main electrical and mechanical specifications

3 Outline drawing with most important views and measures

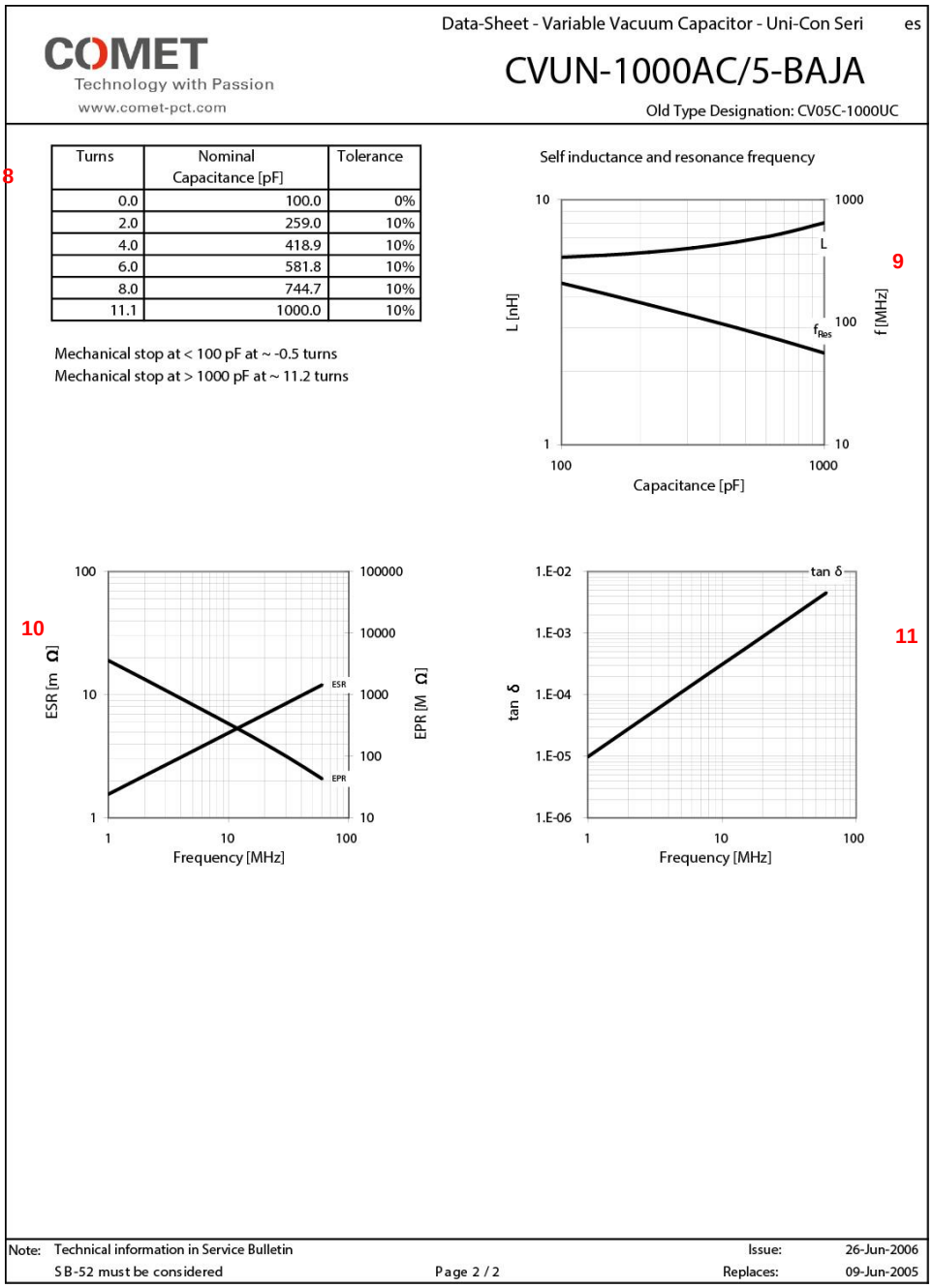
4 Graph of the characteristic capacitance curve; turns (or travel for push-pull types, respectively) vs. capacitance

5 Graph of the current capability of the capacitor vs. applied frequency including required cooling of the capacitor

6 Reference to other COMET documents to be considered

7 Issue date of this data sheet and preceding data sheet if applicate

How to read a Data-Sheet (2)



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Data-Sheet - Variable Vacuum Capacitor - Uni-Con Seri es

CVUN-1000AC/5-BAJA

Old Type Designation: CV05C-1000UC

8

Turns	Nominal Capacitance [pF]	Tolerance
0.0	100.0	0%
2.0	259.0	10%
4.0	418.9	10%
6.0	581.8	10%
8.0	744.7	10%
11.1	1000.0	10%

Mechanical stop at < 100 pF at ~ -0.5 turns
Mechanical stop at > 1000 pF at ~ 11.2 turns

9

Self inductance and resonance frequency

10

11

Note: Technical information in Service Bulletin SB-52 must be considered
Page 2 / 2
Issue: 26-Jun-2006
Replaces: 09-Jun-2005

8 Table of the characteristic capacitance curve including behavior at Cmin and Cmax positions; capacitance and tolerance vs. turns (or travel for push-pull types, respectively)

9 Self inductance and self resonance frequency vs. capacitance

10 Equivalent series (ESR) and parallel (EPR) resistance

11 Loss angle