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What is Arc Suppression?

Three Historical Interpretations and Our Findings

By Reinhold Henke and Bob Thorbus

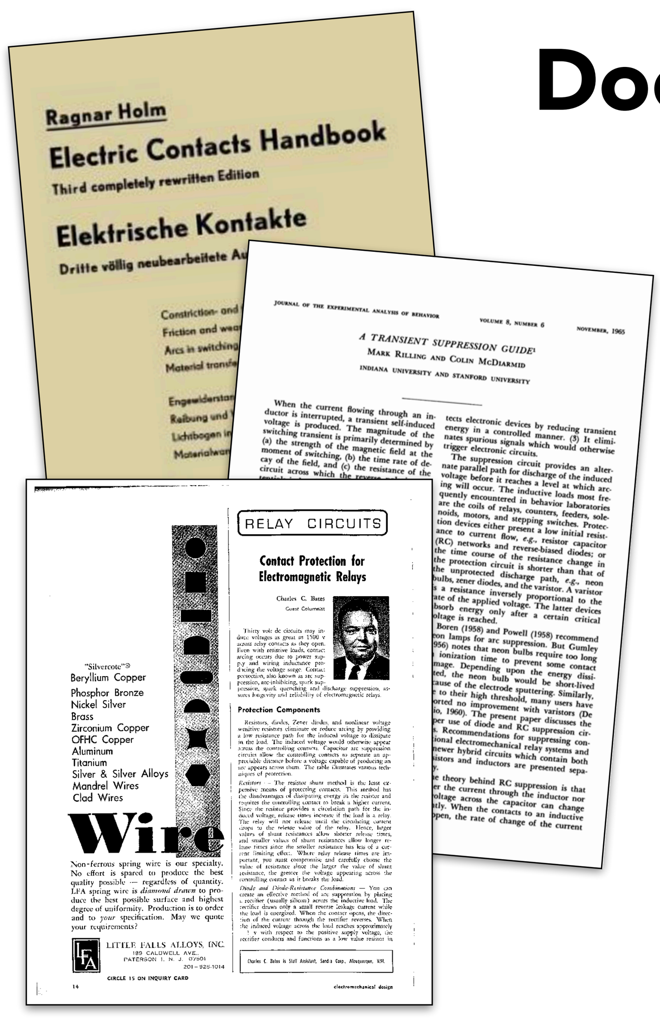

Figure I: Holm's book; Rilling's & McDiarmid's paper; and Bates's article.

Does "Transient Suppression" = "Contact Protection" = "Arc Suppression"?

The 1950s and 1960s saw explosive growth in the electronic components industry, with smaller, more reliable, and more readily available components being used to solve a wide array of issues. Electromechanical designers of this era sought to employ such components as solutions for a variety of issues, including problems arising from contact arcing. We will highlight the findings of three publications (fig. 1) that we find significant and compare them with findings derived from our own industrial research regarding arc suppression as contact protection.

An Engineering Handbook, a Scientific Paper, and a Magazine Article

Arc Suppression, 1958 — Ragnar Holm, the scientist who "wrote the book" on contacts, documented his investigation of arc suppression (or minimization) methods in the "third completely rewritten edition" of his "Electric Contacts Handbook" (fig. I, ref. 1). Holm termed his efforts using resistor and capacitor combinations as "arc quenching" and showed how R and C values can be graphically obtained from differential equations. Holm's study of arc suppression established there were differences between arcs initiated during contact make and arcs initiated during break, and experimentally proved that the quench capacitor sizes become large as currents increase.

Transient Suppression, 1965 — Researchers Mark Rilling (Indiana Univ.) and Colin McDiarmid (Stanford Univ.), published a paper titled "A Transient Suppression Guide" (fig.1, ref. 2), and stated: "Arc Suppression has three purposes: (1) It protects relay contacts from erosion. (2) It protects electronic devices by reducing transient energy in a controlled manner. (3) It eliminates spurious signals which would otherwise trigger electronic circuits." The paper then introduces two equations: $C=I^2\div10$ and $R=E\div(10xIx(1+(50\div E)))$ for calculating R and C values to properly size transient suppressor components. Rilling and McDiarmid did not offer either experimental validation, a scope of limitations, or cite a source for the equations. (We were unable to find copies of their references for review.) The paper also implies "transient suppression" is equivalent to "arc suppression".

Contact Protection, 1966 — Charles C. Bates, a "guest columnist" cited as "Staff Assistant, Sandia Corp., Albuquerque, N.M." wrote an article for the Aug. 1966 issue of "Electromechanical Design" magazine titled "Contact Protection for Electromagnetic Relays" (fig. I, ref. 3) stating that "contact protection is also known as arc suppression". His article includes the same equation highlighted in the Rilling & McDiarmid paper for calculating R and C values: $C=I^2\div10$ and $R=E\div(10xIx(1+(50\div E)))$ … although for "arc suppressor" components. Bates's article explicitly states that "contact protection" is equal to "arc suppression" while also implicitly equating both with "transient suppression" via his examples and the RC equations.

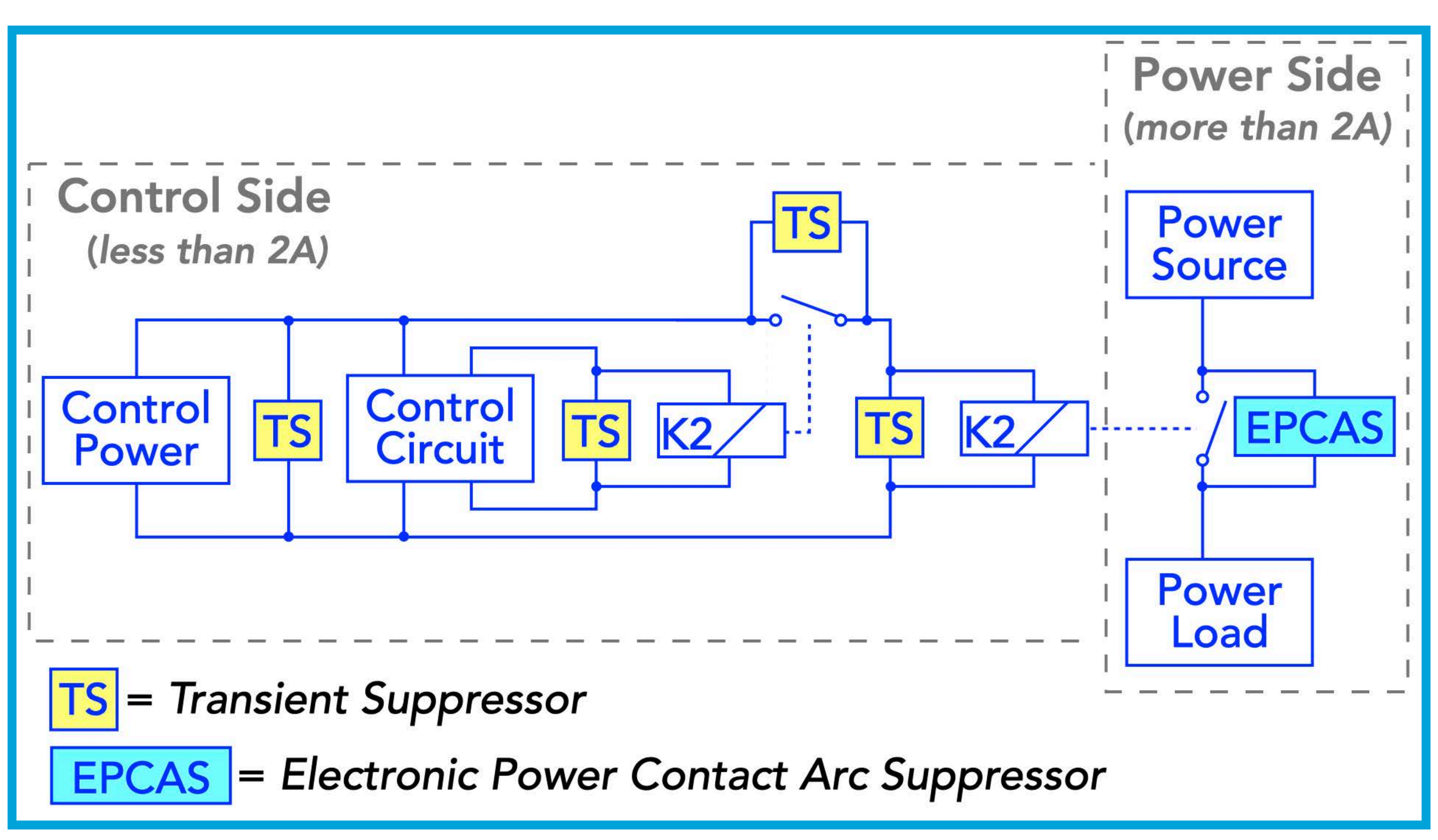

Figure II: Circuit diagram differentiating "control side" (less than 2A) where transient suppressors are appropriate, and "power side" (more than 2A) where transient suppressors have NO value.

Our Discoveries, Findings, and Conclusions

C.C. Bate's article and its RC equations were enthusiastically received by the electromechanical industry. Unfortunately, we will show that transient suppression has NO VALUE switching currents of 2A or more (fig. II). Despite this, industry desire to address the problem of contact arcing overcame the incorrect assumptions and omissions in Bates's article; and to this day the Bates magazine article (often referred to as a "scientific paper") is frequently cited in data sheets and other industry publications from relay OEMs and snubber OEMs (think Tyco, Fuji, CDE/ITW, etc.) … often with Bates being credited as the creator of the RC equations.

We believe the "C.C. Bates equations" have been so uncritically accepted because power contact arcing is not well understood. For instance, a transient suppressor doesn't differentiate between arcs initiated during contact make and arcs initiated during break. As current increases, the ever larger capacitor required by the "C.C. Bates equations" would absorb energy from the break-arc, which in turn fuels damaging make-bounce-arcs (acting like an arc welder). Another example is the common belief that the voltage spike that occurs after the arc plasma has finished burning (fig. III), caused the arcing.

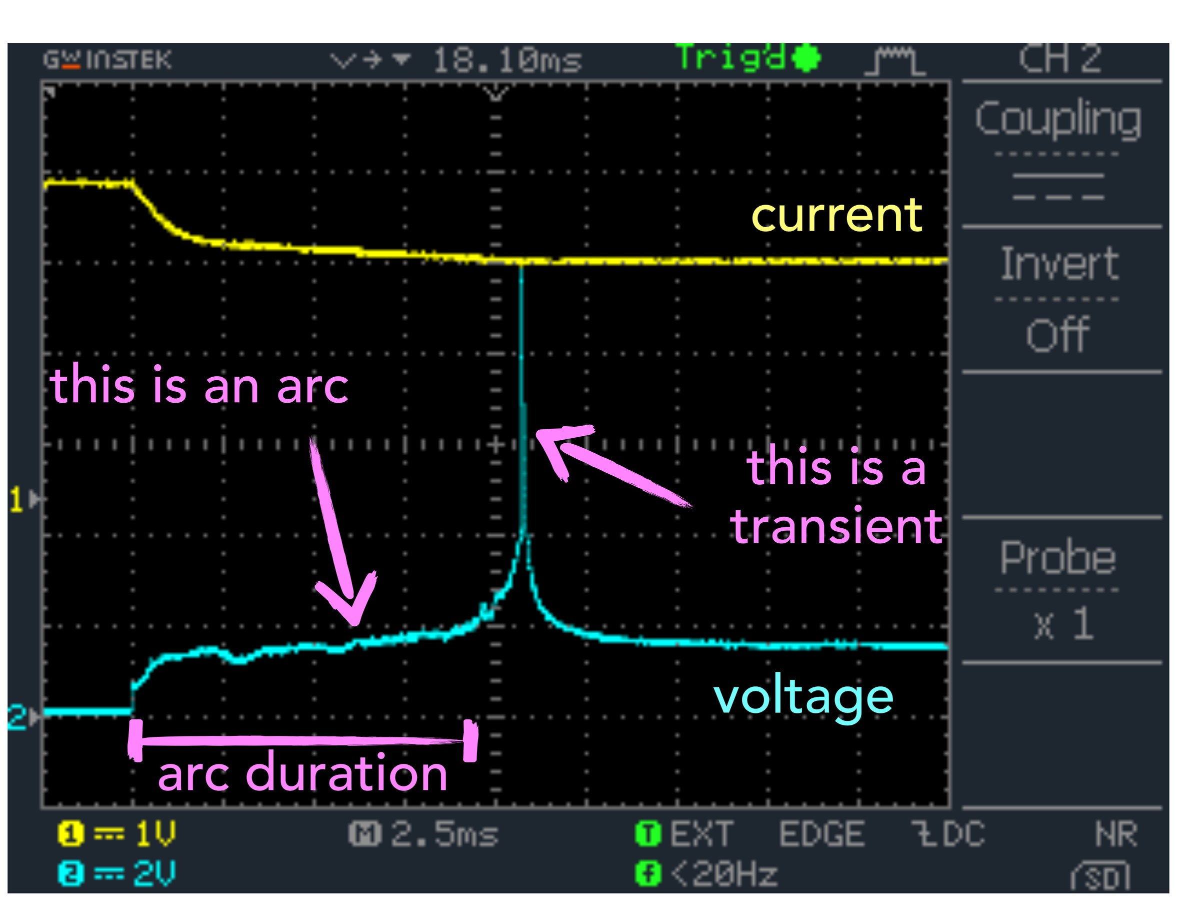

Figure III: One example from our industrial research shows a scope screen capture showing a DC break-arc across a contact along with the related voltage transient.

In summary, transient suppressors are NOT arc suppressors, and therefore DO NOT protect contacts. And, while many components are called "arc suppressors", only an Electronic Power Contact Arc Suppressor (**EPCAS**) truly suppresses arcing and protects contacts. In other words:

EPCAS = ARC SUPPRESSION = CONTACT PROTECTION
TRANSIENT SUPPRESSION ≠ ARC SUPPRESSION
TRANSIENT SUPPRESSION ≠ CONTACT PROTECTION

References:
1. R. Holm, Electric Contacts Handbook, Springer Verlag (Third completely rewritten edition of "Die technische Physik der elektrischen Kontakte"), 1958
2. M. Rilling, et al., "A Transient Suppression Guide," Journal of the Experimental Analysis of Behavior, Vol. 8, No. 6, November 1965
3. C.C. Bates, "Contact Protection for Electromagnetic Relays," Electromechanical Design Magazine, August 1966