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ENGINEERING INFORMATION LETTER

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## **600V VFD AIRGUARD vs. Reflected Wave Peak Voltages**

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This document serves to address the applicability of Prysmian's 600V rated AIRGUARD cables for VFD applications, please be advised that the subject cable is well suited for this application.

The fact there are concerns that 600V insulation can be exposed over-voltages imposed on the system as a result of reflected waves is understandable, given all of the attention these "newer generation" variable frequency drives have received over the past few years. A number of sources recommend the use of 2000V insulation thicknesses to withstand theoretical voltage impulses of up to three times system voltages on a repeated basis. This is a general rule that seems to apply irrespective of the type or strength of insulation being used (e.g. EPR or XLPE). In reality, the 600V XLPE insulation system utilized on AIRGUARD cables is perfectly capable of accommodating these repeated impulses over the 40-year expected life of the cable due to the combination of the very high dielectric strength of the high quality XLPE insulation, and the fact that 600V cables are over-insulated for the electrical application due to the need to have sufficient insulation thickness to withstand mechanical abuse during installation.

Voltage spikes on these systems can occur as a result of a steep front pulse generated by the electronics of the drive. This wave travels from the drive to the motor, where it can be reflected back toward the drive due to the high motor impedance appearing as an open circuit. If it coincidentally meets another wave travelling in the opposite direction and the two happen to be exactly in phase with one another, a near doubling of voltage can occur. Theoretically, with very long lengths of cable, combined with mismatched cable- and motor-impedances, the reflected waves could add to produce a wave with a peak voltage of almost three times the system voltage. This scenario is unlikely to occur and would be the "perfect storm". Assuming this worst case scenario, and using a 575V drive as an example, this would result in a maximum voltage 1725V imposed on the insulation of the 600V cable. A typical **600v** power conductor (e.g. 250 kcm) has an insulation wall of 65 mils (0.065"). CSA C22.2 No.38-14 **and** UL 44 Table 17 show **insulation wall thickness** as little as 54 mils at any point for 2000V cables with EP, XL, Silicone or EPCV insulations. Further, ICEA S-95-658 (2009), Table 3-4

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requires an AC withstand test of between 3.5kV and 11.5kV (depending on conductor-size/insulation-thickness) for 5-minutes per Section 6.10.1.3 for the 600V cables. This is both a higher voltage and a longer duration than would be seen in the aforementioned VFD application.

For these reasons and more, Prysmian is confident in recommending these 600V AIRGUARD cables for the application. This is standard among other manufacturers as well, especially the manufacturers of continuously corrugated and welded (CCW) aluminum armor cables, who have been recommending these 600V cables for IGBT drives for over 15 years.