DMS05U

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1-PHASE MOTORS
START CAPACITOR VALUE

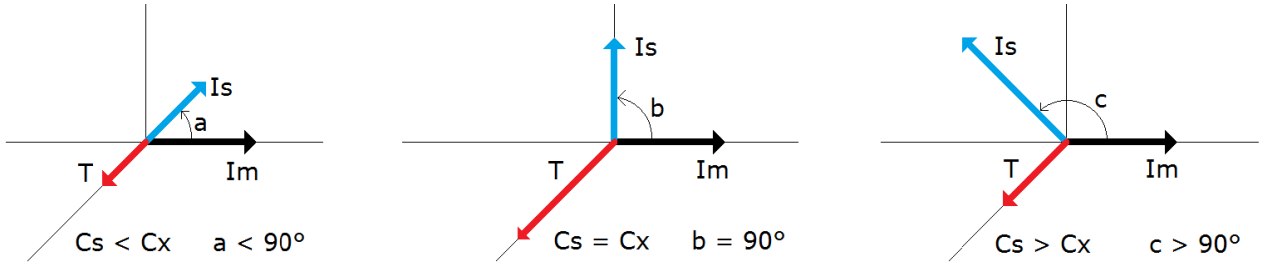
During the development of the DMS module, a lot of motors startups had been measured and analyzed in order to find the mathematical model to be used in the module software. Two issues not well known came up.

1. "The original start capacitor value placed by the manufacturer is the correct one": On many brand new and used motors, we found that the start capacitor value indicated and placed by the fabric is usually larger than the optimum value corresponding to the maximum torque available on these motors.

2. "The bigger the start capacitor value, the bigger the starting torque of the motor": This is somehow true but sometimes misunderstood. As many technicians know, there are two basic circuits on every 1-phase motor: The main winding connected to the VAC line and the start winding in series with the start capacitor connected to the VAC line only during the motor startup.

The startup current through the start winding (LS) increases as the start capacitor (CS) increases, but not necessarily increases the torque developed by the motor.

The startup current across the start winding is proportional to: **VAC / (LS + 1/CS)**
The starting torque developed is proportional to the product: **Is x Im x sin(a)**
(Is) is the start winding current, (Im) is the main winding current
(a) is the electric angle between them, sin(90°)=1 max value.
Assuming Cx is the optimum start capacitor value for a given motor.
In the following vector diagram, there are 3 cases (left to right): where CS is smaller, equal and greater than Cx.



It can be seen that the current (Is) increases as CS increases, but also the angle increases. So, the developed torque not always increases, reaching its maximum when the electric angle between both currents is close to 90°.

Conclusions: Due to the fact that the DMS module is universal, it has to analyze every motor startup to calculate the correct time to disconnect the motors starting circuit. So, the voltage across the start winding has to be measured and evaluated in order to determine the mathematical behavior of the motor. If the start winding voltage increases due to an inappropriate large CS value, it can be interpreted by the module as if the motor has reached its final starting torque. This will lead to an improper or erratic motor startup. If the motor uses its original electromechanical centrifugal switch, the startup would look OK, but due to the larger value of CS, the starting current will be unnecessarily large, stressing the motor starting circuit and delaying the startup time due to the lower torque developed. This will lead to a very short life of the motor and switch.

It is very difficult to measure the above described startup variables to determine the correct CS value just using a voltmeter or a clamp meter.

Based on our experience during so many startups evaluated on so many different motors type, power RPM, etc. We decided to include a table where we suggest appropriate values for every power ratings for motors up to 5HP. **This table is not intended to be used as an exact guide to CS values, but as a starting point to find the best value for a given motor.**

MOTOR (HP)	START CAPACITOR (uf)
1/6	20 - 25
1/5	30 - 40
1/4	40 - 60
1/3	60 - 80
1/2	800 - 100
3/4	100 - 120
1	120 - 160
1.5	140 - 180
2	160 - 220
3	200 - 280
4	240 - 360
5	330 - 470