



## Comprehensive Guide to Motor Starters:

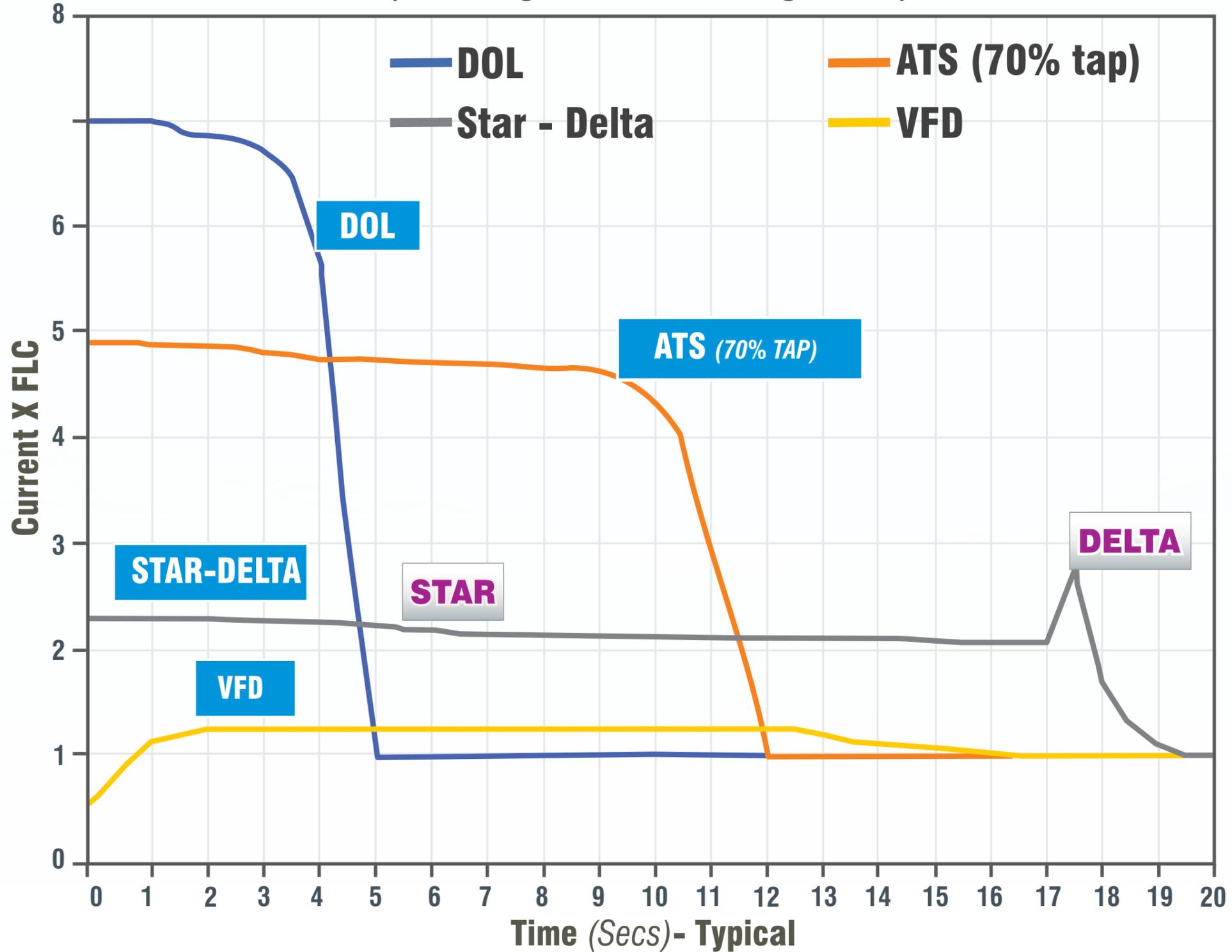
# Key Differences in Starting Current, Cost and Protection

Type of Starter	Suitability for		Starting Current ( $X = \text{Rated Current}$ )	Design & Indent Stage : Level of Technical Collaboration reqd between Pump, Motor, Electrical System & Starter Manufacturer	Speed Variation ?	Risk of Harmonics / PWM output	Protective Features		Soft Start/Stop		Approx Relative Capital Cost	Operation & Maintenance			
	LT Motors	HT Motors					Over Voltage/ Under Voltage Protection	Over Overload Protection	Soft Start ?	Soft Stop ?		Robustness against Dust Moisture & Heat	Robustness against Voltage Fluctuations	Easy Availability of Spares	Cost of Spares
<b>DOL</b> (Direct on Line)	✓		<b>6X to 8X</b> (as per Efficiency Class stds.)	Not Mandatory							100%			✓	Low
<b>Star/Delta</b> $\lambda/\Delta$ (Wye Delta)	✓	✗	<b>2X to 2.75X</b>				To be Provided separately		✗		150%	High		✓	
<b>ATS</b> (Auto Transformer Starter)			(% (typically 60% & 80%) of Tapping) x (6X to 8X) <b>= 3.6X to 6.4X</b> ⚠ Depends on Design Goal given to Starter Manufacturer	Important	✗	No								✗	Medium
<b>Electro Magnetic Soft Starter</b> (Flux Controlled Magnetically Amplified (FCMA) &/or Hybrid Fully Solid State Reduced Voltage (HFSR))	✓		⚠ Depends on Design Goal given to Starter Manufacturer - generally kept upto 3X	Very Important					✓	✗	200%	Medium			High
<b>Micro Processor Soft Starter</b> (Electronics Thyristor based)	✓	⚠	<b>1.5X to 2X</b>	Not Mandatory								250%	Low	Poor	✗
<b>Variable Frequency/ Speed Drive VFD/VSD</b>	✓		Depends on load, Generally, <b>X to 1.5X</b>	Important	✓	High Risk		✓				>350%	Poor	Very Poor	Very High



## Current-Time Curve with Different Starters

(Assuming IE2 motor with  $I_{stg}/FLC = 7$ )





## Question : Why Changes in Starting Performance with Increasing Motor Efficiency Classes ?

### Answer:

When we change Motor Selection from Lower to Higher Efficiencies (i.e. NonIE (nIE) to IE1 to IE2 to IE3); due to Reduced Motor Internal Losses; as an **UnAvoidable Side Effect** - the Starting Performance also changes (to be read in Ascending Order {as moving from Lower to Higher Efficiency Class}) below:

- Starting Torque Reduces & hence needs more Accelerating Time.
- Starting Current Increases (refer IS/ IEC Standards attached)

So, whenever we select Higher Motor Efficiency Classes, the Starter & Power Supply Infrastructure also must Capable to withstand Higher Starting Current & for a Longer Time Duration .... 

IS 12615 : 2018

Table 2 Values of Performance Characteristics of 4 Pole Line Operated a.c. Motors  
( Clauses 1.2, 1.3, 1.6, 10.1, 10.2, 11, 14.1, 14.4, 15.4.1, 17.3.5 )

	Rated Output kW (1)	Frame Size (2)	Full Load Speed rev/min (4)	Full Load Current Max A (5)	Locked Torque in Terms of Full Load Torque Percent (6)	Locked Rotor Current in Terms of Full Load Current			Nominal Efficiency		
						IE2 Percent (7)	IE3 Percent (8)	IE4 Percent (9)	IE2 Percent (10)	IE3 Percent (11)	IE4 Percent (12)
ix)	2.2	100L	1 390	5.1	170	700	750	830	84.3	86.7	89.5
x)	3.7	112M	1 410	8.1	160	700	750	830	86.3	88.4	90.9
xi)	5.5	132S	1 420	12.0	160	700	750	830	87.7	89.6	91.9
xii)	7.5	132M	1 430	15.4	160	700	750	830	88.7	90.4	92.6
xiii)	11.0	160M	1 440	22.0	160	700	750	830	89.8	91.4	93.3
xiv)	15.0	160L	1 440	30.0	160	700	750	830	90.6	92.1	93.9
xv)	18.5	180M	1 440	36.0	160	700	750	830	91.2	92.6	94.2
xvi)	22.0	180L	1 440	43.0	160	700	750	830	91.6	93.0	94.5
xvii)	30.0	200L	1 450	57.0	160	700	750	830	92.3	93.6	94.9
xviii)	37.0	225S	1 450	69.0	160	700	750	830	92.7	93.9	95.2
xix)	45.0	225M	1 460	84.0	160	700	750	830	93.1	94.2	95.4
xx)	55.0	250M	1 460	101.0	160	700	750	830	93.5	94.6	95.7
xxi)	75.0	280S	1 470	134.0	160	700	770	890	94.0	95.0	96.0
xxii)	90.0	280M	1 470	164.0	160	700	770	890	94.2	95.2	96.1
xxiii)	110.0	315S	1 480	204.0	160	700	770	890	94.5	95.4	96.3
xxiv)	132.0	315M <sup>1)</sup>	1 480	247.0	160	700	770	890	94.7	95.6	96.4
xxv)	160.0	315L <sup>1)</sup>	1 480	288.0	160	700	770	890	94.9	95.8	96.6
xxvi)	200.0	As per manufacturer catalogue	1 480	348.0	160	700	770	890	95.1	96.0	96.7
xxvii)	250.0		1 480	435.0	160	700	770	890	95.1	96.0	96.7
xxviii)	315.0		1 480	548.0	160	700	770	890	95.1	96.0	96.7
xxix)	355.0		1 480	618.0	160	700	770	890	95.1	96.0	96.7
xxx)	375.0		1 480	653.0	160	700	770	890	95.1	96	96.7

As per IS 12615, the standard indicates that the starting current increases with an increase in motor efficiency. However, the starting torque is maintained at the minimum specified level across all efficiency classes, ensuring suitability for driving a wide range of applications



## Current-Time Curve with Different Motor Efficiency Classes (Assuming DOL Starter)

