



# L&T-Yaskawa Crane Control Solution enhances crane performance without Worries

Crane has been one of the most vital material-handling equipment in all manufacturing sectors for many years. Variants of this lifting equipment used by industry, ranges from In-door crane like E.O.T., Chain Hoists, Stackers, Outdoor cranes like Goliath Crane, Mobile cranes etc.

Traditionally for all electrically operated cranes various option has emerged with time starting from Standard cage rotor motor, wound rotor motor, conical rotor motor, DC motors etc.

Major contributing factors for the selection of these motor options were hovering around Capital cost, Maintenance cost, Starting Current vis-a-vis Starting Torque, Power consumption, Critical load handling parameters like positioning accuracy, jerks, load sharing etc.

Cage rotor motor along with DOL contactors gives low capital & maintenance cost but the disadvantages with this control system are that it requires more parking time since it has no option of creep-speed, start and stop are jerky leading to heavy load sway and increased wear and tear of brake shoe. It also demands high starting current which makes a big impact on system electricals when handling large nos. of start and stops.

For achieving better positioning accuracy, motors are required to be operated in creep speed. The options with caged rotor motor to achieve this creep speed are either all motions were powered with dual speed motor or an additional planetary geared motor which will be selected thru' electric contactor for low speed operation.

This is little crude way of achieving low speed operation since it calls for an additional motor, gearbox etc. Such system also requires extra mounting space on crane and also leads to overall poor system efficiency due to more components, cables, hardware etc.

Next option for crane control is use of Slip-ring motor with Rotor Resistor Control (RRC) or solid state Variable Voltage Control (VVC) for stator supply or DC motor.

Compared to dual speed option of caged rotor motor, Slip-ring, Motor Control or DC motor control provides increased flexibility in terms of speed steps, consumes lower starting current for producing high starting torque. This benefits of slip-ring motor and DC motor control comes along with disadvantages like slip-ring, carbon brushes maintenance, arcing, bigger size and bulkiness of motor puts extra load on trolley and bridge.

These control systems also have regular maintenance of current carrying contacts of contactor which requires regular maintenance / replacement due to frequent braking and reversal involved.

Many company-encountered problems with Slip-Ring & DC Motor are the difficulty and high cost involved in protecting these motors to necessary IP 54 class of protection.

Additionally if Slip ring motor is used along with VVC control then Techogenerator is must for the VVC control.

In all above cases since brake are operated at relatively higher speed, brake shoe wears off faster and it also requires frequent adjustment to ensure safe operation of crane.

Slip-ring motor or DC motor were preferred choice for crane application even when application not requiring accurate positioning. This was merely due to the apprehension that caged rotor motor may not be able to lift the large rating load.

Introduction of Variable Voltage Variable Frequency (VVVF) AC drive combined with advantages of Caged rotor motor makes an ideal combination for many variable speed application including complex vertical transportation applications like Cranes and Elevators.

A Variable Speed AC Drives essentially works on the principal of keeping V/F or Flux level constant in the motor. This simple V/F control by varying the Voltage "V" and Frequency "F" simultaneously maintains peak torque level produced by motor.

Standard V/F scalar control or less precise vector control faces tough challenges when it comes handling vertical loads like cranes and elevators.

These loads unlike other loads ask for more accurate and stable low speed control since it has to work against gravitational force. The crucial areas in these types of vertical transportation equipment are starting torque, accurate calculation of motor flux to achieve stable low speed operation, proper brake coordination, electric braking to control regenerative load.

The challenges faced in low speed area are accurate calculation of motor flux & it varies dynamically with change of load and speed. Slightest variation in the amount of voltage compensation more than actually required will make motor draw either more current or create saturation leading to motor heating. Contrary if less compensation is given then it produce less torque, which will lead to slippage of load or may be pulsating revolution of motor for horizontal movements.



In addition to this accurate vector calculation, external mechanical brake needs to be tightly coordinated with Crane Hoisting and Lower sequences when Caged rotor motor are used with VVVF control. Logic sequence should ensure:

- Enough torque is produced by motor before brake is released to avoid slippages of load – Safety Factor.
- They provide jerk free start and stop by getting released at the low speed or ideally at zero RPM - Positioning Factor.
- Motor, Brake shoe and overall Crane structure should experience minimum possible stress – Maintenance and Down time Factor.
- Completion of required tasks in reduced number of Start-Stops and Optimization of Power – Operational Efficiency Factor.

In order to achieve these crucial performance parameters of Vertical transportation, L&T-Yaskawa offers their state of art model – 616 G7 drives combined with special embedded CRANE Control Software.

L&T-Yaskawa's 616-G7 model is the world's FIRST and the ONLY drive offering 3 level Architecture in 200V / 400 V class VVVF segment. This not only provides superb servo like performance from standard caged rotor motor but also helps

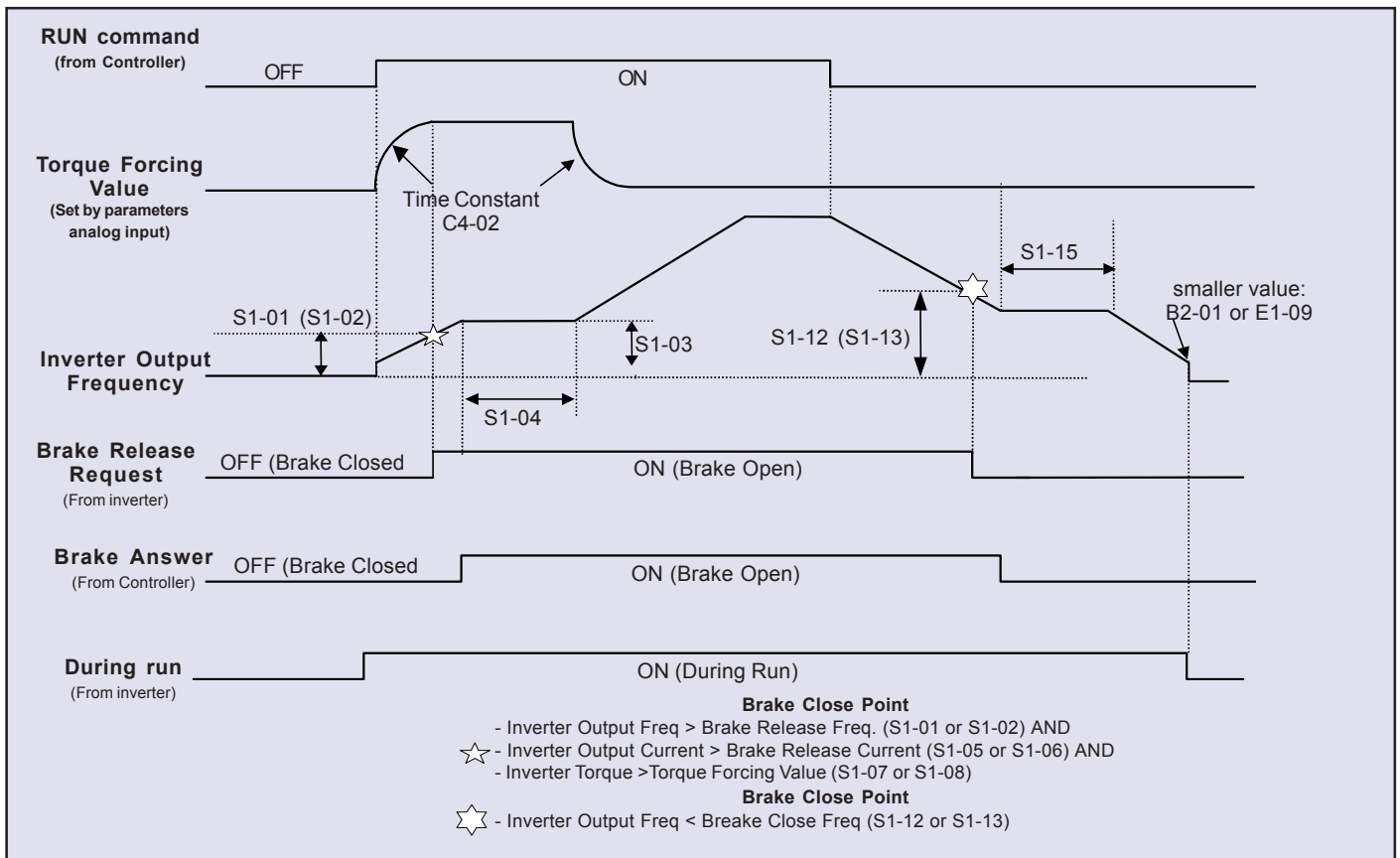
in mitigating many of the previous drawback of 2-level VVVF drive without use of any external components.

This unique 3 level technology of G7 drive along with standard caged rotor motor provides ideal solution for crane control. Special embedded crane software in G7 drives makes L&T-Yaskawa G7 drive as the First choice of crane users and manufacturers.

L&T-Yaskawa's crane control software along with caged rotor motor provides numerous benefits to the crane users.

### Caged Rotor Motor Benefit factor

- Caged rotor motor by virtue of its rotor construction is mechanically more robust than slip-ring or DC motor. Also periodic maintenance of the slip-ring and carbon brushes is eliminated.
- Caged rotor can be offered in IP 54 or even better enclosure protection as a standard helping to serve harsh dusty environment.
- Caged rotor motor are compact, economical and have faster availability then any other type of motor.



(Fig.1) How Yaskawa G7 drive's unique Crane Control Software improves Safety?



## Yaskawa's special Crane Control Software Benefit Factor:

This software handles fundamental requirements of crane application as follows.

- **Safety** – Brake sequence, Independent Hoisting / Lowering torque compensation. Over speed protection.
- **Minimum down time** – Torque / Current - limit, Stall prevention during acceleration, Power supply protection, Major and Minor fault classification, Ultra high reliability of Yaskawa's drive. Input/output phase failure.
- **Dedicated crane functions** – Brake sequence, Travel limit, Light load acceleration, Impact Stop, Zero Servo, Multi-Step speed, S curves
- **Cost performance** – Due to dedicated crane function and inbuilt protection for drives and motors, external hardware and associated wiring are reduced leading to reliable performance at minimum cost.

## How L&T-Yaskawa G7 drive's unique Crane Control Software improves Safety?

One of the most vital roles of this crane software is taking control of opening and closing of external Mechanical Brake thru its multifunction outputs. Timing diagram explains the decision making of drive for brake control in Open Loop system without any encoder feedback. (shown in fig. 1)

Drive releases brake after having three important feedback of output frequency, motor current and internal torque reference and comparing them with preprogrammed values. This ensures maximum safety in brake co-ordination.

These parameters for forward and reverse direction can be set independent of each other making it possible to use on load with or without counterweight.

## Other Advantages of Yaskawa's Crane Controls are:

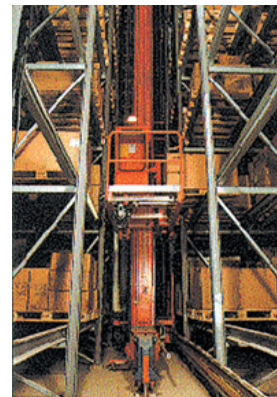
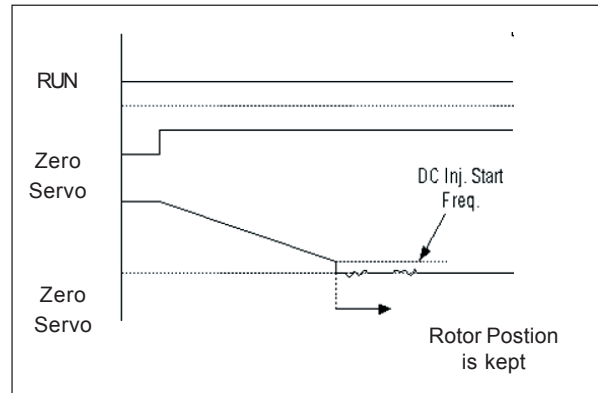
### ● Electric Braking:

Drive will bring the motor to zero speed thru electrical braking and mechanical brake is applied just in the end to hold it. This reduces sway in the load. Also since the mechanical brake is opened and closed in low speed zone, wear and tear of brake, reduces substantially.

Application having higher regenerative load cycle than Yaskawa Drives with Regenerative front end can be provided. This will feed back regenerated energy to the mains supply instead of dissipating it into Dynamic Braking Resistor Bank.

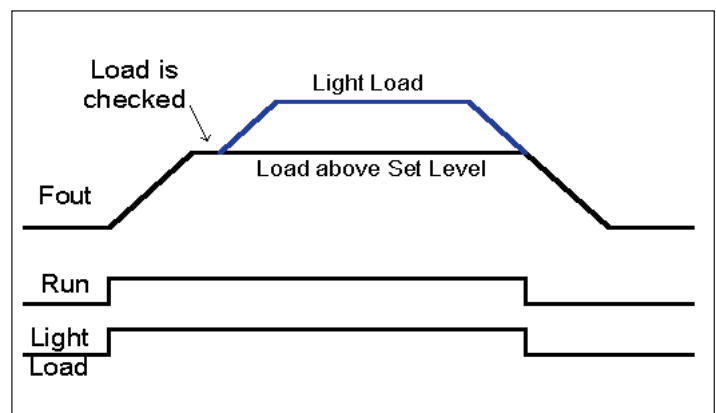
### ● Zero Servo Control (Hold operation without mechanical brake):

Zero Servo feature is possible with Encoder feedback. This enables to hold the load without applying the mechanical brake. The purpose of the zero servo function is to provide position control capability at zero speed. The shaft position is maintained by monitoring the Encoder feedback pulses, and correcting the position error.



### ● Light Load Acceleration (Express):

Motors can be made to run at speed higher than its base speed if crane is lightly loaded. The sensing of light load is automatically done by measuring load current. This reduces cycle time and in-turn improves operational efficiency.

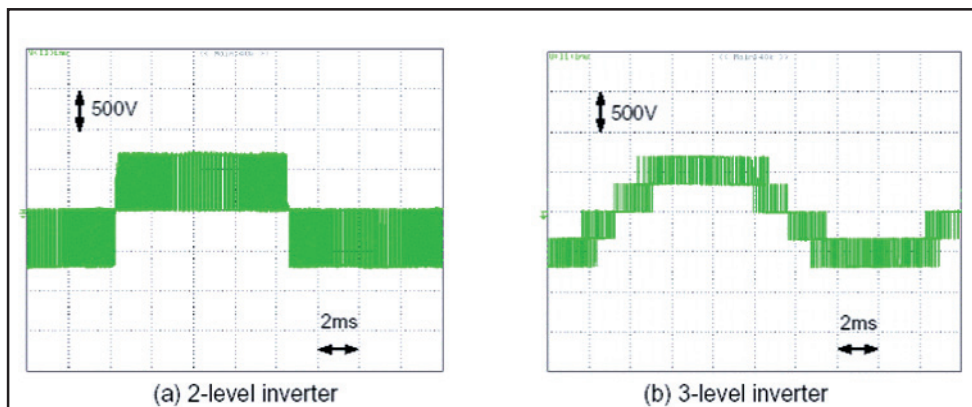




## Other special Crane control features are

- **Travel limit Function** – Management of extreme position limit switches.
- **Impact Stop function** - Stops the operation if drive senses the feeder is impacted thru' current and torque sensing.
- Load sensing based starting torque compensation.
- **Droop Control** for the equal load sharing of motor driving common loads.
- **Slip Compensation during motoring and regeneration** - Keeps Hoisting / Lowering speed nearly same even without encoder speed feedback.

Speed holding accuracy of  $\pm 0.2\%$  in open loop and  $\pm 0.02\%$  in closed loop can be achieved.



Line-to-line inverter output waveforms

## G7- 3 level topology benefit factors:

616-G7 is the only model in the world to offer 3-level technology for 400 V class motor in the world. Output voltage wave form of this 3-level technology is shown in fig. below. G7 Inverter has smaller line-to-line voltage steps than the 2-level inverter.

This technology helps in mitigating some problem associated with 2 level inverters without the use of external components e.g,

- Lesser surge voltage seen by motor terminals as compared to 2-level control. Making it possible to use or upgrade existing old Crane with VVVF drive.
- Reduction of bearing pitting due to reduced bearing current.

G7's Open Loop Vector control mode with the new dual flux observer results in excellent torque control characteristics.

Feed-forward control in the speed control block assures a fast response even in the Open Loop Vector control mode. The use of an encoder for actual motor speed feedback provides even better control and higher response in both speed and torque control.

## Other benefits associated with L&T-Yaskawa Inverters are:

- User friendly 5 line \*16 Character Alphanumeric display for programming and monitoring drive parameters. This can even store last fault history which will be useful in trouble shooting the faults.
- **G7 offers three different control methods:** Electronic Potentiometer function (EP) for two step push button controllers, Potentiometer (PO) for analog joy-stick type of controller interfacing with Radio remote control, On Board Communication option for automated cranes. G7 can be used with any or all of these control modes. This versatility makes it easy to apply G7 to application requiring several control places.
- Common Control card for the entire G7 range of drive.

High Dynamic performance of G7 drive combined with 3-level technology and embedded crane control software provides solution to all apprehensions related to capability of using caged rotor motor in Crane applications.

Credentials of crane control are many in India and abroad.

L&T in India has installation base of over 400 drives which are aimed at eliminating human errors, repetitive tasks, saving time, improving productivity and increasing safety.

These drives offer more functions with faster response time, which maximizes crane performance.

Benefits accrued to user after using L&T-Yaskawa drives with respect to older traditional system are tangible in terms of maintenance cost, operational safety and efficiency. This has not only benefited user who are buying new crane but also the users who have opted for modernization of their existing crane system.

Many Crane user and manufacturer have reposed their faith in L&T-Yaskawa drives system for quality and safer crane control.

L&T-Yaskawa's reference in Crane OEM segment includes brands like Mukund, WMI, Unique, Reva, AVON, Anupam, Saico, Meeka, Tisco and many more...

End user segment includes name like L&T, Ambuja Cement, Tube products of India, BHEL, COFMOW, Indal, Steel majors like Essar Steel, SAIL - Bhilai Steel, Jindal Iron & Steel, Bhushan Steels, Uttam Galva and many more ..

In years to come L&T-Yaskawa with its leadership position in the segment of vertical transportation will provide technologically more and more advanced product to industry. Users will benefit in terms of Safety, Higher Performance to Cost ratio and gentle to the environments.