Drive Link



Serial communication from Drive Dynamics Experts in Motor Control

Edition 11 • September 2009

Welcome to the latest edition of Drive Link for 2009.

Spring has finally sprung!! With the onset of some fine weather and sunny days we have noticed an increased positive mood and market activity.

With our customer base spread across a diverse range of industry sectors including local bodies and infrastructure, food manufacturing, dairy, irrigation and pumping, print and plastics, timber, metals and mining to name just a few, the coming months look to be very positive.

If we can be of any assistance then please feel free to contact the Drive Dynamics team. We look forward to being of service to you.

Drive Dynamics will be exhibiting at this year's Water New Zealand's Annual Conference & Expo.

If you are attending the conference, we look forward to seeing you on our Stand C3 (adjacent to one of the four catering areas). If you are not a conference delegate, but would like to visit us on our stand please send us a line to; sales@drivedynamics.co.nz and we will arrange a pass.

WATER 2020 From Fragmentation to Efficiency
WATER NEW ZEALAND'S ANNUAL CONFERENCE & EXPO
23-25 SEPTEMBER 2009 • ROTORUA

Rotorua Energy Events Centre, 23 - 25 September 2009

Power Electronics Continues Expansion with an Environmental Edge

Despite many competitors cutting back in these tough times, Power Electronics is continuing to expand - but not in the traditional way.

Power carried out a major analysis to identify any areas which affected customer service - in particular any delays to fast-build production. One such area was delays in production due to long lead times with external metalwork production. After trying many external suppliers without the necessary improvement, the decision was made to bring the whole metal work production in-house. A purpose built 3,100m^2 factory was constructed and a complete new range of computer controlled equipment was installed. The improvements have been dramatic with reduced lead-times, reduced stock, reduced waste and fast prototyping. In addition some design changes have been implemented to reduce the assembly times.

The building was purpose built with a roof structure and orientation to optimize the output from the solar panels - this was the perfect test bed for Power's new solar inverters to generate electricity back into the grid and made economic sense. Several years earlier the main factory had solar panels and inverters installed and the benefits of an optimized orientation and structure were calculated to be worthwhile in any new building.

Clean, green, carbon neutral and the efficient use of the latest technology in all aspects of the business is giving customers an advanced product at a competitive price.


V5 Soft Starter Range Extended to Include Internal Bypass Contactor

Power Electronics have recently released the latest range of V5 soft starters incorporating integral bypass contactors for models from 4.5kW thru to 630kW. This new range compliments the existing V5. This development is of great benefit to customers wanting to install the V5 into cabinets or applications where the heat losses of a traditional soft starter present an issue.

The internal bypass contactor is automatically switched on after the acceleration period is completed bridging out the SCRs. When the internal bypass is activated there is no interruption to the normal operation or protections features of the V5. Once bypassed the heat dissipation from the V5 is almost zero eliminating the need for any external ventilation systems or oversized cabinets.

The capacity limitation of soft starters is mainly a thermal constraint. The utilization of an internal bypass contactor means the V5 soft starter can be sized for the correct starting current requirements only, as the normal running currents are passing through the bypass contactor and not the SCRs. This allows for the selection of a V5 soft start to be more closely matched to a specific application. For many applications this may allow a smaller V5 soft starter to be used.

An international norm, IEC 60947-4-2, governs how this data is presented so that it is consistent between manufacturers. The starting ratings that relate to a bypassed soft starter are commonly referred to as the AC53b ratings and show detail in the following manner:

EXAMPLE

110	:	AC53b	4.5	–	30	:	330
①		②	③		④		⑤

① Rated Current of the Softstarter under the described conditions: In, (110 Amps)
② The thyristors will be bypassed
③ Starting Current, as multiple of the nominal current (In), that means: 4.5xIn
④ Starting Time, in seconds, (30s)
⑤ Seconds between the end of starting and the beginning of next starting (10 startings per hour)

To assist customers in selecting the correct model V5 internally bypassed soft starter a selection table showing each V5 model and its AC53b ratings has been produced.

500Vac (-20% to +10%)

FRAME	CODE	AC53b 3.0-30:330		AC53b 4.0-30:330		AC53b 4.5-30:330	
		Rated I (A)	Motor Power (kW) at 500Vac	Rated I (A)	Motor Power (kW) at 500Vac	Rated I (A)	Motor Power (kW) at 500Vac
1	V50009B	14	11	10	7,5	9	5,5
	V50017B	26	18,5	19	15	17	11
	V50030B	45	30	34	22	30	18,5
	V50045B	68	45	51	37	45	30
	V50060B	90	55	68	45	60	37
	V50075B	113	75	85	55	75	45
	V50090B	135	90	101	75	90	55
2	V50110B	165	110	140	90	110	75
	V50145B	218	150	164	110	145	90
	V50170B	255	185	192	132	170	110
	V50210B	315	220	237	185	210	150
	V50250B	375	250	281	200	250	185
3	V50275B	412	280	310	220	275	200
	V50330B	495	355	370	250	330	220
	V50370B	555	400	416	280	370	250
	V50460B	690	500	518	355	460	315
4	V50580B	870	560	650	450	580	400
	V50650B	975	630	731	500	650	450
	V50800B	1200	710	900	630	800	560

NOTE: Rated power and currents at 500VAC (-20% to +10%) for motors of 1500rpm

For further information give us a call or download the latest V5 brochure at www.drivedynamics.co.nz

DV/dT – what's the big deal and how important is it?

In the last Drivelink issue we talked about how the SD700 achieved EMC with unscreened motor cables. Part of this discussion centred on the effects dV/dT has on RFI, however high dV/dT has further negative implications.

A typical output stage of an AC variable frequency drive consists of six transistor switches (usually IGBTs) which are turned on and off at a rate varying between 1 – 20kHz. The evolution of the IGBT has meant that the latest generation devices can be turned on from zero to peak voltage in just 0.1 microseconds. This rapid turn on has resulted in reduced loses and improved output waveforms but has some major drawbacks.

So exactly what is dV/dT?

DV/dT relates to the speed in which it takes the IGBT to fully turn on. This is expressed in the change in voltage (Delta Voltage – dV) with respect to the time it takes (Delta time – dT) and is measured in volts per micro second (v/us). Figure 1 shows a high dV/dT output voltage waveform of a VSD comprising of thousands of on/off pulses each with major voltage overshoot.

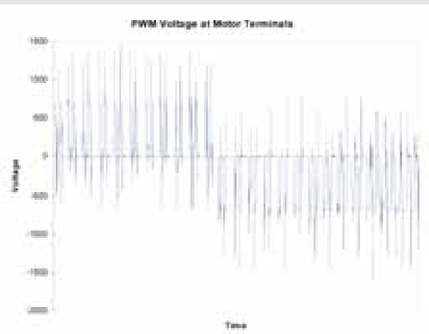

Figure 1. Typical high dV/dT output voltage waveform of VSD

Since the time it takes for the voltage to rise from zero to peak value is so little, dV divided by such a tiny dT results in a very high dV/dT figure. On some 400V drives this can be greater than 6000v/us. In reality when a high dV/dT pulse train is applied across a resistor/capacitor circuit (cable and motor) the resulting voltage is a large spike with a ringing tail as shown in figure 2 wave form captured from an opposition drive.

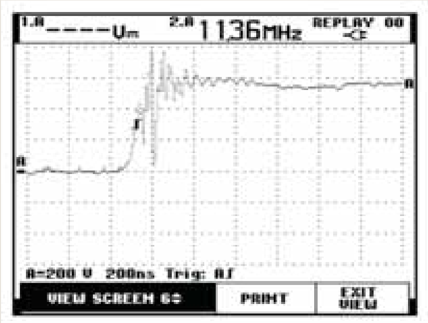

Figure 2. Actual output waveform of competitor 200A drive.

What are the negative implications?

The main problems associated with high dV/DT are motor insulation failure, motor bearing failure (EDM), and increased levels of RFI (covered last month). It has been discovered that the majority of motor failures experienced with VSD's is due to high dV/DT.

The motor windings are subjected to these continuous fast dV/dT pulses and eventually the insulation becomes stressed and breaks down. The typical mode of failure is between turns. The first turn within the motor windings has the greatest voltage applied across it so it is often this first turn that fails. This has coined the phrase 'first turn winding failure'.

Additionally, the drive output voltage pulses must be carried to the motor via an interconnecting cable. There is an impedance mismatch between the cable and the motor that results in a reflection of the voltage pulses once they reach the motor terminals. These reflected pulses can then be added to by the next wave front travelling out from the VSD. This addition can result in terminal voltages reaching twice the DC bus voltage (>1200V). This overvoltage effect is often referred to as 'transmission line effect', 'reflected wave' or 'standing wave' and is characterised by the VSD dV/dt, cable length, cable type and motor characteristics. On a VSD with no dV/dT mitigation, this reflected wave will start to have detrimental effects with only 15m of cable connected – the longer the cable run the worse the reflected wave effect and higher the voltage can reach.

Such a high voltage can break down the insulation of the cable (most standard cables are rated to 1000V) but worse, damage the insulation of the motor. Smaller motors will often suffer winding to winding failures ('punch through') and larger motors partial discharge where unstable ozone is released that attacks the insulation compounds.

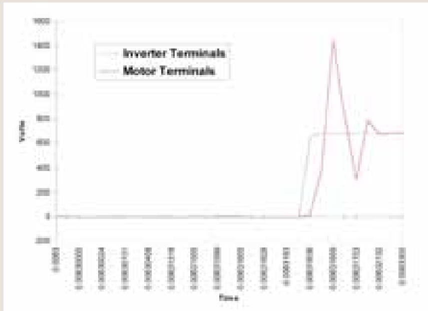

Figure 3. Peak voltage at VSD and motor terminals.

Much has been written about motor bearing failures caused by electro discharge machining (EDM). There are three recognised failure mechanisms. 1. Capacitive coupling to the rotor, 2. Circulating currents, 3. Capacitive coupling from stator to ground. These failure mechanisms are produced mainly by high frequency common mode voltage output of the VSD and high dV/dT. The high switching edge produces very fast currents flowing into the motor frame, which can induce reflected currents in the rotor. This leads to circulating currents through both the bearings and frame.

Lowering the dV/dT may indirectly reduce capacitive discharge in certain applications by reducing motor terminal voltage overshoot (due to 'transmission line effect') on applications with cables exceeding 15 – 20m.

While not the sole contributor to EDM, high dV/dT has a significant impact and is its reduction alone can often be enough to eliminate EDM if the other failure mechanisms are of insufficient magnitude.

How does the SD700 stack up then?

To reduce these over-impulses and thus reduce the problems described above, the SD700 employs unique hardware that limits dV/dT at IGBT level plus incorporates output toroids which further reduce differentially coupled noise. Additional, the low dV/dT permits the installation of unscreened motor cables with runs up to 300m being permissible without the associated 'transmission line' problems. Consider applications such as submersible bore pumps (where the motor design makes them even more susceptible to the high pulse rate and voltage overshoot) and heavy industrial applications such as mining where the drive can be located well away from the motor and this extended cable length can be very beneficial. Figure 5 shows the actual output waveform of a 200A SD700 running at full load. There are no over-impulses. The actual dV/dt (measured at the motor terminals) is less than 500V/us and the voltage overshoot is less than 1000V.

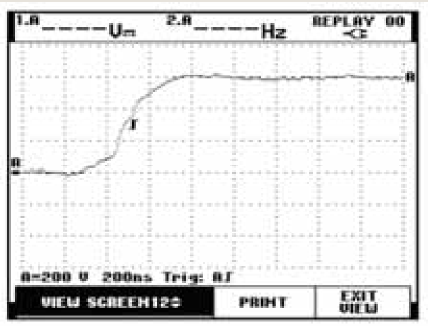

Figure 5. 200A SD700 output wave form.

To date there have been no motor failures attributed to dV/dT on the SD700 series.

DV/dT is becoming a very serious issue and with the increased switching speed of modern IGBT's there is a corresponding increase in motor failures. A reputable drive supplier will have published information on their dV/dT levels and should be able to provide scope traces to back this up.

"Drive Tips" –

Frequently Asked Questions

- Will an Electronic Reduced Voltage Starter (RVS) be suitable to start my slip ring motor with the slip rings shorted?

  A slip ring / wound rotor motor is designed to be used in conjunction with external rotor resistors, which are switched out during the motor start sequence. Slip Ring motors have extremely low resistance rotors and straight rotor bars (as opposed to squirrel caged rotors) and will sometimes not start on D.O.L, or RVS starters. The V5 range of Soft Starters has a unique motor control algorithm which will start Slip Ring motors without the need for external rotor resistance. Note, rotor currents may be higher than usual, under this configuration; however, we have many successful V5 Soft Starters / Slip Ring Motor applications. For further information please contact us.

- If I have a load that cannot be started Direct on Line, will a Reduced Voltage Starter help me?

  An Electronic RVS is used to ramp the voltage up to a motor over a given period of time. Reducing the voltage applied to the motor terminals also reduces the amount of torque that the motor can create. It is this voltage ramp, and resulting torque reduction, that allows us to provide a 'softer' acceleration of most loads. If a load cannot be started DOL this indicates there is insufficient torque available from the motor and applying an Electronic RVS likely to compound your starting dilemma.

  Some loads, such as high inertia loads (flywheels, centrifuges, decanters etc), require extended starting times. This type of load often cannot be started DOL because of the high starting current drawn for extended periods resulting in the operation of the I2T protection, or worse, burning out the motor or distribution equipment. Sometimes an electronic RVS can help with starting a load of this type but often a VSD should be considered. We can help you with the best advice here.

- I am confused about how to select the correct VSD for my application. When comparing brands there appears to be different terminology / selection criteria.

  From a VSD selection perspective there are broadly two types of motor loads - Variable Torque (VT) or normal duty, where load decreases with the speed (Centrifugal Pumps & Fans etc) and Constant Torque (CT) or heavy duty, where load remains constant regardless of speed (Conveyors, Crushers etc).

  In general terms, VT loads require little or no overload capability, and CT loads often require high transient overload capability to break a machine away, or provide short-duration peak overload current. Thus a VSD that is suitable for CT or heavy duty will have a higher overload capacity, and often higher ambient operating temperature rating, than its VT or normal duty counterpart.

  To ensure customers are not commercially penalized, VSD manufacturers will present both VT and CT ratings so the customer can select the right rated VSD for the application. This rating information is presented by different manufacturers in different ways - although the end result is the same. The most common ways of presenting the rating are:

  1. *Some VSD manufacturers rate their equipment for VT applications (normal / pump duty) as standard. These VSDs typically have a peak overload capacity of 110% and are rated for 35 - 40 Degree C operating ambient. If the VSD is used for a CT application (heavy duty) they recommend selecting the next VSD size up. E.g. if you have a 11kW motor on a heavy duty / CT application you need to select a 15kW VSD.*
  2. *Some VSD manufactures, such as Drive Dynamics, rate their equipment for CT applications (heavy duty) as standard. These VSDs typically have a peak overload capacity of 150% and are rated for 45 - 50 Degree C operating ambient. If the VSD is used for a VT application (normal / pump duty) they recommend selecting the next VSD size down. E.g. if you have a 15kW motor on a pump motor, an 11kW VSD is all that you need.*
  3. *Some VSD manufacturers produce separate ranges of VSD for VT and CT applications. Whilst this makes it easier to select the correct unit this can often lead to increased spares holdings and different software between products.*

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Experts in Motor Control

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