12 Pulse DC Drives

Introduction

Twelve Pulse uses two three phase supplies, phase displaced by 30 degrees, to provide a six phase supply which produces 12 pulses in each cycle i.e. 720Hz output ripple from a 60Hz supply. The primary purpose of 12 pulse is to reduce the harmonic currents in the supply. The characteristic harmonics in a rectifier are nf+/-1, where f is the pulse number. The 5^{th} and 7^{th} harmonics, which are the greatest amplitude in a 6 pulse converter, are not present in the 12 pulse which produces 11^{th}, 13^{th}, 23^{rd}, 25^{th} etc. Typically 12 pulse will reduce the Total Demand Distortion to less than half of the 6-pulse level.

Power Configurations

The six-phase supply is most commonly provided by one transformer with two secondaries, one Wye connected and the other Delta connected. The two windings feed two 3 phase Thyristor bridges with the DC outputs connected in parallel, the negatives are directly connected together and to the load negative, and the positives connected via an Interbridge reactor with the center tap connected to the load positive. The Interbridge reactor is required to enable the individual thyristors to conduct for 120 degrees, without it they would only conduct for 60 degrees reducing the current rating.

Alternative supplies can be used, e.g. two separate transformers one with a delta secondary, the other a wye. Another option uses only one transformer, to phase shift the supply to the slave stack, fed from the supply feeding the master stack.

All transformer configurations require each winding to be rated at half the total load so that the combined rating is 100% full load.
Example: 1000HP drive, 500VDC motor. Each drive is 500HP, 800Amps and each transformer winding is 550KVA, total transformer rating 1100KVA.

Quasi 12 pulse is produced using two drives and motors with the drive supplies phased shifted by 30 degrees. If the drives run at the same speed and load, e.g. load sharing on a common shaft, the combination will act as a 12 pulse drive reducing the total supply harmonics.

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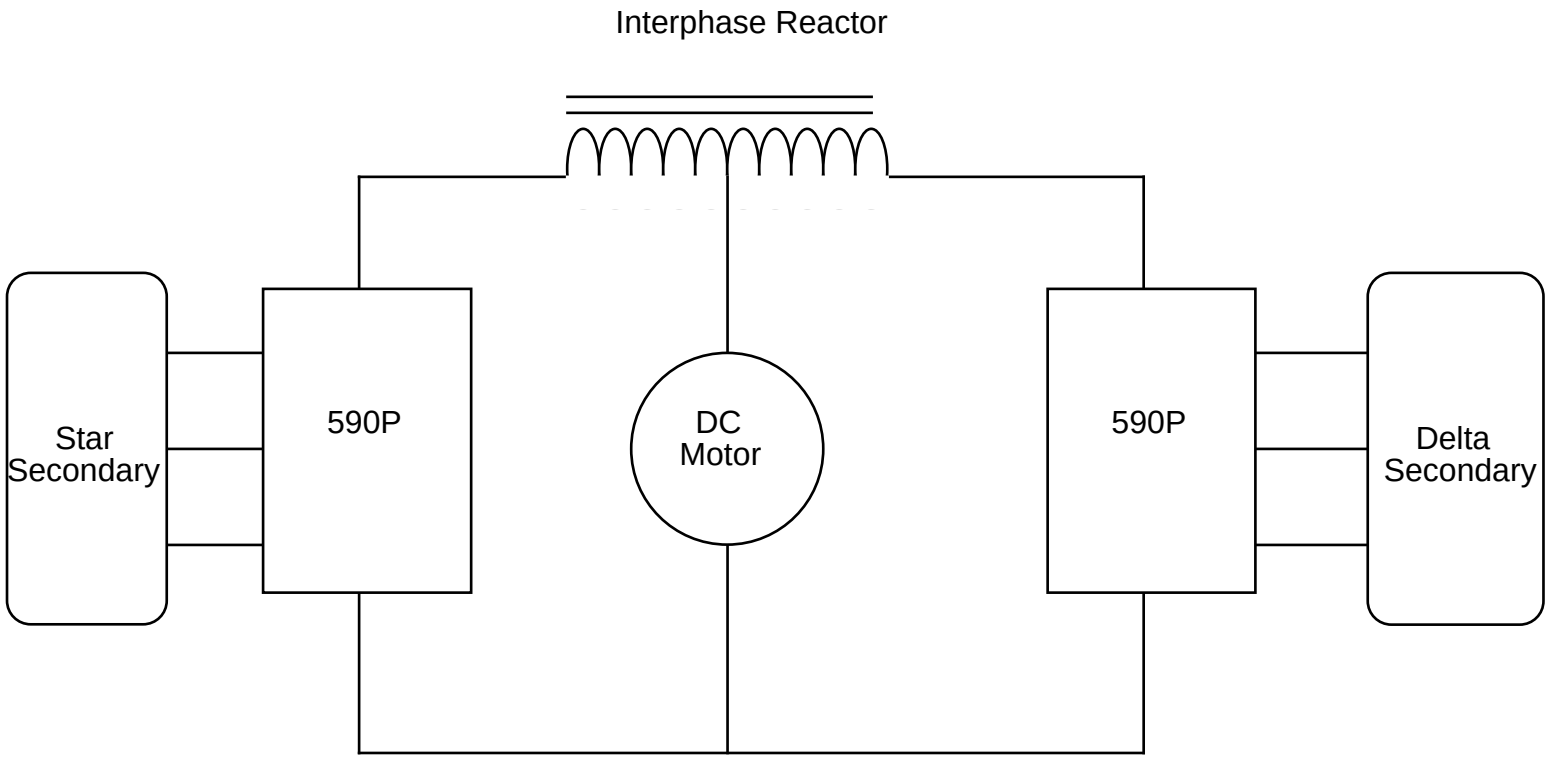

Control Configurations

Single ended 12-pulse control has been possible with the 590 by using two drives; a master speed controlled drive and the slave in current control using the master current demand. This has not been suitable for regenerative drives as there is no interlocking to ensure the two drives are always firing on the same bridge. The 590+ version 5.13 now has a software selection for 12-pulse master or slave, which provides the interlocking for regenerative operation.
The 12 pulse Master drive provides outputs to the slave drive of current demand and the enables for Master or Slave bridges. The Slave drive provides an output, to the master, that the Slave is at Zero Current, for bridge switch interlocking.

The 12-pulse selection is in the Reserved menu as Enable 12 Pulse.
0= Normal operation, 12 pulse disabled,
1= 12 pulse Master and
2= 12 pulse Slave.

Signal wiring connections between master and slave drives:

Master	Slave
Digital OP1 (B5) Master Bridge Enable	Digital I/P1 (C6)
Digital OP2 (B6) Slave Bridge Enable	Digital I/P2 (C7)
Analog O/P1 (A7) Modulus Current Demand	Analog I/P2 (A3)
Digital I/P1 (C6) Slave at Zero Current	Digital OP1 (B5)
Ov Common (B1)	Ov Common (B1)

Configuration
The Digital I/O are hard coded, the source or destination must be set to zero. Disconnect all unused function blocks (set destination to zero) and minimise configuration to optimise performance.
Master Drive
Connect the Unfiltered Ia Demand (tag 66) in the Current Loop to Analog O/P1. Analog O/P1: Modulus = True, 10V Cal =200%.
Reserved: Set Enable 12 pulse = 1, Set Min BS Dead Time = 5
Slave Drive
Current loop: I Dmd Isolate = Enabled
Analog I/P2: Calibration = 2.00, Max Val = 200%,
Field Control: Disable Slave Field
Reserved: Set Enable 12 pulse = 2.

Commissioning

The Master drive can be run initially by itself. The Interbridge reactor may saturate, as the flux will not be cancelled by the equal master and slave currents, changing the effective load time constant. The master drive can be Autotuned but both drives cannot be autotune together. After autotuning the master drive, enter the master current loop parameters for P gain I gain and Discontinuous into the slave drive. Next run both drives together and manually check the Discontinuous level by disabling the field and increasing the Current limit while monitoring the master current with an oscilloscope.