UNITED AUTOMATION

PHASE ANGLE CONTROLLERS USED ON INDUCTIVE LOADS REMEDIES SHEET

ILR

X10378

INTRODUCTION

The United Automation range of single phase and three phase Power Controllers (primarily, Phase Angle type), can be used to control a wide range of AC motors and other inductive loads, such as transformers. The characteristics of an inductive load may cause problems with varying Phase Angle control. This sheet has been introduced to help you identify problems causes and offer simple remedies.

Typical Loads include - Induction motors, Capacitor Start motors, Transformers.

CAUSES

TRANSIENTS

Due to the extremely fast switching action of thyristor devices and the usual high commutating duty of the circuit, the possibility of voltage transients becomes a problem requiring a practical solution. The thyristor (or SCR) has a small thermal capacity and a rapid transition of reverse dynamic resistance in the avalanche breakdown region, resulting in very small differences between the voltage the thyristor can block satisfactorily.

The Transient voltages in thyristor circuits can be generated due to a power line disturbance, interrupting or energizing of transformer circuits and inductive or capacitive load switching etc.

The elimination or reduction of voltage transients requires slowing down the rate of dissipation of stored energy across the device by providing additional energy storage or dissipation means in the circuit. One of the most effective methods of doing this is to use Voltage Dependant Resistors (VDR).

HIGH SURGE INRUSH

When the thyristor power controller is operated, using loads where high inrush current surges can occur, it is desirable to utilise a ‘soft start’ type of circuit. This type of circuit gradually increases the output of the thyristor controller so that there is no immediate application of full voltage to the load, which might cause damaging surge current. A typical load, which exhibits this type of characteristic, is a transformer primary. The magnitude of inrush current of the transformer depends on the design of the particular unit and the basic magnetic construction of the transformer. If the transformer saturates, it causes high inrush currents, which may damage the thyristor or blow the main SCR fuses of the thyristor power stack.

Thus, in soft start operation, if there is an input signal when the thyristor unit is energised, there will be no output of the thyristor unit. The output will initially be zero and then gradually increase to maximum output, as the soft start action takes place over a period of seconds. During normal operation of the thyristor, the soft start feature has no effect on the response speed of the thyristor.

SCR FORWARD VOLTAGES - dV/dt

A thyristor may be switched into the "ON" condition by a high rate of rise of forward voltage. This switching action can result without the presence of the normal firing pulse and is called ‘dV/dt’. The false firing of thyristors in this manner can cause control problems. To prevent this condition occurring, RC and/or C networks are fitted directly across each thyristor or pair of inverse parallel thyristors (A typical SCR/SCR Powerblock

VOLTAGE DEPENDANT RESISTORS (VDR’s)

One of the most effective methods of Transient protection is to use voltage dependant resistors. Below the rated peak voltage the VDR draws negligible current; but as the voltage goes above this value in a transient voltage condition, the VDR current increases very rapidly and dissipates the transient energy.

'SOFT START' – HIGH SURGE INRUSH PROTECTION
Our wide range of soft start options come as built in functions within a Firing Module unit, or as an optional extra remote unit. Some Firing Modules also have an option of varying the soft start time, by selection of a capacitor or cermet adjustment.

R-C SNUBBERS
The introduction of a resistor and capacitor series network, connected across the SCR, helps inhibit any misfiring of the devices to be controlled.
The dV/dt parameter is of particular importance when thyristor power controllers are used in applications where the load has fast 'rise' times, or the unit is subject to high frequency transient voltages, as discussed in the Transient section. Power contactor and circuit breaker closures on industrial power feeder circuits, are possible sources of high dV/dt.
The dV/dt capability of the thyristor is also temperature dependent, as its ability to withstand dV/dt decreases as the junction temperature increases. Operation at lower temperatures thus allows the thyristor to withstand higher rates of dV/dt.
The suppression of dV/dt is also quite important for inductive loads such as transformers. In non-inductive load applications, the voltage and current waveform both pass through zero at the same instant and at this point, one of the conducting thyristors within the pair of inverse parallel thyristors, will be commutated or turned 'off'. However, an inductive load causes the current waveform to lag the voltage waveform. In this case, when the current wave reaches zero, the voltage wave is not at zero and the subsequent voltage appears as a forward bias across the other SCR. The rate of change of this voltage (dV/dt) depends on the amount of inductance in the load circuit. An R-C snubber in parallel with the thyristor can reduce the dV/dt to within allowable limits.

GENERAL SUMMARY
RC Snubbers: - The fitting of a RC snubber (across the 'Inductive Load' and/or 'power controller') will usually improve the performance of the application by reducing the effects of back EMF (Electro-motive force) to the semiconductor device. Typical values would be a 0.22uF + 100R of appropriate ratings.
Voltage Dependant Resistors (VDR's): - A VDR fitted in parallel (across the inductive Load and/or across the supply power controller), with very short leads, will help clamp voltage spikes generated by the inductive loads. The selected VDR's should have a Maximum continuous voltage rating, higher than the supply voltage and have good energy absorption (e.g. a VDR type Z250G, manufactured by Bowthorpe Thermometrics would typically be selected for any range of Mains supplied single phase Power Controllers).
Soft Starts: - This is desirable when controlling loads in single phase where high inrush current surges can occur.
'Minimum Set' Speed: - This applies usually to motor/fan control. Most motors will have an inherent speed below which it will not control properly (known as 'hunting'). A resistance (or adjustable potentiometer) fitted across the main control potentiometer will allow a minimum voltage level (speed) to be fixed, thus stabilising the remaining voltage range (speed control). Typically a 1M Ohm cermet would be suitable across the main 250K potentiometer.
Further Information: - Please contact our Technical Sales Desk. Other supporting Data Sheets, available on request, include the following: -

CODE	IDENTITY	DESCRIPTION
X10255	SRA	Safety requirements- addressing the Low Voltage Directive (LVD)
X10213	ITA	Interaction- problems when using Phase Angle and Burst Firing control
X10229	RFI	Single Phase Mains Filtering- recommendations addressing the EMC Directive
X10403	2-RFI	Phase/Phase Filtering- recommendations addressing the EMC Directive
X10327	3-RFI	Three Phase Filtering- recommendations addressing the EMC Directive
X10390	ZSS	Zero and Span Set-up- Instruction for Firing Circuits with this setting option

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