X10213 – Interaction Causes & Remedies (ITA)

INTERACTION

A sudden current change within a conductor generates Radio Frequency Interference (RFI). Therefore, unsuppressed Phase Angle thyristor or triac power systems inherently generate RFI, rising to maximum at mid-phase angle. High impedance Phase Angle controlled thyristor trigger circuits can be considered as sensitive receivers of any generated RFI.

These two characteristics of adjacent Phase Angle controlled systems, can cause interaction (also called Cross-talk or Tracking), unless the following procedures are used.

Zero Voltage Switching (ZVS) control removes this problem and should always be first choice in multi-thyristor systems for resistive loads.

Both Phase Angle and Burst Firing control are detailed further on page 2

INTERACTION REMEDIES IN PHASE ANGLE CONTROL SYSTEMS

In sensitive applications, interference must be suppressed to comply with the Electromagnetic Compatibility (EMC) Directive (2004/108/EC). This includes emissions and immunity standards, which prevent and protect against interaction with other components. This may be achieved by the addition of a series, parallel combination filter network.

The following guidelines are important aspects for correct circuit layout, to help eliminate interaction problems in power application circuits:

1. Run both leads of each power circuit as a twisted pair and, when practical, avoid close proximity to other RFI transmitting or receiving components. Earth leads should be rated higher than the maximum power of the circuit and kept as short as possible.
2. Ideally, to achieve the above, keep the widest possible spacing between phase angle firing controlled circuits and other large power carrying conductors.
3. Any high impedance signal/control wires should be kept as short as possible, preferably twisted, shielded and separate from power cables.
4. Avoid wires encircling magnetic components (e.g. Transformers).
5. A series inductance fitted in the supply line will limit di/dt at thyristor switch-on and consequent transmitted output, reducing the risk of interaction (See RFI Data Sheet).
6. Interaction is a whole system phenomena resulting from the nature of phase-angle thyristor control and will almost always be eliminated by some or all of the above steps.

Notes

a) Phase Angle units controlling quartz loads may draw more current on initial switch-on, due to the 'cold resistance' of the lamps. An additional 'factor of safety' rating for this should be catered for.

b) When a controller unit fitted with a 'snubber' (R-C network), is used with a remote filter, it may 'interact' (e.g. cause resonance) with the internal choke of the filter. Intermittent and/or periodic malfunction of the controller may be evident. Changes in the RC component values may remedy this.

For further information on electrical wiring see the current IEE wiring regulations to BS7671 (or IEC 950)

RFI FILTERS

A 'type' filter would normally be required because of the function of Phase Angle control firing of Power circuits, to reduce the RFI to an acceptable level of emission within EMC standards. These standards are identified on the appropriate Declaration of Conformity, to address the 'CE' marking of products.

Particular attention should be paid to 'good earth bonding' and current selection for the F1-series 'type' filters which incorporate a series choke, to achieve maximum choke efficiency.

See also RFI Datasheet for connections and available 'type' filters

TYPES OF POWER CONTROL

The performance of any triac or thyristor (also known as an SCR) system and its suitability for a particular application depends on the type of control circuit used. Fundamentally there two types of power control – PHASE ANGLE and BURST FIRE. A visual output analysis of both these types of load would be for:-

PHASE ANGLE – the load would be dim and gradually increase to full on for 0 to 100% control.

BURST FIRE – the load would pulse (at 50% control the output time base would be half-on and half-off).

UNITED AUTOMATION LTD

Southport Business Park
Wight Moss Way
Southport, PR8 4HQ
ENGLAND

Tel: 0044 (0) 1704 – 516500
Fax: 0044 (0) 1704 – 516501
enquiries@united-automation.com
www.united- automation.com

X10213 – Interaction Causes & Remedies (ITA)

In the design of a firing circuit these control methods can be combined to form DUAL CONTROL – this is where one or the other or both may be selected or combined. COMBINED DUAL CONTROL is generally selected for starting in PHASE ANGLE and then switching over to BURST FIRE control, which is particularly suitable for a burst firing application load that is not purely resistive i.e. a tungsten load, which draws larger current than normal when cold.

The main types, characteristics and features of both Phase Angle and Burst Firing circuits, showing the waveforms and probable sources of RFI, are detailed below

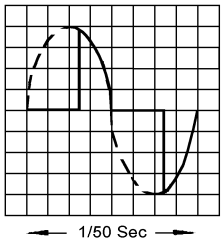
PHASE ANGLE TYPES
(e.g. CSR, QVR and PSR family)

These are universally applicable and are often more economical but are susceptible to RFI caused by interaction between systems

PHASE ANGLE
Graphs show load voltage against time on 1/50 second repeating time base at 30% and 60% throughput. Output is a chopped sine wave allowing more power through as conduction angle is increased.

GENERATION OF RFI
The step function of current creates a wide range of radio frequencies and is the main source of RFI.

FIG . A1
30% PHASE



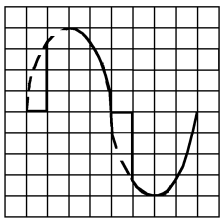
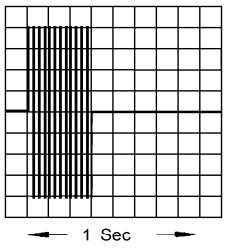


FIG . A2
60% PHASE

BURST FIRING TYPES
(e.g. ZVS, BVR and ZVT family)

These are virtually free from RFI problems but are only suitable for resistive loads.

FIG . A1
30% BURST



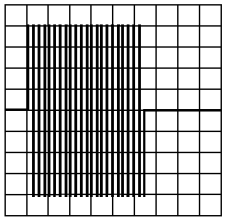


FIG . A2
60% BURST

BURST FIRE
Graphs show load voltage against time on 1 second repeating pattern time base at 30% and 60% throughput. Output is block bursts of complete sine waves, switched on and off at zero voltage mains crossover. More power is allowed through as ON to OFF ratio is increased.

INHIBITION OF RFI
No step function as current is only switched on at zero voltage; therefore the RFI problem is eliminated.

PHASE ANGLE FIRING FEATURES

In each mains supply half cycle the duration of thyristor conduction is determined by the firing instant, relative to mains polarity changeover.

Once switched on, the driven thyristor conducts power to the load until the end of each applied half cycle, resulting in a chopped sine wave output.

A ramp and pedestal input circuit, allowing variation of firing phase angle by DC signal, enables more power through to the load with increasing conduction angle. Advantages of phase angle firing include:

Operation with all types of loads including inductive, with features such as soft start, current limit facility and step-less quick response.

BURST FIRE FIRING FEATURES

Using Zero Volts Switching (ZVS) burst firing, the alternative form of triggering, gives interference free AC power control. This circuit inhibits RFI by switching 'on' and 'off' at zero volts mains crossover, in repeating time periods (typically one second).

The number of complete mains supply sine waves are varied in its ON/OFF ratio, or duty cycle, linearly by the control signal level. The burst firing circuit provides trigger pulses coincident with mains zero polarity change-over, ensuring only complete half cycles are passed through to the resistive loads.

This prevents step changes in load current, and thus virtually no RFI is produced. All our Burst Firing Circuits are available and suitable for 2, 3, 4 or 6 -wire load connections (see 'Stacks' Product Technical Datasheets).

Stability against temperature and supply voltage variations is exceptionally good.

UNITED AUTOMATION LTD
Southport Business Park
Wight Moss Way
Southport, PR8 4HQ
ENGLAND
Tel: 0044 (0) 1704 – 516500
Fax: 0044 (0) 1704 – 516501
enquiries@united-automation.com
www.united- automation.com