



INTERACTION CAUSES AND REMEDIES

ITA

X10213

INTERACTION

A sudden current change within a conductor generates Radio Frequency Interference (RFI). Thus, 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 Electromagnetic Compatibility Regulations 1992 (SI 1992 No. 2372), this includes emissions and immunity standards, to 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. causing resonance) with the internal choke of the filter. Intermittent and/or periodic malfunction of the controller may be evident. Changes in the RC components 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 emissions 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 incorporates a series choke, to achieve maximum choke efficiency.

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

The performance of any thyristor system and its suitability for a particular application depends on the type of control circuit used. 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 interaction between systems.

BURST FIRING TYPES

(e.g. ZVS, BVR and ZVT family)

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

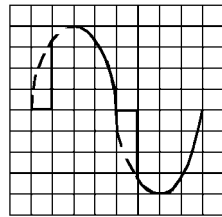
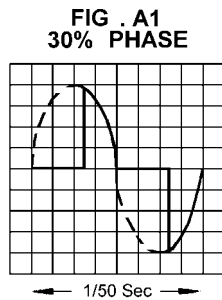
CHARACTERISTICS

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.

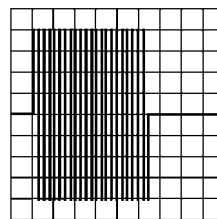
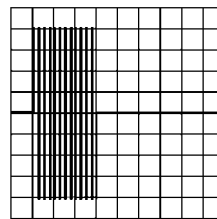
GENERATION OF RFI

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



**FIG . A2
60% PHASE**

**FIG . A1
30% PHASE**



**FIG . A2
60% PHASE**

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

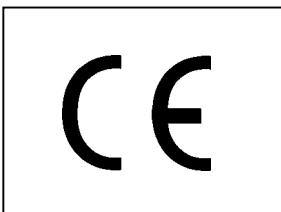
No step function as current is only switched on at zero voltage, therefore the RFI problem is eliminated.

PHASE ANGLE FIRING FEATURES

In each mains half cycle the duration of thyristor conduction is determined by the firing instant, relative to mains polarity changeover. Once switched on, the driven thyristor conduct 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, soft start, current limit facility and stepless 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 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. UAL 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.



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 Page No. 2 of 2 Issue 2 Date 13/04/00

