Why Do DCVG Ltd Interrupters Use Solid-State (MOSFET) Switches?

A better question might be “why do we not use mercury contactors?”

Well……a two word answer would be: ***TIMING ACCURACY***

Whilst mercury contactors are no doubt well made and admirably suited to their primary applications such as switching industrial lighting or heating control, they are not really intended for devices requiring accurate timing and synchronization with other instruments. We were recently asked to investigate using our Quantum data logger with another manufacturer’s GPS synchronized interrupters. Straight away, we observed discrepancies between the programmed switching cycle and the actual one. What was supposed to be a waveform of 400ms ON, 600ms OFF was actually 450ms ON, 550ms OFF. Worse still, the ON and OFF periods were found to vary by up to 20ms. Looking inside our competitor’s interrupter revealed a commonly used 100 amp rated mercury contactor. Examination of the data sheet for this part showed that operate and release times had quoted maximums of 200ms and 100ms respectively, with typical and drift figures not being specified at all. Further testing showed the OFF->ON switching edge to be offset from the GPS pulse-per-second output by 670ms, again with timing jitter of ±20ms.

DCVG Ltd 50 Amp Interrupters

DCVG instruments have none of these problems!

We’ve long believed that our MOSFET switches are the correct choice for a number of other reasons too:-

- More efficient use of power, did you know that a typical mercury contactor requires over 400mA to energize its switching coil?

- Mercury is extremely hazardous to the environment. Whilst it is not yet banned, there are strict

- MOSFETS have no moving contacts to seize nor switching coils to burn out.

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Further notes on the characteristics of our MOSFET switches

Modern power Mosfets are very durable, reliable devices with many thousands of hours of trouble free use behind them. However, some surveyors are still wary of using solid-state switches, due to a lack of understanding of what they can and cannot do. Part of the problem may be that competitors use multiple (20 or more) small Mosfets rather than a single large unit and one of these small Mosfets giving trouble can pose problems for the complete device.

The gate-source current of our MOSFET is less than 100nA, compared with 400mA plus required to energize the switching coil of a typical contactor. It's differences like this that make it possible for us to build interrupters smaller in physical size than our competitors whilst enabling us to have the primary power source to operate the Interrupter built in. However, we do have the facility to power externally to keep the satellite controlled Interrupters running for several weeks without attention.

Rise and fall times (the length of time taken to turn ON and OFF respectively) for a mercury contactor are typically hundreds of milliseconds. By comparison, a MOSFET takes less than one microsecond to make the same transitions. This enables us to accurately generate shorter waveform periods which enable CIPS surveys to be performed at a faster, more natural walking pace. In addition, the switching characteristics of our interrupters have far less influence on the voltage measurements which makes for speedier, more reliable survey results. For example, at an ON/OFF of 0.8 seconds ON/ 0.45 seconds OFF which is the same but reverse of that commonly used for DCVG surveying. Hence, it is possible to run the CIPS and analogue DCVG surveys at the same time and the short cycle a measurement of ON and OFF potentials can be observed for every 1 to 1.5 metres of pipeline.

The factor which determines the rated switching capability of our Interrupters is not the maximum current that the MOSFET can handle but the heat dissipation capability of our heat sinks. Our particular device can handle peak currents of up to 180A. Our larger interrupters use two in parallel, which means peak currents of up to 360A (for very short periods of time) are possible.

One thing the user must ensure is that a MOSFET based interrupter is connected the correct way round or as no ON/OFF pulse will result. However, built-in inverse diodes provide a high degree of reverse polarity protection – they are rated at 180A maximum, the same as the forward current of the MOSFET itself – so a connection error does not result in any device damage. It is interesting to note that most people believe that mercury contactors may be connected either way round which is not the case – their performance and lifetime can be compromised if incorrectly used.

DCVG Ltd 125 Amp Satellite Interrupter using extended operation external power source

The maximum ON resistance of our MOSFET is approximately10 milli-Ω. Whilst this is a low figure, it still needs to be taken into account when setting the transformer-rectifier output for a survey. If, for example, the cathodic protection system normally draws 50A of current, then there will be a drop of 500mV across the MOSFET during the ON cycle. Therefore, the transformer rectifier's output will need to be increased to give the same current output as that without the Interrupter connected to keep normal operational conditions.

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