

Solid State Relay Reliability (MTBF) Report

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INTRODUCTION

Reliability is a term that when applied to Electronic Components or Systems, is used to predict the likelihood of a failure within a given population of similar Components or Systems based upon a set of criteria defining its use or application. Reliability can be expressed several different ways depending upon the type of product being evaluated and how it is applied, but the most commonly used measure in the electronics industry is "Mean Time Between Failure" or MTBF.



MEAN TIME BETWEEN FAILURE (MTBF)

MTBF is a measure of operating time, typically hours, until a failure of a single product occurs within the use population. In its simplest form, a failure is defined as the product's "failure to perform its intended function". However, depending upon specific requirements, a failure could also be defined as a reduction or change in performance of a specific parameter of the product by a given unit value or percentage. A change in performance of a particular value could well be significant in a specific application and therefore constitute a "failure to perform its intended function", but the same parametric change in another application might be irrelevant and not constitute a failure. Therefore, the expectations for a product's use must be well understood in a given application and appropriate calculations or amendments made to the MTBF.

MTBFs can be either "calculated" based upon known criteria and formulas, or "demonstrated" based upon actual data derived from known field applications of the subject product. Ideally, given enough demonstrated data, factors utilized in MTBF calculations of the subject product can be adjusted to more nearly represent real life experiences bringing the two values closer in alignment.

MTBF applies to a population of similar products applied in a similar environment, which may itself be part of a larger system and therefore more appropriately applies to components used within that system. Consequently, the calculated MTBF of a system is the result of combining the MTBFs of its components, since the first component to fail to perform its intended function generally results in the system's failure.

Factors used in MTBF calculations also take into account "stress". That is, the effect on the failure rate based upon the deviation of use from nominal values. It is well understood that as stress levels increase, MTBF declines. Stress can be in the form of either mechanical or electrical values. An example of mechanical stress would be operating temperature; an example of electrical stress would be operating voltage. Increasing or decreasing either or both of these parameters can alter the product's MTBF.

Another factor to consider related to stress is the relationship of "on time" to "off time". In the simplest form, most components have two different states in a given application: "on" and "off". Certain components will have the least stress in the off state and the maximum stress in the on state. However, others may be reversed or simply have lower stress in one state or the other, or indeed different electrical or mechanical driven stress levels in each state. Therefore it is important to understand these effects on the subject products and take them into account when calculating MTBF.

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MTBF OF SOLID STATE RELAYS

Solid State Relays (SSRs) have several important performance attributes, not the least of which is their reliability. Long life and predictable operation in demanding applications/environments are both expected of SSRs and MTBF can be very helpful determining expected reliability for any given model.

SSRs utilized in traditional “on/off” applications are either AC or DC output, but typically not both. AC output models tend to be very similar in component type and count and vary in output current rating mostly due to packaging. Packaging/Mounting determines available heat sinking which governs their thermal characteristics/output current ratings versus ambient temperature.

DC output SSR models are also very similar in component type and count, but utilize significantly different electronic circuits and components from AC output SSRs. Aside from thermal performance based upon packaging, another common factor between AC and DC output types is the effect of operating voltage on component type and count. Higher load voltages generally require either more components and/or more robust components. As a result of these factors, MTBF between the two basic types (AC and DC) may well be different, but in either event are significantly greater than similarly rated electromechanical relays or contactors.

MTBF CALCULATIONS FOR SELECT SOLID STATE RELAYS MODELS

To assist the user with evaluating the reliability of their Solid State Relays, Crydom commissioned an independent Company specializing in the art to analyze the designs of several different Crydom SSR models including both AC and DC output types, PCB mount, DIN Rail and panel mount types, single and multiphase SSRs. The analysis included evaluation of each product’s design, components, specifications and typical uses. **Table 1** is the extract of the results of the calculations contained in the report based upon a benign 25°C environment (best case).

Prediction Method: Telcordia Technologies Special Report SR-332, Issue 3		
Environmental Condition	GB	
Ambient Temperature	25°C	
Product ID	λ [FIT]	MTBF [Hours]
CX480D5	53.91	18,547,862
D2D40	29.20	34,247,164
DRA3P48E4	199.85	5,003,703
H12WD4850	60.85	16,433,050

Table 1- For the complete report including definition of terms [click here](#)

Crydom model D2D40 is a typical single channel DC output panel mount SSR rated at 40 amps /200 VDC. The remaining 3 models are AC output types with the H12WD4850 being a single phase panel mount SSR rated at 50 amps/480 VAC while the CX480D5 is a single phase printed circuit mount type SSR rated at 5 amps/480 VAC. The DRA3P48E4 is a 3 phase AC output DIN rail mounted SSR rated at 4 amps/480 VAC per phase. The key information in the table is of course the calculated MTBF measured in hours.

APPLICATION EFFECTS ON MTBF

The MTBF calculations shown in table 1 vary from a low of ~5 million hours for the 3 phase AC output SSR, to more than 34 million hours for the DC output SSR. That is a range of 570 to 3880 years! A very long time in real life where equipment may typically be expected to operate from 5 to perhaps 50 years. Why are the MTBF values in this report so large?

First, Crydom Solid State Relays are, by design, very reliable long life products which rightfully earn high MTBF ratings. Demonstrated MTBFs routinely exceed 30 years and continue to increase as products age yet continue to perform properly.

Second, the MTBF values are calculations based upon standard factors, two of which are operation within all specified parameters (no abnormal stress), and in the case of this analysis, at a constant 25°C ambient temperature. These conditions rarely exist in real applications where temperatures can be below -25°C to more than 65°C. Note: the impact of elevated

operating temperature environments is demonstrated in the Appendix A of the report. An increase to 65°C ambient temperature (+40°C), decreases the MTBF from 34 million hours to 10 million hours (70%) for the DC output SSR, and from 16 million hours to 6 million hours (60%) for the AC output SSR.

Third, the relationship between on time and off time is not considered, yet these two states, despite both being in allowed operating parameters, have significantly different impacts on Solid State Relays. For example, the thermal stress created by the transition (heating/cooling) between the 2 states creates additional stress as opposed to a constant operating temperature resulting from continuous on or continuous off states.

Fourth, Solid State Relays are subject to power supply and application variations that can have varying negative impacts on MTBF values. Examples would be voltage transients caused by load and line disruptions. In the extreme, voltage transients or load shorts can destroy SSRs. Technically these are faults, not failures, yet the result in the application is the same...a failure. Crydom offers optional transient protection in certain SSR models to mitigate such circumstances thus helping to insure the product's reliability.

None the less, MTBF calculations following standard guide lines and formulas permit useful and valid side by side comparisons of Crydom Solid State Relays to other SSRs or similar switching solutions. Users need only appreciate and evaluate how their expected application and environment may impact actual expectations for the reliability they can expect to experience in their equipment.

For further information concerning Crydom Solid State Relays, contact Crydom Tech Support, Sales or visit us at www.crydom.com.

To view the complete report on Reliability Prediction for CX480D5, D2D40, DRA3P48E4, H12WD4850 Products [click here](#)

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