ARC FAULT DETECTION DEVICE (AFDD) FAQS

Q.1 Will an AFDD trip on any kind of arcing?

An AFDD is designed to differentiate between what is known as dangerous arcing and arcing associated with normal operation of equipment.

Dangerous arcing is when a continuous (long duration) arc is established creating sufficient energy to cause ignition; e.g. ignition of cable insulation.

A long duration arc is one that exceeds the maximum break times (known as trip time) stated in BS EN 62606 (see Q2).

Arcing associated with normal operation e.g. switching or motor brushes, is short duration arcing (sometimes referred to as 'sparking') and will not cause AFDDs to trip.

Q.2 What is the trip time of an AFDD?

The trip time of an AFDD is dependent on the arcing current. For increasing levels of arc current the trip time decreases. BS EN 62606 Table 1 lists the following maximum break (trip) times :

Test arc current (r.m.s. values)	2,5 A	5 A	10 A	16 A	32 A	63 A
Maximum break time	1 s	0,5 s	0,25 s	0,15 s	0,12 s	0,12 s

Q.3 When required for additional fire protection, RCDs shall be a rated residual operating current not exceeding 300 mA. Why is the minimum AFDD tripping current of 2.5 A so much greater than 300 mA?

300 mA (0.3 A) equates to: 230 V x 0.3 A = 69 W which is related to leakage current and not arc current. RCDs do not detect the specific waveform / signature associated with a stable electric arc. The AFDD tripping time at 2.5 A relates to approximately 100 W and can be explained as follows: The break (tripping) time in BS EN 62606 for AFDDs, is derived from the energy to ignite a cable by degrading the insulation with contact arcing and glowing. The minimum energy value of 100 J with an arc voltage of 40 V was established for the tripping characteristic for series arcing. The total break time tB is therefore derived as follows:

$$t_B = \frac{100\ J}{40\ V \quad I_{arc}} = \frac{2.5\ A\ s}{I_{arc}} \quad \text{for } I_{arc} \leq 20\ A \text{ and } t_B = 0.12s \quad \text{for } I_{arc} > 20\ A$$

100 W for 1 s equates to 100 J, so the AFDD can promptly interrupt the current and limit the duration of combustion of the cable, thus significantly reducing the risk of the fire spreading. AFDDs detect the specific waveform / signature associated with a stable electric arc.

Q.4 Will an AFDD trip if I create an arc manually?

It is very difficult to manually create an arc of sufficient current magnitude and duration to trip an AFDD.

Intermittent touching of conductors together will create numerous short duration arcs (sparks), these arcs (sparks) do not create sufficient arcing current and time duration to trip an AFDD.

Q.5 Under what conditions could a high resistance connection develop arcing and an AFDD detect the arc?

At an electrical connection which clamps on the conductor insulation or which is incorrectly torqued, excessive ohmic heating may occur without sustained arcing and therefore an AFDD would not immediately operate. However, if the connection subsequently deteriorates as a result of the heating, sustained arcing can occur that will operate the AFDD.

A high resistance connection can undergo progressive deterioration e.g. high resistance creates localized heating, heating increases oxidation and creep, the connection becomes less tight, which can result in carbonization and sustained arc tracking which will operate the AFDD.

Q.6 Do AFDDs work on low load-current circuits?

For series arc faults below 2.5 A an AFDD according to BS EN 62606 is not required to trip. However, this does not negate the need for an AFDD as the risk of a parallel arc fault greater than 2.5 A is very probable, irrespective of the low current load.

Q.7 Why is a 2.5 A or higher arc fault considered dangerous when it is known that currents below 2.5 A can cause ignition?

2.5 A is the arc current and not the circuit current. An arc current below 2.5 A does not dissipate enough power to cause ignition. In a high resistance electrical connection, the circuit current below 2.5 A could cause ignition but this is not an arcing current.

Q.8 Why was 2.5 A selected as the lowest test arc current?

Based on the probability of cable insulation ignition, values of arc current less than 2.5 A presented a lower risk.

Q.9 Are AFDDs intended to protect more than one final circuit?

No. An AFDD should be placed at the origin of a single final circuit. This arrangement is prescribed in the AFDD product standard to minimise unwanted tripping.

Installation designs should meet the requirements of BS 7671. The fundamental principle in Regulation 314.1 is that every installation shall be divided into circuits, as necessary, to avoid danger and minimize inconvenience in the event of a fault and to reduce the possibility of unwanted tripping.

Q.10 Do AFDDs require SPD protection?

There is no particular requirement to use external SPDs with an AFDD. The AFDD will have internal protection enabling it to conform to the surge tests described in BS EN 62606.

The need for any transient overvoltage protection in the installation is specified in BS 7671.

Q.11 Does AFDD Regulation 421.1.7 apply to shaver sockets?

No, because a shaver socket will either be a shaver supply unit complying with BS EN 61558-2-5 embodying an isolating transformer or a shaver socket to BS 4573 incorporating 200 mA self-protection.

Q.12 Are AFDDs suitable for EV charging circuits and equipment?

Yes, AFDDs are suitable for the protection of EV charging circuits and equipment.

Q.13 Does AFDD Regulation 421.1.7 apply to socket-outlets and connectors of Electric Vehicle Supply Equipment conforming to BS EN IEC 61851?

The electrical installation designer will need to meet the intent of Regulation 421.1.7. Where Electric Vehicle Supply Equipment incorporates connection products conforming to BS EN 62196, these might not be considered to be socket-outlets within the scope of Regulation 421.1.7.

Q.14 Are AFDDs available for three phase circuits?

Yes, BS EN 62606 covers 3-phase AFDDs however currently there is limited availability and will depend on the manufacturer.

Q.15 Will there be a need for a three-phase AFDD?

At this stage it is not possible to predict future requirements however, BS 7671:2018+A2:2022 only mandates/recommends that single phase AC final circuits supplying socket-outlets (up to 32A) be protected by AFDDs, depending on building type.

Q.16 Will the trip flashing codes be standardised across all brands?

BS EN 62606 does not specify indication colour or codes; standardisation may be considered as a proposal for further amendment of the standard.

Q.17 Will welding equipment cause unwanted tripping of an AFDD?

A welder separates the primary supply from the secondary supply which creates the arc for welding therefore, the welding arc is not detected by the AFDD supplying the welder.

An inverter operates by increasing the primary power supply frequency to the transformer, this creates a different frequency signature to that of an arc fault frequency signature therefore, the AFDD will not trip due to the normal load characteristics of the invertor.

Q.18 Are AFDDs parasitic loads? What are the electricity costs to operate an AFDDs?

Parasitic loads consume power when in stand-by mode, waiting for a command to perform their main function. AFDDs are not parasitic loads; similar to smoke alarms, they perform a safety function by constantly monitoring/protecting an installation.

The running cost will depend on the number of installed AFDDs and the energy tariff. In comparison to a number of electrical appliances that require charging or consume energy in standby mode, AFDDs' consumption of power to improve safety may not be considered significant. It should be noted that some electronic protection devices e.g. electronic RCBOs also consumer power to provide constant monitoring/protection of an installation.

Q.19 Will AFDDs be subject to unwanted tripping if harmonics are present?

BS EN 62606 contains tests to verify that the AFDD shall not trip when subjected to various loads that could cause unwanted tripping, including harmonics.

Q.20 Do AFDDs dissipate heat similar to other protection devices, and do they require testing in consumer units and distribution boards?

AFDDs will dissipate some heat however assemblies with AFDDs installed should be temperature rise tested according to the relevant assembly standard e.g. consumer unit or distribution board. The assembly manufacturer's instructions are required to provide information on rated currents and any derating factors (RDF).

Q.21 Does the use of cables with XLPE insulation mitigate the need for AFDDs?

No. Although XLPE insulation doesn't char when exposed to arcing, numerous items of connected equipment will use polymers that do char and ignite when exposed to an arc fault. Also, if the insulation is damaged exposing live conductors, these can be bridged through contamination resulting in char / carbon deposits and an arc fault.

Q.22 How do you identify what type of fault has caused a tripping event?

Although not required by BS EN 62606, generally, visual indication is provided on the AFDD to help determine the type of fault, refer to manufacturer's instructions.

Q.23 How do you fault-find arc fault events?

Generally, visual indication is provided on the AFDD to determine the type of arc fault, refer to manufacturer's instructions.

Fault finding for arc faults would use the same methodology as other protection devices e.g. resistance, insulation measurements.

Q.24 For retrofit, can you replace an MCB or an RCBO with an AFDD?

Retrofit of AFDDs will depend on the construction/configuration of the assembly e.g. consumer unit or distribution board, and the availability of compatible devices. The assembly and AFDD Manufacturer's instructions must be followed.

Where an existing device can be replaced by an AFDD all other relevant requirements of BS 7671 must also be met. Regulation 421.1.7 states that the use of AFDDs does not obviate the need to apply one or more measures provided in other clauses in BS 7671 .

Q.25 Can upstream faults trip an AFDD e.g. Local Area Network faults?

There is a very low likelihood of unwanted tripping due to upstream disturbances due to the arcing signal attenuation and circuit architecture.

Upstream parallel arc disturbances would not be detected by AFDDs. For an upstream series arc disturbance, the upstream signature is different (and attenuated) from a downstream series arc fault signature which minimises the possibility of unwanted tripping.

Q.26 Can you clarify if overload/overcurrent protection is provided by an AFDD?

AFDDs come in various configurations:

- Stand-alone AFDD – provides arc fault protection only.
- AFDD integrated in, or assembled with, an MCB – provides overcurrent and arc fault protection.
- AFDD integrated in, or assembled with, an RCCB – provides residual current and arc fault protection.
- AFDD integrated in, or assembled with, an RCBO – provides overcurrent, residual current and arc fault protection.

The appropriate AFDD configuration should be selected for the application.

Q.27 Does an AFDD provide better arc fault detection / protection for parallel Live to Earth arc faults than an RCD, particularly a 30 mA RCD?

Yes. An RCD will detect most parallel arc faults to earth however, the correct operation of the RCD is not 100 % ensured in all cases, since the RCD is only tested with a continuous test current of defined frequencies.

Q.28 Can the success of Arc Fault Circuit Interrupters (AFCIs) in the US, indicate how AFDDs could provide similar protection in the UK?

Yes, because:

- The UK has approximately two times higher line voltage and arc power than the US 120 V system. The arc fault power is not directly a function of the line voltage, it is the product of arc fault current and arc fault voltage.
- For a series arc fault, the AFCI product standard is 5 A and the AFDD standard is lower at 2.5 A,

Examples of AFCI protection success can be viewed at https://www.afcisafety.org/files/NEMA-Success-Stories.pdf

Q.29 Given the difference in building materials/methods between the US and UK, with the US building a lot of timber-based buildings, are AFDDs really beneficial in UK buildings?

Although the UK still uses brick and block building method, timber frame building has become much more widespread. Electrical fires due to arcing are a risk irrespective of building method, wherever combustible building materials exist (timber frame, roof space, internal stud walls), electrical fires due to arcing are a risk.

In addition, AFDDs also protect against electrical fires due to other arcing risks (e.g. damaged appliance leads, extension leads) in the vicinity of combustible materials within the property.

Q.30 Are AFDDs intended for new installations and additions which should be undertaken to acceptable quality levels and good workmanship?

Yes, however it should be noted that AFDDs are not intended to verify the quality of the installation work, they are not a substitute for good installation practice. They will however detect loose connections that result in arcing. AFDDs are intended to protect against arcing due to installation damage, carelessness by the user, misuse or abuse of the installation and/or the connected supply leads/appliances.

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