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Intrinsic safety for applications with high power

Intrinsically safe ignition protection enables electrical systems to be used safely in the hazardous area. Minimum power requirements are now being increased significantly with the DART Ex-protection concept. Initial applications are being discussed and an open workshop is planned for all market participants during October.

Dynamic Arc Recognition and Termination (DART) was one of the major process industry topics at the 2008 Hanover Fair. The technology eliminates the tight power limitations on existing intrinsically safe applications by enabling up to 50 Watts of effective power to be supplied in hazardous areas with intrinsic safety. The two versions, DART-Power and DART Fieldbus, not only provide the opportunity to equip many existing applications with an intrinsically safe power supply - they also open up new applications where explosion protection was previously possible only at considerable expense and with major compromises.

DART is the result of a research project funded by the German Federal Ministry of Economics and Labor, in which Pepperl+Fuchs was extensively involved. And since a single manufacturer could not succeed on its own in completely developing the technology, it is available by license agreement to companies and competitors in various industries. Presently, the technology is in the last stages of development. Pepperl+Fuchs expects the first products to be available in 2009.

The operating principle: Rapid switch-off instead of limitation

Traditionally, to safely prevent a spark capable of causing an ignition, the power available is limited to approximately 2 Watts. Thus, the protection category Ex i is typically limited to the areas of control and instrumentation technology and the power supply of actuators and sensors with low connected loads.

In a circuit protected with DART, field devices in the explosion-hazardous area with a power consumption of up to 50 W can be supplied under intrinsic safety conditions. Under normal circumstances the electric current flows without restriction. DART detects a fault in the electrical system at the outset and switches it off before the energy released reaches a safety-critical level.

The basis for this is provided by the fact that every formation of a spark leads to a very characteristic and, therefore, a reliably detectable abrupt change in the current in an electric circuit. In contrast to rapidly switching systems and systems that simply trigger at lower voltages, DART reacts to the change in current when a critical level is reached. In this way, all possible faults that lead to the formation of a spark are safely detected and controlled. The underlying physics are clear and simple:

- The characteristic electrical signal of the forming spark
- The wave velocity of more than 160,000 km/s, at which this signal is transmitted via the power supply cable
- The electronic switch, which triggers within microseconds

Because the wave velocity results in a very short propagation time, it must be considered from a safety standpoint. This is roughly proportional to the energy stored in the cable, which can escape from the electrical system in the case of a fault. This means, that the length of cable has an essential influence on the power available (see Table A:) Thus, DART satisfies the specification for an intrinsically safe circuit in accordance with IEC 60079-11 (Explosive Atmosphere – Part 11: Device protection through intrinsic safety “i“)

Dynamically acting sources require alternative test methods

The German national metrology institute *Physikalisch Technische Bundesanstalt* (PTB) in Braunschweig has determined that the documented testing methods for proof of intrinsic safety, such as the spark test apparatus, are not suitable for dynamically acting sources. The spark test apparatus continuously generates a high number of sparks, but the energy propagated by the test piece does not lead to an ignition. In this test case DART would always remain switched off. Various solutions have been developed by the PTB, which have led to the following test methods:

- A variant of the spark test apparatus always ensures, that the dynamic acting source operates at full power before a spark is generated.

- An electronic spark simulator and the associated test method: here, the electrical behavior of an occurring fault is simulated.

The spark simulator can also be used by manufacturers for product development, thus significantly reducing the time and cost-intensive certification procedure. The test methods are currently being introduced in the ongoing standards review cycle.

DART versions

The advantages of DART come into play where existing explosion protection methods make simple processes difficult or where the costs for explosion protection are comparatively high. Two versions are being developed at Pepperl+Fuchs: DART-Power and DART- Fieldbus.

The DART-Power version is tailored to transfer maximum power and provide simple adaptation for a wide range of applications. The topology of a DART-Power circuit is intentionally kept simple in terms of the power supply, cabling components, and the field device with an integrated decoupling module: Depending on the supply voltage used and cable length, an effective power of up to 50 Watt can be achieved.

With DART-Power, devices with high power requirements can be supplied with energy in an intrinsically safe manner without special and expensive safety precautions with respect to installation techniques. Table B: indicates possible applications. Also, the design of the field equipment can incorporate the intrinsic safety method of protection.

Ex i Fieldbus with investment protection

Users frequently want an intrinsically safe design for their fieldbus applications (PROFIBUS PA and FOUNDATION fieldbus H1). However, the intrinsic safety protection classification considerably restricts the number of stations that can be connected and cable lengths.

The trunk is protected with DART while the energy limitation on the connection cabling in conventional intrinsic safety complies with Entity and FISCO, two versions of intrinsic safety that are described in IEC 60079 and developed especially for fieldbus. Since almost every intrinsically safe field device is available with Entity or FISCO compliance, compatibility with the basic installation is ensured. DART provides a connected power of 8 W with a cable length of 1000 m. Currently, this is achieved only with the High-Power Trunk concept, where the trunk satisfies the increased safety classification. DART offers complete intrinsic safety of the fieldbus segment and is the next logical step in the High-Power Trunk concept.

Applications under discussion

As a main topic of conversation at Interkama+ in Hanover, Pepperl+Fuchs experts debated with manufacturers, end-users and certifying authorities the advantages of DART for

applications in which the assurance of explosion protection has previously been associated with extensive installation costs and other disadvantages.

A typical example is an analytic instrument in bio-chemical plants with portable process tanks. In this application the requisite sensor systems are currently installed in special bypass pipes utilizing increased safety explosion protection. With DART, the measurements could take place directly in the medium: The sensors would be integrated in the tanks and connected during actual operation. The bypass pipe and its installation are no longer necessary. More important to the users than the savings in investment costs are the reduced operation costs. There are no longer pipes to clean and measurement accuracy's improved.

The replacement of four-wire technology with intrinsically safe two-wire technology was also discussed: Field devices with a higher power requirement can be supplied with the DART system; for example balances and Corriolis flow meters. Likewise, valve islands with fieldbus interface connection benefit from the simpler installation technology. A preliminary stage for the initiation of valves with higher power requirements is no longer necessary and the valves can be switched faster because of the higher coil current. In addition to the fieldbus solution, an operator terminal with an intrinsically safe Ethernet interface and intrinsically safe power supply is also under development at Pepperl+Fuchs.

The PTB is inviting interested persons to a workshop in October on dynamically acting sources, such as DART. The workshop will explain all aspects of this technology, from the operating principle to certification. Experts from all industries are invited to participate in public discussion for interoperable application of DART. DART provides much energy and creates motion – not limited to intrinsically safe circuits, but in the market place of process automation.

Key words: DART, Intrinsic safety, Fieldbus, Explosion-hazardous area, Installation, Ex-Barriers

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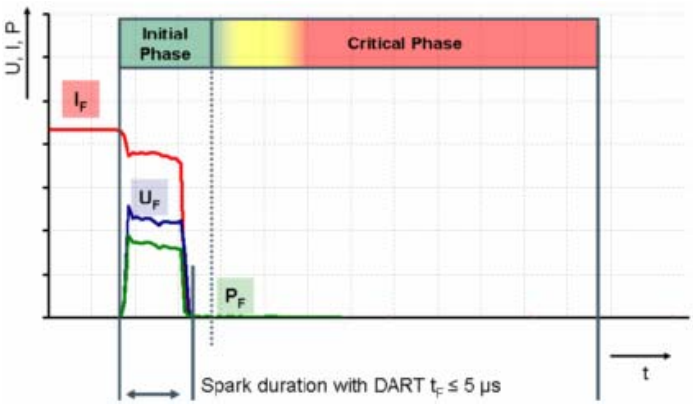

Fig. 1: DART – Dynamic Arc Recognition and Termination detects the characteristic change in current (di/dt) that occurs during the formation of a spark and interrupts the circuit within the initial phase of the spark.

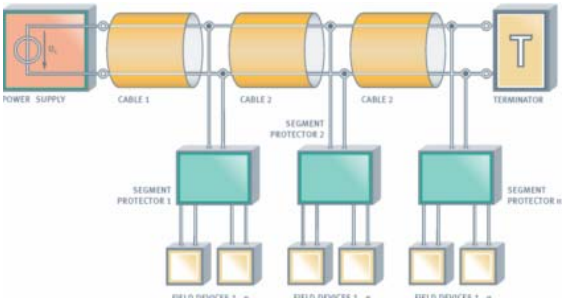

Fig. 2: DART Field bus: Entity-conforming field devices can be operated in an intrinsically safe fieldbus network with 8 W of effective power and a segment length up to 1000 m.

Fig. 3: DART Power Circuit: Intentional simplicity – comprising a power supply, cable, and consumer load. Can be easily adapted to a wide range of requirements.

Table A: DART Power Data: Output voltage, power for various cable lengths.

	V_{out}	P_{out}	Cable length
DART Power	50 VDC	approx. 50 W	100 m
	24 VDC	approx. 22 W	100 m
	50 VDC	approx. 8 W	1000 m
DART Fieldbus	24 VDC	approx. 8 W	1000 m

Table B: DART Applications.

DART Application	DART Fieldbus	DART Power
Field instrumentation		
Valve control	■	■
Magnetic flow measurement	■	■
Corriolis flow measurement	■	■
Fire and gas detectors		■
Other applications		
Optical and acoustic sensors		■
Servomotors		■
Light		■
Analytical devices	■	■
Scales, balances		■
PCs and operator terminals		■