# Certificate of Compliance

**Certificate:** 1653884 **Master Contract:** 151079 (053988_C_000)

**Project:** 70149664 **Date Issued:** 2017-10-17

**Issued to:** **Endress + Hauser GmbH + Co. KG**
**Haupstrasse 1**
**Maulburg, Baden-Württemberg 79690**
**GERMANY**

**Attention: Stefan Probst**

***The products listed below are eligible to bear the CSA Mark shown***

**Issued by:** *Anil Sodhi*
Anil Sodhi

**PRODUCTS**

**CLASS 2258 04** - PROCESS CONTROL EQUIPMENT - Intrinsically Safe Entity – For Hazardous Locations

**Ex db [ia Ga] IIC T6 Gb:**
**Class I, Division 1, Groups A, B, C and D; Class II, Division 1, Groups E, F and G; Class III;**
**Type 4/6 Enclosure:**

Gammapilot M FMG60 Compact Scintillation Detector for Level, Level-Limit, Density and Concentration measurement in liquids and solids. Input rated 90-250Vac, 50/60Hz, 8.5VA or 18-35Vdc, 3.5W. Gammapilot M FMG60-**P**b**E**defDhi, Explosion-Proof with Intrinsically Safe circuits / Entity Parameters per Control Drawing Nos. 960007341 (Intrinsically Safe Profibus PA/Foundation Fieldbus, FISCO/Entity Concept) or 960007132 (Intrinsically Safe 4-20mA/Hart, Entity Concept). Gammapilot M FMG60-**P**b**D**defDhi, Explosion-Proof with Intrinsically Safe circuits / Entity Parameters per Control Drawing Nos. 960007342 (Profibus PA/Foundation Fieldbus, Non-Intrinsically Safe) or 960007343 (4-20mA/Hart, Non-Intrinsically Safe). Temperature Code T6. -40°C ≤ Ta ≤ +75°C. In Division 1, Seal Not Required. In Zone 1 Seal Required within 2".

Note: b, e, f, h & i may be any number or letter representing specific options.

**Certificate:** 1653884 **Master Contract:** 151079

**Project:** 70149664 **Date Issued:** 2017-10-17

**CLASS 2252 06** - PROCESS CONTROL EQUIPMENT

Gammapilot M FMG60-**N**b**A**defghi Compact Scintillation Detector for Level, Level-Limit, Density and Concentration measurement in liquids and solids. Input rated 90-250Vac, 50/60Hz, 8.5VA or 18-35Vdc, 3.5W; -40°C ≤ Ta ≤ +80°C. Type 4/6 Enclosure.

Note: b, e, f, g, h & i may be any number or letter representing specific options.

**APPLICABLE REQUIREMENTS**

| | | |
|---|---|---|
| CAN/CSA C22.2 No. 0-M91 (R2001) | - | General Requirements - Canadian Electrical Code, Part II |
| CSA Std C22.2 No. 25-1966 | - | Enclosures for Use in Class II, Groups E, F and G Hazardous Locations |
| CSA Std C22.2 No. 30-M1986 | - | Explosion-Proof Enclosures for Use in Class I Hazardous Locations |
| CAN/CSA-C22.2 No. 94-M91 | - | Special Purpose Enclosures |
| CAN/CSA-C22.2 No. 157-92 | - | Intrinsically Safe and Non-Incendive Equipment for Use in Hazardous Locations |
| CAN/CSA-C22.2 No. 61010-1-2012 | - | Safety Requirements for Electrical Equipment for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements |
| CAN/CSA-C22.2 No. 60079-0-2015 | - | Electrical Apparatus for Explosive Gas Atmospheres - Part 0: General Requirements |
| CAN/CSA-C22.2 No. 60079-1-2016 | - | Electrical Apparatus for Explosive Gas Atmospheres - Part 1: Flameproof Enclosures "d" |
| CAN/CSA-C22.2 No. 60079-11-2014 | - | Electrical Apparatus for Explosive Gas Atmospheres - Part 11: Intrinsic Safety "i" |
| CAN/CSA-C22.2 No. 60529-2016 | - | Degrees of protection provided by enclosures (IP Code) |

# *Supplement to Certificate of Compliance*

**Certificate:** 1653884 **Master Contract:** 151079 (053988_C_000)

***The products listed, including the latest revision described below, are eligible to be marked in accordance with the referenced Certificate.***

## Product Certification History

| Project | Date | Description |
|---|---|---|
| 70149664 | 2017-10-17 | Update CSA report 1653884 for the certification of Gammapilot M FMG60 level detector to include the revised changes in electronics and new switching power supply. This update includes the revision of applicable CSA standards to the latest editions. |
| 2277212 | 2010-04-08 | Update to cover alternative HV Converter Assembly Version 2 and alternative AC/DC transformer potting materials. |
| 2148733 | 2009-04-28 | Update to include alt. aluminum enclosure, alt. I.C. oscillators, alt. marking method and increase detector ambient temperature. |
| 1962184 | 2007-10-12 | Update to cover alt. cable socket and minor PA/FF (II) and Sensor circuit (II) revisions |
| 1897824 | 2007-04-18 | Update to include Comm Cct Board 4-20mA Variant II |
| 1757873 | 2006-02-02 | Update to cover minor alt. construction to internal H.V. plastic enclosures. |
| 1711775 | 2005-10-18 | Update to cover minor alternative constructions with Category Test Report 15000181 |
| 1653884 | 2005-06-17 | Gammapilot M FMG60 Compact Scintillation Detector for hazardous locations. |

# Descriptive Report and Test Results

**MASTER CONTRACT:** 151079
**REPORT:** 1653884
**PROJECT:** 70149664

**Edition 1:** June 17, 2005; Project 1653884 – Toronto
Issued by R. Wildish

**Edition 5:** October 12, 2007; Project 1962184 – Toronto
Issued by E. Foo, C.E.T.

**Edition 6:** April 28, 2009; Project 2148733 – Toronto
Issued by E. Foo, C.E.T.; Reviewed by Dorin Stochitoiu, P. Eng.

**Edition 7:** April 8, 2010; Project 2277212 – Toronto
Issued by E. Foo, C.E.T.

**Edition 8:** October 17, 2017, Project 70149664 – Toronto
Issued by Anil Sodhi, P.Eng; Reviewed by Behzad Nejad, P.Eng.

Report pages reissued

Contents: Certificate of Compliance - Pages 1 to 2
Supplement to Certificate of Compliance - Page 1
Description and Tests - Pages 1 to 43
Descriptive Documents - *CSA Engineering File Only*

**PRODUCTS**

**CLASS 2258 04** - PROCESS CONTROL EQUIPMENT - Intrinsically Safe Entity – For Hazardous Locations

**Ex db [ia Ga] IIC T6 Gb:**
**Class I, Division 1, Groups A, B, C and D; Class II, Division 1, Groups E, F and G; Class III;**
**Type 4/6 Enclosure:**

• Gammapilot M FMG60 Compact Scintillation Detector for Level, Level-Limit, Density and Concentration measurement in liquids and solids. Input rated 90-250Vac, 50/60Hz, 8.5VA or 18-35Vdc, 3.5W. Gammapilot M FMG60-**P**b**E**defDhi, Explosion-Proof with Intrinsically Safe circuits / Entity Parameters per Control Drawing Nos. 960007341 (Intrinsically Safe Profibus PA/Foundation Fieldbus, FISCO/Entity Concept) or 960007132 (Intrinsically Safe 4-20mA/Hart, Entity Concept). Gammapilot M FMG60-**P**b**D**defDhi, Explosion-Proof with Intrinsically Safe circuits / Entity Parameters per Control Drawing Nos. 960007342 (Profibus PA/Foundation Fieldbus, Non-Intrinsically Safe) or 960007343 (4-20mA/Hart, Non-Intrinsically Safe). Temperature Code T6. -40°C ≤ Ta ≤ +75°C. In Division 1, Seal Not Required. In Zone 1 Seal Required within 2".

Note: b, e, f, h & i may be any number or letter representing specific options.

**CLASS 2252 06** - PROCESS CONTROL EQUIPMENT

• Gammapilot M FMG60-**N**b**A**defghi Compact Scintillation Detector for Level, Level-Limit, Density and Concentration measurement in liquids and solids. Input rated 90-250Vac, 50/60Hz, 8.5VA or 18-35Vdc, 3.5W; -40°C ≤ Ta ≤ +80°C. Type 4/6 Enclosure.

Note: b, e, f, g, h & i may be any number or letter representing specific options.

## APPLICABLE REQUIREMENTS

| | | |
|---|---|---|
| CAN/CSA C22.2 No. 0-M91 (R2001) | - | General Requirements - Canadian Electrical Code, Part II |
| CSA Std C22.2 No. 25-1966 | - | Enclosures for Use in Class II, Groups E, F and G Hazardous Locations |
| CSA Std C22.2 No. 30-M1986 | - | Explosion-Proof Enclosures for Use in Class I Hazardous Locations |
| CAN/CSA-C22.2 No. 94-M91 | - | Special Purpose Enclosures |
| CAN/CSA-C22.2 No. 157-92 | - | Intrinsically Safe and Non-Incendive Equipment for Use in Hazardous Locations |
| CAN/CSA-C22.2 No. 61010-1-2012 | - | Safety Requirements for Electrical Equipment for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements |
| CAN/CSA-C22.2 No. 60079-0-2015 | - | Electrical Apparatus for Explosive Gas Atmospheres - Part 0: General Requirements |
| CAN/CSA-C22.2 No. 60079-1-2016 | - | Electrical Apparatus for Explosive Gas Atmospheres - Part 1: Flameproof Enclosures "d" |
| CAN/CSA-C22.2 No. 60079-11-2014 | - | Electrical Apparatus for Explosive Gas Atmospheres - Part 11: Intrinsic Safety "i" |
| CAN/CSA-C22.2 No. 60529-2016 | - | Degrees of protection provided by enclosures (IP Code) |

## MARKINGS

The manufacturer is required to apply the following markings:

- Products shall be marked with the markings specified by the particular product standard.
- Products certified for Canada shall have all Caution and Warning markings in both English and French.

Additional bilingual markings not covered by the product standard(s) may be required by the Authorities Having Jurisdiction. It is the responsibility of the manufacturer to provide and apply these additional markings, where applicable, in accordance with the requirements of those authorities.

The products listed are eligible to bear the CSA Mark shown without an indicator for Canada only (indicating that products have been manufactured to the requirements of Canadian Standards).

Refer to Descriptive Documents for label details.

## METHOD OF MARKINGS

The main marking labels (Dwgs. 960007130 and 960007131) are minimum 0.02 inch thick metal nameplates that are secured to the outside of the enclosure using screws, rivets or drive pins. The warning label (Dwg. 960006543) is a CSA Accepted adhesive label, manufactured by Woelco GmbH, Type UC matic PS-TT). An overview of approved laser printed adhesive nameplate materials is shown on dwg. 960018037. Alternatively, the above markings may be engraved, embossed, laser printed or casted on the metallic enclosure surface.

*Note - Jurisdictions in Canada may require these markings to also be provided in French language. It is the responsibility of the manufacturer to provide bilingual marking, where applicable, in accordance with the requirements of the Provincial Regulatory Authorities. It is the responsibility of the manufacturer to determine this requirement and have bilingual wording added to the "Markings".*

## ALTERATIONS

Markings per Descriptive Documents.

## FACTORY TESTS

The following factory tests shall be conducted on 100% of production.

Dielectric Voltage Withstand Test:

(a) Test voltages are raised to the specified value within 2 sec and maintained for 2 sec.
(b) Only ac values are specified. As an alternative, the equivalent dc voltage, as specified below, may be used.
(c) The factory test may be done at existing room temperature; equipment is not normally energized.

Warning: The factory test(s) specified may present a hazard of injury to personnel and/or property and should only be performed by persons knowledgeable of such hazards and under conditions designed to minimize the possibility of injury.

For units up to 150V: The equipment at the conclusion of manufacture, before shipment, shall withstand without breakdown, the application of 840V ac or 1200V dc between mains TERMINALS and ACCESSIBLE conductive parts.

For units rated above 150V and up to 300V: The equipment at the conclusion of manufacture, before shipment, shall withstand without breakdown, the application of 1400V ac or 2000V dc between mains TERMINALS and ACCESSIBLE conductive parts.

Only a single test need be made if the ACCESSIBLE parts selected are conductively connected to all other ACCESSIBLE parts.

Mechanical

One hundred percent of all Gammapilot M FMG60 electronic compartment production (welded construction) shall be subjected to a hydrostatic pressure test of 76.2 bar (1106 psi) [three times the maximum recorded pressure of 25.4 bar (368.4 psi)] for a period of at least 1 minute, in accordance with Clause 6.6.2 (b) of CSA Std C22.2 No. 30-M1986. This is considered representative for the routine pressure test of CAN/CSA-C22.2 No. 60079-1:16

## SPECIAL INSTRUCTIONS FOR FIELD SERVICES

1. Component descriptions marked with either the "(INT)" or "(INT*)" identifiers may be substituted with other components providing the requirements specified under the notes in the "Description" are complied with.

2. This report contains reference to certain construction and engineering documents that have been deemed critical to ensuring continued compliance with applicable construction and performance requirements. A list of these documents, with drawing numbers and the appropriate revision levels is summarized in this report. Documents detailed herein are subject to inspection by CSA International personnel and shall be made available in the manufacturing location upon request. Failure to produce these documents in a timely manner constitutes noncompliance and is subject to the actions outlined in the CSA Product Service Agreement.

## DESCRIPTIVE DOCUMENTS

Note: Documents detailed herein are subject to inspection by CSA International personnel and shall be made available in the manufacturing location upon request.

| Subject | Drawing No. | Rev. |
|---|---|---|
| **Nameplate Drawings** | | |
| Nameplates FMG60 CSA (XP/IS) | 960007130 | C |
| Nameplates FMG60 CSA GP | 960007131 | C |
| Overview approved laser printed adhesive nameplate materials | 960018037 | A |
| | | |
| **Labels** | | |
| FMG60 warning labels | 960006543 | B |
| FMG60 Optional label measuring area_safety seal | 960015920 | - |
| Connection pattern label | 960006544 | - |
| | | |
| **Control Drawings** | | |
| Control drawing CSA Gammapilot M FMG60 PA/FF (I.S.) | 960007341 | D |
| Control drawing CSA Gammapilot M FMG60 PA/FF (Non-I.S.) | 960007342 | D |
| Control drawing CSA Gammapilot M FMG60 4-20mA/Hart (Non-I.S.) | 960007343 | D |
| Control drawing CSA Gammapilot M FMG60 4-20mA/Hart (I.S.) | 960007132 | E |
| | | |
| **Enclosure (Summary) Drawings** | | |
| FMG60 general drawing | 960006483 | D |
| FMG60 general drawing, added heat shrink tube | 960009717 | - |
| FMG60 water cooling assembly (accessories) | 960006729 | A |
| FMG60 Block diagram | 960006555 | C |
| FMG60 housing | 960006557 | A |
| FMG60 housing (additional details) | 960007289 | - |
| FMG60 cover | 960006532 | - |
| FMG60 cover (Ex-d/XP) | 960006531 | A |
| FMG60 adapter ring (Ex-d/XP) | 960006530 | - |
| FMG60 HV assembly (2) | 960009566 | - |
| Ex-d/XP feed through (periphery) | 960006534 | - |
| Ex-d/XP feed through (supply) | 960006533 | - |
| Connection cable (sensor) | 960006535 | - |
| HV-Cable | 960009567 | - |
| Ground-cable with ring eye | 960006592 | - |
| Insulation plate | 960006556 | - |
| Plastic housing HV-Electronic (internal lining) | 960007657 | - |
| FMG60 FHX40 Remote cable | 960006589 | B |
| Volume restrictor | 960006590 | - |
| Opto-coupler Type IS435/GL430 (TECMAG Ex) | 960007141 | - |
| PA/FF Cables | 960007142 | - |
| FHX 40 remote cable | 960008356 | - |
| Blind plug with chain | 960008357 | - |
| Adapter M20x1,5 Ex-d/XP | 960006488 | B |

| Subject | Drawing No. | Rev. |
|---|---|---|
| Adapter M20x1,5 | 960006487 | - |
| FMG60 Terminal housing Prot. Bonding term./PE term. | 960016619 | - |
| Plugs | 960016677 | A |
| Alternative Aluminum Enclosure: | | |
| FMG60 Aluminum Enclosure | 960008731 | A |
| FMG60 Cover Exd/XP | 960008828 | - |
| FMG60 Cover | 960008827 | - |
| | | |
| **Communication PCB 4-20 mA Hart (Exi)** | | |
| 01_Assembly plan side A FMG60-HART Ex-i/IS | 960017812 | A |
| 02_Assembly plan side B FMG60-HART Ex-i/IS | 960017813 | A |
| 03_Circuit diagram FMG60-HART Ex-i/IS | 960017707 | A |
| 04_Conductive pattern Layer A1 FMG60-HART Ex-i/IS | 960017815 | A |
| 05_Conductive pattern Layer A2 FMG60-HART Ex-i/IS | 960017816 | A |
| 06_Conductive pattern Layer B1 FMG60-HART Ex-i/IS | 960017818 | A |
| 07_Conductive pattern Layer B2 FMG60-HART Ex-i/IS | 960017817 | A |
| 08_Printed circuit board FMG60-HART Ex-i/IS | 960017814 | A |
| | | |
| **Communication PCB 4-20 mA Hart (Exd)** | | |
| 01_Assembly plan side A FMG60-HART Ex-d/XP | 960017884 | - |
| 02_Assembly plan side B FMG60-HART Ex-d/XP | 960017885 | - |
| 03_Circuit diagram FMG60-HART Ex-d/XP | 960017883 | - |
| 04_Conductive pattern Layer A1 FMG60-HART Ex-d/XP | 960017887 | - |
| 05_Conductive pattern Layer A2 FMG60-HART Ex-d/XP | 960017888 | - |
| 06_Conductive pattern Layer B1 FMG60-HART Ex-d/XP | 960017890 | - |
| 07_Conductive pattern Layer B2 FMG60-HART Ex-d/XP | 960017889 | - |
| 08_Printed circuit board FMG60-HART Ex-d/XP | 960017886 | - |
| | | |
| **Communication PCB PA/FF (Exi/Exd)** | | |
| 01_FMG60 Communication PA/FF Schematic | 960007151 | B |
| 02_FMG60 Communication PA/FF Schematic | 960007152 | C |
| 03_FMG60 Communication PA/FF Schematic | 960007153 | C |
| 04_FMG60 Communication PA/FF Schematic | 960007154 | B |
| 05_Conductive Pattern layer B1, FMG60 Communication PA/FF | 960007155 | C |
| 06_Conductive Pattern layer A1, FMG60 Communication PA/FF | 960007156 | B |
| 07_Conductive Pattern layer B2, FMG60 Communication PA/FF | 960007157 | B |
| 08_Conductive Pattern layer A2, FMG60 Communication PA/FF | 960007158 | B |
| 09_Assembly Plan side A, FMG60 Communication PA/FF Exi | 960007160 | B |
| 10_Assembly Plan side B, FMG60 Communication PA/FF Exi | 960007292 | B |
| | | |
| **CPU PCB** | | |
| 01_FMG60 Application CPU (3 sheets) | 960009112 | A |

| Subject | Drawing No. | Rev. |
|---|---|---|
| 02_Assembly plan cs, FMG60 CPU | 960009114 | A |
| 03_Assembly plan ss, FMG60 CPU | 960009115 | A |
| 04_Conductive pattern cs, FMG60 CPU | 960009116 | A |
| 05_Conductive pattern inner layer 1 cs, FMG60 CPU | 960009117 | A |
| 06_Conductive pattern inner layer 1 ss, FMG60 CPU | 960009118 | A |
| 07_Conductive pattern ss, FMG60 CPU | 960009119 | A |
| 08_Conductive pattern inner layer 2 cs, FMG60 CPU | 960009159 | A |
| 09_Conductive pattern inner layer 2 ss, FMG60 CPU | 960009160 | A |
| 10_Printed circuit board FMG60-CPU | 960017247 | A |
| | | |
| **Periphery PCB (Located in Electronics Housing)** | | |
| 01_Assembly plan side A FMG60-Periphery | 960018144 | - |
| 02_Assembly plan side B FMG60-Periphery | 960018145 | - |
| 03_Circuit diagram FMG60-Periphery | 960018143 | - |
| 04_Conductive pattern Layer A1 FMG60-Periphery | 960018147 | - |
| 05_Conductive pattern Layer A2 FMG60-Periphery | 960018148 | - |
| 06_Conductive pattern Layer B1 FMG60-Periphery | 960018150 | - |
| 07_Conductive pattern Layer B2 FMG60-Periphery | 960018149 | - |
| 08_Printed circuit board FMG60-Periphery | 960018146 | - |
| | | |
| **Power Supply PCB** | | |
| 01_Assembly plan side A FMG60-AC | 960016953 | - |
| 02_Assembly plan side A FMG60-DC | 960016955 | - |
| 03_Assembly plan side B FMG60-AC | 960016954 | - |
| 04_Assembly plan side B FMG60-DC | 960016956 | - |
| 05_Circuit diagram FMG60-AC (2 sheets) | 960016951 | - |
| 06_Circuit diagram FMG60-DC (2 sheets) | 960016952 | - |
| 07_Conductive pattern layer A1 FMG60 - PSU | 960016957 | - |
| 08_Conductive pattern layer A2 FMG60 – PSU | 960016958 | - |
| 09_Conductive pattern layer B1 FMG60 – PSU | 960016960 | - |
| 10_Conductive pattern layer B2 FMG60 - PSU | 960016959 | - |
| 11_Printed circuit board FMG60 - PSU | 960016961 | - |
| | | |
| **Sensor PCB** | | |
| 01_Assembly plan side A FMG60-Sensor (PVT) | 960018130 | - |
| 02_Assembly plan side A FMG60-Sensor (NaJ) | 960018131 | - |
| 03_Assembly plan side B FMG60-Sensor (PVT) | 960018132 | - |
| 04_Assembly plan side B FMG60-Sensor (NaJ) | 960018133 | - |
| 05_Circuit diagram FMG60-Sensor (PVT) (4 sheets) | 960018128 | - |
| 06_Circuit diagram FMG60-Sensor (NaJ) (4 sheets) | 960018129 | - |
| 07_Conductive pattern Layer A1 FMG60-Sensor | 960018135 | - |

| Subject | Drawing No. | Rev. |
|---|---|---|
| 08_Conductive pattern Layer A2 FMG60-Sensor | 960018136 | - |
| 09_Conductive pattern Layer A3 FMG60-Sensor | 960018137 | - |
| 10_Conductive pattern Layer A4 FMG60-Sensor | 960018138 | - |
| 11_Conductive pattern Layer B1 FMG60-Sensor | 960018142 | - |
| 12_Conductive pattern Layer B2 FMG60-Sensor | 960018141 | - |
| 13_Conductive pattern Layer B3 FMG60-Sensor | 960018140 | - |
| 14_Conductive pattern Layer B4 FMG60-Sensor | 960018139 | - |
| 15_Printed circuit board FMG60-Sensor | 960018134 | - |
| **Periphery Terminal PCB** | | |
| FMG60 connector board Exi | 960 570-0500 changed to 960007110 | A |
| 01_Conductive pattern ss, FMG60 connector board Exi | 960 570-0510 changed to 960007111 | A |
| 02_Conductive pattern cs, FMG60 connector board Exi | 960 570-0511 changed to 960007112 | A |
| 03_Assembly plan ss, FMG60 connector board Exi | 960 570-0520 changed to 960007113 | A |
| 04_Assembly plan cs, FMG60 connector board Exi | 960 570-0521 changed to 960007114 | A |
| **Grounding PCB** | | |
| 01_Conductive pattern cs, FMG60 ground PCB | 960 570-0710 | A |
| 02_Assembly plan cs, FMG60 ground PCB | 960 570-0720 | A |
| **Transformers** | | |
| Transformer EF16 85-253 Vac | 960006040 | D |
| Übertrager / Transformer EF16 18-60 Vdc | 960006482 | A |
| Transformer EF16 Detailed Views | 960018763 | - |
| Transformer EF16 Windings | 960018763 | - |
| Transformer EF16 60/60:53/53 | 960007137 | A |
| **HV-Supply-Module**<br>a) HV-Supply-2 | | |
| 01_FMG60 HV (2) Supply Assembly plan side A | 960009494 | A |
| 02_FMG60 HV (2) Supply Assembly plan side B | 960009495 | A |
| 03_FMG60 HV (2) Supply Circuit Diagram | 960009310 | A |
| 04_FMG60 HV (2) Supply Conductive pattern layer A1 | 960009497 | A |
| 05_FMG60 HV (2) Supply Conductive pattern layer A2 | 960009498 | A |
| 06_FMG60 HV (2) Supply Conductive pattern layer A3 | 960009499 | A |
| 07_FMG60 HV (2) Supply Conductive pattern layer B1 | 960009502 | A |
| 08_FMG60 HV (2) Supply Conductive pattern layer B2 | 960009501 | A |

| Subject | Drawing No. | Rev. |
|---|---|---|
| 09_FMG60 HV (2) Supply Conductive pattern layer B3 | 960009500 | A |
| 10_Printed circuit board FMG60-HV-supply-2 | 960009496 | A |
| b) HV-Filter-2 | | |
| 01_FMG60 HV (2) Filter assembly plan side A | 960009503 | A |
| 02_FMG60 HV (2) Filter circuit diagram | 960009309 | A |
| 03_FMG60 HV (2) Filter conductive pattern layer A1 | 960009505 | A |
| 04_FMG60 HV (2) Filter conductive pattern layer A2 | 960009506 | A |
| 05_FMG60 HV (2) Filter conductive pattern layer B1 | 960009508 | A |
| 06_FMG60 HV (2) Filter conductive pattern layer B2 | 960009507 | A |
| 07_Printed circuit board FMG60-HV-Filter-2 | 960009504 | A |
| c) HV-Signal-Out | | |
| 01_FMG60 HV (2) Signal Out Circuit Diagram | 960009311 | - |
| 02_FMG60 HV (2) Signal Out Assembly plan side B | 960009490 | - |
| 03_FMG60 HV (2) Signal Out Printed Circuit Board | 960009491 | |
| 04_FMG60 HV (2) Signal Out Conductive pattern layer A1 | 960009492 | - |
| 05_FMG60 HV (2) Signal Out Conductive pattern layer B1 | 960009493 | - |
| d) HV-Divider-2 | | |
| 01_FMG60 HV (2) Divider assembly plan side A | 960009483 | A |
| 02_FMG60 HV (2) Divider assembly plan side B | 960009484 | A |
| 03_FMG60 HV (2) Divider circuit diagram | 960009312 | A |
| 04_FMG60 HV (2) Divider conductive pattern layer A1 | 960009486 | A |
| 05_FMG60 HV (2) Divider conductive pattern layer A2 | 960009487 | A |
| 06_FMG60 HV (2) Divider conductive pattern layer B1 | 960009489 | A |
| 07_FMG60 HV (2) Divider conductive pattern layer B2 | 960009488 | A |
| 08_Printed circuit board FMG60-HV-Divider-2 | 960009485 | A |
| | | |
| **Technical Description** | | |
| E+H Gammapilot FMG60 8th Amendment (Redesign several Electr.-PCBs) | 961000143-A | 17.05.2017 |
| | | |
| **KEMA Reports** | | |
| KEMA Explosion-Proof Report | 2030290.02-QUA/ING | 01.06.2005 |
| KEMA Intrinsic Safety Report | 2061676-03 | 07.03.2005 |
| KEMA Test Report, I.S. alt. HV converter and alt. potting materials | 212752700 | 2010-02-05 |
| | | |
| DEKRA Certification B.V. Reports (IEC- ExTRs + Annex) | | |
| NL/DEK/ExTR130073/01 (11 Documents) | 219501800 | 2017-01-27 |
| | | |
| **E+H Tests (Conducted under CSA Category Certification Program)** | | |
| | | |
| **Test reports provided under Project 1653884 by submittor** | 15000181 | - |
| Measurement Power Supply - Determination of the max. sec. cutoff current | Enclosure 1 | - |

| Subject | Drawing No. | Rev. |
|---|---|---|
| Determination of the output characteristic curves<br>Transformer Tests<br>Transformer Dielectric Strength Tests | Enclosure 2 | - |
| Optical Isolator Tests (performed by FM) | Enclosure 3 | - |
| HV Converter Output Characteristic Curve | Enclosure 4 | - |
| Determination of Surface Temperatures (Ex d) | Enclosure 5 | - |
| Determination of Surface Temperatures (Dust) | Enclosure 6 | - |
| Dielectric Strength Test (AC Version) | Enclosure 7 | - |
| Dielectric Strength Test (DC Version) | Enclosure 8 | - |
| Bonding Impedance Test | Enclosure 9 | - |
| Impact and Torque Test (Ex d / XP Adapters) | Enclosure 10 | - |
| IP6x Dust Exclusion Test | Enclosure 11 | - |
| IPx5 Test | Enclosure 12 | - |
| IPx7 Test | Enclosure 13 | - |
| NEMA / Type 4 Test | Enclosure 14 | - |
| NEMA / Type 6 Test | Enclosure 15 | - |
| Impact Test - Protection Pipe for FHX Plug Adapter | Enclosure 16 | - |
| O-Ring / Gasket Test Results (Change of Hardness) ref. 960409-0081 | Enclosure 17 | - |
| Power Supply – Discharging of Inner Capacitances | Enclosure 18 | - |
| Torque, Bending and Pullout Tests | Enclosure 19 | - |
| 7 Joule Impact Tests | Enclosure 20 | |
| 1010.1 Report | Enclosure 21 | |
| **Test reports provided under Project 1711775 by submittor** | | |
| **Communication PCB 4-20 mA Hart (Exd)** | | |
| Transformer Temperature Tests (Transformer T100)<br>Transformer Dielectric Strength Test | 15000181 / Encl. 22 | 24.1.05 |
| Optical Isolator Test (HCNR201) | 15000181 / Encl. 23 | 14.01.05 |
| Dielectric Strength Test | 15000181 / Encl. 24 | 09.03.2005 |
| **Communication PCB PA/FF (Exi/Exd)** | | |
| Dielectric Strength Test (non-I.S. Configuration) | 15000181 / Encl. 25 | 14.03.2005 |
| Dielectric Strength Test (I.S. Configuration) | 15000181 / Encl. 26 | 14.03.2005 |
| IPx5 Test (re new Profibus PA or Foundation Fieldbus cables)<br>IPx7 Test (re new Profibus PA or Foundation Fieldbus cables) | 15000181 / Encl. 27 | 5.3.04 |
| NEMA / Type 4 Test (re new Profibus PA or Foundation Fieldbus cables)<br>NEMA / Type 6 Test (re new Profibus PA or Foundation Fieldbus cables) | 15000181 / Encl. 27 | 8.3.04 |
| **Gammapilot M FMG60** | | |
| **Project 2148733: E+H Test Reports** | | |

| Subject | Drawing No. | Rev. |
|---|---|---|
| E+H Technical Description (Aluminum Enclosure, dwg 960008731) | 960009303 | - |
| E+H Technical Description (Alt. I.C. oscillators, G200 & G201) | 960009240 | - |
| KEMA Test Report (Aluminum Enclosure, dwg 960008731) | 211943200-2-QUA/EX | 12.02.2009 |
| Heat-Storage | 970000634 | 18.07.2008 |
| Impact / Enclosure Rigidity Dynamic | 970000667 | 18.07.2008 |
| IP X5 | 970000658 | 23.07.2008 |
| IP X7 | 970000659 | 27.07.2008 |
| NEMA Type 4 | 970000660 | 23.07.2008 |
| NEMA Type 6 | 970000661 | 28.07.2008 |
| Dust Exclusion | 970000634 | 23.07.2008 |
| Conduit Torque | 970000663 | 18.07.2008 |
| Conduit Bending | 970000664 | 18.07.2008 |
| Conduit Pull-Out | 970000665 | 19.07.2008 |

| | | |
|---|---|---|
| **Project 2277212 E+H Test Reports** | | |
| E+H FMG60 HV Alt. Supply Test Report, Thermal Suppressor Diodes | 970000411 | 11.12.2007 |
| E+H FMG60 HV Alt. Supply Test Report, sec. cutoff current | 970001506 | 28.09.2009 |
| E+H FMG60 HV Alt. Supply Test Report, AC/DC xfmer temperature | 970001508 | 28.09.2009 |
| E+H FMG60 Alt. AC/DC Transformer Potting O/P Curves | 970001507 | 18.09.2008 |
| E+H FMG60 AC Transformer Dielectric, Alt. potting | 970001511 Rev A | 07.04.2010 |
| E+H FMG60 DC Transformer Dielectric, Alt. potting | 970001512 Rev A | 07.04.2010 |
| **Project 70149664 E+H Test Reports** | | |
| **Testreports Requalification => for information** | | |
| E+H FMG60 – Testplan (Requal. acc. IEC 60079-31) | 970003222 | 08.05.2012 |
| E+H FMG60 – Thread Adapter Test (Encl. 10, CSA-Cert. Ed. 1) | 970000688 | 09.12.2003 |
| E+H FMG60 – Heat/Cold storage Samples M1, M2 | 970003236 | 23.05.2012 |
| E+H FMG60 – Impact Test Samples M1, M2 | 970003237 | 23.05.2012 |
| E+H FMG60 – Dust Exclusion Test (IP6x) Overpressure Test Samples M1, M2 (+Add.) | 970003238 | 24.05.2012 |
| E+H FMG60 – Heat/Cold storage Samples M3, M4 | 970003372 | 20.06.2012 |
| E+H FMG60 – Impact Test Samples M3, M4 | 970003373 | 03.07.2012 |
| E+H FMG60 – Dust Exclusion Test (IP6x) Overpressure Test Samples M3, M4 | 970003374 | 04.07.2012 |
| E+H FMG60 – Dust Exclusion Test (IP6x) Terminal compartment, pipe housing without O-rings | 970003606 | 30.10.2012 |
| E+H FMG60 – Ingress Protection Test IPx4 Samples M1, M2, M3, M4 (with O-rings) | 970003802 | 18.04.2013 |
| E+H FMG60 – Ingress Protection Test IPx4 Samples M6, M7 (without O-rings) | 970003803 | 18.04.2013 |
| E+H FMG60 – Measuring of inductance (previously document FER-L101-112005 | 970004128 | 23.11.2005 |
| **Testplan ATEX / IECEx** | | |
| E+H FMG60 – Testplan-Specification ATEX / IECEx | 970005782 | 09.06.2016 |
| **Transformer AC/DC:** | | |
| E+H FMG60 – Transformer Temperature Test | 970001508 | 28.09.2009[*1] |
| E+H Dielectric Strength Transformer T100 | 970004117 | 10.12.2013[*1] |
| E+H FMG60_AC-Trafo (1,7xIrat) => for information | 970004425 | 18.06.2014[*2] |
| E+H FMG60_DC-Trafo (1,7xIrat) => for information | 970004426 | 18.06.2014[*2] |
| **Rth-Determination Z-Diodes:** | | |
| E+H FMG60 – Rth-Determination Z-Diodes | 970005859 | 09.06.2016[*1] |
| E+H FMG60 – Rth-Determination F110-F115 => for information | 970005973 | 27.07.2016[*2] |
| E+H FMG60 – Determination of Parameter Uz => for information | 970004299 | 17.04.2014[*1] |
| **Servicetemperature:** | | |
| E+H FMG60 – Re-examination of the service temperature (Ex-i) | 970004118 | 11.12.2013[*1] |
| **Surface temperature/Service temperature Ex d / Ex t:** | | |
| E+H FMG60 – Re-examination of service and surface temperatures (Ex d, Ex t) | 970004235 | 14.03.2014[*1] |
| **HV-Module:** | | |
| E+H FMG60 – Rth determination F100 | 970000411 | 11.12.2007[*1] |
| **Communication HART Ex d:** | | |

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|---|---|---|
| E+H Transformer Characteristic Curve DC/DC-Transformer (Encl. 1 Cerification Issue 1) | 970005974 | 19.11.2004[*2] |
| E+H Transformer Temperature Test incl. HV-Test (witnessed) (Encl. 2 Certification Issue 1) | 970005975 | 14.01.2005[*1] |
| E+H Amendment: Temp. Test Isec=105mA / Iprim=68mA=> for information | 970005976 | 27.07.2016[*2] |
| **Electrical Safety** | | |
| E+H FMG60 - IEC 61010-1:2012 Testreport, CSA Category Program | 970005675 | 02.12.2016 |
| E+H FMG60 - Risk Assessment | 970005745 | 02.05.2016 |
| E+H FMG60 - IEC 61010-1:2012 North American Deviations | 970005765 | 11.05.2016 |
| **Documents for Information:** Further applicable documents of all supplements since 2005: | | |
| E+H FMG60-CSA CrossRef Table, comp. for intrinsic safety | 961000147 Rev A | 31.03.2017 |
| E+H List of test reports + all ENCL CSA Iss1 – Iss 7 | 970006200 | 30.03.2017 |
| E+H FMG60 HV-Converter Output Char (Encl. 4, CSA Appr. Iss1) | 970005991 | 24.03.2004 |
| E+H Encl. 5, CSA Approval Issue 1<br>- Pre_Measurement for Surface temperature<br>- Surface temperatures Gas<br>E+H Encl. 6, CSA Approval Issue 1<br>- FMG60_Surface_Temp_Measurement_Pictures<br>- Surface Temperature Dustlayer 2<br>- Surface Temperature Dustlayer Resistor Array | 970005977 | <br>12.03.2004<br>12.03.2004<br><br>12.03.2004<br>12.03.2004<br>12.03.2004 |
| E+H FMG60 Routine Test Ex d e | 960016621 | 27.01.2014 |
| Layout-Check FMG60 | --- | 28.11.2016 |
| **IECEx Documents:** ExTR13.0073.01-Cover | 219501800 | 27.01.2017 |
| ExTR13.0073.01-Appendix A Description of the Test item | 219501800 | 27.01.2017 |
| ExTR13.0073.01-Bartec Bushing diff 60079-1-2007 and 2014 | 219501800 | 27.01.2017 |
| ExTR13.0073.01-60079-0 | 219501800 | 27.01.2017 |
| ExTR13.0073.01-60079-1 | 219501800 | 27.01.2017 |
| ExTR13.0073.01-60079-11 | 219501800 | 27.01.2017 |
| IECEx_DEK_13.0071X_1_CofC | 219501800 | 27.01.2017 |

Note 1: (witnessed[*1] or issued[*2])
Note 2: The asterisk * denotes drawing duplicated in the descriptive documents.

## COMPONENT SPECIAL PICKUP

1. Component descriptions marked with the identifier "(CT)" are subject to annual pickup and Conformity Testing.

None

## DESCRIPTION

Notes:

1. Component Substitution
   a) Critical components (those identified by mfr name, cat no), which are NOT identified with either "INT" or "INT*" are not eligible for substitution without evaluation and report updating
   b) The term "INT" means a "Certified" and/or "Listed" (or a "Recognized" and/or "Accepted") component may be replaced by one "Certified" and/or "Listed" by another certification organization accredited by the appropriate accreditation body or scheme requirements to the correct standard, for the same application; providing the applicable country identifiers are included and requirements in item "d" below are complied with.
   c) The Term "INT*" means a "Recognized" and/or "Accepted" component may be replaced by one "Recognized" and/or "Accepted" by another certification organization accredited by the appropriate accreditation body or scheme requirements to the correct standard, for the same application, providing the applicable country identifiers are included, the component is **also** CSA Certified, the requirements in item "d" below are complied with and any "conditions of suitability" for the component (as recorded in this descriptive report) are complied with.
   d) Components which have been substituted, must be of an equivalent rating, configuration (size, orientation, mounting) and the applicable minimum creepage and clearance distances are to be maintained from live parts to bonded metal parts and secondary parts.
   e) Substitution of a "Certified" and/or "Listed" component with a component that is "Recognized" or "Accepted" is not permitted without evaluation and report updating.

The subject equipment was evaluated and tested to CSA requirements by KEMA under the KEMA/CSA Agreement. Refer to KEMA Explosion-Proof Report No. 2030290.02-QUA/ING and KEMA Intrinsic Safety Report No. 2061676-03 (Descriptive Documents Package, CSA Engineering File only). The KEMA Reports were reviewed in conjunction with the Engineering drawings and is considered representative and acceptable for CSA Certification of the subject equipment. A brief description follows.

1. General

The detector FMG60 is a device for non-contact measurement of level, level limit, density and concentration in liquids and solids.

The detector housing consists of a welded stainless steel electronics/probe compartment (Ex d/ XP), which contains all active parts (e.g. PCB's, scintillator), and of a stainless steel compartment housing which consists of a compartment (Ex d/XP) containing power terminals (Terminal compartment) and a second compartment containing the intrinsically safe periphery terminals (periphery compartment). The periphery compartment is not part of the explosion proof construction. See dwg. 960006483.

The Supply Terminal Compartment has a free-internal volume of approximately 350mL. The Periphery Terminal Compartment has a free-internal volume of approximately 340mL. The Electronics Compartment has a maximum free-internal volume of approximately 6000mL (based on maximum pipe housing length).

Refer to the E+H Gammapilot M FMG60 Technical Description (Descriptive Documents Package, CSA Engineering File only) for general information and model codes.

Alternative Enclosure: Die-cast aluminum enclosure.

Similar in construction to the above stainless steel enclosure except that it is made of die-cast aluminum enclosure as per dwgs 960008731, 960008828 and 960008827. The aluminum enclosure is screws secured onto the stainless steel electronics/probe compartment as in the original stainless steel enclosure. The aluminum enclosure is similar to the stainless steel enclosure, dwg 960006483, in the sealing geometry, feed-throughs and flamepath construction. Refer to the enclosures comparison table in the test section under project 2148733.

2. Bartec Feed-Throughs

There are two different feed-throughs. The periphery feed-through as described in drawing 960006534 connects the periphery terminal compartment (IS) and the electronics compartment (XP). The supply feed-through as described in drawing 960006533 connect the supply terminal compartment (XP) and the electronics compartment (XP).

The same line of BARTEC feed-throughs has been previously Certified for use with Tankside Monitor under Report 151079-1308795 and Micropilot II / Micropilot M under Report 151079-1035027. The E+H feed-through is of similar construction to that Certified for use with the Promass 8 in 160686-1132623.

3. Flamepaths

3.1 Supply Terminal Compartment

- one cover thread M85 x 1.5 medium fit 6g/6H, ≥ 8 threads engaged, axial length of engagement ≥ 12mm
- two conduit thread M20 x 1.5 with glued adaptor 1/2"-14 NPT to M20 x 1.5 6g/6H ≥ 9 threads, axial length of engagement ≥ 13.5mm (NPT conduit entry thread gauging: + 1/2 to +2-1/2 deeper than nominal)
- one M16 x 1.5 medium fit 6g/6H for the cable feed through to electronics compartment, ≥ 10 threads engaged, axial length of engagement ≥ 15mm

3.2 Electronics Compartment

- one electronics/probe compartment thread M98 x 2 medium fit 6g/6H, ≥ 12 threads engaged, axial length of engagement ≥ 24mm
- one M24 x 1.5 medium fit 6g/6H for the cable feed through to Ex-i compartment, ≥ 11 threads engaged, axial length of engagement ≥ 16.5mm
- one M16 x 1.5 medium fit 6g/6H for the cable feed through to supply terminal compartment, ≥ 10 threads engaged, axial length of engagement ≥ 15mm

4. Grounding Provision

There is a suitable grounding lug/saddle assembly located in the Ex d field wiring compartment (Supply Terminal Compartment) which threads into the enclosure housing. The terminal is suitably identified with the IEC earth symbol.

5. Electronic

The electronics consists of the following circuit boards as described below. Refer to Descriptive Documents Package for board assembly details.

5.1 Electronics Compartment

- Communication PCB 4-20 mA Hart (Exi)
- Communication PCB 4-20 mA Hart (Exd)
- Communication PCB PA/FF (Exi and Exd)
- CPU PCB
- Periphery PCB
- Power Supply PCB
- Sensor PCB
- Voltage Divider PCB
- HV Supply PCB
- HV Control PCB
- Grounding PCB

5.2 Periphery Compartment

- Periphery Terminal PCB

5.3 Supply Terminal Block

The supply terminal block is CSA Certified, suitably rated.

5.4 Protective Components:

| Component | Description | Type | Manufacturer e.g. |
|---|---|---|---|
| | | | |
| **Power supply** | **Reference: drawings 960016951 and 960016952** | | |
| a) PSU | | | |
| F101 | Fuse,<br>T250 mA, 250 V, breaking capacity 1500 A (power supply ac version)<br>T400 mA, 250 V, breaking capacity 1500 A (power supply dc version) | 160016 | Siba |
| F105 | Fuse, T40 mA, 250 V, SMD, breaking capacity 100 A | 160000 | Siba |
| F104 | Fuse, T32 mA, 250 V, SMD, breaking capacity 100 A | 160000 | Siba |
| F103 | Fuse, T160 mA, 250 V, SMD, breaking capacity 100 A | 160000 | Siba |
| C103, C106 | ceramic capacitor 4,7 nF ± 10%, 250 VAC<br>class X1, Y2, Dielectric strength: 1500 VAC | GA355DR7GF472KW01L | Murata |
| R149, R148, R157 | Resistor, 3,32 kΩ ± 3%, 250 mW | Metal Film | |
| R100, R111, R138 | Resistor, 5,62 kΩ ± 3%, 250 mW | Metal Film | |
| R101, R112, R139 | Resistor, 10,0 kΩ ± 3%, 250 mW | Metal Film | |
| R104, R115, R142 | Resistor, 48,7 kΩ ± 3%, 250 mW | Metal Film | |
| R105, R117, R143 | Resistor, 10,0 kΩ ± 3%, 250 mW | Metal Film | |
| R107, R124, R144 | Resistor, 56,2 kΩ ± 3%, 250 mW | Metal Film | |
| R108, R125, R145 | Resistor, 5,6 kΩ ± 3%, 100 mW | Metal Film | |
| R102, R113, R140 | Resistor, 10,0 kΩ ± 3%, 250 mW | Metal Film | |
| R103, R114, R141 | Resistor, 4,7 kΩ ± 3%, 100 mW | Metal Film | |
| V119, V121 | Zener diode, CMZ5921B, Uz = 6,8 V ± 5%, P = 1,5 W | CMZ5921B | |
| V113, V112, V111 | Zener diode, MMSZ5251B, Uz = 22V ± 5%, P = 0,5 W | MMSZ5251B | |
| V118, V120 | Schottky-Diode, PMEG6010, $U_F$ = 0,6V, Pmax = 375mW | PMEG6010 | |
| V101, V104, V110 | Transistor, BCP 53-16, $I_C$ = 1,5 A, P ≥ 1 W | BCP 53-16 | |
| V100, V102, V109 | Thyristor, X0202NN, $U_{DRM}$ = 600V, $I^2t$ = 2,5 $A^2s$, $I_{TSM}$ = 22,5 A, ITavm=0,7A, UTm = 1,1V | X0202NN | |
| N100, N102, N104 | Voltage Regulator, LM431-2,5V, $U_Z$ = 2,5 V ± 1%, P ≥ 0,28 W | LM431-2,5V | |

| | | |
|---|---|---|
| b) Output voltage regulators | | |

| | | | |
|---|---|---|---|
| F200, F201, F202, F203, F205 | Fuse, T40 mA, 250 V, SMD, breaking capacity 100 A | 160000 | Siba |
| F206 | Fuse, T50 mA, 250 V, SMD, breaking capacity 100 A | 160000 | Siba |
| R200, R201 | Resistor, 100 Ω ± 3%, 1 W | | |
| R213, R221, R225 | Resistor, 15,4 kΩ ± 3%, 250 mW | | |
| R214, R222, R226 | Resistor, 27,4 kΩ ± 3%, 250 mW | | |
| R219, R223, R227 | Resistor, 6,81 kΩ ± 3%, 250 mW | | |
| R220, R224, R228 | Resistor, 487 Ω ± 3%, 250 mW | | |
| R203, R204 | Resistor, 100 Ω ± 3%, 1 W | | |
| V204, V209 | Zener diode, CMZ5348B, Uz = 11 V ± 5%, P = 5 W | CMZ5348B | |
| V205, V210 | Zener diode, CMZ5351B, Uz = 14 V ± 5%, P = 5 W | CMZ5351B | |
| V212, V215 | Zener diode, CMZ5921B, Uz = 6,8 V ± 5%, P = 1,5 W | CMZ5921B | |
| V213, V220 | Zener diode, CMZ5348B, Uz = 11 V ± 5%, P = 5 W | CMZ5348B | |
| V200, V201, V202, V203 | Zener diode, 1SMA5924BT, Uz = 9,1 V ± 5%, P = 1,5 W | 1SMA5924BT | |
| V211, V214 | Schottky-Diode, PMEG6010, $U_F$ = 0,6V, Pmax = 375mW | PMEG6010 | |
| N205, N206, N207 | IC (reference diode), SC431, ZR431, $U_Z$ = 2,5 V ± 1%, P ≥ 0,2 W | SC431 | |
| V206, V222, V223 | Transistor, BCP 53-16, $I_C$ = 1,5 A, P ≥ 1 W | BCP 53-16PA | |
| T100 | Transformer, type 2a, class F, test voltage 3,75 kV (i.s. - non-i.s.)<br>Ref. drawings 960006482-A and 960006040 D | | |
| X102 | Terminal block 300 V, 10 A, UL/CUL E60425, CSA 13631 | ZFKDS 1,5-5,08 | Phoenix |
| Supply Terminal | Terminalblock 300V ,16 A, PTB 99 ATEX 3117 U (Iss No. 2, 01.04.2016), IECEx PTB 07.0007U (Iss. No. 2, 01.04.2016), UL/CUL E198917 | 07-9702-0.2 | BARTEC |
| | | | |
| **Periphery board** | **Reference: drawing 960018143** | | |
| R142, R144, R148, R143, R145, R149 | Resistor, 6,81 kΩ ± 3%, 250 mW | Metal film | |
| R140, R141 | Resistor, 6,81 kΩ ± 3%, 250 mW | Metal film | |
| R103, R106 | Resistor, 3,32 kΩ ± 3%, 250 mW | Metal film | |
| R104, R105 | Resistor, 5,62 kΩ ± 3%, 250 mW | Metal film | |
| R152, R147, R153 | Resistor, 6,81 kΩ ± 3%, 250 mW | Metal film | |
| R139 | Resistor, 6,81 kΩ ± 3%, 250 mW | Metal film | |
| R131 | Resistor, 154 Ω ± 3%, 1 W | Metal film | |

| | | | |
|---|---|---|---|
| R110, R113 | Resistor, 226 Ω ± 3%, 1 W | Metal film | |
| R150, R146, R151 | Resistor, 6,81 kΩ ± 3%, 250 mW | Metal film | |
| R138 | Resistor, 6,81 kΩ ± 3%, 250 mW | Metal film | |
| R128, R133 | Resistor, 82,5 Ω ± 3%, 1 W | Metal film | |
| R111, R112 | Resistor, 100 Ω ± 3%, 250 mW | Metal film | |
| R100, R101 | Resistor, 1,0 kΩ ± 3%, 250 mW | Metal film | |
| R118, R119 | Resistor, 562 Ω ± 3%, 250 mW | Metal film | |
| R102 | Resistor, 154 Ω ± 3%, 1 W | Metal film | |
| R107, R108 | Resistor, 15.4 kΩ ± 3%, 250 mW | Metal film | |
| V121, V122, V129, V130 | Diode, BAV99, $I_F$ = 100 mA, $U_R$ = 70 V | BAV99 | |
| V125, V133 | Diode, BAV99, $I_F$ = 100 mA, $U_R$ = 70 V | BAV99 | |
| V123, V131 | Diode, BAV99, $I_F$ = 100 mA, $U_R$ = 70 V | BAV99 | |
| V112, V115 | Schottky Diode, BAT54, $I_F$ = 200 mA, $U_R$ = 30 V | BAT54 | |
| N124, N126, N127, N128, N132, N134, N135, N136 | IC (reference diode), SC431, $U_Z$ = 2,5 V ± 1%, P ≥ 0,2 W | SC431 | |
| L100, L101 | Common-mode choke, ring core; $L_N$=51µH, $L_{STRAY}$ = 2,1µH, IR = 500 mA | B82790C0513N201 | EPCOS |
| U100 | Optocoupler, HCNW2211, test voltage 2652 V, P = 420 mW | HCNW2211 | Agilent / Avago |
| C102, C103, C104, C105, C106, C107, C108, C109, C126, C127, C128, C129 | Capacitor, 2,2 nF ± 20 %, rated voltage: >60 V, test voltage > 500 V | 1812GC222KA_1A_ 1812J2K00222KX_T_, 1812B222K202N_T_ 202S43W222KV4_E_ | |
| | | | |
| **Communication Board 4-20mA Hart (Exi)** | **Reference: 960017707 A** | | |
| V107, V108, V109 | Schottky-Diode, PMEG6010, $U_F$ = 0,6V, Pmax = 375mW | PMEG6010 | |
| F110, F111, F112, F113, F114, F115 | Zener diode (Suppressor), SM6T10V, $U_Z$ = 10 V ± 7 %, P = 5 W | SM6T10V | ST-Micro |
| R115, R116 | Resistor, 68,0 Ω ± 3%, 1 W | | |
| R117 | Resistor, 56,0 Ω ± 3%, 1 W | | |
| R163 | Resistor, 47,0 Ω ± 3%, 1 W | | |
| R164 | Resistor, 82,0 kΩ ± 3%, 1 W | | |

| | | | |
|---|---|---|---|
| R107 | Resistor, 10,0 kΩ ± 3%, 1 W | | |
| R109 | Resistor, 47,0 kΩ ± 3%, 1 W | | |
| R108, R118 | Resistor, 330 kΩ ± 3%, 1 W | | |
| R105, R110 | Resistor, 220 Ω ± 3%, 1 W | | |
| R111, R112, R113, R120, R121, R122 | Resistor, 15,4 kΩ ± 3%, 250 mW | | |
| C101, C102, C104, C105 | Capacitor, 2,2 nF ± 20 %, rated voltage: >60 V, test voltage > 500 V | 1812GC222KA_1A_<br>1812J2K00222KX_T_,<br>1812B222K202N_T_<br>202S43W222KV4_E_ | |
| C136, C137 | Capacitor, 4,7 nF ± 20 %, rated voltage: 3000 VDC, test voltage > 3600 VDC | 2225HC472KAT_1A<br>2225J3K00472KX_T<br>2225B472K302N_T<br>302S48W472KV4_E | |
| | | | |
| **Communication board 4..20 mA/HART (Ex d)** | **Reference: Drawings : 960017883** | | |
| F100 | Fuse, T-50 mA, 250 V, breaking capacity 1500 A | 160016 | Siba |
| R134, R136 | Resistor, 47,0 kΩ ± 3%, 1 W | | |
| T100 | Transformer, type 1a, class B, test voltage 2,5 kVrms (i.s. – non i.s.).<br>Ref. drawing 960007137- - | | |
| | | | |
| **Communication Board PA/FF** (IS-application) | **Reference Dwgs: Refer to specified descriptive documents for details.** | | |
| F100 | Fuse, T-40 mA, 250 V, 4,5x8 mm, breaking capacity 100 A | 160000 | SIBA |
| L101 | Current-compensated coil,<br>leakage inductance ≤ 10 µH | B82790-S0513-N201 | EPCOS<br>S+M components |
| C109, C110 | Capacitor, 100pF ±30% , 50 V | | |
| V102, V103, V104, V105, V106, V107, V108 | Diode, $I_F$ =150 mA, $I_R$≤50 µA, $U_R$ =100 V, P=150 mW | TMMBAT 46 | ST Micro electronics |
| U200, U201, U202, U203 | Optocoupler, test voltage 4 kV<br>Reference FM J.I 1X9A4.AX. | IS435/GL430 | Hutmacher<br>Endress+Hauser |
| | | | |

| | | | |
|---|---|---|---|
| **Communication board PA/FF** (non IS-application) | **Reference Dwgs: Refer to specified descriptive documents for details.** | | |
| U200, U201, U202, U203 | Optocoupler, test voltage 4 kV<br>Reference FM J.I 1X9A4.AX. | IS435/GL430 | Hutmacher<br>Endress+Hauser |
| | | | |
| **Communication board PA/FF** (non IS-application, optional design) | **Reference Dwgs: Refer to specified descriptive documents for details.** | | |
| F100 | Fuse, 40 mA, 250 V, 4,5x8 mm, breaking capacity 100 A | 160000 | SIBA |
| R109 | Resistor, 10 Ω ±3%, 1 W | | |
| U200, U201, U202, U203 | Optocoupler, test voltage 4 kV<br>Reference FM J.I 1X9A4.AX. | IS435/GL430 | Hutmacher<br>Endress+Hauser |
| | | | |
| **CPU Board** | **Reference Dwgs: 960009112** | | |
| R115 | Resistor, 5,62 kΩ ± 3 %, 0,25 W | | |
| | | | |
| **Sensor Board** | **Reference Dwgs: 960018128 and 960018129** | | |
| F300, F301 | Fuse, 40 mA, 250 V, 4,5x8 mm, breaking capacity 100 A | 160000 | SIBA |
| R300, R302, R305, R306, R310, R311, R301, R303, R307, R308, R312, R313 | Resistor, 3,32 kΩ ± 3 %, 0,25 W | Metal Film | |
| R314, R315 | Resistor, 6,81 kΩ ± 3 %, 0,25 W | Metal Film | |
| R322, R326, R323, R327, R324, R328, R325, R329 | Resistor, 3,32 kΩ ± 3 %, 0,25 W | Metal Film | |
| R318, R319, R320, R321 | Resistor, 6,81 kΩ ± 3 %, 0,25 W | Metal Film | |
| R108 | Resistor, 10,0 kΩ ± 3 %, 1 W | Thick Film chip | |
| R102 | Resistor, 562 Ω ± 3 %, 1 W | Thick Film chip | |
| R104, R105* | Resistor, 100 Ω ± 3 %, 0,25 W (PVT-Scintillator) | Metal Film | |

| | | | |
|---|---|---|---|
| R106, R107* | Resistor, 402 Ω ± 3 %, 0,25 W (PVT-Scintillator) | Metal Film | |
| R104…R107* | Resistor, 1,0 kΩ ± 3 %, 0,25 W (NaJ-Scintillator) | Metal Film | |
| V304, V306, V312, V305, V307, V313 | Zener diode, 1SMA5920BT, Uz = 6,2 V ± 5%, P = 1,5 W | 1SMA5920BT | ON-Semi<br>Central |
| V109, V110 | Zener diode, MMSZ5232B, Uz = 5,6 V ± 5%, P = 0,5 W | MMSZ5232B | ON-Semi<br>Vishay |
| V310, V311, V323, V324 | Diode, BAV99, $I_F$ = 100 mA, $U_R$ = 70 V | BAV99 | |
| V339, V347, V340, V348, V341, V349, V342, V350 | Diode, BAV99, $I_F$ = 100 mA, $U_R$ = 70 V | BAV99 | |
| V314, V318, V320, V315, V319, V325 | Schottky-Diode, PMEG6010, $U_F$ = 0,6V, Pmax = 375mW | PMEG6010 | |
| V300, V302, V301, V303, V329, V317, V330, V316 | Schottky Diode, BAT54, $I_F$ = 200 mA, $U_R$ = 30 V | BAT54 | |
| V335, V355, V336, V356, V337, V357, V338, V358 | Schottky Diode, BAT54, $I_F$ = 200 mA, $U_R$ = 30 V | BAT54 | |
| V103, V107 | Schottky-Diode, PMEG6010, $U_F$ = 0,6V, Pmax = 375mW | PMEG6010 | |
| N308, N309, N321, N322 | IC (reference diode), SC431, $U_Z$ = 2,5 V ± 1%, P ≥ 0,2 W | SC431 | |
| N343, N351, N344, N352, N345, N353, N346, N354 | IC (reference diode), SC431, $U_Z$ = 2,5 V ± 1%, P ≥ 0,2 W | SC431 | |
| | *) Note: Values of R104, R105, R106, R107 depend on scintillator type | | |
| | | | |
| **HV Assembly:-HV Supply-2 board** | **Reference: drawing 960009310 A** | | |
| R156 | Resistor, 22,6 kΩ ± 3 %, 0,25 W | Metal film | |
| R136, R157 | Resistor, 3,32 kΩ ± 3 %, 0,25 W | Metal film | |
| R135 | Resistor, 5,62 kΩ ± 3 %, 0,25 W | Metal film | |
| R100 | Resistor, 12,1 kΩ ± 3 %, 0,25 W | Metal film | |
| R130 | Resistor, 5,62 kΩ ± 3 %, 0,25 W | Metal film | |

| | | | |
|---|---|---|---|
| R153 | Resistor, 3,32 kΩ ± 3 %, 0,25 W | Metal film | |
| R107, R109, R154, R155 | Resistor, 332 kΩ ± 3 %, 0,25 W | Metal film | |
| R108 | Resistor, 100 kΩ ± 3 %, 0,25 W | Metal film | |
| R105 | Resistor, 100 kΩ ± 3 %, 0,25 W | Metal film | |
| R145 | Resistor, 82,5 kΩ ± 3 %, 0,25 W | Metal film | |
| R132, R133 | Resistor, 180 Ω ± 3 %, 1 W | Thick Film chip | |
| F100, F101 | Zener diode (Suppr. uni), 1SMB110AT3G, $U_Z$ = 128,5 V ± 6 %, P = 550 mW | 1SMB110AT3G, SMBJ110A | ON-Semi, Vishay |
| V101, V103, V154 | Zener diode, MMSZ5232B, Uz = 5,6 V ± 5%, P = 0,5 W | MMSZ5232B | ON-Semi<br>Vishay |
| V104, V105, V155 | Schottky Diode, BAT54, $I_F$ = 200 mA, $U_R$ = 30 V | BAT54 | |
| | | | |
| **HV Assembly:-HV Filter-2 board** | **Reference: drawing 960009309 A** | | |
| R103 | Resistor, 50 MΩ ± 3 %, $U_N$ = 4000 V, P = 1,9 W | MG716<br>OGP 26 | |
| R141 | Resistor, 100 kΩ ± 3 %, $U_N$ = 4000 V, P = 1,9 W | MG716<br>OGP 26 | |
| C184, C185, C186 | Capacitor, 4,7 nF ± 10 %, 3000 V | 2225B472K302N<br>2225HC472KA<br>2225J3K00472KX<br>302S48W472KV4 | |
| | | | |
| **HV Assembly:-HV-Signal Out board** | **Reference: drawing 960009311** | | |
| C100, C101 | Capacitor, 10 nF ± 10 %, 4000 V | SV16JC103KAA<br>8171MK00103KX | |
| | | | |
| **HV Assembly:-HV-Divider-2 board** | **Reference: drawing 960009312 A** | | |
| | This board does not contain protective components! | | |
| | | | |
| **Periphery terminal board** | **Reference: drawings 960007110 A** | | |
| | This board does not contain protective components | | |

| | | | |
|---|---|---|---|
| **Printed circuit boards** | | | |
| Material | Fibre glass laminate (FR4), rated UL 94 V-0, CTI ≥ 100 (CTI ≥ 275 for high voltage boards); Copper thickness 35 µm; outer layers power supply board ≥ 70 µm | | |
| | | | |
| **Coating** | | | |
| PCB coating: | | | |
| Material: | i. Probimer, type 52 or type 65, Vacrel foil, type 940 or Dynachem foil, type 4.0.<br>ii. IMAGECURE type XV501T-4 Matt Green Curtain Coat, imagecuresSmart XV501T-4 Green Curtain Coat or Elpemer GL 2469 SM-HF Curtain Coat. Conformal coating tested in report 1411829. | | |
| PCB assembly coating (for circuit board including components) | | | |
| Material: | Laquer Type SL1309N, SL1339N, SL1369N or Twin Cure DSL1600E-FLZ | | |

6. Transformers:

Power Supply Board:

i. DC Transformer, T100, type 2a, Class F, P/N EF 16, 18-60 Vdc.
Refer to dwg. 960006482 for specification.

ii. AC Transformer, T100 type 2a, Class F, P/N EF 16, 85-253 Vac.
Refer to dwg. 960006040 (replacing former dwg 960511-0010_B) for specification.

Transformer potting:

Scotchcast 894LV, ≥155 °C operating temperature.

Alternatives:

i. Araldit CW2243-2L by Vantico, ≥155 °C operating temperature.
ii. Epoxylite EIP4682 by Altana, ≥155 °C operating temperature.

7. High Voltage Converter Assembly (I.S.): Version 1

The HV Converter assembly is consisted of a Divider board with mounted contacts for connection to the photo multiplier tube, and two printed circuit boards (HV Supply, HV Control) mounted perpendicularly to the Divider board.

The cable, dwg. 960006536, connected to the HV Control Board is for connection of the assembly to the apparatus supply and the control circuits (Sensor Board).

The coax cable connected to the HV Supply Board is for the connection of the output signal to the apparatus signal processing circuits (Sensor Board).

The assembly is mounted in a plastic enclosure and completely encapsulated inside with potting compound, Silgel 612 by Wacker GmbH.

Construction Details:

| Drawing | Description |
|---|---|
| 960006545 | HV Assembly |
| 960570-0601 | HV Circuit Divider |
| 960570-0602 | HV Generator (Supply) and Signal out circuit with blocking capacitors |
| 960570-0603 | HV Control Circuit |

7.1 Alternative High Voltage Assembly (I.S.): Version 2

Similar to Version 1 above in construction and identical in function regarding electrical and mechanical interfaces.

The naming and indices (-2) show that there are some minor changes in the circuits of Version 2 for example MELF exchanged to Chip-Resistors or change of some footprints and therefore shifting of some components. But there are no changes in the Ex-concept. This means also that the layouts are transferred from old CAD-system to the latest version.

Construction Details:

| Drawing | Description |
|---|---|
| 960009566 | HV Assembly |
| 960009312 | HV Circuit Divider |
| 960009312 A | HV-Divider-2 |
| 960009311 | HV Generator (Supply) and Signal out circuit with blocking capacitors |
| 960009311 | HV-Signal-Out (no changes!) |
| 960009310 | HV Control (Supply) Circuit |
| 960009310 A | HV-Supply-2 |
| 960009309 | HV Filter circuit |
| 960009309 A | HV-Filter-2 |

7.1.2 HV Supply-2: Dwg. 960009310 A

Resistors:

| **Position** | **P** (fault condition) | **$P_{max}$ (70°C)** data sheet | **Type** | **Rated Voltage** | **Value, Ω** | **Tol.** |
|---|---|---|---|---|---|---|
| R156 | 16.7 mW | 250 mW | metal film | 200 V | 22,6 k | ± 3% |
| R136 | 150.5 mW | 250 mW | metal film | 200 V | 2.74 k | ± 3% |
| R157 | 150.5 mW | 250 mW | metal film | 200 V | 2.74 k | ± 3% |
| R135 | 73.4 mW | 250 mW | metal film | 200 V | 5.62 k | ± 3% |
| R100 | 18.7 mW | 250 mW | metal film | 200 V | 12.1 k | ± 3% |
| R130 | 73.4 mW | 250 mW | metal film | 200 V | 5.62 k | ± 3% |
| R153 | 91.5 mW | 250 mW | metal film | 200 V | 3.32 k | ± 3% |
| R154 | 1.2 mW | 250 mW | metal film | 200 V | 332 k | ± 3% |
| R155 | 1.2 mW | 250 mW | metal film | 200 V | 332 k | ± 3% |
| R108 | 4.1 mW | 250 mW | metal film | 200 V | 100 k | ± 3% |
| R107 | 1.2 mW | 250 mW | metal film | 200 V | 332 k | ± 3% |
| R109 | 1.2 mW | 250 mW | metal film | 200 V | 332 k | ± 3% |
| R105 | 3.7 mW | 250 mW | metal film | 200 V | 100 k | ± 3% |
| R145 | 4.4 mW | 250 mW | metal film | 200 V | 82.5 k | ± 3% |
| R132 | 572.7 mW | 1 W | metal film | 200 V | 180 | ± 3% |
| R133 | 572.7 mW | 1 W | metal film | 200 V | 180 | ± 3% |

Limiter (generator): Suppressor diodes.

| Position | $P_{(fault\ condition)}$ | $P_{max}$ (data sheet) | $P_{max}$ *2 (measured) | Type | Manufacturer | Uz | Tol. |
|---|---|---|---|---|---|---|---|
| F100, F101 | 272.2 mW*1 | 330 mW @75°C 600 $W_{peak}$ | 1 W @ 75°C | 1SMB110AT3G | ON Semiconductor | 128.5 | ±6% |
| | | | | SMBJ110A | Vishay | | |

Notes:

*1 Calculated by assuming power matching when connected to R132 plus R133 at maximum limited supply voltage of 19.5 V.

*2 See Test Report 970000411: Verification of thermal properties of F100, F101

$R^{th}_{meas}$ = 65 K/W
Tj = 150 K,
Resulting P (75°C) 1W.

Number of stages ("segments") of the voltage cascade: n = 11
Maximum zener voltage (F100, F101): $U_Z$ =136.2 V
Resulting maximum voltage at the HV circuitry: UHV = n x $U_z$ = 1498.2 V

Limiter (HV-MON):

| Position | P (fault condition) | $P_{max}$ (75°) (data sheet) | I (fault condition) | $I_F$ | Uz | Tol. | Type | Mfr |
|---|---|---|---|---|---|---|---|---|
| V101 V103 V154 | 27.3 mW | 220 mW | 4.55 mA | >10 mA | 5.6 V | ±7% | MMSZ5232B | Vishay (INT) |
| | | | | | | | CMHZ5232B | Central (INT) |

The calculated max. voltage of the zener limiter, V101/V103/V154 is 6.0 V.

Diodes:

| Position | P (fault condition) *1 | $P_{max}$ (75°) (data sheet) | I (fault condition) | $I_F$ | $U_R$ | Type | Mfr |
|---|---|---|---|---|---|---|---|
| V104 | 2.3 mW | 111 mW | 4.55mA | 200 mA | 30 V | 1PS76SB10 | NXP |
| V105 | | 80 mW | | 200 mA | 30 V | SD103AWS | Vishay |
| V155 | | 136 mW | | 300 mA | 30 V | BAT54 | ST-Micro |

Note: *1 calculated with $U_F$ = 0.5 V

7.1.3 HV Filter-2: Dwg. 960009309 A

High Voltage Resistors

| Position | P (fault condition) | $P_{max}$ (data sheet) | Type | Rated Voltage | Value, Ω | Tol. | Manufacturer |
|---|---|---|---|---|---|---|---|
| R103 | 46.3 mW | 1.0 W (70°C) | thickfilm on ceramic, Type GC70 | >4000 V | 50 M | ±3% | TT electronics / Welwyn |
| | | 1.9 W (75°C) | metaloxide film Type OGP 26 | 4000 V | 50 M | ±3% | EBG |
| | | 1.5 W (125°C) | metaloxide film Type MG716 | 4000 V | 50 M | ±3% | Caddock Inc. |
| | | 1.0 W (70°C) | metaloxide film Type HVR100 | >4000 V | 50 M | ±3% | Firstohm |
| R141 | 273.2 mW | 1.0 W (70°C) | thickfilm on ceramic, Type GC70 | >4000 V | 100 k | ±3% | TT electronics / Welwyn |
| | | 1.9 W (75°C) | metaloxide film Type OGP 26 | 4000 V | 100 k | ±3% | EBG |
| | | 1.5 W (125°C) | metaloxide film Type MG716 | 4000 V | 100 k | ±3% | Caddock Inc. |
| | | 1,0 W (70°C) | metaloxide film Type HVR100 | >4000 V | 100 k | ±3% | Firstohm |

Capacitors: The triple redundant smoothing capacitors C184, C185, C186 (4.7 nF) are ceramic multilayer types with an operating temperature range -55..125°C and a rated voltage of 3000 V (dielectric strength 3600 V).

Types: 2225B472K302 (manufacturer Novacap), or
2225HC472K (manufacturer AVX), or
2225J3K00472KX (manufacturer Syfer), or
302S48W472K (manufacturer Johanson)

These components are already used in the circuit of the present HV Converter Assembly Version 1.

7.1.4 HV Signal Out: Circuit diagram 960009311

The capacitors C100 and C101 (10nF ±11%) in series are used as block capacitors.
Each component is a ceramic multilayer X7R or COG type with an operating temperature range of -55...125°C, has rated voltage of 4000 V and a dielectric strength of 4800 V.

Types: SV16JC103K (manufacturer AVX), or
8171M4K00103KX (manufacturer Syfer)

These components are already used in the circuit of the present HV assembly.

7.1.5 HV Divider-2: Circuit diagram 960009312 A

The alternative HV Converter Assembly does not have components relevant for intrinsic safety on the HV divider board.

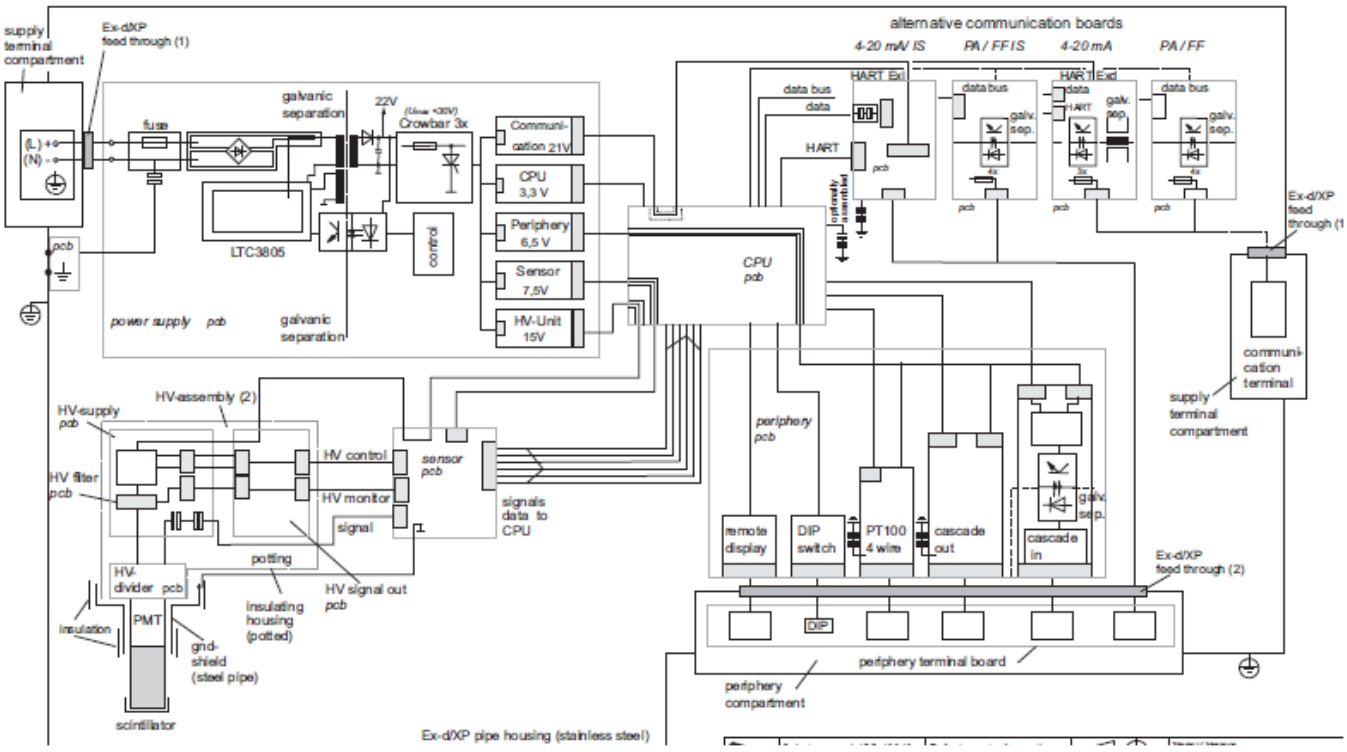
7.1.6 Printed Circuit Boards, Potting:

The potting type Silgel 612 by Wacker having the following data:

CTI>400
Continuous service temperature: ≥150°C
Dielectric strength: ≥20 kV/mm.

The printed circuit boards "HV-supply-2", "HV-filter-2" and "HV-signal-out" are made of FR4 material with CTI >275. The PCB "HV-divider-2" which does not contain components relevant for intrinsic safety is made of FR4 material with CTI>100.

Block Diagram of the product:



## TEST HISTORY

Project 1653884

1. Explosion-Proof Evaluation / Tests

   Representative tests were conducted by KEMA under the KEMA/CSA Agreement. Refer to KEMA Explosion-Proof Report No. 2030290.02-QUA/ING (Descriptive Documents Package, CSA Engineering File only).

   The same line of BARTEC feed-throughs has been previously Certified for use with Tankside Monitor under Report 151079-1308795 and Micropilot II / Micropilot M under Report 151079-1035027. The E+H feed-through is of similar construction to that Certified for use with the Promass 8 in 160686-1132623.

2. Intrinsic Safety Evaluation / Tests

   Representative tests were conducted by KEMA under the KEMA/CSA Agreement. Refer to KEMA Intrinsic Safety Report No. 2061676-03 (Descriptive Documents Package, CSA Engineering File only).

   Refer to the E+H Gammapilot M FMG60 Technical Description (Descriptive Documents Package, CSA Engineering File only) for a complete technical rationale and power calculations of protective components.

   The AC Protective Transformer was evaluated under Levelflex FMP40 Project 151079-1234621.

   The DC Protective Transformer Tests were conducted under the CSA Category Certification Program (Descriptive Documents Package, CSA Engineering File only).

   Hutmacher HK3030 Optocoupler was previously accepted under FTL325P/FTL325N I.S. Power Supply Project 151079-1234595. The test was actually performed by Factory Mutual (Descriptive Documents Package, CSA Engineering File only).

3. E+H Tests Conducted Under the CSA Category Certification Program

   The following tests were conducted by E+H under the CSA Category Certification Program (Descriptive Documents Package, CSA Engineering File only). These tests supplement those conducted by KEMA.

   - Determination of the Maximum Secondary Cutoff currents and Output Characteristic Curves
   - DC Protective Transformer Tests and Transformer Dielectric Strength Tests
   - Optical Isolator Tests (Performed by FM)
   - HV Converter Output Characteristic Curve
   - Determination of Surface Temperatures (Ex d)
   - Determination of Surface Temperatures (Dust)
   - Dielectric Strength Test (AC Version)
   - Dielectric Strength Test (DC Version)
   - Bonding Impedance Test

- Impact and Torque Test (Ex d / XP Adapters)
- IP6x Dust Exclusion Test
- IPx5 Test
- IPx7 Test
- NEMA / Type 4 Test
- NEMA / Type 6 Test
- Impact Test - Protection Pipe for FHX Plug Adapter
- O-Ring / Gasket Test Results (Change of Hardness)
- Power Supply – Discharging of Inner Capacitances
- Torque, Bending and Pullout Tests
- 7 Joule Impact Tests

4. Evaluation to CAN/CSA-C22.2 No.1010.1-92:

The equipment has been evaluated by the manufacturer according to CAN/CSA-C22.2 No.1010.1-92 under the CSA Category Certification program. The complete Conformity Verification Report IEC61010-1 is included in the Descriptive Documents Package as confirmation of the evaluation.

**Project 1711775**:

Update to report to cover alternative constructions and additions (intrinsically safe) as described below as per E+H Gammapilot M FMG60 Technical Description 1st Amendment dated June 24, 2005.

Refer to Descriptive Documents Package for complete details on the following mentioned drawings and technical description.

1. Addition of Communication Circuit Board Profibus PA or Foundation Fieldbus (I.S. / Non-I.S.)

Alternative to the existing communication circuit board. It allows both I.S. and Non-I.S. communication depending on the connectors used.

Circuit board is described by the added drawings 960 570-1100, -1101, -1102, -1103, -1110A, -1110B, -1111, -1112, -1113, -1120 and –1121. Control Drawing 960007341 is added to show the I.S. Profibus PA or Foundation Fieldbus installation. Control Drawing 960007342 is added to show the non-I.S. Profibus PA or Foundation Fieldbus installation. Drawing 960007142 is for the new Profibus PA or Foundation Fieldbus cables.

The entity parameters and protective component evaluations are detailed in the Technical Description 1st Amendment dated June 24, 2005.

The main critical component is the opto-coupler Endress+Hauser/Hutmacher Type TECMAG Ex, also known as Type IS435/GL430. It has been previously accepted for use under Endress+Hauser Flowtec AG projects 160686-1111289 (Promag 50/51/53 W/P/H), 160686-1132623 (Promass 40/80/83/84 A/E/F/H/I/M) and 160686-1185210 (Proline Prosonic Flow 9.).

The following tests were conducted by Endress+Hauser under their CSA Category Certification Program (E+H project number 15000181):

- Dielectric Strength (Non-I.S. Configuration)
- Dielectric Strength (I.S. Configuration)
- IPx5 Test (re new Profibus PA or Foundation Fieldbus cables)
- IPx7 Test (re new Profibus PA or Foundation Fieldbus cables)
- NEMA / Type 4 Test (re new Profibus PA or Foundation Fieldbus cables)
- NEMA / Type 6 Test (re new Profibus PA or Foundation Fieldbus cables)

Spacings across protective components/circuits are in accordance with the Applicable Standards.

2. Addition of Communication Circuit Board 4-20mA/Hart (Non-I.S.)

Alternative to the existing I.S. 4-20mA/Hart communication circuit board. Provides a non-I.S. 4-20mA/Hart field circuit. It is equipped with a protective transformer and protective opto-couplers which isolates the non-I.S. 4-20mA/Hart circuit from the I.S. circuits on the Periphery Board.

Circuit board is described by the added drawings 960 570-1000, -1001, -1010, -1011, -1012, -1013, -1020 and -1021. Control Drawing 960007343 is added to show the non-I.S. 4-20mA/Hart installation.

Protective component evaluations are detailed in the Technical Description 1st Amendment dated June 24, 2005.

The main critical components are Protective Transformer T100 and Opto-couplers U100, U101 and U102. Transformer detail is described by drawing 960007137. The opto-couplers are by HP/Agilent HCNR201 (only pages 1-6 and 10 are critical to safety).

The following tests were conducted by Endress+Hauser under the CSA Category Certification Program (E+H project number 15000181):

- Transformer Temperature & Dielectric Strength (Transformer T100)
- Optical Isolator Test (HCNR201)
- Dielectric Strength

Spacings across protective components/circuits are in accordance with the Applicable Standards.

3. Addition of Power Supply PCB Variant 2

Alternative to the existing Power Supply PCB (Variant 1).

Circuit board is described by drawings 960007567, 960007576, 960007568, 960007569, 960007570, 960007571, 960007574 and 960007575.

The differences are in areas not critical to Intrinsic Safety (in the area of Diode V102).

All tests previously conducted on the Power Supply Variant 1 remained representative.

4. Updated Evaluation to CAN/CSA-C22.2 No.1010.1-92:

   The revised equipment construction has been evaluated by the manufacturer according to CAN/CSA-C22.2 No.1010.1-92 under the CSA Category Certification program (E+H PN 15000181). Updated Conformity Verification Report IEC61010-1 included.

**Project 1757873**: Update to cover alternative internal plastic housing and HV assembly; and increase transformer dielectric strength test to 3KVrms from 2.5KVrms.

Drawings revised/added in this project are:

960006483/B; 960006545/B; 960007657; 960007137/A.

The alternative internal plastic housings are evaluated to have no affect on the tests conducted in this report. No further testing was considered necessary.

**Project 1897824**: Update to cover alternative schematics for EMC purposes; (a) Communication PCB 4-20mA Hart (Exi) (Variant II) dwg 960007072/ A and, (b) Communication PCB 4-20mA Hart (Exd) (Variant II) dwgs 960007143 ….150/ B.

1. Alternative Comm Circuit Board 4-20mA Hart (Exi) - (I.S.) Schematic (Variant II): Dwg 960007072/ A:

   Value of capacitor C107 changed from 1 nF to range 1..10 nF.
   Value of inductance L108 changed from 10 mH to range 10..27 mH.

   Drawing revised/added in this project is 960007072/ A.

   The extended values are not critical to Intrinsic Safety characteristics.
   All tests conducted on the previous Variant I remained representative.

   Remarks : Circuit diagram 960007072/ A (Variant II) is alternative to 960570-0100 A (Variant I).
   Remaining drawings (components/trace pcb layout) of Variant I are also applicable to Variant II.

2. Alternative Comm Circuit Board 4-20mA Hart (Exd) - (Non-I.S.) Schematic (Variant II): Dwgs 960007143 … 150/ B.

   Capacitor C138 (220 pF) supplemented on layer B.
   Capacitor C137 (220 pF) supplemented on layer A.

   The differences are in areas not critical to Intrinsic Safety (in the area of op-amp N104 and optocoupler U101). All tests previously conducted on the previous Variant I under dwgs 960 570-1000/ A ….-1021 /A remained representative.

No further testing was deemed necessary.

**Project 1962184**: Update to include alternative remote cable dwg 960008356 (potted with Silgel 612 inside the connector; without protection pipe), minor non-critical components revisions in the Communication pcb PA/FF and Sensor PCB (created as Variant II), and minor drawing revisions due to the above alterations. Revisions described in E+H Technical Description dated 19.09.2007 kept on file.

The following tests conducted by Endress+Hauser under CSA Category Certification Program in project no. 15000325 were evaluated to be acceptable to the applicable standards on the alternative remote cable assembly without pipe protection, dwg 960008356.

- Impact Test
- Dust Exclusion Test
- Type 4 Test
- Type 6 Test
- IP x5 Test
- IP x7 Test

No further testing was deemed necessary.

**Project 2148733**: Update to include alternative I.C. oscillators N201 and N202 (dwg 960 570 0201 A) to new oscillators G200 and G201 in added dwg 960009113 as Variant 2; alternative similar die-cast aluminum explosion-proof enclosure, dwgs 960008731, 960008828 and 960008827; include alternative marking method by laser printing, casting, embossing or engraving on the metallic enclosure; and increase the Detector with plastic scintillator (PVT) type ambient temperature in the control drawings..

1. Alternative oscillators G200 and G201: Changes, per E+H Technical Description Doc. No. 960009240, to the oscillators type do not affect any intrinsically safe testing and/or evaluation conducted in this report.

   Drawings Added: Related drawings in the pcb component and trace layout.

| CPU pcb Drawings (Variant 1) | Added CPU pcb Drawings (Variant 2) |
|---|---|
| 960 570 0203 A | 960009158 |
| 960 570 0200 A | 960009112 |
| 960 570 0201 A | 960009113 |
| 960 570 0221A | 960009114 |
| 960 570 0211 A | 960009116 |
| 960 570 0213 A | 960009117 |
| 960 570 0215 A | 960009159 |
| 960 570 0220 A | 960009115 |
| 960 570 0210 A | 960009119 |
| 960 570 0212 A | 960009118 |
| 960 570 0214 A | 960009160 |

2. Alternative Explosion-proof Enclosure: Added alternative enclosure made of die-cast aluminum, dwgs 960008731, 960008828 and 960008827.

Drawings added:

Aluminum Enclosure: 960008731, 960008828 and 960008827.

Enclosures comparison table:

| Location | Item | Stainless Steel Cover | Aluminum Cover |
|---|---|---|---|
| Supply terminal cover compartment | Thread size | M85 x 1.5 6g/6H medium fit | M85 x 1.5 6g medium fit |
| | Thread length | > 12.7 mm | > 12.7 mm |
| | Number of threads | > 8.4 | > 8.4 |
| **Location** | **Item** | **Stainless Steel Housing** | **Aluminum Housing** |
| Thread for supply cover compartment | Thread size | M85 x 1.5 6H | M85 x 1.5 6H medium fit |
| | Thread length | ≥ 15 mm | ≥ 15 mm |
| | Number of threads | > 9 | > 9 |
| Thread of cable entries (2) at supply compartment | Thread size | M20 x 1.5 6H | M20 x 1.5 6H |
| | Thread length | ≥ 15 mm | ≥ 15 mm |
| | Number of threads | > 9 | > 9 |
| Thread for cable feed-through to supply compartment | Thread size | M16 x 1.5 6H medium fit | M16 x 1.5 6H medium fit |
| | Thread length | ≥ 18.6 mm | 20.6 mm |
| | Number of threads | > 12 | > 13 |
| Thread for cable feed-through to I.S. compartment | Thread size | M24 x 1.5 6H medium fit | M24 x 1.5 6H medium fit |
| | Thread length | 25 mm | 23.8 mm |
| | Number of threads | > 16 | > 15.5 |
| Thread to pipe housing | Thread size | M98 x 2 6g medium fit | M98 x 2 6g medium fit |
| | Thread length | > 25 mm | > 25 mm |
| | Number of threads | > 12 | > 12 |
| Supply compartment with cover | Volume | 335 ml | 337 ml |

Due to the similarity of the aluminum enclosure only the following tests were necessary.

Testing on the above alternative aluminum enclosure, dwgs 960008731, 960008828 and 960008827, conducted by KEMA under report 211943200-2-QUA/EX dated 12 February, 2009 was evaluated to be representative to the relevant requirements as follows:

Refer to the above KEMA Test Report for test results and justification.

a. Test for resistance to impact: CSA C22.2 No. 30-M1986, cl. 6.2.1
CAN/CSA-C22.2 No. 60079-0:07, cl. 26.4.2

The aluminum enclosure and cover were subjected to an impact of 7 Joules resulting from a test mass of 1 kg falling vertically from a height of 70 cm. The test mass is fitted with a steel hemisphere of 25 cm diameter.

Result: No damage of the tested parts observed that would affect the type of protection.

b. Determination of explosion pressure (reference pressure): CSA C22.2 No. 30-M1986, cl. 6.3

The explosion pressure tests on the Electronics/probe compartment and the Terminal housing were waived based on the internal geometry and the flamepath construction (including feed-throughs) remained the same as the stainless steel enclosure tested originally in this report.

For reference, the original measured values (stainless steel) are as follows:

- Electronics/probe compartment Group B, hydrogen:
  The highest ignition pressure recorded was 16.7 bar at the end of the Electronics/probe compartment.

- Electronics/probe compartment Group A, acetylene:
  The highest ignition pressure recorded was 25.4 bar at the end of the Electronics/probe compartment.

- Terminal housing Group B, hydrogen:
  The highest ignition pressure recorded was 13.5 bar at the wall of the enclosure with an ignition at the end of the 15 feet conduit.

- Terminal housing Group A, acetylene:
  The highest ignition pressure recorded was 22.7 bar at the wall of the enclosure with an ignition at the end of the 10 feet conduit.

c. Test for non-transmission of an internal ignition: CSA C22.2 No. 30-M1986, cl. 6.5.3

The non-transmission tests on the Electronics/probe compartment and the Terminal housing were waived based on the internal geometry and flamepath construction remained the same as in the stainless steel enclosure.

d. Hydrostatic tests: CSA C22.2 No. 30-M1986, cl. 6.6

The above impacted aluminum enclosures were subjected to the overpressure test. The pressure was increased at a rate of at least 6.89 bar/min. and held at the test pressure as mentioned below for one minute.

• A hydrostatic test was conducted on the Electronics/probe compartment enclosure at a pressure equal to 400 % of the maximum explosion pressure of 25.4 bar = 102 bar, for 1 minute.

Result: No visible of permanent deformation of the enclosure was observed.

• A hydrostatic test was conducted on the Terminal housing at a pressure equal to 400 % of the maximum explosion pressure of 22.7 bar = 91 bar, for 1 minute.

Result: No visible of permanent deformation of the enclosure was observed.

Note: The equipment can be marked as “Factory Sealed, conduit seal not required”.

e. Determination of explosion pressure (reference pressure): CAN/CSA-C22.2 No. 60079-1:07, cl. 15.1.2

The explosion pressure tests on the Electronics/probe compartment and the Terminal housing were waived based on the internal geometry and the flamepath construction (including feed-throughs) remained the same as the stainless steel enclosure tested originally in this report.

For reference, the original measured values (stainless steel) are as follows:

- Electronics/probe compartment Group IIC, hydrogen:
The highest ignition pressure recorded was 16.7 bar at the end of the Electronics/probe compartment.

- Electronics/probe compartment Group IIC, acetylene:
The highest ignition pressure recorded was 25.4 bar at the end of the Electronics/probe compartment.

- Terminal housing Group IIC, hydrogen:
The highest ignition pressure recorded was 5.9 bar at the wall of the enclosure with an ignition at the end of the 15 feet conduit.

- Terminal housing Group IIC, acetylene:
The highest ignition pressure recorded was 6.4 bar at the wall of the enclosure with an ignition at the end of the 10 feet conduit.

f. Overpressure test (Hydrostatic): CAN/CSA-C22.2 No. 60079-1:07, cl. 15.1.3

• A hydrostatic test was conducted on the Electronics/probe compartment enclosure at a pressure equal to 150 % of the maximum explosion pressure of 25.4 bar = 38.1 bar, for 1 minute.

Result: No visible permanent deformation on the enclosure was observed.

An additional hydrostatic test for a minimum of ambient temperature of -40 °C was conducted on the Electronics/probe compartment at a pressure equal to 135 % of the 38.1 bar = 51.5 bar, for 1 minute and a pressure of 102 bar, for 1 minute.

Result: No visible permanent deformation on the enclosure was observed.

• A hydrostatic test was conducted on the Terminal enclosure at a pressure equal to 400 % of the maximum explosion pressure of 6.4 bar = 25.6 bar, for 1 minute.

Result: No visible permanent deformation on the enclosure was observed.

An additional hydrostatic test for a minimum of ambient temperature of -40 °C was conducted on the Terminal housing at a pressure equal to 135 % of the 25.6 bar = 34.5 bar, for 1 minute and a at a pressure of 91 bar, for 1 minute.

Result: No visible permanent deformation on the enclosure was observed.

g. Test for non-transmission of an internal ignition: CAN/CSA-C22.2 No. 60079-1:07, cl. 15.2

The non-transmission tests on the Electronics/probe compartment and the Terminal housing were waived based on the internal geometry and the flamepath construction (including feed-throughs) remained the same as in the stainless steel enclosure tested originally in this report.

3. Others: The following drawings were replaced in this project.

i. 960007341_C; 960007343_C; 960007342_C; and 960007132_D to reflect the permissible ambient temperature from 50 °C to 60 °C for the Detector with plastic scintillator (PVT) type in the control drawings.

ii. 960006531_A to include alternate nameplate marking by laser printing or engraving.

4. The following tests conducted by Endress+Hauser under CSA Category Certification Program were evaluated to be acceptable to the applicable standards in this report on the alternative aluminum enclosure, dwgs 960008731, 960008828 and 960008827.

| Test | Test Report |
|---|---|
| • Heat-Storage | 970000634 |
| • Impact / Enclosure Rigidity Dynamic | 970000667 |
| • IP X5 | 970000658 |
| • IP X7 | 970000659 |
| • NEMA Type 4 | 970000660 |
| • NEMA Type 6 | 970000661 |
| • Dust Exclusion | 970000634 |
| • Conduit Torque | 970000663 |
| • Conduit Bending | 970000664 |
| • Conduit Pull-Out | 970000665 |

No further testing was deemed necessary.

**Project 2277212**: Update to include alternative HV Converter Assembly Version 2, alternative AC/DC transformer T100 potting material types Araldit CW2243-2L and Epoxylite EIP4682 and minor drawings revision as documented in E+H Technical Description 7th Amendment Parts 1 and 2 under document nos. 960009828 and 960009829 respectively.

The above revisions were reviewed in conjunction with KEMA Test Report No. 212752700, provided by the submittor, to be representative to the tests and/or evaluation previously conducted in this report.

Tests /Assessments (I.S.) Reviewed: HV Converter Assembly Version 2 and alternative AC/DC transformer potting materials.

1. Protective components ratings;
2. Creepage and Clearance Distances;
3. Capacitance and Inductance evaluation;
4. Temperature measurements;
5. Dielectric strength tests
6. Transformer secondary cutoff current

The above revisions were included in the IEC 61010-1:2001 and National Deviation reports 970001158 Rev. A and 970001159 Rev. A respectively. The reports were reviewed to be representative to CAN/CSA-C22.2 No. 61010-1-04 and accepted under the submittor CSA Category Program.

No further tests were deemed necessary.

## Project 70149664 – Edition 8

### 1. Project Summary

This project is to update Report 1653884 to assess the following modifications:

a) New switching Power supply for AC and DC.
b) HART Ex-I circuit update for new HART-Chip.
c) HART Ex-d circuit update for new HART-Chip.
d) FMG60-CPU: exchange of some components.
e) FMG60-periphery: exchange to some new components.
f) FMG60-sensor: circuit update for alternate scintillator material PVT or NaJ.
g) FMG60-HV-circuit update of 3 of the 4 inserted circuits: only minor changes.
h) Evaluation/changes according to newer editions of standards.
i) Reduction in working ambient temperature from 80°C to 75°C.

### 2. Assessment of Modifications

**2a.** New switching Power supply for AC and DC version with new switch mode controller, new Crowbar circuit (3 times) at the secondary side of the transformer, new optical components for the feedback from the secondary side, new Voltage converter components including current and voltage limitation for the power supply pcb's new layout. The complete assessment of this new Switching Power supply is described in technical description document 961000143-A, chapter 7.2.

The FMG60 is internally supplied by a switching power supply. There are two variants available: The AC variant and the DC-variant which is an assembly variation of the AC-version. The circuit is protected by a fuse F101 (IEC 60127 / UL 248-14) with a rated breaking capacity of 1500A. For EMC reasons the circuit is capacitivly grounded by the safety capacitors C103 and C106. The required spacings are maintained and the dielectric strength is stated as 1500Vrms. The bridge rectifier is also assembled in the DC version for reverse battery protection.

| | Position | AC separation capability | Type e.g | Manufacturer e.g. | $I_{rat}$ (=$I_{fuse}$) | $U_{rat}$ |
|---|---|---|---|---|---|---|
| AC-version | F101 | 1500 A | 160016 | Siba | T250mA | 250 V |
| DC-version | | | | | T400 mA | 250 V |

| Position | Value | rated voltage | Type | Class | Dielectric Strength | Manufacturer e.g. |
|---|---|---|---|---|---|---|
| C103, C106 | 4,7 nF ± 10% | 250 VAC | GA355DR7GF472KW01L | X1, Y2 | 1500Vac | Murata |

The switching power supply is working as a Flyback-converter with regulation of the output voltage on the secondary side. The output voltage is fed back over an optical transmission (H100, B100) to the new switch mode controller e.g. LTC3805-5 (N100). The controller needs an own voltage regulation (V115) because the component can only be supplied by a DC-Low-voltage. The switch mode controller delivers a PWM-signal (with constant frequency) to the external FET (V107). In dependency of the load current at the output the pulse width will be changed. The output voltage is limited to a maximum value <30V by three parallel Crowbar circuits. The normal output voltage is regulated to approx. 22V.

The assessment was reviewed by CSA and considered satisfactory. No additional testing is required.

**2b.** HART Ex-i: optimized circuit incl. new HART-Chip, new HART-output concept (I.S.), no change of entity parameters, new layout. A new HART chip (D103) is implemented. The complete schematic is reduced to one sheet and all components are placed on one side of the PCB. There are no changes in the Ex-concept. The communication Board 4…20mA ex-i/IS is supplied by the 21.5V-branch of the power supply unit and is limited by a zener limitation to Uzmax=26.75V and a 40mA fuse. Via the connector X401 the branches 21.5V (max. 26.75V) and 3.3V (max. 4.2V) are infallibly connected to its limiters on the power supply board. Also ground via X400, X401 is infallibly connected. Circuit is complying and no testing is needed.

**2c.** HART Ex-d: optimized circuit incl. new HART-Chip, new HART-output concept, new optical transmission instead of optocouplers, maximum input voltage of the DC/DC-converter reduced from 28,4V to 26,75V (decrease of the power), new layout. This PCB is connected to the CPU board by the connectors X400 and X401. The ground-layer via X400, X401 is infallibly connected. The primary circuit of the transformer T100 is supplied by the 21.5V-branch of the power supply board. This branch is limited by a zener limitation to max. 26.75V and is protected by a 40 mA fuse. The 3.3V-supply as well as the data lines are clamped by the voltage limiter on the power supply board to max. 4.2V. The measures for the Ex-concept are clearly reduced. The three optocouplers in the former circuit are exchanged to the optical transmission through the PCB. The optical Transmitter on one side of the PCB and the optical Receiver on the other side are no longer considered as optocoupler. Thus the complete limiting Resistors on the CPU side and the Fuses on the Ex-side to limit the power dissipation in the optocoupler are no longer needed. The required Ex spacings for Um=250 V and the solid insulation through the pcb are fulfilled. The power supply of the output is realized by an Ex DC/DC-converter with the transformer T100. The galvanic separation at the transformer meets the IS requirements for 375 V. The requirements of the IS spacings at the transformer (at the component T100) and on the surface of the PCB are fulfilled. The secondary side of the circuit provides the 4..20 mA loop to the connector X427 and the internal 3.3V supply for the secondary circuit. The connector X427 is connected to the signal terminal in the supply compartment of the compartment housing (Ex db) by the wires of the already approved XP feed through. The fuse F100, with high breaking capacity (I=1500A), limits the input current from the terminal. The old fuses F102 and F101 to limit the current to the optocouplers are no longer needed. The spacings fulfill the IS requirements for 375 V. The spacings to the communication circuit are suitable for 375 V acc. to the IS standards.The assessment is satisfactory and no further testing is necessary.

**2d.** FMG60-CPU: exchange of some components, which are not relevant for ex-protection, update of the layout. None of the parameters are affected with change of components on this board. No further testing is required.

**2e.** FMG60-periphery: Change to some new components, no change of entity parameters, new layout**.** None of the parameters are affected with change of components on this board. No further testing is required.

**2f.** FMG60-sensor: 2 new circuit diagrams if the scintillator material is PVT or NaJ, new concept for the internal power supply (+5,4V / -5,4V) incl. new ex-limiter circuit, new voltage converter circuits, new layout**.** The sensor board is supplied with 7.5V in normal operation and is limited by a zener limitation Uz (new: Uzmax = 11.77V, old: Uz = 21.4V) and a fuse with Irat = 50mA. For functional reasons the sensor board generates its own supply voltages. All board voltages are limited by zener limitations and at the interfaces there are voltage and current limiters to the other boards. The negative sensor board voltage is clamped by diodes to -0,5 V (V315, V319, V325). The board supply is limited by two limiters consisting in V304, V306, V312, V314, V318, V320 (branch +5V) V305, V307, V313, V315, V319, V325 (branch -5V). The ground-layers DGND and AGND are infallibly connected. The current into the two limiters is limited by two fuses F300 and F301. The power under fault conditions is less then 2/3$^{rd}$ the rated power. The signal lines of the sensor board are connected to the CPU board by the connector X200. Each signal line has its own voltage and current limiter. GND is infallibly connected to gnd of the CPU. Voltage and current from/to the HV-control board is limited by the resistors R102, R108, the Schottky diodes V103, V107 and Zener-diodes V109, V111. The limiter is designed infallibly. All limiters are infallibly connected to GND. The sensor signal via X202 from HV supply board is limited by F100…F103

(Suppressor diode) for single transients coming from the sensor line in case of fault, the current from the sensor board is limited by the resistors R104…R107. The suppressor diodes are infallibly connected to the resistors and to GND. Clearance and creepage distances and separations on the PCB are maintained according to applicable standards, i.e. the distances between conductive parts of circuits affecting the intrinsic safety are in accordance with IEC60079-11 table 5. The assessment is satisfactory and no further testing is required.

**2g.** FMG60-HV-circuit: update of 3 of the 4 inserted circuits: HV-Divider-2, HV-Supply-2, HV-Filter-2. The circuit HV-Control (HV-Signal-Out) remains unchanged. Only minor changes**.** MELF exchanged to Chip-Resistors and change of some footprints, therefore shifting of some components. But there are no changes in the Ex-concept. The PCB "HV-Filter" is assembled on the PCB "HV Supply" by redundant rigid contact pins with integrated spacers. The "HV Filter/HV Supply" assemblies as well as the PCB "HV Signal out" are connected to the PCB "HV Divider" by the means of redundant rigid soldered connectors. The 4 PCBs are assembled in an insulating housing (dwg. 960007657) which is largely identical to the present approved construction. The aforementioned housing is potted with silicone potting Silgel 612 (manufacturer e.g. Wacker). The potting assures that the required IS spacings on the PCBs within the assembly and from inside the exterior of the assembly are maintained. As applied at the present approved HV assembly IS spacings for 30V and for 1575V are used. Additionally circuits are separated by infallibly connected and designed ground (gnd) layers or tracks of ≥2mm width. Also identical to the present assembly the alternative one is connected to the Sensor PCB by cables and connectors and is mechanically fixed within the existing surrounding plastic housing (see dwg. 960007657). The cylindrical outer surface of the isolating housing of the HV-assembly is covered with a copper foil (affixed all over). The copper foil itself is infallibly connected to GND by a soldering seam (see dwg. 960009566). The geometrical and insulating properties of the HV assembly housing in combination with the isolating plastic housing assure that the required IS spacings between circuits and from circuits to earth grounded metallic parts are fulfilled.

A functional block diagram is given in Fig. 1.

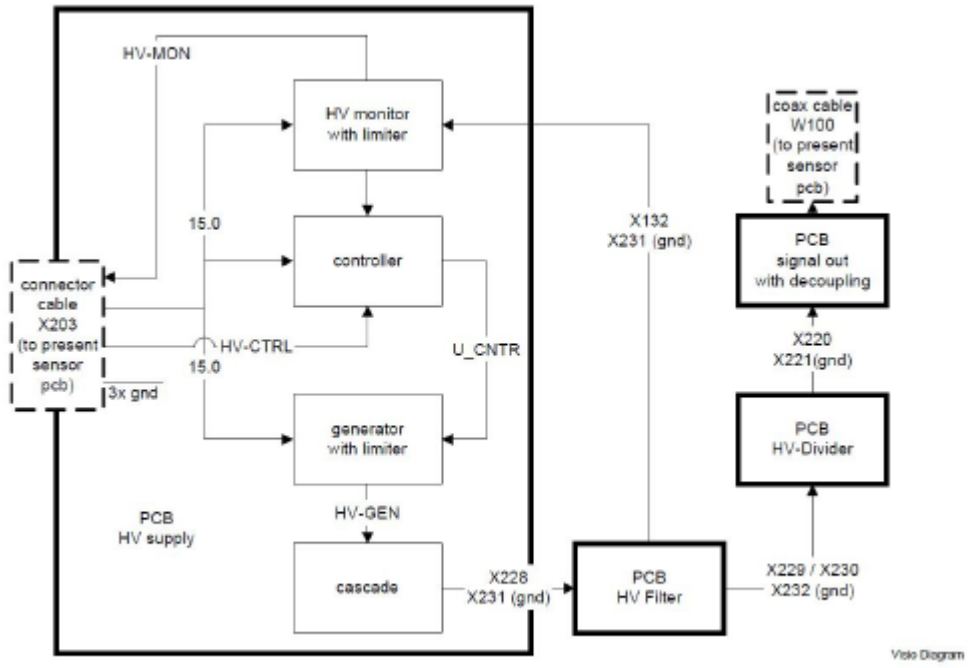



Fig. 1: Functional blocks of the HV assembly

The HV assembly is connected to the circuitry of the Gammapilot by the connector cable X203 which provides a 15V supply, limited to 19.5V, and HV-control (HV-CTRL) signal limited to 6.0V. The HV assembly delivers the (HV-MON) signal, which is restricted to 6.0V by the zener limiter (V154, V101,

V103). The HV-CTRL line gives an input signal to the controller to set the generator output to a certain voltage value. The output voltage (HV-GEN) is limited by F100, F101 to 136.2V. The following cascade circuit "multiplies" the generator voltage according to the number of "segments". The present cascade has 11 segments, i.e. the maximum available DC output voltage at the connector X228 is 1498.2V (= 11 x 136,2V). Faults of components or tracks within the cascade always lead to reduced segment voltages and consequently reduced output voltage. The high voltage is distributed by the PCB "HV filter" to the PCB "HV divider" to supply the photomultiplier tub and to the HV-filter input (X132) through a voltage divider on the PCB "HV supply". On the PCB "HV divider" the photomultiplier output signal (X220) is lead to PCB "HV signal out" which decouples the DC high voltage to the coax cable by the means of two blocking capacitors. This principle is already identically used at the present approved HV assembly.

Throughout the assembly ground (GND) connections are designed infallibly by using either infallible ground layers, triple redundant cables and connectors, or single tracks of ≥3mm width. All voltage limiting components are infallibly connected either by triple redundant tracks or by tracks or areas of ≥2mm width. The printed circuit boards "HV supply-2", "HV filter-2", and "HV signal out" are made of FR4 material with CTI>275. The PCB "HV divider-2" which does not contain components relevant for intrinsic safety is made of FR4 material with CTI>100. The circuit paths are covered by a protective film except the soldering points and component soldering pads. Voltage limiting measures are either infallibly connected acc. to Ex-i requirements or connected in a way which maintains intrinsic safety considering two faults. Clearance and creepage distances and separations are maintained according to applicable standards, i.e. the distances between conductive parts of circuits affecting the intrinsic safety are in accordance with IEC60079-11 table 5.

**2h.** Evaluation/changes according to newer editions of standards. Standard references have been updated to the latest current editions. The assessment is based on the IECEx test report NL/DEK/ExTR13.0073/01 and its corresponding certificate IECEx DEK 13.0071X_Issue_1. Review of the assessment of this device covered in IECEx report was conducted and is considered satisfactory. No further tests were deemed necessary. The national deviations for Canada were evaluated for the revised standards and considered acceptable. The IECEx test reports are available in Documentum.

The complete product description and revision history is documented in E+H Technical Description 8th amendment under document no. 961000143 Rev. A respectively.

The above revision was reviewed in conjunction with DEKRA Certification B.V. IECEx Test-Report No. 219501800, provided by the submittor, to be representative to the tests and /or evaluation conducted in this report. Because of the tests for the requalification for T6 the maximum ambient temperature has to be decreased to 75°C.

The Test reports are listed under "E+H Tests" (Conducted under CSA Category Certification Program)

The above assessment for Hazloc location is satisfactory and hence further testing is deemed not necessary.

The requirements for ordinary locations per standard CSA C22.2 No. 61010-1-12 were fulfilled and reported in the test report 970005675 and 970005765. The test were performed at Endress+Hauser GmbH+Co. KG under the CSA Category Certification Program. The reports were reviewed to be representative to CAN/CSA-C22.2 No. 61010-1-12 and accepted under the submittor CSA Category Program No further testing is deemed necessary.

---End of Report---