

SPECIFICATION (SPEC.)

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Piezoelectric Crystal

No. F1301-903790

Sheet
1 (5)

Issue	Date	Prepared/Checked	Approved/Proposal No.	Issue	Date	Prepared/Checked	Approved/Proposal No.
B	90-03-13	<i>LBA</i>	11778				

*0 813 370
issue 2/
INTERN*

1 RELEVANT DOCUMENTS

in addition to this specification:

Drawing	F1301-060520
Description of method for testing of piezoelectric crystals	F1301-903160
Sampling procedures and tables for inspection by attributes	SS 02 01 30 or MIL-STD-105D

2 DESCRIPTION OF PRODUCT

The circular piezoelectric crystal is provided with silver electrodes. Mechanical stresses make the crystal emit electric charges proportional to the applied forces.

3 PRODUCT REQUIREMENTS

3.1 MATERIAL

3.1.1 Approved materials: Matsushita PCM-5 and Hoechst SONOX P5.

3.1.2 The crystal shall, without breaking, withstand a pressure of min 9 800 N evenly distributed over the circular area.

AQL: 2.5 %. Destructive test.

W010UNA2

Issue	B										Appendix	No. F1301-903790
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0 813 370
issue 2

3.2 SURFACE QUALITY AND DIMENSIONS

3.2.1 The silver electrodes of the crystal shall be free from silver oxide, sulphide etc. that may adversely affect the function of the crystal.

3.2.2 The dimensions of the crystal shall be within the limits specified in the drawing.

AQL: 1.0 %.

3.3 ELECTRICAL REQUIREMENTS

3.3.1 At room temperature, approx. 20 °C, the capacitance between the silver electrodes of the crystal shall be min. 1 000 pF.

AQL: 2.5 %.

3.3.2 The following voltage shall be obtained when dropping a steel ball from 150 mm with the crystal fitted in a testing device as described in the description of method specified in para. 1.

The mean amplitude of the generated voltage shall be min. 575 V.

AQL: 0.65 %. No mean value to be below 525 V.

The mean to be calculated on 5 tests with the same crystal. Voltage polarity shall be in accordance with the description of method in para. 1.

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0 813 370
Issue 2

3.4 MARKING

The positive electrode of the crystal shall be clearly marked by means of a stamp or equal; functioning shall however not be endangered.

AQL: 0.65 %.

4 MANUFACTURE

4.1 PLANNING AND FOLLOW-UP

A manufacturing journal in accordance with the vendor's practice shall be kept and, on request, be shown. The journal shall give information on essential alterations in the manufacturing process and state results of tests made during manufacture. The journal shall be retained for at least 20 years.

5 DELIVERY

5.1 PACKING

5.1.1 The package shall protect the crystals from damage during transport, handling and storing.

5.1.2 The crystals are delivered in lots of approx. 5.000 or multiples thereof.

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0 813 370

issue 2

5.2 TRANSPORTATION MARKING

The package shall be marked with name of product, drawing number with issue letter, stock number, quantity and lot designation.

6 INSPECTION

6.1 VENDOR'S INSPECTION

6.1.1 The vendor shall perform inspection to the extent necessary to verify that the requirements of this specification are met.

6.1.2 In case of deviations, a deviation routine agreed upon between purchaser and vendor shall be used.

6.1.3 Unless otherwise stated in this specification, normal environmental conditions (+25 ± 10 °C, 30-75 % RH, 960 ± 100 millibars) are to be maintained before and during inspection.

6.2 PURCHASER'S INSPECTION

The purchaser shall be given an opportunity to be present at and follow the vendor's manufacture and inspection.

6.3 CERTIFICATES

6.3.1 The vendor shall account for his inspection by means of certificates to the extent agreed upon between purchaser and vendor. The certificate shall show that the lot has been inspected and approved by the vendor.

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issue 2/

6.3.2 Certificates from sub-contractors shall be available to the purchaser.

7 OTHER CONDITIONS

None.

SPECIFICATION (SPEC.)

					Description of Method for Testing of Piezoelectric Crystals					No. F1301-903160				
										Sheet 1 (3)				
Issue	Date	Prepar- ed	Check- ed	Appd	Issue	Date	Prepar- ed	Check- ed	Appd	Issue	Date	Prepar- ed	Check- ed	Appd
D	84-11-08	LN		AG										

Translated from Swedish GÅ

0 813 401 issue 4

1 PURPOSE

To measure the peak positive voltage from piezoelectric crystals.

2 GENERAL

A fixture provided with a device for generation of reproducible mechanical stresses on the test specimens is used for the test as well as a measuring instrument for indication of voltage. The units are connected by means of a lead on the fixture.

3 EQUIPMENT

3.1 Crystals to relevant specification.

3.2 Tweezers for fitting of the crystals in the testing equipment.

3.3 Testing Equipment

3.3.1 Fixture and parts as shown on page 3.
Futhermore parts as specified in paras. 3.3.2 - 3.3.4.

3.3.2 Device for fixing of the plexiglass tube on the testing device.

3.3.3 Device to release the steel ball in the plexiglass tube.

3.3.4 Lifting device with detent to facilitate fitting of crystals in the testing device.

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0 813 401 issue 4

4 PROCEDURE

Before starting the test, the operator shall be well acquainted with the testing equipment and the measuring equipment.

- 4.1 Place 2 crystals with the positive poles towards the contact plate as shown in the figure, page 3.
- 4.2 Place the steel ball in the release device.
- 4.3 Release the ball.
- 4.4 Read and record the obtained value.

Issue	D									Appendix	No. F1301-903160
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0 813 401 issue 4

Steel ball $\varnothing 14.25$
Weight 11.8 g

Guide, plexiglass
inside $\varnothing 16$

150

Pressure plate

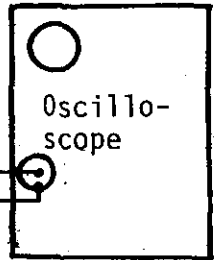
Bolt

Test specimens
2 piezoelectric
crystals

Contact plate^{x)}

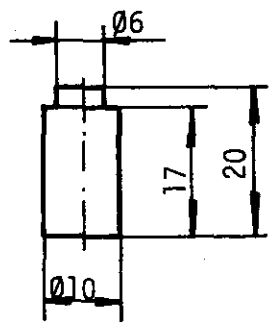
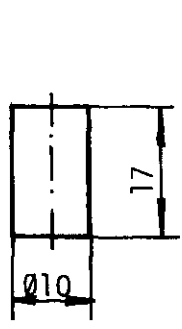
Anvil

Fixture
 ≈ 2.8 kg



Compressive force
 ≈ 1.5 kp

x) Contact plate
Material:
SIS 2225-05 or equal
Hardness 270 - 330 H_B
Hardened
Thickness 0.4 mm



Anvil Material:
SIS 2090-04 or equal
Hardness 440 - 510 H_B
Hardened

Bolt Material:
SIS 2090-04 or equal
Hardness 440 - 510 H_B
Hardened

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Piezoelectric Generator for HEAT 551

(IN)

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ÄNDRINGSFÖRTECKNING *RECORD OF CHANGES*

Ä-nr <i>Rev No</i>	ÄB-nr Rev Requisition No ÄO-nr Rev Order No	Berörda paragrafer + kort beskrivning <i>Relevant paragraph + brief description</i>
1	39077426	Document status changed to Issued. Item 4.3.7 General: revision of text.

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1 Applicable documents

1.1 Article main document

Article and document designation	1 215 798
Assembly drawing	4 113 713
Verification program	2 789 567

1.2 Other documents referenced

Product Specification, HEAT 551	0 808 526
Drawing, piezoelectric generator (with four-layer diode)	4 101 895
Technical Specification A6060 (ESD protection)	38 000 141
Production equipment for impact test	9 240 411-C-1
Standard for soldering electrical connections	FSD 5201
Classification of properties, interpretation of classes	0 817 418
Standards for environmental testing	MIL-STD-331B IEC 68-2 FSD 0124

2 Description of product

The piezoelectric generator contains five piezoelectric crystals connected in parallel, an electric initiator consisting of a surface-mount printed circuit assembly and a holder for the crystals, two contact washers and a weight. The crystals are electrically connected to each other and to the printed circuit assembly via the two contact washers. The holder and weight are made of polycarbonate. One of the contact washers is also used for mechanical assembly of the piezoelectric generator by being crimped over the surface of the weight. The printed circuit assembly has terminals for screw connection of the electric wires to the S&A Device in the shell.

3 Product specifications

3.1 Resistance to environmental conditions

The piezoelectric generator shall operate in the temperature range -40°C to $+63^{\circ}\text{C}$, and shall meet the requirements stipulated in item 7 after environmental testing in accordance with this Technical Specification.

This shall be verified by design type testing.

3.2 General

The constituent parts shall meet the requirements stipulated for them in the applicable technical documentation, and shall be free from any defect that may have a detrimental effect on the functionality, operation, safety, and storage capability of the piezoelectric generator.

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3.3 Interface requirements

3.3.1

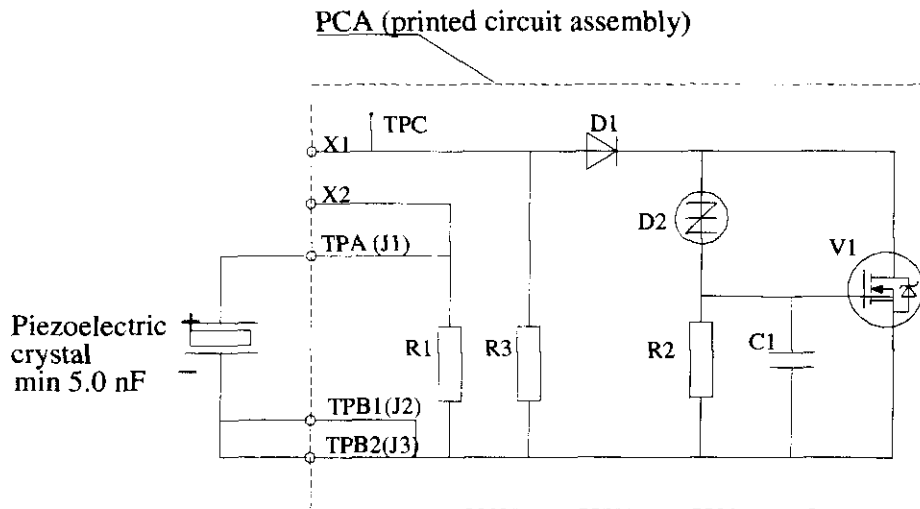
The piezoelectric generator shall have the same sensitivity at target impact, and the same mask safety, as the previously used piezoelectric generator on Drawing No. 4 101 895. This shall be verified in the design type testing.

3.3.2

At initiation the voltage pulse, measured between the terminals X1 and X2 (earth), shall have such properties that it is capable of initiating electric detonator N8. This shall be verified in the design type testing.

3.4 Function

The electrical functions, terminals, connections and test points of the piezoelectric generator shall be as shown in Figure 1 below. The measurement values specified apply at a room temperature of +19°C to +25°C.



The crystal is connected to the PCA via the piezoelectric generator contact washers and jumpers J1, J2 and J3.

Figure 1

3.4.1 Piezoelectric crystals

The capacitance between TPA and TPB1 shall be 5.0 nF minimum [2]. Alternatively, the measurement can be made between TPA and TPB2. The method of measurement shall be as specified in item 4.3.5.

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3.4.2 Discharge resistor R1

The resistance between X2 and TPB1 shall be 10 ± 0.2 kohm [2]. Alternatively, the measurement can be made between X2 and TPB2. The method of measurement shall be as specified in item 4.3.6.

3.4.3 Discharge resistor R3

The resistance between X1 and TPB1 shall be 470 ± 10 kohm [2]. Alternatively, the measurement can be made between X1 and TPB2. The method of measurement shall be as specified in item 4.3.6.

There must be no load resistance connected between X1 and X2 when measuring R3.

3.4.4 Initiation function

When tested in the impact apparatus in the drawing referenced in item 1, and with a resistance of 90 ± 5 ohms connected between X1 and X2, the initiation circuit shall initiate. Measurement of voltages shall be done with TPA as neutral (earth). The initiation voltage level shall be -90V to -20V, and the time until initiation shall be 30 μ s.

Test method and definitions shall be as specified in item 4.3.7.

4 Manufacture

4.1 General

4.1.1

The piezoelectric generator shall be assembled in premises with a cleanliness level and ESD protection that are normal for this type of work. Technical Specification A6060, document no. 38 000 141, is applicable for ESD protection.

4.1.2

The parts shall be free from dust, burrs and other contaminants.

4.1.3

Assembly of the piezoelectric generator shall be governed by instructions specifying the method and sequence of operations (including inspection/verification operations).

4.1.4

Personnel who perform soldering shall be certified solderers.

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4.2 Planning and monitoring

A production log shall be kept that shall be produced on request. The log shall contain information concerning the batches of substances used in each lot, the results of tests conducted during manufacture, and any changes made in the manufacturing process.

The log shall be kept available for at least 20 years.

4.3 Methods and equipment

4.3.1

When assembling piezoelectric crystals in the piezoelectric generator it is vital to ensure that the positive poles of all the crystals face the same direction as per Drawing No. 4 113 713. The positive poles of the crystals are designated by a dot. Tweezers or equivalent shall be used to handle crystals.

4.3.2

The contact washers shall be free from grease, oxides and other contaminants that degrade solderability.

4.3.3

The wire jumpers, J1, J2 and J3, of the printed circuit assembly shall be soldered to both the contact washers of the piezoelectric generator as per Drawing No. 4 113 713.

4.3.4

The measuring voltages and currents used during manufacture and inspection shall be such that constituent components are not damaged.

4.3.5

The capacitance value specified in item 3.4.1 applies when measuring with a measuring bridge with 1 kHz measuring frequency and 1V sinusoidal measuring voltage. A different measuring method may be used subject to approval by the purchaser.

4.3.6

The resistance values specified in items 3.4.2 and 3.4.3 are applicable to direct current.

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4.3.7

Designations for the measuring points specified below are as per Figure 1 in item 3.4.

When measuring the initiation function as per item 3.4.4 the impact apparatus specified in item 1 shall be used. The impact apparatus is pneumatic. The piezoelectric generator shall be located in a fixture designed so that the installation is equivalent to the installation in HEAT 551. In the test the fixture is first compressed, after which a shock wave is generated. This shall be of such magnitude that the peak value of the crystal voltage, measured between TPA (neutral) and TPB, and without load between X1 and X2, is -120V to -160V. The rise time shall be 30 μs measured from when the crystal voltage reaches -2V until it reaches its peak value. Periodic inspection of the impact apparatus shall be conducted to the extent necessary to ensure correct magnitude of the shock wave.

The functional requirements are defined in Figure 2.

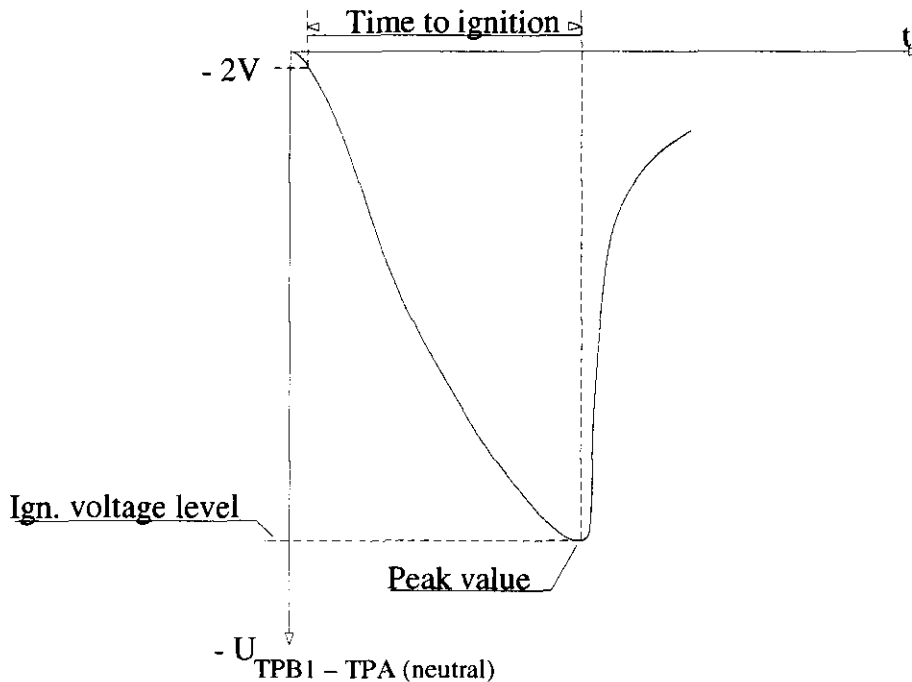


Figure 2

Utfärdad av, tjtst <i>Compiled by, Dept.</i> Göran Sahlin/RTEV	Granskad av, tjtst <i>Reviewed by, Dept.</i>	Datum <i>Date</i> 03-06-25	Utg nr <i>Edition No.</i> 2	Dokumentnummer <i>Document no.</i> 0 817 511
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5 Shipment

5.1 Packaging of goods unit

5.1.1

The packaging shall have ESD protection, and shall be designed so that the product is not damaged during transportation, handling or storage.

5.1.2

The piezoelectric generator shall be delivered in the lot sizes agreed with the purchaser.

5.2 Labelling of transport packaging

Each packaging unit shall be labelled with the quantity, denomination, article number with change number and lot designation.

6 Inspection

6.1 Vendor inspection

6.1.1

The vendor shall perform inspection to the extent required to verify compliance with the requirements stipulated in this technical specification.

6.1.2

Any non-compliance shall be subject to the applicable non-compliance procedure agreed between the purchaser and vendor.

6.1.3

Unless otherwise specified in this technical specification the standard environment (25 ±10°C, 30–75% RH, 960 ±100 millibars) shall apply before and during inspection.

6.2 Purchaser inspection

The purchaser is entitled to attend and monitor the vendor's production and inspections.

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6.3 Certificates

6.3.1

The vendor inspection shall be reported in test certificates to the extent agreed between the purchaser and the vendor. The main certificate shall state that the lot has been inspected and approved by the vendor.

6.3.2

Attestations from subcontractors shall be made available to the purchaser.

7 Additional requirements

7.1 Environmental testing

7.1.1

Change of temperature as per IEC 68-2-14 test Nb.

7.1.2

Dry heat as per IEC 68-2-2 test Bb.

7.1.3

Damp heat, steady state, as per IEC 68-2-3 test Ca.

7.1.4

Damp heat, cyclic, as per IEC 68-2-30 test Db.

7.1.5

Long-term storage as per MIL-STD-331B.

7.1.6

Vibration at +63°C and -46°C as per FSD 0124:016.
Safety requirement.

7.1.7

Vibration at +63°C and -46°C as per FSD 0124:018.
Safety and functional requirements.

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7.1.8

Jolt at +63°C and -46°C as per MIL-STD-331B Method 101.1.

7.1.9

Shock test at -46°C as per FSD 0124:052.

7.1.10

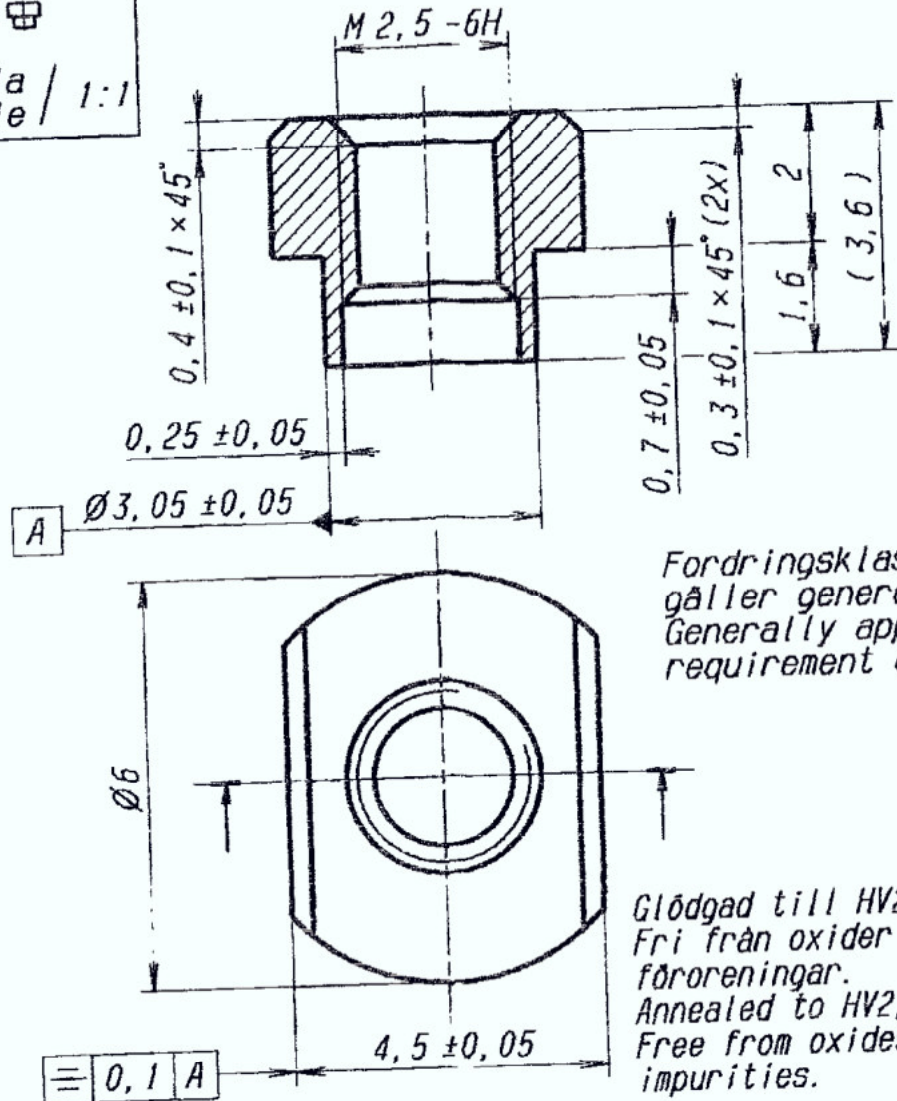
Shock test in horizontal recovery firing with an acceleration of 200.000 m/s².

TO BE MARKED ON
TOOL/GAUGE/PART
TRD-1-2-2218

VETTED-FOR PLANNING AND TRADE ENQUIRY.

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Skala /
Scale / 1:1



Fordringsklass [3]
gäller generellt
Generally applies
requirement class [3]

Glödgad till HV2,5 ca 75.
Fri från oxider och andra
föroreningar.
Annealed to HV2,5 approx 75.
Free from oxides and other
impurities.

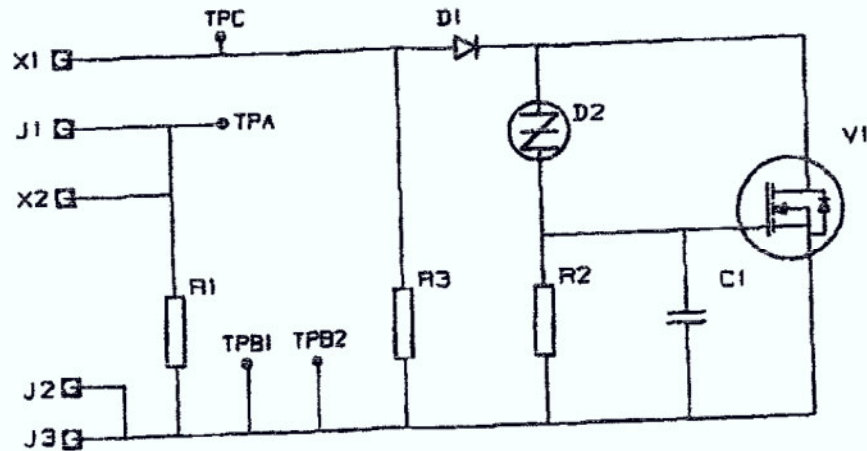
Material SS Mässing/Brass 5165 OR 3-2/ ✓
SSEN 12164 CW607N R 400
SPECN - 0817 418 MASS = 0.39g APPROX.

				ITEM No.	DESCRIPTION	No. OFF	MATERIAL
INSP.	DATE	HOS/ CDO	DA No	HEAT TREATMENT Rc.		TUBULAR RIVET	
AMENDMENTS				12.5-25 Ra ▽	0.2-0.8 Ra ▽▽	M/C	
JWM/ RED	28/5/07			1.6-6.3 Ra ▽▽	0.1-0.025 Ra ▽▽▽	DRG No. TRD-1-2-2218	
HOS/ CAD C.	gn	DATE	30/5/07	DIMENSIONS ARE IN mm.		SCALE:- NTS	
CKD	Boadi	CKD		UNTOL. DIMNS. IS.2102 MEDIUM		No. OF SHT - 1	
DRN		TRD		SHARP EDGES TO BE REMOVED		SHEET No. - 1	
APPROVED BY JFGM/RED/CTR				GUGING SURFACES SHOWN BY THICK LINES		ORDNANCE FACTORY KHAMARIA	
PS/GS.				STORE:- Q4 mra HEAT 551		COMPT.	
				DRG. No.		DRG.No 6436435	

TO BE MARKED ON
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TRD - 1.2.2219

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				ITEM No	DESCRIPTION	No. OFF	MATERIAL
INSP.	DATE	HOS/ CDO	DA No	HEAT TREATMENT Rc.		CIRCUIT DIAGRAM HEAT 511	
AMENDMENTS				12.5-25 Ra ▽	0.2-0.8 Ra ▽▽▽		
JWM/ RED	<i>[Signature]</i>	<i>[Signature]</i>		16-6.3 Ra ▽▽▽	0.1-0.025 Ra ▽▽▽▽	DRG. No. TRD - 1.2.2219	
HOS/ CAD C.	<i>[Signature]</i>	DATE	30/5/67	DIMENSIONS ARE IN mm.		SCALE:- NTS	
CKD	<i>[Signature]</i>	CKD		UNTOL. DIMS IS.2102 MEDIUM			
DRN		TRD		SHARP EDGES TO BE REMOVED		No OF SHT - SHEET No. -	
APPROVED BY JHGM RB'D/OTR				GUGING SURFACES SHOWN BY THICK LINES			
PS/GS				STORE:-		COMPT.	
				DRG No		DRG No.	

TO BE MARKED ON
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TRD- 1.2.2220

VETTED-FOR PLANNING AND TRADE ENQUIRY.

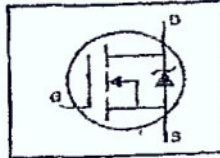
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PD-9.597A

**International
Rectifier**

HEXFET® Power MOSFET

- Dynamic dwdt Rating
- Repetitive Avalanche Rated
- Surface Mount (IRFR310)
- Straight Lead (IRFU310)
- Available in Tape & Reel
- Fast Switching
- Ease of Paralleling

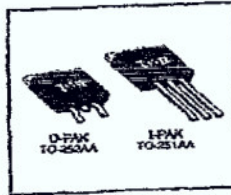


$V_{DSS} = 400V$
 $R_{DS(on)} = 3.6\Omega$
 $I_D = 1.7A$

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.

The D-Pak is designed for surface mounting using vapor phase, infrared, or wave soldering techniques. The straight lead version (IRFU series) is for through-hole mounting applications. Power dissipation levels up to 1.5 watts are possible in typical surface mount applications.



Absolute Maximum Ratings

Parameter	Max.	Units
$I_D @ T_C = 25^\circ C$	1.7	A
$I_D @ T_C = 100^\circ C$	1.1	A
I_{DM}	6.0	A
$I_{DM} @ T_C = 25^\circ C$	2.5	A
$P_D @ T_C = 25^\circ C$	2.5	W
$P_D @ T_A = 25^\circ C$	0.20	W
Linear Derating Factor	0.020	W/°C
Linear Derating Factor (PCB Mount)**	0.020	W/°C
V_{GS}	±20	V
E_{AS}	86	mJ
I_{AS}	1.7	A
E_{ARS}	2.5	mJ
dwdt	4.0	V/ns
T_J, T_{STG}	-55 to +150	°C
Soldering Temperature, for 10 seconds	260 (1.6mm from case)	

Thermal Resistance

Parameter	Min.	Typ.	Max.	Units
R_{JC}	—	—	5.0	°C/W
R_{JA}	—	—	60	°C/W
R_{JA}	—	—	110	°C/W

** When mounted on 1" square PCB (FR-4 or G-10 Material).
For recommended footprint and soldering techniques refer to application note #AN-994.

1103

Internal information: Inköpsförbehåll

Page 1 (8)

				ITEM No	DESCRIPTION	No OFF	MATERIAL
INSP.	DATE	HOS/ CDO	DA No		HEAT TREATMENT Rc.		TRANSISTOR POWER MOSFET
AMENDMENTS					12.5-25 Ra ▽ 0.2-0.8 Ra ▽▽▽		
JWM/ R&D					1.6-6.3 Ra ▽▽▽ 0.1-0.025 Ra ▽▽▽▽	M/C	
HOS/ CAD C.		DATE 30/5/07			DIMENSIONS ARE IN mm.	DRG. No.	TRD- 1.2.2220
CKD		CKD			SHARP EDGES TO BE REMOVED		SCALE:- NTS
DRN		TRD			GUGING SURFACES SHOWN BY THICK LINES		No. OF SHT. - 8
APPROVED BY JHGM R&D/CTR					ORDNANCE FACTORY KHAMARIA		
PS/GS.				STORE:-		COMPT	
				DRG. No.		DRG.No.	

TO BE MARKED ON
TOOL/GAUGE/PART
TRD- 1.2.2220

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IRFR310, IRFU310



Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

Parameter	Min.	Typ.	Max.	Units	Test Conditions
V _{DS(BR)}	400	—	—	V	V _{GS} =0V, I _D =250μA
ΔV _{DS(BR)}/ΔT_J}	—	0.47	—	V/°C	Reference to 25°C, I _D =1mA
R _{DS(on)}	—	—	3.6	Ω	V _{GS} =10V, I _D =1.0A @
V _{GS(th)}	2.0	—	4.0	V	V _{DS} =V _{GS} , I _D =250μA
g _m	0.97	—	—	S	V _{DS} =50V, I _D =1.0A @
I _{DSS}	—	—	25	μA	V _{GS} =400V, V _{DS} =0V
I _{DSS}	—	—	250	μA	V _{GS} =320V, V _{DS} =0V, T _J =125°C
I _{DSS}	—	—	100	nA	V _{GS} =20V
I _{DSS}	—	—	-100	nA	V _{GS} =20V
Q _g	—	—	12	nC	I _D =2.0A
Q _{gs}	—	—	1.9	nC	V _{DS} =320V
Q _{gd}	—	—	6.5	nC	V _{GS} =10V See Fig. 6 and 13 @
t _{ON}	—	7.9	—	ns	V _{DS} =200V
t _r	—	9.9	—	ns	I _D =2.0A
t _{OFF}	—	21	—	ns	R _θ =24Ω
t _f	—	11	—	ns	R _θ =95Ω See Figure 10 @
L _D	—	4.5	—	nH	Between lead, 8 mm (0.25in.) from package and center of die contact
L _S	—	7.5	—	nH	
C _{iss}	—	170	—	pF	V _{GS} =0V
C _{oss}	—	34	—	pF	V _{GS} =25V
C _{rss}	—	6.3	—	pF	f=1.0MHz See Figure 5

Source-Drain Ratings and Characteristics

Parameter	Min.	Typ.	Max.	Units	Test Conditions
I _S	—	—	1.7	A	MOSFET symbol showing the integral reverse p-n junction diode.
I _{SM}	—	—	8.0	A	
V _{SD}	—	—	1.8	V	T _J =25°C, I _G =1.7A, V _{GS} =0V @
t _{rr}	—	240	540	ns	T _J =25°C, I _F =2.0A
Q _{rr}	—	0.85	1.6	μC	dI/dt=100A/μs @
t _{ON}	Intrinsic turn-on time is negligible (turn-on is dominated by L _S +L _D)				

Notes:

- ⓐ Repetitive rating; pulse width limited by max. junction temperature (See Figure 11)
- ⓑ V_{GS}=50V, starting T_J=25°C, L=52mH, R_θ=25Ω, I_{AS}=1.7A (See Figure 12)
- ⓒ I_{AS}=1.7A, dI/dt=40A/μs, V_{GS}≤V_{DS(BR)}, T_J≤150°C
- ⓓ Pulse width ≤ 300 μs; duty cycle ≤ 2%.

				ITEM No	DESCRIPTION	No. OFF	MATERIAL
INSP.	DATE	HOS/ CDO	DA No		HEAT TREATMENT R _c .		TRANSISTOR POWER MOSFET
AMENDMENTS					12.5-25 Ra ▽ 0.2-0.8 Ra ▽▽▽		
JWM/ R&D	<i>Datta</i>				1.6-6.3 Ra ▽▽▽ 0.1-0.025 Ra ▽▽▽▽▽		M/C
HOS/ CAD C	<i>Ar</i>	DATE	30/5/07		DIMENSIONS ARE IN mm.		DRG. No
CKD	<i>Ar</i>	CKD			UNTOL DIMS IS-2102 MEDIUM		TRD- 1.2.2220
DRN	TRD				SHARP EDGES TO BE REMOVED		SCALE:- NTS
APPROVED BY <i>JFGM R&D/CTR</i>					ORDNANCE FACTORY KHAMARIA	No. OF SHT. - 8	SHEET No. - 2
PS/GS.				STORE:-		COMPT	
				DRG. No.		DRG.No.	

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IRFR

IRFR310, IRFU310

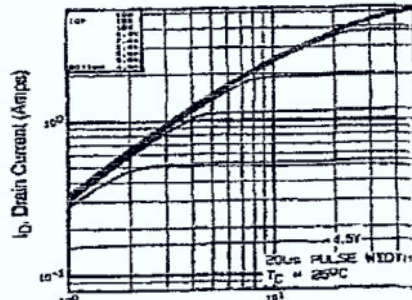


Fig 1. Typical Output Characteristics,
T_C=25°C

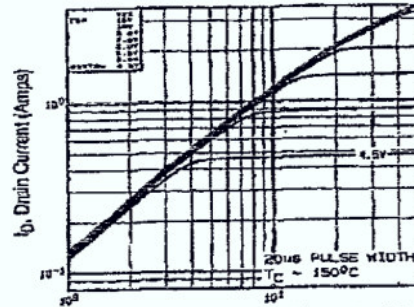


Fig 2. Typical Output Characteristics,
T_C=150°C

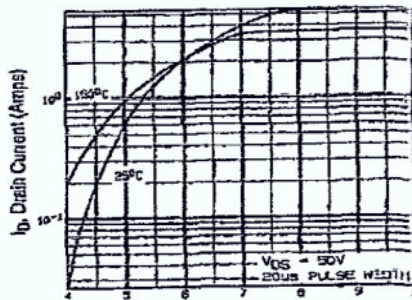


Fig 3. Typical Transfer Characteristics

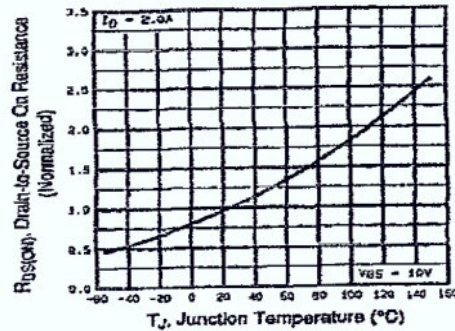


Fig 4. Normalized On-Resistance
Vs. Temperature

Page 3

				ITEM No	DESCRIPTION	No OFF	MATERIAL
INSP.	DATE	HOS/ CDO	DA No	HEAT TREATMENT Rc.		TRANSISTOR POWER MOSFET	
AMENDMENTS				12.5-25 Ra	▽ 0.2-0.8 Ra	M/C	
JWM/ RE'D	HOS/ CAD C		DATE 30/5/07	1.6-6.3 Ra	▽ 0.1-0.025 Ra	DRG. No. TRD- 1.2.2220	
CKD	CKD			DIMENSIONS ARE IN mm		SCALE:- NTS	
DRN	TRD			UNTOL. DIMNS IS:2102 MEDIUM		No. OF SHT. - 8	
APPROVED BY JIGM RE'D/CTR				SHARP EDGES TO BE REMOVED		SHEET No. - 3	
PS/GS.				GUGING SURFACES SHOWN BY THICK LINES		ORDNANCE FACTORY KHAMARIA	
STORE:-				COMPT			
DRG. No.				DRG No.			

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TOOL/GAUGE/PART
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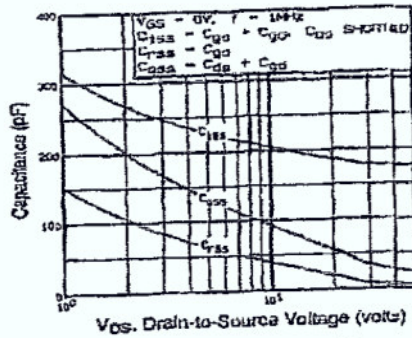


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

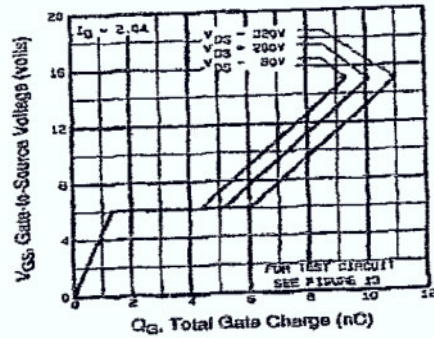


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

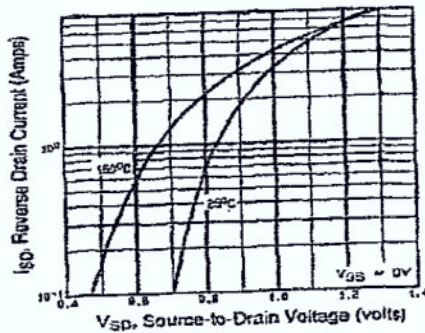


Fig 7. Typical Source-Drain Diode Forward Voltage

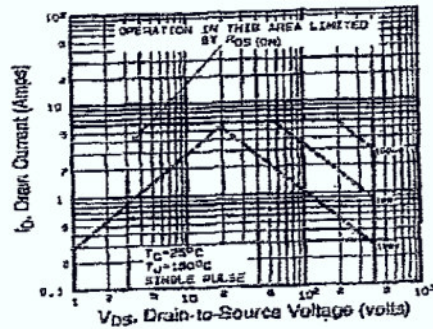


Fig 8. Maximum Safe Operating Area

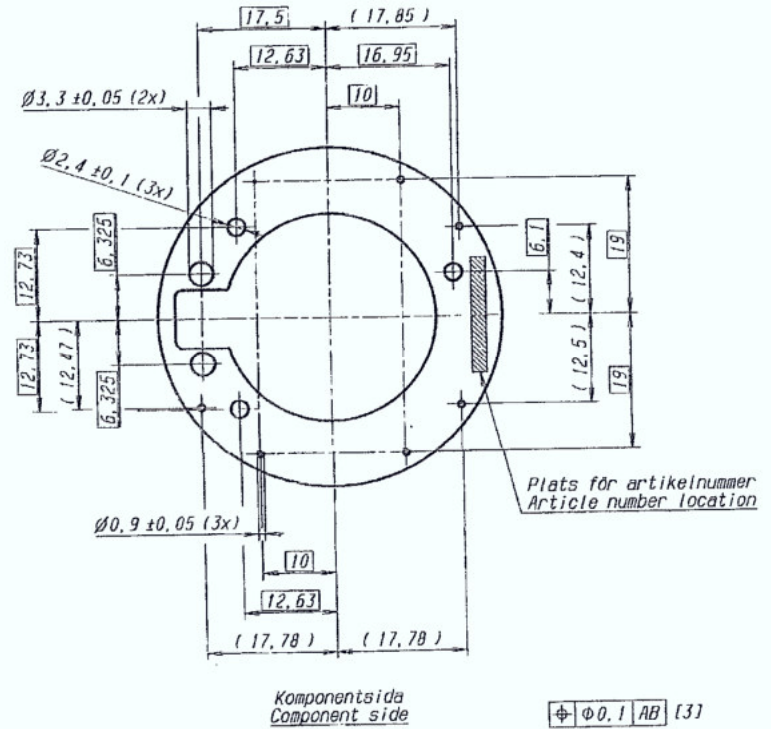
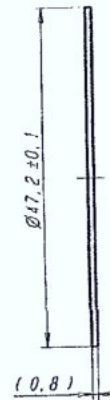
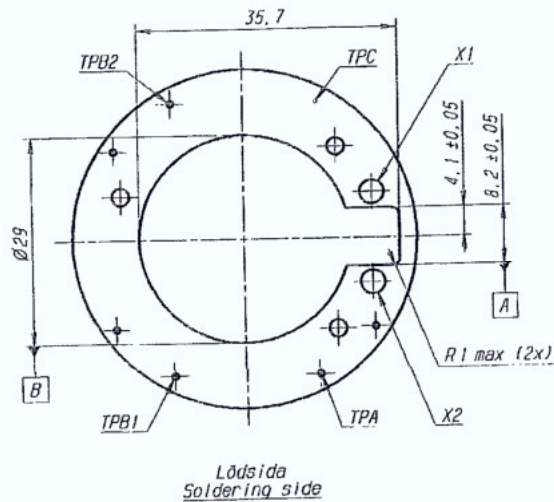
Page 4

				ITEM No	DESCRIPTION	No OFF	MATERIAL
INSP.	DATE	HOS/CDO	DA No		HEAT TREATMENT Rc		<u>TRANSISTOR POWER MOSFET</u>
AMENDMENTS					12.5-25 Ra ▽ 0.2-0.8 Ra ▽▽▽		
JWM/RBD	<i>[Signature]</i>				1.6-6.3 Ra ▽▽▽ 0.1-0.025 Ra ▽▽▽▽		M/C
HOS/CAD C.	<i>[Signature]</i>	DATE	30/5/07		DIMENSIONS ARE IN mm.		DRG No.
CKD	<i>[Signature]</i>	CKD			UNTOL. DIMNS. IS 2102 MEDIUM		TRD- 1.2.2220
DRN		TRD			SHARP EDGES TO BE REMOVED		SCALE:- NTS
APPROVED BY <i>JHGM RBD/CTR</i>					GUGING SURFACES SHOWN BY THICK LINES		No. OF SHT. - 8
					ORDNANCE FACTORY KHAMARIA		SHEET No. - 4
PS/GS.				STORE.-		COMPT.	
				DRG. No.		DRG.No.	

TO BE MARKED ON TOOL/GAUGE/PART
TRD-2-2-22/3

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$\text{H} \text{ } \Phi 0.1 \text{ } AB \text{ } [3]$

Gäller för samtliga hål.
Applies to all holes.

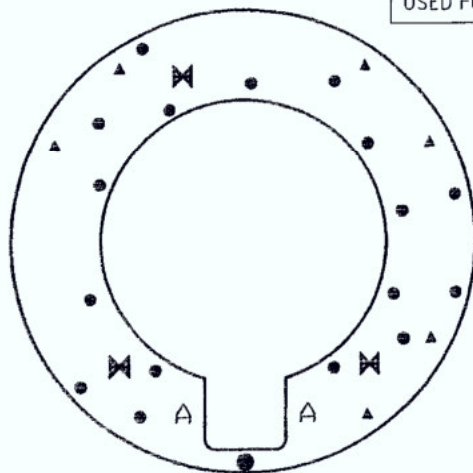
Tol acc. to ISO 2768-m. SPEC. - 0-817-418

INSP.	DATE	HOS/ CAD	DA No	ITEM No.	DESCRIPTION	NO. OFF	MATERIAL	DRG. NO
					HEAT TREATMENT Rc.			CIRCUIT BOARD OUTLINE DRAWING
AMENDMENTS					12.5-25 Ra ▽ 0.2-0.8 Ra ▽▽▽			
JWM/R&D		DGM/			1.6-6.3 Ra ▽▽ 0.1-0.025 Ra ▽▽▽▽			M/C
HOS/ CAD		DATE	30/5/07		DIMENSIONS ARE IN mm.			DRG. No. TRD-2-2-22/3
CKD		CKD			UNTOL. DIMNS. IS:2102 MEDIUM			SCALE-- NTS
DRN		TRD			SHARP EDGES TO BE REMOVED			No. OF SHT - 1 SHEET No. - 1
APPROVED BY JE. GM R&D/CTR					GUGING SURFACES SHOWN BY THICK LINES			
PS/GS.					ORDNANCE FACTORY KHAMARIA			
					STORE-- 84 mm 551			COMPT
					DRG. No.			DRG.No. 4113711

TO BE MARKED ON TOOL/GAUGE/PART
TRD-2-2- 2214

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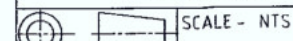
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Through Holes				
Symbol	Diameter(mm)	Tolerance(mm)	Plated	Quantity
●	0.4	+0.1 -0.1	Yes	17
▲	0.9	+0.1 -0.1	Yes	6
A	3.3	+0.1 -0.1	Yes	2
⊠	2.4	+0.1 -0.1	No	3

Processing	
Material	Epoxy glass FR4
Type	Double sided
Material thickness	0.8 mm
Cu thickness	0.35 um
Routing tolerance	± 0.1 mm
Surface treatment	Ni/Au
Solder resist	Wet film

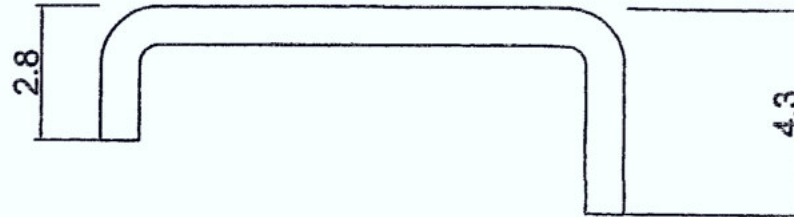
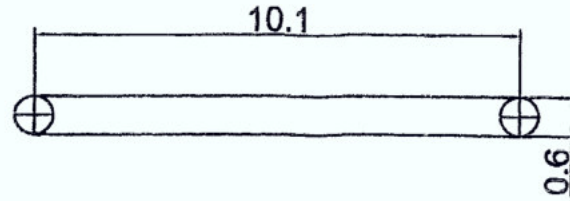
ITEM No.	DESCRIPTION	NO. OFF	MATERIAL	DRG NO
INSP.	DATE	HOS/ CAD	DA No	HEAT TREATMENT Rc.
AMENDMENTS				12.5-25 Ra ▽ 0.2-0.8 Ra ▽▽▽
JWM/ R&D	DGM/	DATE 30/5/17		1.6-6.3 Ra ▽▽ 0.1-0.025 Ra ▽▽▽▽
HOS/ CAD	CKD	TRD		DIMENSIONS ARE IN mm.
DRN	TRD	APPROVED BY Jt. GM R&D/CTR		UNTOL. DIMNS. IS 2102 MEDIUM
PS/GS				SHARP EDGES TO BE REMOVED
STORE:- 84 mm 551				GUGING SURFACES SHOWN BY THICK LINES
DRG. No.				ORDNANCE FACTORY KHAMARIA
COMPT.				No. OF SHT. - 1
DRG. No.				SHEET No - 1



TO BE MARKED ON TOOL/GAUGE/PART
TRD-2-2-2215

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Skala/ Scale 1:1

Skala/ Scale 10:1

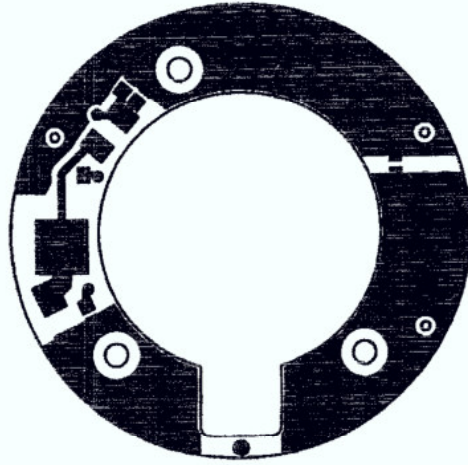
Material: Förtent koppartråd/
Tin coated copper wire

ITEM No	DESCRIPTION	NO OFF	MATERIAL	DRG. NO.
				JUMPER
INSP.	DATE	HOS/ CAD	DA No	HEAT TREATMENT Rc.
				12.5-25 Ra ▽ 0.2-0.8 Ra ▽▽▽
				16-6.3 Ra ▽▽ 0.1-0.025 Ra ▽▽▽▽
AMENDMENTS				
JWM/ R&D/CTR		DGM/		M/C
HOS/ CAD	DATE 30/5/07			DRG. No.
CKD		CKD		TRD- 2- 2- 2215
DRN		TRD		SCALE - NTS
APPROVED BY Jt. GM R&D/CTR				ORDNANCE FACTORY KHAMARIA
PS/GS				STORE:- 84 mm 551
				COMPT
				DRG.No.
				No OF SHT. - 1
				SHEET No. - 1

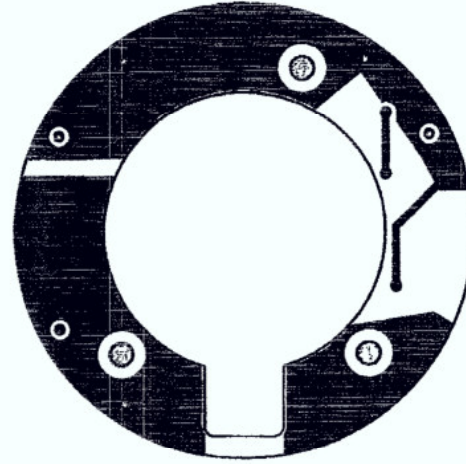
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Primärsida/
primary side



Sekundärsida/
Secondary side

Skala/ Scale 2:1

ITEM No.	DESCRIPTION	NO. OFF	MATERIAL	DRG NO
INSP.	DATE	HOS/ CAD	DA No	HEAT TREATMENT Rc
AMENDMENTS				PRINTED CIRCUIT BOARD
JWM/ R&D	DGM/	12 5-25 Ra ▽ 0.2-0.8 Ra ▽▽▽		M/C
HOS/ CAD	DATE 30/5/07	16-6.3 Ra ▽▽ 0.1-0.025 Ra ▽▽▽▽		DRG. No TRD- 2.2.2216
CKD	CKD	DIMENSIONS ARE IN mm.		SCALE-- NTS
DRN	TRD	UNTOL. DIMNS IS:2102 MEDIUM		No. OF SHT. - 1 SHEET No. - 1
APPROVED BY Jt.GM. R&D/CTR		SHARP EDGES TO BE REMOVED		
PS/GS.		GUGING SURFACES SHOWN BY THICK LINES		COMPT. DRG No.
		ORDNANCE FACTORY KHAMARIA		
		STORE-- 84 mm 551		
		DRG. No.		

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TRD - 1.2.2220

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IRFR310, IRFU310

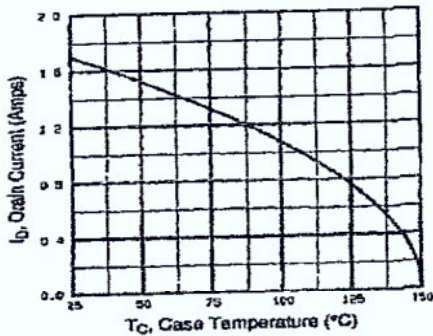


Fig 9. Maximum Drain Current Vs. Case Temperature

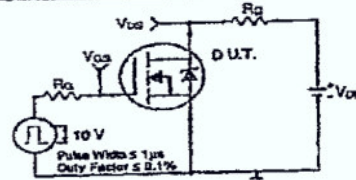


Fig 10a. Switching Time Test Circuit

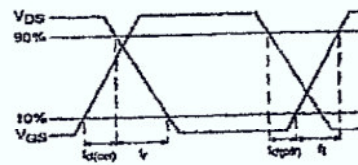


Fig 10b. Switching Time Waveforms

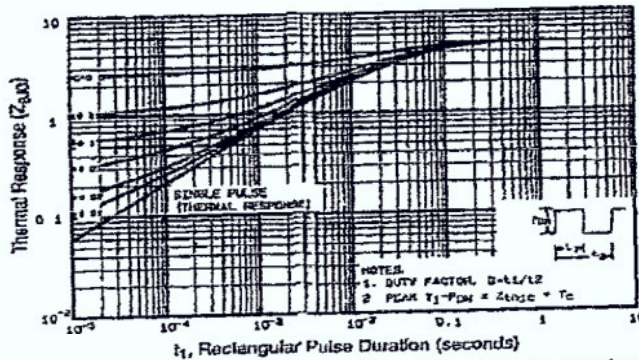


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

				ITEM No	DESCRIPTION	No. OFF	MATERIAL
INSP.	DATE	HOS/CDO	DA No	HEAT TREATMENT R _c		TRANSISTOR POWER MOSFET	
AMENDMENTS				12.5-25 Ra	0.2-0.8 Ra	M/C	
JWM/RE'D	<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>	1.6-6.3 Ra	0.1-0.025 Ra	DRG. No. TRD. 1.2.2220	
HOS/CAD C.	<i>[Signature]</i>	DATE	30/1/07	DIMENSIONS ARE IN mm		SCALE.- NTS	
CKD	<i>[Signature]</i>	CKD		UNTOL. DIMNS. IS:2102 MEDIUM		No. OF SHT. - 8	
DRN		TRD		SHARP EDGES TO BE REMOVED		SHEET No. - 5	
APPROVED BY JHGM RED/CTR				GUGING SURFACES SHOWN BY THICK LINES			
				ORDNANCE FACTORY KHAMARIA			
PS/GS.			STORE:-			COMPT	
			DRG. No			DRG.No.	

TO BE MARKED ON
TOOL/GAUGE/PART
TRD- 1.2.2220

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IRFR310, IRFU310

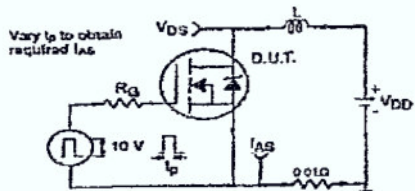


Fig 12a. Unclamped Inductive Test Circuit

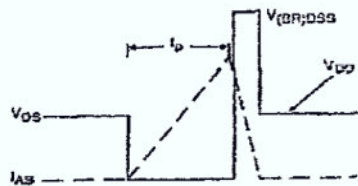


Fig 12b. Unclamped Inductive Waveforms

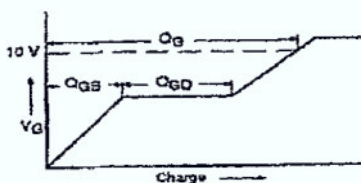


Fig 13a. Basic Gate Charge Waveform

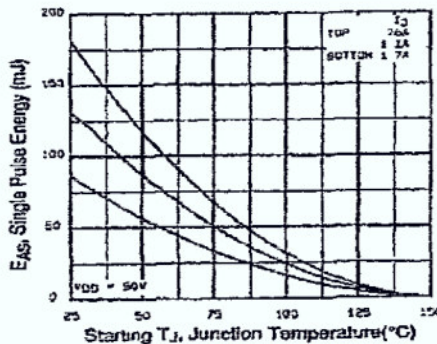


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

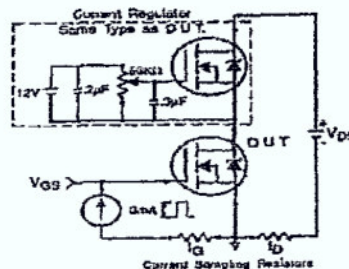


Fig 13b. Gate Charge Test Circuit

Appendix A: Figure 14, Peak Diode Recovery dv/dt Test Circuit – See page 1505

Appendix B: Package Outline Mechanical Drawing – See pages 1512, 1513

Appendix C: Part Marking Information – See page 1518

Appendix D: Tape & Reel Information – See page 1523

**International
IRF Rectifier**

				ITEM No	DESCRIPTION	No. OFF	MATERIAL
INSP.	DATE	HOS/ CDO	DA No		HEAT TREATMENT Rc.		TRANSISTOR POWER MOSFET
AMENDMENTS				12.5-25 Ra	▽ 0.2-0.8 Ra	▽▽▽	
JWM/ RED				1.6-6.3 Ra	▽▽ 0.1-0.025 Ra	▽▽▽▽	M/C
HOS/ CAD C		DATE	30/5/67	DIMENSIONS ARE IN mm.			DRG. No.
CKD		CKD		UNTOL DIMNS IS.2102 MEDIUM			TRD- 1.2.2220
DRN		TRD		SHARP EDGES TO BE REMOVED			SCALE:- NTS
APPROVED BY J+GM RED/CTR				ORDNANCE FACTORY KHAMARIA		No. OF SHT. - 6	SHEET No. - 6
PS/GS.				STORE:-		COMPT.	
				DRG. No.		DRG.No.	

TO BE MARKED ON
TOOL/GAUGE/PART
DRG. No. TRD 1-2- 2220

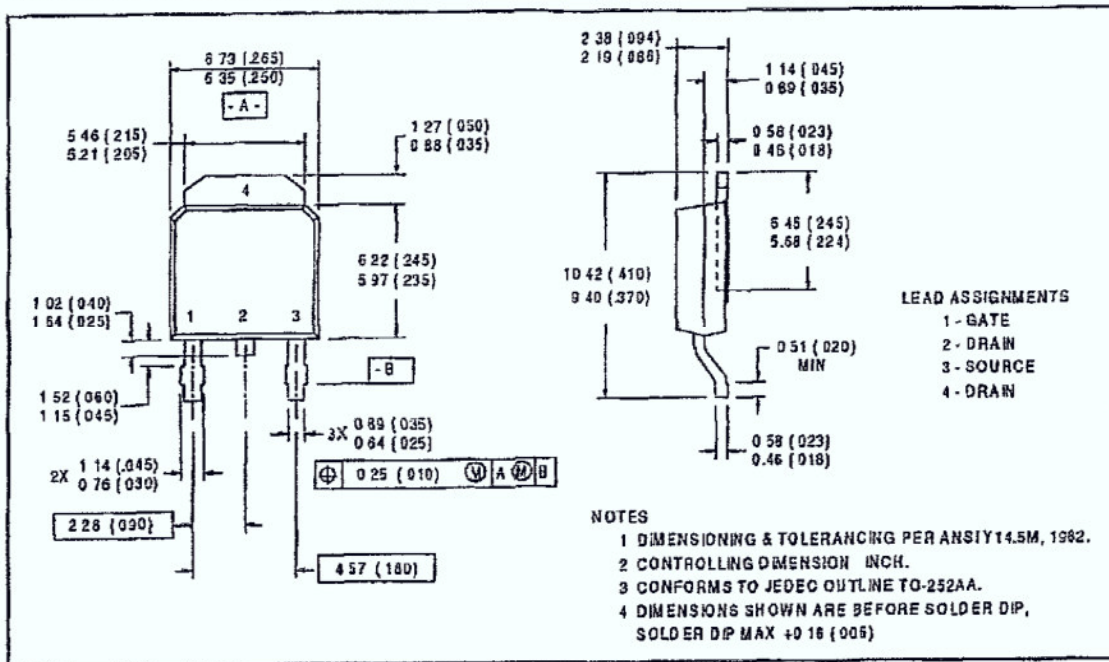
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Package Outline

HEXFET TO-252AA (D-PAK) Outline

Dimensions are shown in millimeters (inches)



				ITEM No	DESCRIPTION	No. OFF	MATERIAL
INSP.	DATE	HOS/ CDO	DA No		HEAT TREATMENT Rc.		<u>TRANSISTOR POWER MOSFET</u>
AMENDMENTS					12.5-25 Ra ▽ 0.2-0.8 Ra ▽▽▽		
JWM/ R&D					1.6-6.3 Ra ▽▽▽ 0.1-0.025 Ra ▽▽▽▽	M/C	
HOS/ CAD C.		DATE 30/5/07			DIMENSIONS ARE IN mm.		DRG. No. TRD-1-2- 2220
CKD		CKD			UNTOL DIMNS. IS:2102 MEDIUM		SCALE - NTS
DRN		TRD			SHARP EDGES TO BE REMOVED		
APPROVED BY J/HGM R&D/crr					GUGING SURFACES SHOWN BY THICK LINES		No. OF SHT. - 8 SHEET No. - 7
PS/GS.				STORE:-			COMPT.
				DRG. No.			DRG.No.

TO BE MARKED ON
TOOL/GAUGE/PART
DRG. No. TRD 1-2- 2220

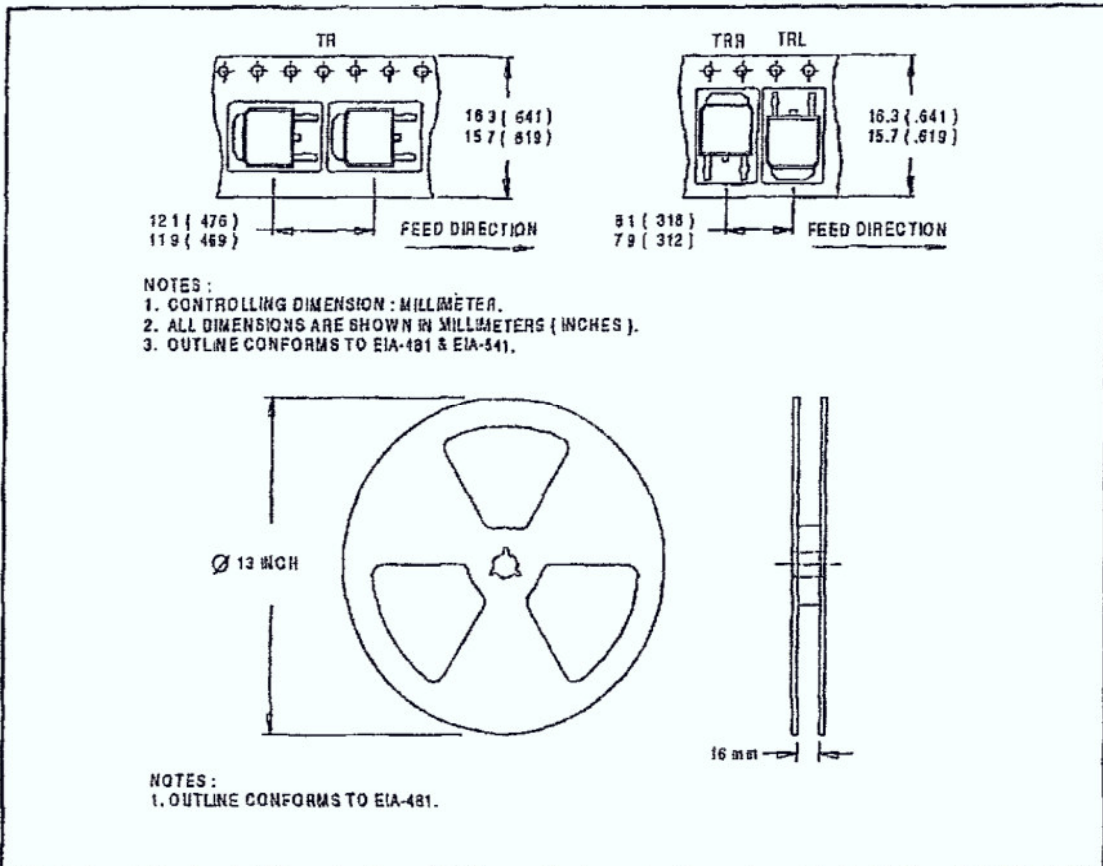
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Tape & Reel Information

HEXFET TO-252AA (D-PAK)

Dimensions are shown in millimeters (inches)



Page 8

				ITEM No.	DESCRIPTION	No. OFF	MATERIAL
INSP.	DATE	HOS/ CDO	DA No	HEAT TREATMENT Rc		TRANSISTOR POWER MOSFET	
AMENDMENTS				12.5-25 Ra ▽ 0.2-0.8 Ra ▽▽▽		M/C	
JWM/				16-6.3 Ra ▽▽▽ 0.1-0.025 Ra ▽▽▽▽		DRG. No. TRD 1-2- 2220	
HOS/ CAD C.		DATE 30/5/02		DIMENSIONS ARE IN mm		SCALE:- NTS	
CKD		CKD		UNTOL. DIMNS IS.2102 MEDIUM		No OF SHT. - 8	
DRN		TRD		SHARP EDGES TO BE REMOVED		SHEET No. - 8	
APPROVED BY JGM R8 Diere				GUGING SURFACES SHOWN BY THICK LINES		ORDNANCE FACTORY KHAMARIA	
PS/GS.			STORE:-			COMPT	
			DRG. No.			DRG.No	

TO BE MARKED ON
TOOL/GAUGE/PART
TRD- 1.2.2221

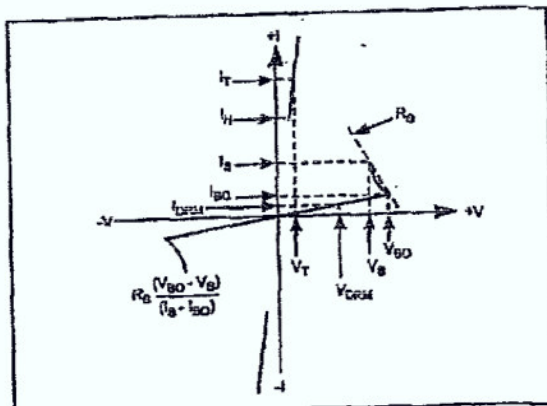
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SIDAC (Silicon Diode for Alternating Current)

Electrical Specification

- $I_{T(RMS)}$: 1 A max
- V_{DRM} : ± 90 V min
- V_{BO} : 104....118 V
- I_{DRM} : 5 μ A max
- I_{BO} : 10 μ A max
- I_H : 60 mA typ. 150 mA max
- V_{TM} : 1,5 V max
- I_{TSM} : 20 A (60Hz), 16,7 A (50Hz)
- R_S : 0,1 K Ω min
- dv/dt : 1500 V/ μ s min
- di/dt : 150 A/ μ s typ.
- Storage temperature : -65 to +150 $^{\circ}$ C
- Junction temperature : -40 to +125 $^{\circ}$ C
- Lead solder temperature: 230 $^{\circ}$ C for 10 s max: $\leq 1/16''$
(1,59 mm) from case.



V-I Characteristics

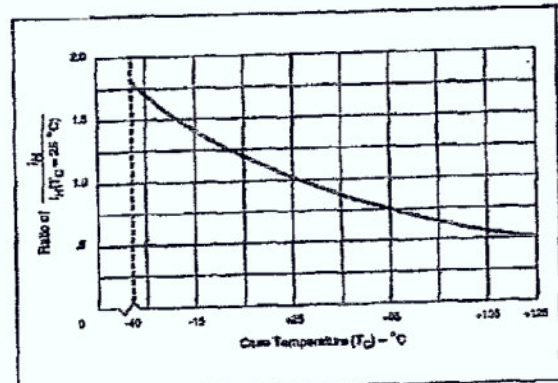


Figure E9.2 Normalized DC Holding Current versus Case/Lead Temperature

Page 1(2)

				ITEM No	DESCRIPTION	No OFF	MATERIAL
INSP.	DATE	HOS/ CDO	DA No	HEAT TREATMENT Rc.		BILATERAL SWITCH	
AMENDMENTS				12.5-25 Ra ∇ 0.2-0.8 Ra $\nabla\nabla\nabla$	M/C		
JWM/ R.E.D.	DATE 30/5/07		16-6.3 Ra $\nabla\nabla$ 0.1-0.025 Ra $\nabla\nabla\nabla$		DRG. No. TRD. 1.2.2221		
HOS/ CAD C.	CKD		DIMENSIONS ARE IN mm.		SCALE.- NTS		
CKD	TRD		UNTOL DIMNS IS 2102 MEDIUM				
DRN			SHARP EDGES TO BE REMOVED				
APPROVED BY JFGM R.E.D./CTR				GUGING SURFACES SHOWN BY THICK LINES		No. OF SHT. - 2 SHEET No. - 1	
ORDNANCE FACTORY KHAMARIA				PS/GS.		STORE:- DRG. No.	
						COMPT. DRG.No.	

6.3/

TO BE MARKED ON
TOOL/GAUGE/PART
TRD-1.2.2221

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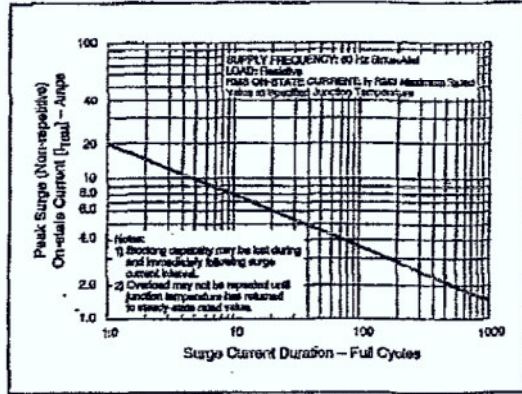
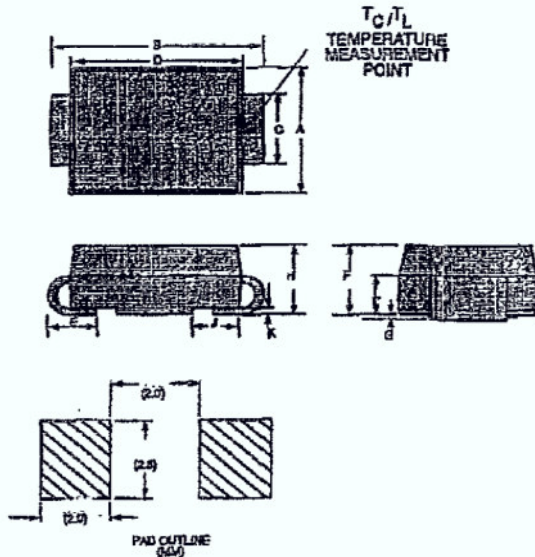


Figure E9.1 Peak Surge Current versus Surge Current Duration



Designation	Dimensions	
	MIN	MAX
A	3.58	3.94
B	5.21	5.59
C	1.96	2.11
D	4.22	4.57
E	0.91	1.42
F	1.85	2.11
G	0.10	0.20
H	2.08	2.18
J	1.09	1.35
K	0.20	0.30
L	0.99	1.24

Internal information: Inköpsförbehåll

Page 2 (2)

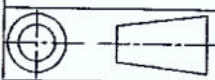
				ITEM No.	DESCRIPTION	No OFF	MATERIAL
INSP.	DATE	HOS/ CDO	DA No		HEAT TREATMENT Rc		<u>BILATERAL SWITCH</u>
AMENDMENTS					12.5-25 Ra ▽ 0.2-0.8 Ra ▽▽▽		
JWM/ RSD					1.6-6.3 Ra ▽▽▽ 0.1-0.025 Ra ▽▽▽▽	M/C	
HOS/ CAD C.		DATE 30/5/07			DIMENSIONS ARE IN mm.		DRG. No.
CKD		CKD			UNTOL DIMNS. IS 2102 MEDIUM		TRD - 1.2.2221
DRN		TRD			SHARP EDGES TO BE REMOVED		SCALE.- NTS
APPROVED BY SIGN RE'D/CTR					ORDNANCE FACTORY KHAMARIA	No. OF SHT. - 2	SHEET No. - 2
PS/GS.				STORE:-		COMPT.	
				DRG. No.		DRG.No.	

DRG.No.
TRD-122223

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TWINE SUTURE WIRE, 7x0.14.
MATERIAL :- SIS STEEL 2343-02 OR
SSEN 10088-31.4436A

Insp.	Date	JWM/ CDD	DA No	Item No.	DESCRIPTION	No. off	MATERIAL
					Heat Treatment Rc.-		TWINE SUTURE WIRE
Amendments					▽ 12.5-25 Ra ▽▽▽ 0.2-0.8 Ra		
JWM/ R&D					▽▽ 1.6-6.3 Ra ▽▽▽▽ 0.1-0.025 Ra	M/C	
JWM/ CADC		DATE 2/5/07			DIMENSIONS ARE IN mm.		Drg. No. TRD-122223
CKD		CKD			UNTOL. DIMNS. IS:2102 MEDIUM		 SCALE:-
DRN		TRD			SHARP EDGES TO BE REMOVED		
Approved by JAGM REDKTR					ORDNANCE FACTORY KHAMARIA		No. of sheets - 01 Sheet No. - 01
PS/GS.					Store :- 84 m ³ HEAT 551		Compt.:- DRG.M:- 6413398
					Drg.No.		

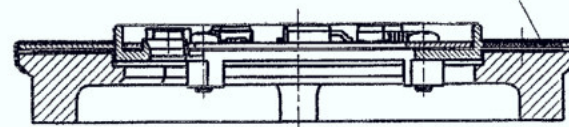
TO BE MARKED ON TOOL/GAUGE/PART

TRD-2-2-2203

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TRD-1-2-2211 / Plus side against TRD-1-2-2212



A-A

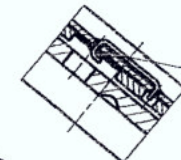
TRD-1-2-2212

Upset against TRD-2-2-2208

TRD-2-2-2208

TRD-2-2-2204

TRD-1-2-2209



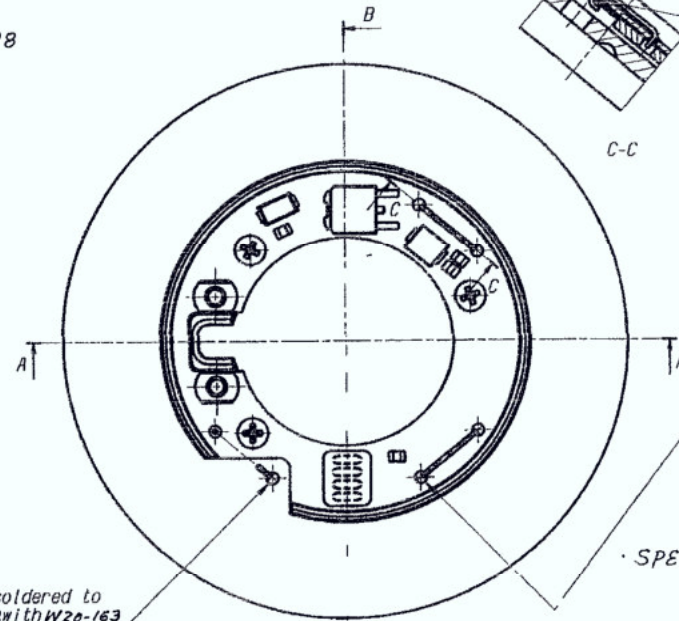
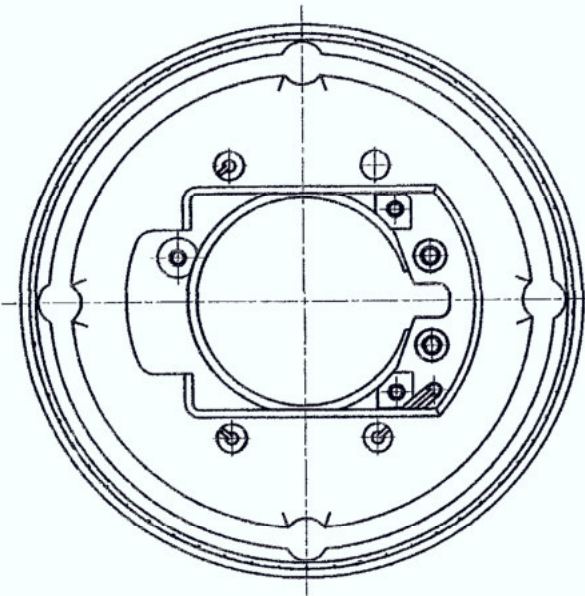
C-C

Bent and soldered to TRD-1-2-2209 with W20-163

SPEC.-O-817511

Bent and soldered to TRD-1-2-2212 with W20-163

(MASS APPROX. 46.4g)

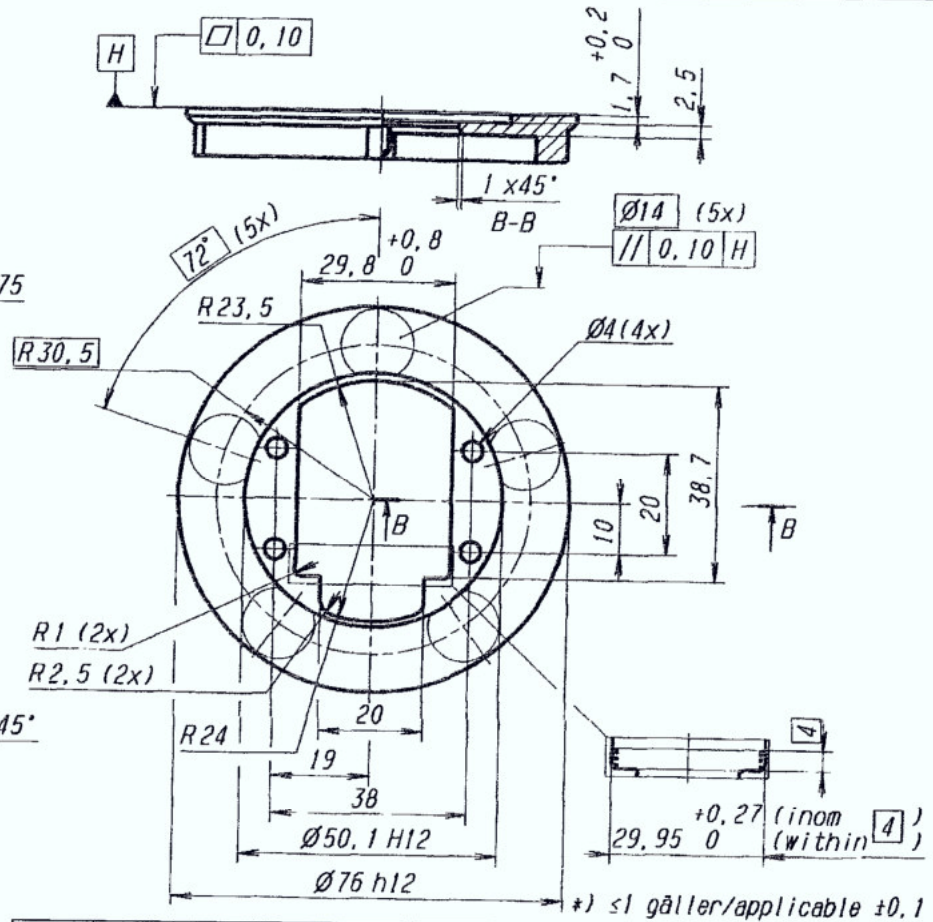
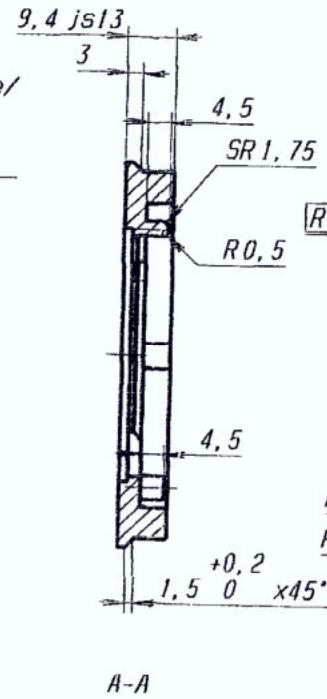
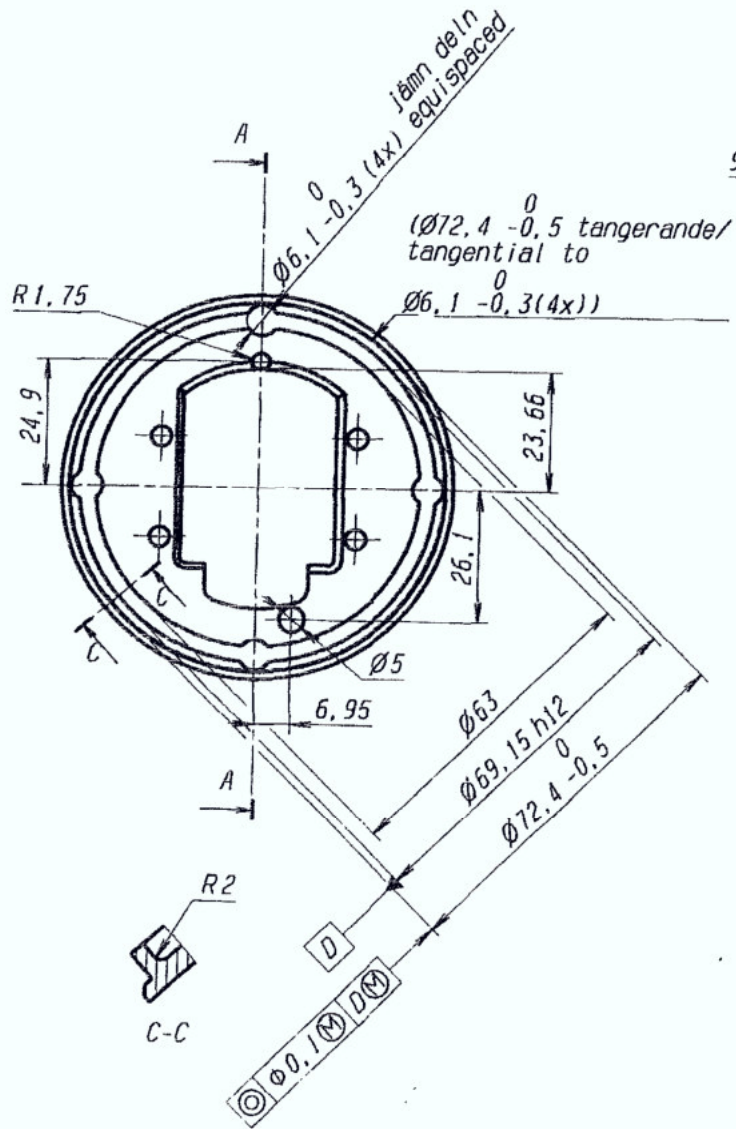


B-B

INSP.	DATE	HOS/ CAD	DA No	ITEM No.	DESCRIPTION	NO OFF	MATERIAL	ORG. NO.
					HEAT TREATMENT Rc.		PIEZOELECTRIC GENERATOR	
					12.5-25 Ra ▽ 0.2-0.8 Ra ▽▽▽			
					1.6-6.3 Ra ▽ 0.1-0.025 Ra ▽▽▽▽		M/C	
					DIMENSIONS ARE IN mm.		DRG. No.	
					UNTOL. DIMNS. IS-2102 MEDIUM		TRD-2-2-2203	
					SHARP EDGES TO BE REMOVED		SCALE:- NTS	
					GUGING SURFACES SHOWN BY THICK LINES		No. OF SHT. - 1	
					ORDNANCE FACTORY KHAMARIA		SHEET No. - 1	
					PS/GS.	STORE:- 84 mm 551	COMPT.	
					DRG. No.		DRG.No.	

Requirement of this is to spec. 011/418

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MATL:-
POLYCARBONATE MAKROLON 8035 SVART/BLACK
(MASS APPROX- 22g)

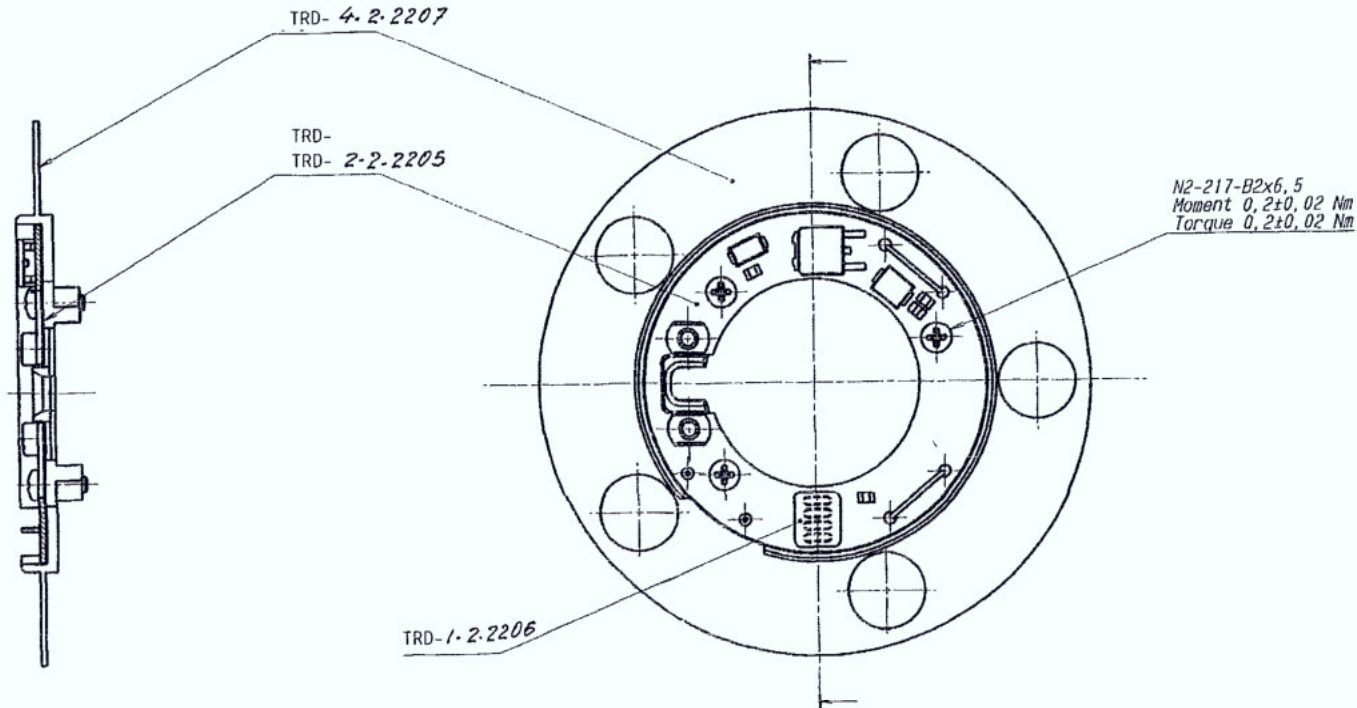
INSP	DATE	HOS/ CAD	DA No	ITEM No.	DESCRIPTION	NO OFF	MATERIAL	DRG. No.
					HEAT TREATMENT Rc.		COUNTER PRESSURE RING	
AMENDMENTS					125-25 Ra ▽ 0.2-0.8 Ra ▽▽▽			
JWM/ R&D		DGM/			1.6-6.3 Ra ▽ 0.1-0.025 Ra ▽▽▽▽		M/C	
HOS/ CAD		DATE	30/5/07		DIMENSIONS ARE IN mm		DRG. No.	TRD-2-2-2208
CKD		CKD			UNTOL. DIMS. IS:2102 MEDIUM			SCALE - NTS
DRN		TRD			SHARP EDGES TO BE REMOVED			
					GUGING SURFACES SHOWN BY THICK LINES			
APPROVED BY ST. GM R&D/CTR					ORDNANCE FACTORY KHAMARIA		No. OF SHT - 1	SHEET No. - 1
PS/GS					STORE - 84 mm 551		COMPT.	
					DRG. No.		DRG.No. 5209541	

Tol. (tol. ±IT14, *)

TO BE MARKED ON TOOL/GAUGE/PART
TRD-2-2-2204

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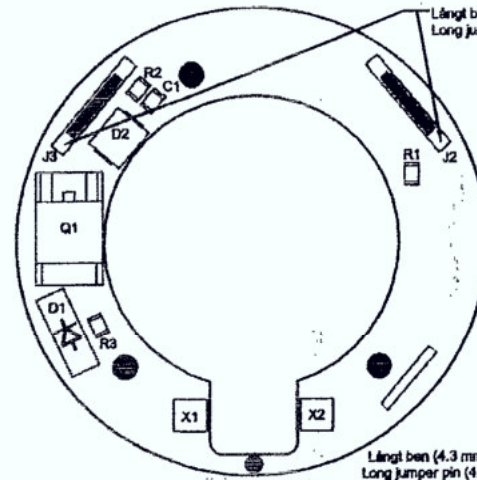
SPECN.- 0 817 418 (MASS APPROX. 12.4g)

				ITEM No.	DESCRIPTION	NO. OFF	MATERIAL	DRG. No.
INSP	DATE	HOS/ CAD	DA No	HEAT TREATMENT Rc.			ELECTRIC IGNITION UNIT	
AMENDMENTS				12.5-25 Ra ▽	0.2-0.8 Ra ▽▽			
JWM/ R&D		DGM/		1.6-6.3 Ra ▽	0.1-0.025 Ra ▽▽▽	M/C		
HOS/ CAD		DATE	30/5/07	DIMENSIONS ARE IN mm			DRG. No.	
CKD		CKD		UNTOL. DIMNS. IS-2102 MEDIUM			TRD-2-2-2204	
DRN		TRD		SHARP EDGES TO BE REMOVED			SCALE:- NTS	
APPROVED BY J1-GM R&D/CTR				GUGING SURFACES SHOWN BY THICK LINES			No. OF SHT. - 1	
				ORDNANCE FACTORY KHAMARIA			SHEET No. - 1	
PS/GS.				STORE.- 84 mm 551			COMPT.	
				DRG. No.			DRG.No.	

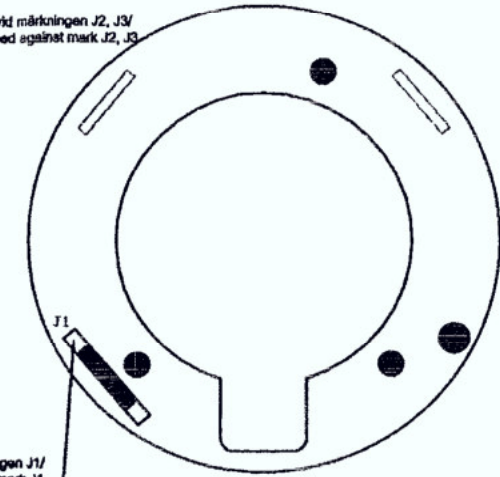
TO BE MARKED ON TOOL/GAUGE/PART
TRD-2-2-2205

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Primärsida/
Primary side



Sekundärsida/
Secondary side

INSP.	DATE	HOS/ CAD	DA No	ITEM No.	DESCRIPTION	NO OFF	MATER
					HEAT TREATMENT Rc.		
AMENDMENTS					12.5-25 Ra ▽ 0.2-0.8 Ra ▽▽▽		
JWM/ R.E.D	23/5/17	DGM/			1.6-6.3 Ra ▽▽ 0.1-0.025 Ra ▽▽▽▽		M/
HOS/ CAD		DATE	30/5/17		DIMENSIONS ARE IN mm.		DI
CKD		CKD			UNTOL. DIMNS. IS-2102 MEDIUM		
DRN		TRD			SHARP EDGES TO BE REMOVED		
					GUGING SURFACES SHOWN BY THICK LINES		No
APPROVED BY JtGM R.E.D/CTR					ORDNANCE FACTORY KHAMARIA		Sf
PS/GS.					STORE:- 84 mm 551		

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Godkänd av, tjst <i>Approved by, Dept.</i> Enp/RTMIW		Released		INTERNAL

Classification of properties, interpretation of classes

(IN)

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ÄNDRINGSFÖRTECKNING *RECORD OF CHANGES*

Ändring nr <i>Revision No</i>	ÄO-nr <i>Rev order No</i>	Berörda paragrafer + kort beskrivning <i>Relevant paragraph + brief description</i>
2	39077820	The document has been reviewed to meet Saab Bofors Dynamics requirements. A workgroup has been working with this, and the result is this document.

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4 Corrective actions 8

5 Examples 8

Appendices

1. Example of classified requirements in a Technical Description
2. Example of classified measurements in a enlargement of drawing.
3. Example of document that gives the reasons for the classification
4. Example of Requirement fulfillment Technical Description

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Godkänd av, tjtst <i>Approved by, Dept.</i> Enp/RTMIW		Released		INTERNAL

2 Scope

Property classification is based upon SS 2222, which states that 4 classes are to be used.

A general interpretation is given in the standard. This document contains a more comprehensive interpretation with emphasis on weapon and ammunition.

Class 1 is safety-critical properties.

Class 2 is function-critical and safety-affecting properties.

Class 3 is function-affecting or production-preventing properties.

Class 4 is properties entailing a slight risk for product function or production disruption.

Certain additional symbols can be used, such as [D] which means that the obligation, as noted in documentation, for the requirement has been verified.

Observe that requirements, specified interpretations and instructions in the product documentation always have precedence over the rules given in this document. All technical drawings and technical specifications containing property classifications shall refer to this document instead of referring to SS 2222, and 0 817 418 shall be assigned to the document structure of the article.

3 Classification of requirements

3.1 Requirement class 1

Class 1 shall apply to **safety-critical** properties (very serious faults). This means that when producing units the process shall be controlled in accordance with the corrected capability index (Cpk) of at least 2, which means that the probability for obtaining values outside the tolerance is less than 10^{-9} for a given property.

In cases where process control as indicated above is not possible, the units produced shall be subject to 100% inspection. This shall be performed:

- with automatic test equipment that can correct or fault.
- or by at least two separate 100% inspections (performed by other than the manufacturer operator). Inspections shall be performed on the unit or in subsequent stages of the assembled unit. When purchasing articles, all required inspections shall be performed by the supplier unless otherwise stated in the contract.

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Godkänd av, tjtst <i>Approved by, Dept.</i> Enp/RTMIW		Released		INTERNAL

- or by at least one effective fault-detection at a subsequent process stage (for example, where it is not possible to further assemble a faulty unit).

In those cases where process inspection and 100% inspection are not relevant, e.g. destructive testing, then the method and scope of the inspection shall be indicated in each specification (for example, inspection of a fuze in safe position). A table based on sampling plan S4, in accordance with ISO 2859 (SS 02 01 30), is given below as a guideline. No faults are allowed. The limited selection of samples presumes that the production process is well-inspected and under control.

Sampling can be performed through continuous inspections evenly distributed during production or as sampling when the production lot is complete.

Lot size	Samples
<50	3
51-150	5
151-280	8
281-500	13
501-1200	20
1201-3200	32
3201-10000	32
10001-35000	50

When faulty results are obtained in the sample control group, take corrective actions in accordance with Section 4.

Class 1 means that the obligation [D], as noted in documentation, for obtaining measurements of each individual or the use of a “gauge”, and that the number of units inspected and any faulty results shall be indicated.

Example: A dimension if inspected with a gauge, 452 units are inspected and none is faulty. It shall be noted in the documentation that of 452 inspected, 452 were approved and 0 were faulty.

The results shall be documented in the production journal. Many properties can be documented under the same paragraph in the journal, presuming that references are made to applicable operational documentation.

Certain properties shall have all obtained measurement values documented and archived. This can apply for certain customer requirements, for example arming times for acceptance tests, x-ray information for structural analysis. If there is a requirement for the documentation of individual values, then such shall be indicated in each specification.

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3.2 Requirement class 2

Class 2 shall be applied for **function-critical** (function-preventive) or **otherwise safety-affecting** properties (serious faults) This means that when producing units the process shall be controlled in accordance with the corrected capability index (Cpk) of at least 1.67, which means that the probability for obtaining values outside the tolerance is less than 10^{-7} for a given property.

In cases where process control as indicated above is not possible, the units produced shall be subject to 100% inspection not performed by the operator. This shall be performed:

- on the unit or in subsequent stages of the assembled unit
- or in accordance with Class 1.

In those cases where process inspection and 100% inspection are not relevant, for example destructive testing, then the inspection method and scope of the inspection shall be indicated in each specification (for example, function inspection of an electric igniter). A table based on sampling plan S4, in accordance with ISO 2859 (SS 02 01 30), is given below as a guideline. No faults are allowed. This limited sampling presumes that the production process is monitored and under control. Sampling can be performed through continuous inspections evenly distributed during production or as sampling when the production lot is complete.

Lot size	Samples
<50	3
51-150	5
151-280	8
281-500	13
501-1200	20
1201-3200	32
3201-10000	32
10001-35000	50

When faulty results are obtained in the sample control group, take corrective actions in accordance with Section 4.

3.3 Requirement class 3

Class 3 shall be applied for **function-affecting** (function-degrading) or **otherwise production-preventing** properties (less serious faults) This means that when producing units the process shall be controlled in accordance with the corrected

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capability index (Cpk) of at least 1.33, which means that the probability for obtaining values outside the tolerance is less than 10^{-4} for a given property.

When process control as indicated above is not possible, the units produced shall be subject to statistical inspection. This shall be performed:

- by at least one statistical inspection, see recommended sampling below.
- or in accordance with Class 2.

Random testing scope:

Non-destructive testing. Simple sampling with a control group as indicated below and approved with 0 faults.

Sampling can be performed through continuous inspections evenly distributed during production or as sampling when the production lot is complete.

Lot size	Samples
<50	50%
51-150	20
151-280	32
281-500	50
501-1200	80
1201-3200	125
3201-10000	200
10001-35000	315

In those cases where process inspection and 100% inspection are not relevant, for example destructive testing, then the inspection method and scope of the inspection shall be indicated in each specification (for example, mechanical strength of a locking lug). A table based on sampling plan S2, in accordance with ISO 2859 (SS 02 01 30), is given below as a guideline. No faults are allowed. This limited sampling presumes that the production process is monitored and under control.

Sampling can be performed through continuous inspections evenly distributed during production or as sampling when the production lot is complete.

Lot size	Samples
<50	2
51-150	3
151-280	5
281-500	5
501-1200	5
1201-3200	8
3201-10000	8
10001-35000	8

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When faulty results are obtained in the sample control group, take corrective actions in accordance with Section 4.

3.4 Requirement class 4

Class 4 shall apply to **other** required properties. This class requires that at least a **first article inspection** of the required properties, as stipulated by the technical specifications or technical drawings. First article inspection shall be performed at production start-up.

When faulty results are obtained in the sample control group, take corrective actions in accordance with Section 4.

4 Corrective actions

Guidance upon obtaining faulty results:

Class	Corrective actions
1	The lot is returned, corrective actions and preventive measures are enacted prior to continued production.
2	The units produced during at least the previous inspection occasion are returned. A corrective action is required.
3, 4	The least corrective actions.

All corrective actions shall be documented.

5 Examples

There is an example in Appendix 1 regarding how two visual properties have been classified in a technical specification (Section 3.2) for an article. Observe that Class 1 is indicated with [1] and not with a ringed triangle. Both symbols may be used in accordance with SS 2222.

There is an example of dimensional classification for technical drawings in Appendix 2.

Class 4 properties are not normally marked, but if one tolerance limit is within Classes 1 – 3 and the other tolerance limit is Class 4, then it shall be marked with [-].

Certain dimensions or properties, which are safety or product function-related, can in some cases be Class 3 on a drawing. The condition for this is that the superior unit be inspected for these properties as Class 1 or 2.

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To meet the classified design requirements for Class 1, a requirement fulfillment Technical Description (**Appendix 4**) shall be produced that specifies how the requirements are to be fulfilled. This document shall refer to the article/document structure as document type BC. (Controlled by the operations system.)

For the remaining classes, only a comprehensive document is required showing how these have been verified.

Appendix 3 refers to documents that indicate the reasons for each class having been selected for the different properties, in accordance with the technical specifications and drawings. This document shall play an important role when possible alterations are to be decided upon. This document shall refer to the article/document structure as document type KE. (Controlled by the operations system.)

When the required dimensions are of a normal character, for example an axel diameter that shall fit in a hole or a linear measure that shall be fitted in between two surfaces, the causes do not need to be specified. On the other hand, if the requirement is special and the effects of a fault are difficult for an outsider to assess, the cause shall be specified.

The table in Appendix 3 can be used to inform suppliers.

A list of safety-critical properties is the normal basis for the classification of a Class 1 property. A corresponding list of function-critical properties forms the basis for the classification of a Class 2 property. These lists are developed from fault trees and FMECA analyses in the ordinary safety and operational reliability work.

For certain components and assembled units it is not relevant to use Class 4. In these cases only Class 1 and 2 are given for each property and the document is to supplemented with the text "Generally Requirement Class [3] applies".

In a stable manufacturing process, the scope of inspections is reduced for Requirement Class [3]. If the process is set up so that several dimensions have connections to each other, it can be sufficient that one dimension in the group is inspected in accordance with [3]. Inspection of the remaining dimensions in the group can be reduced. This applies for example when a number of lathed dimensions are done in the same mounting and using the same lathe tool. The supplier shall then inform in the inspection and/or delivery documents that this process model has been selected.

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Appendix 1

Saab Bofors Dynamics AB

TEKNISK BESTÄMMELSE
TECHNICAL SPECIFICATION

3 (5)

Uppgjord av/Avd Compiled by/Dept. Axx/Avd	Kontrollerad av/Avd Checked /Dept. Bxx/Avd	Datum Date 04-04-04	Utgåva nr Edition No 1	Dokumentnummer Document number 0 888 XXX
Godkänd av/Avd Approved by/Dept. Dxx/Avd		Dokumentstatus Document status Utgiven	Informationsklass Classification INTERN	

1 Produktbestämmelser

1.1 Allmänt

Ingående detaljer skall uppfylla fordringarna enligt gällande tekniskt underlag samt vara fria från fel som menligt kan påverka detonators funktion, handhavande, säkerhet och lagringsbeständighet.

1.2 Okulära egenskaper [1]

3.2.1 Sprängämnet skall efter pressning och maskinbearbetning vara fritt från sprickor och håligheter.

3.2.2 Före pressning enligt pkt 4.2.2 resp 4.2.3 kontrolleras att pressning enligt föregående pkt är utförd.

1.3 Övriga fordringar

3.3.1 Densitet [2D]

Utförs som förstabitskontroll på 5 st detonatorer därefter kontrolleras 2 st/dag under löpande produktion. (Obs! Densitetskontroll sker efter att samtliga pressteg utförts, se punkt 4.2). Förstörande provning.

3.3.1.1 Sprängämne, nominell diameter 3,5 mm.

Densitet, $\rho = Y \pm Z \text{ g/cm}^3$. Pressad i 2 steg.

Kornstorlek <XXX μm .

Densitetens medelvärde skall ligga inom ovan angivna gränsvärden.

Fel får ej förekomma i provgruppen.

3.3.1.2 Sprängämne, nominell diameter 6,5 mm.

Densiteten skall vara högre än det uppmätta värdet för diameter 3,5 mm och lägre än det uppmätta värdet för diameter 22,2 mm.

Fel får ej förekomma i provgruppen.

3.3.1.3 Sprängämne, nominell diameter 22,2 mm.

Densitet, $\rho = Y \pm Z \text{ g/cm}^3$.

Fel får ej förekomma i provgruppen.

3.3.2 Mått [2]

3.3.2.1 Kontroll av att adaptorn är skruvad mot anslag i detonatorhylsan.

Samtliga enheter skall kontrolleras en gång med avseende på mått $0,1 \pm 0,1 \text{ mm}$.

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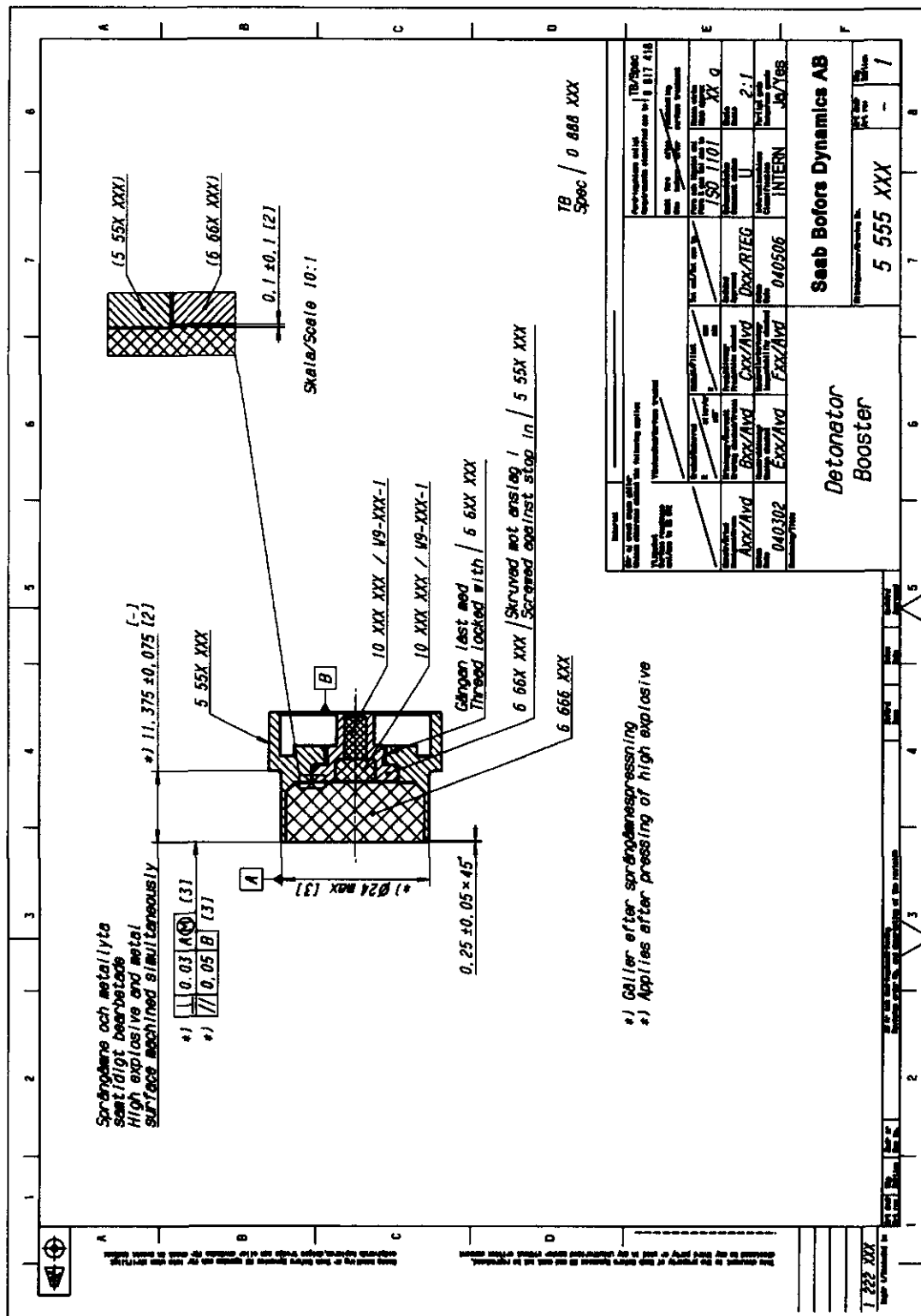
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Appendix 2



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Appendix 3

Saab Bofors Dynamics AB

KLASSIFICERING FORDRINGAR
CLASSIFIED REQUIREMENTS 1 (1)

Utfärdare, tjänsteställe, telefon Issued by, department, telephone Xxx, Avd, 123 45	Datum Date 2004-04-04	Utgåva issue ID 1	Dokumentnummer Document ID 2 88X XXX
Antal bilagor No. of appendices -	Dokumentstatus Document status Utgiven	Informationsklass Classification INTERN	

Benämning Detonator	Artikelnummer 1 222 XXX	A-nr -	Utgåva 1
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Läge	Mått / Egenskaper	Klassificering		Motivering	
		Övre gräns []	Undre gräns []	Övre gräns	Undre gräns
	5 555 XXX - - 1				
B2	Vinkelräthet	3	3	Risk för spalt. Kan ge en asymmetrisk initiering av RSV-laddningen.	Risk för spalt. Kan ge en asymmetrisk initiering av RSV-laddningen.
B2	Parallellitet	3	3	Risk för spalt. Kan ge en asymmetrisk initiering av RSV-laddningen.	Risk för spalt. Kan ge en asymmetrisk initiering av RSV-laddningen.
A4	11,375±0,075	-	2	-	Risk för spalt mellan sprängämne och detonator.
B7	0,1±0,1	2	2	Risk för spalt.	Risk för spalt.

	0 888 XXX utg 1				
Pkt 3.2	Okulära egenskaper	1	-	Risk för spalter som påverkar sprängämnets hållfasthet dvs säkerheten vid utskjutning.	-
3.3.1	Densitet	2D	-	Funktionsstörning övertändning till RSV-laddning	-
3.3.2	Mått	2	2	Se B7 ovan.	Se B7 ovan.

Sökord: Keywords:

Granskad och godkänd Reviewed and approved

Granskad av, namnteckning Reviewed by, signature	Tjtst Dept	Godkänd av, namnteckning Approved by, signature	Tjtst Dept

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c08/klassificerade fordringar.dot/uta1

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Appendix 4

Saab Bofors Dynamics AB

KRAVUPPFYLLNADS-TB

1 (1)

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Artikelbenämning Detonator	Artikelnummer 1 222 XXX		
Tillverkande avdelning/Leverantör Avd / SBD	Informationsklass INTERN		

KRAVSTÄLLANDE DOKUMENT

Dokumentnummer	Utgåva
5 555 XXX	1
0 888 XXX	1

EGENSKAPSKLASS 1:

Läge	Egenskap	Verifieringsmetod	Dokumentation Documentation
3,2,1	Sprängämne fritt ifrån sprickor och håligheter	2 st allkontroller 1 st vid planborming 1 st vid tdr. montering	Tillv. journal
3,2,2	Att pressning är utförd	2 st allkontroller 1 st vid pressning 1 st vid nästa pressoperation	Tillv. journal

EGENSKAPSKLASS 2:

Läge	Egenskap	Verifieringsmetod	Dokumentation Documentation
3,3,1	Densitet	Första bitskontroll 5st. Sedan 2 st/dag	Densitetsprotokoll
3,3,2,1	Adapter skruvad mot anslag	Mätlocka 1 st allkontroll	Tillv. journal
A.4	Min 11,300 mm	Mätlocka 1 st allkontroll	Tillv. journal

Granskad och godkänd SBD

Granskad av, namnteckning	Tjt	Godkänd av, namnteckning	Tjt
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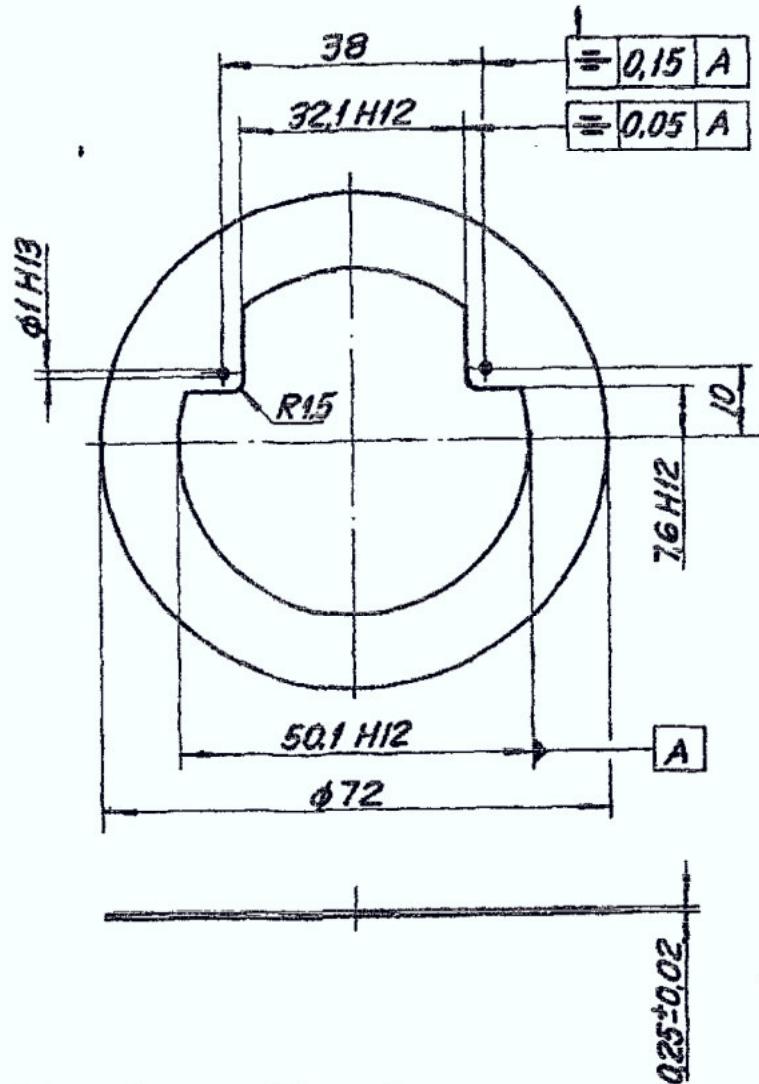
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TOOL/GAUGE/PART
TRD-1.2.2209

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Degreased. (Free from oxide and
other foreign matter.)

EN 1652 CW403JR430 OR
MATL- SIS COPPER-NICKLE-ZINC ALLOY 5243-04

Weight: 3 grams

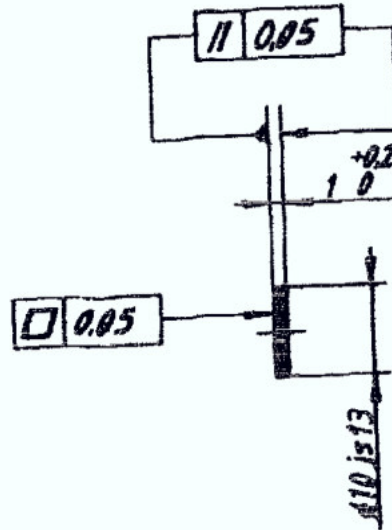
2.5/

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AMENDMENTS					12.5-25 Ra ▽ 0.2-0.8 Ra ▽▽▽		
JWM/ R&D/ <i>[Signature]</i>					1.6-6.3 Ra ▽▽▽ 0.1-0.025 Ra ▽▽▽▽		M/C
HOS/ CAD C. <i>[Signature]</i>		DATE 30/5/07		DIMENSIONS ARE IN mm		DRG. No. TRD- 1.2. 2209	
CKD <i>[Signature]</i>		CKD		UNTOL. DIMNS. IS.2102 MEDIUM		SCALE:- NTS	
DRN		TRD		SHARP EDGES TO BE REMOVED		No. OF SHT -	
APPROVED BY Jt. GM R/D/CTR				GUGING SURFACES SHOWN BY THICK LINES		SHEET No -	
ORDNANCE FACTORY KHAMARIA							
PS/GS.				STORE:-		COMPT.	
				DRG. No.		DRG.No. 6413236	

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TRD- 1-2.2211

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MATL :- MATSUSHITA PCM-5 AND
HOECHST SONOX P5

Övriga fordringar enligt TB F1301-903799
Other requirements to Spec F1301-903799

Massa / 0.6g
Mass / 0.6g

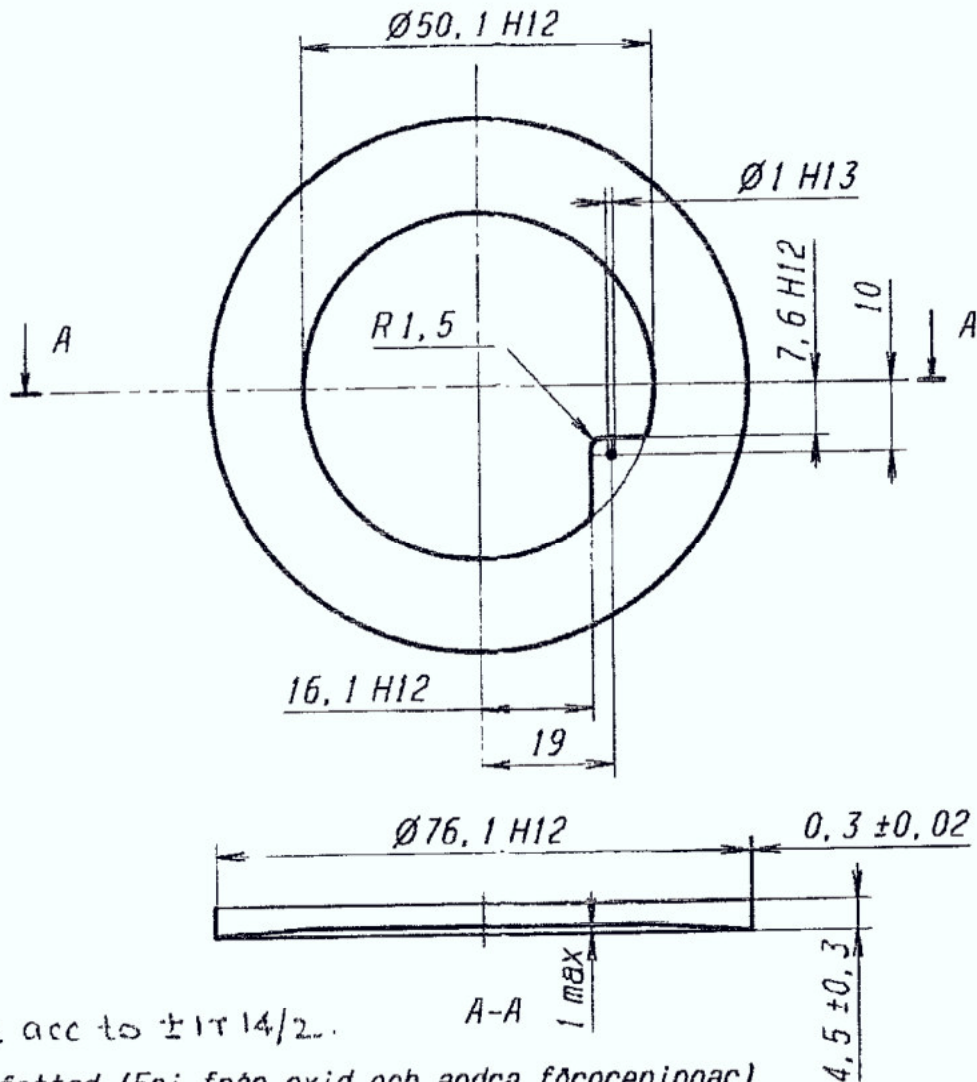
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JWM/ R&D				16-6.3 Ra ▽▽▽ 0.1-0.025 Ra ▽▽▽▽		DRG. No	
HOS/ CAD C.		DATE 30/5/07		DIMENSIONS ARE IN mm.		TRD- 1-2.2211	
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DRN		TRD		SHARP EDGES TO BE REMOVED		No OF SHT -	
APPROVED BY J/GM R&D/CTR				GUGING SURFACES SHOWN BY THICK LINES		SHEET No -	
PS/GS.				ORDNANCE FACTORY KHAMARIA		COMPT	
				STORE.- 84mm HEAT 55!		DRG.No. 6413233	
				DRG. No			

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TOOL/GAUGE/PART
DRG No TRD 1-2-2212

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Tol acc to $\pm 14/2$.

A-A

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4.5 ± 0.3

2.5/

Avfettad (Fri från oxid och andra föroreningar)
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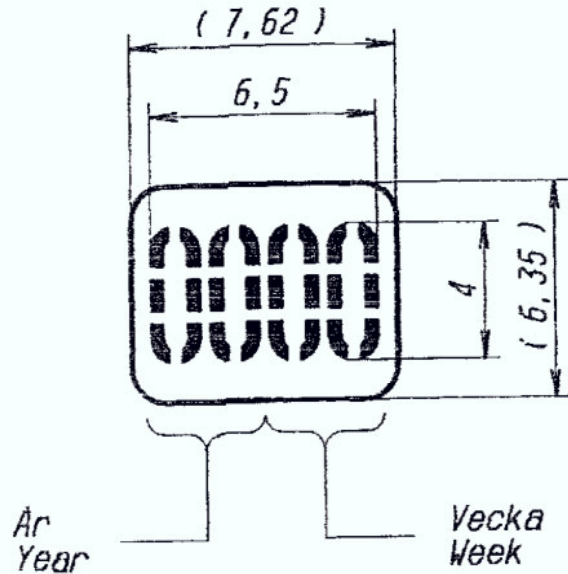
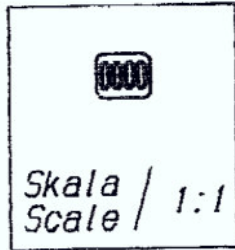
MATL:- SIS/COPPER-NICKEL-ZINC ALLOY 5243-04 (MASS APPROX. 10g)

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AMENDMENTS				125-25 Ra	▽ 02-08 Ra	▽▽▽	
JWM/ <i>[Signature]</i>				16-6.3 Ra	▽▽ 0.1-0.025 Ra	▽▽▽▽	
R&D <i>[Signature]</i>				DIMENSIONS ARE IN mm.			
HOS/CAD E. <i>[Signature]</i>		DATE 30/5/07		UNTOL. DIMNS. IS:2102 MEDIUM			
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DRN <i>[Signature]</i>		TRD		GUGING SURFACES SHOWN BY THICK LINES			
APPROVED BY Jt.GM RAD/CTR				ORDNANCE FACTORY KHAMARIA		No OF SHT. - SHEET No. -	
PS/GS.			STORE-- DRG. No.			COMPT DRG.No. 6413237	

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TOOL/GAUGE/PART
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Material:
Part No. LAT-1-652-10. Brady WH Co.

Text:
Typsnitt/Font: Swis721BT
Teckenuppsättning/Character Map: Latin
Stil/Type: Fet/Bold

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HOS/ CAD C.	<i>[Signature]</i>	DATE	30/5/07	DIMENSIONS ARE IN mm.		M/C	
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DRN	<i>[Signature]</i>	TRD	<i>[Signature]</i>	SHARP EDGES TO BE REMOVED		SCALE:- NTS	
APPROVED BY <i>[Signature]</i> JGM RE'D/CTR				GUGING SURFACES SHOWN BY THICK LINES		No. OF SHT - 1	
				ORDNANCE FACTORY KHAMARIA		SHEET No. - 1	
PS/GS.			STORE:-			COMPT.	
			DRG. No.			DRG No.	