SEVENSTAR ELECTRONICS LIMITED

SevenStar Electronics

S.701
Search And Rescue Transponder

Contents

Introduction

The S.701 Search & Rescue Transponder (SART) from SevenStar Electronics Limited has been designed to fulfil and exceed the requirements of X-band Marine Search & Rescue Radar Transponders as specified for use within the GMDSS community. It has been designed and built using the most modern components available, and offers several features which give it significant advantages over first and second generation SARTs. SevenStar Electronics Limited has been examined and accredited to ISO BS EN 9001:2000 (Copy of certificate in Appendix 6).

General Type Description

Search & Rescue Transponders are mandatory carriage safety devices as part of the Global Maritime Distress Signalling System (GMDSS). SARTs are active radar transponders, and operate exclusively in the X-band, receiving and transmitting at nominally 9,200 MHz to 9,500 MHz.

In brief, they are deployed during maritime emergencies as an aid to locating either vessels, or survivors who may be adrift in a life raft. Once activated, a SART 'looks' for an incoming radar signal from a passing vessel – note that this can be from ANY vessel equipped with a standard X-band radar set, and is not restricted to specific Search & Rescue craft.

When the SART receives a valid signal, it switches into Transmit mode, and transmits a series of twelve (12) sweeps through the band 9,200 to 9,500 MHz lasting just over 100 microseconds in total. This signal is seen on the passing vessel's radar screen as a line of twelve dots, with the SART position being given by the closest dot. This is an unmistakable signal and clearly shows the presence AND location of a vessel, survivor or life raft with an active SART.

SARTs within the GMDSS have to meet a number of International Maritime specifications and conventions, and these are detailed in the following section.

Applicable Specifications and Standards

Marine Equipment Directive:

Commission Directive 2002/75/EC of 2 September 2002 amending Council Directive 96/98/EC on marine equipment

Regulations referenced by 2001/53/EC (Annex A.1/4.18):

SOLAS 74 as amended, Regulation III/6.2.2, Regulation IV/7.1.3

IMO Resolution MSC.36 (63) 8.2.1.2 (1994 HSC Code)

IMO Resolution A.530 (13)

IMO Resolution A.802 (19)

IMO Resolution A.694 (17)

ITU-R M.628-3 (11/93) Technical Characteristics of SARTs

Standards referenced by 2001/53/EC (Annex A.1/4.18):

IEC 61097-1 (1992), EN 61097-1 (1993): SART Operational & Performance Requirements, Methods of Testing & Required Test Results.

IEC 60945 (1996), EN 60945 (1997): General Requirements for Maritime Equipment – Methods of Testing & Required Test Results.

SevenStar S.701 Search & Rescue Transponder

The SevenStar S.701 SART is the result of many years collective experience in a number of key areas. The key stakeholders all have highly relevant backgrounds in Marine Equipment Design, Consultancy or Manufacture. In particular, SevenStar Electronics Ltd has brought together the following invaluable areas of expertise highly relevant to this marketplace:

- We have had access to leading industry consultants and experts during the research, specification and mechanical design stages
- We have intimate knowledge of the specifications, and also contribute to the various working parties and ongoing improvement process
- We have significant in-house microwave and RF design experience, with particular expertise in the design of cost-effective equipment suitable for high volume manufacture. Specifically, this experience includes a number of Marine Radar Transponders and Enhancers, and also EPIRBs.
- We have direct, personal experience of the design, pre-production and volume manufacturing requirements of both first and second-generation market leading SARTs.
- As a result, the S.701 SART:
  - Is physically small and light (only 40mm thick, and 400gm)
  - Is easy to carry-off and deploy (easy shape to hold, light)
  - Is easy to install permanently in life rafts (low profile)
  - Has electronics that are sealed for life
  - Has a field-changeable, NON-HAZARDOUS battery
  - Uses digital technology to guarantee lifetime performance
  - Uses state-of-the art, high reliability manufacturing

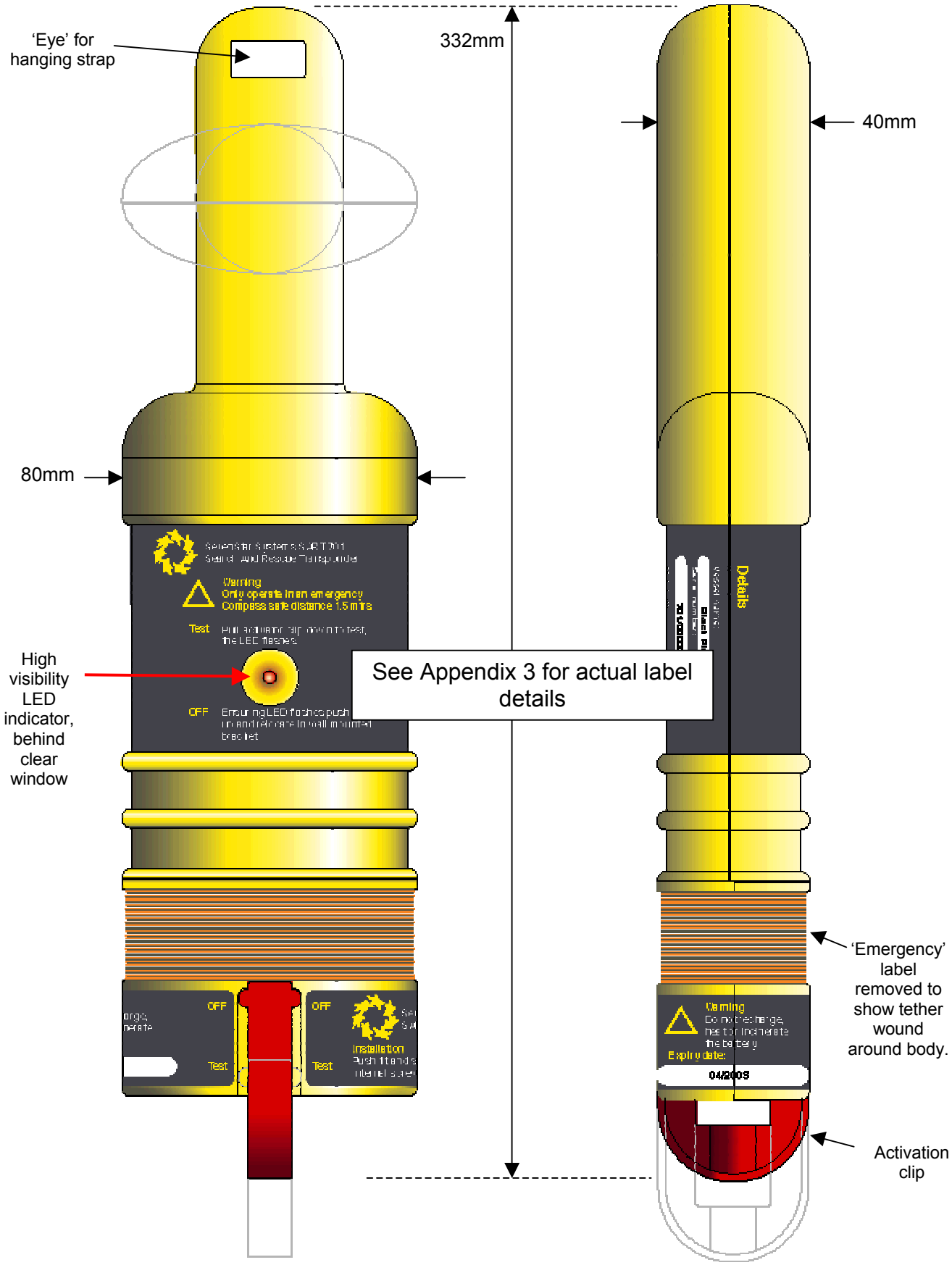


Figure 1 - SevenStar S.701 SART

S.701 SART Technical Specification

Response signal: 12 sweeps, sawtooth, starting with a return sweep

Frequency: 9,200 MHz (+0/-60MHz) to 9,500 MHz (+60/-0MHz)

Sweep rate: 40MHz per µsec nominal (forward sweep)

Sweep linearity: better than +/- 20MHz from straight line

Antenna polarisation: horizontal

Output power: 400mW (+26dBm) minimum

Forward sweep: 7.5µs +/1µs

Return sweep: 0.4µs+/- 0.1µs

Total transmit emission time: 100µs nominal

Input sensitivity: better than –50dBm

Response delay: less than 0.5µs

Recovery time after transmitting: less than 10µs

Antenna vertical beamwidth: better than +/-12.5°

Antenna azimuthal variation: less than +/-2dB

Effective antenna height: >1metre mounted in accordance with instructions

Operating temperature range: -20°C to +55°C

Stowage temperature range: -30°C to +65°C

Duration: more than 96 hours in standby, followed by 8 hours in transponding mode at 1KHz duty factor

SART Weight: 400g. incl battery

SART Dimensions: 332mm x 80 mm x 40mm incl battery

Mounting bracket: 407mm x 108mm x 66mm, UV resistant ABS

Mounting pole (option): 3 section telescopic, glass fibre

SART body: UV-stabilised, impact modified polystyrene, bright yellow

Battery: Type SevenStar S.701B pack, factory sealed, in same material as main body. Batteries are classified as NON-HAZARDOUS for shipment and usage. S.701B pack contains 4 x CR/DL123A Lithium/ Manganese Dioxide cells with internal short-circuit protection (IEC designation 17345). (see Appendix 7).

S.701 SART Design Concept

General

The S.701 SART has been designed to meet and exceed all the relevant operational and performance specifications. The casing for the electronics and antenna is of UV-stabilised, high-visibility yellow thermoplastic construction, and is permanently sealed during manufacture. (Details of materials used can be found in the Materials section below.) The battery pack can be changed with minimal tools, and without risking water ingress into the electronics enclosure, which remains sealed throughout the operation. Provision is made for hanging the SART from the top, or for pole mounting from the bottom (see Appendix 4). Unlike many existing SARTs, provision is made for the tidy, **integral** stowage of 10 metres of buoyant tether line. A mounting bracket is supplied for location on a suitable bulkhead or bridge wing (see Appendix 4).

Build Standard

The electronics assembly takes the form of a single, compact printed circuit board assembly with the antenna rigidly attached to the upper end, and a single connector at the lower end. A metal can provides shielding and protection to the microwave section of the circuitry.

The circuit board assembly is heat-staked onto pillars in one half of the plastic case. The other half of the case is then solvent welded in place, forming a permanent watertight enclosure. (Every unit is inspected and individually tested for integrity of the sealing.) The upper section of the casing houses the antenna, which takes the form of a single multi-slot waveguide. No labels are used on this section, as they might disturb the propagation of the radar signals.

The battery and activation switch are contained in the lower enclosure, which attaches to the main unit with a single recessed screw. A number of gaskets and seals prevent moisture ingress and seal the battery pack to the main unit.

The battery moulding, coded S.701B for replacement purposes, is also comprised of two case halves solvent-welded together.

A bright red sliding moulding clips into place on the lower end of this assembly – sliding this from one detent position to another, or removing it completely, is used to activate the unit (see Activation section below).

Activation

Prior to activation, the S.701 SART must first be removed from its mounting bracket by releasing the retaining strap and pulling the SART clear. The S.701 SART can then be switched into the 'Standby/Test' mode by firmly pulling the red clip downwards (i.e. away from the main housing). There are spring-loaded detent positions for the 'Off' and 'Standby/Test' positions. This position should be used when testing the device. Returning the clip to the closed position will turn the SART off again. The red clip can be removed completely for activation – the 'ON' position – it remains attached to the SART by the tether, so can be replaced again if required.

Indication

A bright red LED (light emitting diode) is visible through a transparent section in the centre of the main unit label. The LED is off when the unit is off, flashes at a low duty cycle when in the standby mode, and flashes rapidly when it has been triggered by an incoming radar signal.

Markings and Labels

Careful consideration during the design of the S.701 SART has led to the use of simple, clear labels that allow intuitive use of the SART. The labels are fully compliant with the requirements of IEC 1097-1, IEC 90645and the FCC. Appendix 3 shows the complete label set as printed. Placement details can be seen in Figure 1.

Materials

Main casing: Styrosun® 5400, from Nova Chemicals Europe, Impact modified and UV-stabilised polystyrene (See Appendix 2)

Battery casing: as main casing

Activation clip/moulding: UV-stabilised ABS, colour to RAL3000

Tether: 1mm diameter woven nylon cord, sealed ends, buoyant, colour to RAL3000

Main label: 150 micron UV-stabilised polyester, 3-colour reverse print, with 3M type 468 adhesive

Battery label: as main label

Mounting bracket: UV-resistant ABS

Mounting pole (optional extra): Glass GRP 'wrapped roving'

Electronics

All the active circuitry is contained on a single, multi-layer printed circuit board (PCB). There are four copper layers used, and two different dielectric constant materials bonded together during pcb manufacture. All the microwave circuitry is on one side of the board – the side with a PTFE-based dielectric – and the high frequency circuitry is shielded and protected by a photo-etched metal can, soldered to the ground plane of the PCB. The control part of the circuitry is on the FR4 side of the board.

The high frequency (microwave) sections of the circuit use very modern components and design techniques to provide superb performance and reliability *without* the use of specialist MMIC or thin

-film assemblies. Considerable experience in the design and manufacture of X-band (and much higher frequency) circuits has enabled SevenStar to develop a SART design that uses relatively low cost, commercially available components. This enables much simpler manufacturing processes, as virtually all components can be placed automatically, which itself creates more consistent unit performance. Most importantly, due to the intelligent and careful broadband design, and this consistency of component placement, the units need very little tuning to achieve the specified performance. (Manual tuning of microwave circuits has in the past been a 'necessary evil' required to make each production unit meet the test specifications. This is usually a time-consuming and therefore costly operation, which also introduces further variability in build standard and reliability.)

SevenStar have made another breakthrough, in that the basic tuning parameters of the S.701 SART can be set in SOFTWARE, so most unit-to-unit variation can be easily taken out during test. This has significant manufacturing and testing benefits, and the 'hands-off' technique and absence of tuning components further enhances the reliability of the completed unit.

The S.701 SART is controlled by a single chip microcontroller (I.C.1) with Flash memory programming capability (see Schematic diagram in Appendix 1). The microcontroller is driven by a crystal oscillator, and performs all the timing functions, which are therefore highly accurate and consistent. It also stores the individual tuning data for each unit, and drives the VCO control voltage to sweep the SART output over the specified frequency band. The maximum and minimum frequencies and the sweep rate are set digitally, and therefore change far less over temperature and the life of the product than with conventional analogue-driven designs.

Compliance

In this section are details of specific design measures to meet the requirements of IEC 1097-1 (1992), referenced to the appropriate paragraph numbers from that specification:

Operational aspects:

3.2.1 'be capable of being easily activated by unskilled personnel'

- ✓ ***Operation of the S.701 is by the pulling of the bright red activation clip, aided by simple, clear labelling.***

3.2.2 'be fitted with means to prevent inadvertent activation'

- ✓ ***The S.701 has been designed to prevent inadvertent activation in all operating modes – when held in the hand, it needs a clear, unambiguous action to pull the clip to the 'ON' position. In its mounting bracket, it is impossible to move the activation clip out of the 'OFF' position.***

3.2.3 'be equipped with visible and/or audible indication'

- ✓ ***The S.701 features a high brightness LED, which flashes rapidly in the Active mode.***

3.2.4 'be capable of manual activation and deactivation, provision for automatic activation may be included'

- ✓ ***Manual activation is by the pulling of the bright red activation clip. The design of the S.701 and its activation switch has also SPECIFICALLY allowed for the SART to be permanently located in survival craft, and can be operated automatically as the liferaft inflates.***

3.2.5 'be provided with an indication of being in the Standby condition'

- ✓ ***The S.701 features a high brightness LED, which flashes slowly in the Standby mode.***

3.2.6 'be able to withstand 20 metre drop into water'

- ✓ ***The low mass, smooth profile, 'one-piece' sealed construction and choice of thermoplastics make the S.701 very strong. It has passed all such tests with no damage.***

3.2.7 'be watertight at 10 metre depth for >5 mins', *and*

3.2.8 'remain watertight during and after 45 °C thermal shock'

- ✓ ***The electronics are permanently encased in the mouldings during manufacture – there are no gaskets or screw***

threads to leak or deteriorate over time, or to deform on impact and allow the ingress of water.

3.2.9 'be capable of floating'

- ✓ ***The advanced electronics design of the S.701 reduces both the mass of the circuit board components and the mass of the batteries.***

3.2.10 'be equipped with a buoyant lanyard, length >10metres'

- ✓ ***The unit comes supplies with a 10 metre buoyant nylon tether, wound around the battery casing in a purpose-designed recess, and protected by a clearly-marked, peel-off label.***

3.2.11 'be not unduly affected by seawater or oil', *and*

3.2.12 'be resistant to deterioration in prolonged exposure to sunlight'

- ✓ ***Careful, intelligent choice of suitable materials for ALL components, and the use of reputable suppliers, ensures a long service life.***

3.2.13 'be of a highly visible yellow/orange colour'

- ✓ ***The S.701 is bright yellow, with a bright red activation clip.***

3.2.14 'be of smooth external construction to avoid damaging survival craft'

- ✓ ***The S.701 SART has been designed with stowage on board survival craft as a key element. All edges are smoothly radiused, and the side profile is VERY slim to enable stowage in pockets without risk of damage to either the craft itself or the occupants.***

3.3 'shall have sufficient battery capacity..'

- ✓ ***The use of modern components and rigorous broadband design techniques throughout has enabled SevenStar to design a SART with very low power consumption, which will meet and exceed the specified 96 hour standby period, followed by 8 hours operation at 1kHz duty cycle.***

3.4 'Environment (temperature)'

- ✓ ***The S.701 SART will operate correctly over an ambient temperature range of –20°C to + 55°C, and may be stored at a temperature within the range –30°C to +65°C without damage.***

3.5 'Antenna height'

- ✓ ***The S.701 SART is designed to enable two major mounting methods to achieve a mounting height of 1 metre above sea level:***

a) The top of the unit features a strong, integral mounting 'eye' with attached webbing strap, which can be easily wrapped over a liferaft support tube and fastened.

b) The lower end of the unit incorporates a fixing hole for an optional 1 metre mounting pole

3.6 'Antenna Characteristics'

- ✓ ***The antenna design used in the S.701 fully meets the directional and polarisation characteristics specified.***

4.1, 4.2 'Labelling'

- ✓ ***Labels on the S.701 SART include simple, clear activation directions, in English, and battery expiry date.***

Other Technical Characteristics: (See IEC 1097-1 para 5):

Note: All frequency settings and timings are stored digitally, based on a crystal-controlled reference, so vary much less with temperature or ageing than with conventional analogue designs

5.1 Frequency

- ✓ ***The S.701 SART operates over the 9,200 to 9,500 MHz band. Output frequency sweeps from 9,200 MHz +0/-60 MHz to 9,500 MHz +60/-0 MHz***

5.2 Polarisation

- ✓ ***Antenna polarisation is horizontal***

5.3 Sweep rate

- ✓ ***The output frequency sweep rate is crystal-controlled, set at 40Mhz/µs nominally, +/- 20MHz linearity, and forms a 'sawtooth'***

5.4 Response signal

- ✓ ***There are 12 sweeps per transmission***

5.5 Form of sweep

- ✓ ***Transmission begins with a fast return sweep***

5.5 Form of sweep

- ✓ ***Forward sweep time is 7.5 µs +/-1 µs***

5.5 Form of sweep

- ✓ ***Return sweep time is 0.4 µs +/- 0.1 µs***

5.6 Pulse emission

- ✓ ***Nominal transmit duration is 100µs***

5.7 E.I.R.P.

- ✓ ***Transmit power E.I.R.P. is > 26bBm (400 mW)***

5.8 Receiver sensitivity

- ✓ ***Receive sensitivity is better than –50 dBm (0.1mW/m^2) for received pulses > 400 ns duration***

5.8 Receiver sensitivity (low pulse width)

- ✓ ***Receive sensitivity is better than –37 dBm for received pulses 80 < t_{pulse} < 100 ns duration***

5.9 Duration of operation

- ✓ ***>96 hours standby, followed by 8 hours active @1KHz***

5.10 Temperature range

- ✓ ***Operating temp range -20℃ to +55℃, stowage temp range -30℃ to +65℃***

5.11 Recovery time

- ✓ ***Recovery time after transmission is <10µs***

5.12 Effective antenna height

- ✓ ***Mounting height of > 1metre is easy to achieve (see response to 3.5 above)***

5.13 Rx to Tx delay

- ✓ ***Delay between receipt of incoming signal and start of transmission is < 0.5 µs***

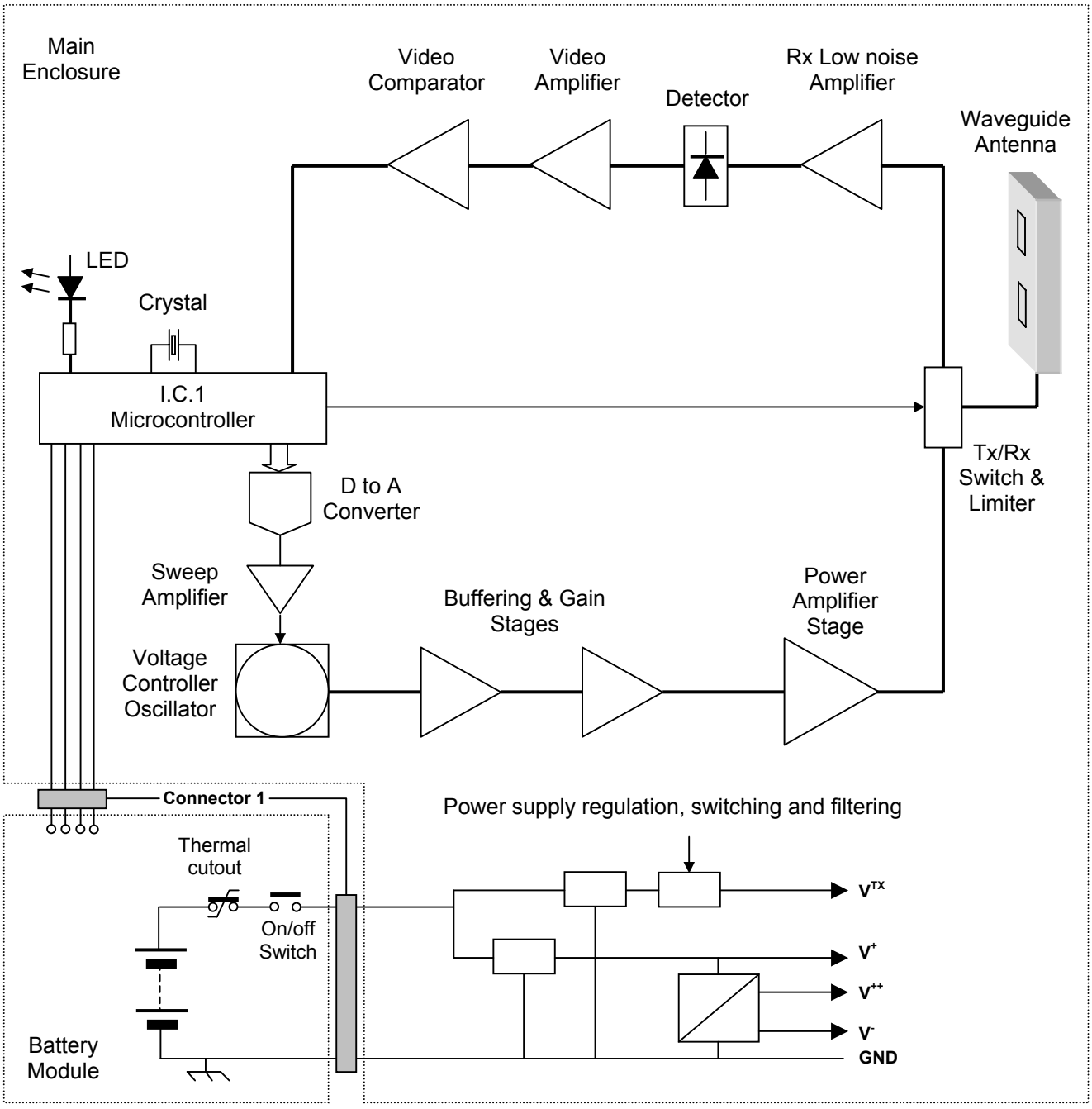
5.14 Antenna vertical beamwidth

- ✓ ***Antenna vertical beamwidth > +/- 12.5° from horizontal plane***

5.15 Antenna azimuthal beamwidth

- ✓ ***Antenna azimuth variation < +/- 2dB***

Appendix 1 - S.701 SART Schematic Diagram



Notes:

1. There are no field-serviceable parts within the S.701 SART. Maintenance is limited to regular testing and battery changing at the specified interval.
2. Only major functions are shown in this diagram, which forms part of confidential information contained in this document. No part of this information may be copied or used elsewhere other than for the purpose of Type Approval of the S.701 SART.

Appendix 2 – Styrosun® 5400

Styrosun® 5400 is a UV-stabilised, impact modified polystyrene thermoplastic. It is much more durable than standard High Impact Polystyrene (HIPS) or ABS, and has been used in a wide range of products in a variety of markets, notably including marine safety products. Its physical properties, coupled with its dielectric constant, make it a near-ideal choice for low power radio and radar equipment.

It can be injection moulded or extruded, and can be solvent welded very effectively.

Styrosun® 5400 Physical Properties

Property	Test Methods	Value	Units
Density	DIN 53479	1.02	g/cm^3
Water Absorption (24hr)	DIN 53495	<0.1	%
Melt Volume Index MFI 200/5	DIN 53735/ ISO 1133	3.0	cm^3 /10 min
Impact strength, notched (1)	DIN 53453/ ISO 179	9	kJ/m^2
Impact strength, un-notched (1)	DIN 53453	NB	kJ/m^2
Tensile Stress at Break (1)	DIN 53455	22	MPa
Elongation at Break (1)	DIN 53455	40	%
Flexural Modulus (1) - at 1 minute - 6 day value	Flexural creep test ($10N/mm^2$)	2100 1650	N/mm^2
Ball indentation Hardness (358/30)	DIN 53456	85	MPa
Vicat Softening Point VSP B/50	DIN 53460	88	°C
Dimensional Stability under Heat (Martens)	DIN 53458	78	°C

Note (1): Measured under standard conditions 50% RH and 23 °C

Appendix 2, continued...

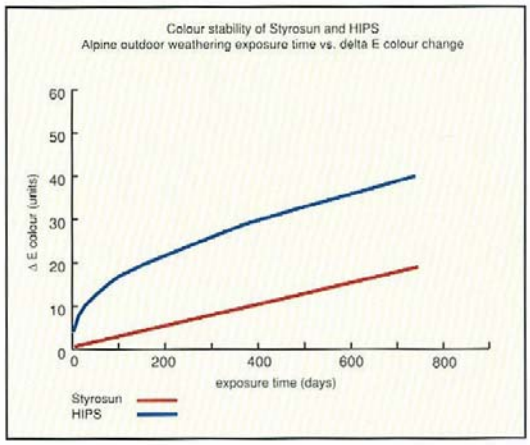
Properties

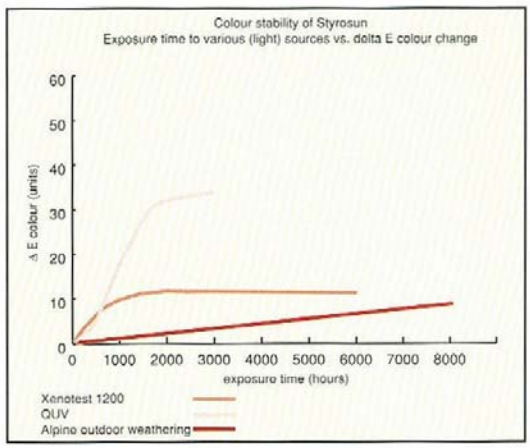
The impact resistance of Styrosun remains sufficiently high during its entire lifespan, in spite of continuous exposure to sunlight. In contrast, ABS and HIPS lose their impact resistance abruptly after only a few hundred hours of exposure to ultraviolet light, which limits their practical lifespan. Styrosun, however, is much more durable.

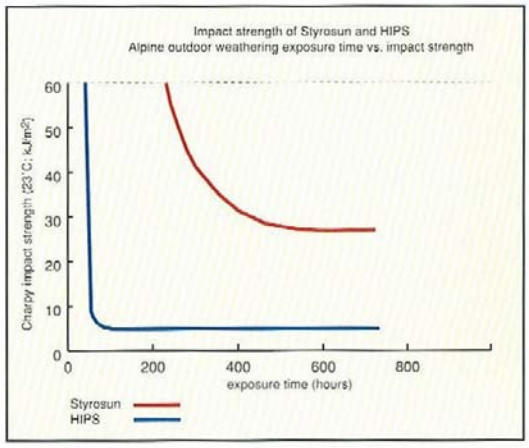
Styrosun, with a chemical blowing agent, can be extruded to form structural foamed sheets. These sheets are lightweight yet strong and may be used to replaced wooden components. They can be worked on with standard woodworking tools.

Because of its excellent flow characteristics, Styrosun is also suitable for injection moulding, both with and without the use of a blowing agent. This makes it an ideal material for the production of parts with complicated shapes.

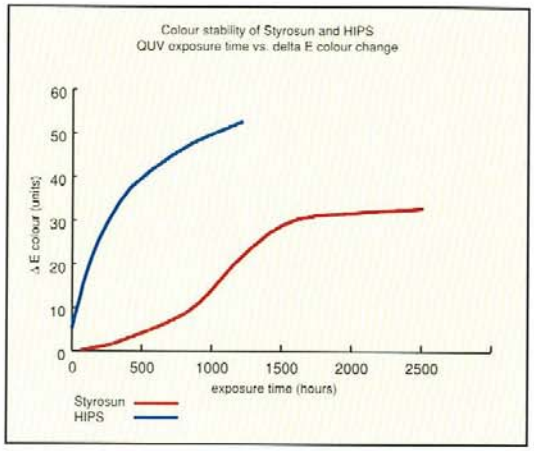
Due to its nature and relative high rubber content, Styrosun maintains its impact resistance over a wide temperature range, from 70°C down to -30°C.
The graphs show a comparison between Styrosun 6600 and regular HIPS in different tests. Weather resistance is a combination of resistance to ultraviolet light, temperature changes, oxidation by exposure to air and resistance to moisture. For most materials, weather resistance depends on local conditions of light spectrum and intensity. For instance, in mountainous areas or in the desert, temperature differences between day and night are much



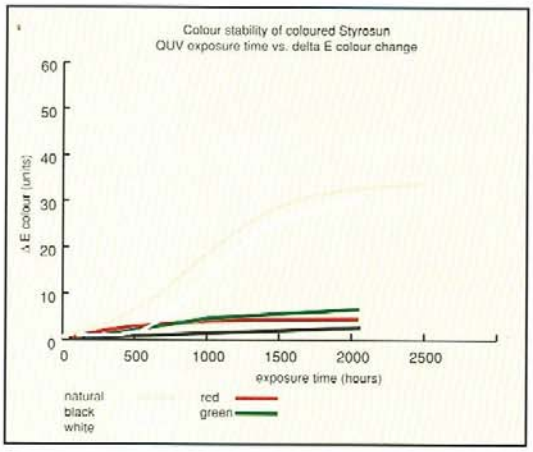


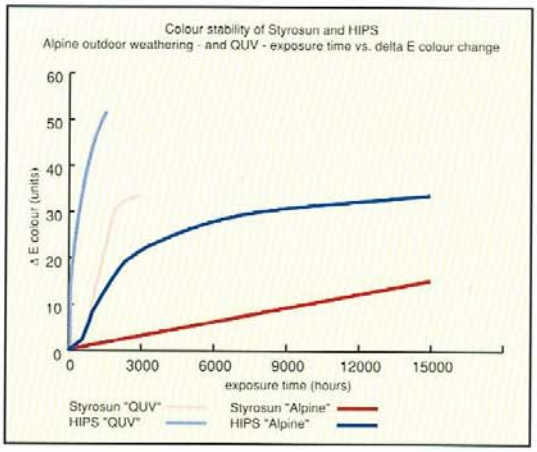


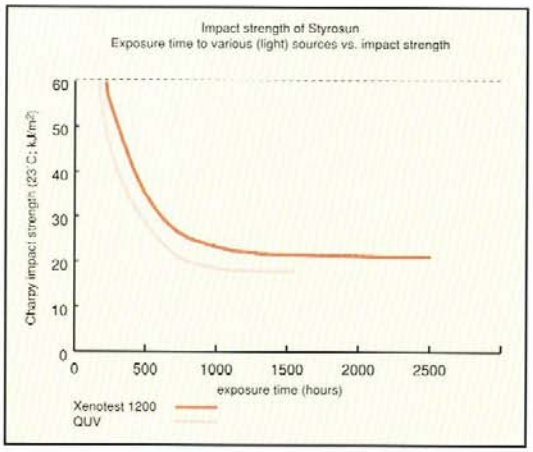
Appendix 2, continued...



more extreme than at sea level in temperate climates. Moisture plays a more important role in



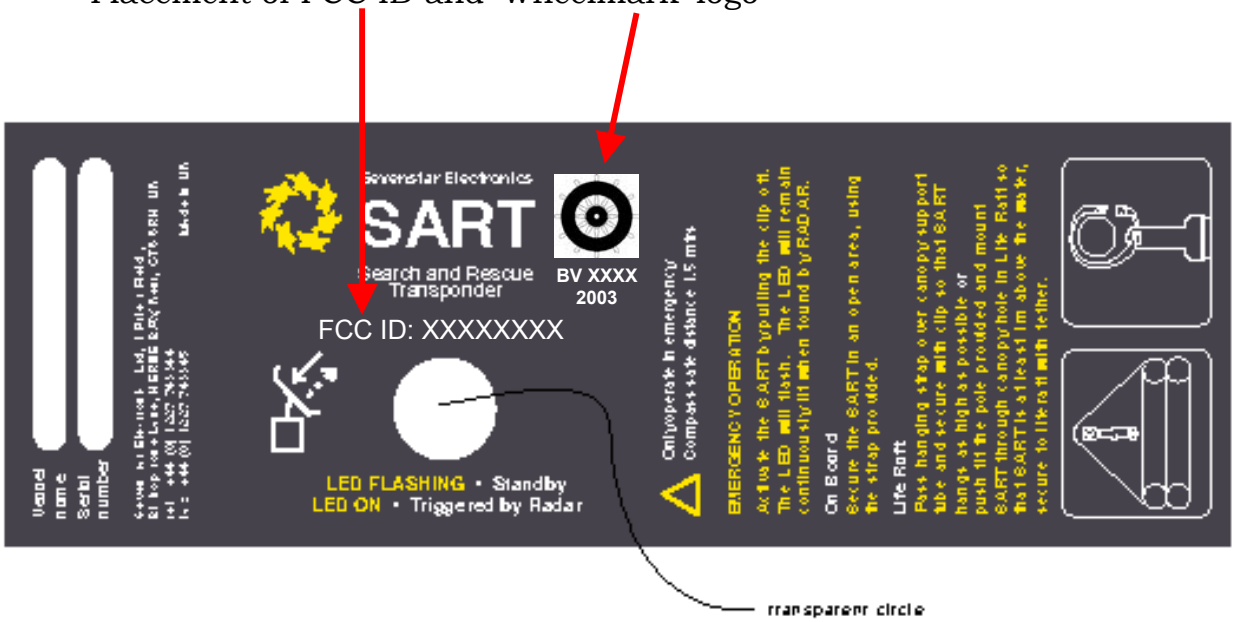




sea climates. Correct maintenance, in particular regular cleaning, also has a positive influence on the functional lifespan of a product made from Styrosun. Thus, laboratory tests do not always provide absolute information about the actual performance of materials in the field.
Both the laboratory tests and the field exposure tests show, however, that Styrosun is superior to regular HIPS and ABS in retaining impact strength and colour. As these materials have roughly comparable mechanical properties when new, and may be processed by the same technologies, the choice is clear when a product is manufactured for outdoor use. Its functional lifespan may be multiplied 8 to 25 times by choosing Styrosun over HIPS or ABS.

Appendix 3 S.701 SART Labels and Marking

Placement of FCC ID and 'Wheelmark' logo

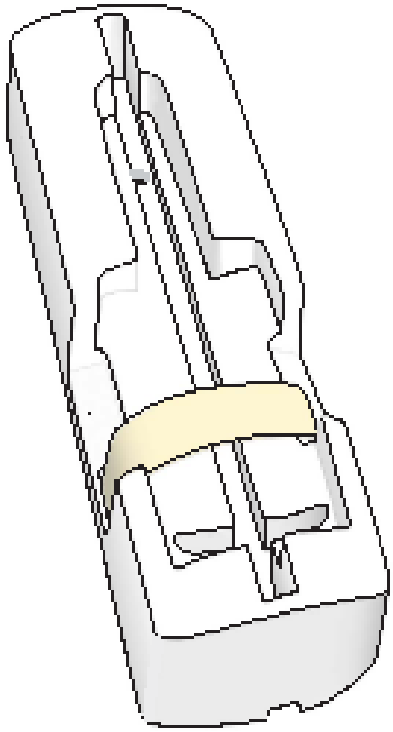


Note:

Considerable attention has been paid in designing the label set to give clear, intuitive instructions and information. The 'Wheelmark' symbol and other specific approval related information will be added when available.

Appendix 4 Mounting Bracket and Pole (option)

Showing the S.701 SART attached to its extended telescopic mounting pole (Option)



The SART Mounting Bracket

Hanging strap neatly stowed behind SART

Ergonomic design allows ready access when needed, even with gloved hands

Retaining strap

Simple interlock design means that SART cannot be turned ON accidentally while in the bracket

Appendix 5 Manufacturing, Testing and Inspection

The S.701 SART from SevenStar Electronics Ltd has been designed to fully benefit from modern manufacturing techniques, processes, components and materials. The circuit board uses surface-mount techniques throughout, including the automatic 'pick and placing' of ALL components (excluding one connector) – this generates a very high degree of consistency and repeatability in both the build quality and the unit performance.

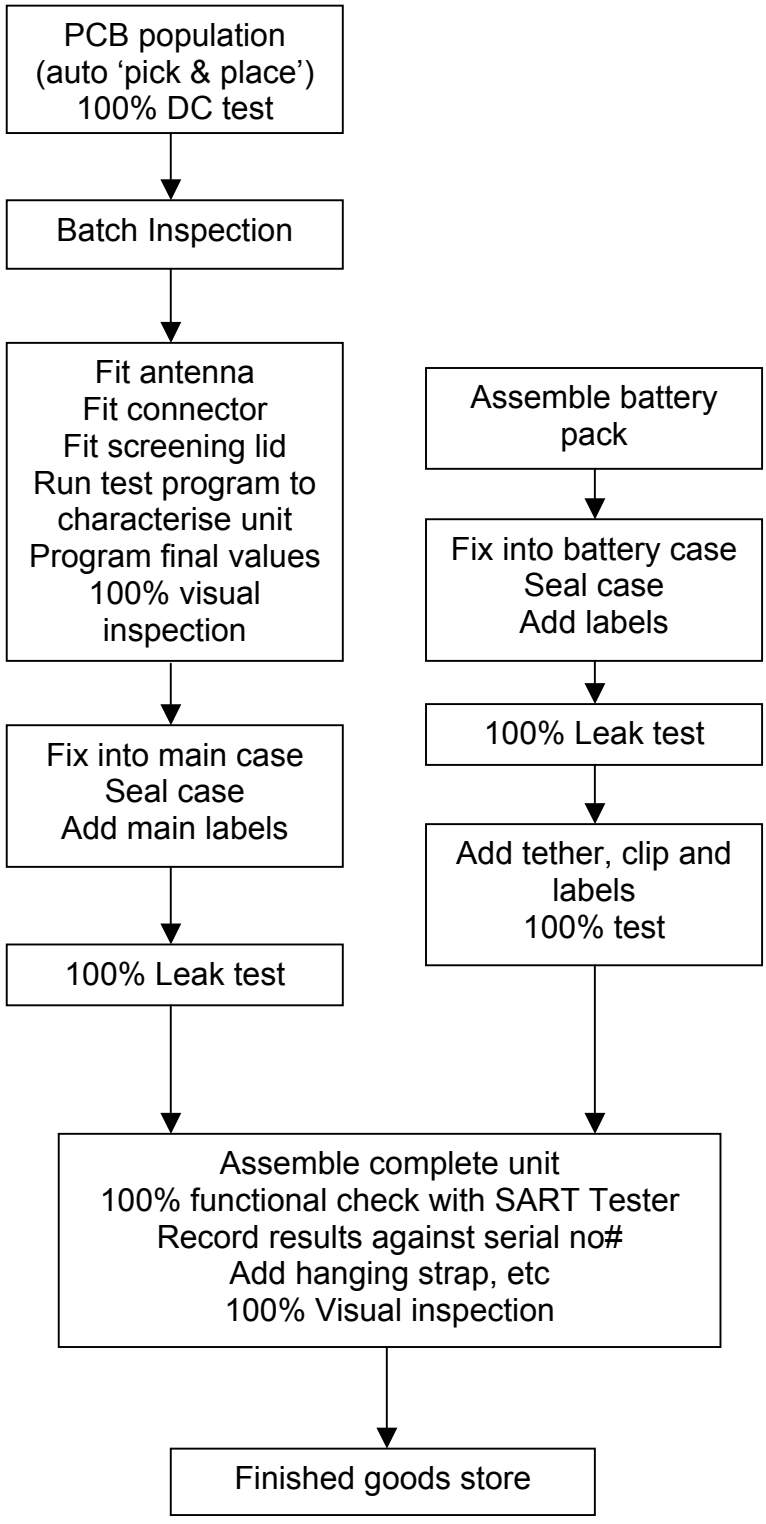
We have carefully avoided the use of highly integrated circuit blocks in the RF/microwave section, as these tend to be highly stressed elements, and lead to excessive placement and soldering requirements that can reduce overall yield and reliability. We have designed a simple yet elegant electronics package that eliminates the use of adjusting components (such as 'trimmer' capacitors or potentiometers, which can cause performance to drift or fail altogether), which again maximises reliability.

And our use of crystal controlled, digitally stored frequency parameters and timing guarantees high levels of consistency over temperature and lifetime.

Our Manufacturing, Test and Inspection plan is based around this simple yet advanced build standard. It naturally uses ISO 9001:2000 as the core. Every unit will be leak tested and tested for electrical compliance at room temperature. Sample(s) from each manufacturing batch will be tested at the temperature limits to verify that our temperature compensation algorithm remains accurate. Normal AQL methods will be used to determine batch sizes to test. Goods from sub-contractors will be batch inspected according to the appropriate AQL levels.

Appendix 5 – continued

MTI Flow Chart



Appendix 6 – BS EN ISO9001:2000 Accreditation

Certificate of Registration

This document certifies that the quality administration systems of

SEVENSTAR ELECTRONICS LTD

have been assessed and approved by CQS Certified Quality Systems Limited to the following Quality administration systems, standards and guidelines:

BS EN ISO 9001 : 2000

The approved quality administration systems apply to the following:

SALE AND MANUFACTURE OF ELECTRONIC EQUIPMENT

Certificate issued	*20th February 2003*
Certificate expiry	*19th February 2013*
Certificate number	GB2000470

On behalf of CQS Certified Quality Systems

IQA

This Certificate remains valid while the holder maintains their quality administration systems in accordance with the standards and guidelines above, which will be audited by CQS Certified Quality Systems Limited.
This Certificate remains the property of CQS Certified Quality Systems Limited and must be returned in the event of cancellation.

Appendix 7

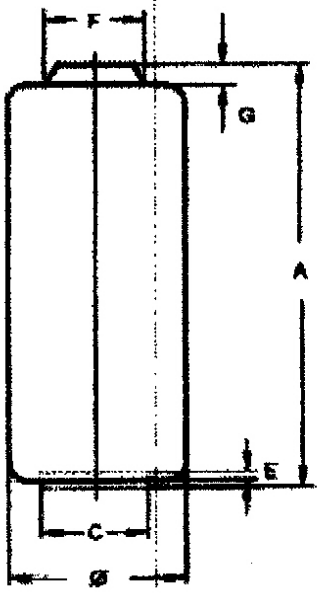
Example Data Sheet from one manufacturer of '123A' type cell

VARTA
DIE BATTERIE-EXPERTEN

Data Sheet **6205**
Photo

Recommended Application Photo

Type Designation	CR 123 A
Designation IEC	CR 17345
System	Li-MnO_2
Shelf Life *	10 years
Nominal Voltage [V]	3
Typical Capacity C [mAh]	1300 (Load 200 Ω at 20° C down to 1.8V)
Permissible Temperature Range	- 20 °C ... 70 °C
Weight, approx. [g]	17
Volume [ccm]	7



Dimensions [mm]

	min:	max:
Ø	16.8	17.0
A	33.5	34.5
C	11.9	-
E	0.5	0.9
F	-	9.6
G	1.0	-

Typical Capacities (at 20°C)

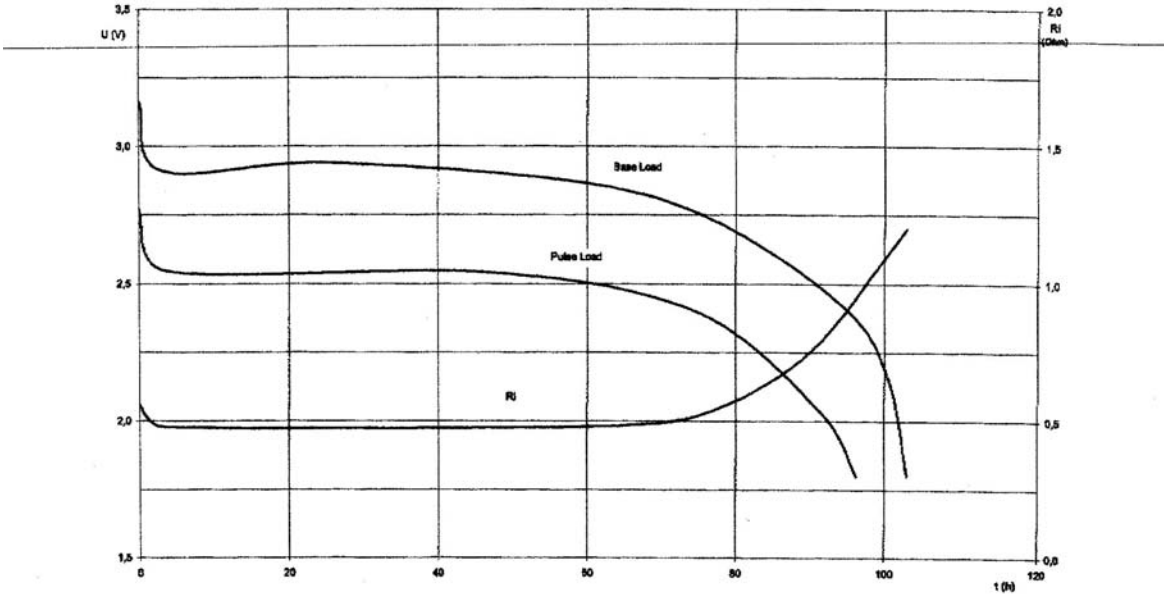
Discharge Type	Load	End Voltage[V]	2.0	1.8
Pulse Test	3.9 Ω	Time [cy]	424.00	440.00
15s/m, 7d/w		Capacity [Ah]	1.14	1.18
		Energy [Wh]	2.89	2.96
Discharge Type	**Load**	**End Voltage[V]**	**2.0**	**1.8**
Service Output Test	200 Ω	Time [h]	85.40	85.90
24h/d, 7d/w		Capacity [Ah]	1.21	1.22
		Energy [Wh]	3.45	3.46

Appendix 7 – continued

VARTA
DIE BATTERIE-EXPERTEN

Discharge Curve **6205** Photo

Internal Resistance at Continuous 200 Ω, 1s/1h 3.9 Ω



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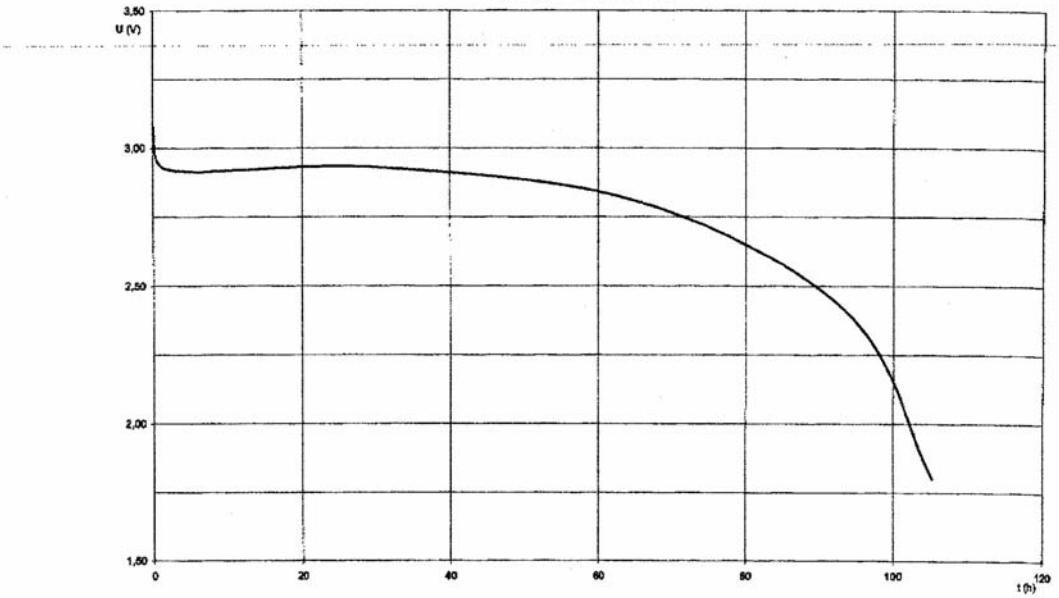
VARTA
DIE BATTERIE-EXPERTEN

Discharge Curve **6205** Photo

Continuous - 200 Ω



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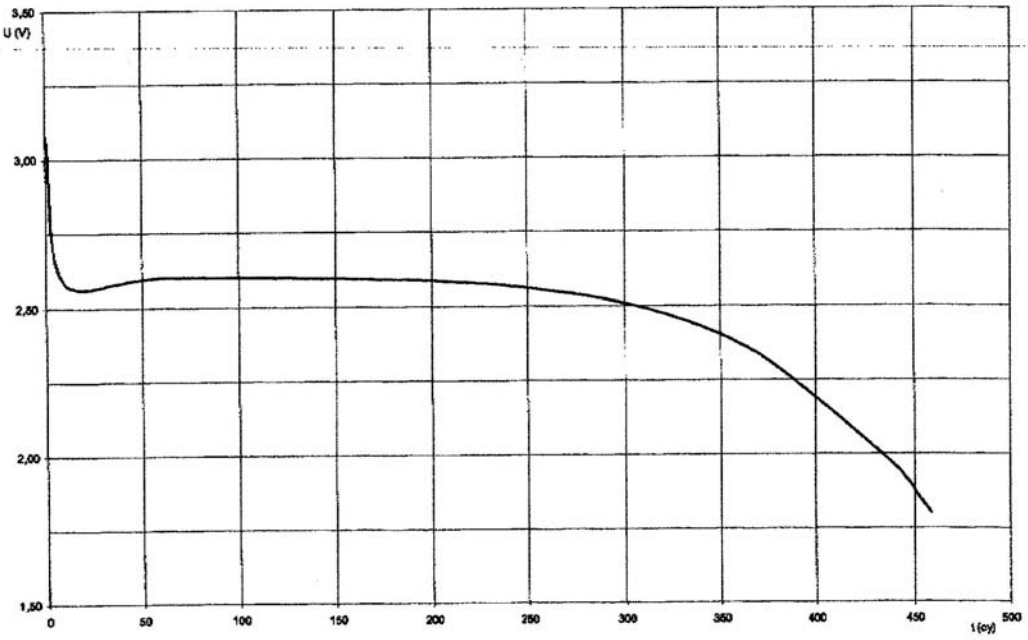
Appendix 7 – continued

VARTA
DIE BATTERIE-EXPERTEN

Discharge Curve **6205** Photo

Discontinuous 15s/m - 3.9 Ω



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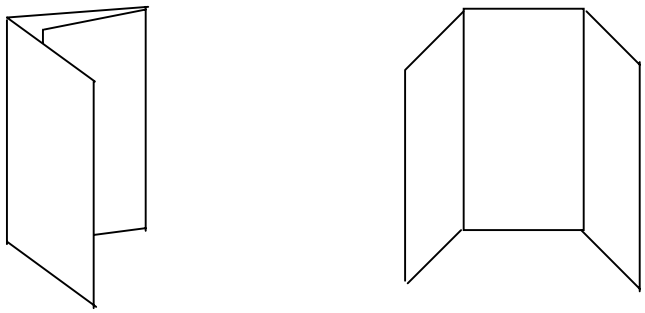
Appendix 8 – User Guide

To satisfy the requirements for providing clear instructions for installation, maintenance and usage, and yet have these instructions readily available at all times, SevenStar are providing these in the form of a simple User Guide, as shown in this appendix. Rather than produce a thick document that tells you how a SART works, SevenStar have concentrated on a simple User Guide that is **clearly worded** in English, and has **simple diagrams** to ensure the user understands what he has to do, particularly in the event of an emergency.

The S.701 User Guide will be produced as a twice-folded 'brochure', which can be conveniently stored for easy access. The material chosen is both water and oil proof, and has, for example, been used by the RNLI for similar documents.



[Insert User Guide after this page]