ORGANISATION EUROPEENNE POUR LA RECHERCHE NUCLEAIRE
EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Laboratoire Européen pour la Physique des Particules
European Laboratory for Particle Physics

Market Survey

MS–????/??/ATL

Supply of packaged VCSELs and PIN photodiodes for the SCT and the Pixel Detector of the ATLAS Detector

Original: English
TA1 Group

Contains:

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Abstract

The purpose of this Market Survey is to establish a list of firms able to supply approximately 6500 on- detector opto-packages containing 2 VCSELs (Vertical Cavity Surface Emitting Lasers) and 1 PIN photodiode, and approximately 2500 on-detector opto-packages containing 1 VCSEL and 1 PIN photodiode. It is planned to pigtail these packages with radiation hard pure Si fibres (SIMM 50/60/125/250), and optically couple them to 12 way fibre ribbons using standard MT connectors.

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General Description

1. Introduction

CERN is one of the world's largest scientific laboratories and an outstanding example of international collaboration of its many member states. The LHC project, a large proton-proton collider, was approved in 1994 by CERN. The LHC will be the next major research tool for world particle physics and it is planned to be operating in 2005. ATLAS is one of the two general purpose experiments, which will be installed on this accelerator. Its Inner Detector (ID), consisting of three sub-detectors, is situated closest to the interaction point and provides tracking information. Two of the components of this inner detector are the SemiConductor Tracker (SCT) and the Pixel Detector. The innermost Pixel Detector is surrounded by the SCT, and both semiconductor detectors consist of a barrel and a forward region.

The baseline for the data transfer is on-detector packaged optical links with Vertical Cavity Surface Emitting Lasers (VCSELs) as optical sources and PIN photodiodes as detectors. These devices have to be non-magnetic, operate in a high radiation environment and have low mass. Approximately 6500 packages are required containing 2 VCSELS and 1 PIN photodiode, and a further 2500 mechanically similar packages, but now containing only 1 VCSEL and 1 PIN photodiode. Development work on pigtailing such devices with radiation hard pure Si fibre (SIMM 50/60/125/250) and optically coupling them to multi-fibre ribbons using MT connectors is in progress. These issues will require detailed technical discussions and close collaboration between the user and the company.

2. Scope of the Market Survey

The purpose of this market survey is to identify companies specialised and experienced in the manufacture of optical packages containing Vertical Cavity Surface Emitting Lasers (VCSELs) and PIN photodiodes which meet the required specifications (see 3.1, 3.2 and 3.3).
CERN, on behalf of several of the collaborating Institutes of ATLAS, intends to issue an Invitation to Tender for approximately 6500 packages with 2 VCSELs and 1 PIN photodiode, and 2500 similar packages with 1 VCSEL and 1 PIN photodiode. CERN requests that the tender action quotes separately for the 6500 and 2500 packages but also includes a combined quote. The forthcoming Invitation to Tender shall only be sent to companies that have thoroughly answered the Questionnaire and have fulfilled the Qualification Criteria of this Market Survey.

3. Technical Description of the Supply

3.1 Opto-Package Specifications

Introduction

This note gives the specifications for the on-detector opto-packages for the SCT and Pixel detectors. Detailed specifications are given for the VCSELs, the PINs and for the environmental and radiation conditions in which the opto-packages have to operate.

VCSELs

The specifications for the VCSEL bare die are given in Table 1 below (certain parameters would be tested on bonded die, as part of a batch screening sequence):

Table 1 VCSEL die specifications

Parameter	Minimum	Typical	Maximum	Units	Notes
Wavelength	820	840	860	nm	
Output power	600	1000	3000	µw	Measured with large area photo-detector @10 mA input current (pre-irradiation)
Slope efficiency	100			µw/mA	As above
Beam angular divergence			12	degrees	Unlensed
Threshold current	2	3	6	mA	
Allowed input current			25	mA	
Forward voltage		2	2.5	V	@20 mA
Reverse voltage			2	V	
Rise/fall time (20%-80%)		<1	2	ns	
Device reliability			1400	FIT	15^0C worst case operating temperature. @ 10 mA input current

FIT(failures in 10^9 operating hours) has been calculated to allow for up to 1% failures over the lifetime of ATLAS(10^8 seconds; an ATLAS year is defined to be 10^7 seconds).

The specifications for the VCSELs in opto-packages are given in Table 2 below:

Table 2 Opto-packaged VCSEL specifications

Parameter	Minimum	Typical	Maximum	Units	Notes
Wavelength	820	840	860	nm	
Output power	300		3000	μw	Coupled into 50/125 μm multimode fibre @10 mA input current (pre-irradiation)
Slope efficiency	50			μw/mA	Coupled into 50/125 μm multimode fibre
Threshold current	2	3	6	mA	
Allowed input current			25	mA	
Forward voltage		2	2.5	V	@20 mA
Reverse voltage			2	V	
Rise/fall time (20%-80%)		<1	2	ns	
Output power after irradiation	300			μw	Coupled into 50/125 μm multimode fibre @10 mA input current
Device Reliability			1400	FIT	15^0C worst case operating temperature @10mA input current

PINs

The specifications for the PINs are given in Table 3 below (certain parameters would be tested on bonded die, as part of a batch screening sequence):

Table 3 PIN specifications

Parameter	Minimum	Typical	Maximum	Units	Notes
Wavelength	820	840	860	nm	
Input saturation power	3			mW	
Responsivity	0.4	0.5		A/W	Pre-irradiation
Dark current		<1	50	nA	Pre-irradiation @-5V
Reverse voltage		1	5	V	Voltage required for complete signal collection (pre-irradiation)
Breakdown voltage	30			V	Absolute maximum
Diameter of active area	100			μm	
Capacitance		2	3	pF	Measured at 1V bias.
Rise/fall time (20%-80%)		<1	2	ns	
Radiation resistance (a)			40	%	Decrease in responsivity post-irradiaition, for bias voltage < 10V
Radiation resistance (b)			10	μA	Leakage current at bias voltage sufficient to satisfy responsivity, worst case T=15^0C
Device Reliability			350	FIT	15^0C worst case operating temperature

3.2 Package and Environment

Materials

The package should be made from materials with low Z (minimal radiation length requirement) non-magnetic and be radiation resistant

Dimensions

The package should be no larger than 5.5x5.5x1.6 mm^3

Environmental Conditions

Operating temperature during testing: -25^0C to 40^0C.
Operating temperature in ATLAS: - 25^0C to 15^0C
Radiation environment:
500 KGy(Si)
1 MeV equivalent neutron fluences:
for Si devices: 10^{15} n/cm^2
for GaAs (or InGaAs or AlGaAs): 6.4 10^{15} n/cm^2

Magnetic field: 2T

Cross-Talk

When operated with VDC and DORIC4A chips the cross-talk should not cause a BER > 10^{-9} with input optical power of 200 µW at the PIN diode of the TTC link and 20 mA drive current for the VDC outputs. Pseudo-random data for TTC link and asynchronous 40 MHz clocks for VDC. This specification ensures that the cross-talk is negligible even for the worst case conditions (minimum optical power into the PIN and maximum drive current out of VDC).

3.3 Device Reliability

The required reliability tests for dice of VCSEL and PIN are given in Table 4 below:

Table 4 Reliability of bare die.

Parameters	Reference	Condition	Sample Size
Die shear	MIL-STD-883 Mothod 2019		
Wire bond strength	MIL-STD-883 Mothod 2011	5 g	
Accelerated ageing (High Temperature)		85^0C, rated power, 5000 hr.(*1)	25(for ref)

The required reliability for opto-packages are based on telecommunication standards modified for the ATLAS operating conditions are given in Table 5 below:

Table 5 Opto-package reliability.

The opto-packages will be in a dry Nitrogen atmosphere during ATLAS operation. It is assumed that a low humidity will be maintained during the assembly process.

Parameters	Reference	Condition	Sample Size
Vibration		10G 20-2000Hz 4 min/cy, 4 cy/axis	11
Fibre Pull		0.2kg, 3 times, 5sec	11
Accelerated Ageing (High Temperature)		60^0C , rated power, 1000 hr.	25(for ref)

High Temperature Storage		60^0C, 100 hr	11
Low Temperature Storage		-20^0C, 100 hr	11
Temperature Cycling	MIL-STD-883 Mothod 1010	-10^0C - 60 ^{0}C, 500 cycles	11

Quantity and Delivery

4.1. Quantity and Extent of the Supply

The supply consists of:

The production of approximately 6500 opto-packages(2 VCSELs and 1 PIN photodiode) and 2500 opto-packages(1 VCSEL and 1 PIN photodiode) as specified above.

4.2. Provisional Delivery Schedule

The year foreseen for tendering and adjudication is 2000. The delivery for the SCT and PIXELs is anticipated through the years 2001 – 2002.

5. Person in Charge for Technical Aspects

Dr A.R. Weidberg Tel: 44(0)1865 273370
Fax: 44(0)1865 273418
E-mail: t.weidberg1@ph.ox.ac.uk

Qualification Criteria

In order to be considered as a possible bidder for the forthcoming Invitation to Tender, the company shall satisfy the criteria specified below.

(a) The company should have proven experience in the production of packages of VCSEL and PIN devices with a radiation wavelength of about 850 nm.
(b) The company should be able to prove their experience in the field by providing 6 samples of such packaged components within 12 weeks upon request from CERN. The company must demonstrate that it has the capacity for delivery of opto-packages that meet the requirements of 4.1 and 4.2.
(c) The annual turnover should be greater than 1.2 MSFr in the year 1999.
(d) The company must be registered in one of the CERN Member States or in one of the countries collaborating in ATLAS (see document DG/ATL/98-13).
(e) A registered Quality Assurance Plan meeting the requirements of ISO9000 or a national equivalent.

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Original: English
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Questionnaire

(To be returned in duplicate, by the companies interested in tendering)

Company ....

<u>Company:</u>

Name: ....

Address: ....

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Commercial Contact Person ....
Telephone Number ....
Fax Number ....
Electronic Mail ....

In case of absence:

Commercial Contact Person ....
Telephone Number ....
Fax Number ....
Electronic Mail ....

Technical Contact Person ....
Telephone Number ....
Fax Number ....
Electronic Mail ....

In case of absence:

Technical Contact Person ....
Telephone Number ....
Fax Number ....
Electronic Mail ....

1. General Information

1.1. Are you interested in receiving the Invitation to Tender ?

❑ Yes ❑ No

1.2. Financial information

When established: ....
Registered capital: ....
Number of employees in 1998: ....
Turnover in 1998: ....

1.3. Would you sub-contract part of the work ?

❑ Yes ❑ No

If yes, please specify which part of the work that would be sub-contracted, and give the name, address, person in charge and the telephone number of the potential sub-contractors:

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1.4. Have you previously replied to a CERN call for tender?

❑ Yes ❑ No

If yes, specify for which product(s):

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2. Qualification Criteria

i. Does your company comply with the qualification criteria stipulated in this market survey?

❑ Yes ❑ No

If not, indicate in what respects:

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3. Further Technical Information

i. Give details of your experience in manufacturing VCSEL and PIN photodiode packages with a radiation wavelength of about 850 nm.

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ii. Are you interested in producing opto-packages containing VCSELs and PIN photodiodes?

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iii. Can you prove your experience in the field by providing 6 samples of such VCSEL and PIN photodiode opto-packages within 12 weeks upon request from CERN? (Qualification Criterion item (b)).

❑ Yes ❑ No

iv. Do you have a Quality Assurance Plan?

❑ Yes ❑ No

If yes, is it registered by an accredited body like ISO?

❑ Yes ❑ No

Indicate which one:

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4. Comments on the Product Requirements:

i. Are there points within the requirements that cause you particular concerns either technically or as cost-driving items?

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ii. General suggestions from the company:
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iii. Questions from the company:
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Date *Company seal and signature*