-SQA-SCOTTISH QUALIFICATIONS AUTHORITY

HIGHER NATIONAL UNIT SPECIFICATION

GENERAL INFORMATION

-Unit number-	**D6NL 04**
-Unit title-	**RADIO FREQUENCY GENERATION FOR SEMI-CONDUCTOR FABRICATION**
-Superclass category-	**XM**
-Date of publication- (month and year)	**APRIL 2001**
-Originating centre for unit-	**SQA**

-DESCRIPTION-

GENERAL COMPETENCE FOR UNIT: Applying radio frequency principles to the operation and maintenance of semi-conductor fabrication processes involving radio frequency powered plasmas.

OUTCOMES:

1. apply the principles of radio frequency (r.f.) generation, amplification and power transfer to radio frequency powered semi-conductor fabrication processes;

2. evaluate the performance of radio frequency (r.f.) powered semi-conductor fabrication processes.

CREDIT VALUE: 0.5 HN Credit

ACCESS STATEMENT: Access to the unit is at the discretion of the centre. However it would be beneficial if the candidate had basic competence in A.C. theory. This may be evidenced by possession of National Certificate Module E9SO 12 Single Phase A.C. or similar qualification or experience.

Additional copies of this unit can be obtained from:

The Committee and Administration Unit, SQA, Hanover House, 24 Douglas Street, Glasgow G2 7NQ, (Tel: 0141-242 2168).

At the time of publication the cost is £2.50 per unit (minimum order £5.00).

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STATEMENT OF STANDARDS

Unit number: D6NL 04

Unit title: RADIO FREQUENCY GENERATION FOR SEMI-CONDUCTOR FABRICATION

Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

OUTCOME

1. APPLY THE PRINCIPLES OF RADIO FREQUENCY (R.F.) GENERATION, AMPLIFICATION AND POWER TRANSFER TO RADIO FREQUENCY POWERED SEMI-CONDUCTOR FABRICATION PROCESSES

PERFORMANCE CRITERIA

(a) Description of the principles of operation of an r.f. oscillator and an r.f. amplifier is correct.
(b) Description of principles and applications of r.f. matching to semiconductor fabrication equipment is correct.
(c) Explanation of the characteristics and operation of a loss free transmission line when terminated by a matched load and unmatched loads is correct.
(d) Description of safety and environmental issues related to r.f. generation is correct.

RANGE STATEMENT

Principles of r.f. matching: maximum power transfer; reactive and resistive loads; impedance transformation.

Applications of r.f. matching: operation of automatic matching units; load presented by a plasma chamber.

Transmission line characteristics: impedance; attenuation; voltage rating.

Transmission line operation: forward and reflected power; standing waves.

Safety issues: lockout-tagout procedures; workplace procedures; danger of shock from high r.f. voltages; danger of r.f. burns; skin and eye exposure.

Environmental issues: radio frequency interference; electromagnetic compatibility.

EVIDENCE REQUIREMENTS

Written and/or oral evidence to demonstrate understanding r.f. generation, amplification and matching in r.f. powered semiconductor fabrication processes.

Written and/or oral evidence of ability to explain the characteristics and operation of transmission lines.

Written and/or oral evidence to demonstrate knowledge of safety and environmental issues related to r.f. generation.

OUTCOME

2. EVALUATE THE PERFORMANCE OF RADIO FREQUENCY (R.F.) POWERED SEMI-CONDUCTOR FABRICATION PROCESSES

PERFORMANCE CRITERIA

(a) Measurements of radio frequency power using an in-line power meter with dummy load are correctly and safely carried out.
(b) Matching of an r.f. generator to a variety of loads is correctly carried out using a manually adjusted matching unit.
(c) Diagnosing causes and proposing remedial action from the symptoms of common fault conditions in r.f. powered semiconductor fabrication processes is correct.

RANGE STATEMENT

Measurements: forward power; reverse power.

Safe measurement: risk assessment consulted and procedures followed; all connections correctly made; power only applied once all connections made; power switched off before any disconnections.

Loads: resistive; low impedance (<30Ω) capacitive.

Symptoms: absence of r.f. power; power output of generator too high or low; arcing or flickering of plasma; matching system overshoots and oscillates; reflected power in transmission line cannot be reduced to an acceptable level; overheating of cable or connectors between matching network and chamber; matching network cannot be tuned in one direction.

EVIDENCE REQUIREMENTS

Performance/written evidence of the candidate's ability to perform practical r.f. measurements and matching.

Written evidence of identification of fault conditions and possible remedies.

MERIT STATEMENT: To gain a pass in this unit, a candidate must meet the standards set out in the outcomes, performance criteria, range statements and evidence requirements.

To achieve a merit in this unit, a candidate must demonstrate a superior or more sophisticated level of performance. In this unit this might be shown in the following ways:

- diagnosing causes and proposing remedial action from the symptoms of common fault conditions in r.f. powered semi-conductor fabrication processes.

ASSESSMENT

In order to achieve this unit, candidates are required to present sufficient evidence that they have met all the performance criteria for each outcome within the range specified. Details of these requirements are given for each outcome. The assessment instruments used should follow the general guidance offered by the Scottish Qualifications Authority (SQA) assessment model and an integrative approach to assessment is encouraged. (See references at the end of support notes).

Accurate records should be made of the assessment instruments used showing how evidence is generated for each outcome and giving marking schemes and/or checklists, etc. Records of candidates' achievements should also be kept. These records will be available for external verification.

SPECIAL NEEDS

Proposals to modify outcomes, range statements or agreed assessment arrangements should be discussed in the first place with the external verifier.

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SUPPORT NOTES

Unit number: D6NL 04

Unit title: RADIO FREQUENCY GENERATION FOR SEMI-CONDUCTOR FABRICATION

SUPPORT NOTES: This part of the unit specification is offered as guidance. None of the sections of the support notes is mandatory.

NOTIONAL DESIGN LENGTH: SQA allocates a notional design length to a unit on the basis of time estimated for achievement of the stated standards by a candidate whose starting point is as described in the access statement. The notional design length for this unit is 20 hours. The use of notional design length for programme design and timetabling is advisory only.

CONTENT/CONTEXT The unit should be delivered in the context of r.f. generators in current use in industry and reference should be made to appropriate equipment manuals.

During delivery of the unit, there would be advantage in including a brief overview of the processes, equipment and related frequencies which are r.f. powered.

Corresponding to outcomes:

Outcome 1

A qualitative approach is intended.
Oscillators might include L-C and quartz crystal types in the Colpitts, Hartley and Pierce configurations utilising solid state devices (FET and bipolar transistors) only.
The use of integrated circuit R-C governed oscillators for frequencies in the range 100kHz – 500 kHz could also be covered.

r.f. amplifiers classified by purpose (buffer, driver and power amplifiers); class of operation (A, AB, B and C); interstage coupling (broadband and narrowband) and restricted to solid state devices only (FET and bipolar transistors). Reference could be made to methods of combining devices (parallel and push-pull operation) and the use of combiners in power amplification stages.
Valve power amplifiers are likely to be used in some applications for some years yet, and could be included if additional time was available for delivery.

Transmission line characteristics may be restricted to coaxial cable. The generation of standing waves when a line is mismatched and the subsequent impedance transformation effects can be covered in a qualitative treatment and it is suggested that this include such examples as quarter wavelength open and short circuited lines. The treatment could include the effects of varying length of line in matched and unmatched conditions.

Safety issues should pertain largely to I.f., m.f. and h.f. frequencies but should include a brief treatment of the extra issues pertaining to microwaves.

Reference may also be made to U.K. and European legislation on radiation protection and electromagnetic compatability.

Outcome 2

Measurement techniques include correct interconnection of matching unit, in-line power meter and dummy load, correct selection of r.f. head in terms of frequency and power rating, correct selection of dummy load in terms of power rating and checking calibration certification of power meter.

The manual operation of the matching unit should follow the same sequence of operations as an automatic unit.

The fault symptoms specified in the range statement may each have a variety of possible causes and remedies. These should be fully covered.

ASSESSMENT PROCEDURES Corresponding to outcomes:

Outcome 1

Performance Criteria (a), (b) and (c) could be assessed by short answer questions. For (a) and (b) questions could relate to equipment, circuits and their associated diagrams in equipment manuals.

Assessment of Performance Criterion (d) could take the form of restricted response questions.

Outcome 2

Performance Criterion (c) could be assessed by use of matching questions in which common fault conditions, their symptoms and possible remedies are correctly related. Satisfactory performance of this criteria would be the correct correlation of each symptom with one fault condition and the specification of an appropriate remedy.

Merit performance would be evidenced by the correct specification of more than one cause (where appropriate) for each fault condition together with an appropriate remedy.

REFERENCES

1. Guide to unit writing, SQA, 1993 (Code: A018).
2. Guide to assessment, SQA, 1993 (Code: B005).
3. Guide to certification, SQA, 1996 (Code: F025).
4. Notes for unit writers, SQA, 1995 (Code: A041).

For details of other SQA publications, please contact staff in the Sales and Despatch section (Tel: 0141-242 2168) who can supply you with a copy of the publication list (Code: X037).