Appendix

Technical file provided for CE declaration of conformity

1 System Description

ST Robotics produces a range of "bench-top" robots with applications in educational establishments, laboratories and factories.

Three basic types of robot are produced differing in the geometry of the mechanical parts of the robot but having similar controller electronics and software. The maximum pay-load is 10kg but is usually less than 2kg and maximum velocity of the work-piece is 2m/s but is usually less than 1m/s. All robots are driven by stepper motors with feedback from encoders to check that the required movement is obtained.

The controller uses 2 microprocessors which drive the motors via power amplifiers. Sensors are used to calibrate the position of the robot axes and feed-back is obtained via shaft encoders.

Special end effectors are attached to the robot according to the user's requirements. These are typically low power pneumatic or electro-mechanical actuators.

2 Normal Working Practices

In normal operation people are excluded from the hazard area around the robot by barriers. The hazard area includes the area which could be reached by the robot and by a work-piece dropped from the robot. This requires 1m clearance from the furthest reach of the robot in the direction of the maximum velocity of 2m/s.

The controller is provided with a circuit which can be connected to standard safety devices such as emergency stop button, light guard, safety switch, floor mat.

The controller is positioned outside the hazard area. There is no need to accesss the inside of the controller which is mains (240V / 110V) powered.

3 Abnormal Working Practices

Adjustments may have to be carried out on the end-effector or on the controller while these are powered. Only skilled or instructed persons will carry out these adjustments.

The specific hazard in working on the end-effector is that if the power fails part of the robot, the end-effector and work-piece could fall. Users are warned of this hazard.

4 List of Essential Health and Safety Requirements

This section lists the health and safety requirements relevant to the working practices as given above. References in () are to The Supply of Machinery (Safety) Regulations. The way in which the requirements have been met is outlined in the following Section 5.

4.1 This section outlines the obligatory requirements of section 1.1.2 of the Regulations.

4.1.1 Eliminate risk as far as possible by safe design and construction. (1.1.2a)

4.1.2 Take necessary protection measures against risks that cannot be eliminated.

Inform users of residual risks. (1.1.2b)

4.1.3 Warn users of the limitations of the robot. (1.1.2c)

4.2 This section outlines other regulations relevant to the foreseen use of the robots.

4.2.1 Make machine capable of being handled safely. (1.1.5)

4.2.2 Make control system safe and reliable in foreseeable work situations. (1.2.1)

4.2.3 Ensure that control devices are:
clearly visible and identifiable;
positioned for safe operation;
located outside danger zone except where necessary;
designed such that intentional operation is required to produce movement
and that:
when using a key-board the action to be performed is clearly displayed.
the control box is close to the barrier so that the operator has an unrestricted view of the danger area. (1.2.2)

4.2.4 The robot system can be started only by voluntary action at the controller. (1.2.3)

4.2.5 The robot system has a stop button which brings the machine to a stop. (Power may be removed by disconnection from the supply.) (1.2.4) (see EN60204-1)

4.2.6 Power supply failure should not produce a significant risk. (1.2.6)

4.2.7 Failure of the control circuit should not cause a significant risk. (1.2.7)

4.2.8 The software should be easy to use. (1.2.8)

4.2.9 The robots are designed and constructed to prevent hazards of an electrical nature. (1.5.1)

4.2.10 The robots are designed and constructed to prevent errors of fitting. (1.5.4)

4.2.11 The maintenance required for the robots is minimal and is carried out when the robots are disconnected from the electrical supply. (1.6)

4.2.12 Information relating to the control of the machine appears on screen. (1.7.0)

4.2.13 Warning is given of residual risks eg electrical. (1.7.2)

4.3 This section covers the marking and instruction as required in the regulations.

4.3.1 Marking is in compliance with 1.7.3.

4.3.2 Instructions are given in compliance with 1.7.4.

5 Methods of Eliminating Hazards

The primary method of eliminating hazards is to exclude people from the hazard area around the robot itself. The controller and other electrical parts of the system are built with due consideration of the requirements of EN60204 Safety of Machinery-Electrical equipment of machines. Thus under normal working there is negligable risk from the robot system.

Hazards may arise in abnormal working eg when a person is close to the robot and the robot is powered. A person working close to the robot will be skilled or instructed in the operation of the robot and possible hazards and will have direct control of the robot. Furthermore the small size and relatively low maximum velocity of the robot is unlikely to cause injury even if a person comes into contact with it. Thus taking all these factors into account the risk of injury to a person by a robot is felt to be acceptably small.

Additional measures taken to met the essential health and safety requirements are as follows. Refer to section 4 above for the health and safety requirements to be met.

5.1 The electrical system is built with EN60204 in mind. The part of the cabinet with mains powered components is not accessible to users: it has warning notices and tamper proof fixings.

The robot itself is robust and reliable and does not present a hazard.

5.2 When abnormally working close to a powered robot there is a risk that if the power fails parts of the robot and the work-piece will fall. Users are warned of this hazard.

Users are warned of residual risks:
of failure of the robot power supply as in 5.2;
of the need for care when disconnecting power to the controller;
of the possible loss of control of the robot if there is an attempt to exceed the maximum speed or acceleration rates or the maximum payload.

5.3 Users are warned of the limitations of the robot ie maximum load, maximum velocity and maximum acceleration.

5.4 The robot and controller can be handled separately, the weight of each is typically 25kg.

5.5 This hazard is small since people are not normally close to the robot when it is in motion. The risk of loss of control is minimal since the stepper motors driver circuits have to receive a pulse from the microprocessor system for each step of a stepper motor. After a sequence of steps the position reached by an axis of the robot is compared against the output from an encoder, the robot is stopped if the expected and actual positions do not agree.

If in abnormal working ie close to the robot, it is necessary to change the robots position the skilled or instructed person carrying out the work uses a special keypad at the place of

work which gives direct control of each axis of the robot. Thus the risk to this person is minimised.

Users are advised of the risk of power failure as in 5.2.

5.6 The cables connecting the control box and robot are normally about 3m in length. Hence in normal operation the operator will have a clear view of the hazard area and will be located outside the hazard area.

When a key-board is used the command words used indicate the action to be performed. Only skilled or instructed persons will carry out these operations. The key_pad which may be used by a person working close to the robot has specially marked keys.

5.7 The machine is started only by voluntary action ie typing a command word on the key-board, pressing a specific key on the key-pad.

5.8 The control unit has an stop button which terminates motion. Only a keyboard command can restart it.

When the controller goes into a stop condition the supply to the stepper motors is maintained so that the stepper motors are held in position. The risk of injury through removing power and allowing the motors to rotate freely would be higher than in the system used.

The stop button operates via the software. Whenever a pulse is generated to cause a motor to step the input from the stop button is sensed. Thus the motors will stop immediately the stop button is pressed.

There is a risk that a power failure could allow parts of the robot and the work-piece to fall as explained in 5.2. Risk of injury through this hazard is minimal.

5.9 Power supply failure will cause the controller and the robot to stop. Parts of the robot and the work-piece may fall slowly as in 5.2 above. The risk is minimal.

5.10 Failure of the microprocessor controller will cause the robot to stop since pulses will no longer be produced to cause the stepper-motors to move. A partial failure causing unpredictable movements is very unlikely since pulses have to be generated by the program in an orderly fashion to cause the motors to move.

The risk to people is minimal under normal conditions they are excluded from the hazard area.

In abnormal use the situation is improbable since the only a small amount of time is spent close to the robot while it is in motion. The risk of injury taking all factors into account is very small.

Safety usage of ST Robots
(per CE schedule 3, 1.7.4 and amendment 3.1e)
updated 04 Sept 2011

Foreseen use of the machinery, both normal use and use which could reasonably be expected

Putting into service
The robot should always be bolted down and not left free standing on the bench.
Install the robot where it does not interfere with the workspaces of human operators.

Use
When commanding the robot, especially when programming for the first time, keep one hand poised over the stop button to prevent any accident due to incorrect part or positioning of the robot.
Always test a new program at a low speed, say 1000

Handling
ST robot arms are characterised by having no stiffness when switched off and are thus difficult to carry as they are limp when carried. Always carry the robot with at least two hands. When putting the robot down take care not to trap fingers under the base.
The R12 weighs 12.8Kg
The R17 weighs 20.5Kg
The R19 weighs 14.5Kg
The controller weighs 11Kg

Adjustment
Normally no adjustments are necessary. However on occasion it may be necessary to adjust the chain tension of the R17. This should be done with power off according to instructions in the service manual.

Maintenance
No maintenance is necessary,

Equivalent continuous A weighted sound pressure level:
This is always less than 70dB(A), measured with Bruel & Kjær meter 1995.