AuthenTec, Inc.
Personal Security for the Real World™

Design Considerations for Integrating the FingerLoc Sensor in a Housing

Introduction

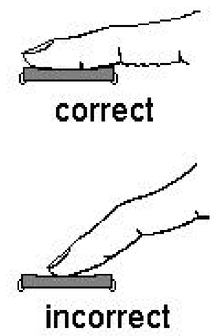
The AuthenTec FingerLoc sensor chip is designed to be easily integrated into many different types of designs, from laptop PCs to standalone access control applications. The purpose of this paper is to present a few design guidelines which will assist the user in the best way to integrate the sensor into a new product. These guidelines deal with the physical constraints imposed by the sensor packaging, best practices for dealing with environmental problems like impact damage and ESD, and the design of the finger groove to constrain movement of the user's finger to achieve the highest recognition rates possible.

Physical constraints

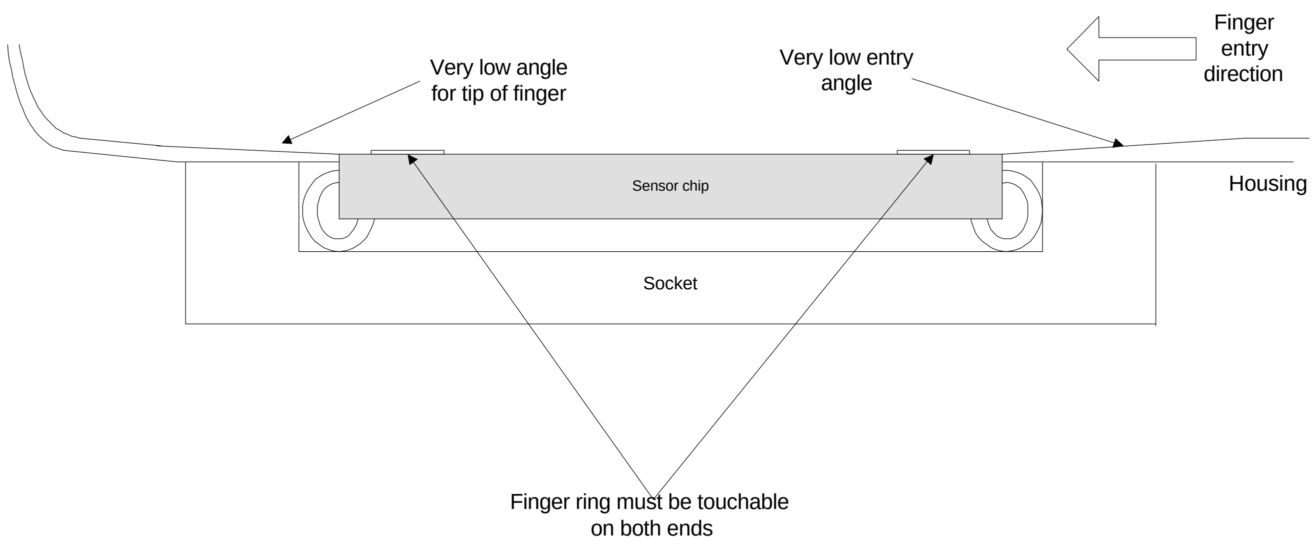
The sensor is packaged in a standard 68 lead PLCC package (see appendix). The package has the unusual feature that the top area of the integrated circuit die is exposed. The user's finger makes direct contact with the top surface of the silicon chip. This arrangement is necessary in order to image the fingerprint, but also potentially allows damaging environmental conditions to directly act on the surface of the chip. In addition, on the surface of the package there is a white or silver-colored **finger ring** which is used to make contact to the user's finger. This ring applies a very small electrical signal to the finger, which is necessary in order to image the finger.

The first two constraints that this packaging require are as follows:

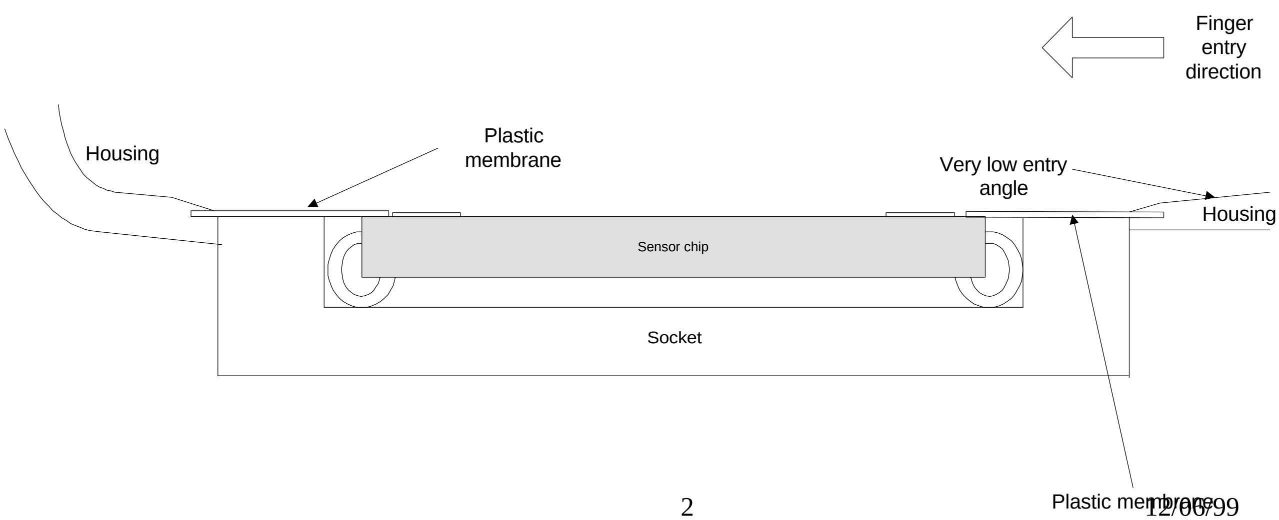
1) The user's finger must lie flat on the surface of the silicon. Housing which prevents the finger from lying flat will result in poor imaging.
2) The user's finger must be able to make contact with the finger ring. The ring must not be hidden by the housing. It is preferred that all four sides of the finger ring be exposed, but at a minimum the top and bottom of the ring should be exposed to the finger. Many users' fingers are too narrow to contact the sides of the finger ring, so partially covering the sides of the ring with the housing is acceptable.



In general, in order to meet these constraints, the housing must present a very low angle to the sensor package, as illustrated below:

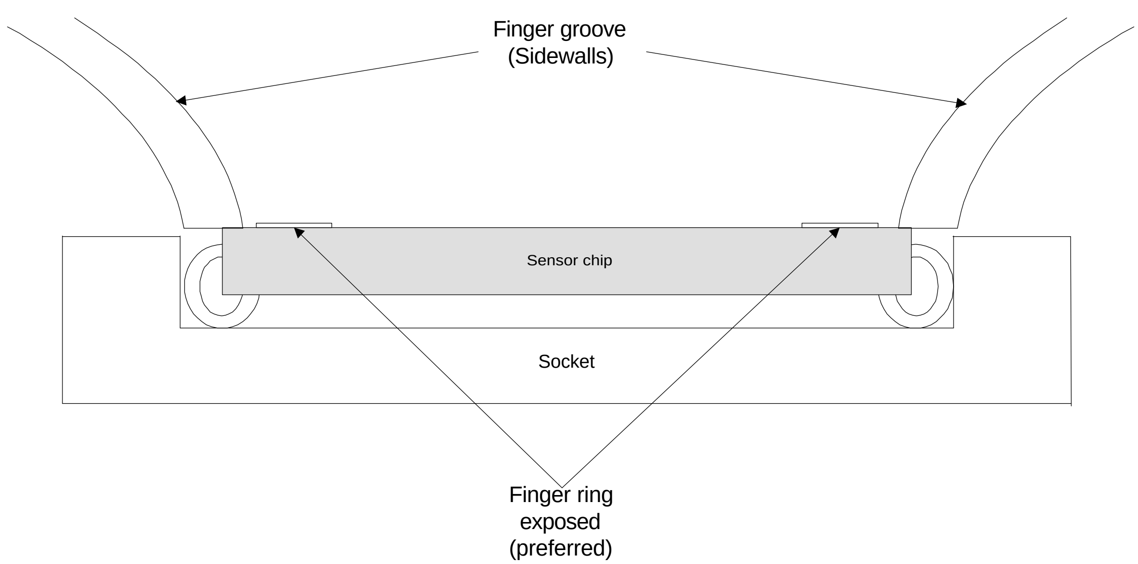


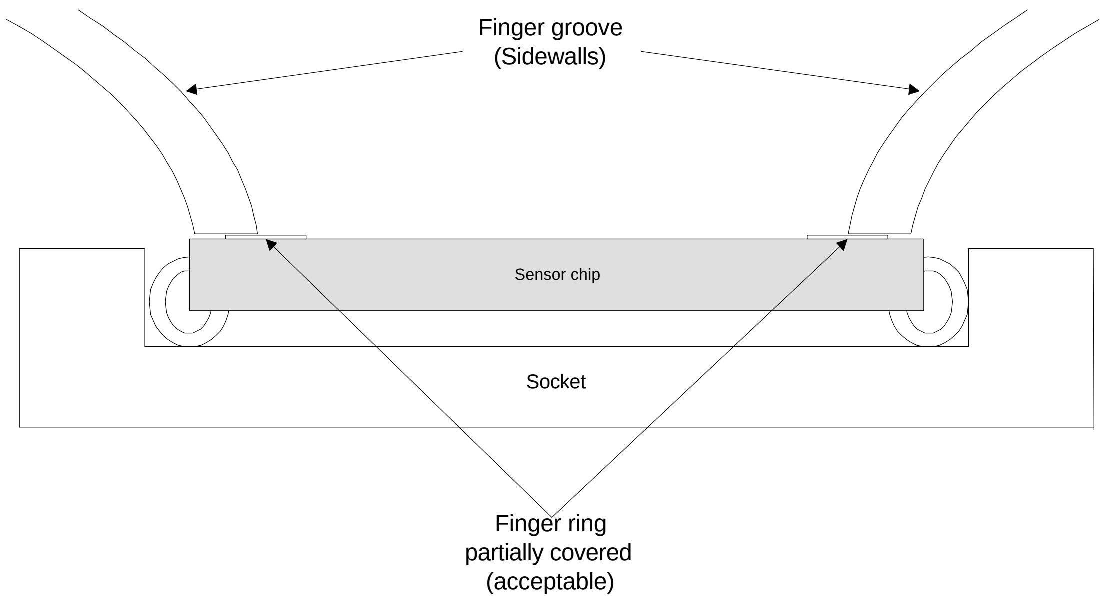
Another way to achieve this effect is with the use of a plastic membrane to interface to the sensor ackage, as shown in the figure below:



The above two illustrations show a sensor mounted in a socket, but the same techniques can be used for a sensor that is mounted directly on a PC board. This direct mounting is preferable when the total height of the sensor plus PC board is an important consideration, or when lower cost is desired and the sensor will not have to be replaceable. In the direct mounting case another possible packaging technique is to encapsulate the board in a plastic potting compound. Care should be taken that the plastic used be a low-temperature setting compound and that the compound not apply tensile or compressive stress to the sensor during or after the setting process. In addition, the compound should not be allowed to get onto the sensor surface or finger ring while it is being applied.

In order to achieve the best matching rates with many algorithms, it is often necessary to prevent the user from rotating his finger excessively or from placing the tip incorrectly on the sensor. A well-designed finger guide can greatly improve matching results. There are many ways this can be accomplished, leaving great scope for originality in the design. One constraint that should be observed is that the sidewalls of the finger groove should not be designed to completely cover the finger ring. While many people's fingers are too narrow to contact the finger ring on the sides of the sensor, those that do have wider fingers will probably generate better images if the finger ring is allowed to contact their fingers on the sides as well as the top and bottom. Two possible designs for the side walls are shown below:



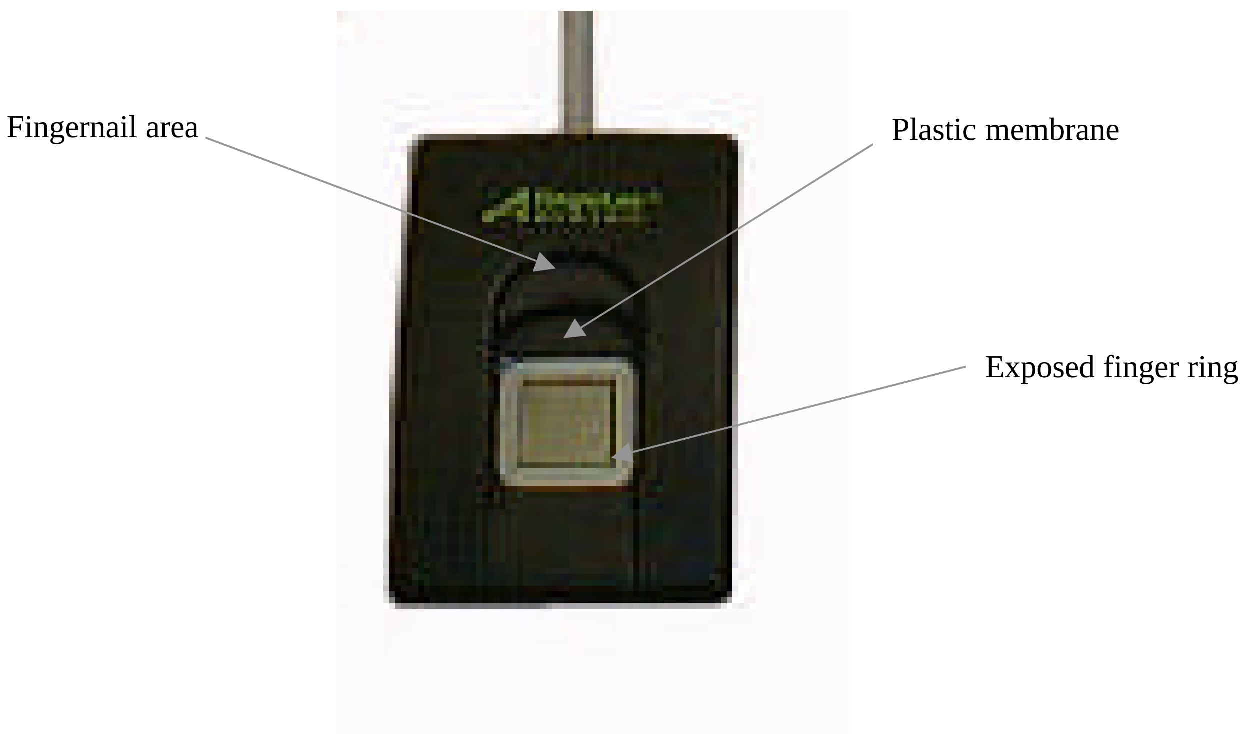


As shown in the figures above, it is important to cover the sensor package pin area to prevent reliability problems due to contaminants shorting the pins together or causing corrosion of the pins or socket. Probably the most effective way of doing this is by encapsulating the sensor package, as discussed above.

The sidewalls of the finger groove should not be steeper than a 45 degree angle if the sidewalls partially cover the finger ring or it appears that the user's finger may be wider than the bottom of the finger groove. Grooves that are steeper than 45 degrees in this case can result in the sides of the user's finger not making contact with the sensor surface.

A finger groove that was designed by AuthenTec that embodies the above principles is shown in the figure below. This housing was designed to be used with a plastic film to cover the sensor pins.

Top of housing, showing the finger groove without the membrane.



Complete casing, showing the plastic membrane and exposed finger ring. Note the very low angle of entry from the front and the special groove for a fingernail.

Reliability Considerations

Because the surface of the silicon chip is exposed in the FingerLoc sensor, the possibility of the environment damaging the sensor exists. Protections at many levels for these types of damage exist in the sensor packaging and reference design, but the designer may want to consider further protective measures, depending on the severity of the application. For example, the reliability requirements for a sensor to be used in an office area are probably not as stringent as those for an outdoor access control application. The probability of intentional attack on the sensor should be considered. The following reliability issues should be considered in any design:

1. Physical scratching and impact

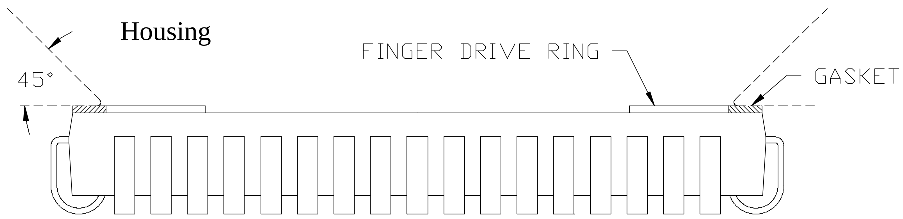
   The sensor coating is able to withstand impacts of 2.5 mJ, which is applied over an area the size of a ballpoint pen tip. This is the amount of force created when dropping a weight of 50g from a height of 0.2". Future coatings of the sensor are expected to achieve much higher impact resistance. The resistance to rubbing is very good, with the sensor having been tested with 500,000 rubs of a chamois "finger tip" with no noticeable effect. Scratching the surface with metal objects may create channels for contaminants to enter the surface of the sensor and cause eventual failure through corrosion of the metal lines inside the chip.

   For these reasons, if the intended usage is in an environment where the user may attack the sensor with sharp objects, then a sliding cover or door over the sensor may be needed. Alternatively, the sensor may be placed in a housing designed to prevent direct attack on the sensor, such as by placing the sensor in a recessed area within the housing. Such a cover can also be designed to discharge ESD from the finger, further protecting the chip.

2. Chemical attack

   The sensor has been tested by soaking for long periods and scrubbing in various common chemicals such as cleaners, soft drinks, etc. with no failures. However, solvents that dissolve the plastic packaging of the sensor will cause it to fail. Also, as was discussed above, it is important to cover the pin area of the sensor to prevent contaminants from corroding or shorting the pins. If the environment is expected to have strong solvents, acids, or alkalis present, the sensor must be covered with a housing that is impervious to these substances. Since these substances are also inimical to the humans who would use the sensor, the only possible way this could occur would be as part of a cleaning operation. In general, the sensor should only be cleaned by gently wiping with a damp, grit-free cloth.

   The use of a gasket, as shown below, is another way to prevent contaminants from reaching the pins of the sensor:



3. ESD

There are several levels of ESD protection included in the FingerLoc reference designs, both within the sensor chip and within the PC board layout. The actual layout of the components on the board can have an effect on the ESD results as well. The primary ESD protection circuit is connected to the white finger ring on the surface of the sensor. High voltage ESD can arc from the sensor package or package pins directly to other components on the PC board, if they are placed too close to the sensor. In addition, arcing has been observed from the finger ring to the sensor package pins, when the pins are not covered by an intervening layer. Encapsulating the sensor is the surest way to prevent this latter phenomenon. ESD circuit design will be discussed in another paper.

The designer can supplement the circuit-related ESD preventive measures with physical protections, depending on the environment. The following measures could be considered:

1) Use of a conductive finger ring. Conductive plastic or metal could be used in the finger groove area of the housing design. To be effective, this conductive finger ring should be connected to pins 18 and 52 of the sensor. This connects the conductive finger ring to the finger ring on the surface of the PLCC package, and so the conductive finger ring will become part of the finger drive circuit. Care must be taken not to make the conductive finger ring too large or the sensor finger drive circuitry may not be able to drive the load required.

   The effect of this conductive ring is to discharge the finger before it comes in contact with the sensor. Note that it is important that the entire housing not be made conductive. The reason for this is that if the finger guide is conductive and is in contact with the finger ring on the sensor, it greatly increases the size of the radiating surface used to drive the finger for imaging. This may overload the output of the finger ring drive, or even short it out. When a conductive finger guide is used, adjustments to circuit components may be necessary in some cases to maintain the finger detect threshold. This measure has not proved necessary for finger guides of reasonable size.

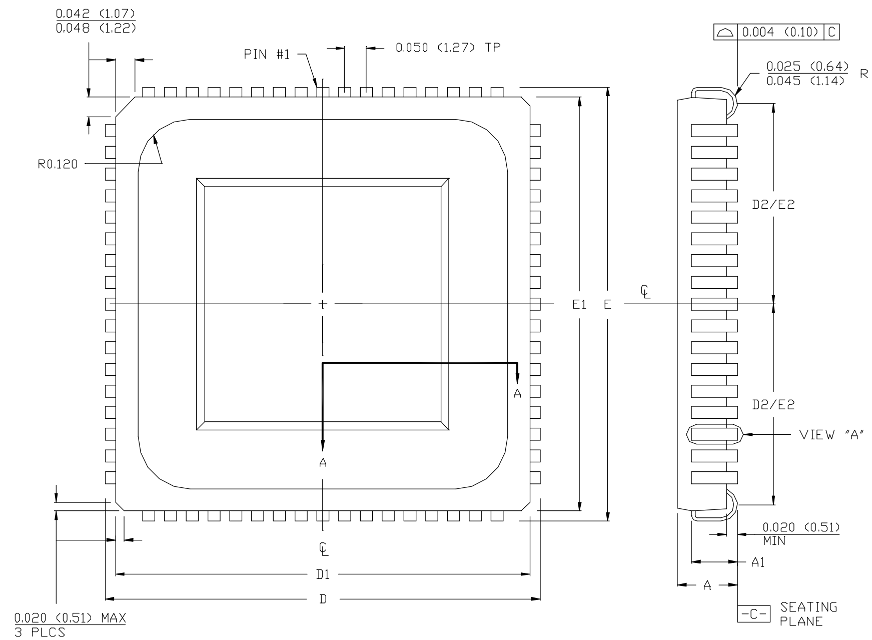
If for some reason it is desirable to make the housing out of a conductive material, an insulating layer between the housing and the finger ring should be part of the design.

In order to improve its ability to attract ESD sparks, the conductive finger ring may be designed to have sharp edges or corners. This will increase the electrical field in the areas with sharp corners so that the ESD will have a strong tendency to discharge to these points, much the same as a lightning rod on a house.

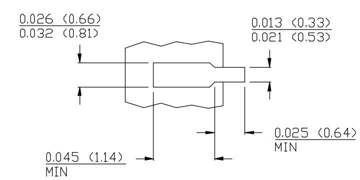
2) Use of a conductive cover over the sensor. As in the case for impact damage, this should only be considered for severe environments, due to the cost of this type of solution, as well as its lack of ergonomic appeal.

Appendix: The sensor package

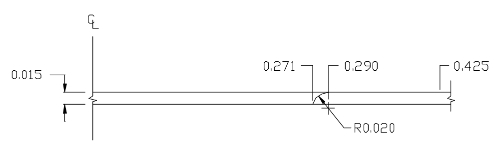
LTR	NOTATION	ENGINEER	DR/CHG BY	DATE
—	NEW SPECIFICATION	MS	DMM	04 JAN 1999



SYMBOL	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX	NOTES
A	0.122	0.154	3.10	3.91	–
A1	0.090	0.120	2.29	3.05	–
D	0.988	0.996	25.10	25.30	–
D1	0.949	0.957	24.10	24.31	3
D2	0.457	0.465	11.61	11.81	4,5
E	0.988	0.996	25.10	25.30	–
E1	0.949	0.957	24.10	24.31	3
E2	0.457	0.465	11.61	11.81	4,5
N	68		68		6



VIEW "A" TYP



SECTION A-A

NOTES:

1. CONTROLLING DIMENSION: INCH. CONVERTED MILIMETER DIMENSIONS ARE NOT NECESSARILY EXACT.
2. DIMENSIONS AND TOLERANCING PER ANSI Y14.5M-1982.
3. DIMENSIONS D1 AND E1 DO NOT INCLUDE MOLD PROTRUSIONS. ALLOWABLE MOLD PROTRUSION IS 0.010 INCH (0.25mm) PER SIDE. DIMENSIONS D1 AND E1 INCLUDE MOLD MISMATCH AND ARE MEASURED AT THE EXTREME MATERIAL CONDITION AT THE BODY PARTING LINE.
4. TO BE MEASURED AT SEATING PLANE -C- CONTACT POINT.
5. CENTERLINE TO BE DETERMINED WHERE CENTER LEADS EXIT PLASTIC BODY.
6. "N" IS THE NUMBER OF TERMINAL POSITIONS.
7. PACKAGE OUTLINE AND DIMENSIONS CONFORM TO JEDEC MS-018AE ISSUE A, 68 LEAD PLASTIC LEADED CHIP CARRIER PACKAGE EXCEPT FOR "A" DIMENSION, PIN #1 IDENTIFIER AND PACKAGE BODY TOP SURFACE FEATURES.

TITLE: FINGERLOC PHASE 3.1 PACKAGE OUTLINE

AuthenTec, Inc.

CHECKED BY:

SPECIFICATION NUMBER: PM10001–003

(SHEET 1 OF 1)