PEOPLE COUNTER APPLICATION NOTES

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1.People Counter Principles: Field of View

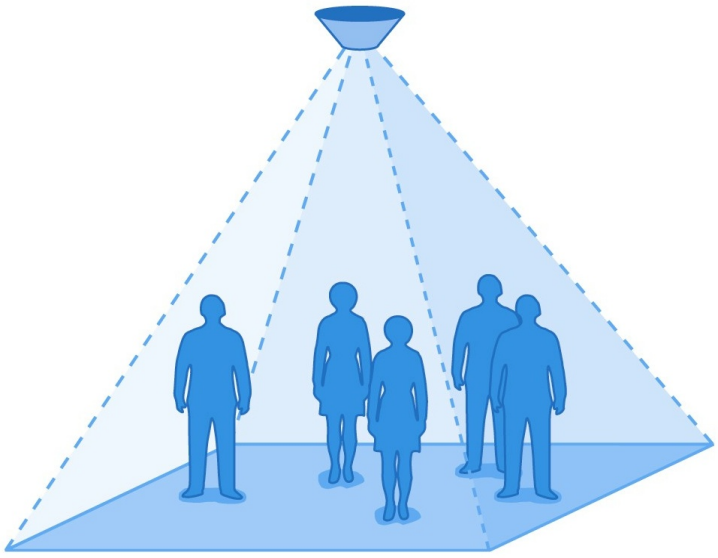

Figure 1.1

The IRISYS People Counter is downwards looking.

- **Counter should look straight down.**
- **The area on the ground is a square whose size is dependant on the height of the counter, see the Mounting Height Graph document IPU40106 for details.**
- **If required the counter can be mounted up to 5 degrees off horizontal but this should be avoided if possible.**

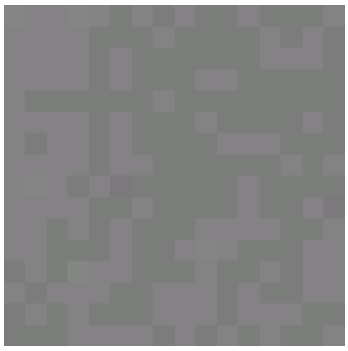

Figure 1.2 – Square Field of View

An UNOBSTRUCTED view of the area beneath the counter is essential.

- **Ensure in-store posters and signs do not obscure the counters view or under counting could occur.**

It counts moving FREE-FLOWING People.

- **Avoid areas of stationary people, for example, waiting or queuing areas, customer service desks etc.**
- **If people become crowded within the field of view then accuracy will be reduced.**
- **The setup software should be used in order to see what the people counter 'sees' to ensure correct operation. As part of the commissioning of each counter the installer should view the people counter output to ensure the counter is working as intended.**

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2.People Counter Principles: What the counter 'Sees'

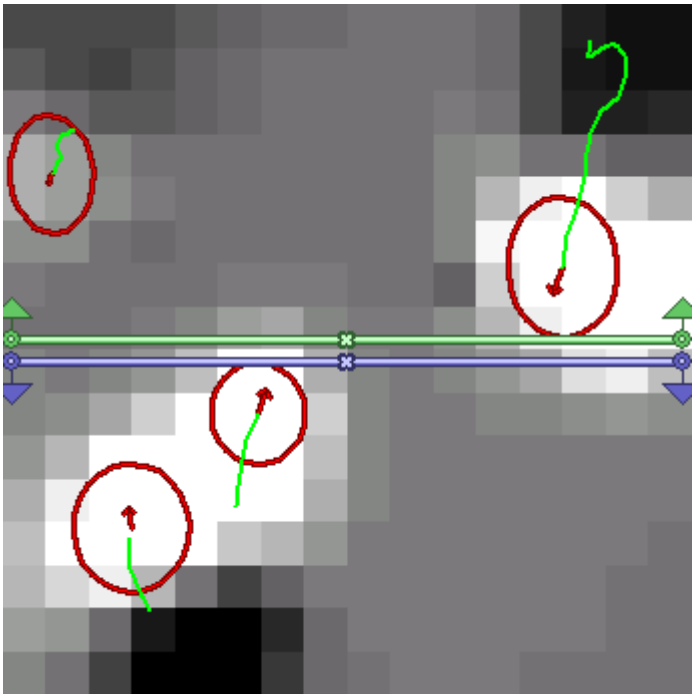

Figure 2.1 – What The Counter 'Sees'

The people counter 'sees' the temperature differences between person & background.

- **It does not measure the temperature itself.**
- **People may be hotter or colder than the background. (Temperature sensitivity is approximately 0.5°C)**
- **People are seen as Hot or Cold 'BLOBS'.**
- **If hotter than the ground they appear as white 'Blobs', if colder than the background they appear as black 'blobs'.**

Figure 2.2 – Hot Targets and Cold Targets

- **A person who stops will fade from view – when they move they will be detected again. Fade away takes approximately 10 seconds of inactivity.**
- **People are 'tracked' through the field of view, and their size, path, direction and speed, are all used in the counting process. The green line behind each target is the route that the target was tracked through.**
- **The counter does not emit anything – it is a 'passive' device (not an 'active' device).**

Two count lines are overlaid on top of the array view for the actual counting (see next sections).

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3.People Counter Operation: The Count Lines

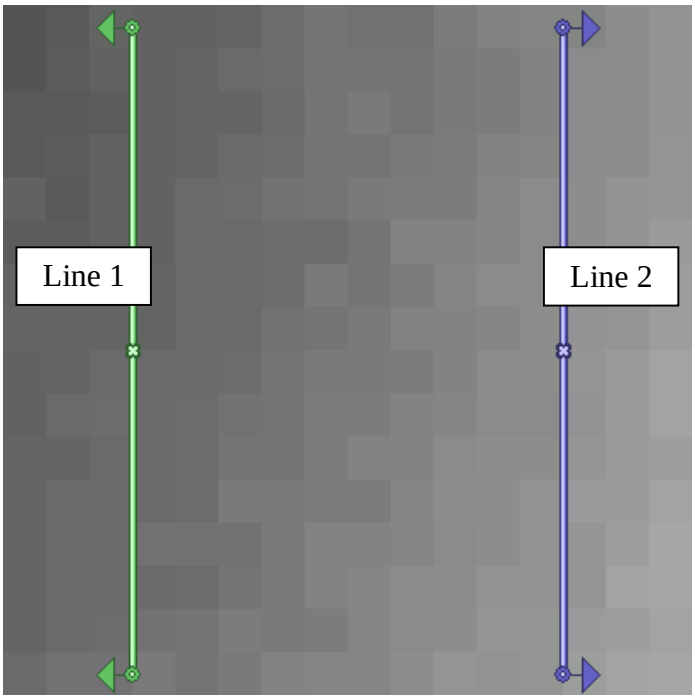

Figure 3.1 – The Count Lines

Two independent 'count lines' are provided in each counter.

- **The count lines are configured as part of the installation process appropriate to the counting requirement.**
- **Best performance is always achieved by fine adjustment of the count lines' position and shape.**

The 'arrows' indicate direction of counting.

- **A person must cross the count line in the indicated direction. If a person crosses a count line against the direction of the arrow a count increment will not occur.**
- **Generally, one count line counts 'in', the other count line counts 'out', but lines can be configured as required.**
- **When a person crosses a line, they are counted. The count is incremented once that person leaves the field of view.**
- **The lines work independently from each other – you do not have to cross one line then the other in order to generate a count increment.**

In the above example, 'Line 1' – the green line – counts people going Right to Left and 'Line 2' – the blue line – counts people going Left to Right.

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4.People Counter Operation: The Counting Principle 1

A count increment is registered when a person crosses the count line AND exits the field of view.

In Figure 4.1 the person has crossed line 1 – the green line – in the correct direction indicated by the arrows on the end of the lines, and therefore line 1 will increment by one when the target leaves the field of view. Line 2 – the blue line – was not crossed in the direction of its arrows so no increment is given.

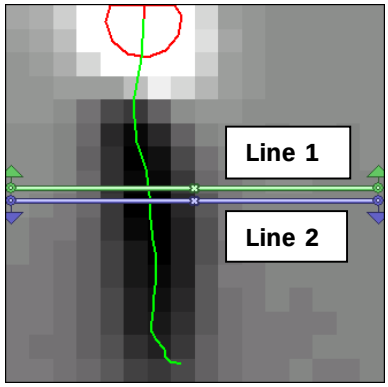

Figure 4.1

People must exit the field of view for the count to increment. People can exit the field of view by, either:

- **Physically walking out of the field of view (Figure 4.2).**
- **By standing still for long enough that the counter loses that person's target (Figure 4.3).**

Figure 4.2 shows the path that two people took to walk through the field of view of a counter. In this case two counts will be generated; one increment for line 1 and one increment for line 2. The increments occur at the point that the target was seen to leave the field of view.

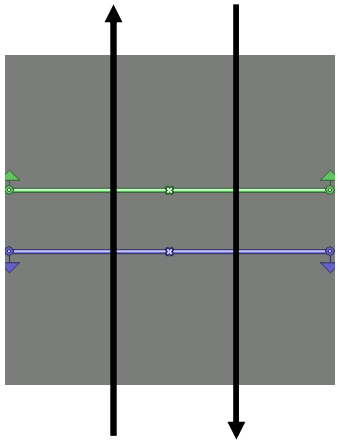

Figure 4.2

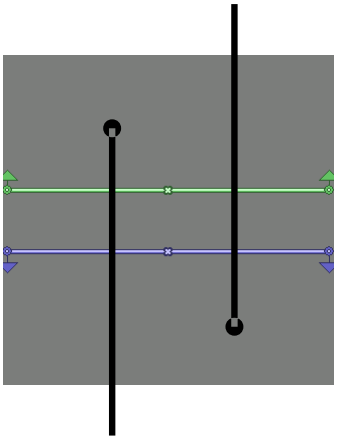

Figure 4.3

Figure 4.3 shows the path that two people took to walk through the field of view of a counter. In this case both people stopped within the field of view long enough for the counter to lose their target. At this point an output would be given for the line that they crossed.

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5.People Counter Operation: The Counting Principle 2

The movement of the people shown in Figure 5.1 and Figure 5.2 will also generate counts. Figure 5.1 will result in an increment on line 1 (the green line) and Figure 5.2 will result in an increment on line 2 (the blue line).

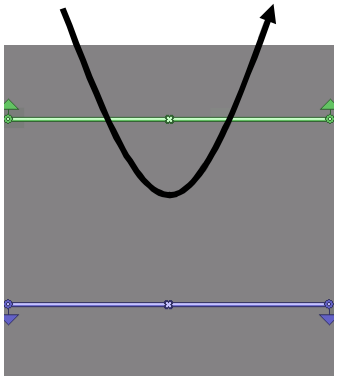

Figure 5.1

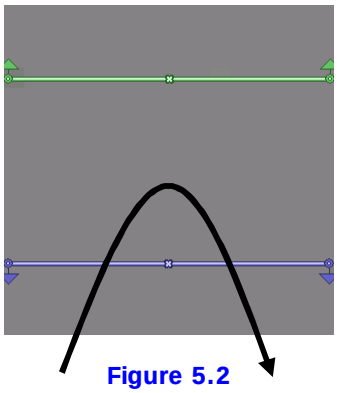

Figure 5.2

It is necessary to understand the counting principles when interpreting counter operation and deciding on count line positioning and configuration.

In Figure 5.3 and Figure 5.4 the movement across the lines will result an increment on line 1 and an increment on line 2, in both cases.

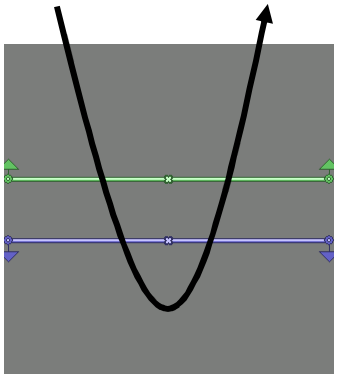

Figure 5.3

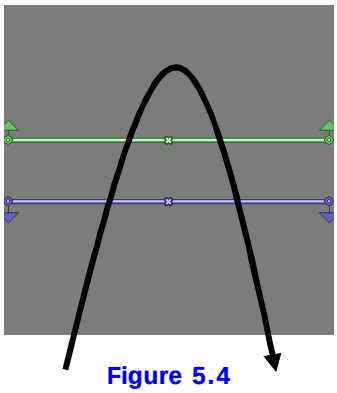

Figure 5.4

In Figure 5.5, two people walk in the direction as shown by the arrows. Both paths cross line 1 (the green line) and therefore both will result in an increment to line 1 when they leave the field of view. Note that it does not matter where a target appears in the field of view or where they leave the field of view, count increments are based on the lines crossed only.

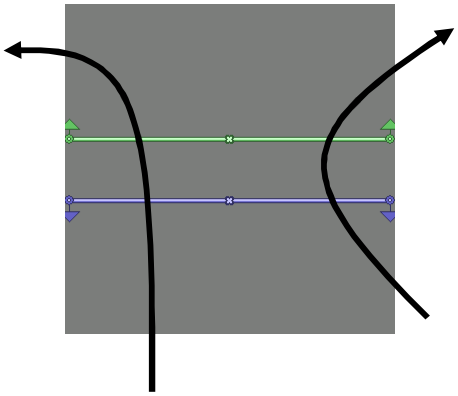

Figure 5.5

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6.People Counter Operation: The Counting Principle 3

To prevent multiple count increments being generated from a single person, an 'Anti-dithering' algorithm is employed. This prevents multiple crossings of the same count line by any one person from generating more than one count.

This 'anti-dither' operation is designed to overcome the commonly observed 'dithering' behaviour at shop entrances where a person will make multiple crossings of the count line before deciding to enter or leave, or whilst waiting for a family member, for example.

This is also the reason why a person must be seen to leave the field of view before any increments are given – the correct count increments are calculated and output at this time.

The Anti-Dithering Algorithm means that any one target can only generate a maximum of one count per count line:

- **A count increment will occur on the line that was crossed the most number of times**
- **If both lines are crossed the same number of times, both will increment by one**

This operation should also be considered when interpreting count operation; for example, whilst doing a manual verification of the counter operation.

In Figure 6.1 a person is seen to cross line 1 (the green line) multiple times. As it is the same person an increment of one only, for count line 1, would be output.

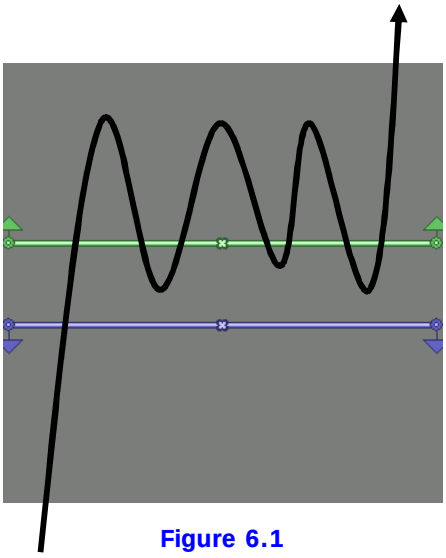

Figure 6.1

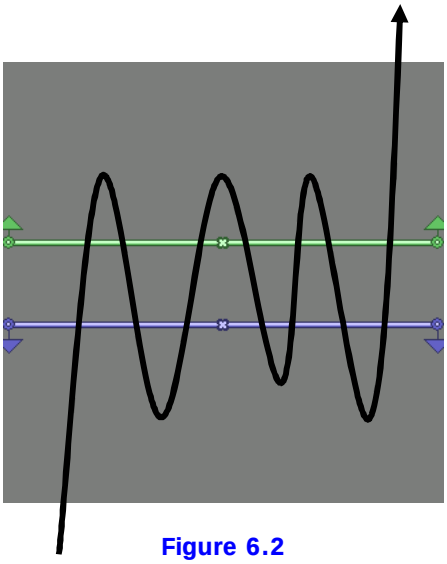

Figure 6.2

In Figure 6.2 a person is seen to cross both count lines multiple times. Again this is the same person and in this case line 1 (green line) was crossed more times than line 2 (blue line) so this line would increment by one only. Line 2 would not be incremented at all.

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In Figure 6.3 a person is seen to cross both count lines multiple times. In this case both lines are crossed the same number of times, so therefore both count lines will increment by one only.

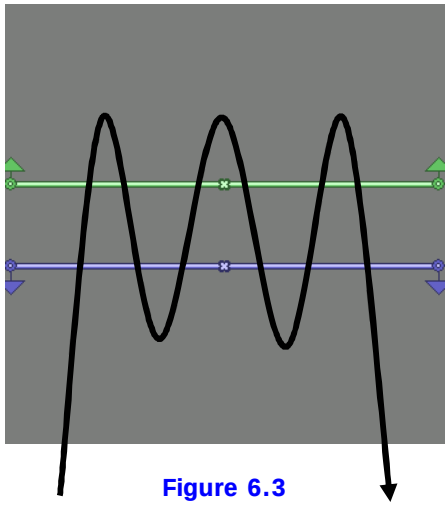

Figure 6.3

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7.People Counter Principles: Initialisation

The counter requires a certain amount of time and space to detect a person entering the field of view.

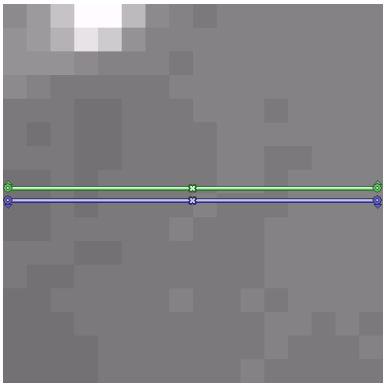

Figure 7.1

Sequence of events is as follows:

1. **Temperature change detected (Figure 7.1).**
2. **Counter Assigns Target – target initialised (Figure 7.2) – and target tracking begins.**
3. **Target crosses count line and leaves field of view.**

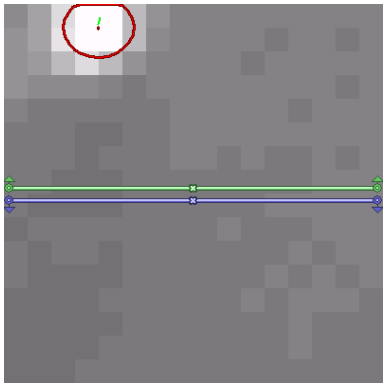

Figure 7.2

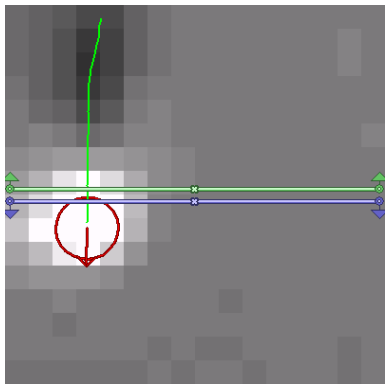

Figure 7.3

If the count lines were positioned so that it was possible for a person to cross a count line before the counter had initialised a target, then that person would not be counted.

Always allow sufficient space between the edge of the field of view and the count line to ensure that a person is detected as a target before the line is crossed. This space is called 'initialisation'. Initialised targets are shown by a circular identifier in the counter set-up software screen. Approximately three pixels are required for correct initialisation to take place. The exact requirement is dependant on the particular environment – walk testing is advised. If possible maximise the initialisation space by placing the count line as far away from the edge where the people enter as practically possible.

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8.People Counter Installation: Installation Basics

- The counter is typically installed near entrances or exits to count people entering and leaving an area.
- The counter is a downward looking device.
- The counter can be mounted on solid ceilings or suspended ceilings (provided a secure mounting can be achieved).
- Select a central location with a clear unhindered view of the scene. Visualise the counter as seeing a pyramid and attempt to locate the counter such that the count lines are at the centre of the field of view. This should allow for adequate initialisation in both directions.
- Select a location where people move freely into an area; avoid queues, areas where people bunch or gather or areas where people are stationary. For example, select an area inside the entrance where people have entered and are moving steadily away from the entrance.
- Avoid pinch points or areas where people bunch together or queue.
- If there is a potential or observed accuracy problem caused by supermarket trolleys or baggage trolleys then the Supermarket Variant counter may be required. See Section 12 'People Counter Installation: Supermarket Trolleys & Airport Baggage' for more details of this.
- Measure the mounting height; this must be above 2.5m and less that 4.5m for the standard 60° lens unit - the ideal mounting height is in the middle of the height range (3.5m for the standard 60° lens). Other lens options are available for mounting up to 13m high.
- Always use the correct lens variant counter for the height you are installing.
- Measure the width of opening (measure that part of the opening where people pass through).
- By comparing the height and width with that on the Mounting Height Graph (shown at the back of this document) you will be able to judge whether one counter is sufficient for your particular environment. If one counter will not cover the width then more than one counter will be required to span the opening. Wide Opening Networks such as these can be up to 8 units; contact IRISYS for details.
- Install the counter at the selected location. If you have any doubts about the location then a temporary installation should be made and the people counter output should be carefully observed.
- Shape and position the count lines as required. Remember, the optimum line positioning is the key to accurate counting. Always walk test thoroughly to confirm accurate counting.
- Observe the counter output and fine-tune the count lines to achieve optimum performance. This is best done by observing people moving through the scene and observing the counter operation.

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9.People Counter Installation: Mounting Height Issues

- **Mounting at heights of 2.5m or lower is NOT recommended. Below 2.5m a persons arms and legs may be seen as separate targets and therefore, OVER-COUNTING may result.**
- **Survey the scene to see whether an alternative mounting point with height greater than 2.5m is available. If no alternatives exist, then a temporary installation should be carried out and judgement should be made as to whether the counting result is acceptable.**
- **Mounting at, or above, 4.5m will lead to problems in discriminating closely spaced people and UNDER-COUNTING may result. This is because the size of the target starts to approach the size of a single pixel and therefore the resolution of closely spaced people becomes difficult. Other lens options are available which should be used above 4.5m.**
- **Always measure the mounting height accurately and set correctly in the people counter software as part of the configuration process.**
- **At the upper end of the mounting height range, groups of people can merge into one target resulting in UNDER COUNTING. To compensate for this, a 'Couple Counting' option is provided; this should be turned on as part of the setup process, if required. Switching on this setting will enable a double count output for targets which are deemed to be more than one person – the correct mounting height setting must be entered for correct operation. Again, this should be thoroughly tested to ensure it has the desired effect. See the software user manual IPU40027 for details of this setting.**

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10. People Counter Installation: Doorways, Doors and Entrances

A door will interact with the count line in circumstances where a temperature difference exists between the outside of the door and the interior temperature (which commonly happens in the case of a door which opens from inside to outside).
Rotating doors and sliding doors should be catered for in the same manner (as again a temperature differential may exist).

- **Avoid mounting the counter over a doorway where the door opens into the scene, where possible. In some circumstances the door will cause false counts. See Figure 10.1.**

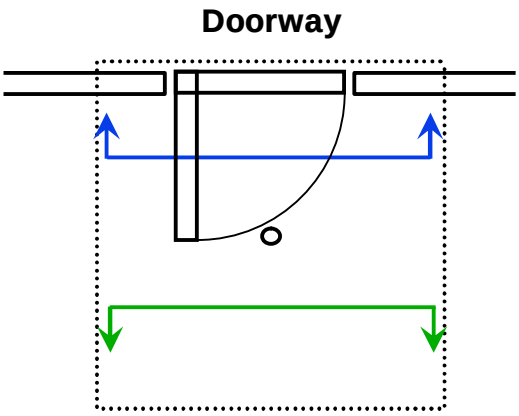

Figure 10.1

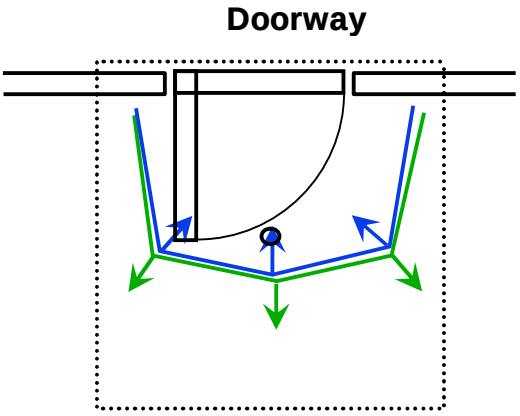

Figure 10.2

- **Customise the count line to surround the doorway. This prevents the opening and closing of the door from generating false counts whilst ensuring that people who pass along the wall are also counted. See Figure 10.2.**

- **Do not move the counter too far away from the door so that an opening is formed. People who are not seen in the field of view will not be counted and accuracy would therefore be affected. See Figure 10.3.**

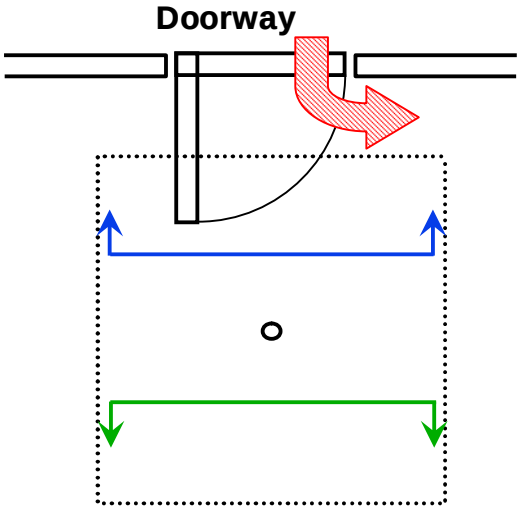

Figure 10.3

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11. People Counter Installation: Groups, Crowds and Queues

- **The counter works best for free-flowing groups of people.**
- **If people stop in the field of view or bunch up in such a way that there is no observable separation between people then the counting accuracy will fall.**
- **Stationary people, who come to a standstill due to obstructions or queues in their path, may not be counted.**
- **Mount the counter to avoid the following situations wherever possible:**
  - **Static groups of people or queues.**
  - **Very dense groups of people or crowds.**
  - **Bunching or queuing caused by pinch points or obstructions.**
  - **Door security staff, floorwalkers etc.**
  - **Tills, service desks, kiosks etc.**
  - **Security check points and 'stop & search' areas.**
- **At the upper end of allowable mounting height range groups of people can merge into one target resulting in under counting. To compensate for this a 'Couple Counting' option is provided as part of the setup process. Switching this on will enable a double count output for targets which are deemed to be more than one person – the correct mounting height setting must be entered for correct operation. Again, this should be thoroughly tested to ensure it has the desired effect. Note this option is not available in the Supermarket Counter variants (see Section 12 'People Counter Installation: Supermarket Trolleys & Airport Baggage' for details of this variant). See the software user manual IPU40027 for details of the 'Couple Counting' setting.**

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12. People Counter Installation: Supermarket Trolleys & Airport Baggage

The counter will detect changes in temperature caused by other moving objects such as trolley in supermarkets and luggage trolleys in airports. Moving objects like this will initialise a target and will be counted if they cross a count line. To avoid counting things other than people a 'Supermarket' variant people counter was developed.

Figure 12.1

The supermarket variant counter should be used:

- **In supermarkets and shopping centres where trolleys/carts are prevalent**
- **In airports where baggage trolleys are prevalent**

The Supermarket variant counter has another layer on top of the standard tracking algorithm which recognises behaviour comparable to a person pushing a trolley and it links the two corresponding targets – linked targets are then counted as one person.

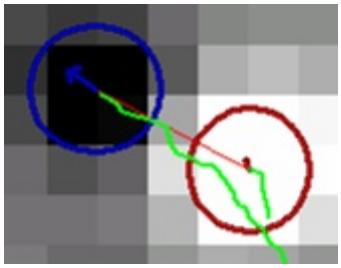

Figure 12.2

The supermarket variant counter should not be used:

- **In smaller supermarkets where trolleys are not used**
- **In secure areas of airports where people are not carrying luggage**
- **In typical 'retail'/'office building' people counting applications**

If the supermarket variant counter is used in the wrong context then genuine people targets may get linked together and under counting will result.

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13. People Counter Installation: Thermal Issues

The detector provides optimum performance in stable thermal environments. Situations where the thermal background in the field of view of the detector can have marked localised temperature differences (hot spots) or can change temperature rapidly, should be avoided if possible, as these circumstances can lead to a reduction in performance.

Examples of such situations are: -

- **Locations where machinery or lighting may cause significant localised heating of the floor, such as the top or bottom 'landing zones' of escalators or walkways (see next section for escalator issues), or under high power lights.**
- **Areas where intense sunlight falls on the floor within the field of view of the detector and where the following circumstances exist:**
  - **The detector is close to doors which separate two areas with very different temperatures, e.g. those which separate an indoor air-conditioned area from an extremely hot (or cold) exterior, particularly where the floor surface can change temperature rapidly, e.g. where the flooring material is carpeting. Where these circumstances cannot be avoided, care must be taken over the positioning the count lines to avoid over-counting.**
  - **The flooring materials in the field of view are of different types and any of these is able to change temperature rapidly, e.g. carpeting over tiles. Particular care should be taken with rubberised floor mats which may become hot in direct sunlight and cause localised hot-spots in the field of view. Where these circumstances cannot be avoided, care must be taken over the positioning the count lines to avoid under-counting.**

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14. People Counter Installation: Mounting Issues

Ensure a clear field of view is provided in order to maximise the potential line placement options and allow for sufficient target initialisation in both directions.

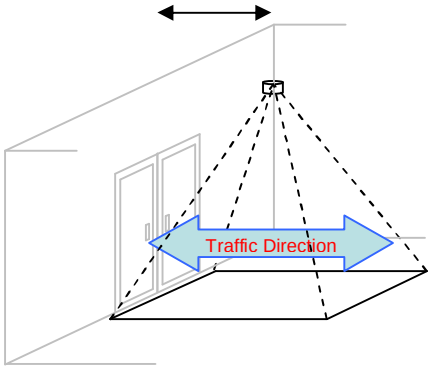

Figure 14.1

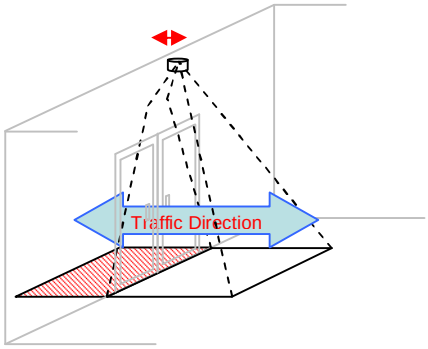

Figure 14.2

If possible, always avoid situating the counter too close to a wall, or other barrier (as shown in Figure 14.2), as this will reduce the amount of usable field of view available. As a consequence, the initialisation and line placement choices will also be reduced (as shown in Figure 14.3).

Target initialisation from the direction of the blocked part of the field of view will also be affected as people will 'appear' further into the field of view and not at the edge of the field of view.

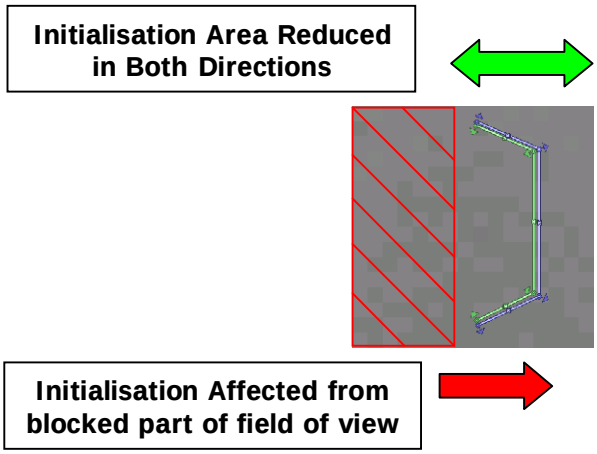

Figure 14.3

Positioning the counter in such a way that an obscured part of the field of view leaves an area that is not covered at all (Figure 14.4) will result in frequent under counting (Figure 14.5).

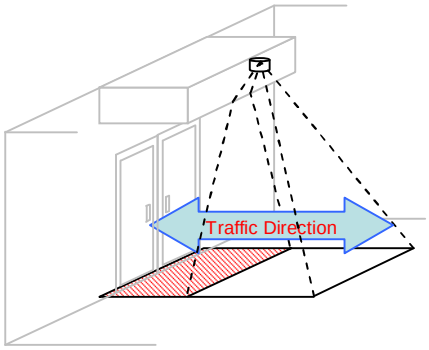

Figure 14.4

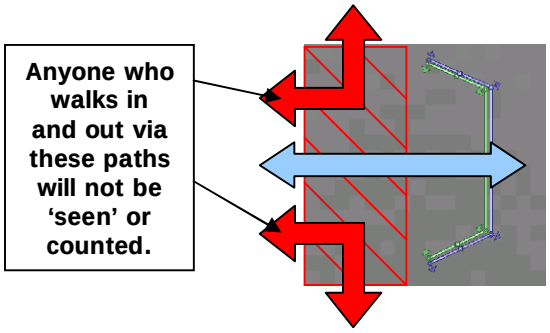

Figure 14.5

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Avoid installing into physically small rooms where the size of the field of view is reduced significantly. Locations such as vestibules and airlocks (Figure 14.6) can reduce the field of view to an ineffective size where it is not possible to provide enough initialisation AND position the count lines for accurate counting (Figure 14.7).

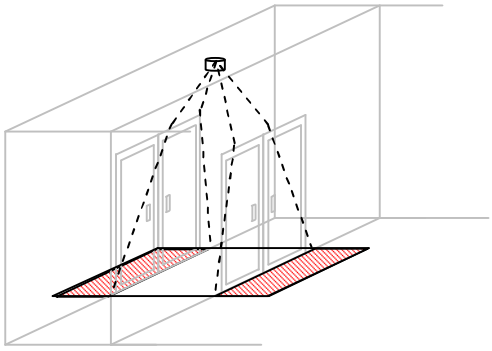

Figure 14.6

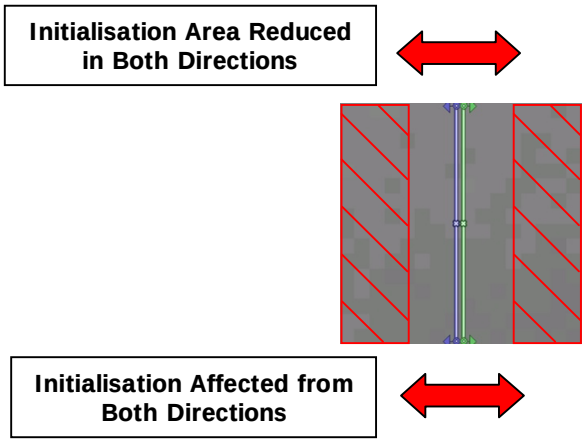

Figure 14.7

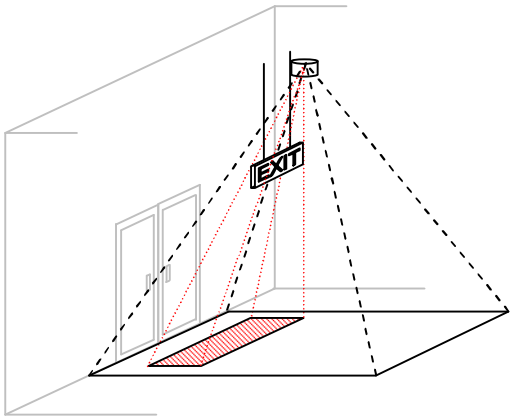

Figure 14.8

Obstacles in the field of view will create a 'gap' in the array view where people cannot be seen. Even a relatively small sign in the field of view (Figure 14.8) can obscure a large area of the ground (Figure 14.9).

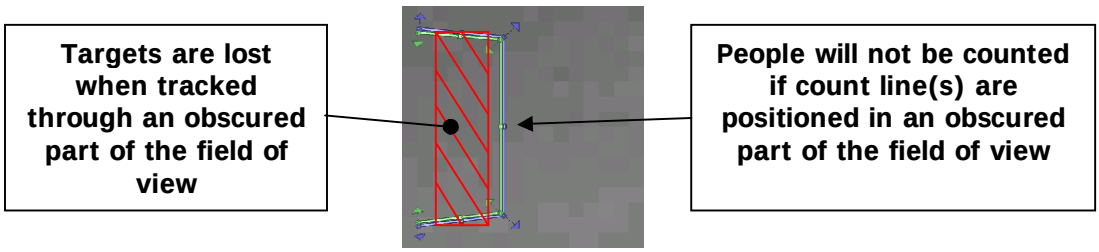

Figure 14.9

People Counter Applications Notes

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When monitoring pedestrian flow up and down stairs, position the counter at the top or bottom of the staircase (Figure 14.10). Do not install the counter in the middle of a staircase – over the steps – as the natural movement of people closer to, and further away from, the counter, results in the targets altering in size which can confuse the counter.

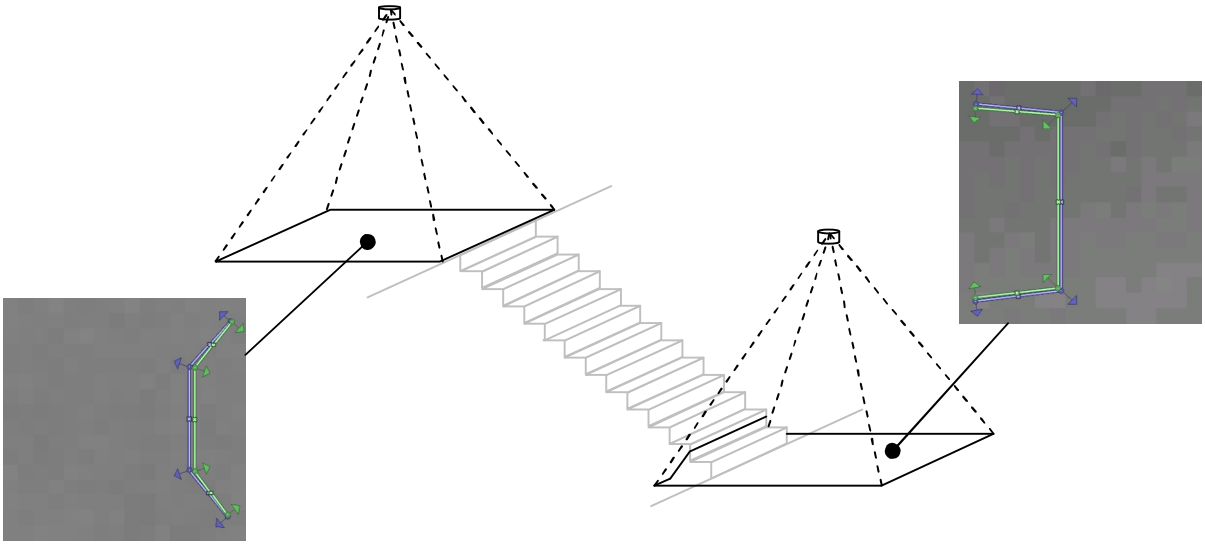

Figure 14.10

Escalators should be installed in the same manner as staircases, i.e. at the top or bottom and not in the middle (Figure 14.11).

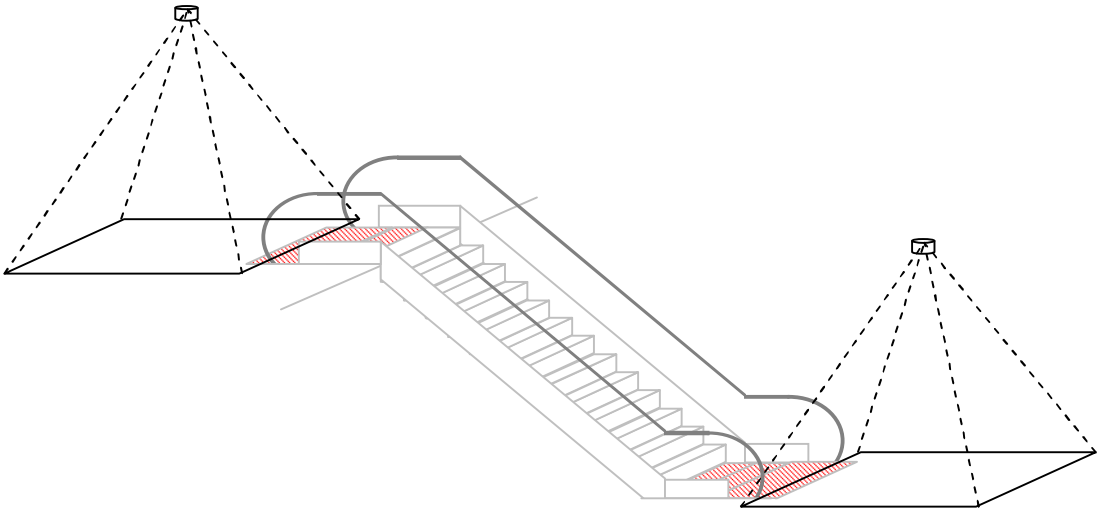

Figure 14.11

Additionally, thermal effects are occasionally observed above the 'landing plates' of escalators where people get on and off the steps. This is caused by the escalator steps moving underneath the metal plate. The effects seen are either false 'ghost' targets or sometimes genuine targets being lost as they pass over the landing plate area. Because of this, counters should not be installed above these landing plate areas unless unavoidable. Care should be taken with line positioning and observing the counter operation for an extended period is recommended, in these examples, to avoid count inaccuracies.

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15. People Counter Installation: Other Mounting issues

- **Ensure that there are no hanging signs, decorations, fans, or other objects which will mask the field of view anywhere in the field of view of the counter. On site staff should be informed of the effect of hanging product signage or seasonal decorations beneath the counter**
- **The counter is intended to be ceiling mounted. If this proves impossible, the counter may be wall mounted. If this is required, then a bracket or mounting arrangement should be used that the counter will look down on the scene with a clear field of view (remember the issues of initialisation).**
- **Do not mount the unit adjacent to vibrating equipment or in contact with heating ducts or pipes where temperature changes will be encountered.**
- **The counter requires a 'settling time' at switch on; this is set at 2 minutes, irrespective of conditions. This is effective on first power on and subsequent power up cycles. Resetting the counter by cycling the power supply should be avoided.**
- **On site staff should be informed of the operation of the counter in order to avoid any unwanted counts caused by staff movements. This especially refers to security guards who may walk through the entrance to a shop for example and whose movements will be counted if s/he crosses the count line(s). Also staff should be made aware of the impact on the counting figures of entering through a door where counting occurs but then leave through a door which is not monitored – a staff door, for example – or vice versa.**

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16. People Counter Verification: The Interpretation of Count Data

- **When installed the people counter output should be compared to visual observations from the scene to ensure that the performance is as good as expected. For the purposes of accuracy, video tape recordings may be taken for later corroboration. Care should be taken to ensure synchronisation between corroborative counting methods. Manual counts should be carefully done to ensure all people passing through are counted.**
- **Care should always be taken with the interpretation of count data. The people counter counts everyone who passes over the count lines provided the installation requirements of mounting height, line crossing and initialisation are met.**
- **Counted objects will include adults and children, dogs, babies & infants in buggies and carriers, and shopping trolleys in some circumstances (particularly where the trolley has a thermal difference to the background – see section 12 for details of how to deal with shopping trolleys). The counter does not discriminate differences between objects; if an object has a thermal difference to the background and has the appropriate size and shape it will be counted as a person. Staff members, security guards and the like will be counted if their motion is appropriate to that of valid people entering the premises.**
- **Remember that the counter will count all people, for example, it will not ignore staff and only count customers! Also, if a person enters and then leaves but then returns later, they will be counted again – the counter does not recognise people and ignore them if they have been counted previously!**
- **Groups of people are counted as individuals as long as there is sufficient distance between everyone for the counter to recognise each person individually. If people are merging into a single target then switching on the 'Couple Counting' option will enable a double count output for targets which resemble couples.**
- **Ensure that the position of the count lines is suitable to capture all the people entering or leaving the scene. Ensure, in particular, that people cannot pass around the ends of the lines without being captured. Equally, care should be taken to place the count lines only in areas where you want to count people and to avoid unwanted traffic counts were applicable.**

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17. People Counter Data Usage: Safety and Occupancy Issues

- **IRISYS does not recommend the use of the people counter in any safety critical environment, e.g. fire safety, building evacuation etc. Be extremely careful about using any automated counter for occupancy and safety issues – this applies to any counting technology, not just IRISYS counters. This is because no automated counter will be 100% accurate.**
- **In the case of occupancy, where occupancy is defined as the number of people within a building or area, you are effectively subtracting OUT traffic from IN traffic. Even a very small inaccuracy on the IN and OUT counts will build up very quickly throughout the course of a day (or even an hour where throughput is very high), and eventually the occupancy figure may be so far out that the number is meaningless.**
- **If using count data for evacuation counting then the data should be considered a guide rather than a measure of the exact numbers of people left in a building. People will move much more quickly and may be packed together more tightly if forced to evacuate a building in an emergency situation and this will affect accuracy.**

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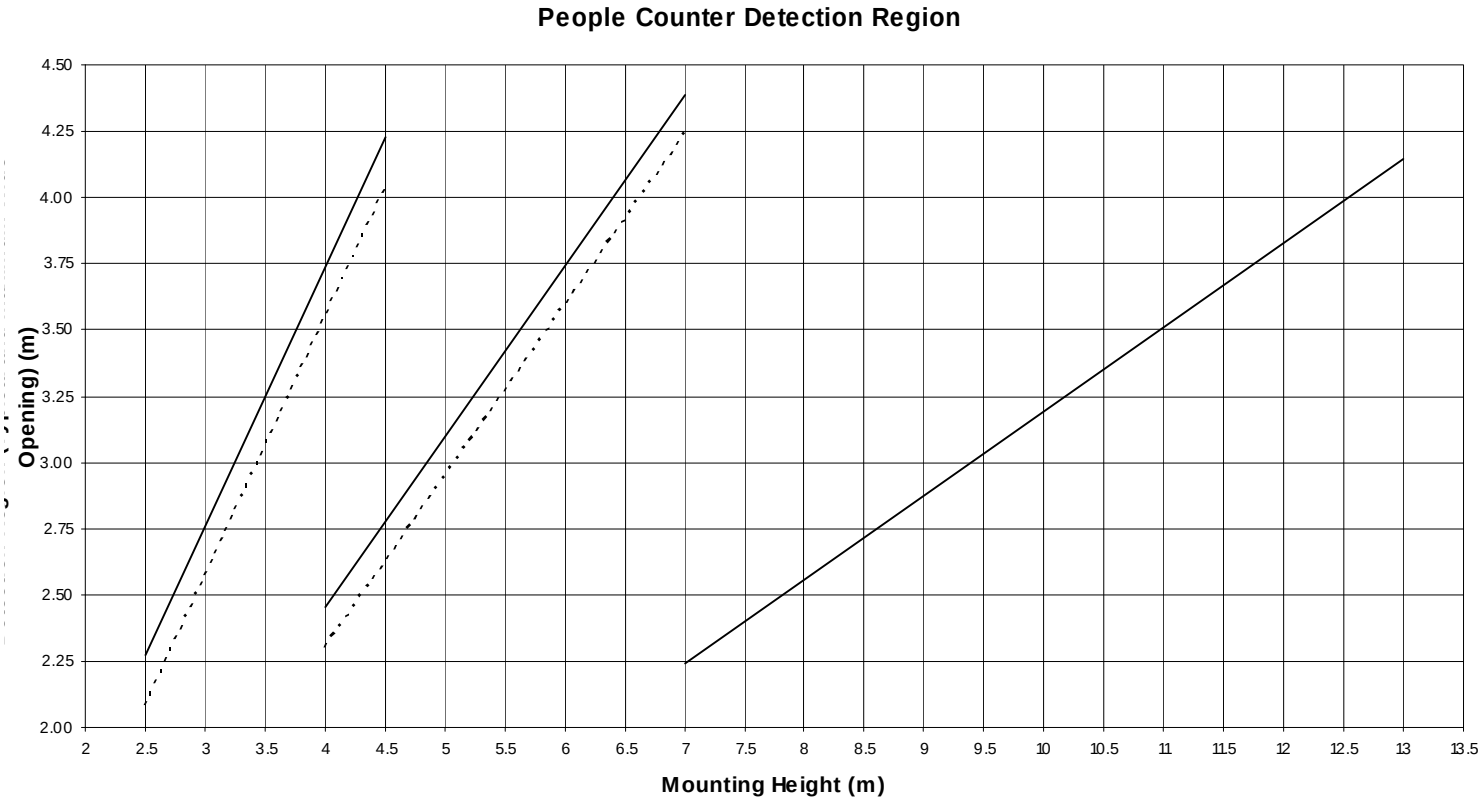
18. Mounting Height Graph



NOTES:

1. The 'typical' detection region graph (solid line) indicates the maximum reliable coverage for a single counter mounted at the given height.
2. The coverage indicated by the dashed line is the minimum coverage for a single counter mounted at the given height. This line should also be used as the maximum separation in multiple-unit (wide opening) counter configurations.
3. For each optical configuration, the line endpoints indicate the recommended mounting height range.
4. These graphs do not indicate the detection region in the direction of motion which will be reduced due to initialisation constraints.

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