

Evolution of Wide Screen Broadcasting in the United Kingdom

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This paper reviews the recent evolution of widescreen broadcasting in the United Kingdom. Early work sought to develop enhancements to the analogue PAL system in order to deliver clearer, sharper pictures in the 16:9 format, but widescreen broadcasting has become associated firmly with the successful introduction of digital broadcasting. As a result, sales of widescreen television receivers are growing rapidly, while UK broadcasters are transmitting a significant and increasing proportion of their output in 16:9. This has become technically possible and economically viable because of the ability to use a single production chain to serve both the widescreen digital and analogue 4:3 transmission networks - with careful attention given to appropriate 'safe areas' for picture framing and the positioning of captions, applying the principles of Rec. ITU-R BT.1379.

1 Introduction

Most people would agree that a widescreen picture is more pleasing aesthetically than the squarer 4:3 shape of conventional television systems. It is closer to the way in which the eye views the world, and enhances the sense of realism.

Widescreen formats are in general use in today's cinema, although there is no single worldwide widescreen aspect ratio for the film image – films are framed for projection in aspect ratios typically in the range 1.75:1 to 1.85:1; in some cases 2.35:1 or wider. Nevertheless, many films are shot in aspect ratio that is close to the widescreen television aspect ratio of 16:9 (approximately 1.78:1). A widescreen television display is therefore well suited to allowing viewers to see films as the director originally intended them to be seen - avoiding loss of important image area or the need for large black 'letterbox' bands if displayed in their original widescreen cinema format on 4:3 television screens.

The television widescreen format of 16:9 is regarded as the format of the future. It is used in high definition television systems, and also by new flat-panel display technologies.

2 Widescreen Digital Broadcasting

The UK terrestrial broadcasters played an active role in the European consortium that developed the PALplus system during the early 1990s (Rec. ITU-R BT.1197). There was also the development and standardisation of an echo cancellation reference signal (Rec. ITU-R BT.1124). While technically successful, these technologies to enhance analogue transmission systems were effectively superseded by digital transmission systems developed by the European DVB project. These offer the added benefit of much improved spectrum efficiency, furthermore permitting the transmission of new terrestrially delivered services on channels that are not able to be used for analogue broadcasting; for example, channels adjacent to existing analogue transmissions.

While only limited use was made of the PALplus system in the UK during the mid-1990s, it did serve to familiarise UK broadcasters with the practical issues in the studio associated with production, contribution, and distribution in the 16:9 format. It also introduced the idea of widescreen broadcasting to the general public prior to the introduction of digital services.

But it has been digital broadcasting that has been the driver behind a recent dramatic growth in both widescreen broadcasting and sales of widescreen television receivers. Digital transmissions have now been available for more than two years on satellite and terrestrial digital platforms, and are currently being introduced on cable also.

The digital terrestrial transmissions use the 8 MHz channel multi-carrier OFDM (2k mode) of System B in Rec. ITU-R BT.1306, a 625-line transmission system. The 625-line format is also used for DVB services delivered by satellite and cable.

3 The Introduction of Digital Services

The four main UK terrestrial analogue services (BBC1, BBC2, ITV, Channel 4) are delivered using the PAL system from more than 1100 UHF transmitting sites, and are available to around 99.4% of the population. A fifth terrestrial channel (Channel 5) was introduced in 1997, reaching about 80% of the population from 44 transmitters.

Digital terrestrial television (DTT) was introduced on 15 November 1998. Six digital multiplexes are radiated from 80 transmitting sites, currently covering between 64% and 81% of the population. The terrestrial multiplex giving the highest coverage is operated by the BBC, while Digital 3&4 Ltd operate a multiplex that simulcasts the existing ITV and Channel 4 services – together with other new channels and digital teletext. Three multiplexes are operated by ONdigital and the fourth by SDN Ltd. Between them, these simulcast the existing programme services, including regional programming, that are available from the analogue transmission networks, together with a range of new services – some are subscription or pay-per-view; more than 30 channels in total.

An even greater number of channels is available on satellite from Sky digital, which launched earlier in 1998, and which includes many of the terrestrial free-to-air channels.

4 The Significance of Widescreen for Digital Broadcasting

Widescreen has proven to be an important element in attracting the public to digital services, as it is a very visible differentiating factor for simulcast services that might otherwise be regarded as merely “more of the same”. The 16:9 format is seen as a particularly important feature of the digitally-simulcast traditional analogue terrestrial services. It provides a highly visible new element in a world dominated by multiplicity of channels. It also provides a ‘fresh look’ to go with the new services such as BBC Choice, BBC 24-Hour News and ITV2.

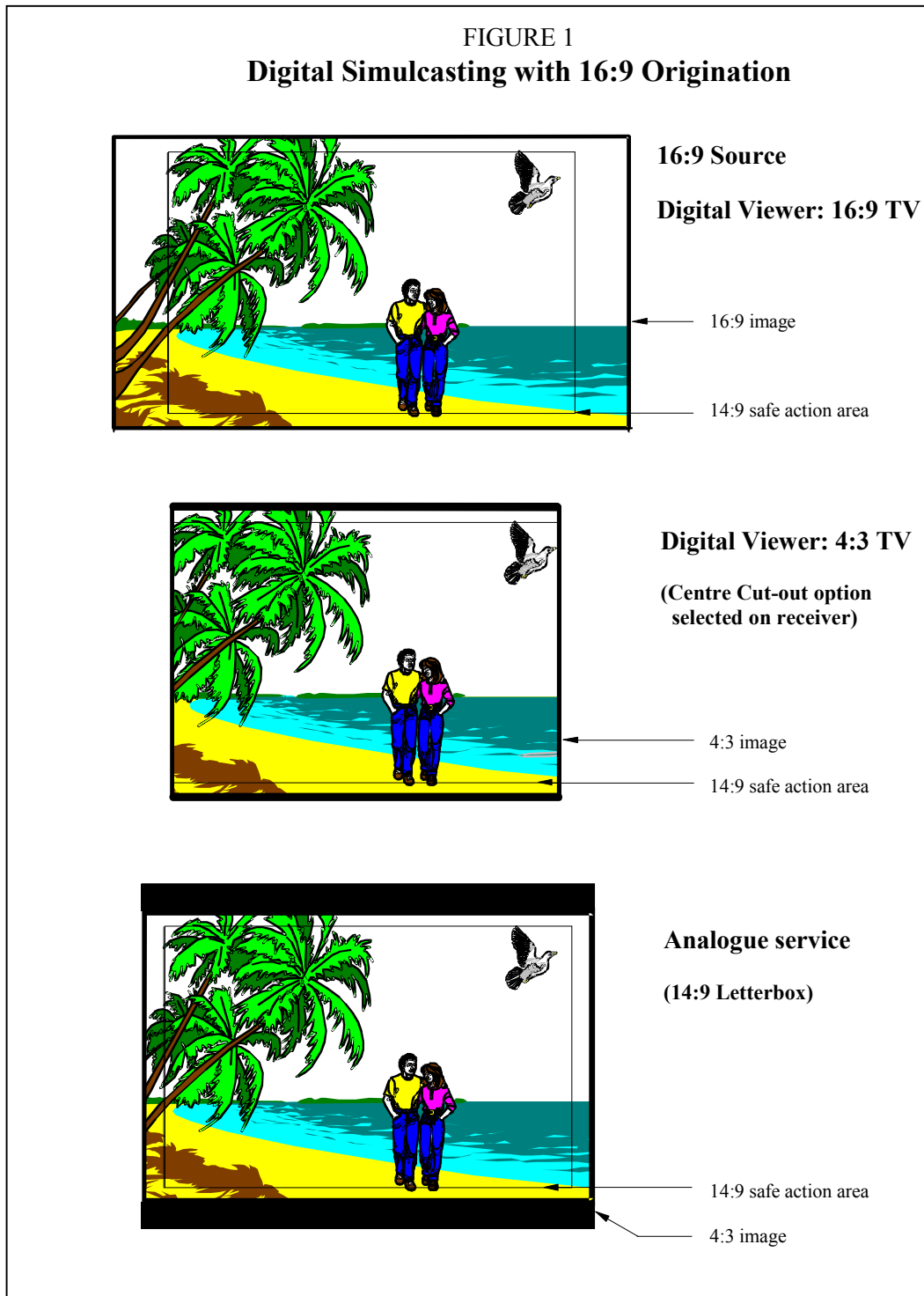
The digital transmission infrastructure is neutral so far as the aspect ratio is concerned. The programme maker can concentrate on the aesthetics of production in widescreen, and the viewer with a digital set-top-box or digital receiver can simply enjoy the result without having to be concerned about the technology of the method of delivery.

Widescreen therefore provides a powerful incentive for viewers to move to digital, since this is the only way to gain full access to 16:9 broadcasts. The proportion of programming available in widescreen to digital viewers is substantial, and is continuing to grow:

- currently, well over 50% of BBC evening prime-time programmes are broadcast in 16:9 on their digital channels, with similar proportions on ITV and Channel 4;
- all advertisements on ITV, Channel 4, Channel 5, the other terrestrial channels, and channels on the Sky digital satellite platform are now broadcast in 16:9;
- three of BskyB’s 24-hour Premiere film channels are in widescreen, as are some films shown on the Carlton Cinema Channel and Film 4 broadcast on digital networks.

5 Simulcasting in Widescreen Using a Common Production Format

It would not be economically feasible to originate, produce and play-out different 4:3 and 16:9 versions of the same programmes for the simulcast services. The UK's approach to digital simulcasting (on both the terrestrial and satellite platforms) is, wherever possible, to deliver widescreen programmes on the digital service, and to use an aspect ratio converter (ARC) at the studio output so that the analogue service carries (in general) a 14:9 letterbox. This is shown in Figure 1, which also illustrates the principle of applying a 'safe area' to protect important picture information.



A common widescreen 'shoot and protect for 14:9' specification for programme makers has been agreed between UK broadcasters (this is included in Annex 2: 'Safe areas for television programmes intended for wide-screen 625-line transmission'). This ensures that important action and advertising disclaimers and captions are retained. Essentially, the main action in a 16:9 frame is contained within the 14:9 centre portion, and graphics are contained within a 4:3 central area. This represents a compromise, but appears to work well in nearly all cases.

The principles behind the use of these 'safe areas' are described in Recommendation ITU-R BT.1379. A detailed description of the recently adopted UK specification was given in an illustrated article in the EBU Technical Review [1].

In summary, the steps taken for simulcasting of widescreen programmes have been:

- Wherever possible, common origination for both digital and simulcast analogue channels is from a 16:9 anamorphic (full screen) master
- Digital transmission is at full-screen 16:9
 - digital 16:9 sets display the full screen widescreen as transmitted;
 - digital 4:3 sets can be display either the centre portion or a full-image letterbox version of the 16:9 digital transmission. This is a viewer choice.
- Analogue simulcast widescreen transmissions are normally in 14:9 letterbox
 - this is obtained from the digital widescreen original via an aspect ratio converter (ARC) prior to analogue transmission;
 - analogue sets display a mild letterbox;
 - pictures on 16:9 analogue sets can be 'zoomed' if required by the viewer;
 - this has resulted in virtually no public complaints from viewers with 4:3 receivers.

Digital broadcasts can contain information giving guidance to the receiver on how best to display the transmitted picture. Data carrying Active Format Descriptors (AFDs) is transmitted as **user_data** in the video elementary stream, supplementing (but not replacing) the MPEG video **sequence_header** that identifies the coded raster shape as being either 16:9 or 4:3. AFDs inform the digital receiver of the actual picture shape within the raster. Using this information (see Annex 1), the digital receiver can automatically optimise the displayed picture format to suit the programme material and the aspect ratio of the display. Integrated digital television receivers (IDTVs) and set-top boxes are being equipped to respond to these signals.

Most receiver manufacturers have decided to equip their integrated digital television receivers with widescreen displays. It is likely that the majority of televisions in UK stores will be digital from about 2004/5. While a firm date for switching off the analogue terrestrial services has not yet been set, it is anticipated that this might happen between 2006 and 2010.

The combined effect of these measures is to ensure that the development of digital widescreen television is rapid. They effectively remove the legacy issues that would otherwise be associated with existing 4:3 television receivers, whether receiving analogue services or digital signals via a set-top box.

This opens the way for the growth of widescreen programming to be determined on editorial grounds without being hampered by technical constraints.

6 Programme Making

The entire range of programme genres is now broadcast in widescreen on the digital services:

- SPORT: Tennis, Golf, Racing, Darts and others from the BBC; Football and Rugby including the national and international coverage of the Rugby World Cup from ITV and Sky.
- MOVIES: not only from the free-to-air channels, but also from three of Sky's 24 hour Premiere Movie Channels; Film 4 and Carlton Cinema; and the terrestrial pay-per-view ONrequest service.
- POPULAR SOAPS including EastEnders from the BBC, and Channel 4's Brookside.
- HIGH RATING POPULAR ENTERTAINMENT. ITV are broadcasting "Who Wants to be a Millionaire" in widescreen, as are the BBC with their twice weekly "Lottery Programme". The BBC's massive outside broadcast celebrating the Millennium was in 16:9.
- A HIGH PROPORTION OF POPULAR DRAMA - approaching 90% for some broadcasters, including "Casualty" from BBC and "The Bill" from ITV.
- MANY DOCUMENTARIES on Channel 4, ITV and BBC, including the remarkable "Walking with Dinosaurs" that attracted high audiences on BBC1.
- CHILDREN'S PROGRAMMES including "Blue Peter", the famous long-running children's magazine on BBC1.
- BBC NEWS, including the entire output of BBC News 24, with 4:3 news-gathering input processed to 14:9 pillar-box format for 16:9 transmission.
- NEW PROGRAMMING on ITV2, BBC Choice and BBC Knowledge.
- CHANNEL 4 PROGRAMMES are commissioned in 16:9 unless there are special production reasons.

Super 16 mm film has can be used at virtually no additional cost for making programming available in 16:9, and this was a major factor in the early provision of widescreen programmes. Most film drama has been shot in Super 16 by BBC and ITV for about the past eight years, even though the initial broadcasts were in 4:3. Currently BBC, ITV and Channel 4 commission a large proportion, probably about 90%, of their film drama in widescreen. More than 85% of 16mm film sold in the UK is Super 16.

Electronic production has developed more slowly due to the initial capital cost of digital production equipment, and has been largely tied to equipment replacement programmes. The opportunity has been taken over a number of years to ensure that the digital studio and Outside Broadcast equipment that is necessary to replace analogue, is widescreen capable. As a result, there is now a large base of widescreen digital electronic production and post-production equipment available throughout the UK, bringing with it opportunities for the full panoply of electronic studio and OB widescreen production opportunities.

Programme distribution markets are of increasing importance as the number of outlets for widescreen programming grows around the world. 16:9 is the one standard that is common to all new TV systems; and new media such as DVDs are designed to be capable of showing widescreen. Some countries have opted for HDTV transmission, which is itself a widescreen format. Increasingly, producers need to be aware of other markets when decisions on formats are made at the production planning stage.

7 The Market for Widescreen Receivers

The anticipated UK sales volume for 2000 is about 1.35 million sets, almost five times greater than in 1998. This will account for more than half of the regular replacement set market, with a value of some £750 m. The current rate of growth is expected to continue, with sales during 2001 expected to rise to 1.7 million. Sales of IDTV widescreen sets are also rising, forecast to reach 125,000 during 2000.

Sales of analogue widescreen sets are growing at a faster rate in the UK than elsewhere in Europe. There are few analogue widescreen broadcasts, and many of these sets are used with digital set-top boxes.

- The growth rate for the UK widescreen market between 1998 and 1999 was 167%, whereas the average widescreen growth rate in the major European markets was 69%.
- The UK overtook all other European countries in sales of widescreen sets 1998; during 1999 widescreen sales were more than double that of any other country in Europe.
- During the 12 months to the end of August 2000, 61% of the value of the turnover in sales of large-screen television sets was for widescreen.

8 General Conclusions from the UK experience

The transition to digital television is well under way, with more than 1 in 5 households already having access to digital broadcasts: there are over 4 million Sky digital satellite set-top boxes in use, and more than 900,000 terrestrial digital set-top boxes. Overall, the installed base of widescreen televisions has reached 2 million. By the end of 2000 there will be a widescreen television in 1 in 10 UK households, and this proportion is set to rise considerably over the coming years. In conclusion:

- There is a growing awareness amongst the UK public that digital means widescreen..
- It is clear that there is strong public support for widescreen viewing.
- Digital development can benefit from being seen as providing widescreen programmes. They are a highly visible sign that digital is different - and not just more of the same. Even the 14:9 simulcast analogue version is a continuing advertisement for widescreen digital.
- Digital television provides the ideal opportunity for widescreen to be introduced in a way that benefits both broadcaster and viewer. All the elements are in place to allow this to occur to meet editorial requirements and with virtually no legacy problem.
- The UK's practical implementation of appropriate 'safe areas' for wide-screen 16:9 and standard 4:3 aspect ratio productions to achieve a common production format during what is expected to be a transition period to wide-screen 16:9 production and broadcasting, according to the principles described in Recommendation ITU-R BT.1379, has contributed to the successful introduction and rapid growth of digital widescreen broadcasting in the United Kingdom.

Bibliography

- [1] Safe areas for widescreen transmission, Ian Baker, BBC, EBU Technical Review, Edition 280, Summer 1999.
- [2] Framing of wide-screen 16:9 and standard 4:3 aspect ratio productions to achieve a common production format during a transition period to wide-screen 16:9 production and broadcasting, Rec. ITU-R BT.1379.

ANNEX 1

Active Format Descriptors used for digital broadcasts in the UK

AFD Code	Description
0	Full frame - same as coded raster
1	4:3
2	16:9
3	14:9
4	Reserved for future use
5	4:3 - shoot & protect for 14:9
6	16:9 - shoot & protect for 14:9
7	16:9 - shoot & protect for 4:3

NOTES:

1. The 'Description' of the picture shape is that which is carried in the digitally coded video raster, which itself may be either 4:3 or 16:9.
2. In the case of a coded 4:3 raster, the image may be conveyed as letterbox.
3. In the case of a coded 16:9 raster, the image may be 'pillar-box' (i.e., it occupies the full height of the raster).

ANNEX 2

Safe areas for television programmes intended for wide-screen 625-line transmission

These guidelines are aimed at those involved in any stage of the programme-making process and at manufacturers of production equipment for programmes intended to be broadcast using 625-line transmission systems, particularly where simulcasting on 16:9 and 4:3 networks from a single programme master is involved.

Depending on the type of programme, priority for 16:9 productions may be given to protecting the content of the overall 16:9 wide-screen picture area or to protecting the 4:3 central zone. However, protection of the central 14:9 central zone as a compromise option for programmes expected to be viewed on both 16:9 and 4:3 television displays has been found to work well in practice on most types of programme material.

In each case, within the chosen priority zone, two safe areas are needed. All essential action is placed inside an Action Safe area, and all graphics inside a Graphics Safe Area.

For programmes made in the 16:9 wide-screen format protected for the compromise 14:9 central zone, these areas are specified in Appendix 1.

For programmes made in the 16:9 wide-screen format protected for the 4:3 central zone, these areas are specified in Appendix 2. This type of protection is useful where it is required to ensure that protection of a 16:9 picture is acceptable to international broadcasters who require a 4:3 version to have exactly the same protection as an original 4:3 production. This has been found to be particularly useful for some types of sport, and where certain types of international supply contracts exist.

Where there is no requirement to provide compatibility with a 4:3 display, the areas are specified in Appendix 3. Productions made in this way are currently in a minority, but their number could be expected to increase over a period of a number of years as the penetration of wide-screen television receivers grows, and as we move closer to the conclusion of the transition period to wide-screen broadcasting.

For programmes made in the 4:3 format protected for the 14:9 central zone, these areas are specified in Appendix 4.

All the safe areas have been specified on the premise that the overscan on modern domestic television receiver displays will normally be in the range $3.5 \pm 1\%$ of overall picture width or height, but any one picture edge, the overscan should not exceed 4% of total picture width or height. No account is taken of the possibility that viewers might choose to make use of the manual zoom functions available on many wide-screen receivers.

NOTES:

- 1. The text of this Annex is based on Contribution I1A/I18-E (United Kingdom), 31 January 2000: Proposed revision of Recommendation ITU-R BT.1379 - Framing of wide-screen 16:9 and standard 4:3 aspect ratio productions to achieve a common production format during a transition period to wide-screen 16:9 production and broadcasting.*
- 2. These guidelines have been agreed among UK broadcasters, and are being applied for the production of programme material intended for widescreen 625-line transmission in the UK. See also EBU Technical Recommendation R95-1999: 16:9 Widescreen Television Production: Safe Areas.*

APPENDIX 1

**Safe areas for television programmes made in the 16:9 wide-screen format:
Shoot-to-protect the compromise 14:9 central zone**

Clearly the aspect ratios of 16:9 images and 4:3 displays are mutually incompatible. However, a number of broadcasters consider a 14:9 letter-box presentation provides a good compromise for many programme genres when a 16:9 wide-screen production is viewed on a 4:3 display. The wide-screen pictures must be framed to protect the central 14:9 area.

The Action safe area is within the 14:9 zone. However, for the time being, the Graphics safe area should be constrained within the 4:3 central zone to ensure that graphics and captions are adequately protected when viewed under the least favourable conditions.

The table below shows how the action and graphics areas are defined to protect the central 14:9 zone in a 16:9 wide-screen image.

	Vertical	Horizontal		
		16:9 image	14:9 zone	4:3 zone
Action safe margin (14:9)	3.5%	10%	4.2%	-
Graphics safe margin (4:3)	5%	15%	10%	3.3%

Figure 1 shows these areas in more detail.

The definitions of the safe areas are given in numbers of lines and pixels, which are more definitive than the percentages used previously. However, percentages are also included because they are the basis on which comparisons are made. The line numbering has been calculated on the basis that field 1 is paired with the field 2 line below it, and the line from field 1 which is just inside the percentage box is defined as the edge of active picture.

Thus the drawings give the first and last lines and the first and last pixels which are inside the safe areas.

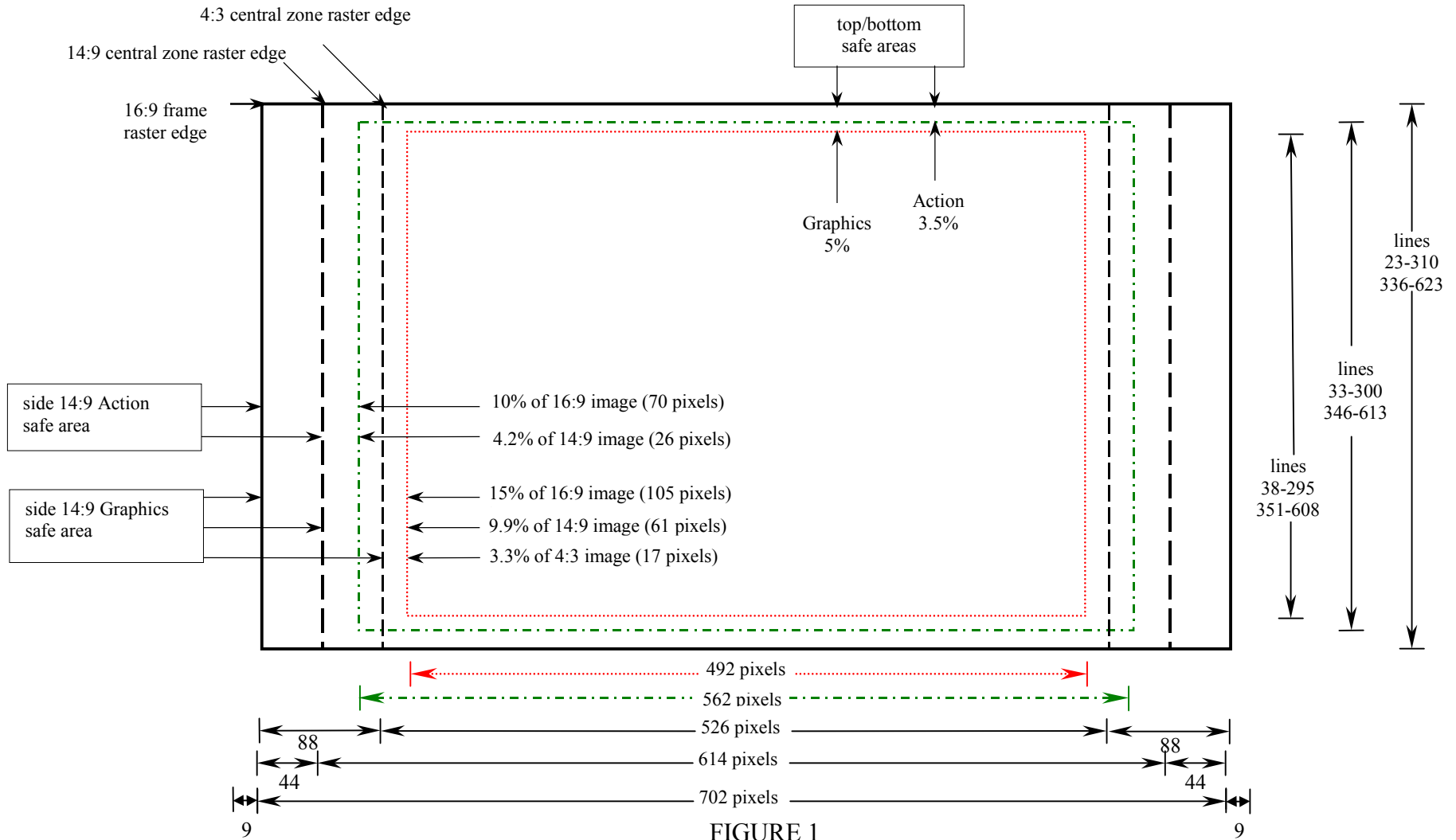


FIGURE 1

16:9 Shoot-to-protect 14:9 Action and Graphics Safe Areas

APPENDIX 2

Safe areas for television programmes made in the 16:9 wide-screen format: Shoot-to-protect the 4:3 central zone

For certain programme genre there is a requirement to fully protect the 4:3 central zone for action and graphics. This may include sports productions, or where a fully compatible 4:3 image is required for international sales or on-passing to another broadcaster.

If the policy of the programme maker and/or the commissioner is to present 16:9 images on 4:3 services in the full screen mode, the central 4:3 zone should be protected. This will ensure that 16:9 pictures are "4:3 compatible". That is, the extracted 4:3 pictures will:

- frame the main subject of the 16:9 picture;
- comply with the normal artistic practice of framing in 4:3.

The table below shows how the action and graphics areas are defined to protect the central 4:3 zone in a 16:9 wide-screen image.

	Vertical	Horizontal	
		16:9 image	4:3 zone
Action safe margin	3.5%	15%	3.3%
Graphics safe margin	5%	17.5%	6.7%

Figure 2 shows these areas in more detail.

The definitions of the safe areas are given in numbers of lines and pixels, which are more definitive than the percentages used previously. However, percentages are also included because they are the basis on which comparisons are made. The line numbering has been calculated on the basis that field 1 is paired with the field 2 line below it, and the line from field 1 which is just inside the percentage box is defined as the edge of active picture.

Thus the drawings give the first and last lines and the first and last pixels which are inside the safe areas.

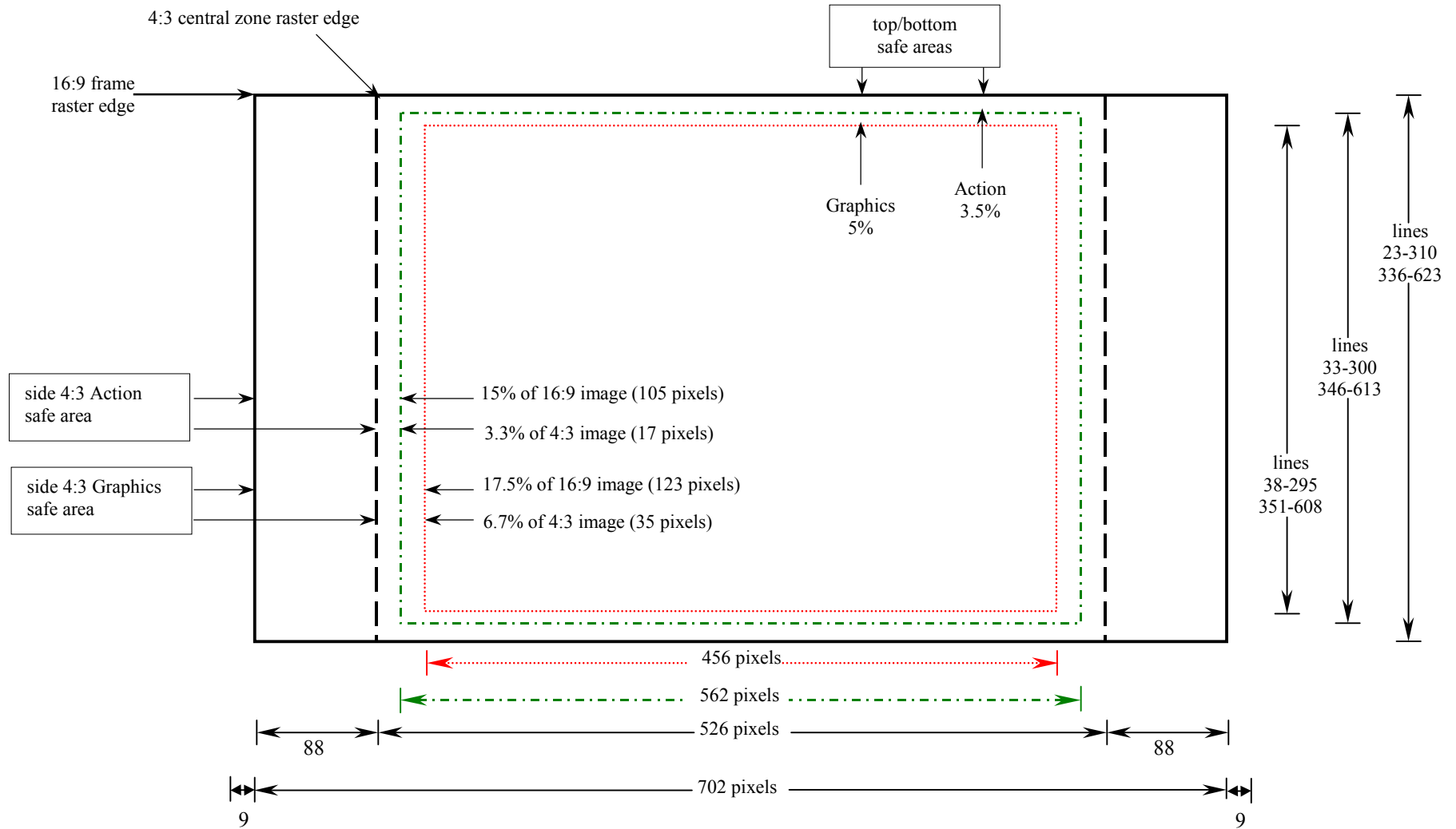


FIGURE 2

16:9 Shoot-to-protect 4:3 Action and Graphics Safe Areas

APPENDIX 3

Safe areas for television programmes made in the 16:9 wide-screen format: Shoot-to-protect the 16:9 full image

The table below shows how the action and graphics areas are defined to protect the full 16:9 wide-screen image. The horizontal graphics safe area is narrower to take account of the greater overscan on older receivers, which may affect wide-screen pictures when viewed in letterbox presentation.

	Vertical	Horizontal
Action safe margin	3.5%	3.5%
Graphics safe margin	5%	10%

Figure 3 shows these areas in more detail.

The definitions of the safe areas are given in numbers of lines and pixels, which are more definitive than the percentages used previously. However, percentages are also included because they are the basis on which comparisons are made. The line numbering has been calculated on the basis that field 1 is paired with the field 2 line below it, and the line from field 1 which is just inside the percentage box is defined as the edge of active picture.

Thus the drawings give the first and last lines and the first and last pixels which are inside the safe areas.

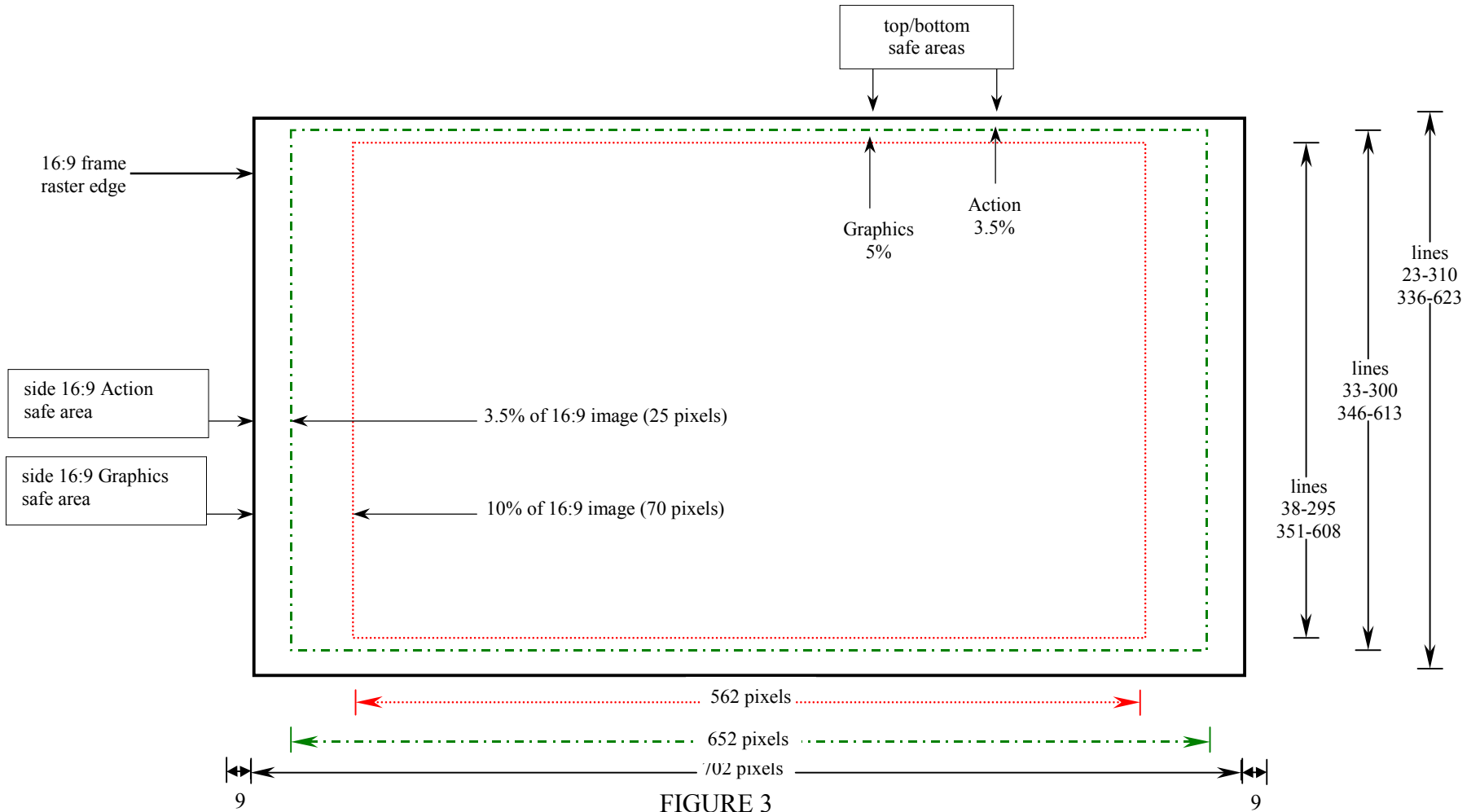


FIGURE 3

16:9 Shoot-to-protect the 16:9 full image

APPENDIX 4

Safe areas for television programmes made in the 4:3 wide-screen format: Shoot-to-protect the 14:9 central zone

For certain programmes shot in 4:3 there is a requirement to protect the 14:9 central zone for action and graphics; for example, in cases where it is required that the 14:9 central zone be placed in a 16:9 frame for digital transmission.

The table below shows how the action and graphics areas are defined to protect the central 14:9 zone in a 4:3 image.

	Vertical		Horizontal
	4:3 image	14:9 zone	
Action safe margin	10%	3.3%	5%
Graphics safe margin	11.5%	5%	10%

Figure 4 shows these areas in more detail.

The side safe areas are a compromise, but they allow protection of graphics when the 14:9 image is placed in a 16:9 wide-screen frame, and when such transmissions are viewed in the least favourable conditions by extraction of a 4:3 centre cut-out. In such circumstances there is a minimal loss of safe action area. Figure 5 shows this situation in more detail.

The definitions of the safe areas are given in numbers of lines and pixels, which are more definitive than the percentages used previously. However, percentages are also included because they are the basis on which comparisons are made. The line numbering has been calculated on the basis that field 1 is paired with the field 2 line below it, and the line from field 1 which is just inside the percentage box is defined as the edge of active picture.

Thus the drawings give the first and last lines and the first and last pixels which are inside the safe areas.

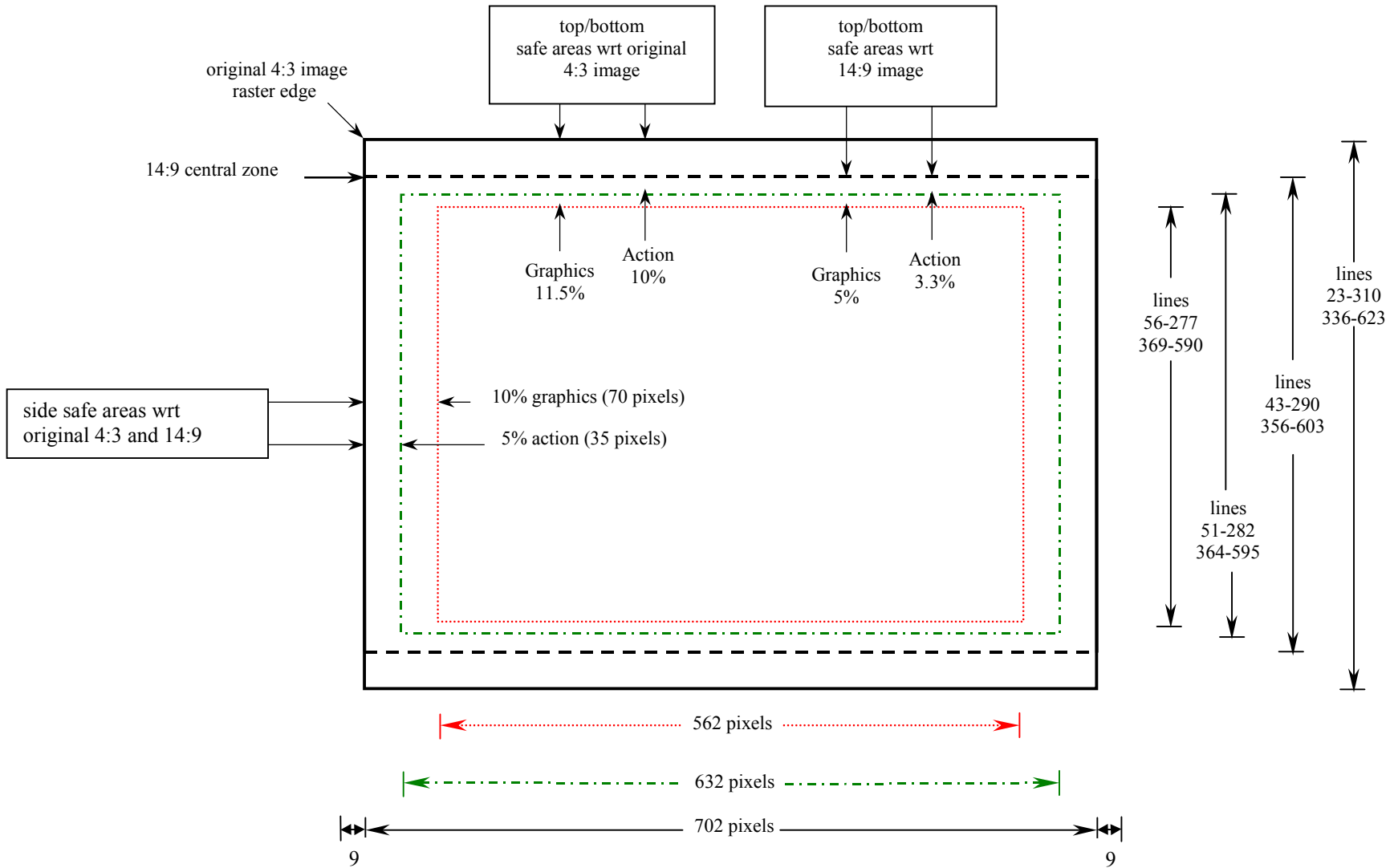


FIGURE 4

4:3 Shoot-to-protect 14:9 Action and Graphics Safe Areas

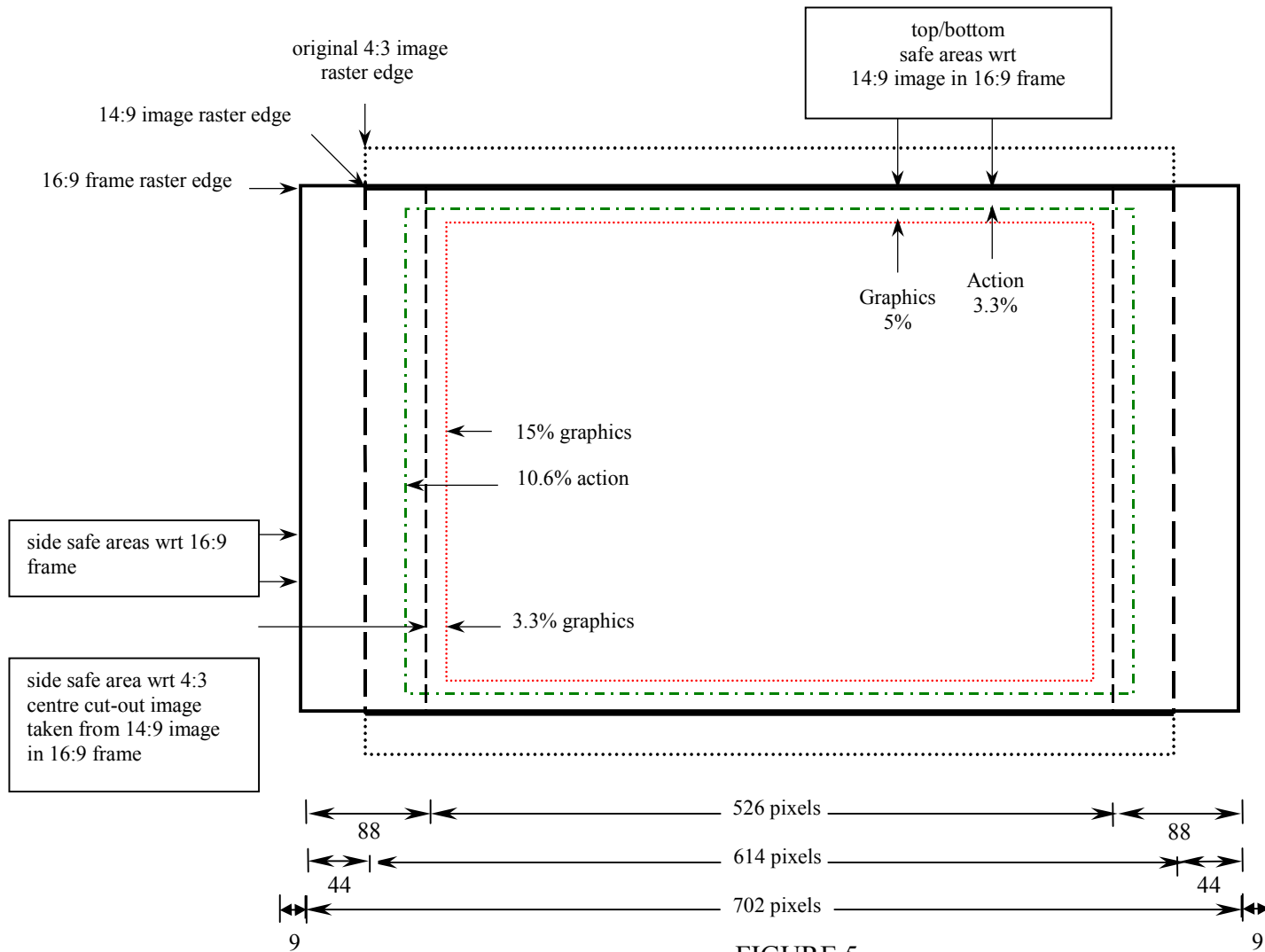


FIGURE 5

4:3 Shoot-to-protect 14:9 Action and Graphics Safe Areas: resulting 14:9 image when transmitted within 16:9 frame