



**Recommendation ITU-R F.1777-2**  
**(01/2018)**

**System characteristic of television outside  
broadcast, electronic news gathering and  
electronic field production in the fixed  
service for use in sharing studies**

**F Series**  
**Fixed service**

## Foreword

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<b>SNG</b>	Satellite news gathering
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*Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

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## RECOMMENDATION ITU-R F.1777-2\*

**System characteristic of television outside broadcast, electronic news gathering and electronic field production in the fixed service for use in sharing studies**

(Question ITU-R 252/5)

(2007-2015-2018)

**Scope**

This Recommendation, dealing with system characteristics of television outside broadcast (TVOB), electronic news gathering (ENG) and electronic field production (EFP) in the fixed service for use in sharing studies contains the typical system parameters and operational requirements for these broadcast auxiliary services (BAS)<sup>1</sup>, which are required for sharing studies between the analogue and digital BAS in the fixed service and other radiocommunication services.

**Keywords**

Electronic news gathering (ENG), system characteristics

The ITU Radiocommunication Assembly,

*considering*

- a) that some administrations operate extensive terrestrial broadcast auxiliary services (BAS) under fixed service (FS) allocations;
- b) that administrations who operate analogue terrestrial BAS under FS allocations are likely to continue for a reasonable amount of time into the future;
- c) that some administrations are migrating from analogue to digital terrestrial BAS under FS allocations;
- d) that many administrations are likely to operate both terrestrial analogue and digital electronic news gathering (ENG) and television outside broadcast (TVOB) equipment under FS allocations for a reasonable amount of time in the future;
- e) that the frequency bands used for these BAS including TVOB, ENG and electronic field production (EFP) are, in many cases, shared by the FS and other services;
- f) that system characteristics for BAS including TVOB, ENG and EFP are different from those of typical fixed wireless systems (FWSs) as originally found in Recommendation ITU-R F.758;
- g) that it is desirable to identify the system parameters and operational characteristics for BAS applications including TVOB, ENG and EFP for efficient sharing studies with other services,

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\* This Recommendation should be brought to the attention of Radiocommunication Study Group 6.

<sup>1</sup> The term "BAS" also known as services ancillary to broadcasting (SAB) is defined in Report ITU-R BT.2069.

*noting*

- a) Report ITU-R BT.2069 – Tuning range and operational characteristics of terrestrial electronic news gathering systems (ENG), provides specifications on TVOB, ENG and EFP;
- b) Recommendation ITU-R M.1824 – System characteristics of television outside broadcast, electronic news gathering and electronic field production in the mobile service for use in sharing studies;
- c) that as digital terrestrial BAS is the more sensitive service, successful sharing studies conducted with digital BAS assume that analogue BAS will be protected,

*recommends*

- 1 that the description of the user requirements and key characteristics of analogue and digital terrestrial BAS in Annexes 1 and 2 be used by administrations seeking to operate these applications in the frequency bands allocated to the FS sharing with other services;
- 2 that the parameters described in Annex 2 should be used for sharing studies between digital BAS and other services;
- 3 that, for typical sharing considerations including development of criteria for these applications, the basic principles provided in Recommendation ITU-R F.758 should be used.

## **Annex 1**

### **System characteristics and user requirements for BASs including TVOB, ENG and EFP**

#### **1 Overview**

Certain bands allocated to the FS are used for fixed wireless links to provide BASs which are “contribution” links (i.e. an input to the broadcast studio) usually operated by television broadcasters and vital for the production of various television programmes. These services are commonly known as:

*Television outside broadcast (TVOB)*: a planned use of group links using a variety of techniques to provide specialist coverage of an event.

*Electronic news gathering (ENG)*: the rapid, unplanned deployment of links to cover breaking news events, generally for short periods of time.

*Electronic field production (EFP)*: a planned use of links to provide elements of a television production, can be “live” to air or recorded for later broadcast, generally with more elaborate television production values.

The later sections in this Annex provide basic descriptions for these applications within the scope of this Recommendation. For more detailed information, Report ITU-R BT.2069 could be referenced.

## 1.1 TVOB

Operations for TVOB can range across a number of events which may include live entertainment, sports and other events of national or worldwide importance.

TVOB involves the transmission of events back to a studio facility for inclusion as programme material. TVOB operations are generally planned (e.g. sports broadcasts, concerts) multicamera live-to-air events. Such events may take place almost anywhere, but typically take place in urban area venues. Television broadcasters operate multiple OB trucks with TVOB links, in addition to typical fixed links, in locations of high-population density and locations where TVOB events are frequently scheduled.

The TVOB point-to-point (P-P) links generally involve the use of directional antennas (e.g. parabolic) and relatively low elevation angles. Operational duration ranges from a few minutes up to several days, depending upon the type of event and its timing.

In many cities, TVOB collection sites in the bands assigned for them are often mounted on the broadcast tower facilities located near the edge of the urban area.

## 1.2 ENG

Operational requirements for ENG include fixed, nomadic and mobile applications ranging from stationary reporting by journalists, mobile camera coverage of scenes of regional and world conflict to aerial coverage of natural disasters. Much news gathering takes place in the central business districts of major cities, including sites close to major airports through to rural areas.

ENG operations often involve the setting up of an unplanned P-P link or series of links. For daily news gathering in major city areas, broadcast network operators have utilized fixed collection sites operating in a number of bands for analogue or digital ENG. ENG transmissions are consolidated from multiple nomadic operations over a large (up to 100 km radius) area. ENG collection sites are operated, in most cases, by TV networks in major city areas where the typical central collection site is located within the city centre, on the roof of a high building (e.g. 150 m above the surrounding terrain), including a range of steerable (e.g. parabolic dish) and fixed (e.g. panel arrays with 360° of azimuthal coverage). Many TV networks often have an alternative dedicated ENG collection site mounted on their broadcast transmission tower. In most cities these are located near the edge of the urban area.

## 1.3 EFP

As an extension of a television studio production, EFP is planned and requires higher production values that dictate a higher quality level in the video link performance. EFP operations are facilitated through the use of radio cameras, affording the operator with additional flexibility and avoiding the need for troublesome cables. Radio cameras relay programme material from portable cameras (e.g. as carried by a field cameraman) to a transportable or fixed receiving point, typically with path lengths of up to a couple of hundred metres. Typically, radio cameras operate at lower power levels and low gain omnidirectional transmitting antennas are used. Radio camera operation tends to be limited by battery life with operations lasting up to one hour in duration.

Many other characteristics, however, are similar to ENG, including use of the collection sites.

## 2 Specific operational characteristics affecting sharing considerations

BAS including TVOB, ENG and EFP are used in a number of configurations and operational locations. Therefore, they are not characterized with operational characteristics typical to general FS systems, and this has led to separate considerations in ensuring frequency sharing with various services operating in the same bands. Currently the operation of BAS may be likened to “nomadic” applications.

By their very nature, BAS links are not planned in the same manner as other fixed links as they are deployed in response to breaking news events or to follow action of a sporting event. The BAS service could be likened to a *broadcaster toolkit* (including a variety of transmitters, antennas and receivers) used in a spectrum toolbox. The tools are chosen on an as-needed basis to cover a particular event.

Whilst a BAS operator will predominantly operate within the bounds of their *home* administration, globalization of news and sport often requires them to temporarily relocate their equipment to operate within other administrations.

The operational deployment characteristics of BAS are typically listed as follows:

*Geographic spread of operations:* Fixed collection sites located near city centres of major and capital cities. Nomadic news collection and sporting events principally around the major city and urban areas, but potentially anywhere where news events occur. EFP and TVOB operations located on an event-by-event basis.

*Link densities:* Major TV networks operate TVOB/ENG collection sites in major cities. For ENG operations news crews perform between one to five ENG collection operations per day, each of between half an hour up to a one-hour duration per broadcaster. The very nature of competitive news broadcasting creates peak usage times where all channels are operated simultaneously.

*Operational times/duration:* TVOB/ENG collection sites operate continuously, picking up program material from nomadic news teams using mobile and transportable ENG equipment. Events take place at any time of the day, with fewer events taking place at night, between about 2400 h and 0400 h. ENG collections have been typically between about 1/2 h to 1 h in duration, with special event collections involving durations of between 2 to 5 h. On occasions some operations have extended over days or even weeks. EFP operations tend to be between 3 and 8 h. With the introduction of digital ENG technology, the different functionality of digital systems have permitted broadcasters more flexibility to cover an increased number of events within the bandwidth assigned to BAS.

## 3 Equipment characteristics

BAS operations involve a variety of equipment including transmitters mounted on the back of cameras and in other specialized applications such as temporary fixed links and vehicle mounted links.

Likewise a variety of receivers are deployed to suit the situation. These range from a small antenna deployed at a BAS collection site for reception of camera-back transmitters to a central receiving site.

### 3.1 Central receiving sites

Analogue TVOB/ENG operations have utilized a variety of antennas, including parabolic dish and co-linear with ENG collection receiving stations typically using medium-gain horn arrays with terrestrial coverage over the full azimuth range. The characteristics of analogue FM modulated video signals dictated that only one antenna could be used into one receiver at a time. Digital technology allows numerous antennas to be connected in an array to a diversity receiver which selects the optimum signal automatically at any instant in time. The antenna types may be a mixture of steerable

(e.g. parabolic dish), fixed panel arrays with up to 360° of azimuthal coverage. Additionally, diversity reception techniques are employed between collection sites to feed one “master” decoder and hence provide continuous coverage over a wider area. Now digital ENG systems have moved to a cellular-type of operation whereby a network of collection sites provides coverage over the wanted service area.

### **3.2 Operational requirements of BAS equipment**

The design of BAS systems including TVOB, ENG and EFP has the following requirements (see Note 1):

- The transmission equipment must be robust and suitable for mounting in mobile vehicles.
- The transmitter must be capable of speedy set-up, allowing relatively unskilled staff to arrive at a news event and commence broadcasting very quickly.
- The entire system must be expandable to allow the number of stations using the repeater simultaneously, the number of local encoders at the repeater site or the number of repeater sites to be increased.
- The quality and robustness of the microwave link must be sufficient to allow reliable, broadcast quality transmissions to be received from almost anywhere within the broadcaster’s defined service region.
- The transmission frequency must be selectable to enable avoidance of congestion that may be prevalent in some bands.
- BAS collection sites should have the capability of transmitting and receiving so they can act as a repeater.
- BAS repeater sites, which may be located on tall buildings, should be capable of providing reception and transmission for a number of simultaneous operations thus providing encoding to a number of feeds to studios.

NOTE 1 – The term “BAS systems” includes equipment used for central receiving sites discussed in the previous section and collection equipment which are, in many cases, operated in nomadic or mobile applications. When they are operating in moving vehicles, their characteristics are basically outside the scope of this Recommendation. The operational requirements above, however, are common to all the applications.

## **4 Other considerations on BAS operations**

### **4.1 Migration from analogue to digital television including high-definition broadcasts**

Many administrations have commenced or have completed the introduction of digital television services including high-definition broadcasts. The migration from analogue to digital technology for BAS has to support high-definition television broadcast requirements.

For this and for the ongoing improvement in the quality and/or other capability of video, audio and associated data channels, the design of digital systems must accommodate both standard definition as well as high-definition television signals impacting upon the equipment performance.

Where analogue ENG operations have been concentrated around major city and urban areas, ENG operators have configured centrally located “collection” sites that have utilized wide-beam horn array antennas. These “collection” site fixed receiving station antennas have been vulnerable to co-channel interference.

Analogue ENG systems have found that around tall buildings ENG operations have always been problematic. In a terrestrial urban environment, it is not always possible to guarantee a line-of-sight of the ENG signal path. With analogue FM modulation techniques multipath interference is often suffered and the signal can be unusable. Video links for ENG are difficult to set up in these conditions, requiring time, many staff and a line-of-sight to the receiving antenna. Depending upon the circumstances ENG operators may resort to recording ENG inserts and not transmit live at all.

As digital systems have a longer drop-out recovery time, analogue modulation had been preferred in some situations where the link may have momentary drop-outs. For example, the high-speed action of motor racing broadcast from a race car incurs drop-outs when the car passes under a pedestrian bridge. In the following second where a digital link recovers, an analogue link may provide an exciting action for the viewer. This impediment has been under study as the need increases to migrate to digital.

Digital BAS add encoders and decoders to the toolkit allowing the broadcaster to modify spectrum utilization to suit the event. Coded orthogonal frequency division multiplex (COFDM) modulation has been chosen by designers of digital ENG systems in consideration of the elements known to break conventional modulation techniques, including:

- multipath signals;
- operation with significant frequency errors introduced by Doppler shift;
- use of a low-cost, omnidirectional transmit antenna;
- operation with varying signal strengths and very low signal-to-noise ratios;
- environmental noise.

COFDM modulators are designed to offer different levels of QAM modulation and inner code rates in 6, 7 or 8 MHz bandwidths to trade usable bit rate (for the video encoder) versus ruggedness of the link. As digital BAS links are on the input or contribution side of a broadcast system, the highest bit-rate is preferred to minimize concatenation effects of multiple video encode/decode cycles through the broadcast chain. Coding parameters based on 8 MHz channels provide a range of usable data rates from 4.976 Mbit/s to 31.668 Mbit/s by selection of bandwidth, guard interval, forward error correction (FEC) and modulation type.

QPSK, 8-PSK and 16-QAM modulation over a variable bandwidth offer a selection of FEC, modulation type and channel bandwidth and may be used to trade ruggedness of the link versus usable bit rate.

In a 24 MHz channel, bit rates of up to 64.51 Mbit/s may be transmitted, or in a 32 MHz channel, rates exceeding 85 Mbit/s may be achieved. High definition video encoding systems utilizing MPEG-2 are widely available which produce a satisfactory video quality at these bit rates, however, advanced coding techniques under development promise to lower the bit rates required for high-definition links.

## 4.2 Differences between FWSs and BAS

The principal difference between conventional FWS and BAS operations is the wide range of antenna types with wider main beam radiation patterns deployed for BAS. Many of these antennas exhibit considerable asymmetry in the azimuth versus elevation planes. BAS “collection” sites are fixed receiving stations utilizing antennas that may be vulnerable to interference from emitters with arrival angles somewhat higher than conventional P-P systems.

BAS operations may be bidirectional P-P, but more usually involve one or more one-way transmissions from nomadic/mobile news cameras to a fixed network access point, for onward transmission to a central studio location.



## **Annex 2**

### **Digital FS system parameters for BAS**

The following system characteristics of BAS, including TVOB, ENG and EFP are intended for use in sharing studies between these BAS in the FS and other radio services.

Table 1 provides system parameters for digital BAS systems. Whilst in practice a range of operating parameters may be employed, this example provides a representative sample of the system parameters developed to date.

TABLE 1  
Digital FS system parameters for BAS Video Systems

Frequency band (GHz)	0.770 < f < 0.806	1.240 < f < 1.300 2.330 < f < 2.370		2.025 (f < 2.110) 2.200 (f < 2.290) 2.500 (f < 2.690) 3.400 (f < 3.600)			5.850 < f < 8.500 10.250 < f < 13.250			41.000 < f < 42.000		
				QPSK	64-QAM	16-QAM	QPSK-OFDM 16-QAM-OFDM 32-QAM-OFDM 64-QAM-OFDM	64-QAM	QPSK 16-QAM 32-QAM 64-QAM			QPSK-OFDM 16QAM-OFDM 8-PSK 16-QAM
Modulation	QPSK-OFDM 16-QAM-OFDM 32-QAM-OFDM	QPSK-OFDM 16-QAM-OFDM 32-QAM-OFDM 64-QAM-OFDM		QPSK	64-QAM	16-QAM	QPSK-OFDM 16-QAM-OFDM 32-QAM-OFDM 64-QAM-OFDM	64-QAM	QPSK 16-QAM 32-QAM 64-QAM	QPSK-OFDM 16QAM-OFDM 8-PSK 16-QAM		
Capacity (Mbit/s)	Up to 16	Up to 30	Up to 60	Up to 10.556	Up to 31.668	Up to 64.51	Up to 30	Up to 60	Up to 40	Up to 66	Up to 120	Up to 240
Channel spacing (MHz)	9	9	18	8	8	24	9	18	9	18	62.5	125
Maximum Rx antenna gain (dBi)	15	19	19	27	27	27	35	35	45	35	40	40
Feeder/multiplexer loss (minimum) (dB)	Tx 1 Rx 1	Tx 1 Rx 1	Tx 1 Rx 1	Tx 0.5 Rx 0.2	Tx 0.5 Rx 0.2	Tx 0.5 Rx 0.2	Tx 1 Rx 1	Tx 1 Rx 1	Tx 1 Rx 1	Tx 1 Rx 1	Tx 0.1 Rx 0.1	Tx 0.1 Rx 0.1
Antenna type (Tx and Rx)	Colinear/ Yagi	Colinear/ Yagi	Colinear/ Yagi	Various	Various	Various	Parabolic	Parabolic	Parabolic	Parabolic	Various	Various
Maximum Tx antenna gain (dBi)	10	19	19	25	25	25	35	35	45	35.24	40	40
Maximum Tx output power (dBW) <sup>(1)</sup>	7	11 <sup>(4)</sup> 13 <sup>(5)</sup>	14 <sup>(4)</sup> 16 <sup>(5)</sup>	6	6	6	4	7	3	1.76	0	0
e.i.r.p. (maximum) (dBW) <sup>(2)</sup>	16	29 <sup>(4)</sup> 31 <sup>(5)</sup>	32 <sup>(4)</sup> 34 <sup>(5)</sup>	32.5	32.5	32.5	38	41	47	36	39.9	39.9
Receiver IF bandwidth (MHz)	9	9	18	8	8	24	9	18	9	18	62.5	125
Adjacent channel selectivity (dB)	-40 <sup>(6)</sup>	-40 <sup>(6)</sup>	-40 <sup>(7)</sup>	-75	-75	-75	-40 <sup>(6)</sup>	-40 <sup>(7)</sup>	-50 <sup>(8)</sup>	-40 <sup>(9)</sup>	-20 <sup>(10)</sup>	-20 <sup>(11)</sup>
Adjacent channel guard band (MHz)	Not specified	Not specified	Not specified	≥ 5			Not specified	Not specified	Not specified	Not specified	Not specified	Not specified
Receiver noise figure (dB)	4	4	4	2.5	2.5	2.5	4	4	4	4	10	10

TABLE 1 (end)

Frequency band (GHz)	0.770 < f < 0.806	1.240 < f < 1.300 2.330 < f < 2.370				2.025 (f < 2.110) 2.200 (f < 2.290) 2.500 (f < 2.690) 3.400 (f < 3.600)			5.850 < f < 8.500 10.250 < f < 13.250				41.000 < f < 42.000	
Receiver thermal noise (dBW)	-130.5	-130.5		-127.4		-132.3	-132.3	-127.6	-130.5	-127.4	-131.5	-127.4	-116.0	-113.0
Nominal Rx input level (dBW)	-88	SISO <sup>(12)</sup>	MIMO <sup>(13)</sup>	SISO <sup>(12)</sup>	MIMO <sup>(13)</sup>	-85	-70	-75	-88	-85	-88	-91	-92.8	-90.1
		-93	-103	-97	-100									
Rx input level for 1 × 10 <sup>-3</sup> BER (dBW)	-120	-119.6 <sup>(14)</sup>	-121.5 <sup>(14)</sup>	-116.5 <sup>(14)</sup>	-118.4 <sup>(14)</sup>	-125	-112	-115	-120	-116.9	-104 <sup>(14)</sup>	-116.9	-106.0 <sup>(14)</sup>	-103.0 <sup>(14)</sup>
	-113	-113.0 <sup>(14)</sup>	-111.5 <sup>(14)</sup>	-109.9 <sup>(14)</sup>	-108.4 <sup>(14)</sup>				-113	-109.9	-109.9	-98.8 <sup>(14)</sup>	-95.8 <sup>(14)</sup>	
	-110.7	-110.0 <sup>(14)</sup>	-	-106.9 <sup>(14)</sup>	-				-110.7	-107.6	-107.6	-102.5 <sup>(14)</sup>	-99.5 <sup>(14)</sup>	
		-107.2 <sup>(14)</sup>	-	-104.1 <sup>(14)</sup>	-				-108.2	-105.1	-105.1	-98.8 <sup>(14)</sup>	-95.8 <sup>(14)</sup>	
Nominal long-term interference (dBW) <sup>(3)</sup>	-140.5	-140.5		-137.4		-142.3	-142.3	-137.6	-140.5	-137.4	-141.5	-137.4	-126.0	-123.0
Spectral density (dB(W/MHz))	-146.0	-150.0		-150.0		-147.3	-147.3	-147.3	-146.0	-146.0	-151.0	-146.0	-144.0	-144.0

- (1) For the band 10.6-10.68 GHz, which is shared with the Earth exploration-satellite service (passive), there are the restrictions on maximum transmitter power as -3 dBW and maximum e.i.r.p. as 40 dBW, except some countries in accordance with No. 5.482 of the Radio Regulations (RR).
- (2) For the band 10.6-10.68 GHz, which is shared with the Earth exploration-satellite service (passive), there are the restrictions on maximum transmitter power as -3 dBW and maximum e.i.r.p. as 40 dBW, except some countries in accordance with RR No. 5.482.
- (3) Based on an I/N-th criterion of -10 dB. I/N-th = -6 dB is applicable to cases where the sharing with the terrestrial co-primary services with an interference affecting a limited portion of service area.
- (4) For the band 1.215 GHz-1.300 GHz.
- (5) For the band 2.300 GHz-2.450 GHz.
- (6) Filter characteristic of a receiver at 6.75 MHz from channel centre frequency.
- (7) Filter characteristic of a receiver at 13.5 MHz from channel centre frequency.
- (8) Filter characteristic of a receiver at 6.7 MHz from channel centre frequency.
- (9) Filter characteristic of a receiver at 14.0 MHz from channel centre frequency.
- (10) Filter characteristic of a receiver at 62.5 MHz from channel centre frequency.
- (11) Filter characteristic of a receiver at 125 MHz from channel centre frequency.
- (12) SISO stands for Single Input Single Output system.
- (13) MIMO stands for Multiple Input Multiple Output system.
- (14) Rx input level for 1 × 10<sup>-4</sup> BER.