"TELEVISION TRANSMISSION SYSTEM"

The invention relates to a television transmission system having a time multiplexed signal in component form the majority of the lines of a frame period of which contain a first component comprising a digital data burst and a second component comprising vision information, the data in successive data bursts in a frame period, which data is derived from a plurality of sources, being assembled as a series of data bits at a given data bit rate. The invention also relates to such a system for use over a media of restricted bandwidth and also to equipment for use with such a system.

Such a data transmission system has been proposed for use with the broadcasting of television signals from satellites where the sound and other data (apart from the main vision components) are to be broadcast in digital form.

Following the decision in March 1982 that direct broadcast by satellite (DBS) of television programmes for the United Kingdom would commence in 1982 an Advisory Panel chaired by Sir Anthony Part was established to report on technical transmission standards. The findings of this Panel published in November 1982 by Her Majesty's Stationery Office as Cmnd 8751 "Direct Broadcasting by Satellite - Report of the Advisory Panel on Technical Transmission Standards" (known as the Part Report) recommended that the Independent Broadcast Authority's Multiplexed Analogue Component (C-MAC) system should be adopted for DBS, which recommendation has subsequently been accepted.

The C-MAC system has been described in the Independent Broadcast Authority's Experimental and Development Report 118/82 "MAC - A Television System for High-Quality Satellite Broadcasting" dated August 1982, this report also describing the A-MAC system (the prefix relating to the type of sound and other data transmission). Proposed specifications were included in this report for the two systems, that for the C-MAC system having been revised since the adoption of that system for DBS. The changes in the structure of the video waveform include a reduction in

transition periods following the sound/data, chrominance and luminance components with a consequent lengthening of the sound/data component.

Figure 1 of the accompanying drawings (which is not to scale) diagrammatically shows one line period of a C-MAC television signal which occupies 64μs and each line is divided notionally into a number of bit or sample periods at a clock rate of 20.25MHz, there being 1296 such samples per line. Figure 1 is derived from Figure 1 on page 11 of the European Broadcasting Union (EBU) Draft New Report "Television Standards for 625-line 12 GHz Satellite Broadcasting", SPB 284, dated June 1983, the entire contents of which is incorporated herein by way of reference. Each line contains the following in the sequence given:-

a =	203 bits	- synchronisation, sound/data (data burst)
b =	4 samples	- transition from end of data
c =	15 samples	- main clamp period (zero-level of chrominance reference)
SC1 =	6 samples	- reserved for vision scrambling.
d =	354 samples	- chrominance (C)
g =	704 samples	- luminance (Y)
SC2 =	6 samples	- reserved for vision scrambling.
h =	4 samples	- transition into data.

The chrominance component is time compressed by 3:1 so that approximately 52μs of chrominance information is compressed to occupy 17.48μs (354 samples) with the R-Y colour difference signal being transmitted on alternate lines and the B-Y colour difference signal being transmitted on the intervening lines. The luminance component is time compressed by 3:2 so that approximately 52μs of luminance information is compressed to occupy 34.76μs (710 samples). For DBS transmissions the compressed chrominance and luminance components are frequency modulated with a bandwidth of 27MHz whilst the radio frequency carrier is modulated using 2-4 phase shift keying (2-4 PSK) by the digital sound/data component. The current proposal is that the sound/data component shall be packet multiplexed and located in 624 lines of each television

frame, each packet comprising 751 bits made up from the 195 bits available in each line for the 624 lines (the first 8 bits of each data burst comprising 1 bit for data run-in followed by 7 bits forming a line sync. word). This is shown in Figure 2 which is derived from Figure 2 of the above mentioned EBU Report, a packet occupying approximately 3.85 of the 195 bit data periods of each television line whilst the whole of line 625 is arranged to carry data as explained in this EBU Report. In Figure 2:-

S - is the line sync. word

L1 to L625 - are the line numbers of the data burst

V - is the area occupied by the vision signal

P1 to P162 - are the packets, and

L625D - is the data in line 625

Whilst it will be possible for households to directly receive the DBS transmission by means of a dish aerial of appropriate size sighted onto the satellite, with a down-converter at the aerial to bring the frequency of the incoming transmission to just above the broadcast U.H.F. bands, it has also been suggested that many households will prefer to receive such transmission via a cable television distribution system which at the same time can convey other television programmes whilst doing away with the need for individual aerials. Such distribution by way of cable will obviously have advantages where the signal from the satellite is weak e.g. the transmission is not primarily intended for the country in which it is received, where transmissions are being received from a number of satellites located in different geostationary positions thus requiring a complex aerial array, or in areas of high occupancy where the sighting of aerials may be difficult.

Chapter 7 of the Part Report deals with the interaction between DBS and cable distribution systems and it is reported that the Cable Television Association of Great Britain considered they would be able to provide a cable service even if C-MAC was chosen as the DBS transmission standard. Several examples are given in that chapter and where appropriate to C-MAC the inference is that

this type of signal could be directly transmitted over cable systems. Present cable transmission systems use co-axial cable conveying their television programmes in the V.H.F broadcast band and whilst there is much debate at present as to whether future installed systems should use optical fibre cables it is quite likely that many of the systems yet to be installed will also be co-axial cable in view of lower installation cost.

It has recently been realised that the transmission of a C-MAC signal over a VHF cable transmission system is not as feasible as originally thought as the 27MHz bandwidth of such a signal would occupy too much bandwidth thus reducing the number of programmes that such a cable system could carry and there is also opposition especially in Continental Europe to extending the channel spacing of the cable channels which at present stands at 7 MHz. In addition transmission of the sound/data component at the high 20.25Mbit/s rate would pose severe problems on such cable systems because of the short delay reflections produced and there is therefore a much lower bit rate limit for such cable systems. With the above in mind early suggestions were that the only practical way of handling such a signal over a VHF cable transmission system would be to convert the C-MAC signal into a PAL type signal prior to its application to a cable system. Such a conversion would lose the advantage of time multiplexed chrominance and luminance and re-introduce the defects of cross-luminance and cross-colour present with colour subcarrier systems but more important where the received DBS signal is scrambled to prevent unauthorised reception e.g. subscription television services, it would be necessary to descramble the signal prior to conversion and then rescramble the converted signal.

In our co-pending United Kingdom Patent Application No. 8306921 published as UK Patent Application GB 2 137 843 A we proposed to overcome the above problem by amplitude modulating the vision component (compressed chrominance and compressed luminance) and by expanding the data burst (the digital sound/data component) such that it had a lower bit rate so that it can then modulate a

separate carrier. Whilst this proposal substantially reduces the bandwidth requirements it still needs a bandwidth of about 14 MHz which is virtually the bandwidth of two channels and which has not found favour with cable operators wishing to contain such a DBS signal within a single channel.

It has subsequently been appreciated that the vision components for a MAC system if subsequently amplitude modulated can be bandwith limited to conveniently lie within the 7 MHz channel spacing available to European cable operators and still produce after decompression a television picture which is at least as good as displays produced from transmitted PAL television signals whilst not suffering from the cross colour and cross luminance defects of such PAL signals. However, this still presents a problem with the sound/data components especially if they are not to be used to modulate a separate carrier for reasons of bandwidth but have to be retained time multiplexed in the data burst period of the MAC signal. One suggestion for cable operation by the German Post Office has been to remodulate all the sound/data components as a quaternery signal still retaining the bit rate of 20.25 Mbits per second but which effectively consists of symbols at a 10.125 MHz rate where each symbol is one of four levels and carries two bits of information. However, this proposal has been found to be very sensitive to reflection in a cable, to be difficult to recover the clock frequency from, and the signal has both small vertical and horizontal eyes. A further suggestion has been to halve the bit rate such that it is 10.125 Mbits per second which has shown itself to be acceptable for transmission over cable when used with duo-binary coding (a three level signal where there is intentional inter-symbol interference) where it can be accommodated in a bandwidth of 5.0625 MHz. This would result in only half the sound/data components being conveyed as compared with the C-MAC Packet system proposed in the above EBU Report. The above systems and the advantages and problems surrounding them are discussed in the report MDD/RDT/007/84/MA of Centre Commun d'Études de Télédiffusion et Télécommunications (CCETT) "Le Codage

MAC/Duobinaire - Adaptation du Signal C-MAC - Paquets aux Reseaux Terrestres" by M. Alard and R. Lassalle, dated 19th January, 1984.

A further disadvantage of reducing the number of components that can be transmitted at the reduced bit rate of 10.125 Mbits per second (say eight sound/data sources in the C-MAC Packet proposal at 20.25 Mbits per second but only four such sources at half that bit rate) is that the cable operator on receiving the C-MAC signal has to select the four sources he requires for transmission over cable and with the manner proposed in the above EBU document for assembling the packets from the various sources the only practical way of achieving this would be to de-multiplex the sound/data sources of the C-MAC signal, to store these de-multiplexed components, to select the four sources primarily required to accompany the vision signal, and then to re-multiplex the selected sources prior to their transmission over a cable.

It is an object of the invention to provide a transmission system with which the above disadvantage can be avoided.

From a first aspect the invention provides a television transmission system having a time multiplexed signal in component form the majority of the lines of a frame period of which contain a first component comprising a digital data burst and a second component comprising vision information, the data in successive data bursts in a frame period, which data is derived from a plurality of sources, being assembled as a series of data bits at a given data bit rate, wherein that said sources are divided into a number of groups with the data from the sources for each group being time multiplexed as a series of blocks of bits from each source in a data bit stream to form a corresponding number of sub-multiplexes, the data bits forming each data burst being derived from each of the said number of data bit streams at the said given data bit rate with the number of bits in a data burst corresponding to an integral multiple of the said number of groups.

From a further aspect the invention provides a television transmission system having a time multiplexed signal in component form the majority of the lines of a frame period of which contain a

first component comprising a digital data burst and a second component comprising vision information, the data in successive data bursts in a frame period, which data is derived from a plurality of sources, being assembled as a series of data bits at a given data bit rate, wherein said sources are divided into a first and a second group with specific sources being assigned to a specific group, the data from the sources for the first group being time multiplexed as a series of blocks of bits from each of its sources in a first data bit stream to form a first sub-multiplex whilst the data from the sources for the second group are time multiplexed as a series of blocks of bits from each of its sources in a second data bit stream to form a second sub-multiplex, the data bits forming each data burst being derived from the first and second data bit streams at the said given data bit rate with an even number of bits in each data burst.

From yet a further aspect the invention provides a television transmission system for the transmission and reception of a time multiplexed signal in component form the majority of the lines of a frame period of said signal containing a first component comprising a digital data burst and a second component comprising vision information, the data in successive data bursts in a frame period, which data is derived from a plurality of sources, being assembled as a series of data bits at a given data bit rate, said sources being divided into a first and a second group with specific sources being assigned to a specific group, the data from the sources for the first group being time multiplexed as a series of blocks of bits from each of its sources in a first data bit stream to form a first sub-multiplex whilst the data from the sources for the second group are time multiplixed as a series of blocks of bits from each of its sources in a second data bit stream to form a second sub-multiplex, the data bits forming each data burst being derived from the first and second data bit streams at the said given data bit rate with an even number of bits in each data burst, wherein on reception of said time multiplexed signal, the bits relating to a selected one of said groups are extracted from each data burst,

which extracted bits are expanded and assembled as the first component in each of the majority of the lines of a frame period of a further time multiplexed signal which first component comprises a digital data burst with a data bit rate which is substantially half that of said given data bit rate whilst the second component of said further time multiplexed signal comprises said vision information.

Such systems allow the data from the various groups to be readily derived from the data burst so that for a particular application, namely when reforming the television signal for transmission over a medium of restricted bandwidth, the data from that group may be used alone with the reformed television signal.

Where the sources are divided into two groups, successive lines of each data burst may always start with a bit from a first of said two groups.

The invention also provides television transmitter equipment for use with the above television transmission system comprising a source of vision signals for forming the vision signal components of said time multiplexed signal, a plurality of sources of sound/data signals, means for processing the sound/data signals as digital signals and for time multiplexing the digital signals as said series of data bits in said data bursts of said television signal at said given data bit rate, wherein said sources of sound/data signals are divided into said number of groups, means for time multiplexing the signals from the sources of each group as a series of blocks of bits in a data bit stream to form said corresponding number of sub-multiplexes, means for selecting the bits from each of the said number of bit streams and for assembling said bits into said data burst such that each data burst contain bits derived from each of the bit streams at the said given data bit rate whilst the number of bits in a data burst corresponds to the integral multiple of the said number of groups.

The invention additionally provides television transmitter equipment for use with the above television transmission system

comprising a source of vision signals for forming the vision signal components of said time multiplexed signal, a plurality of sources of sound/data signals, means for processing the sound/data signals as digital signals and for time multiplexing the digital signals as said series of data bits in said data bursts of said television signal at said given data bit rate, wherein said sources of sound/data signals are divided into the first and the second group with specific sources assigned to a specific group, means for time multiplexing the signals from the sources of the first group as a series of blocks of bits in the first data bit stream to form the first sub-multiplex, means for time multiplexing the signals from the sources of the second group as a series of blocks in the second data stream to form the second sub-multiplex, means for selecting the bits from each of the said first and second bit streams and for assembling said bits into said data burst such that each data burst contain bits derived from the first and second bit streams at the said given data bit rate with an even number of bits in each data burst.

When the sources of sound/data signals are divided into two groups, the selecting means may select the bits from each goup such that successive data burst start with a bit from a first of said two groups.

The invention further provides television receiving equipment for use with the above television transmission system comprising means for receiving said television signal, means for separating said vision information from said television signal, means for producing the data bursts from said television signal and means for selecting the bits from the data burst representing a particular one of said groups.

Such equipment may additionally comprise means for re-modulating said vision information on a carrier with a bandwidth less than that of said received signal, means for forming said bits from said particular one of said groups into a reformed data burst with a reduced data bit rate corresponding to the said given data bit rate divided by the said number of sub-multiplexes, and means

for modulating the data burst so formed onto said carrier to form the further time multiplexed television signal comprising said bandwidth restricted vision components and the reformed data burst.

The invention also provides television receiving equipment for use with the above television transmission system comprising means for receiving said television signal, means for separating said vision information from said television signal, means for re-modulating said vision information on a carrier with a bandwidth less than that of said received signal, means for producing the data burst from said television signal, and means for extracting the bits from each data burst representing the selected one of said first and second groups for forming said bits from said selected group into a reformed data burst with a data bit rate which is half that of said given data bit rate, and means for modulating the data burst so formed onto said carrier to form the further time multiplexed television signal containing the first component which comprises the reformed data burst and the second component which comprises the bandwidth restricted vision information.

The above and other features of the invention will now be described by way of example with reference to the accompanying drawings in which:-

Figure 3 is a block diagram of transmitter equipment for use with the present invention,

Figures 4, 5, 6 and 7 are timing diagrams for explaining the operation of the transmitter equipment of Figure 3,

Figure 8 is a block diagram of a receiver and converter for use with the present invention,

Figure 9 is a block diagram of part of Figure 8 in greater detail, and

Figure 10 is a timing diagram for explaining the operation of part of Figure 9.

The block diagram of Figure 3 shows transmitter equipment for generating one form of the time multiplexed television signal according to the invention. The vision components of the transmission equipment are supplied by a vision source 1 and

applied to a MAC vision encoder 2 where the luminance and colour difference signals from the source 1 are compressed at their required rates and assembled time-wise as shown in Figure 1. It will be assumed that the MAC vision component from the encoder 2 is not subject to scrambling but if it were to be scrambled this would also take place in the encoder 2 by anyone of the known techniques which have recently received considerable discussion. The multiplexed vision component from the encoder 2 is applied to a frequency modulator 3 to which oscillations at the appropriate frequency are applied from an oscillator 4 such that that signal transmitted occupies a bandwidth of 27 MHz at the required transmission frequency. The modulated output from modulator 3 is applied to a multiplexer 5 whose output is applied through a transmitter 6 to a dish aerial 7 for directing the transmitted signal to the appropriate satellite. The construction and operation of the vision signal generation equipment is relatively well-known and will not be described further.

The transmitter also includes eight sound/data sources numbered 8-15 inclusive and which may in turn, include a pair of sources providing stereo sound signals associated with the vision signal, further sources providing other stereo or mono-aural sound signals, data in the form of teletext signals and data representing the over-air authorisation for the vision and some of the other signals. In the present description it will be assumed that the sources 8 and 9 provide the two sound signals for the stereo sound signal associated with the vision signal, source 10 provides a teletext signal which may be used for sub-titling the vision signal whilst source 11 provides the above-mentioned over-air authorisation, these four sources forming a first group 'A'. Each of the sources 8-15 inclusive has a input terminal C for receiving from an appropriate output of a clock pulse generator 16 a clock signal of a frequency appropriate to the nature of the source. The outputs from the sources 8-11 inclusive are applied to respective inputs of an 'A' or first packet multiplexer 17 whilst the outputs of the remaining source 12-15 which form a second group 'B' are

applied to inputs of a 'B'or second packet multiplexer 18. Each of the packet multiplexers 17 and 18 has a clock input C1 for receiving clock pulses at the rate of 10.125 MHz from an output of the clock pulse generator 16. The 'A' packet multiplexer 17 takes the incoming digital signals from the sources 8-11 and assembles these signals into packets in known manner with appropriate headers at the rate of 10.125 Mbits/s, the assembly of these packets being into a time region or area similar to that occupied by the data burst in the C-MAC Packet signal proposed in the above EBU Report. Figure 4 shows diagrammatically the above time area containing the sub-multiplex from the output of the 'A' packet multiplexer 17 which, at the bit rate of 10.125 Mbits/s contains 98 bits in each line portion, and if each packet contains the prescribed 751 bits then each packet will occupy approximately 7.66 such line portions, Figure 4 corresponding to a portion of Figure 2. The above bits are shown in Figure 4 with each bit in a line portion being indicated by A with a numbered bit suffix whilst the start of a packet on line L1 (which ends during line L8) is indicated by a doubled boundary line. Sub-multiplex 'A' will then contain 81 such packets per frame whilst in addition there will be 321 spare bits starting towards the end of line 621 and extending through lines 622, 623 and 624. Therefore, the bit rate and number of packets per sub-multiplex will be half that specified in the above EBU Report. The signals from the sources 12-15 will be processed in an identical manner by the 'B' packet multiplexer 18 with the number of bits per line again being 98, each 751 bit packet also occupying approximately 7.66 line portions. In such a case the sub-multiplex 'B' will also contain 81 packets per frame with the same number of spare bits appearing in lines 621, 622, 623 and 624 as for sub-multiplex 'A'. The sub-multiplex 'B' is shown diagrammatically in Figure 5 which is numbered in a corresponding manner with Figure 4.

The 'A' and 'B' sub-multiplexes from the 'A' and 'B' packet multiplexers 17 and 18 are applied to respective inputs of a multiplexer 19 also having a clock input C2 which receives clock

pulses at 20.25 MHz from a further output of clock pulse generator 16. The multiplexer 19 is arranged to convey bits at the 20.25 MHz rate from the 'A' and 'B' sub-multiplexes of the 'A' and 'B' packet multiplexers 17 and 18 such that the multiplex so formed has the prescribed bit rate of 20.25 Mbits/s with its bits drawn from the two groups ('A' and 'B') of the sound/data sources 8 to 15. The output from the multiplexer 19 is applied to a first input of a data assembler 20 which may be in the form of a further multiplexer a second input of which is connected to the output of a sync word generator 21 having a clock input C3 which receives clock pulses at 20.25 MHz from the further output of the pulse generator 16, the sync. word generator 21 producing the 8 bits which in the assembled data frame precedes on each line the sound/data bits and which comprises the one bit of run-in and the appropriate 7 bit line sync. word. The third input of the data assembler 20 is connected to a source 23 for the data which is to appear in line 625 as prescribed in the above EBU Report (or lines 624 and 625 if modified as described below) and which also has a clock input C4 for receiving clock pulses at 20.25 MHz from the further output of the clock pulse generator 16. The output of the data assembler 20 contains during lines 1 to 625 the data frame for the C-MAC Packet signal and Figure 6 shows the assembly of the data bits in a data frame which deviates from that proposed in the above EBU Report in that each bit of the active data is alternately obtained from two groups of sources with each active data portion of each line containing 196 bits instead of the previously proposed 195 bits, but contains the line sync. word in prescribed form and either line 625 data information in that form or modified lines 624 and 625. This output is applied to the data input of a 2-4 PSK modulator 22 a further input of which receives oscillations from the oscillator 4 to produce a phase shift keyed signal which is applied to the second input of the multiplexer 5 such that this modulated data is introduced into the C-MAC packet signal during the appropriate time intervals. From Figure 6 it wil be seen that the sound/data bits on each line always start with an 'A' group source and end with a

'B' group source such that each line contains 98 'A' bits and 98 'B' bits.

With the active data period per line being increased from 195 to 196 bits the number of bits or samples in the remaining portion of the line will need to be changed if each line period still contains 1296 sample periods. It is therefore proposed that the number of sample periods for the vision components be slightly reduced and the transition periods be slightly increased. The table relating to Figure 1 would then be modified as follows:-

a = 204 bits - synchronisation, sound/data (data burst)
b = 5 samples - transition from end of data
c = 15 samples - main clamp period (zero-level of chrominance reference)
SC1 = 5 samples - reserved for vision scrambling.
d = 352 samples - chrominance (C)
g = 704 samples - luminance (Y)
SC2 = 6 samples - reserved for vision scrambling.
h = 5 samples - transition into data.

As has been previously stated the whole of line 625 in the above EBU document is allocated to carry data and Figure 7a shows the structure of this line where:-

FSD = 104 bits - frame synchronising data
UDT = 5 bits - unified date and time
SDF = 94 bits - static data frame
RDF = 470 bits - repeated data frame comprising five 94 bit data blocks TDMCTL (1) to (5)-time division multiplex control groups
NA = 564 bits - six 94 bit data blocks not allocated
UDF = 59 bits - undefined

The frame synchronising data (FSD) contains:

LSW = 8 bits - 1 bit demodulator run-in plus 7 bits line synchronisation word
CRI = 32 bits - clock run-in
FSW = 64 bits - frame synchronisation word

In order to allow the required data from line 625 to be

accommodated at a cable head end converter in a line period but at half bit rate it is further proposed to modify lines 624 and 625 as shown in Figure 7b. As with the present system the active data period of line 624 does not carry sound/data from sources 8-15 it is proposed that this period conveys the static data frame (SDF) leaving 102 bits undefined (UDF1) in that data period. Line 625 is modified by not carrying the static data frame (SDF) but continues to carry the other information, the undefined period (UDF2) at the end of line 625 being increased to 153 bits. The reason for the changes will be explained hereinafter.

The block diagram of Figure 8 shows a receiver which includes a converter for converting a received C-MAC DBS television signal of the above described type into one suitable for application to a cable distribution system. This Figure shows a dish aerial 31 of appropriate dimensions for receiving C MAC Packet DBS television signals which are located in the 12 GHz broadcasting band. Attached to the aerial 31 is a down converter unit 32 in which the frequencies of the incoming signals are shifted such that they are positioned just above the UHF broadcasting bands and lie between 950 and 1750 MHz, so that they can be readily applied via a co-axial cable 33 to an input terminal 34 of the receiver. In the receiver the signals at terminal 34 are applied to a tuner unit 35 where the required television signal is selected in the usual manner by mixing it with a tuned local oscillator signal to produce an intermediate frequency (i.f.) signal which in this case has a frequency of 134 MHz. The bandwidth of the tuner and the resulting i.f. signal is 27 MHz to match the bandwith of the DBS signal. Tuning in the tuner unit 35 is by means of a selection voltage applied over a connection 36 from a selector unit (not shown) applied by way of a first input of an adder circuit 37 whose output is connected to the the appropriate input of the tuner unit 35. The adder circuit 37 has a second input to which an automatic frequency control (a.f.c.) voltage is applied over a connection 38, this a.f.c. voltage being added to the selection voltage to ensure correct tuning of the tuner unit 35. The i.f. signal from the

tuner unit 35 is amplified in an amplifier stage 39 and applied to surface accoustic wave (S.A.W.) filter 40 having a pass band of 27MHz centred on the i.f. of 134 MHz. The output of the SAW filter 40 is applied to a limiter and discriminator stage 41 in which the frequency modulated chrominance and luminance vision components of the i.f. signal are demodulated to produce at its output a baseband vision MAC signal which is subjected to de-emphasis in a de-emphasis stage 42. The limiter and discriminator stage 41 also produces the a.f.c. voltage which is applied over connection 38 to adder circuit 37.

The i.f. signal is also applied to a limiter and 2-4 PSK demodulator stage 43 in which the data burst (sound/data component) and the additional digital information all at 20.25 Mbit/s are recovered. These digital signals are applied to a converter 44 which has a number of functions one of which is to expand the bits of the sound/data digital signals such that they have a much lower bit rate. Certain features of the converter unit 44 are shown in greater detail in Figure 9. In Figure 9 the digital information at 20.25 Mbit/s is applied to the input 52 of the converter 44 from where it is applied as an input to a pulse generator 45 which generator produces the various required clock frequencies together with the various write and read control signals that will also be required for the correct operation of the converter 44. The input at 52 is also applied to a demultiplexer circuit 46 to receive the 196 sound/data bits per line at the clock rate C1 of 20.25 MHz which under the control of a second clock signal C2 of 10.125 MHz produces at its output alternate pulses from the input data i.e. only 'A' bits or only 'B' bits as related to Figure 6. The output of the demultiplexer circuit 46 containing, say, only 'A' bits is applied to a latch and delay circuit 47 where the length of each bit is doubled and subjected to a short delay as will be described below, the circuit 47 also receiving C2 clock pulses at 10.125 MHz.

The data at terminal 52 is also applied to a first-in-first-out circuit (FIFO) 48, designated the L624/625 FIFO, which operates on the active data in line 624 and 625 of each frame

to make a part of this data suitable for transmission at the lower bit rate of 10.125 Mbits/s, this FIFO also receiving C1 and C2 clock pulses at their respective frequencies. Terminal 52 is also connected to a sync. circuit 49 which under the control of clock frequencies C1 and C2 extracts the synchronising information from the received line sync. words, and knowing the predetermined sequence of such sync. words produces the appropriate sync. word for each line at the 10.125 Mbits per second rate at the desired time as will be explained hereinafter with reference to Figure 10. The sync. circuit 49 also produces a timing control signal from the incoming sync. words which is applied over a connection 50 to a further input of the pulse generator 45 to accurately control the appearance of the write and read signals produced by the pulse generator.

The outputs of the latch and delay circuit 47, the L624/625 FIFO 48 and the sync. circuit 49 are all connected to respective inputs of a multiplexer 51 which under the control of a control signal (not shown) from the pulse generator 45 to produce the data burst and line 625 data at half the C-MAC Packet bit rate, namely at 10.125 Mbits/s at an output 53. How this is achieved with respect to the data in those lines conveying data from the 'A' and 'B' multiplexes will be explained in relation to the timing diagrams shown in Figure 10. Figure 10a shows in detail a portion from adjacent lines containing the 5 sample periods of the transition into data - (h), the 204 bits of synchronisation and sound/data (data burst) - (a) and the 5 sample periods of the transition from the end of data - (b), all these being at the 20.25 Mbits per second rate having been previously referred to in relation to Figure 1. The 204 bit periods of the synchronisation and sound/data are numbered consecutively and it will be seen that the bit depicted as R is the run-in for synchronisation whilst bits 2 to 8 inclusive (S) form the 7 bits of the appropriate line sync. word. The remaining bits 9 to 204 carry the sound/data with the odd numbered bits carrying data from group 'A' whilst the even numbered bits carry data from group 'B'. For certain types of

modulation the periods (h) and (b) will not be required as transitions and can thus be utilised to carry data in a converted signal and thus if the bit rate is halved the number of bits can be increased from $\frac{a}{2} = \frac{204}{2} = 102$ to $\frac{h+a+b}{2} = \frac{214}{2} = 107$. It will not be necessary to transmit the run-in bit R for the sync. word making it possible to utilise 98 bits for the active data. Transmission of the data may now start from the beginning of the period (h) but as will be seen from Figure 10a the sync. word for the line under consideration starts after the period (h). This can be overcome by using the line sync. words produced by the sync. circuit 49 as described above with a run-in bit and positioned as shown in Figure 10b. In Figure 10b the numbered bits are those which the correspond to the bits in the data burst of Figure 10a. The latch and delay circuit 47 latches or expands each 'A' bit from the demultiplexer 46 and produces an expanded train of the 'A' bits at the 10.125 Mbits per second rate delayed by one bit period at this rate. The first expanded 'A' bit therefore follows the seventh expanded bit of the sync. word, this 'A' bit being numbered A9 to show from which bit of the incoming data it is derived, this applying to the other 'A' bits. The last 'A' bits of this data (A201 and A203) extend into the transition period (b) with half an expanded bit period to spare and thus it will be seen that the line sync. word and 'A' bits of the data can readily be accommodated in the periods (h), (a) and (b).

The L624/625 FIFO 48 in addition to receiving the data at terminal 52 also receives the output S from the sync. circuit 49. This FIFO takes the appropriate expanded line sync. word to be used with lines 624 and 625 and position them at the start of the expanded lines 624 and 625 which again will commence at the beginning of the period (h). The data from these lines is not dealt with as the previous lines but is simply read on a first-in-first-out basis at the expanded rate. This means that it will not be possible to include all the possible data that could appear in lines 624 and 625 in expanded form. With the proposed modifications to lines 624 and 625 as previously described this is

not a disadvantage as portions of these lines have no active data allocated to them. The removal of the static data frame (SDF) to the active data area of line 624 allows the frame synchronising data (FSD), unified date and time (UDT), and repeated data frame (RDF) to be accomodated when expanded within a line period.

In addition to the above data being produced at the output 53 of the converter 44, a further output 54 supplies clock pulses at 10.125 MHz.

Referring again to Figure 8, the vision signal from the de-emphasis stage 42 is applied to the modulation input of a modulator 55 in which this signal is amplitude modulated onto a carrier received at a second input from a carrier oscillator 56, the frequency of the carrier being in the frequency bands used for cable distribution systems. The output from the modulator 55 is applied to a first input of a multiplexer 57 whose output is applied through a vestigial sideband filter 58 to an output 59 of the conversion unit for application to a cable distribution system.

The outputs at terminals 53 and 54 of the converter respectively conveying the expanded digital signals and the associated clocking frequency (10.125 MHz) are applied to a digital modulator 60 which at a further input receives the carrier from the carrier oscillator 56 and in which this carrier is digitally modulated by the expanded digital signals which may have been converted to duo-binary form. The modulated output from modulator 60 is applied to a second input of the multiplexer for application to the output terminal 59 by way of the filter 58.

Reception of the data signals of the present transmission system for a receiver connected to a cable conveying only the 'A' group data will not differ greatly to that proposed for C-MAC Packet receivers save that the data will be at half bit rate. A receiver for reception of the data signals directly from a satellite will require a demultiplexer which will reconstruct the data into its two separate groups, A and B. This will have the advantage that operation on the data to recover its signals will be at a lower bit rate (10.125 MHz instead of 20.25 MHz) which will

make handling of the data easier. A dual standard receiver for cable/satellite operation can readily be obtained by a combination of the above with the two necessary data demodulators and a suitable switching arrangement between the demultiplexed data from the satellite and that obtained from the cable.

CLAIMS:-

1. A television transmission system having a time multiplexed signal in component form the majority of the lines of a frame period of which contain a first component comprising a digital data burst and a second component comprising vision information, the data in successive data bursts in a frame period, which data is derived from a plurality of sources, being assembled as a series of data bits at a given data bit rate, wherein said sources are divided into a number of groups with the data from the sources for each group being time multiplexed as a series of blocks of bits from each source in a data bit stream to form a corresponding number of sub-multiplexes, the data bits forming each data burst being derived from each of the said number of data bit streams at the said given data bit rate with the number of bits in a data burst corresponding to an integral multiple of the said number of groups.

2. A television transmission system having a time multiplexed signal in component form the majority of the lines of a frame period of which contain a first component comprising a digital data burst and a second component comprising vision information, the data in successive data bursts in a frame period, which data is derived from a plurality of sources, being assembled as a series of data bits at a given data bit rate, wherein said sources are divided into a first and a second group with specific sources being assigned to a specific group, the data from the sources for the first group being time multiplexed as a series of blocks of bits from each of its sources in a first data bit stream to form a first sub-multiplex whilst the data from the sources for the second group are time multiplexed as a series of blocks of bits from each of its sources in a second data bit stream to form a second sub-multiplex, the data bits forming each data burst being derived from the first and second data bit streams at the said given data bit rate with an even number of bits in each data burst.

3. A television transmission system for the transmission and reception of a time multiplexed signal in component form, the



majority of the lines of a frame period of said signal containing a first component comprising a digital data burst and a second component comprising vision information, the data in successive data bursts in a frame period, which data is derived from a plurality of sources, being assembled as a series of data bits at a given data bit rate, said sources being divided into a first and a second group with specific sources being assigned to a specific group, the data from the sources for the first group being time multiplexed as a series of blocks of bits from each of its sources in a first data bit stream to form a first sub-multiplex whilst the data from the sources for the second group are time multiplexed as a series of blocks of bits from each of its sources in a second data bit stream to form a second sub-multiplex, the data bits forming each data burst being derived from the first and second data bit streams at the said given data bit rate with an even number of bits in each data burst, wherein on reception of said time multiplexed signal, the bits relating to a selected one of said groups are extracted from each data burst, which extracted bits are expanded and assembled as the first component in each of the majority of the lines of a frame period of a further time multiplexed signal which first component comprises a digital data burst with a data bit rate which is substantially half that of said given data bit rate whilst the second component of said further time multiplexed signal comprises said vision information.

4. A television transmission system as claimed in Claim 2 or 3, in which successive data bursts always start with a bit from a first of said two groups.

5. A television transmission system substantially as herein described with reference to Figures 3 to 10 of the accompanying drawings.

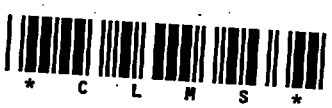
6. Television transmitter equipment for use with the television transmission system as claimed in any of the preceding claims, comprising a source of vision signals for forming the vision signal components of said time multiplexed signal, a plurality of sources of sound/data signals, means for processing

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the sound/data signals as digital signals and for time multiplexing the digital signals as said series of data bits in said data bursts of said television signal at said given data bit rate, wherein said sources of sound/data signals are divided into said number of groups, means for time multiplexing the signals from the sources of each group as a series of blocks of bits in a data bit stream to form said corresponding number of sub-multiplexes, means for selecting the bits from each of the said number of bit streams and for assembling said bits into said data burst such that each data burst contain bits derived from each of the bit streams at the said given data bit rate whilst the number of bits in a data burst corresponds to the integral multiple of the said number of groups.

7. Television transmitter equipment for use with the television transmission system as claimed in Claim 2, 3 or 4, comprising a source of vision signals for forming the vision signal components of said time multiplexed signal, a plurality of sources of sound/data signals, means for processing the sound/data signals as digital signals and for time multiplexing the digital signals as said series of data bits in said data bursts of said television signal at said given data bit rate, wherein said sources of sound/data signals are divided into the first and the second group with specific sources assigned to a specific group, means for time multiplexing the signals from the sources of the first group as a series of blocks of bits in the first data bit stream to form the first sub-multiplex, means for time multiplexing the signals from the sources of the second group as a series of blocks in the second data stream to form the second sub-multiplex, means for selecting the bits from each of the said first and second bit streams and for assembling said bits into said data burst such that each data burst contain bits derived from the first and second bit streams at the said given data bit rate with an even number of bits in each data burst.

8. Television transmitter equipment as claimed in Claim 7, in which said selecting means selects the bits from each group such that successive data bursts start with a bit from a first of said



two groups.

9. Television transmitter equipment substantially as herein described with reference to Figures 3, 4, 5, 6 and 7 of the accompanying drawings.

10. Television receiving equipment for use with the television transmission system as claimed in Claim 1, 2, 3, 4 or 5, comprising means for receiving said television signal, means for separating said vision information from said television signal, means for producing the data bursts from said television signal, and means for selecting the bits from the data bursts representing a particular one of said groups.

11. Television receiving equipment as claimed in Claim 10 when dependent on Claims 3, 4 or 5, comprising means for re-modulating said vision information on a carrier with a bandwidth less than that of said received signal, means for forming said bits from said particular one of said groups into a reformed data burst with a reduced data bit rate corresponding to the said given data bit rate divided by the said number of sub-multiplexes, and means for modulating the data burst so formed onto said carrier to form the further time multiplexed television signal comprising said bandwidth restricted vision information and the reformed data burst.

12. Television receiving equipment for use with the television transmission system as claimed in Claim 3, 4 or 5, comprising means for receiving said television signal, means for separating said vision information from said television signal, means for re-modulating said vision information on a carrier with a bandwidth less than that of said received signal, means for producing the data burst from said television signal, means for extracting the bits from each data burst representing the selected one of said first and second groups, means for forming said bits from said selected group into a reformed data burst with a data bit rate which is half that of said given data bit rate, and means for modulating the data burst so formed onto said carrier to form the further time multiplexed television signal containing the first component which comprises the reformed data burst and the second

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component which comprises the bandwidth restricted vision information.

13. Television receiving equipment substantially as herein described with reference to the Figures 8, 9 and 10 of the accompanying drawings.

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