Title of the Invention: Tower mounted amplifier apparatus and method of production thereof

Abstract Title: The housings of a tower mounted amplifier unit and a multiplexer unit are stacked on top of each other

This application relates to tower mounted apparatus with a multi-band capability. A signal in a first band received at a first antenna (1800 ANT1, Fig. 7) is passed through a tower mounted amplifier (TMA) unit 104. A multiplexer unit 106 multiplexes output signal 108 from the TMA unit with another signal such as a signal 114 in a second band received at a second antenna (900 ANT1, Fig. 7). The output of the multiplexer unit is attached to the top end of a feeder cable 52. Use of the multiplexer unit permits a reduction in the number feeder cables. The housing of the TMA unit 104 is stacked on top of the housing of the multiplexer unit 106 so that the TMA acts as a lid or cover for the multiplexer unit. Alternatively, the multiplexer unit may be stacked on top of the TMA unit. Preferably the TMA unit includes two TMAs for amplifying signals from two antennas. Preferably the multiplexer unit includes two diplexers, each outputting to a separate feeder cable.
Fig. 1
(PRIOR ART)
Tower Mounted Amplifier Apparatus and Method of Production Thereof

This invention relates to tower mounted amplifier apparatus and to a method of production or use thereof.

A wireless communication network typically includes a plurality of cell sites which allow radio frequency signals to be transmitted to and received from mobile phone units. Each cell site typically includes a mast, at the top of which is typically mounted an antenna for transmitting and/or receiving one or more radio frequency signals and optionally a tower mounted amplifier (TMA) for amplifying the radio frequency signals. A base transceiver station (BTS) is typically located at the base of the mast and is connected via a feeder cable to the TMA. The BTS typically includes a transceiver that generates one or more radio frequency signals for transmission to a mobile phone unit, as well as receiving one or more radio frequency signals from the mobile phone unit.

Historically, the wireless connections between a cell site and a mobile phone unit have been made using two or three frequency bands per region. For example, in the UK these frequency bands are at 900MHz, 1800MHz and 2100MHz. Each frequency band has also conventionally been assigned to a particular technology; the 900MHz and 1800MHz bands have typically been licensed for second generation (2G) system use only, and the 2100MHz band has been licensed for third generation (3G) system use. As 3G systems support higher data rates than 2G systems, the licenses for frequency bands previously restricted to 2G systems only have now been amended to allow 3G and fourth generation (4G) systems to be deployed within them. In addition, further bandwidth is being made available via freeing up additional frequency bands. For example, spectrum freed up by the move from analogue to digital television has created an available frequency band within Europe at 800MHz. Mobile communication operators therefore need to invest significant amounts of money in their networks to provide the latest
technologies in multiple bands whilst continuing to support legacy technology/band combinations. Consequently, mobile communication operators are under pressure to reduce capital expenditure (CAPEX) and operating expenditure (OPEX) wherever possible in their wireless communication networks.

Conventionally, a BTS at a cell site has been needed for each frequency band, each operator and each technology. Feeder cables, a type of coaxial cable, have typically been provided between each BTS and each TMA or each antenna to allow the radio frequency signals to pass along the same. Such feeder cables are expensive to buy and fit. For example, due to the length and weight of feeder cables, it typically requires a plurality of fitters to fit the feeder cables in place on the mast, which is time consuming, expensive and the mast may not be sufficiently strong to support a large number of feeder cables thereon. A significant opportunity for cost saving for a mobile communication operator is sharing of network infrastructure. A single operator can share infrastructure between equipment operating in different bands. Thus, in order to reduce the problems associated with using separate feeder cables for each different operator and/or each different frequency band, it is possible for feeder cables to be shared at cell sites. Multiplexing means or combiners have been used to bring signals of two frequency bands together or to separate the signals of two frequency bands out into the separate frequency bands to allow sharing of some of the feeder cables.

An example of a conventional cell site which uses multiplexing means and which allows sharing of some of the feeder cables is shown in figures 1 and 2. The cell site arrangement shown in figure 1 comprises two antennae: a first antenna 2 operating in the 900MHz frequency band and a second antenna 4 operating in the 1800MHz frequency band. A first base transceiver station (BTS) 6 is provided for transmitting and/or receiving signals in the 900MHz frequency band and a second base transceiver station (BTS) 8 is provided for transmitting and/or receiving signals in the 1800MHz frequency band. The antennae 2, 4 are mounted at the top of a
mast 10 and the BTSs 6, 8 are located at the base of the mast 10. Two
diplexers 12, 14 are provided adjacent the top and base of the mast 10
respectively for allowing combining/separation of the transmit/receive
signals of the 900MHz frequency band and the 1800MHz frequency band. A
TMA 16 is provided in the transmit/receive path of the 1800MHz
frequency band between antenna 4 and diplexer 12 for amplifying signals in
the 1800MHz frequency band.

Jumper leads 22 are provided between antennae 2, 4 and diplexer 12 and
TMA 16. Jumper leads 22 are also provided between TMA 16 and diplexer
12, and diplexer 14 and BTSs 6, 8. Two feeder cables 18, 20 are provided
between diplexer 12 and diplexer 14, thereby allowing sharing of feeder
cables between the 1800MHz and 900MHz frequency bands.

A simplified arrangement of the circuitry provided in the TMA 16 and
diplexer 12 is shown in figure 2. The TMA 16 is a dual TMA in that there
are two copies of the radio frequency (RF) functionality in the same TMA
housing. TMA 16 has a pair of input/output ports 30, 30' that are connected
to antenna 4 via jumper cables 22, 22', and a pair of input/output ports 32,
32' that are connected to diplexer 12 via jumper cables 22, 22'.

First and second transmit paths 34, 34' are provided in TMA 16 for the
transmission of one or more radio frequency transmit signals from first and
second transmitters of BTS 8 to antenna 4. A transmit filter 36, 36' is
located in each transmit path 34, 34' for filtering one or more transmit
signals respectively. In the illustrated example, the transmit filters 36, 36' are
1800 MHz transmit bandpass filters (i.e. they allow the passage of one or
more transmit radio frequency signals in the 1800 MHz transmit frequency
band but substantially stop the passage of radio frequency signals outside of
this frequency band). The first and second transmit paths 34, 34' are
provided between the input/output ports 30, 30' and 32, 32' of the TMA 16
respectively.
Receive paths 38, 38’ are provided in the TMA 16 for receiving one or more radio frequency receiver signals from antenna 4. First and second receive filters 40, 40’; 42, 42’ are provided in series in the receive paths 38, 38’ respectively for filtering one or more receive signals. In the illustrated example, the receive filters 40, 40’, 42, 42’ are 1800MHz receive bandpass filters (i.e. they allow the passage of one or more receive radio frequency signals in the 1800MHz receive frequency band but substantially stop the passage of radio frequency signals outside of this frequency band). The first and second receive paths 38, 38’ are provided between the input/output ports 30, 30’ and 32, 32’ of the TMA 16 respectively. A low noise amplifier (LNA) 44, 44’ is located between first and second receive filters 40, 42; 40’ 42’ respectively for amplifying one or more receive signals. An amplifier bypass path 46, 46’ is provided between the first and second filters 40, 42; 40’, 42’ in each receive path 38, 38’ to allow one or more receive signals to bypass the LNA 44, 44’ in the event of failure of or loss of power to the LNA. Each LNA 44, 44’ can be provided with LNA supervision and an alarm 60 to signal failure or power loss to the LNA 44, 44’. A bias-tee 62, 62’ can be provided adjacent input/output ports 32, 32’ respectively to direct a Direct Current (DC) power supply to the LNAs 44, 44’ in each receive path 38, 38’ without substantially effecting the transmit or receive signals. A capacitor 64, 64’ can be provided between the second receiver filter 42, 42’ and the bias-tee 62, 62’ to act as a DC block to prevent DC current from entering the receive or transmit paths 34, 38, 34’, 38’ respectively. Lightning strike protection circuitry 66, 66’ can be provided between the bias-tee 62, 62’ and the LNA supervision and alarm 60 if required.

DC power and control within the TMA 16 can be performed in two different ways:

1. Current Window Alarm (CWA) Mode, in which DC is supplied on both feeder cables from BTS 8. The DC is diverted by the bias-tee 62, 62’ to control electronics. Alarms indicating a malfunctioning unit can be provided as a rise in the current drawn/used by the TMA unit.
16. The amount of current drawn via the TMA unit is monitored by one or both of the BTSs 6, 8.

2. Antenna Interface Standards Group (AISG) Mode, in which DC power and a communications protocol is used allowing one or more messages to be exchanged between BTS 8 and TMA 16. It is to be noted that both the DC power and communications protocol can be provided on one feeder cable and this can control and power both halves of the TMA.

Diplexer 12 has a pair of input/output ports 48, 48' that are connected to antenna 2 via jumper cables 22, 22', and a pair of input/output ports 50, 50' that are connected to TMA 16 via jumper cables 22, 22'. Diplexer 12 also has a pair of input/output ports 52, 52' for connection to diplexer 14 via feeder cables 18, 20. A common junction 54, 54' is provided between input/output ports 52, 52' and the filters 56, 58; 56', 58'. A bandpass filter 56, 56' is provided in the 900MHz path in the diplexer between input/output ports 52, 52' and 48, 48'. Filters 56, 56' allow receive and transmit signals in the 900MHz frequency band to pass through but substantially stop signals in other frequency bands from passing therethrough. A bandpass filter 58, 58' is provided in the 1800MHz path in the diplexer between input/output ports 52, 52' and 50, 50'. Filters 58, 58' allow receive and transmit signals in the 1800MHz frequency band to pass through but substantially stop signals in other frequency bands from passing therethrough. It is to be noted that the filters 56, 56', 58, 58' do not have to be bandpass filters but could be bandstop filters, low pass filters, high pass filters and/or the like. A bias-tee 53, 53' can be provided adjacent input/output ports 52, 52' respectively to direct a Direct Current (DC) power supply to a bias-tee 55, 55 adjacent input/output ports 50, 50'. A capacitor 57, 57' is provided between the bandpass filter 58, 58' in the 1800MHz path and the bias-tee 53, 53' to act as a DC block to prevent DC current from entering the 1800MHz bandpass filter 58, 58'. A capacitor 59, 59' is provided between the bandpass filter 58, 58' and the bias-tee 55, 55 to also act as a DC block to prevent DC current from entering the 1800MHz bandpass filter 58, 58'.
In the illustrated cell site arrangement in figures 1 and 2, a relatively large number of jumper cables 22, 22' are used between the antennae, TMA, diplexers and BTSs to allow sharing of the two feeder cables 18, 20. This results in an external cabling arrangement that looks messy and is therefore aesthetically displeasing. In addition, the provision of a separate TMA and diplexers takes up space and increases the cost of the overall apparatus. Due to the large number of external port connections in the diplexer unit 12 and the TMA 16, this results in high insertion loss, high return loss and poor P.I.M (passive intermodulation) readings in the overall apparatus.

It is therefore an aim of the present invention to provide TMA apparatus that overcomes the abovementioned problems.

It is a further aim of the present invention to provide a method of producing or using TMA apparatus that overcomes the abovementioned problems.

According to a first aspect of the present invention there is provided tower mounted amplifier (TMA) apparatus, said apparatus including at least a first TMA unit and at least a first multiplexing means unit, said at least first TMA unit including a housing having at least one opening defined therein for the location of one or more electronic components therethrough, and wherein said at least first multiplexing means unit is attached to said at least first TMA unit and is arranged to act as a cover or lid for said at least one opening of said at least first TMA unit.

Thus, the present invention combines the TMA and multiplexing means into a single final unit, thereby reducing the number of interconnections present when separate TMA and multiplexing means units are provided and overcoming the problems associated with separate TMA and multiplexing means units of
high cost, high insertion loss, high return loss and high P.I.M readings. Thus, the manufacturer is therefore more easily able to guarantee good P.I.M, return loss and insertion loss for the entire apparatus. In addition, the final unit of the present invention is significantly improved aesthetically.

Preferably the at least first TMA unit and the at least first multiplexing means unit have substantially the same footprint, cross sectional area and/or external dimensions to allow one or more sides, and preferably all the sides, of the units to be substantially flush with each other when provided in a stacked arrangement (i.e. one unit on top of another unit in substantially overlapping relationship) to form the apparatus. This significantly improves the external aesthetic appearance of the final apparatus, reduces the space and reduces the cost of the apparatus.

In one embodiment the at least first TMA unit and/or the at least first multiplexing means unit is/are modular units in that more than one of each type of unit can be provided and/or the electronic components with any unit can differ or be adjustable if required to provide a large possible number of different TMA/multiplexing mean combinations to form different types of TMA apparatus. For example, the at least first multiplexing means can be a multiplexer or a diplexer; two TMA units could be provided with one multiplexing means unit, two multiplexing means unit could be provided with one or more TMA units and/or the like.

Preferably the footprint, cross sectional area and/or external dimensions of each TMA and multiplexing means modular unit is substantially the same to allow different sized stacks of TMA apparatus to be formed, the external side walls of the modular units forming the stack being substantially flush with each other.
Preferably sealing means are provided between adjacent TMA units and/or multiplexing means units in the apparatus. Any suitable sealing means can be provided, such as any or any combination of one or more gaskets, o-rings and/or the like.

Preferably one or more channels, recesses, grooves and/or the like are defined in the TMA unit and/or the multiplexing means unit to allow location of one or more sealing means therewith.

In one embodiment each multiplexing means unit comprises a body portion or lid having a first side and a second side, or a front side and a rear side. The first or front side of the body portion/lid typically faces the opening and/or interior of the TMA unit. The second or rear side of the body portion/lid typically faces away from the opening and/or interior of the TMA unit.

In one embodiment both sides of the multiplexing means body portion/lid typically have functionality. For example, the first or front side of the body portion could be arranged so as to allow sealing means to be provided thereon and/or associated therewith and/or for sealing engagement with one or more internal walls of the TMA to be provided or defined therewith. The second or rear side of the body portion could be arranged so as to house or support one or more electronic components of the multiplexing means unit, provide sealing means and/or provide one or more internal walls of the multiplexing means unit.

In one embodiment the multiplexing means unit has a body portion including a base wall with a plurality of side and end walls surrounding the base wall on a first or front side thereof protruding outwardly of said base wall from said first or front
side. The outermost edges of the side and end walls typically define an opening therebetween.

Preferably the electronic components are locatable through the opening of the body portion.

In one embodiment the opening of the multiplexing means body portion faces the opening of the TMA unit when the TMA unit and multiplexing units are joined together.

Preferably a plurality of side walls and end walls surround the base wall on a second or rear side of the multiplexing means body portion and protrude outwardly of said base wall from said second or rear side. The outermost edges of the side and end walls typically define an opening therebetween.

Preferably a lid or cover is fitted to, provided over and/or associated with the opening defined on the second or rear side of the body portion multiplexing means unit. This allows one or more electronic components provided adjacent the second or rear side of the body portion to be enclosed therein.

Further preferably sealing means are associated with said lid or cover and/or said second or rear side of the body portion multiplexing means unit to allow sealing therebetween.

In one embodiment one or more apertures or channels are provided between the first and second sides of the body portion or lid of the multiplexing means unit with the TMA unit. These through apertures or channels allow pressure equalisation internally and externally to prevent a pressure differential across the sealing means of the apparatus.
One or more link cables can be provided between one or more electronic components of the TMA unit and one or more electronic components of the multiplexing means unit. The one or more link cables can be provided substantially internally and/or externally as required. However, the provision of substantially external link cables has been found to provide higher quality connections between the units to reduce P.I.M.

In one embodiment the TMA unit is a conventional TMA unit in which the lid/cover has been removed. The multiplexing means unit is of such dimensions and is arranged so as to act as the lid/cover for the TMA (i.e. the first or front side of the TMA can have the same functionality as the conventional lid/cover of a conventional TMA unit). Thus, in this embodiment the multiplexing means unit is retrofitted to an existing TMA unit which has had its lid or cover removed.

 Preferably the apparatus has one or more input/output ports to allow connection of the apparatus to one or more other electronic components directly or indirectly, such as for example, to an antenna, a BTS and/or the like.

The input/output ports can be connected to one or more feeder cables, jumper cables and/or the like if required which are then connected to one or more further or other electronic components.

In one embodiment, the apparatus has short circuit detection means provided in or associated with said one or more input/output ports. For example, the short circuit detection means allows detection of a short circuit from the antenna to which the apparatus may be connected to in use.
In one embodiment the short circuit detection means includes a Direct Current (DC) switch and detection means. When a short circuit is detected by the detection means, the switch is moved to an open position to ensure the input/output port is not DC enabled. If a short circuit is not detected by the detection means, the switch is moved to a closed position and the input/output port is DC enabled.

Preferably the short circuit detection means is provided between a BTS input/output port of the apparatus and an antenna input/output port. This pathway is typically called a "bypass" pathway since it bypasses the internal TMA circuitry of the apparatus.

The one or more electronic components provided in or associated with each of the TMA unit and/or multiplexing means unit can be contained substantially entirely within the external boundaries of said unit or could protrude outwardly from an opening of said unit. In the latter embodiment, one or more electronic components contained within one of the TMA unit and/or multiplexing means could protrude into or within the external boundaries of the other of the TMA unit and/or multiplexing means unit.

According to a second aspect of the present invention there is provided a method of producing tower mounted amplifier (TMA) apparatus, said apparatus including at least a first TMA unit and at least a first multiplexing means unit, said at least first TMA unit including a housing having at least one opening defined therein for the location of one or more electronic components therethrough, and wherein said method includes the step of attaching the at least first multiplexing means unit to said at least first TMA and arranging the multiplexing means
unit so as to act as a cover or lid for said at least one opening of said at least first TMA unit.

According to a third aspect of the present invention there is provided multiplexing means apparatus, said apparatus including at least a first TMA unit and at least a first multiplexing means unit, said at least first multiplexing means unit including a housing having at least one opening defined therein for the location of one or more electronic components therethrough, and wherein said at least first TMA unit is attached to said at least first multiplexing unit and is arranged to act as a cover or lid for said at least one opening of said at least first multiplexing means unit.

According to a fourth aspect of the present invention there is provided a method of producing and/or using multiplexing means apparatus.

According to further independent aspects of the present invention there is provided a telecommunications system including TMA apparatus or multiplexing means apparatus; and a method of producing and/or using said telecommunications system.

The term multiplexing means in this application means refers to any electronic apparatus that is capable of combining and/or separating out two or more radio frequency signals.

Embodiments of the present invention will now be described with reference to the following figures, wherein:

Figure 1 (PRIOR ART) is an example of a conventional cell site of a telecommunications system;
Figure 2 (PRIOR ART) is a simplified arrangement of the circuitry provided in a TMA and diplexer of the conventional cell site shown in figure 1;

Figure 3 is an example of a cell site of a telecommunications system according to an embodiment of the present invention;

Figure 4 is a simplified arrangement of the circuitry in one embodiment that could be provided in the TMA apparatus shown in figure 3;

Figure 5 (PRIOR ART) is a simplified arrangement of the circuitry provided in a conventional dual TMA showing a DC power and control arrangement;

Figures 6-8 show different embodiments of the circuitry that can be provided in the apparatus of the present invention;

Figure 9 shows an external view of the apparatus according to an embodiment of the present invention; and

Figures 10a and 10b illustrate features of the short circuit detection circuitry according to an embodiment of the present invention.

Referring firstly to figure 3, there is illustrated a cell site arrangement 100 according to an embodiment of the present invention. The same reference numerals are used to define the common features previously described in relation to figures 1, 2 and 5.

The cell site arrangement 100 includes a first antenna 2 operating in the 900MHz frequency band and a second antenna 4 operating in the 1800MHz frequency band provided at the top of a mast 10. A first BTS 6 is provided for transmitting and/or receiving signals in the 900MHz frequency band and a second
BTS 8 is provided for transmitting and/or receiving signals in the 1800MHz frequency band. Diplexer 14 is provided adjacent BTSs 6, 8 at the base of mast 10.

In accordance with the present invention, TMA apparatus 102 is provided which includes TMA circuitry for amplifying one or more RF signals in the 1800MHz frequency band and diplexer circuitry for splitting or bypassing one or more RF signals in the 900MHz frequency band.

Feeder cables 18, 20 are provided between diplexer 14 and TMA apparatus 102. Jumper cables 22 are provided between antenna 2, 4 and TMA apparatus 102 and between diplexer 14 and BTSs 6, 8.

With reference to figures 4 and 9, there is shown a more detailed view of the circuitry provided in TMA 102 and the external appearance of TMA 102. In particular, TMA 102 includes a TMA unit 104 and a multiplexing means unit in the form of a diplexer unit 106 (shown by dashed lines in figure 4). TMA unit 104 and diplexer unit 106 are provided in a stacked arrangement (i.e. one unit on top of another unit), with the side walls and end walls of each unit arranged such that the footprint or cross sectional area of the units is substantially the same. As such, the side walls and end walls of the unit are substantially flush with each other. This provides a neat appearance to the finished apparatus, which significantly enhances the aesthetic appearance of the same compared to conventional arrangements wherein separate TMA apparatus and diplexer apparatus is provided. External cabling 108 is provided in this example to allow good connectivity to be provided between the electronic components of units 104, 106.
A lid or cover 110 is provided on the TMA unit or diplexer unit 104, 106 as required. BTS ports 52, 52' are shown on the same
end as external cabling 108. Antenna ports 48, 48' are located at the opposite end of the unit from the BTS ports 52, 52'.

The TMA circuitry and diplexer circuitry of the present invention, as shown in figure 4, is largely the same as that shown in the separate TMA and diplexer units in figure 2, with some exceptions as will be explained in more detail below.

Input/output ports 48, 48, 30, 30' and 52, 52' associated with the TMA and diplexer circuitry are defined on the external apparatus body.

In one embodiment shown in figure 6, the DC power and control signals for the present invention are illustrated. In this embodiment, DC and control signals are routed along pathway 111, 111' from input/output ports 52, 52', which are connected via feeder cables to BTS 6, 8 in use, to the internal input/output ports 50, 50' associated with the diplexer circuitry of the 1800MHz frequency band pathway. A DC block 112, 112' is provided in the 900MHz pathway between 900MHz filter 56, 58' and input/output ports 48, 48'. This allows the 900MHz antennae ports 48, 48' to be connected to an antenna 2 that may provide a DC short circuit and not short circuit the internal TMA circuitry. CWA mode or AISG mode could be used to power and control the internal TMA circuitry as required.

In an alternative embodiment shown in figure 7, input/output port 52 connected to BTS 6 can be used to provide DC control to both the internal TMA circuitry, as shown by pathway 111, and a 900MHz TMA, as shown by pathway 113. A bias-tee 155 and capacitor 159 is provided between 900MHz filter 56 and input/output port 48 associated with the 900MHz pathway 114 and the 900MHz antenna 2. In this case, AISG mode would be used as only one BTS port is DC connected. DC blocks in the
form of capacitors 116, 112' are provided in the 1800MHz pathway between 1800MHz filter 56' and internal input/output port 50' and in the 900MHz pathway between 900MHz filter 58' and input/output port 48'.

Short circuit detection circuitry 118 is provided in the 900MHz pathway 114 between input/output port 52 and input/output port 48.

In a yet further embodiment (not shown), both sides of the apparatus 102 can be connected in the same way, such that DC blocks 112', 116 are removed and everything is DC connected. Short circuit detection circuitry would be provided in the 900MHz pathway between input/output portions 52' and 48'.

In figure 8, BTS 8 provides power and control for the internal TMA circuitry via the feeder cable connected to input/output port 52 and BTS 6 provides power and control for an external TMA, as shown by bias tee 155' and capacitor 159' fitted between the 900MHz input/output port 48' and antenna 2 via the feeder cable connected to input/output port 52'. Short circuit detection circuitry 118 is provided in the 900MHz pathway between input/output portions 52' and 48'.

Figure 10a shows an example of short circuit detection circuitry 118 that can be provided in the “bypass” pathway (i.e. the pathway that bypasses the TMA circuitry). The short circuit detection circuitry essentially consists of a switch 120 located between the BTS input/output port and the antenna input/output port in a particular pathway and detection means 122. The switch is in an open position if a short circuit is detected by detection means 122 and is in a closed position if a short circuit is not detected by detection means 122. Thus, providing no short circuit is detected, DC is enabled in the
bypass pathway. If a short circuit is detected, DC is not enabled in the bypass pathway. This ensures that if a bypass pathway is provided between a BTS input/output port of the apparatus and an antenna port of the apparatus (i.e. bypassing the TMA circuitry within the apparatus), DC is not enabled on the BTS input/output port.

More particularly, in one example, DC power is only applied to the antenna input/output port if the impedance of the port is $>60\Omega$. This is checked during the initial power up phase of the apparatus where a small bleed current is applied to the antenna input/output port. If the minimum impedance criterion is met, then the power from the BTS input/output port is switched on to the antenna input/output port.

Figure 10b shows a time diagram in one example, wherein $T_{on}$ is $<500\text{ms}$. If during the start up phase the minimum impedance criterion is not met, the power is not enabled and the bleed current is disabled after approximately $1000\text{ms}$ (or in a range between $900-1200\text{ms}$).
Claims:

1. Tower mounted amplifier (TMA) apparatus, said apparatus including at least a first TMA unit and at least a first multiplexing means unit, said at least first TMA unit including a housing having at least one opening defined therein for the location of one or more electronic components therethrough, and wherein said at least first multiplexing means unit is attached to said at least first TMA and is arranged to act as a cover or lid for said at least one opening of said at least first TMA unit.

2. TMA apparatus according to claim 1 wherein the at least first TMA unit and the at least first multiplexing means unit have substantially the same footprint, cross sectional area and/or external dimensions.

3. TMA apparatus according to claim 2 wherein side walls of the at least first TMA unit and the at least first multiplexing means unit are substantially flush with each other when provided in a stacked arrangement.

4. TMA apparatus according to claim 1 wherein the at least first TMA unit and/or the at least first multiplexing means unit is/are modular units in that more than one of each type of unit can be provided and/or the electronic components with any unit is adjustable.

5. TMA apparatus according to claim 1 wherein the at least first multiplexing means unit is a diplexer unit.

6. TMA apparatus according to claim 1 wherein at least two TMA units and/or at least two multiplexing means units are provided.
7. TMA apparatus according to claim 1 wherein sealing means are provided between adjacent TMA units and/or multiplexing means units in the apparatus.

8. TMA apparatus according to claim 7 wherein the sealing means include any or any combination of one or more gaskets or o-rings.

9. TMA apparatus according to claim 7 wherein one or more channels, recesses and/or grooves are defined in the TMA unit and/of the multiplexing means unit to allow location of the sealing means in use.

10. TMA apparatus according to claim 1 wherein each multiplexing means unit comprises a body portion or lid having a first or front side and a second or rear side, the first or front side facing the opening or interior of the TMA unit and the second or rear side facing away from the opening or interior of the TMA unit.

11. TMA apparatus according to claim 1 wherein both the front and rear sides of the body portion or lid have functionality.

12. TMA apparatus according to claim 11 wherein the front side of the body portion or lid has sealing means provided thereon and/or associated therewith for sealing engagement with one or more internal walls of the TMA unit.

13. TMA apparatus according to claim 11 wherein the rear side of the body portion or lid houses or supports one or more electronic components of the multiplexing means
unit, provides sealing means and/or provides one or more internal walls of the multiplexing means unit.

14. TMA apparatus according to claim 1 wherein the multiplexing means unit has a body portion including a base wall with a plurality of side walls and end walls surrounding the same on a first side thereof and protruding outwardly therefrom, the outermost edges of the side and end walls defining an opening therebetween.

15. TMA apparatus according to claim 14 wherein the opening of the multiplexing means unit body portion faces the opening of the TMA unit when the TMA unit and the multiplexing means units are joined together.

16. TMA apparatus according to claim 14 wherein the base wall of the multiplexing means unit body portion has a second or opposite side and side walls and end walls protrude outwardly from said second or opposite side, the outermost edges of the side and end walls defining an opening therebetween.

17. TMA apparatus according to claim 16 wherein a lid or cover is fitted over and/or is associated with the opening.

18. TMA apparatus according to claim 17 wherein sealing means are provided on or associated with the lid or cover and/or the side walls and ends walls of the second or opposite side of the base wall of multiplexing means unit body portion.

19. TMA apparatus according to claim 1 or claim 10 wherein one or more apertures or channels are provided between the first and second sides of the body portion, lid or cover
of the multiplexing means unit to allow pressure equalisation internally and externally.

20. TMA apparatus according to claim 1 wherein one or more link cables are provided between one or more electronic components of the TMA unit and one or more electronic components of the multiplexing means unit.

21. TMA apparatus according to claim 20 wherein the link cables are provided substantially externally of the units.

22. TMA apparatus according to claim 1 wherein the multiplexing means unit is retrofitted to an existing TMA unit which has had its lid or cover removed.

23. TMA apparatus according to claim 1 wherein one or more input/output ports are provided to allow connection of the apparatus to one or more other electronic components directly or indirectly.

24. TMA apparatus according to claim 1 wherein short circuit detection means is provided in or associated with said one or more input/output ports.

25. TMA apparatus according to claim 24 wherein the short circuit detection means includes a Direct Current (DC) switch and detection means.

26. TMA apparatus according to claim 25 wherein when a short circuit is detected by the detection means, the switch is moved to an open position to ensure the input/output port is not DC enabled; and wherein when a short circuit is not detected by the detection means, the switch is
moved to a closed position and the input/output port is DC enabled.

27. TMA apparatus according to claim 25 wherein the short circuit detection means is arranged to bypass the internal circuitry of the TMA unit.

28. TMA apparatus according to claim 1 wherein one or more electronic components provided in or associated with each of the TMA unit and/or multiplexing means unit are contained substantially entirely within the external boundaries of said unit.

29. TMA apparatus according to claim 1 wherein one or more electronic components provided in or associated with one of the TMA unit and/or multiplexing means unit protrude outwardly from an opening of said unit and/or into or within the external boundaries of the other of the TMA unit and/or multiplexing means unit.

30. A method of producing tower mounted amplifier (TMA) apparatus, said apparatus including at least a first TMA unit and at least a first multiplexing means unit, said at least first TMA unit including a housing having at least one opening defined therein for the location of one or more electronic components therethrough, and wherein said method includes the step of attaching the at least first multiplexing means unit to said at least first TMA and arranging the multiplexing means unit so as to act as a cover or lid for said at least one opening of said at least first TMA unit.

31. Multiplexing means apparatus, said apparatus including at least a first Tower Mounted Amplifier (TMA) unit and at
least a first multiplexing means unit, said at least first multiplexing means unit including a housing having at least one opening defined therein for the location of one or more electronic components therethrough, and wherein said at least TMA unit is attached to said at least first multiplexing means unit and is arranged to act as a cover or lid for said at least one opening of said at least first multiplexing means unit.
Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

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<td>US2010/0279730 A1 (ORTIZ) See Figure 1 and para 14. Note TMAs 210, 211 and multiplexing means 202.</td>
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<td>US2010/0113097 A1 (SEEOR) See Fig. 3, and paras 23 and 53-58. Note TMAs 17.1 and 17.2 and multiplexing means 11H.</td>
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Field of Search:
Search of GB, EP, WO & US patent documents classified in the following areas of the UKC:

Worldwide search of patent documents classified in the following areas of the IPC
H01Q, H04B, H04W, H05K

The following online and other databases have been used in the preparation of this search report
Online: WPI, EPODOC, TXTE, INTERNET
### International Classification:

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