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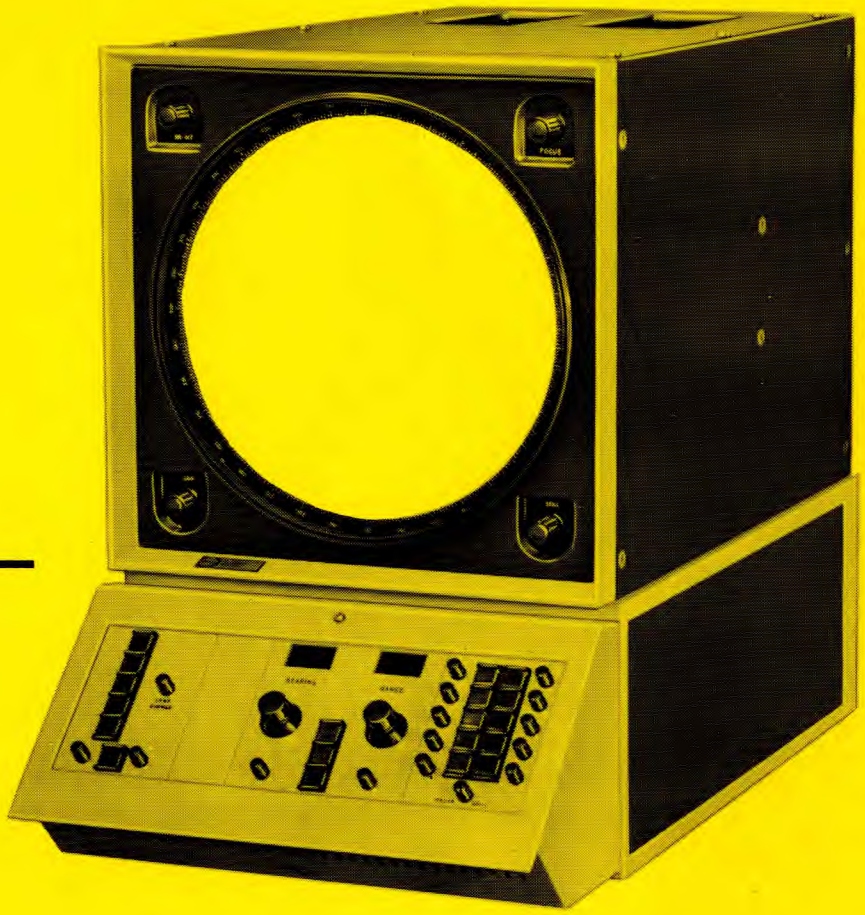
Colin Hinson
In the village of Blunham, Bedfordshire.

Plessey 16-A2

AUTONOMOUS DISPLAYS



- Programmable
- Versatile
- Character Writing
- D.F. Inputs
- Range and Bearing Line with L.E.D. Numeric Readout
- Simple to Install
- Simple to Maintain

PLESSEY RADAR

Plessey 16-A2

AUTONOMOUS DISPLAYS

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RSL. 1267

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The description and specification contained in this brochure are current at time of publication, but may be subject to variation as a result of later improvements in design or technique. Equipment supplied will be in accordance with the Company's specifications current at the time of manufacture or as otherwise agreed in writing.


FOCUS
BEARING
RANGE

CHAPTER 1

INTRODUCTION

1. The Plessey 16-A2 Autonomous Display, in its simplest form, provides a radar controller with a conventional plan position indicator (p.p.i.) presentation on a 405mm (16in) screen. With the addition of 'Customer Options' the basic display capability may be extended to provide :-

(1) Character label data (typically, as derived from an automatically decoded s.s.r. system).

(2) An electronic range and bearing line with digital readouts on light emitting diodes.

(3) Direction finder (d.f.) data.

All these facilities may be included in the one display, at the time of manufacture or, if required, may be added at a future date.

2. Space is available within each display, such that other facilities may also be provided. These include :-

(1) Radar head selection

(2) Internally generated characters

(3) Video compression

(4) Output drives to slave displays.

3. The 16-A2 displays have been designed so that the 'Standard Facilities', in terms of the unit of range calibration, range mark intervals and range scales may all be 'programmed' to suit the precise operational parameters required by the customer. Contrary to previous practice, no 'specific' components are required in a 16-A2 display to suit any particular customer requirements. Hence no special (and expensive) design work is necessary when manufacturing a 'standard' 16-A2 autonomous display.

4. Consideration should also be given to the advantages to be gained by the use of autonomous displays, as opposed to a central drive system with slave displays. These advantages may be summarised as :-

(1) Each display is entirely independent of the others, and hence one display failure will not affect another display.

(2) Installation, cabling and maintenance become simple tasks.

(3) Negligible system design problems.

(4) High quality character presentation with local generation, as opposed to centrally generated and distributed characters.

5. With the advent of highly stable circuits using a large percentage of integrated circuits, regular maintenance is only necessary at monthly intervals. In the instance of a failure, the Plessey 16-A2 display can be easily removed from the operations room without disturbance of other displays.

6. The 16-A2 autonomous display utilises the well-established Plessey Mk. 8 405mm (16in) slave viewing unit, together with a number of standard printed circuit boards and control panels.

7. The complete 16-A2 display assembly comprises the Mk. 8 405mm slave viewing unit and a plinth unit (containing the drive circuits and control panels). This is ideally suited for mounting on a table. Alternatively, the display may conveniently be mounted on a trolley which then fits into a suitable aperture in the customer's console. As a further option, the main units of the display may be separated and then mounted directly into a console in the precise positions required by the customer.

CHAPTER 2

OPERATIONAL FEATURES

GENERAL

1. The 16-A2 display has been designed as a general purpose, self-contained radar display capable of being used with all air traffic control and surveillance radar equipments.

2. Of particular importance in any radar display equipment, is the ability to provide the Controller with the precise operational parameters (in terms of range scales and range mark intervals etc) that he requires. By the use of a simple system of 'patch links', the display may be adjusted to virtually any requirements in this respect; similarly, it may be programmed to accept the interface requirements of different a.t.c. and surveillance radar equipments.

3. All displays are fitted with an illuminated compass rose and a rotating cursor with parallel line index. The cathode ray tube has a standard long persistence radar phosphor Type P26 (or 'Z'). (Other phosphor types may be fitted to special order).

STANDARD FACILITIES

4. The precise requirements of each customer, in respect of the operational parameters, are set on the display by means of 'patch links' on the back wiring of the printed circuit board box. These parameters which comprise the 'Standard Facilities' of the display provide for:-

(1) Range calibration: Nautical miles (1,852m)
or Data miles (1,828.8m)
or Kilometres (km)

(2) Maximum range: Timebase range may be set to any point between: 50 and 300 miles (or 92 and 548km)

(3) Range expansion: Five scales, each of which may be set to any one of 64 ratios between 1:1 and 15.5:1 with respect to maximum timebase range, provided that the resultant range is not less than 5 miles or 10km.

(4) Range markers: Markers are generated at intervals of 1, 2, 5, 10, 20, 50 and 100 units of range (nm., dm., or km). Any three markers may be made available for normal operator usage.

CUSTOMER OPTIONS

5. Within the standard range of 16-A2 autonomous displays, there are twelve types available. Each of these provides a p.p.i. presentation on the 405mm (16in) Mk.8 viewing unit. Additional facilities and the choice of azimuth input, are provided by 'Customer Options', thereby making the twelve standard types. These are shown, and related to the Plessey type numbers, in the following table:-

Plessey Type No.	Azimuth Data		Range and Bearing Line	Direction Finder	Synthetic Data Input
	Resolver	D.C. Sin/Cos			
678/16800/001	✓				
678/16800/002		✓			
678/16800/003	✓				✓
678/16800/004		✓			✓
678/16800/005	✓		✓		
678/16800/006		✓	✓		
678/16800/007	✓		✓		✓
678/16800/008		✓	✓		✓
678/16800/009	✓		✓	✓	
678/16800/010		✓	✓	✓	
678/16800/011	✓		✓	✓	✓
678/16800/012		✓	✓	✓	✓

6. All displays within this standard range are wired in an identical manner, for two reasons; firstly, so that one version may be readily modified at a later date to another version without alterations to the basic display wiring, and secondly, to simplify production of the displays. (This means that the appropriate 'mix' of standard sub-assemblies may be put together to form a complete display, the 'patch links' applied as required for the standard facilities, and the complete display then passed through final testing ready for despatch to the customer, without any design involvement whatever)

Azimuth Data

7. It is apparent from the above table that the display will accept azimuth data in either synchro resolver modulated sine/cosine or d.c. sine/cosine form. In the former case, the display is fitted with an additional printed circuit card which provides a 400Hz. drive waveform for a synchro resolver being driven at a ratio of 1:1 with respect to the radar aerial. The modulated sine/cosine outputs from the synchro resolver are then accepted into the display. Where more than one display is being used, a 'master display' selection switch is necessary so that one display is selected to drive the synchro resolver. The resultant modulated sine/cosine outputs are then fed in parallel to all displays. Alternatively, standard d.c. sine/cosine azimuth inputs may be accepted direct into each display.

8. If neither a shaft, rotating at 1:1 with the aerial which is suitable for fitment of a synchro resolver, nor d.c. sine/cosine data are available, then Plessey Radar will be pleased to supply a suitable conversion unit. This may be either an Azimuth Data Converter, which accepts digital azimuth data and converts to d.c. sine/cosine data, or alternatively, an aerial servo unit which accepts synchro data and provides a resolver or a digitiser at its output.

Range and Bearing Line

9. The range and bearing line option is in the form of an electronic interscan line. The bearing line is controlled by a two-speed control with readout of the bearing given on the control panel by a three digit indicator. The range control is similarly controlled, and again provided with a three digit indicator. (If the maximum timebase range is set below 100 miles or kilometres, the third digit will give a range readout to one decimal point).

10. The origin of the range and bearing line is normally set at radar centre, but it may be switched to an off-centred condition under the control of X and Y multi-turn potentiometers. The origin may be off-centred to any position within the maximum timebase range.

11. The range and bearing line readout gives a bearing as related to North (QDR, assuming the radar is aligned to magnetic north). A spring-loaded push-button switch is provided which will change the readout to a reciprocal bearing or course to steer (QDM).

12. The range and bearing line option is catered for by adding to the display, (with just the basic p.p.i. capability), a control panel and four printed circuit cards.

Direction Finder

13. Provision can be made for accepting azimuth data from a direction finding equipment. This option can only be exercised if the range and bearing line is also incorporated.

14. The input data will be d.c. sine/cosine for the azimuth input, together with a pair of wires with a 'clean' closed contact when there is a valid d.f. transmission being made.

15. A d.f. on/off switch is incorporated in the range and bearing line control panel. When the controller selects d.f., then control of the interscan line is transferred from the range and bearing line function to the d.f. function as soon as a valid d.f. transmission is received. When the d.f. transmission ceases, the control of the line automatically reverts to the range and bearing line function. When the interscan line is in the d.f. mode, its length automatically extends to maximum timebase range.

16. The direction finder option is catered for by the addition of two printed circuit boards to the display with the p.p.i. and range and bearing line capability. If the synthetic data input option is also incorporated, then only one additional printed circuit board is required.

Synthetic Data Input

17. The synthetic data input option enables synthetic labels to be presented in conjunction with the standard p.p.i. picture, thereby creating a labelled plan display (l.p.d.). The input data required is in the form of:-

(1) X and Y major deflection (position)

(2) x and y minor deflection (character shape and minor shifts)

(3) Synthetic video (bright-up)

(4) Synthetic data interrupt (mainscan to synthetic data switching).

18. The synthetic data may be presented during radar dead time (if available) or asynchronously with the mainscan. Typical presentations of synthetic data may be derived from automatically decoded s.s.r. data. To take an example, using a typical terminal area primary and secondary radar installation, 140 labels each containing 8 characters can be presented at a refresh rate of 20 per second without any loss of primary radar data. This is based on the following assumptions:-

(1) Radar p.r.f. 700
p.r.i. 1433μs

(2) Maximum display range: 80nm.

Mainscan duration: 990μs
Radar dead time: 443μs

(3) Average character writing time: 4μs

(4) Each label comprises a symbol, four figure identity and three figure height code 8 characters

32μs

Plus minor shifts between characters: 8μs

Plus display recovery: 45μs

Total time to position and write one label 85μs

In each radar dead time 4 complete labels can be written:-

$4 \times 85\mu s = 340\mu s$

Plus Final recovery time for display = 45μs

385μs

On the above typical assumptions, 2800 complete labels may be written per second or say, 140 labels refreshed 20 times per second without any loss of primary radar data.

19. The synthetic data input option is catered for by addition to the display, with just the basic p.p.i. capability, of three printed circuit boards. If the range and bearing line option is also incorporated, only two additional printed circuit boards will be required; also if the d.f. option is incorporated as well, then only one additional printed circuit card is required for the synthetic data input option.

OPERATOR CONTROLS

20. All the main controls are situated on the modular panel at the front of the display beneath the viewing unit. Four controls are also provided on the viewing unit itself.

21. The controls on the viewing unit are as follows:-

(1) On/Off switch - this will switch on the a.c. mains supply in the power unit which immediately makes all d.c. supplies available to the slave viewing unit and to the autonomous display drive circuits. Also, the e.h.t. supply within the slave viewing unit will become available at the same time, providing that the a.c. supply to the power unit has been available for a period of greater than 60 seconds; otherwise, a thermal delay will prevent the e.h.t. from being switched on until the c.r.t. heaters have been on for this period. (A.C. mains supply is not actually taken into the viewing unit).

(2) 'Focus' - Control of the electro-static focussing of the cathode ray tube.

(3) 'Brightness' - Control of the overall brilliance of the cathode ray tube picture.

(4) 'Gain' - Control of the gain of the composite video as input to the viewing unit. This is normally set to maximum when the viewing unit is used in the autonomous display configuration and then each individual video gain is on the main control panel (See paragraph (4) below).

22. Control of the illumination of the compass rose and the rotating cursor is by a preset dimmer control situated within the viewing unit.

23. The main control panel (Figure 2.1) is constructed on a modular basis. The controls relevant to the display with just a p.p.i. presentation (no range and bearing or d.f. line, or synthetic data presentations) are as follows:-

Range Select Control Panel (lefthand side)

(1) Five mechanically interlocked push-button switches for selection of the displayed range scale. The actual range expansion ratios are preselected (by patch links) from 64 ratios that are available between 1:1 and 15.5:1 with respect to maximum range.

(2) Centre/Off Centre - a push-button switch providing the facility to operate the display with the picture centred at tube centre, or off-centred to any position within maximum timebase range and as controlled by X and Y multi-turn potentiometers.

(3) Lamp Dimmer - a control to adjust the illumination in all the push-button switches contained within the complete control panel.

Video Select Control Panel (righthand side)

(4) On/Off switch and gain controls appropriate to each of the five available video inputs to the display, (lefthand columns of switches and controls).

(5) On/Off switch and gain controls appropriate to each of three range markers which may be selected for presentation with the radar picture. Range markers at intervals of 1, 2, 5, 10, 20, 50 and 100 units of range (nm., dm., or km,) are generated in each display; any three of these can be selected (by patch links) for normal presentation. (These switches and controls are the top three of the right hand columns).

(6) On/Off switch and gain control-(fourth pair down right hand column) for the electronic range and bearing line, (if this facility is incorporated in the display).

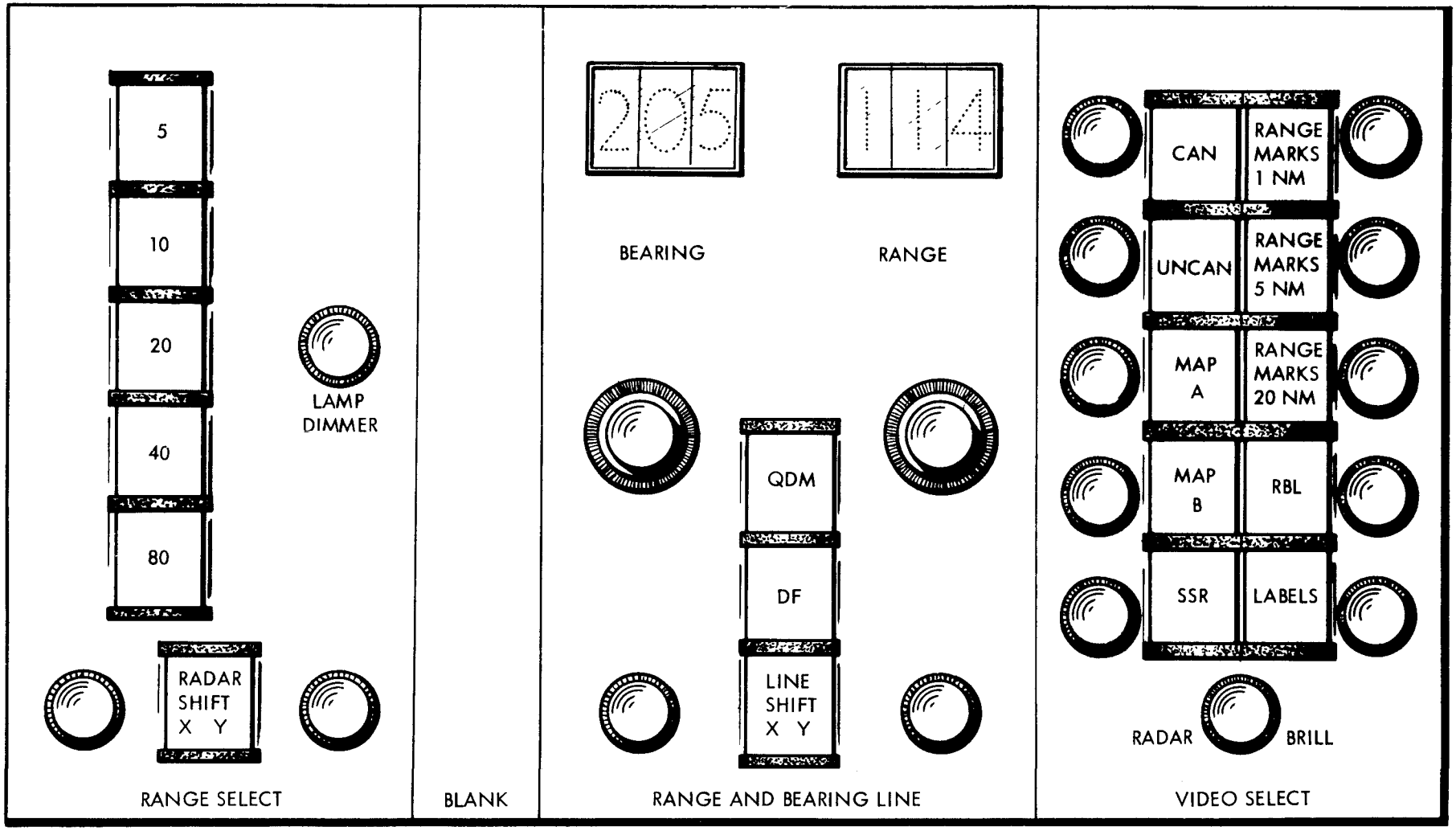


Figure 2.1

MAIN CONTROL PANEL
WITH TYPICAL LABELLING

(7) On/Off switch and gain control-(bottom pair of the right hand column) for the synthetic data presentation, (if this facility is incorporated in the display).

(8) Radar Brilliance control providing adjustment of the brightness level of the radar trace.

24. The controls on the range and bearing line control panel are described above in the section dealing with this customer option and the direction finder option (paragraphs 9-16 above).

25. The legends for all the illuminated push-button switches are provided by photographic negatives which are inserted into the cap of each switch. These may be changed very easily if it should be so desired.

EXTENSION CAPABILITY

26. As may be seen from the photographs included in this brochure, only one row of printed circuit boards is used to provide all the Customer Options provided in the standard range of displays. Space is available for another complete set of printed circuit boards (20 maximum) and hence there is ample provision made for future extensions. Provision is also made for the additional input/output connections which will almost certainly be required with any extensions. Examples of this extension capability follow.

Autonomous Labelled Radar Display

27. Plessey Radar have completed development of an autonomous display with a full character generation capability (a separate brochure on this Autonomous Labelled Radar Display is available). Also, scan compression circuits may be incorporated if the radar parameters are such that no radar dead time is otherwise available for character presentation.

Radar Head Selection

28. Another version of the display has been produced which incorporates radar head selection switching between two radars. This version could readily be adapted for three or four radar heads. In the displays with the radar selection facility all the Customer Options, as described above, are also available. The radar selection control panel is fitted in place of one blank panel on the main control panel.

Slave Display Drive

29. A further version of the 16-A2 display provides for output drive to one, two or three slave displays (Mk. 8 305mm, 405mm or 560mm). These displays may be driven as pure slaves to reproduce an identical presentation to that presented on the 'Master' 16-A2 display; or alternatively, individual range selection, off-centering and video selection/gain controls can be provided for each slave display.

CHAPTER 3

TECHNICAL DESCRIPTION

GENERAL

1. The display is effectively divided into three sections: the viewing unit, the power unit and the plinth assembly. The descriptions that follow are taken in this order.

2. A complete block schematic diagram of the display is shown at Figure 3.1. In this diagram, each block represents a single printed circuit board, control panel, the viewing unit or thepower unit. Where a printed circuit board or control panel forms part of a 'Customer Option' it is marked thus +. The numbers in each block represent a code which in turn relates to the type number of the relevant unit.

VIEWING UNIT

3. The viewing unit used is the completely standard high performance Mk. 8 slave viewing unit. A full description and specification of the range of Mk. 8 viewing units is available in a separate brochure. (The specification following in Chapter 5 relates to the total assembly of the autonomous display).

4. Basically, the Mk. 8 viewing unit comprises a single fixed deflection coil driven by a pair of deflection amplifiers and a single channel video amplifier.

5. The X and Y deflection amplifiers are identical and comprise a common mode rejection and mixing amplifier followed by the final deflection amplifier. If synthetic data is to be presented, then the character shape waveform (minor deflection) will be input separately to the common mode rejection and mixing amplifier and there it is mixed with the major deflection input prior to being passed onto the final deflection amplifier and single fixed coil.

6. The deflection system of the viewing unit has a nominal recovery time across the diameter of 23μs,with a worst case figure of 30μs (when the mains input voltage is 10% below nominal). Also, it has a small signal bandwidth of approximately 3MHz, enabling characters to be written in an average time of 4μs, or 0.35μs per limb.

7. The final video amplifier has just a single channel and accepts the fully mixed

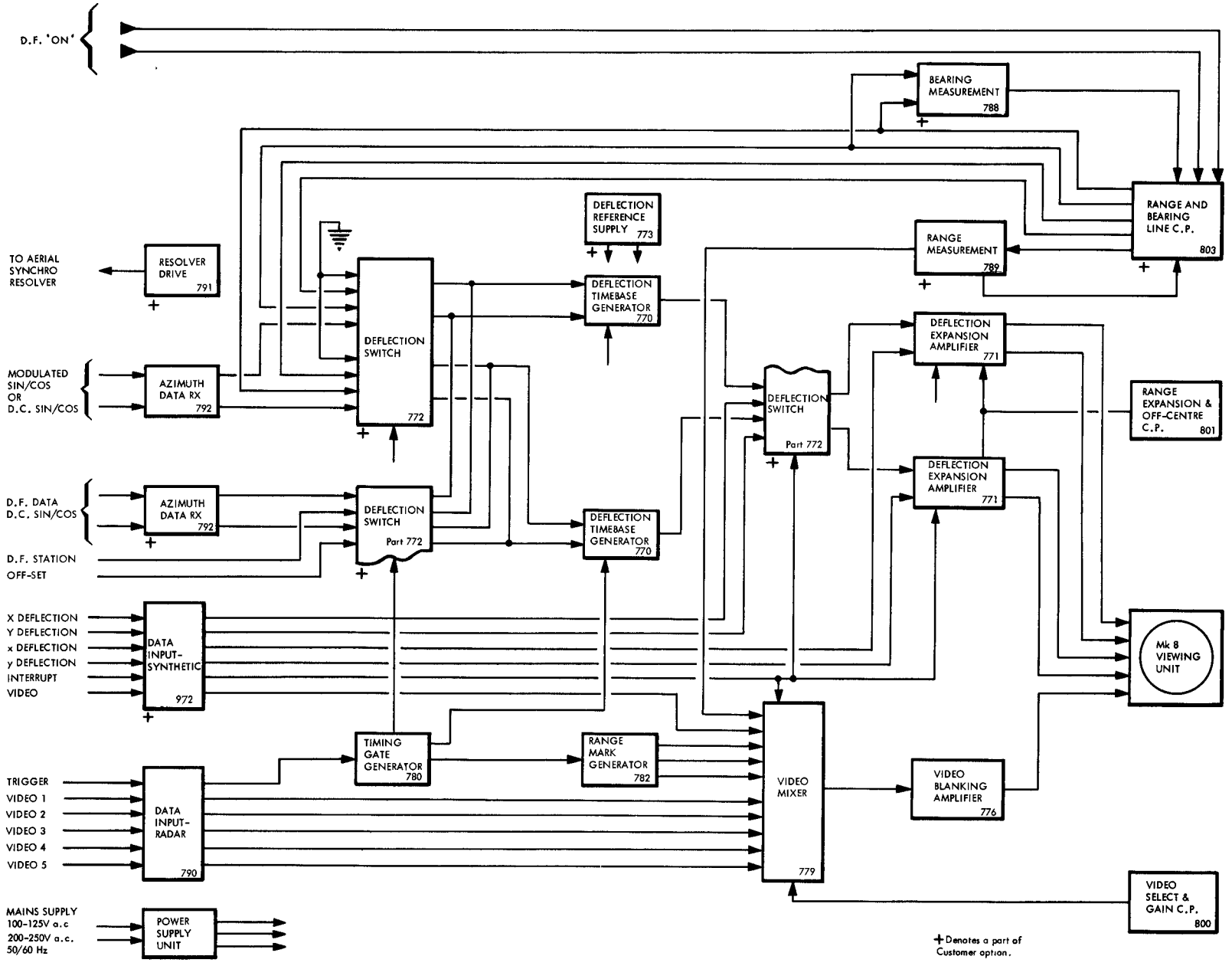


Figure 3.1

16-A2 AUTONOMOUS DISPLAY, WITH CUSTOMER OPTIONS

video waveform from the plinth assembly. It provides the necessary drive to the cathode ray tube grid and cathode.

8. The e.h.t. unit is incorporated in the viewing unit and supplies 15kV to the cathode ray tube. The unit is all solid-state, with the high voltage components contained in an encapsulated block.

9. A printed circuit board generates a 400V supply for the electrostatic focussing of the cathode ray tube.

10. A scan failure protection circuit is included in the viewing unit on another printed circuit card. This will minimise the risk of burning the phosphor on the cathode ray tube in the event of a failure in the deflection circuits. The circuit will detect certain deflection failures and then automatically reduce the brilliance of the presented picture.

POWER UNIT

11. Physically separate but electrically part of the autonomous display is a power supply unit requiring a single phase 50Hz or 60Hz mains input. This power supply will provide all the requisite d.c. supplies to the viewing unit and the autonomous drive circuits. The connection between the power unit and the Autonomous Display assembly is via a cable of approximately 3 metres length.

PLINTH ASSEMBLY

12. When considering the plinth assembly it is easiest to first look at the display with just the basic standard and to ignore the 'Customer Options'. These are described in paragraph 31 and onwards.

Trigger and Videos

13. As illustrated in the block schematic diagram, the radar trigger and up to five video inputs are accepted into the data input-radar printed circuit board (p.c.b.). This p.c.b. applies a high degree of common mode rejection to the input signals and also allows inputs in the range of 1V to 15V to be adjusted to a level that is suitable for following circuits.

14. The radar trigger is taken into the timing gate generator p.c.b.. This p.c.b. works in conjunction with the range mark generator p.c.b. Calibration crystals are contained in the timing gate generator p.c.b. and control a digital clock which in turn controls the mainscan gate length and hence the timebase gate waveform. The running time for the mainscan gate length is set by patch links on the back wiring of the board box.

15. The display is designed so that the timebase actually starts 5μs before t_o (these 5μs of scan being video blanked). Adjustments are available so that the trigger input may be set at any time between t_o minus 5μs and t_o minus 75μs.

16. A test switch is situated at the left hand side of the p.c.b. drawer assembly which enables the above mentioned digital clock to free run and hence, in effect, to allow the display to run without any external trigger.

17. The three range mark generator crystals will calibrate the display in nautical miles, data miles or kilometres: selection of the unit of range is achieved by patch links on the back wiring.

18. The range mark generator generates range marks at intervals of 1, 2, 5, 10, 20, 50 and 100 units of range. Any three of these intervals can be patch linked out for normal operator usage. A test switch is provided so that 1 unit of range markers are presented on the p.p.i. picture in place of the shortest interval set by the patch links.

19. The patch link selected range mark intervals are fed onto the 10 way video mixer p.c.b. This video mixer p.c.b. also accepts the 5 external videos from the data input-radar p.c.b. (four video input circuits are suitable for analogue waveforms, whilst the fifth is suitable for a digital type of video; e.g. : s.s.r. bracket decode, video map, north mark or angle mark).

20. Each video (including range marks) has its own operator controlled on/off switch and gain control. All videos are mixed in the video mixer and thence the combined output is fed onto the video blanking amplifier.

21. The video blanking amplifier will apply peripheral blanking to the picture presented on the cathode ray tube such that no 'blooming' effect is visible around the edges of the tube. This blanking is controlled by an output from the deflection expansion amplifiers.

22. Facilities are also incorporated in the video blanking amplifier for blanking a segment of the p.p.i. presentation. This may be required if the display is later extended to show synthetic data and a microtabular presentation is required in a little used segment of the picture.

23. The output from the video blanking amplifier is fed out to the viewing unit.

Deflection System

24. Azimuth inputs to the display are in the form of d.c. Sine θ / Cosine θ data or modulated Sine θ / Cosine θ data. Either of these may be fed into the azimuth data receiver p.c.b. If a modulated waveform is input, then a positive going sample pulse will be required additionally to allow the demodulator circuits to sample the peaks of the modulating waveform.

25. The outputs from the azimuth data receiver, after common mode rejection has been applied at the input, are set to a differential amplitude of 4V. These sine and cosine d.c. outputs are then output as heading voltages to the X and Y timebase generators.

26. The timebase duration is controlled by the mainscan gate waveform from the timing system, but the ramp rundown is set by selecting the appropriate 'mix' of capacitors on each timebase p.c.b. This is achieved by use of 'patch links' on the back wiring of the board box. The patch links will select specific FET switches on the timebase p.c.b.'s to be closed and hence select the specific capacitors required.

27. The timebase outputs are fed out to the deflection expansion amplifier p. c. b. 's. The function of these boards is under the control of the operator's Range Expansion and Off-Centre Control Panel. The actual expansion ratio that is provided for each of the five range selection buttons is set by programming links on the control panel itself. This in turn, provides control logic to the expansion amplifiers. Each button may be programmed so that any of 64 ratios of expansion between 1:1 and 15. 5:1 may be set.

28. The expansion amplifiers will also be under the control of the X and Y picture off-centre controls, allowing the complete p. p. i. presentation to be off-centred in any direction up to maximum timebase range.

29. Blanking signals are generated within the expansion amplifiers such that the videos may be blanked whenever the deflection is taken outside the periphery of the cathode ray tube. This octagonal blanking signal is fed to the video blanking amplifier. Facilities also exist so that a segment at any one of the cardinal points may be blanked from normal p. p. i. presentation so that this area may then if desired, be used in the synthetic role to present micro-tabular data.

30. The final output from the expansion amplifiers is fed direct to the final deflection amplifiers within the viewing unit.

CUSTOMER OPTIONS

Range and Bearing Line

31. The range and bearing line control panel is basically comprised of a bearing sine/cosine potentiometer and a range linear potentiometer. Also, X & Y multi-turn potentiometers are provided for off-centering of the line from radar centre.

32. The sine and cosine outputs from the control panel are fed into a deflection switch p. c. b. in conjunction with the sine and cosine outputs from the azimuth data receiver which provides the radar trace heading voltages for the time-base. The range and bearing line is presented every 10th mainscan and timing for this facility is provided from the timing gate generator. The timing gate generator will provide a suitable switch wave-form to the deflection switch such that the radar data and range and bearing line data are switched at the appropriate times. The switched outputs for sine and cosine data are then fed into the corresponding time base generators.

33. The X and Y off-centering control volts for the line are also fed into the above mentioned deflection switch and are switched simultaneously with the sine and cosine data such that the off-centering control volts are fed through to off set the origin of the timebase when the timebase is operating in the range and bearing role. During mainscan time the deflection switch will feed through an earth potential to keep the timebase origin at zero (c. r. t. centre).

34. The sine and cosine outputs from the bearing potentiometer will also be fed into the bearing measurement p. c. b. This board will accept the sine/cosine data and translate it into digital format through digital counters. The resultant output will then be fed back into the control panel and control the three digital indicators. These digital indicators are solid state light emitting diodes.

35. The range potentiometer output is fed into a range measurement p.c.b. which will firstly provide a brilliance waveform with a knock-off point appropriate to the length required to be presented by the line. This brilliance waveform will then be fed into the video mixer p.c.b. and from there on it will be treated as a normal video function.

36. The range measurement board will also convert the range potentiometer output into a digital format and this resultant digital signal will be fed back to the control panel to control the range digital indicators. These are again light emitting diodes.

37. If the maximum timebase range programmed on to the display is less than 100 units of range then the range readout will be to one decimal point. If the display range is greater than 100 units of range then the range readout will be to the nearest unit of range.

Direction Finder Data

38. If it is required to present direction finder data then this data must be in the form of d.c. sine and cosine voltages in the same range of those that can be accepted for normal radar azimuth data. The direction finder data will be fed into an identical azimuth data receiver p.c.b.

39. It is often the case that the d.f. station is geographically separated from the radar station and hence it is necessary to off set the origin of the d.f. line when it is presented on the p.p.i. picture. For this reason inputs are available to the display such that appropriate off set voltages may be provided.

40. The direction finder data is presented in place of the range and bearing line only when the controller specifically wants this data and when there is a valid d.f. transmission available. For this reason it is required that a single 'clean' closed contact be provided during a valid d.f. transmission. This contact will be in series with a d.f. on/off switch on the range and bearing line control panel. By this means it is ensured that the operator has maximum use of the range and bearing line facility and its presentation is only interrupted for d.f. line presentation when there is a valid transmission available. When a transmission ceases, control of the line will automatically revert back to the range and bearing line controls.

41. The d.f. data sine and cosine and off-set signals will be fed into a further deflection switch, the switch functions of which are tied to those described above for the range and bearing line.

42. Whenever a d.f. transmission is made, the length of the line presented automatically goes out to maximum timebase range.

Synthetic Label Data

43. Synthetic character data may be presented in conjunction with the p.p.i. data. For this purpose X and Y major deflection inputs, x and y character shape deflection inputs, character video and an interrupt signal will be required. All these signals will be accepted into a data input- synthetic p.c.b. This p.c.b. will apply common

mode rejection to each of the synthetic input signals and will output them to the relevant parts of the following drive circuitry.

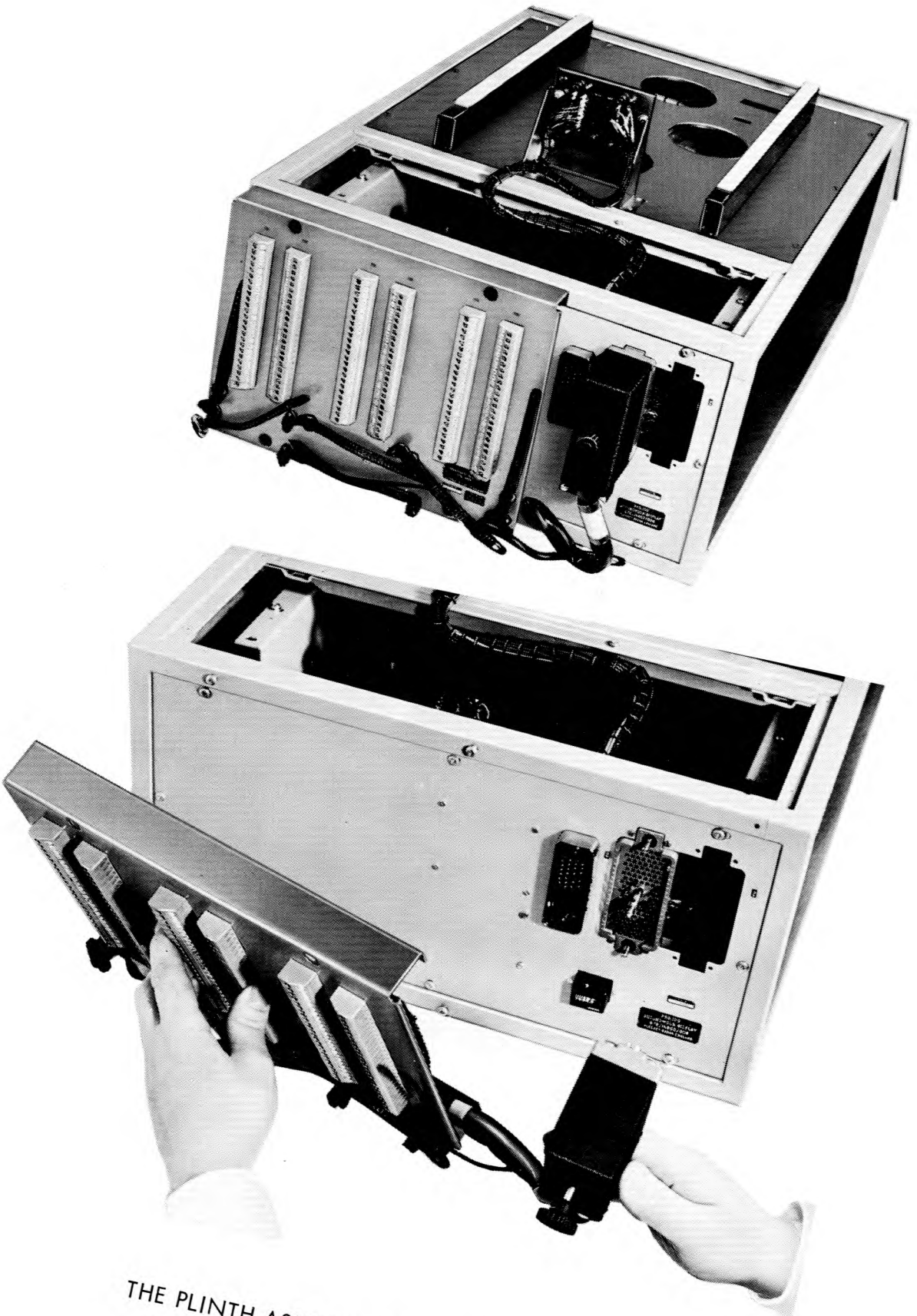
44. The X and Y major deflection signals will be taken to a deflection switch which is placed after the timebase generators but before the expansion amplifiers. The switching function of this deflection switch will be under the control of the interrupt signal and hence the switched output from this deflection switch will provide a composite radar mainscan and synthetic major deflection waveform which is then fed into the expansion amplifiers.

45. The x and y minor deflection signals are fed into an electronic switch which, for convenience, is contained within the expansion amplifier p. c. b. Obviously, unlike the synthetic major deflection, this character deflection waveform is not subjected to range expansion. The function of this electronic switch is again under the control of the synthetic interrupt signal; its output will be fed direct to the final deflection amplifier in the viewing unit where it will be mixed with the major deflection signals before application to the single fixed deflection coil.

46. The synthetic video will be taken into the video mixer as will also the synthetic interrupt signal. When the interrupt signal occurs all the radar function videos will be switched off and the synthetic video signal will be switched through and output as a normal video via the video blanking amplifier to the viewing unit.

Deflection Reference Supply

47. If any of the above three 'customer options' are included in the display then the deflection reference supply p. c. b. will also be fitted. This p. c. b. will provide a 4 volt reference for the deflection system and hence enable accurate registration to be maintained between mainscan, range and bearing line, direction finder data and synthetic data.



THE PLINTH ASSEMBLY AND TERMINATION UNIT

CHAPTER 4

MECHANICAL CONFIGURATION

GENERAL

1. The overall autonomous display assembly comprises a standard Mk. 8 405mm (16in) slave viewing unit which is mounted on top of a plinth assembly. The plinth assembly contains all the requisite drive circuits for the slave viewing unit and also provides a suitable mounting for the controls. All input connections to the display are made via a termination unit at the rear of the display.

2. A power unit electrically forms part of the complete autonomous display, but it is a physically separate unit. It is connected to the display by a cable 3m in length.

SLAVE VIEWING UNIT

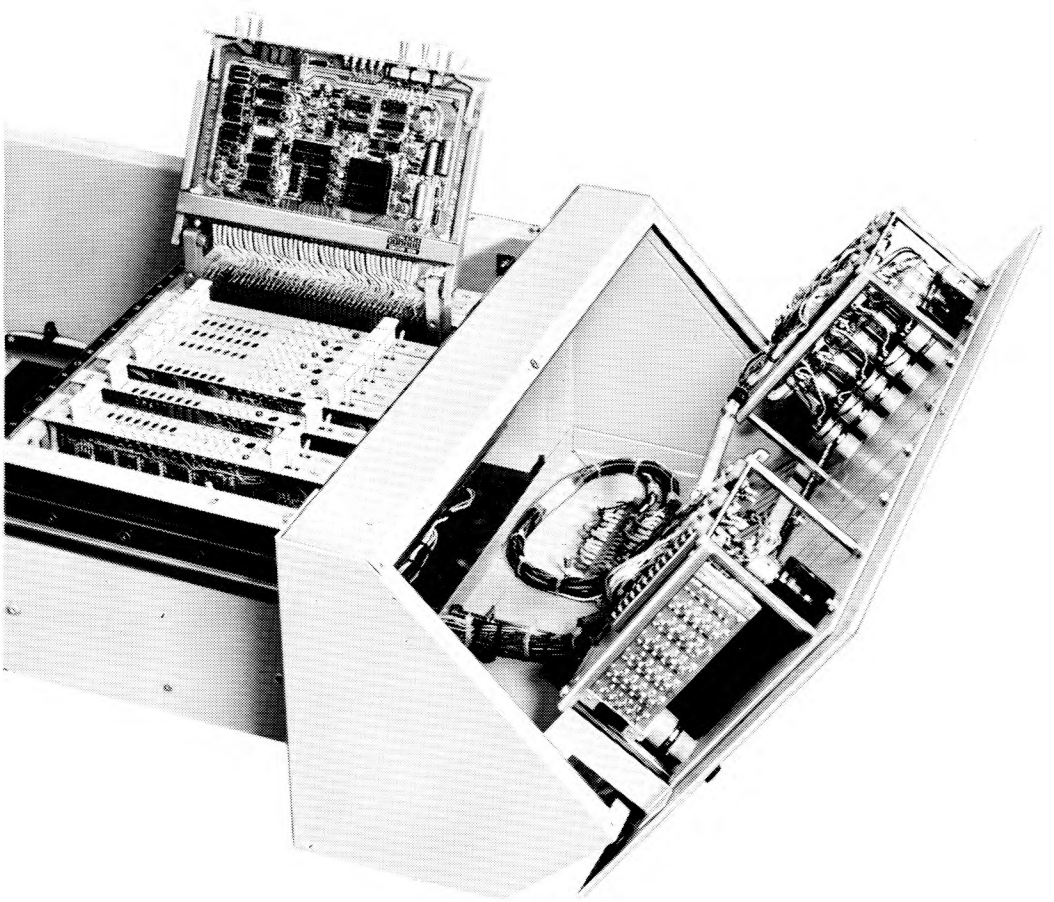
3. The Mk. 8 405mm slave viewing unit is primarily constructed from two castings. The front casting encloses the bowl of the cathode ray tube and supports the tube as necessary, while the rear casting (which is bolted to the back of the front casting), supports the fixed deflection coil, the final deflection amplifiers, the final video amplifier and the e. h. t. unit.

4. The whole viewing unit which is protected by dust covers, slides onto the top of the plinth assembly. A mating plug/socket arrangement (with a dowel guide pin) makes contact when the viewing unit is in its correct position on the plinth; hence all requisite connections from the plinth assembly to the viewing unit are made.

PLINTH ASSEMBLY

5. The plinth assembly forms a mounting base for the Mk. 8 405mm slave viewing unit and contains a drawer which, in turn, houses all the printed circuit boards and control panels for the display.

6. The basic plinth is fabricated from box section girders and covered with plastic clad aluminium panels. Sliding runners are mounted in the plinth on which the drawer is mounted, so enabling it to be pulled out for ease of access to the printed



DISPLAY ACCESSIBILITY FOR MAINTENANCE

from just inside the front of the plinth, and thence the whole viewing unit can be pulled forward and taken away. Dust covers are fitted to the sides and top of the viewing unit by quick-release fasteners and may require removal for maintenance purposes at irregular intervals.

16. Access to the rear of the display is normally only required during installation, or if the complete display is to be removed for workshop servicing. (See paras. 11 and 12 above).

17. All dimensions of the display and the power unit together with mounting hole centres are shown in figures 4.1, 4.2 and 4.3.

CONSOLE MOUNTING

18. Should it be impractical to mount the display assembly as described above then the display may be split down into units suitable for console mounting.

19. In the console mounting arrangement, the viewing unit, the plinth assembly, the control panels and the power unit are each mounted separately within the customer's console. In this instance, the viewing unit should ideally be mounted on sliding runners thereby providing frontal access; or alternatively, the viewing unit can be mounted on a shelf inside the console with the front of the viewing unit being accessible to the controller through an aperture.

20. Each individual modular control panel can be removed from the plinth assembly (see para. 7 above) and mounted on the customer's console to meet his requirements.

21. The plinth assembly and power unit should be mounted within the console in an arrangement suitable to the customer.

22. In the standard display assembly the cable to connect the power supply to the plinth is supplied. If it is required to mount the display in a console as described above, then Plessey Radar can supply special extension cables (approximately 2.4m (or 8ft) in length) suitable for connecting the plinth to the viewing unit and the plinth to the control panels. Also, Plessey Radar can supply a suitable set of runners for the mounting of the viewing unit.

COOLING

23. The complete display is cooled by natural air convection. Adequate circulation of room air must be allowed in four areas, as follows:-

(1) At the front of the plinth assembly under the control panels.

(2) At the rear of the viewing unit.

(3) At the rear top of the viewing unit.

(4) At the top of the power unit.

These areas are indicated in Figures 4.1 and 4.3.

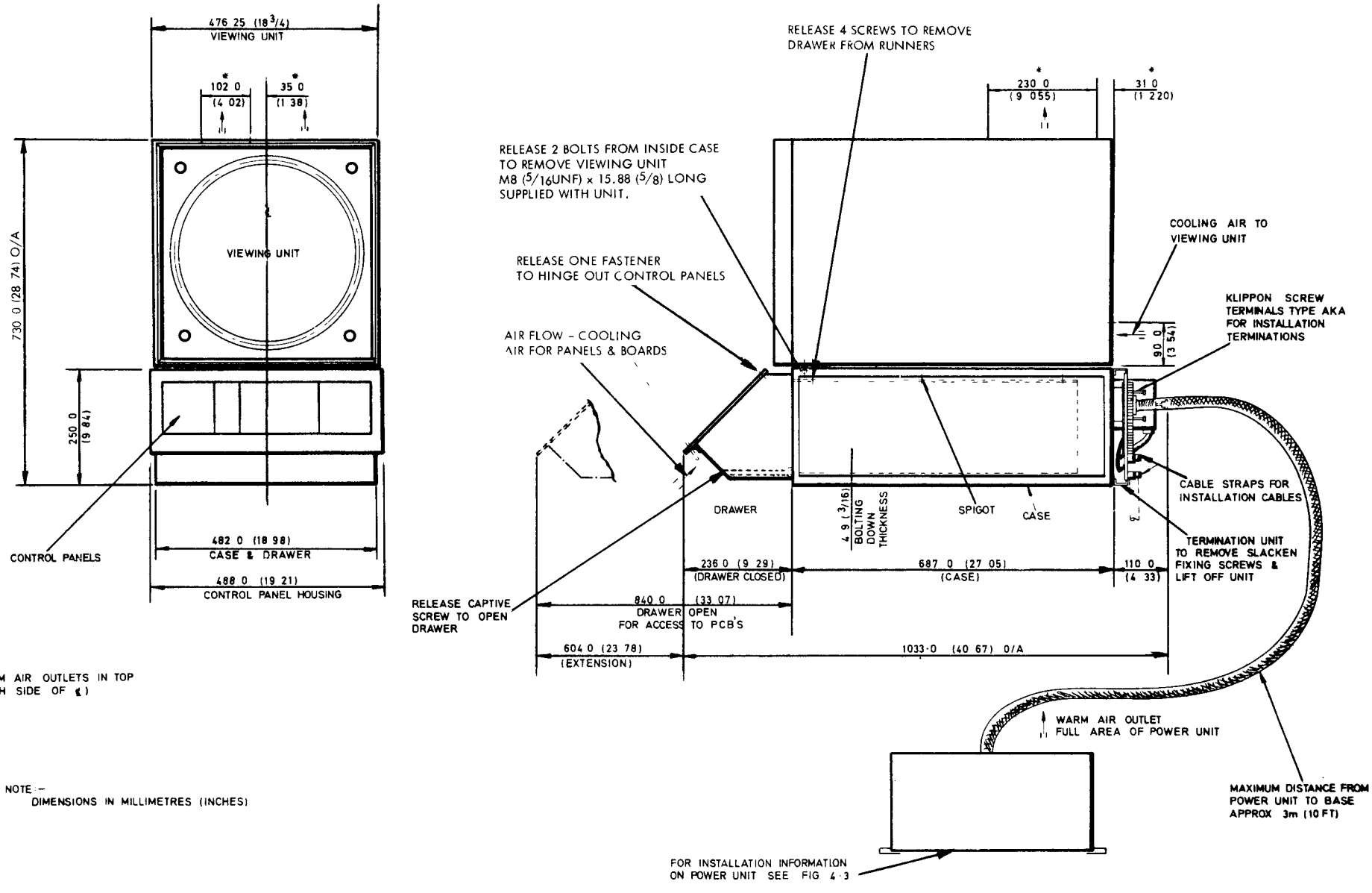


Figure 4.1

AUTONOMOUS DISPLAY - INSTALLATION

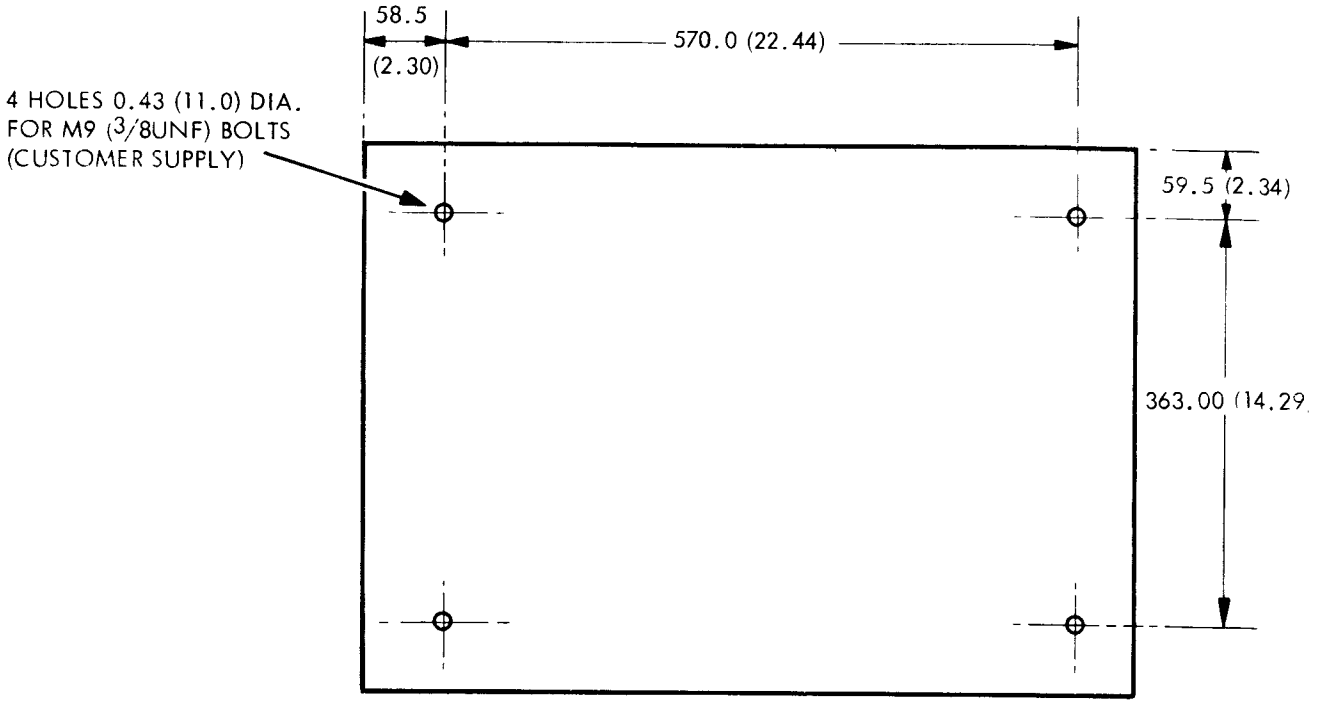


DIAGRAM OF BOLTING DOWN HOLES IN BOTTOM OF CASE

NOTES:-

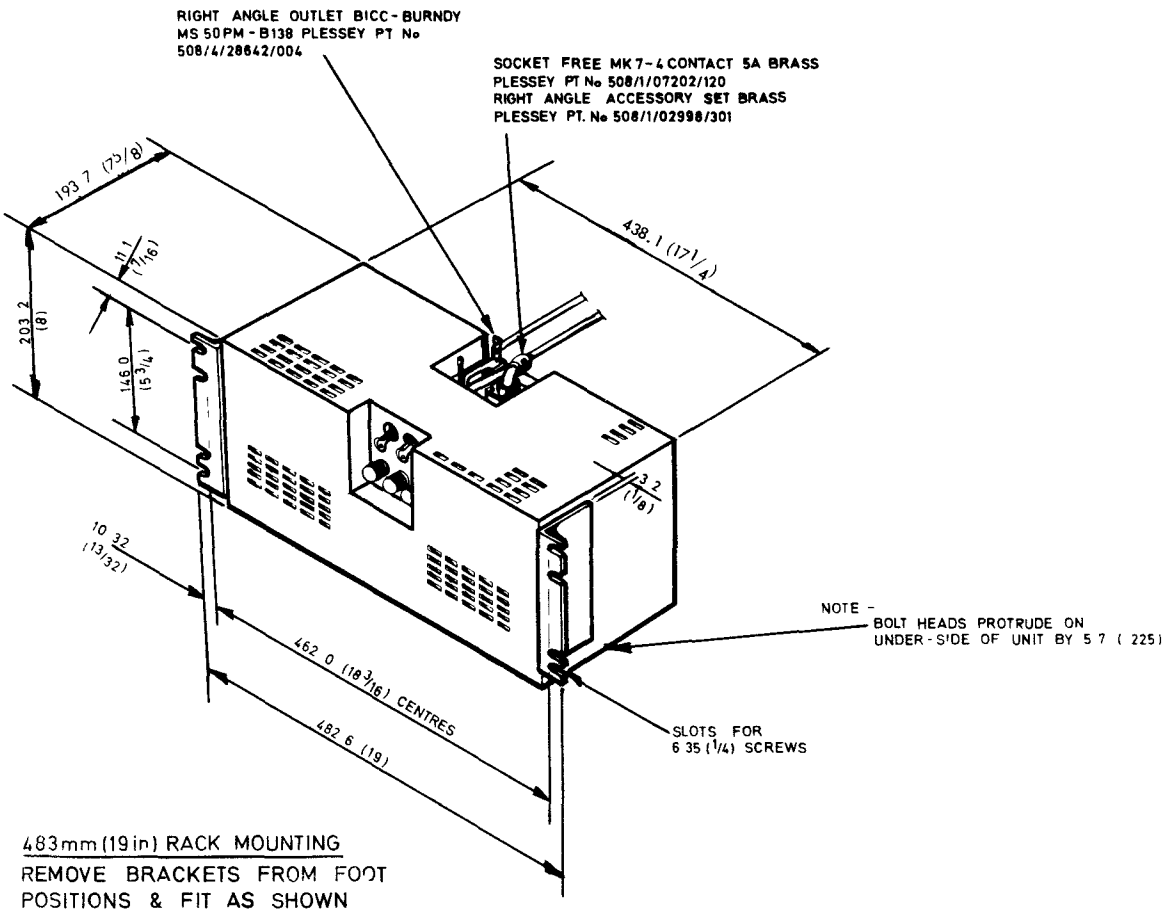
1. Support and remove drawer. Bolt down case.
2. In normal operational use, case must be bolted down before drawer is opened.
3. Drawer may be turned upside down on runners, for access to bottom wiring, by removing 4 screws.
   Ensure that spigots register in holes in flanges.
4. Weights:-

Viewing Unit	49.5kg (109lb)
Case & Drawer	41 kg (90lb)
Termination Unit	1.5kg (3lb)
	92 kg (202lb)
Power Unit	24 kg (53lb)

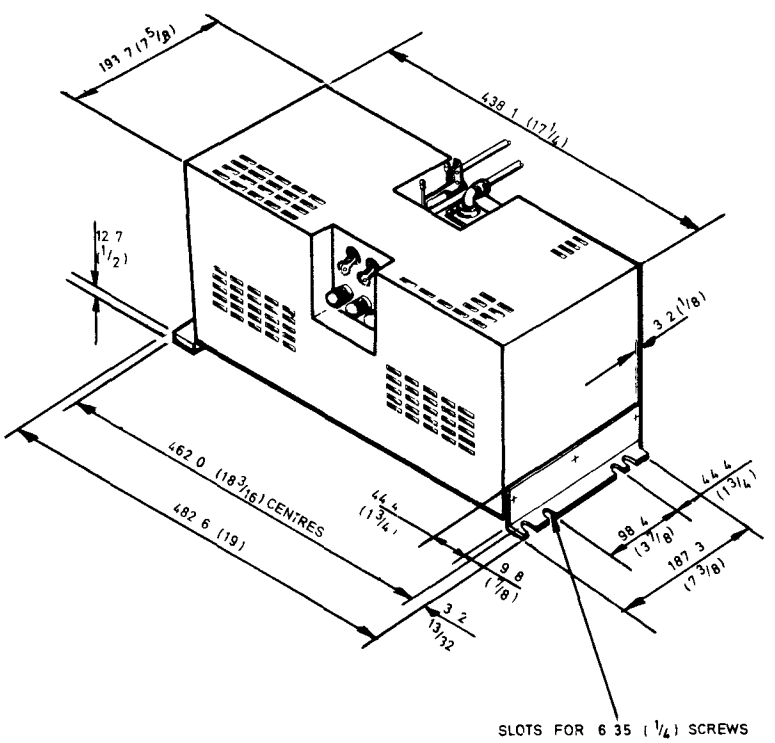
5. Power consumption 600VA approx.
6. Dimensions shown are nominal dimensions in millimetres (inches)

AUTONOMOUS DISPLAY INSTALLATION

Figure 4.2



483mm (19in) RACK MOUNTING
REMOVE BRACKETS FROM FOOT
POSITIONS & FIT AS SHOWN



FOOT MOUNTING

NOTE -
DIMENSIONS IN MILLIMETRES (INCHES)

POWER UNIT - INSTALLATION

Figure 4.3

CHAPTER 5

16-A2 AUTONOMOUS DISPLAY SPECIFICATION

GENERAL

1. The 16-A2 Autonomous Display is constituted from a standard Plessey Mk. 8 405mm (16in) slave viewing unit, a plinth assembly containing the drive circuits and control panels and a power unit.

2. A number of 'Customer Options' are available which may be provided by insertion of the appropriate printed circuit boards in the plinth.

3. The 'Standard Facilities' of the display may be programmed to provide the precise operational parameters required. The labelling of the operators control switches is achieved by insertion of the appropriate photographic film into the illuminated push-button switch. In the unselected condition, all push-button switches are illuminated to half brilliance; upon selection they come up to full brilliance.

THE MK. 8 405mm (16in) SLAVE VIEWING UNIT

4. (1) Cathode Ray Tube

405mm (16in) diameter.

Electrostatic focus control.

0.6mm spot diameter (nominal) at 50μA beam current.

(2) Deflection System

Single fixed coil type.

Recovery time - limit to opposite end of diameter:-

(1) 23μs typical.

(2) 30μs worst case (with mains input voltage 10% down on nominal).

		Small signal bandwidth - 3MHz typical at 3dB points, (measured with sinusoidal input giving a deflection of 0.4% of screen diameter). Character writing with 330ns limbs.
(3)	Video Channel	Bandwidth - d. c. to 10MHz at -3dB points.

A scan failure protection circuit is incorporated to minimise c. r. t. phosphor damage in the event of failure of the deflection circuits. This circuit can be programmed to suit the type of presentation on the viewing unit.

(4) Controls

(a)	On/Off	On/off switch for all d. c. supplies from the power unit to the viewing unit and plinth assembly. E. H. T. supply is prevented from switching on until such time as the cathode ray tube heaters have been 'on' for approximately 60 seconds.
(b)	Focus	Electrostatic control on focus.
(c)	Brilliance	Overall picture brilliance control.
(d)	Gain	Overall video gain control. This control is recommended to be set to maximum when the viewing is used as part of the autonomous display assembly.
(e)	Rotating Cursor	A rotating cursor, with a 7 line parallel index, is provided which is set against an illuminated compass rose graduated at one degree intervals. The level of illumination is preset on the slave viewing unit.

STANDARD FACILITIES

5. (1) Unit of Range

The display can be programmed for	Nautical miles (1852m) Data miles (1828. 8m) Kilometres.

(2) Maximum Display Range

The display can be programmed for	A maximum range between 50 and 300 miles (nautical or data) or 92 and 548km.

(3) Range Expansion

(a)	Range Scales	Five range scales are available for normal operator usage.
(b)	Expansion Ratios	The display can be programmed such that each of the five selection buttons provides a value given by the maximum timebase range divided by 1 to 15.5:1 in 64 steps, provided that the resulting range is not less than 5 miles or 10km.

(4) Range Markers

(a)	Number of Channels	Three; fine, medium and coarse.
(b)	Marker Intervals	Available at intervals of 1, 2, 5, 10, 20, 50 and 100 units of range, any three of which may be programmed for normal operator usage.
(c)	Test Facility	Switch S1 on the range mark generator printed circuit board provides markers at 1 unit of range in place of fine markers irrespective of programming.
(d)	Range Marker Accuracy	Better than 0.2% of displayed range plus 0.0125 of a range unit.
(e)	Controls	On/off switch and brilliance control provided for each of three range marker intervals.

CUSTOMER OPTIONS

6.	Azimuth Data	Synchro resolver, turning at a ratio of 1:1 with the radar aerial. This option consists of one printed circuit board providing a 400Hz resolver drive waveform.
		OR
		D.C. Sine θ and Cosine θ. The inputs for this option are contained in the basic display.
7.	Range and Bearing Line	This option consists of a control panel and three printed circuit boards. The addition of this option produces a vector line on the display which is controlled by the controller from the control panel. The

vector line is produced by replacing every tenth mainscan trace with the vector line.

Controls:

(1) Line Length — Two speed control (fine and coarse).

Length readout in range units (nautical mile, data mile or kilometre) on digital display (3 digits).

(a) Resolution (readout) — 0.1 range unit for maximum range less than 100.

1 range unit for maximum range equal to or greater than 100 units of range.

(b) Range Accuracy (to mainscan) — For maximum range of:-

50 units of range: ±0.5% of maximum range
90 units of range: ±0.4% of maximum range
100 units of range: ±0.8% of maximum range
200 units of range: ±0.6% of maximum range
300 units of range: ±0.5% of maximum range

(2) Bearing — Two speed control (fine and coarse).

Bearing readout in degrees on digital display (3 digits).

(a) Resolution (readout) — 1^{o}.

(b) Bearing Accuracy (to mainscan) — 1^{o} maximum error.

(3) QDM — QDR presentation with press switch to provide reciprocal (QDM) readout on bearing digital display.

(4) Line Shift, On/Off — Line origin centred to radar centre, or off-centred and controlled by X and Y shift controls.

(5) X and Y Shift — Multi-turn potentiometer controls enabling line origin to be positioned anywhere within the maximum timebase range.

(6) Line On/Off — On/off switch for line.

(7) Line Brilliance — Brilliance control for line.

8. Direction Finder Data — This option consists of one (or two) additional printed circuit boards. (The

second p. c. b. will be required if the Synthetic Label Input Option is not already provided in the display). The vector line may be controlled from an external source, the option being exercised by a d. f. on/off switch on the control panel plus an external 'clean' closed contact. The d. f. line option may only be used in conjunction with the range and bearing line option. Control of the vector line is transferred to the d. f. data input when a valid d. f. transmission is present.

(1) D. F. Azimuth Inputs — D. C. sine/cosine data, as defined at paragraph 10.

External 'clean' closed contact on one pair of wires, for valid d. f. transmission.

D. C. voltages in the range +4V to -4V (X and Y) may be input to offset the origin of the d. f. line from radar centre.

(2) Accuracy of Centred D. F. Line to Mainscan: — 1^{o} maximum error, with respect to input voltages.

(3) Controls:

(a) Line On/off)
(b) Line Brilliance) — Same controls as used for range and bearing line function.

(c) D. F. On/off — On/off switch for d. f. function which will be in series with the external 'clean' closed contact, thereby ensuring that control of the line is only passed to d. f. data when d. f. information is required and a valid transmission occurs.

9. Synthetic Label Data — This option consists of one (or two) additional printed circuit boards. (The second p. c. b. will be required if the Direction Finder Data Option is not already provided in the display).

Synthetic label data may be presented in conjunction with the p. p. i. picture by asynchronous interruption of the mainscan trace or in radar dead time.

Synthetic Inputs:

(1) Main deflection (X, Y)

(a)	Mode	Balanced line
(b)	Differential Amplitude	3.2V = Maximum display range.
(c)	Bandwidth	50kHz typical, at 3dB points.
(d)	Expansion	In conjunction with mainscan.
(e)	Common Mode Signal	±3V maximum
(f)	Common Mode Rejection	60dB at 100Hz
(g)	Differential Input Impedance	24k ohms, typical

(2) Auxiliary Deflection (x, y)

(a)	Mode	Balanced line
(b)	Differential Amplitude	3.2V maximum
(c)	Sensitivity	3.2V represents maximum screen diameter, adjustable to zero.
(d)	Bandwidth	3MHz typical, at 3dB points
(e)	Common Mode Signal	±3V maximum
(f)	Common Mode Rejection	60dB at 100Hz
(g)	Differential Input Impedance	24k ohms, typical

(3) Video

(a)	Form	Balanced digital current drive from Plessey Driver Type SP721 or equivalent
(b)	Drive	

(4) Interrupt — As for video

(5) Controls

(a)	Labels On/Off	On/off switch for synthetic labels
(b)	Labels Brilliance	Brilliance control for synthetic labels

(6)	Synthetic to Mainscan Registration Accuracy	Better than 0.5% of maximum timebase range.
(7)	Synthetic Recovery Time	When calculating overall system timing, allowance for display recovery time should be made on the following basis:- 45μs for off-centred picture on maximum expansion. 30μs for centred picture on 1:1 expansion.
(8)	Synthetic Video Delay Line	
(a)	Maximum Delay	200ns $\pm$5%
(b)	Delay Tappings	10 taps, each of 20ns $\pm$5%

It should be noted that in addition to the printed circuit board requirements noted above that a Reference Voltage Supply p.c.b. must also be fitted when one or more of the Customer Options (excepting synchro resolver drive) are fitted.

PRIMARY RADAR INPUTS

10.	(1)	Azimuth Data	Customer options provide for azimuth data to be input either as synchro resolver turning data or as d.c. Sine θ, Cosine θ.
	(2)	Synchro Resolver Turning	
	(a)	Resolver Drive Output	
		Frequency	400Hz
		Mode	Balanced line
		Differential Amplitude	50V
		Resolver Types	23RSF4 (Note 1 at end paragraph 10), 23RS4, 15RS4 (Note 2 at end paragraph 10)
	(b)	Resolver Inputs, Sine θ and Cosine θ	
		Mode	Balanced line or Single-ended
		Differential Amplitude	For balanced line - In the range 4 to 160V For single-ended - In the range 4 to 118V (This is the peak-to-peak excursion of one signal relative to the other.)

	Common Mode Signal for Balanced Input	In the range -10 to +10V
	Common Mode Rejection	53dB •
	Input Impedance	60k ohms minimum - differential 30k ohms minimum - single-ended.
	Drive Capability	Up to 8 displays may be driven from a single resolver over a distance up to 4000m.
(3)	D. C. Sine θ, Cosine θ Turning	As for Resolved Inputs, Sine θ and Cosine θ (see paragraph (2) above).
(4)	Azimuth Accuracy	
	Centred Mainscan to Compass Rose	Error not greater than $\pm 1.5^{o}$
(5)	Radar Trigger	
	(a) Mode	Single-ended, positive going (Note 3 at end paragraph 10).
	(b) Differential Amplitude	1 to 15V
	(c) Base Level When Programmed	For diff. amp. of 1-5V... 390m V max. For diff. amp. of 3-8V... 1.46V max. For diff. amp. of 6-15V.. 3.3V max.
	(d) Input Impedance	3.1k ohms minimum (Note 4 at end paragraph 10)
	(e) Duration	200ns to 50μs
	(f) Pre-trigger Delay (leading edge of pulse to t_o)	5μs minimum to 75μs maximum, adjustable in 200ns steps.
	(g) Minimum Pulse Interval	For maximum display ranges equal to or less than 255 miles or 510km... 45μs plus maximum range time. For maximum display ranges greater than 255 miles or 510km... 60μs plus maximum range time.

(6) Video

Analogue Video

(a)	Number of Channels	4 identical Channels
(b)	Mode	Single-ended, positive going (Note 3 at end paragraph 10)
(c)	Differential Amplitude	1 to 15V
(d)	Base Level	+15V to -15V (a. c. coupled)
(e)	Input Impedance	3. 6k ohms minimum (Note 4 at end paragraph 10)
(f)	Droop	10% maximum in 4ms.

(7) Digital Video

(a)	Number of Channels	1
(b)	Mode	Single-ended, positive going (Note 3 at end paragraph 10)
(c)	Differential Amplitude	1 to 15V
(d)	Base Level - When Programmed	For diff. amp. of 1-5V... 390mV max. For diff. amp. of 3-8V... 1. 46V max. For diff. amp. of 6-15V.. 3. 3V max.
(e)	Input Impedance	3. 1k ohms minimum (Note 4 at end paragraph 10)

(8) Controls — On/off switch and gain control provided for each video channel.

NOTE 1 A connection exists within the display to accept the feedback voltage from resolvers fitted with feedback windings.

NOTE 2 For resolvers without feedback windings (or where a cable from the feedback winding is not available), the feedback voltage is derived from the resolver drive transformer within the display.

NOTE 3 The signals may be input on balanced lines, but within the display they are connected on coaxial cable.

NOTE 4 Facilities exist on the Termination Unit for the Customer to terminate the input cable in its characteristic impedance.

POWER REQUIREMENTS

11.	Supply Voltage	Single phase, 100 to 125V or 200 to 250V, adjustable in 5V steps.
	Tolerance	Within ±10% of selected voltage
	Frequency	45 to 60Hz
	Consumption	600VA maximum

ENVIRONMENTAL CONDITIONS

12.	Operating Temperature	0^{o}C to $+55^{o}$C. Full accuracies of the above specification will be maintained in the temperature range ... $+15^{o}$C to $+35^{o}$C.
	Storage Temperature	-30^{o}C to $+70^{o}$C
	Other Parameters	The complete assembly is designed to good commercial standards.

OVERALL WEIGHTS AND DIMENSIONS

13.

		DISPLAY ASSEMBLY	POWER UNIT
HEIGHT	mm	730	203.2
	in	28.74	8
WIDTH	mm	448	438.1
	in	19.21	17.25
DEPTH	mm	1033	193.7
	in	40.67	7.625
WEIGHT	kg	92	24
	lb	202	53

For further details see Installation Data in Chapter 4.

CHAPTER 6

DOCUMENTATION, TOOLS AND TEST EQUIPMENT

DOCUMENTATION

1. Plessey Radar have available a standard set of manuals covering the complete display equipment. The set of manuals contains three volumes as follows:-

(1) 16-A2 autonomous display system - illustrations
(2) 16-A2 autonomous display system - text
(3) The printed circuit boards

2. In these manuals full circuit diagrams and components lists are provided. Additionally full descriptions of how each individual circuit board functions is given together with a description of how the complete autonomous display system functions.

3. Full instructions are also given on the setting up procedures required on the complete display.

SPECIAL TOOLS

4. Plessey Radar have available a special tool kit for use in conjunction with the autonomous display. These tool kits are comprised solely of items which are of a special nature and it assumes that the customer will have available such items as screw-drivers, spanners and soldering irons etc.

5. The tool kit is comprised of the following items :-

(1) Tube Alignment Jig

This jig is necessary when fitting a new cathode ray tube, since it is required that a strap be positioned around the periphery of the tube, clamping into specific positions locating and fixing lugs which mate with fixing holes within the actual viewing unit itself.

(2) Goggles

For safety reasons it is advisable that any person handling cathode ray tubes should wear a pair of protective goggles.

(3) Deflection Coil Adjusting Tool

This tool allows simple rotational adjustment of the deflection coil.

(4) Printed Circuit Board Extension Card

This extension card allows for any individual printed circuit board in the plinth assembly to be worked upon in the operating position. The head of the card may be tilted through 180^{o} while in the operating condition.

(5) The Termi-point Crimping Tool

In the event that the customer wishes to reprogramme his 16-A2 display in any manner, the display is supplied with spare lengths of wire and Termi-point connectors such that suitable patch-links may be made by the customer. For this purpose a crimping tool is required.

(6) Monitor Probes (6 off)

Each of the printed circuit boards in the plinth is provided with a number of monitor sockets; to facilitate the use of an oscilloscope without damage to the printed circuit cards these monitor probes should be used.

TEST EQUIPMENT

6. For normal routine maintenance only a high quality oscilloscope is required.

7. For extensive fault finding and repairs the following test equipment should be available.

(1) Digital volt meter
(2) Electro-static volt meter (0 to 18kV)
(3) Avometer
(4) Pulse Generator