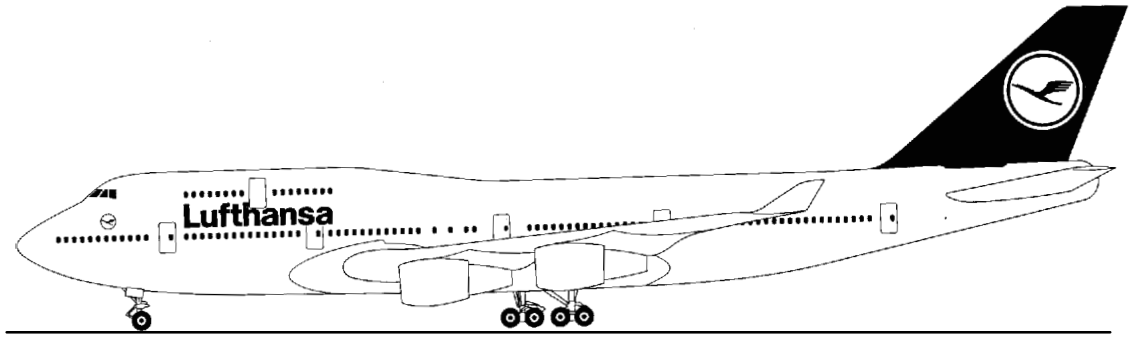
Lufthansa Technical Training

Training Manual B 747-400



ATA 31-61
IDS - EFIS

ATA Spec. 104 Level 3

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ATA 31-61 IDS - EFIS

ELECTRONIC FLIGHT INSTRUMENT SYSTEM (EFIS)

General

The electronic flight instrument system (EFIS), which is part of the integrated display system (IDS), provides the flight crew with both primary flight data and navigational information. The IDS replaces many separate indicators in the flight deck. The consolidation of flight-related information improves system reliability, and reduces crew work load.

Primary Flight Display

The PFD is normally on the outboard display unit, and shows primary flight information. The primary flight display (PFD) has only one mode of operation. The arrangement of the information on the PFD follows the standard ”T” concept, providing the following information:

- Airspeed
- Attitude
- Heading
- Altitude
- Vertical speed
- Flight mode annunciations
- Radio altitude
- Guidance cues

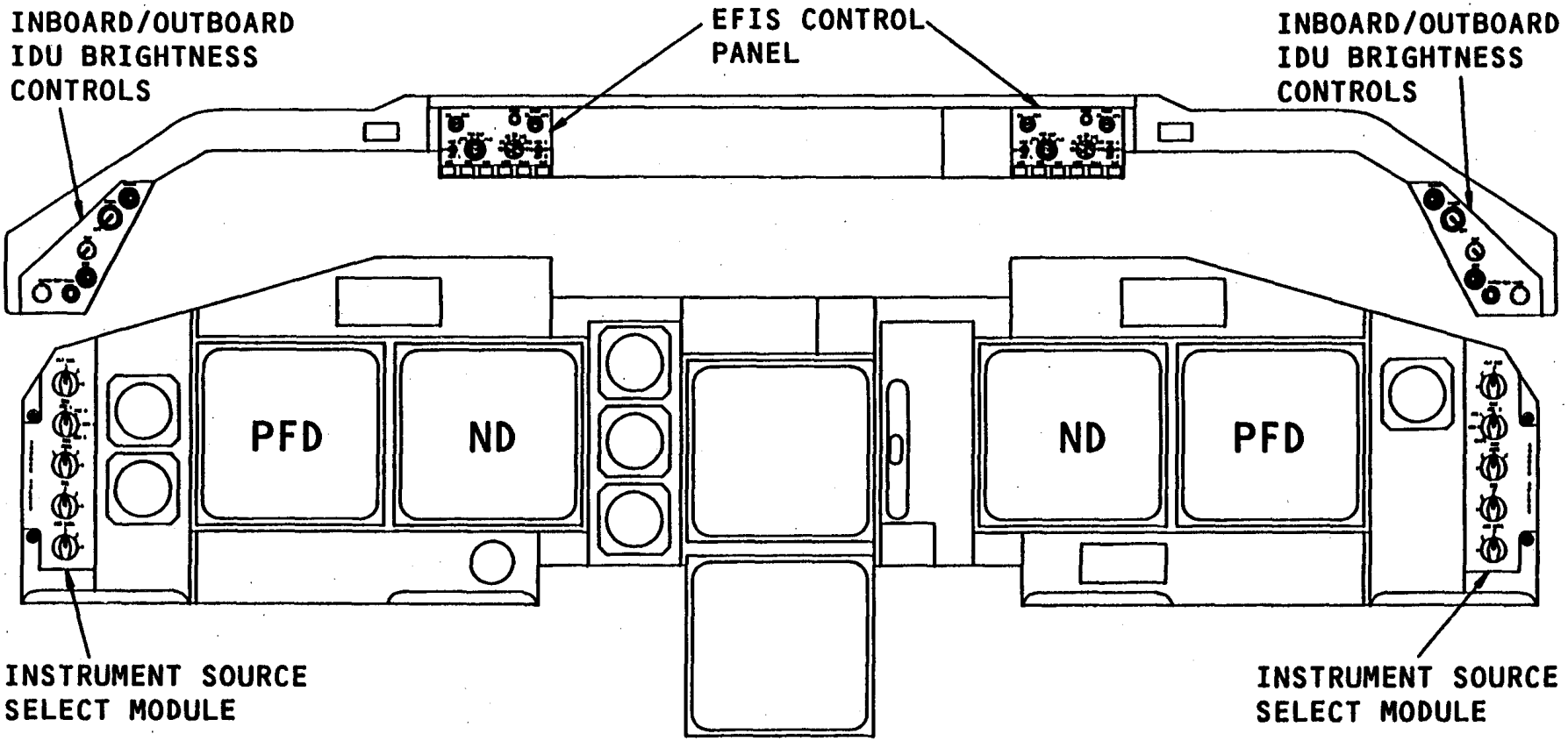
Navigation Display

The ND is normally on the inboard display unit, and shows navigation information. The navigation display (ND) is arranged to look like many conventional instruments with a map-type display. The ND shows these different modes, as selected from the EFIS control panel:

- Approach
- VOR
- Map
- Plan

Source Selection

The instrument source select module is used to manually switch the input sources for EFIS displays.



PRIMARY FLIGHT DISPLAY

- AIRSPEED
- ATTITUDE
- HEADING
- ALTITUDE
- VERTICAL SPEED
- FLIGHT MODE
- RADIO ALTITUDE
- GUIDANCE CUES

NAVIGATION DISPLAY

- VOR MODES
- APPROACH MODES
- MAP MODES
- PLAN MODE

Figure 1 ELECTRONIC FLIGHT INSTRUMENT SYSTEM (EFIS)

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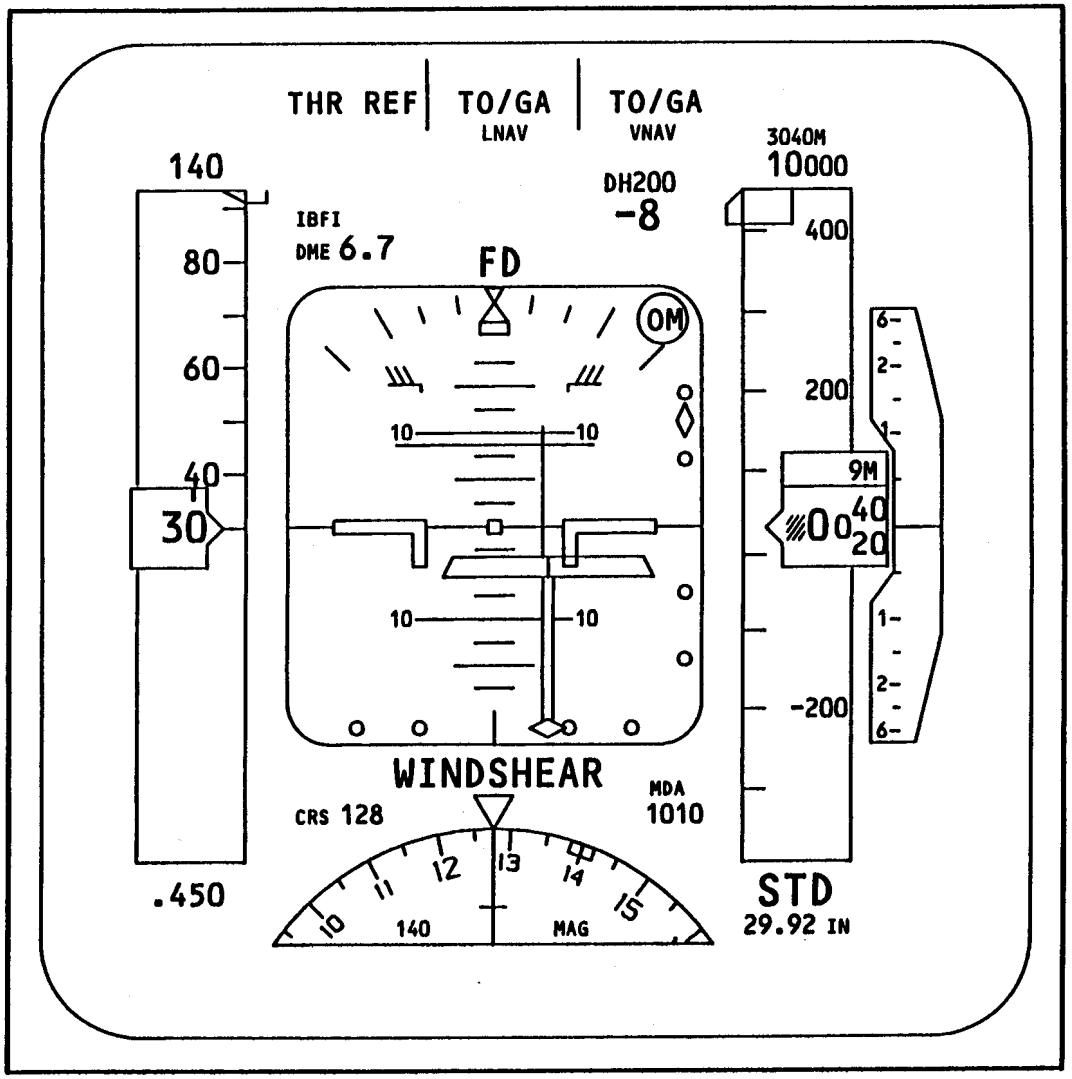
PRIMARY FLIGHT DISPLAY

The major displays on the PFD are:

- Attitude displays (source: inertial reference system or IRS)
- ILS displays (source: instrument landing system or ILS, and distance measuring equipment or DME)
- Airspeed tape displays (source: air data computers or ADCs, flight management computer system or FMCS, and stall warning management computer)
- Flight mode displays (source: flight control computers or FCCs, and FMCS)
- Radio altitude displays (source: radio altimeters, and EFIS control panel)
- Altitude tape displays (source: ADCs)
- Vertical speed displays (source: IRS and ADCs)
- Heading tape displays (source: FMCS and IRS)
- Selected heading (source: FCC)
- Selected runway heading (source: ILS)
- Marker beacon (source: marker beacon)
- Windshear warning (source: GPWS)



NOTE:
THIS DISPLAY
FOR ILLUSTRATION
PURPOSES ONLY

Figure 2 PRIMARY FLIGHT DISPLAY

PFD SYMBOLOGY

This table shows the basic symbology used on the PFD. The table shows the symbol, name, and data source.

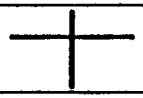
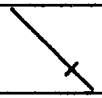
SYMBOL	NAME [COLOR]	REMARKS
	SKID/SLIP INDICATOR [WHITE]	INDICATES AIRPLANE SKID/SLIP IN A COORDINATED TURN
	PITCH LIMIT INDICATOR [AMBER]	INDICATES MAXIMUM PITCH ANGLE WITH FLAPS DOWN
	FLIGHT DIRECTOR [MAGENTA]	SUPPLIES GUIDANCE DATA TO FLY ON THE FLIGHT PLAN
	AIRPLANE SYMBOL [WHITE]	INDICATES AIRPLANE ATTITUDE RELATED TO THE HORIZON
	HEADING POINTER [WHITE]	INDICATES AIRPLANE HEADING
	DRIFT ANGLE POINTER [WHITE]	INDICATES AIRPLANE TRACK
	SELECTED HEADING BUG [MAGENTA]	INDICATES SELECTED AIRPLANE HEADING
	SELECTED AIRSPEED BUG [MAGENTA]	INDICATES SELECTED AIRPLANE AIRSPEED
	SELECTED ALTITUDE BUG [MAGENTA]	INDICATES SELECTED AIRPLANE ALTITUDE
	SELECTED VERTICAL SPEED BUG [MAGENTA]	INDICATES SELECTED AIRPLANE VERTICAL SPEED
	HEADING REFERENCE INDICATOR [WHITE]	INDICATED SELECTED REFERENCE FOR AIRPLANE HEADING
	MINIMUM DESCENT ALTITUDE POINTER [GREEN]	INDICATES SELECTED MINIMUM DESCENT ALTITUDE

Figure 3 PFD SYMBOLOGY (SHEET 1)

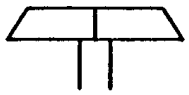
SYMBOL	NAME [COLOR]	REMARKS
	RISING RUNWAY [GREEN] RISING RUNWAY STEM [MAGENTA]	INDICATES AIRPLANE ALTITUDE RELATED TO THE RUNWAY ON APPROACH
	RESOLUTION ADVISORY INDICATOR FOR TCAS [RED]	INDICATES VERTICAL POSITION AREAS TO AVOID COLLISIONS IN FLIGHT WHICH RESULT FROM A RESOLUTION ADVISORY (RA)
WINDSHEAR	WINDSHEAR WARNING [RED]	TELLS THE CREW A WINDSHEAR CONDITION EXISTS
PULL UP	PULL UP WARNING [RED]	TELLS THE CREW TO PULL UP TO AVOID TERRAIN

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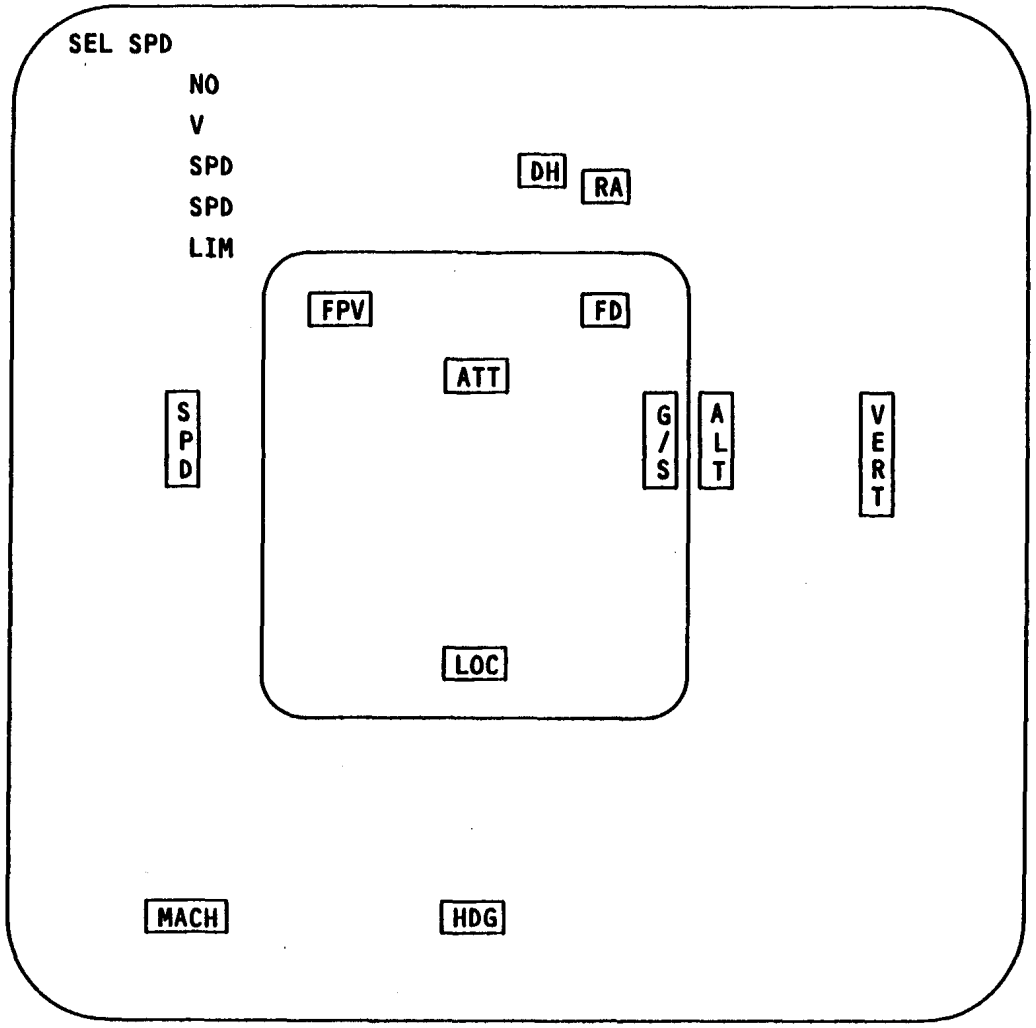
Figure 4 PFD SYMBOLOGY (SHEET 2)

PFD FLAGS

The primary flight display receives data from many sytems. A no-computeddata (NCD) condition removes EFIS symbology from the display. An invalid condition removes EFIS symbology from the display and shows an EFIS flag.



NOTE:
THIS DISPLAY IS FOR ILLUSTRATION PURPOSES ONLY

Figure 5 PFD FLAGS

PFD NCD / INVALID CONDITIONS

This table shows EFIS NCD and invalid data conditions. The table shows the parameter, data removed, EFIS flag and color, and the condition.

PARAMETER	REMOVED DATA	FLAG	COLOR	REMARKS
ATTITUDE	HORIZON, PITCH LINES, ROLL POINTER, SKY/GROUND, AND SKID/ SLIP INDICATOR	ATT	YELLOW	INVALID PITCH AND/OR ROLL DATA FROM IRS
	HORIZON, PITCH LINES, ROLL POINTER, SKY/GROUND, AND SKID/ SLIP INDICATOR	NONE	----	NCD PITCH AND/OR ROLL DATA FROM IRS
FLIGHT DIRECTOR	FLIGHT DIRECTOR	FD	YELLOW	INVALID PITCH AND/OR ROLL FD COMMANDS FROM FCC
	FLIGHT DIRECTOR	NONE	----	NCD PITCH AND/OR ROLL FD COMMANDS FROM FCC
GLIDESLOPE DEVIATION	GLIDESLOPE POINTER AND SCALE	G/S	YELLOW	INVALID GLIDESLOPE DATA FROM ILS
	GLIDESLOPE POINTER	NONE	----	NCD GLIDESLOPE DATA FROM ILS
LOCALIZER DEVIATION	LOCALIZER POINTER AND SCALE	LOC	YELLOW	INVALID LOCALIZER DATA FROM ILS
	LOCALIZER POINTER	NONE	----	NCD LOCALIZER DATA FROM ILS
AIRSPEED	AIRSPEED TAPE AND READOUT BOX	SPD	YELLOW	INVALID CAS FROM ADC

Figure 6 PFD NCD / INVALID CONDITIONS (SHEET 1)

PARAMETER	REMOVED DATA	FLAG	COLOR	REMARKS
ALTITUDE	ALTITUDE TAPE AND READOUT BOX	ALT	YELLOW	INVALID OR NCD ADC DATA
DECISION HEIGHT	NUMERICS AND CHARACTERS	DH	YELLOW	INVALID OR NCD SELECTED DH FROM EFIS CP
RADIO ALTITUDE	RADIO ALTITUDE DISPLAY	RA	YELLOW	INVALID DATA FROM ALL THREE RA'S
	RA LESS THAN OR EQUAL TO 2500 FT, RA DATA (ADD FLAG), RA MORE THAN OR EQUAL TO 2500 FT	NONE	----	NCD DATA FROM RA
MACH	MACH DISPLAY	MACH	YELLOW	INVALID MACH DATA FROM ADC
	MACH DISPLAY	NONE	----	NCD MACH OR INVALID CAS DATA FROM ADC
HEADING	HEADING TAPE TICKS, SCALE AND INDEX	HDG	YELLOW	INVALID HDG DATA FROM IRU
	HEADING TAPE NUMERICS	NONE	----	NCD HDG DATA FROM IRU
VERTICAL SPEED	V/S SCALE AND POINTER	VERT	YELLOW	INVALID INERTIAL V/S DATA
	V/S SCALE AND POINTER	NONE	----	NCD INERTIAL V/S DATA
RESOLUTION ADVISORY	RESOLUTION ADVISORY INDICATOR	NONE	----	NCD/INVALID TCAS DATA

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Figure 7 PFD NCD / INVALID CONDITIONS (SHEET 2)

PARAMETER	REMOVED DATA	FLAG	COLOR	REMARKS
FLIGHT MODE ANNUNC-IATION	FMA DISPLAYED (NORMAL COLOR CHARACTERS WITH YELLOW LINE)	~~LNAV~~	YELLOW LINE	FLIGHT MODE FAULT DATA
	CHARACTERS	NONE	----	NCD FLIGHT MODE DATA
SELECTED SPEED	SEL SPD BUG AND READOUT	SEL SPD	YELLOW	INVALID AIRSPEED DATA FROM FCC OR INVALID CAS DATA
	SEL SPD READOUT SHOWS---	NONE	----	NCD AIRSPEED DATA
V SPEEDS	V1, VR, V2 VALUES	NO V SPD	YELLOW	INVALID V1, VR, V2 DATA FROM FMC OR INVALID CAS DATA
SPEED LIMIT	V1	SPD LIM	YELLOW	INVALID V1 DATA FROM FMC OR CAS

Figure 8 PFD NCD / INVALID CONDITIONS (SHEET 3)

NAVIGATION DISPLAYS

The navigation display (ND) has seven modes of operation. Each mode is used during different phases of flight, flight planning, and flight changes. These modes are:

- Expanded Approach
  Full Rose Approach
- Expanded VOR
  Full Rose VOR
- Expanded Map
  Center Map
- Expanded Plan

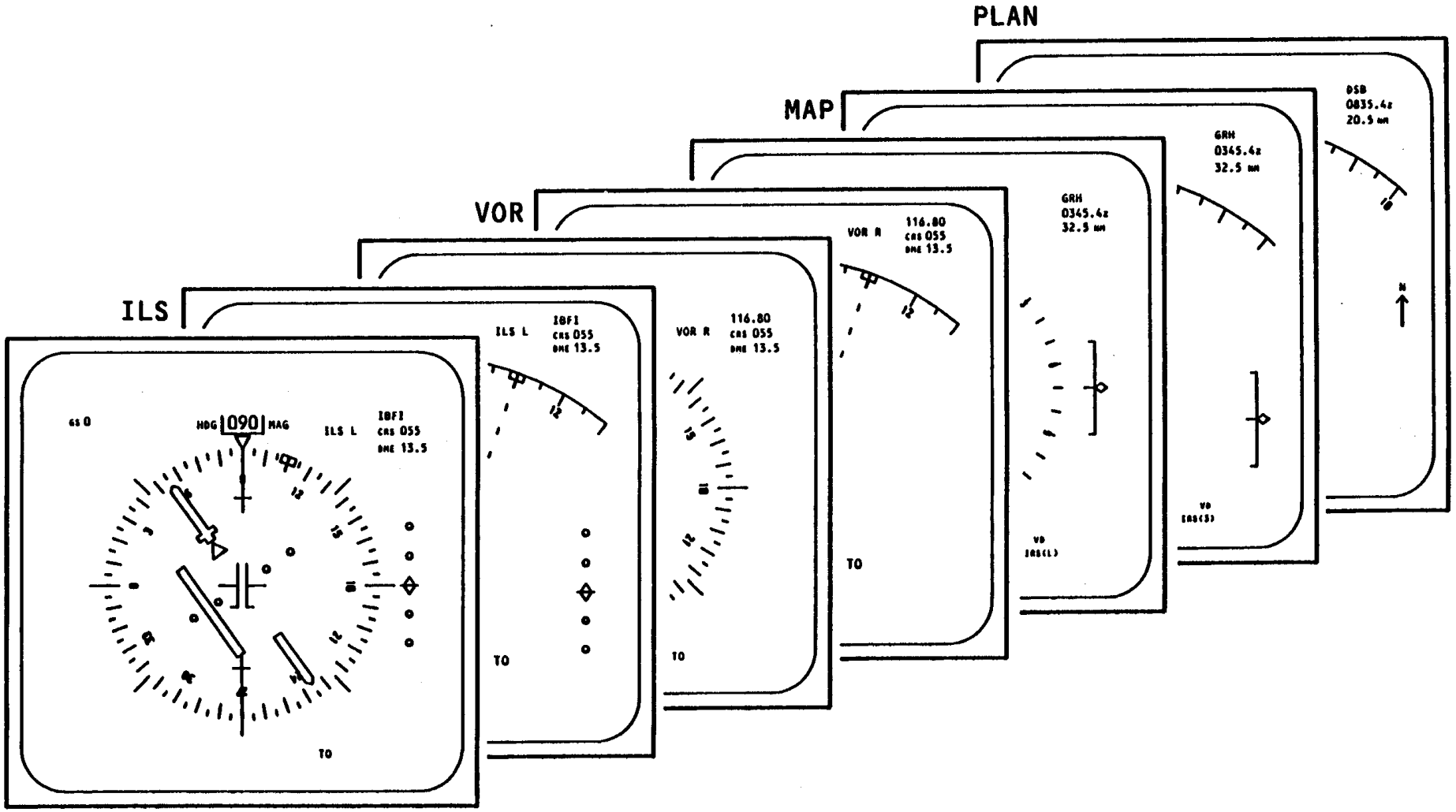


Figure 9 NAVIGATION DISPLAYS

APPROACH MODES

Approach mode shows guidance data during an instrument approach. The approach mode data is:

- Airplane symbol
- Selected runway heading
- System source annunciation
- Heading
- Track
- Drift angle
- Localizer deviation
- Glideslope deviation
- ILS frequency
- DME distance
- Weather radar
- Traffic alert and collision avoidance system (TCAS)
- Ground speed
- Wind direction and speed
- Selected heading
- Navaid data

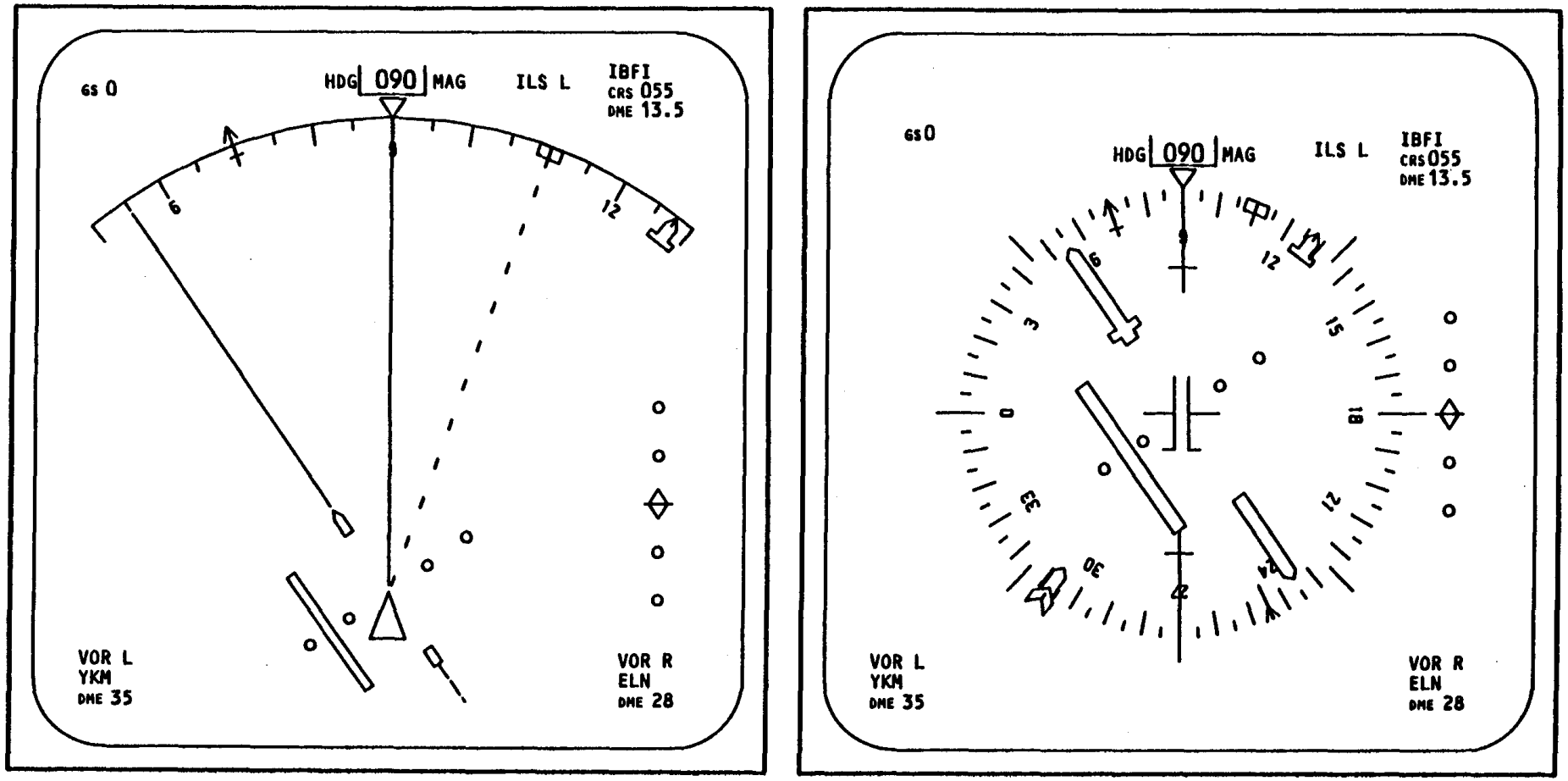


Figure 10 APPROACH MODES

APPROACH MODE FLAGS

The ND receives data from the ILS system. A no-computed-data (NCD) condition removes the data. An invalid data condition removes the data and shows an EFIS flag.

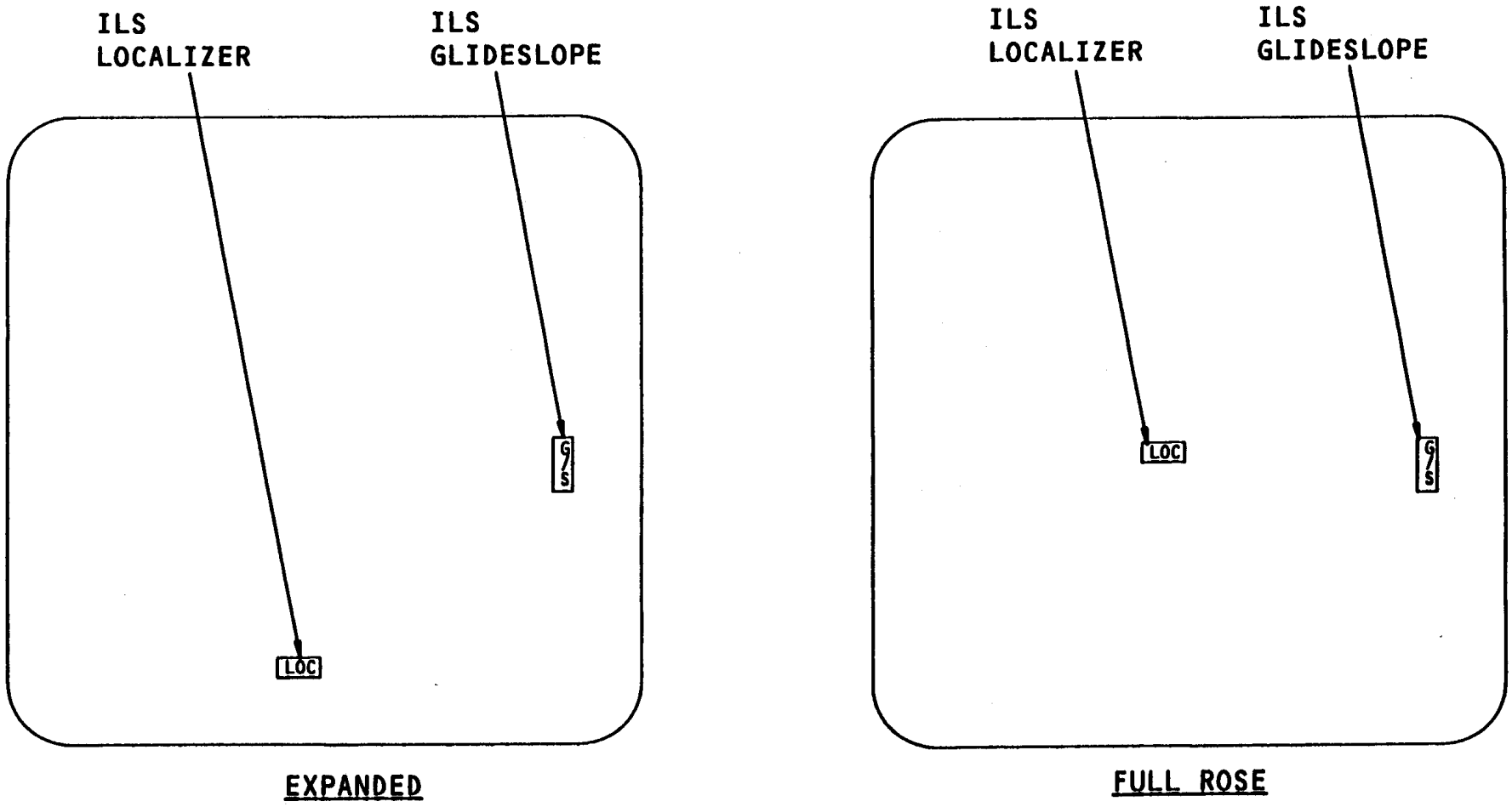


Figure 11 APPROACH MODE FLAGS

RADIO NAVIGATION AID DATA DISPLAYS

Control

The EFIS control panel VOR/ADF switches enable data displays which show:

- VOR or ADF pointer(s)
- Navaid IDENT (station identifier) or frequency
- DME distance (co-located stations only)

ADF and/or VOR data displays show in all ND modes of operation except PLAN.

When the VOR/ADF switch is in the OFF position, the pointers and data will not show.

ADF Data

The cyan ADF bearing pointers show as an arrow. Both the head and tail show in the center modes of operation. Both ADF pointers (left and right) can show at the same time if enabled by the VOR/ADF switches on the EFIS control panel.

The lower part of the ND shows the cyan station identifier, if that data is

received from the ADF receiver. If no station identifier data is received, the ADF frequency will show.

There is no DME distance related to the ADF data display.

VOR Data

The green VOR bearing pointers show as an arrow. Both the head and tail show in the center modes of operation. Both VOR pointers (left and right) can show at the same time if enabled by the VOR/ADF switches on the EFIS control panel.

The lower part of the ND shows data from the navaid in green. This display can show the station three-letter identifier, if that data is received from the VOR receiver. DME distance will also show when there is a DME ground station co-located with the navaid, and the distance data is valid.

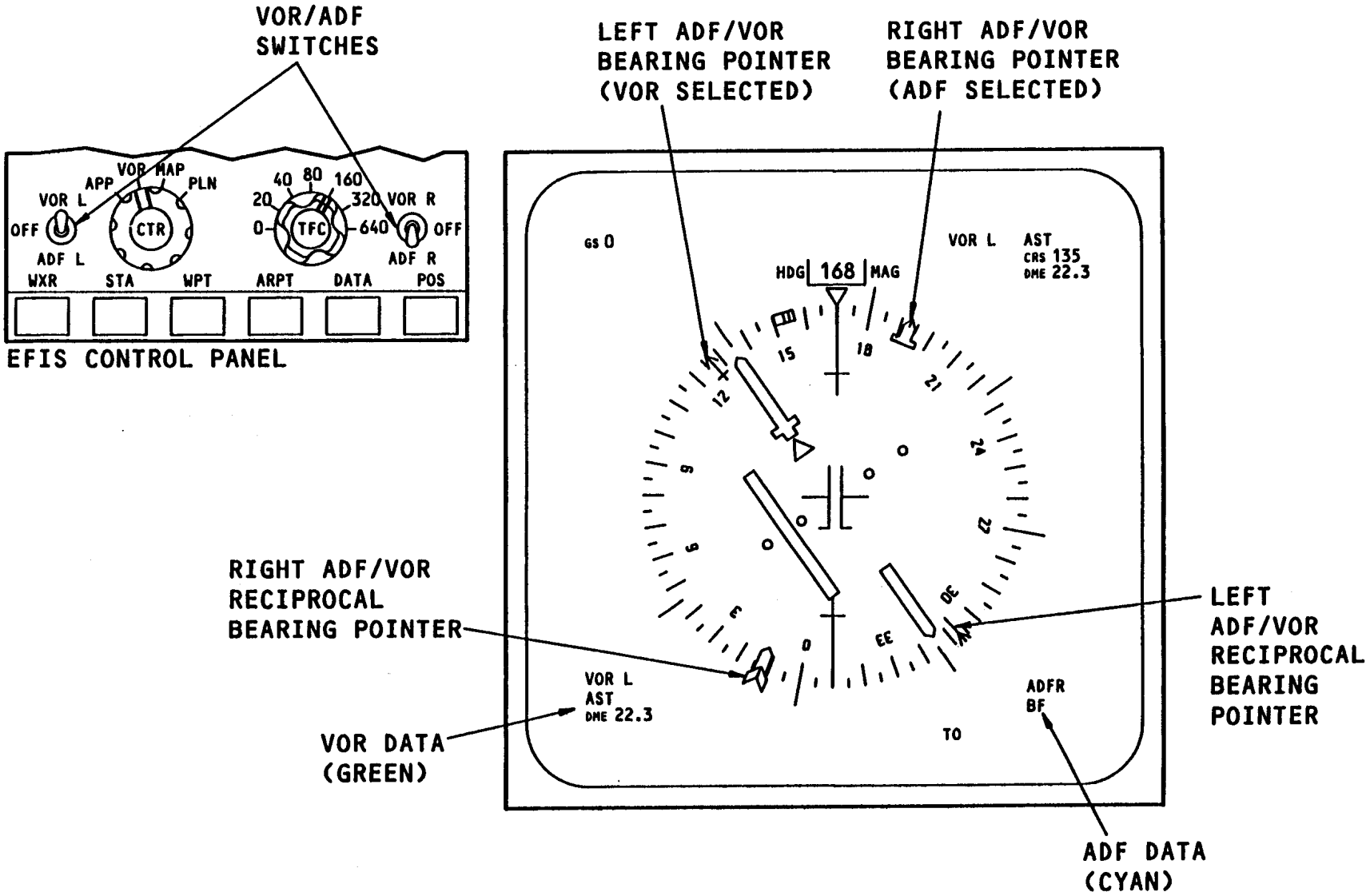
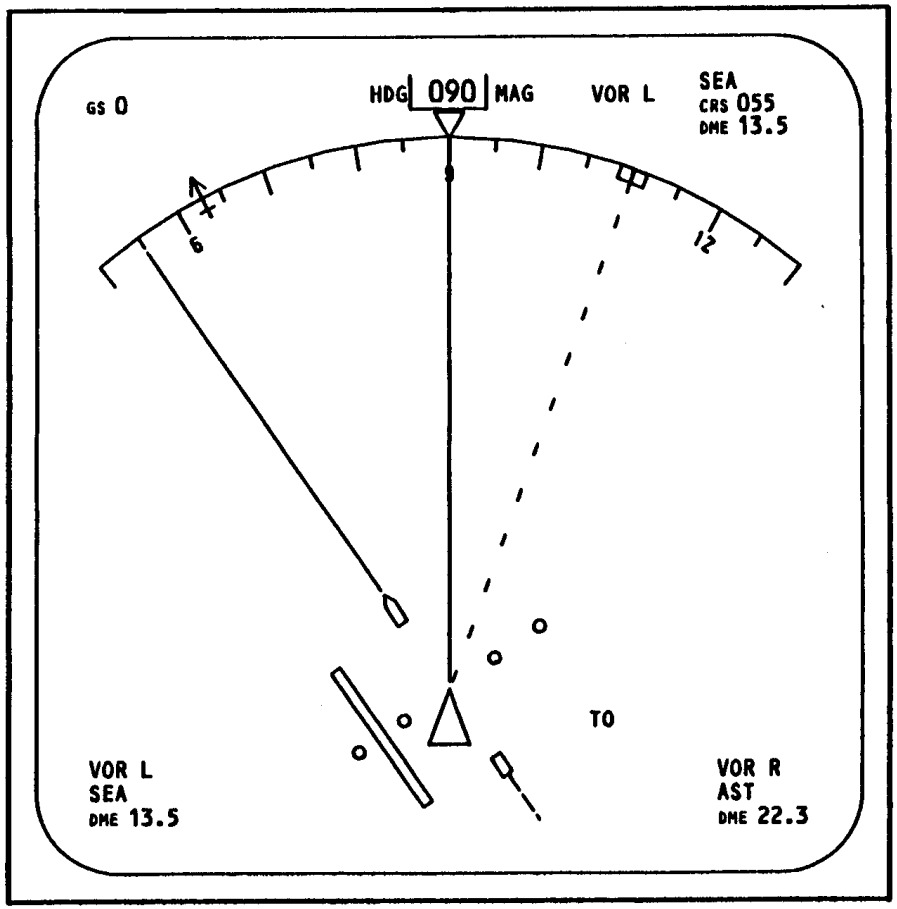


Figure 12 RADIO NAVIGATION AID DATA DISPLAYS

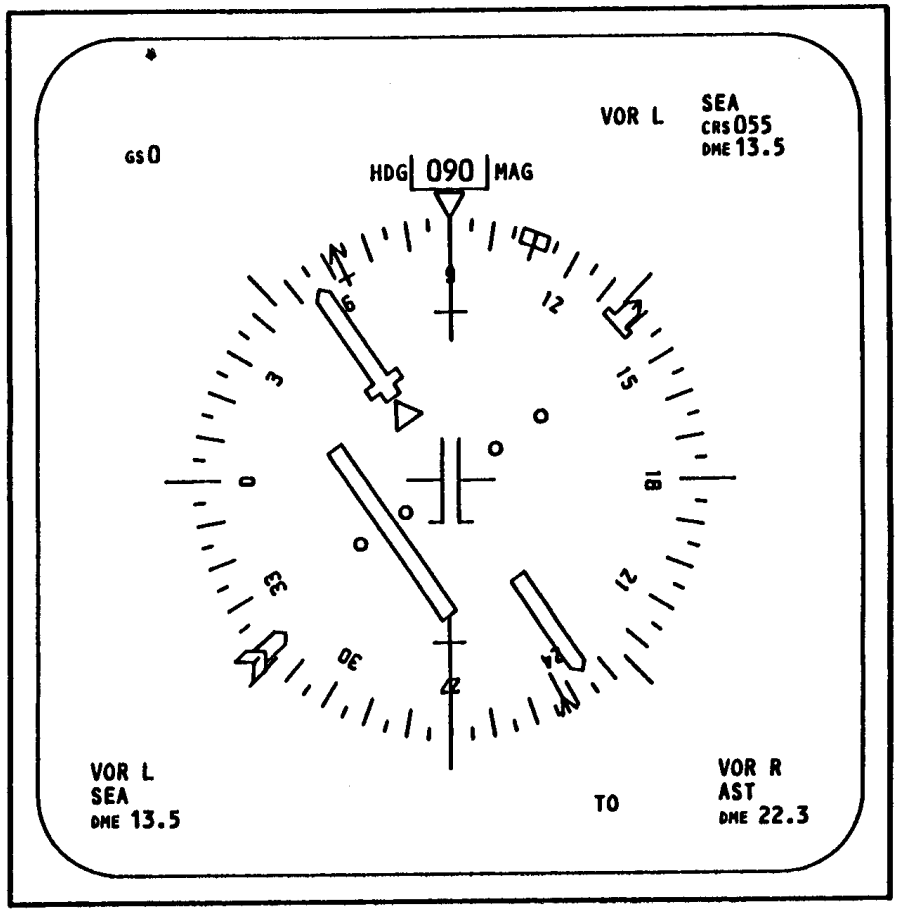
VOR MODES

The VOR mode shows guidance data needed to fly along a selected course. The VOR mode data is:

- Airplane symbol
- Selected course
- System source annunciation
- Heading
- Track
- Drift angle
- VOR deviation
- VOR frequency/identifier
- DME distance
- Weather radar
- TCAS
- Ground speed
- Wind direction and speed
- Selected heading
- Navaid data



EXPANDED VOR MODE



CENTER VOR MODE

Figure 13 VOR MODES

VOR MODE FLAGS

The ND receives data from the VOR system. A no-computed-data (NCD) condition removes the data. An invalid data condition removes the data and shows an EFIS flag.

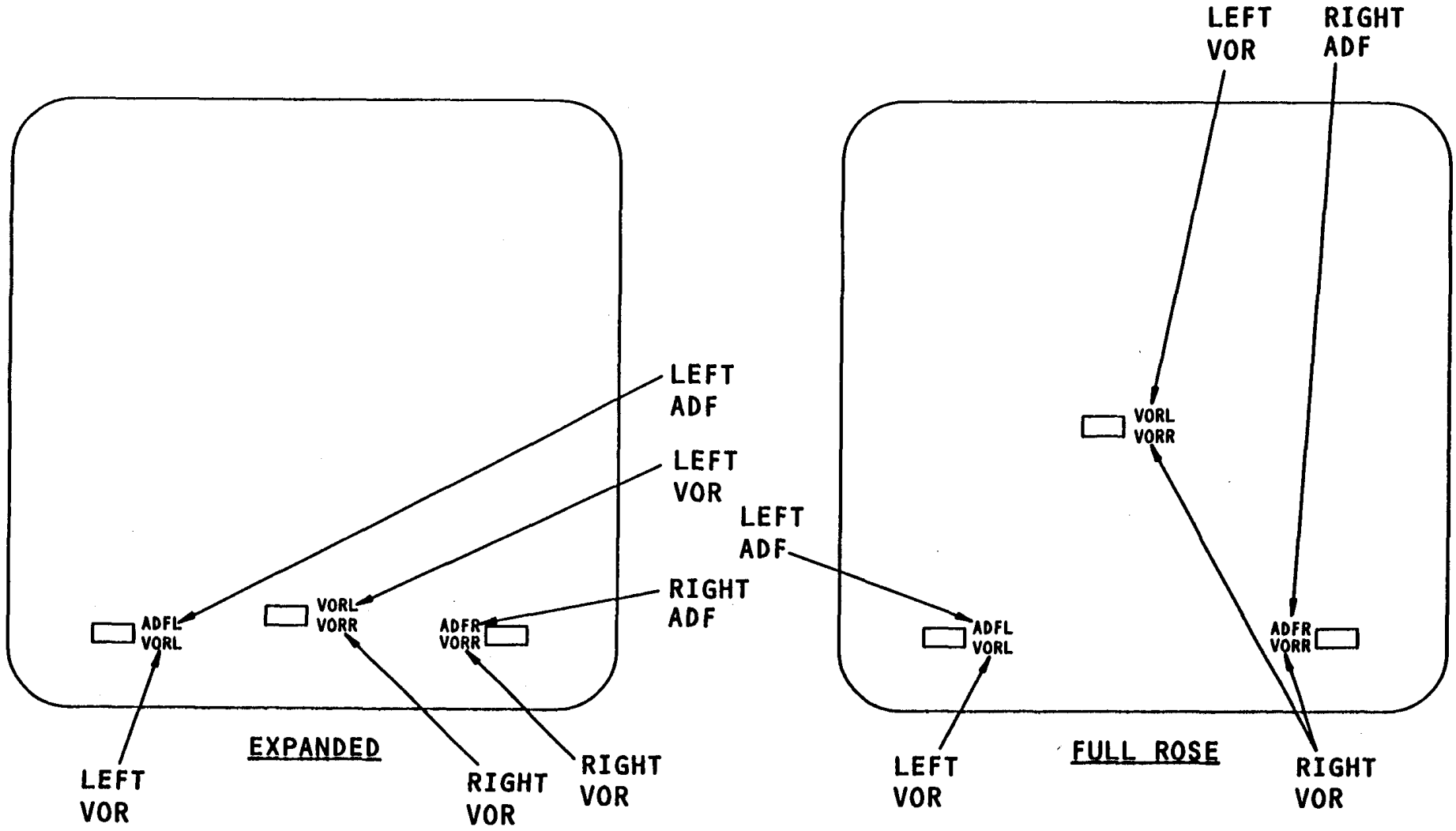


Figure 14 VOR MODE FLAGS

MAP MODES

The data in the map mode is almost all supplied by the flight management computer. The Map mode data is:

- Track
- Heading
- Flight plan and waypoints
- Origin and destination airports
- Altitude profile points
- Range to altitude arc
- Vertical deviation
- Curved trend vector
- Selected reference points
- Manually tuned navaids

Other map symbols can show when selected on the EFIS control panel.

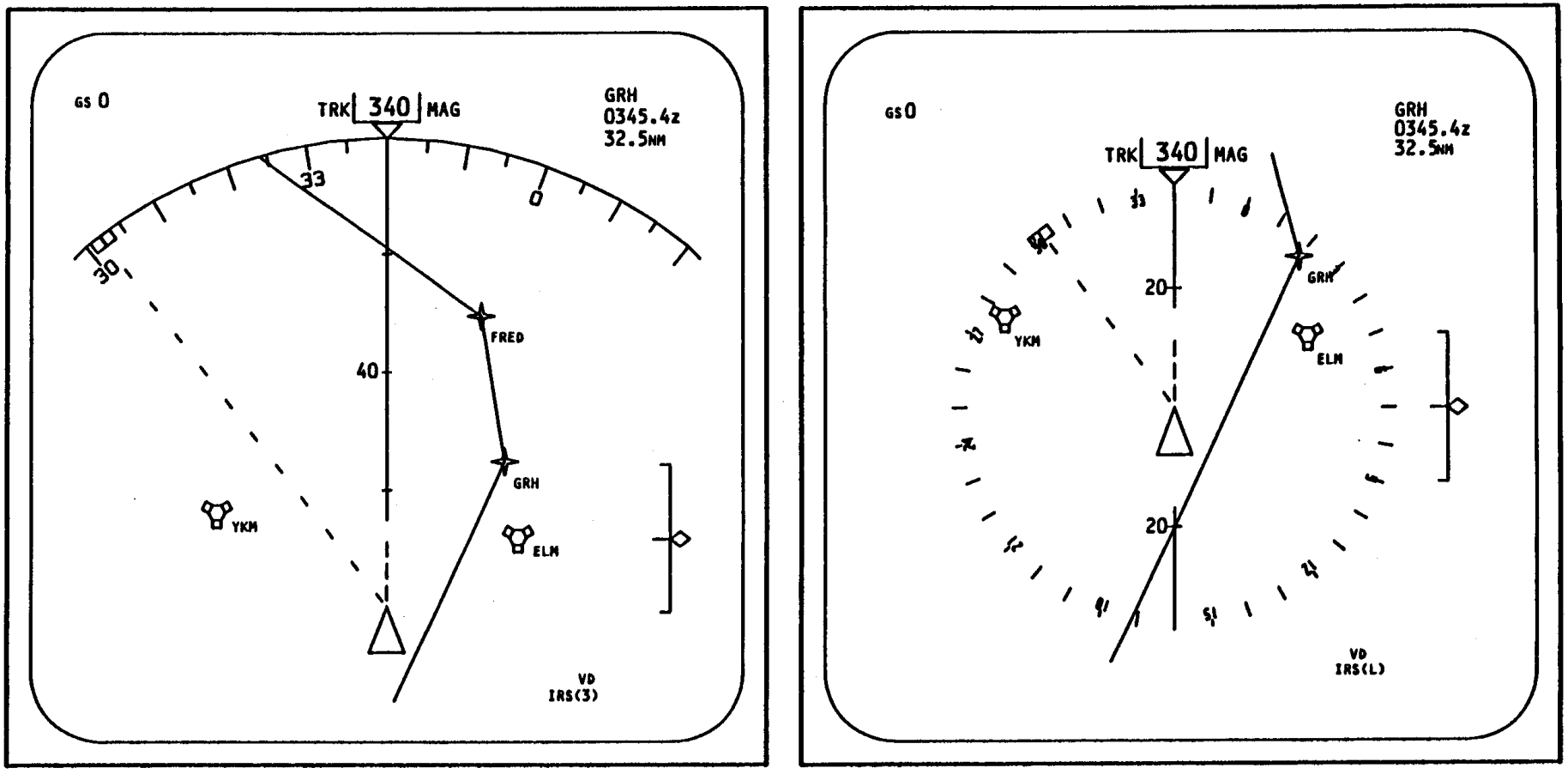


Figure 15 MAP - MODES

MAP MODE FLAGS

The ND receives data from the FMC. A no-computed-data (NCD) condition removes the data. An invalid data condition removes the data and shows an EFIS flag.

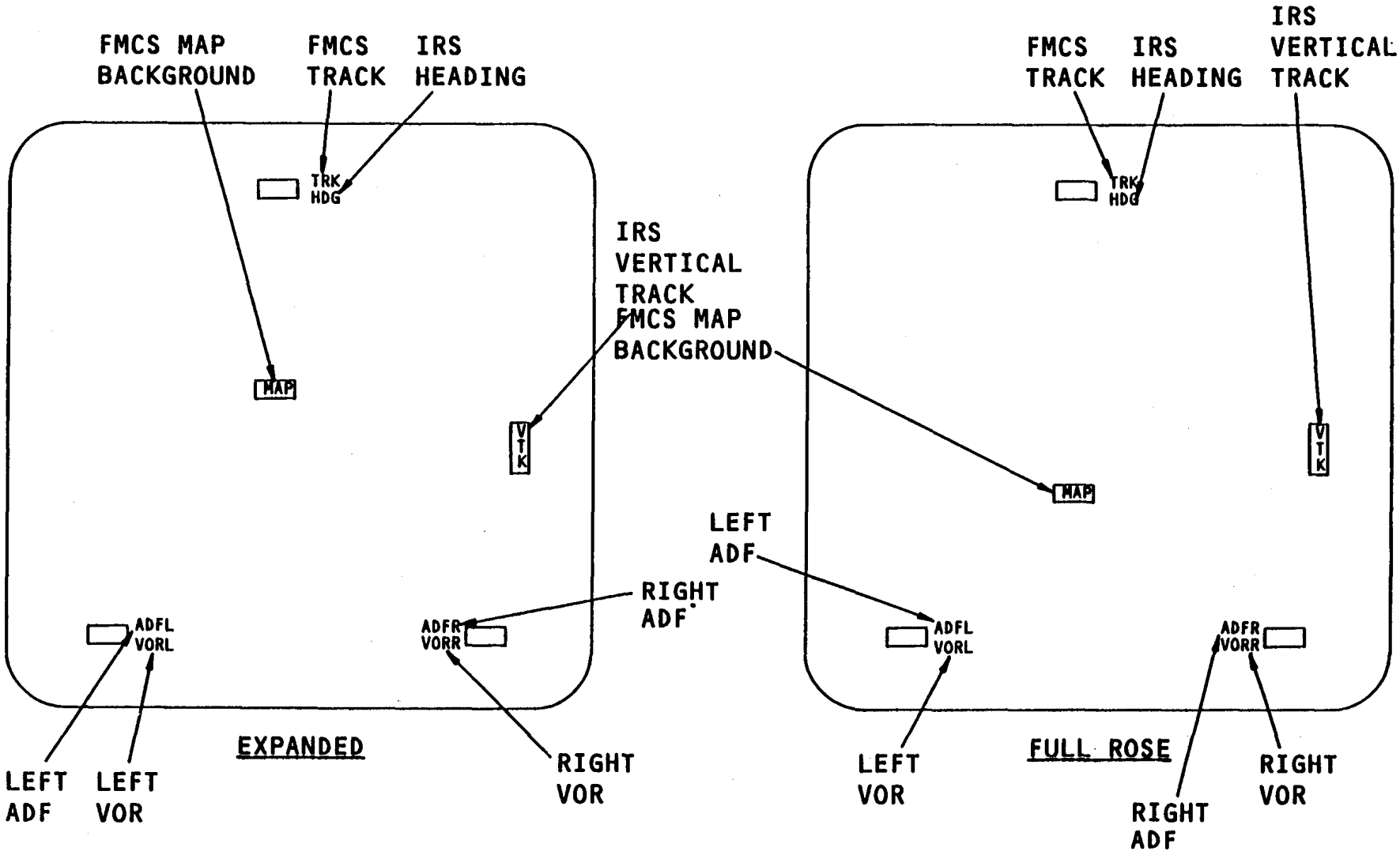


Figure 16 MAP MODE FLAGS

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PLAN MODE

The plan mode shows the flight plan with true north as a reference (shown by the north up arrow). This mode is used for flight planning both on the ground and in the air.

The data for the compass, groundspeed and waypoint is the same as the map mode.

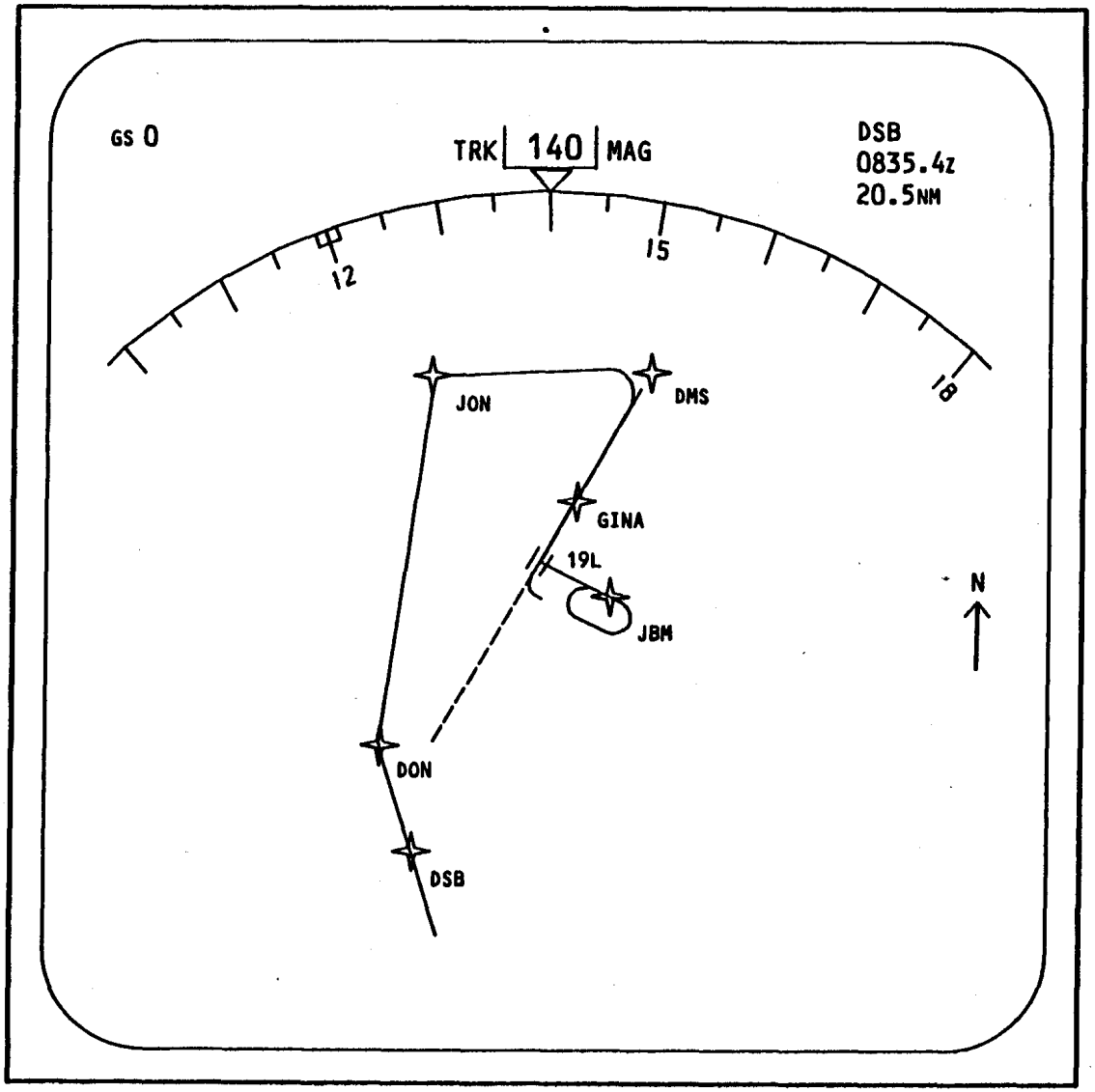

Figure 17 PLAN MODE

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PLAN MODE FLAGS

The ND receives data from the FMC. A no-computed-data (NCD) condition removes the data. An invalid data condition removes the data and shows an EFIS flag.

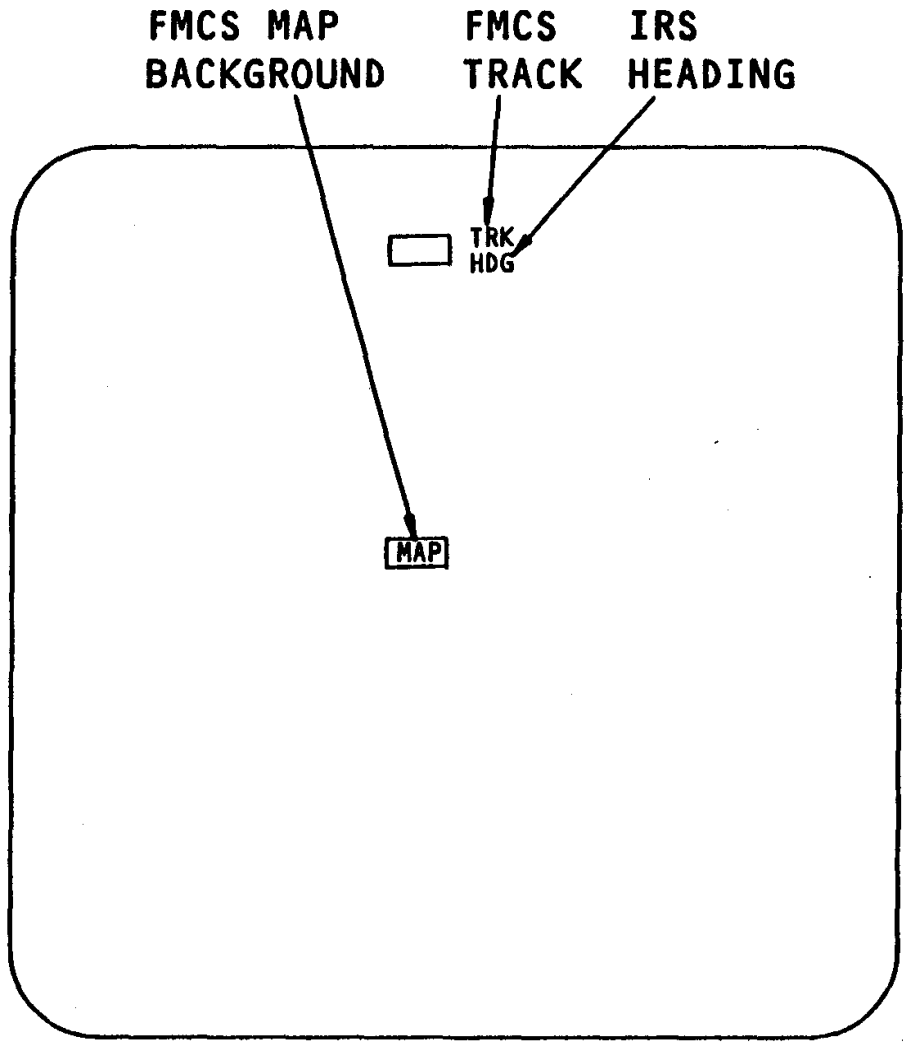


Figure 18 PLAN MODE FLAGS

ND SYMBOLOGY

This table shows the basic symbology used on the ND. The table shows the symbol, name, mode, and data source.

SYMBOL	NAME	APPLICABLE MODE(S)	REMARKS
GS310	GROUND SPEED INDICATION	ALL	GROUND SPEED
350°/15 ↙	WIND BEARING SPEED AND DIRECTION	MAP, MAP CTR, VOR, VOR FULL ROSE, APP, APP FULL ROSE, PLAN	INDICATES WIND BEARING, WIND SPEED, AND WIND DIRECTION WITH RESPECT TO DISPLAY ORIENTATION AND HEADING/ TRACK REFERENCE
AAAAA	ACTIVE WAYPOINT IDENTIFIER	MAP, MAP CTR, PLAN	INDICATES ACTIVE FLIGHT PLAN WAYPOINT CURRENTLY NAVIGATING TO
VOR L, R ILS L, C, R	RECEIVER REFERENCE	VOR, VOR FULL ROSE, APP, APP FULL ROSE	INDICATES RECEIVER REFERENCED FOR THE DISPLAY
116.80 or SEA	ILS/VOR FREQ OR IDENTIFIER DISPLAY	VOR, VOR FULL ROSE, APP, APP FULL ROSE	FREQUENCY DISPLAYED BEFORE IDENTI-FIER IS DECODED. DECODED IDENTIFIER REPLACES THE FREQUENCY
124 NM	DISTANCE DISPLAY	MAP, MAP CTR, PLAN	INDICATES DISTANCE TO THE ACTIVE WAYPOINT
DME 24.6	DME DISTANCE DISPLAY	VOR, VOR FULL ROSE, APP, APP FULL ROSE	INDICATES DME DISTANCE TO THE REFERENCED NAVAID
0835.4z	ETA DISPLAY	MAP, MAP CTR, PLAN	INDICATES FMC CALCULATED ETA FOR THE ACTIVE WAYPOINT
CRS 135	COURSE DISPLAY	VOR, VOR FULL ROSE, APP, APP FULL ROSE	INDICATES VOR COURSE OR FMC RUNWAY COURSE

Figure 19 ND SYMBOLOGY (SHEET 1)

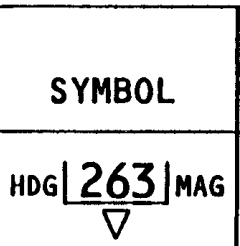
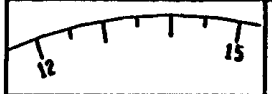
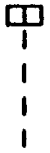
SYMBOL	NAME	APPLICABLE MODE(S)	REMARKS
	HEADING - ORIENTATION INDICATOR REFERENCE	VOR, VOR FULL ROSE, APP, APP FULL ROSE, MAP, MAP CTR, PLAN	INDICATES NUMBER OVER POINTER IS HEADING
	HEADING/TRACK REFERENCE	ALL	INDICATES HEADING/TRACK IS REFERENCED TO MAGNETIC NORTH OR TRUE NORTH. SWITCHING FROM TRU TO MAG DISPLAYS A BOX AROUND THE MAG FOR 10 SECONDS
	EXPANDED COMPASS	MAP, APP, VOR, PLAN	360° IS AVAILABLE BUT ONLY 90° SHOWS
	HEADING POINTER INDICATOR	MAP, MAP CTR, PLAN	INDICATES AIRPLANE HEADING
	TRACK INDICATOR	VOR, VOR FULL ROSE, APP, APP FULL ROSE	INDICATES AIRPLANE TRACK
	SELECTED HEADING CURSOR	ALL	INDICATES THE HEADING SET ON THE MCP. A DOTTED LINE MAY EXTEND FROM THE CURSOR TO THE AIRPLANE SYMBOL

Figure 20 ND SYMBOLOGY (SHEET 2)

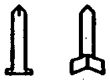
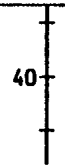
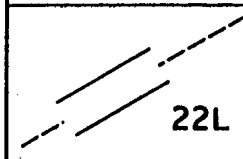
SYMBOL	NAME	APPLICABLE MODE(S)	REMARKS
	VOR OR ADF BEARING - LEFT	MAP, MAP CTR, VOR, VOR FULL ROSE, APP, APP FULL ROSE	DISPLAYS BEARING TO (HEAD) OR FROM (TAIL) TUNED STATION, IF SELECTED ON THE RESPECTIVE EFIS CONTROL PANEL
	VOR OR ADF BEARING - RIGHT		
	PRESENT TRACK LINE AND RANGE SCALE	MAP, MAP CTR, VOR, APP	TRACK RESULTING FROM PRESENT HEADING AND WINDS. DISPLAYED IN VOR OR APP MODE WHEN WEATHER RADAR IS SELECTED
	AIRPORT IDENTIFIER AND RUNWAY	MAP, MAP CTR, PLAN	DISPLAYED WHEN SELECTED AS ORIGIN OR DESTINATION AND ND RANGE IS 80, 160, 320 OR 640 NM
	AIRPORT	MAP, MAP CTR	WHEN ARPT MAP SWITCH SELECTED ON, AIRPORTS WITHIN THE MAP AREA ARE DISPLAYED. ORIGIN AND DESTINATION AIRPORTS ARE ALWAYS DISPLAYED INDEPENDENT OF ARPT SWITCH
	AIRPORT AND RUNWAY	MAP, MAP CTR, PLAN	DISPLAYED WHEN SELECTED AS ORIGIN OR DESTINATION AND ND RANGE IS 10, 20 OR 40 NM. DASHED RUNWAY CENTERLINES EXTEND OUTWARD 14.2 NM
	WAYPOINT: ACTIVE INACTIVE	MAP, MAP CTR, PLAN	ACTIVE - REPRESENTS THE WAYPOINT THE AIRPLANE IS CURRENTLY NAVIGATING TO. INACTIVE - REPRESENTS WAYPOINTS ON THE ACTIVE ROUTE

Figure 21 ND SYMBOLOGY (SHEET 3)

SYMBOL	NAME	APPLICABLE MODE(S)	REMARKS
MLF	OFF ROUTE WAYPOINT	MAP, MAP CTR	WHEN WPT MAP SWITCH SELECTED ON, DATA BASE WAYPOINTS NOT ON THE SELECTED ROUTE ARE DISPLAYED IN ND RANGES OF 10, 20, OR 40 NM
AMBOY KILMR PARBY	FLIGHT PLAN ROUTE: ACTIVE MODIFIED INACTIVE	MAP, MAP CTR, PLAN	THE ACTIVE ROUTE IS DISPLAYED WITH A CONTINUOUS LINE BETWEEN WAY-POINTS. ACTIVE ROUTE MODIFICATIONS ARE DISPLAYED WITH SHORT DASHES BETWEEN WAYPOINTS. INACTIVE ROUTES ARE DISPLAYED WITH LONG DASHES BETWEEN WAYPOINTS
KILMR 12000 0835Z	ROUTE DATA: ACTIVE WPT INACTIVE WPT	MAP, MAP CTR	WHEN DATA MAP SWITCH SELECTED ON, ALTITUDE AND ETA FOR ROUTE WAYPOINTS ARE DISPLAYED
	HOLDING PATTERN: ACTIVE ROUTE MODIFIED ROUTE INACTIVE ROUTE	MAP, MAP CTR, PLAN	A FIXED SIZE HOLDING PATTERN APPEARS WHEN IN THE FLIGHT PLAN. THIS PATTERN INCREASES TO CORRECT SIZE FOR HOLDING
	PROCEDURE TURN: ACTIVE ROUTE MODIFIED ROUTE INACTIVE ROUTE	MAP, MAP CTR, PLAN	A FIXED SIZE PROCEDURE TURN APPEARS WHEN IN THE FLIGHT PLAN. IT INCREASES TO CORRECT SIZE FOR THE PROCEDURE TURN

Figure 22 ND SYMBOLOGY (SHEET 4)

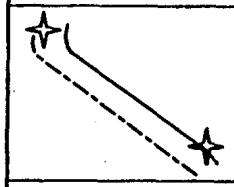
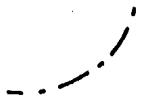
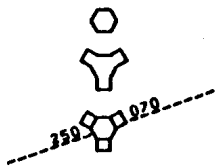
SYMBOL	NAME	APPLICABLE MODE(S)	REMARKS
	OFFSET PATH AND IDENTIFIER: ACTIVE ROUTE MODIFIED ROUTE	MAP, MAP CTR, PLAN	PRESENTS A DASHED LINE PARALLEL TO AND OFFSET FROM THE ACTIVE OR MODIFIED ROUTE. SELECTED ON THE FMCS-CDU
	ALTITUDE RANGE ARC	MAP, MAP CTR	DISPLAYS THE RANGE WHERE THE MCP ALTITUDE WILL BE REACHED. BASED ON VERTICAL SPEED AND GROUNDSPEED
 T/D	ALTITUDE PROFILE POINT AND IDENTIFIER	MAP, MAP CTR	REPRESENTS AN FMC CALCULATED T/C (TOP-OF-CLIMB), T/D (TOP-OF-DESCENT), S/C (STEP CLIMB), AND E/D (END OF DESCENT). DECELERATION AND PREDICTED ALTITUDE/ETA POINTS HAVE NO IDENTIFIER
	ENERGY MANAGEMENT CIRCLES	MAP, MAP CTR	DISPLAYS CLEAN AND SPEEDBRAKE ENERGY MANAGEMENT CIRCLES AS DEFINED ON OFFPATH DES PAGE
	VOR DME/TACAN VORTAC	MAP, MAP CTR	WHEN STA MAP SWITCH SELECTED ON, APPROPRIATE NAVAIDS ARE DISPLAYED. TUNED VHF NAVAIDS ARE DISPLAYED IN GREEN REGARDLESS OF THE STA SWITCH. WHEN A NAVAID IS MANUALLY TUNED, THE SELECTED COURSE AND RECIPROCAL ARE DISPLAYED

Figure 23 ND SYMBOLOGY (SHEET 5)

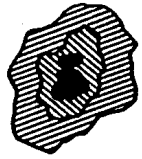
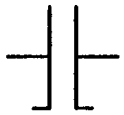
SYMBOL	NAME	APPLICABLE MODE(S)	REMARKS
	SELECTED REFERENCE POINT AND BEARING DISTANCE INFORMATION	MAP, MAP CTR, PLAN	DISPLAYS THE REFERENCE POINT SELECTED ON THE FMCS-CDU FIX PAGE. BEARING AND/OR DISTANCE FROM THE FIX ARE DISPLAYED WITH DASHES
*	IRS POSITION	MAP, MAP CTR	WHEN POS MAP SWITCH SELECTED ON, INDICATES IRS POSITION RELATIVE TO FMC POSITION
	WEATHER RADAR RETURNS	MAP, MAP CTR, VOR, APP	WHEN THE WEATHER RADAR IS SELECTED ON, WEATHER RETURNS ARE DISPLAYED. MOST INTENSE AREAS ARE DISPLAYED IN RED. LESSER INTENSITY AMBER, AND LOWEST INTENSITY GREEN. TURBULENCE IS DISPLAYED IN MAGENTA
	AIRPLANE SYMBOL	MAP, MAP CTR, VOR, APP	CURRENT AIRPLANE POSITION IS AT THE APEX OF THE TRIANGLE
	AIRPLANE SYMBOL	VOR FULL ROSE, APP FULL ROSE	CURRENT AIRPLANE POSITION IS AT THE CENTER OF THE SYMBOL
	TREND VECTOR (DASHED LINE)	MAP, MAP CTR	PREDICTS AIRPLANE DIRECTIONAL TREND AT THE END OF 30, 60, AND 90 SECOND INTERVALS. EACH SEGMENT REPRESENTS 30 SECONDS. BASED ON BANK ANGLE AND GROUND SPEED

Figure 24 ND SYMBOLOGY (SHEET 6)

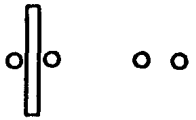
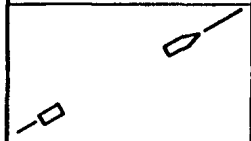
SYMBOL	NAME	APPLICABLE MODE(S)	REMARKS
	VERTICAL POINTER AND DEVIATION SCALE	MAP, MAP CTR	DISPLAYS VERTICAL DEVIATION FROM SELECTED VERTICAL PROFILE (POINTER) DURING DESCENT ONLY. SCALE INDICATES ±400 FEET DEVIATION. DIGITAL DISPLAY PROVIDED WHEN POINTER OVER ±400 FEET
	COURSE DEFLEC-TION INDICATOR DEVIATION SCALE	VOR, VOR FULL ROSE, APP, APP FULL ROSE	DISPLAYS LOC OR VOR DEVIATION. DEFLECTION INDICATOR POINTS IN DIRECTION OF VOR COURSE OR ILS SELECTED RUNWAY
	SELECTED COURSE POINTER AND LINE	VOR, VOR FULL ROSE, APP, APP FULL ROSE	DISPLAYS SELECTED COURSE SET IN THE FMCS-CDU
	GLIDESLOPE POINTER AND DEVIATION SCALE	APP, APP FULL ROSE	DISPLAYS GLIDESLOPE POSITION AND DEVIATION IN ILS MODE
	NORTH POINTER	PLAN	INDICATES MAP BACKGROUND IS ORIENTED AND REFERENCED TO TRUE NORTH
	TO/FROM INDICATOR	VOR FULL ROSE	LOCATED NEAR AIRPLANE SYMBOL. DISPLAYS VOR TO/FROM INDICATION
TO FROM	TO/FROM DISPLAY	VOR, VOR FULL ROSE	DISPLAYS VOR TO/FROM INDICATION

Figure 25 ND SYMBOLOGY (SHEET 7)

SYMBOL	NAME	APPLICABLE MODE(S)	REMARKS
STA WPT ARPT	MAP OPTIONS SELECTION	MAP, MAP CTR	DISPLAYS MAP DATA AS SELECTED ON THE RESPECTIVE EFIS CONTROL PANEL
VOR L, R ADF L, R	VOR OR ADF REFERENCE	MAP, MAP CTR, VOR, VOR FULL ROSE, APP, APP FULL ROSE	LOCATED LOWER LEFT OR RIGHT CORNER. REPRESENTS POSITIONS OF VOR/ADF SWITCHES ON THE EFIS CONTROL PANEL
116.80 or SEA	VOR FREQUENCY OR IDENTIFIER DISPLAY	MAP, MAP CTR, VOR, VOR FULL ROSE, APP, APP FULL ROSE	FREQUENCY DISPLAYED BEFORE IDENTIFIER IS DECODED. DECODED IDENTIFIER REPLACES THE FREQUENCY. SMALL FONT INDICATES ONLY DME INFORMATION IS BEING RECEIVED
DME 24.6	DME DISTANCE DISPLAY (LOWER CORNERS)	MAP, MAP CTR, VOR, VOR FULL ROSE, APP, APP FULL ROSE	INDICATES DME DISTANCE TO THE REFERENCED NAVAID
CDU L, C, R	MAP SOURCE ANNUNCIATION	MAP, MAP CTR	DISPLAYS ND SOURCE IF CDU IS SELECTED ON RESPECTIVE NAV SOURCE SELECT SWITCH
IRS (3) IRS (L) IRS (C) IRS (R)	IRS/FMC UPDATE STATUS	MAP, MAP CTR	DISPLAYS IRS/FMC UPDATE STATUS BASED ON THE IRU'S. TRANSITION FROM IRS (3) TO ANY OTHER ANNUNCIATION HIGHLIGHTED BY A GREEN BOX FOR 10 SECONDS
DD VD LOC	FMC-RADIO UPDATE STATUS	MAP, MAP CTR	DISPLAYS FMC RADIO UPDATE MODE. DD, DME DME; VD; VOR DME; LOC, LOCALIZER

Figure 26 ND SYMBOLOGY (SHEET 8)

SYMBOL	NAME	APPLICABLE MODE(S)	REMARKS
+12 ◇ ↕	OTHER TRAFFIC	MAP, MAP CTR, APP, VOR	SHOWS A NON-THREAT AIRCRAFT
TA 3.8 04 ↕	NO-BEARING TRAFFIC	MAP, MAP CTR, APP, VOR	SHOWS A TA OR RA THAT HAS NCD BEARING DATA
-08 ● ↕	TRAFFIC ADVISORY	MAP, MAP CTR, APP, VOR	SHOWS INTRUDERS AT THE CLOSEST POINT OF APPROACH
-09 ◆ ↕	PROXIMATE TRAFFIC	MAP, MAP CTR, APP, VOR	SHOWS INTRUDERS WITHIN 6 MILES AND 1200 FEET OF RELATIVE ALTITUDE
-02 ■ ↕	RESOLUTION ADVISORY	MAP, MAP CTR, APP, VOR	WARNS THE CREW A COLLISION IS IMMINENT

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Figure 27 ND SYMBOLOGY (SHEET 9)

ND NCD / INVALID CONDITIONS

This table is for NCD and invalid data conditions. The table shows the parameter, data removed, EFIS flag and color, and the condition.

PARAMETER	REMOVED DATA	FLAG	COLOR	CONDITION
MAP BACKGROUND	MAP DISPLAY	MAP	YELLOW	INVALID MAP DATA FROM FMC
TRACK	TRK TAPE, NUMERICS, SEL HDG BUG, PRESENT HDG BUG, CURVED TREND VECTOR, ADF POINTERS OR VECTORS AND MAP DATA. TRK AND MAG/TRUE ANNUNCIATIONS. REMOVE WIND SPEED READOUT AND POINTER, AND VOR VECTORS/RADIALS	TRK	YELLOW	INVALID TRACK DATA FROM FMC
	TRK TAPE NUMERICS, SEL HDG BUG, PRESENT HDG BUG, CURVED TREND VECTOR, ADF POINTERS OR VECTORS MAP DATA. SHOW --- FOR NUMERICS OF TRK AND WIND SPEED	NONE	----	NCD TRACK DATA FROM FMC

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Figure 28 ND NCD / INVALID CONDITIONS (SHEET 1)

PARAMETER	REMOVED DATA	FLAG	COLOR	CONDITION
GLIDESLOPE DEVIATION	GLIDESLOPE POINTER AND SCALE	G/S	YELLOW	INVALID GLIDESLOPE DATA FROM ILS
		NONE	----	NCD GLIDESLOPE DATA FROM ILS
LOCALIZER DEVIATION	LOCALIZER POINTER AND SCALE	LOC	YELLOW	INVALID LOCALIZER DATA FROM ILS
		NONE	----	NCD LOCALIZER DATA FROM ILS
VOR DEVIATION	VOR DEVIATION POINTER AND SCALE	VOR L VOR R	YELLOW	INVALID VOR DEVIATION DATA FROM VOR
	VOR DEVIATION POINTER	NONE	-----	NCD VOR DEVIATION DATA FROM VOR
ADF	ADF POINTER	ADF L ADF R	YELLOW	INVALID ADF DATA FROM ADF
	ADF POINTER	NONE	-----	NCD DATA FROM ADF

Figure 29 ND NCD / INVALID CONDITIONS (SHEET 2)

PRIMARY FLIGHT DISPLAY

The primary flight display (PFD) shows many different functions.
These functions are:

- Flight mode annunciator (FMA)
- Autothrottle mode annunciator (A/T)
- Autopilot mode annunciator (A/P)
- Flight director commands (F/D)
- Pitch limit indicator (PLI)
- Decision speed (V1)
- Rotation speed (VR)
- Landing speed (VREF)
- Flap maneuver speed
- Airspeed trend arrow
- High speed buffet speed
- Maximum operating speed
- Minimum operating speed
- Stick shaker speed

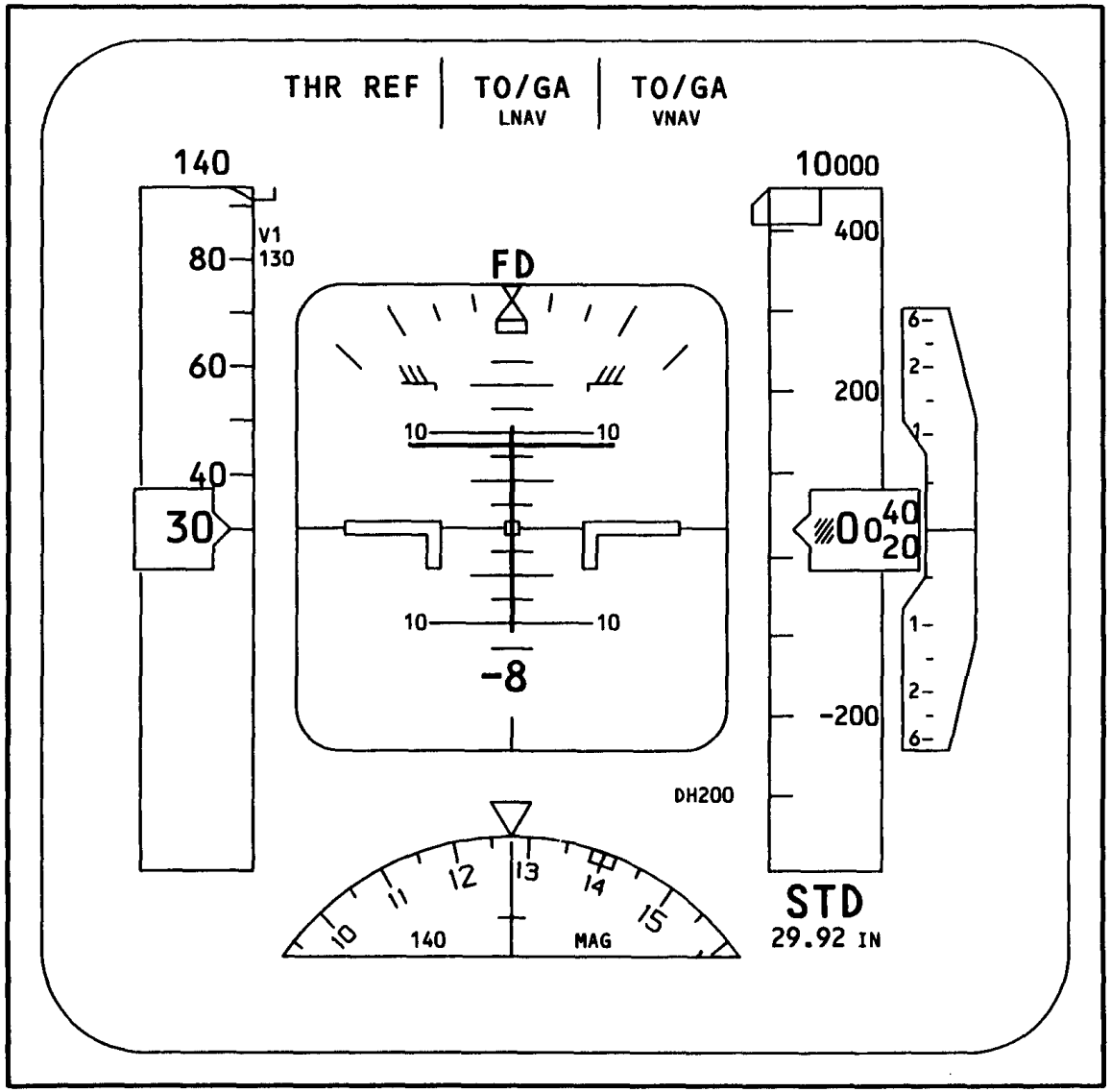
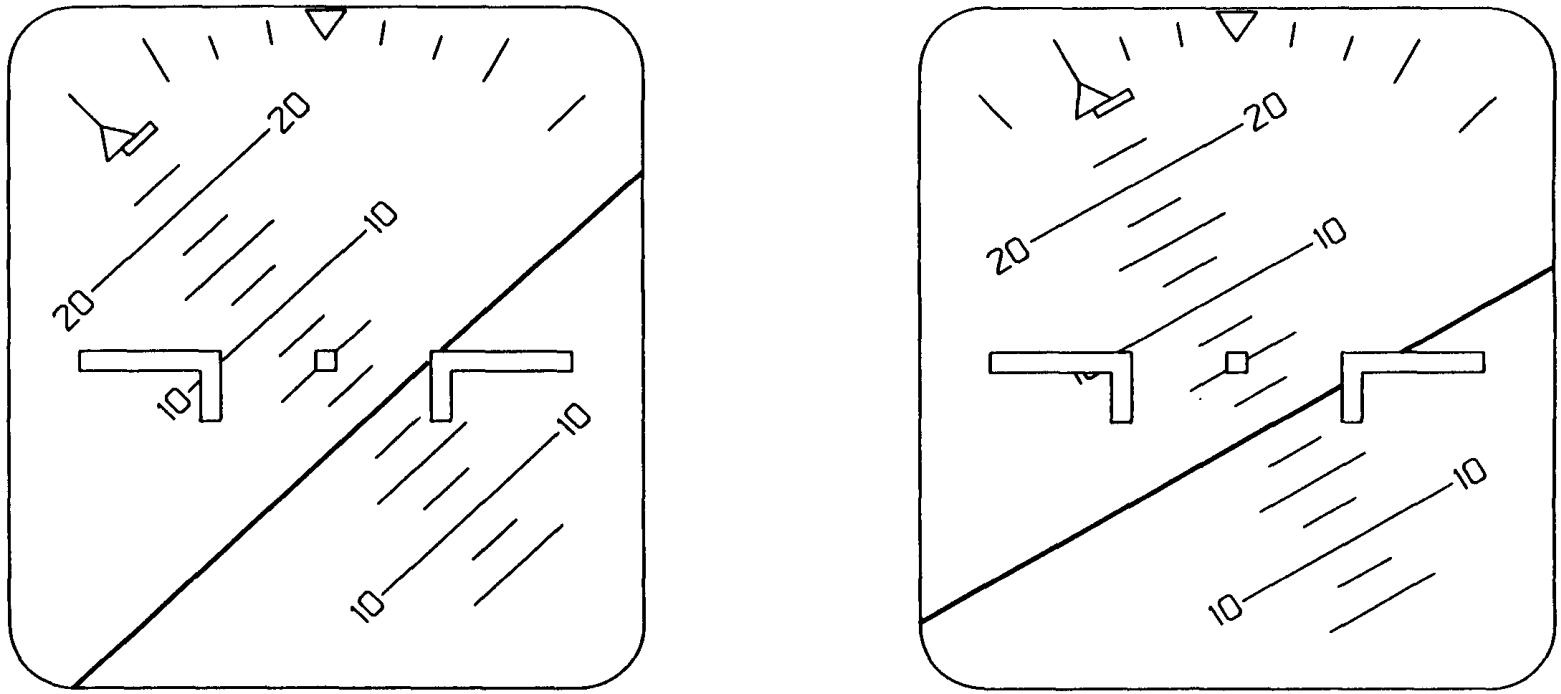


Figure 30 PRIMARY FLIGHT DISPLAY

ATTITUDE COMPARATOR

When the captain's and first officer's pitch and or roll attitude display is different by 3 degrees for .75 seconds, a caution message Shows an EICAS, a level B aural tone sounds, and the master caution lights come on.



CAPTAIN'S PFD

F/O'S PFD

EICAS MESSAGE: ATTITUDE

LEVEL B — AURAL

MASTER — CAUTION — LIGHT

Figure 31 ATTITUDE COMPARATOR

ATTITUDE ANNUNCIATION

A program pin selection (sp 20) enables ”PITCH” or ”ROLL” annunciations an the PFD.

Pitch

When the captain’s or first officer’s pitch display is different by 3 degrees for .75 seconds, the annunciation of PITCH shows an the PFD.

Roll

When the captain’s or first officer’s roll display is different by 3 degrees for .75 seconds, the annunciation of ROLL shows an the PFD.

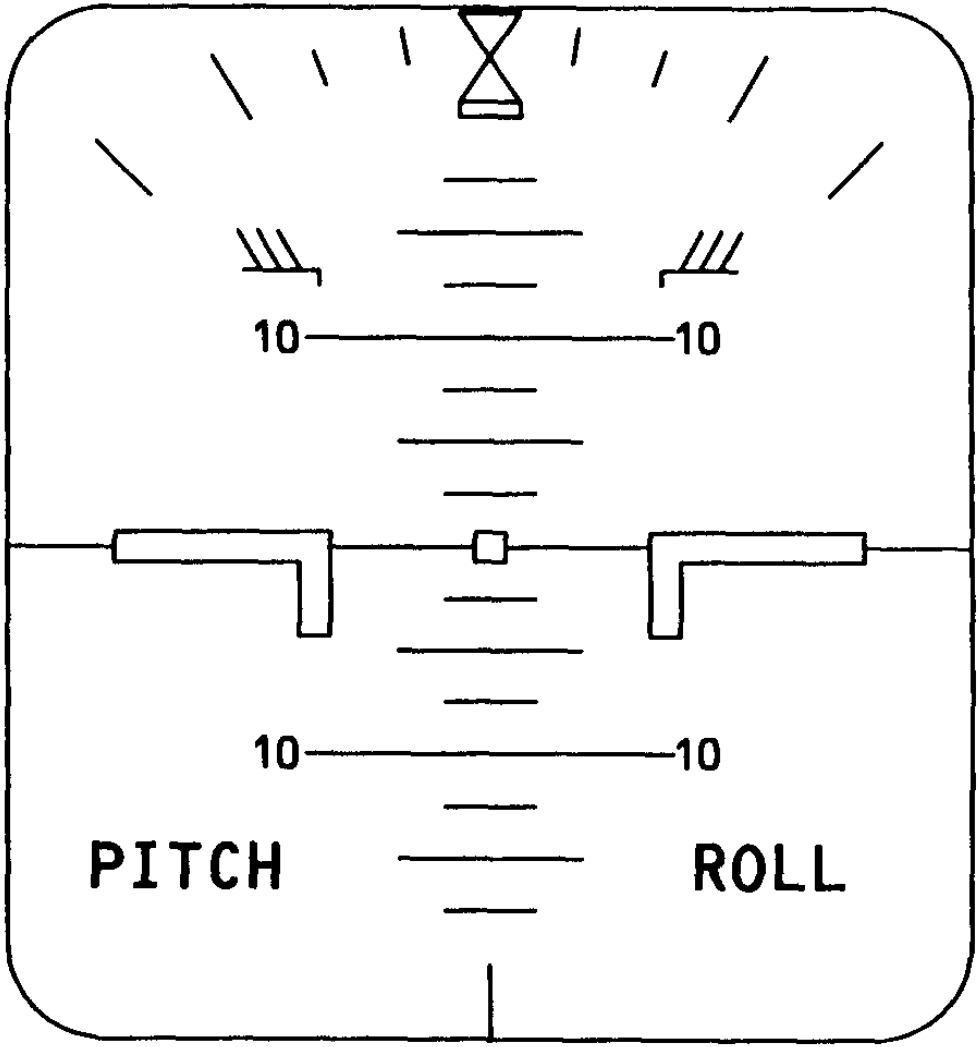
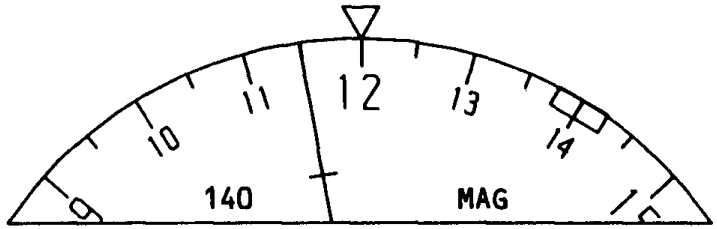


Figure 32 ATTITUDE ANNUNCIATION

HEADING/TRACK COMPARATOR

A program pin selection (DIPP 55) enables the level C EICAS message of heading or track when the following is true:

- Captain's and first officer's heading display is different by 4 degrees for .75 seconds.
- Captain's and first officer's track display is different by 6 degrees for .75 seconds.

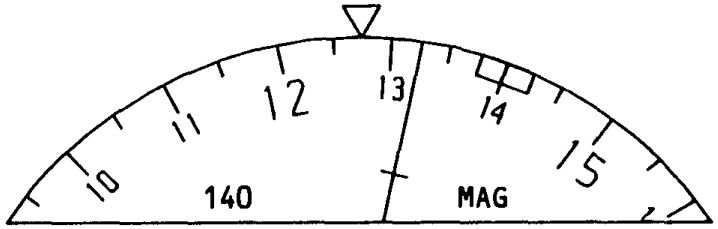


CAPTAIN'S PFD

EICAS MESSAGES:

>HEADING

>TRACK



F/O'S PFD

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Figure 33 HEADING / TRACK COMPARATOR

PITCH LIMIT

Pitch Limit Symbol

The stall warning computers transmit pitch limit data when the flaps are lowered. The yellow pitch limit symbol guides the pilot to maximum pitch (stick shaker speed) during windshear conditions. This symbol moves vertically.

Source Selection

The left PFD uses left stall warning computer card data unless it detects a failure. If a failure is detected, the PFD automatically switches to right stall warning computer card data.

The right PFD uses the right stall warning computer card data unless it detects a failure. If a failure is detected, the PFD automatically switches to left stall warning computer card data.

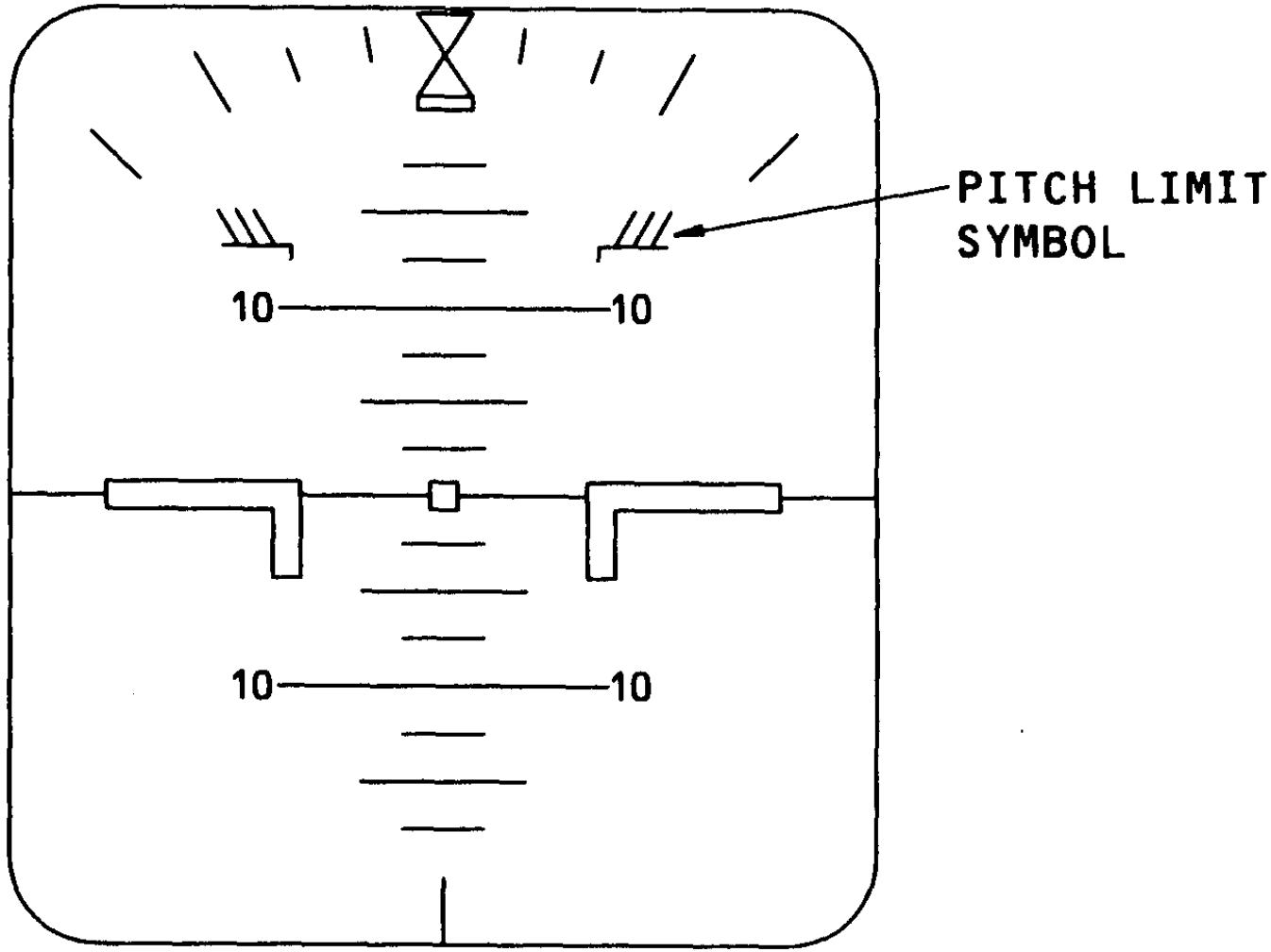


Figure 34 PITCH LIMIT

AIRSPEED TAPE AND SYMBOLS

General

The airspeed tape shows these symbols:

- Airspeed trend arrow
- Minimum maneuver speed
- Stick shaker speed
- Maximum operating speed
- High speed buffet
- Decision speed (V1)
- Rotation speed (VR)
- Flap maneuver speeds
- Landing speed
- Selected speed

Airspeed Trend Arrow

The PFD computes the airspeed trend from the ADC computed airspeed and IRU flight path acceleration. The green airspeed trend arrow shows when the PFD calculates a speed trend (positive or negative) greater than 4.5 knots. The airspeed trend arrow goes away if the airspeed trend then goes less than 3.5 knots. The maximum length of the trend arrow is 60.5 knots.

Minimum Maneuver Speed

The minimum maneuver speed shows as a yellow bar. The bar extends from the stick shaker speed barber pole to the minimum maneuver speed an the tape. If

the stick shaker speed is out of view, the bar continues to the lower edge of the tape.

The bar does not Show if the value of minimum maneuver speed is out of view. The source of minimum maneuver speed data is the selected FMC.

Stick Shaker Speed

Stick shaker speed shows as red and black (barber pole) boxes. The boxes extend from the stick shaker speed an the tape to the lower edge of the tape. The boxes do not Show if the value of stick shaker speed is out of view. The source of stick shaker speed data is the stall warning computer.

Maximum Operatina Speed

The maximum operating speed shows as red and black boxes (barber pole). The barber pole extends from the maximum operating speed to the upper edge of the Speed tape. The PFD uses either stall warning computer card or air data computer maximum operating speed data, whichever is less.

High Speed Buffet

The high speed buffet speed shows as a yellow bar that extends from the maximum operating speed to the maximum maneuver speed (buffet speed) an the tape. If the high speed buffet speed is off the display, the bar does not Show. The Speed source of high speed buffet data is the selected FMC.

Decision Speed (V1)

The takeoff decision speed shows as a green V1, and digital readout. When decision speed data is greater than the speed at the top of the tape, Vl and the digital readout shows at the upper limit of the tape. When the value of decision speed is in view, Vl shows next to the Speed an the tape. The source of decision speed data is the selected FMC.

Rotation Speed (VR)

Takeoff rotation speed shows as a green R when the rotation speed and decision speed are less than four knots apart. If the decision speed and rotation speed are more than four knots apart, rotation speed shows as VR next to the speed an the tape. The source of rotation speed data is the selected FMC.

Flap Maneuver Speeds

The units of flap extension show as green numbers next to the associated speed. The flap retraction speed shows in green as UP. The source of flap maneuver speed data is the selected FMC.

Landing Speed

Landing speed shows in green as REF, a digital readout, and a bar. Landing speed shows only after Vl data blanks. If the value of landing speed is less than the minimum low speed position (the bottom of the tape), REF and the bar show one line up from the bottom of the tape.

When the value of landing speed is in view, the letters REF and the bar show next to the landing speed. The source of landing speed data is the selected FMC.

Source Selection

The source of FMC speed tape data is controlled by presence and validity monitoring.

The captain's display uses left FMC data until a left FMC failure is detected. If the left FMC fails, the captain's display will use right FMC data.

The firnt officer's display uses right FMC data until a right FMC failure is detected. If the right FMC fails, the first officer's display will use left FMC data.

The source of stall warning computer speed tape data is selected in the saure way as FMC speed tape data.

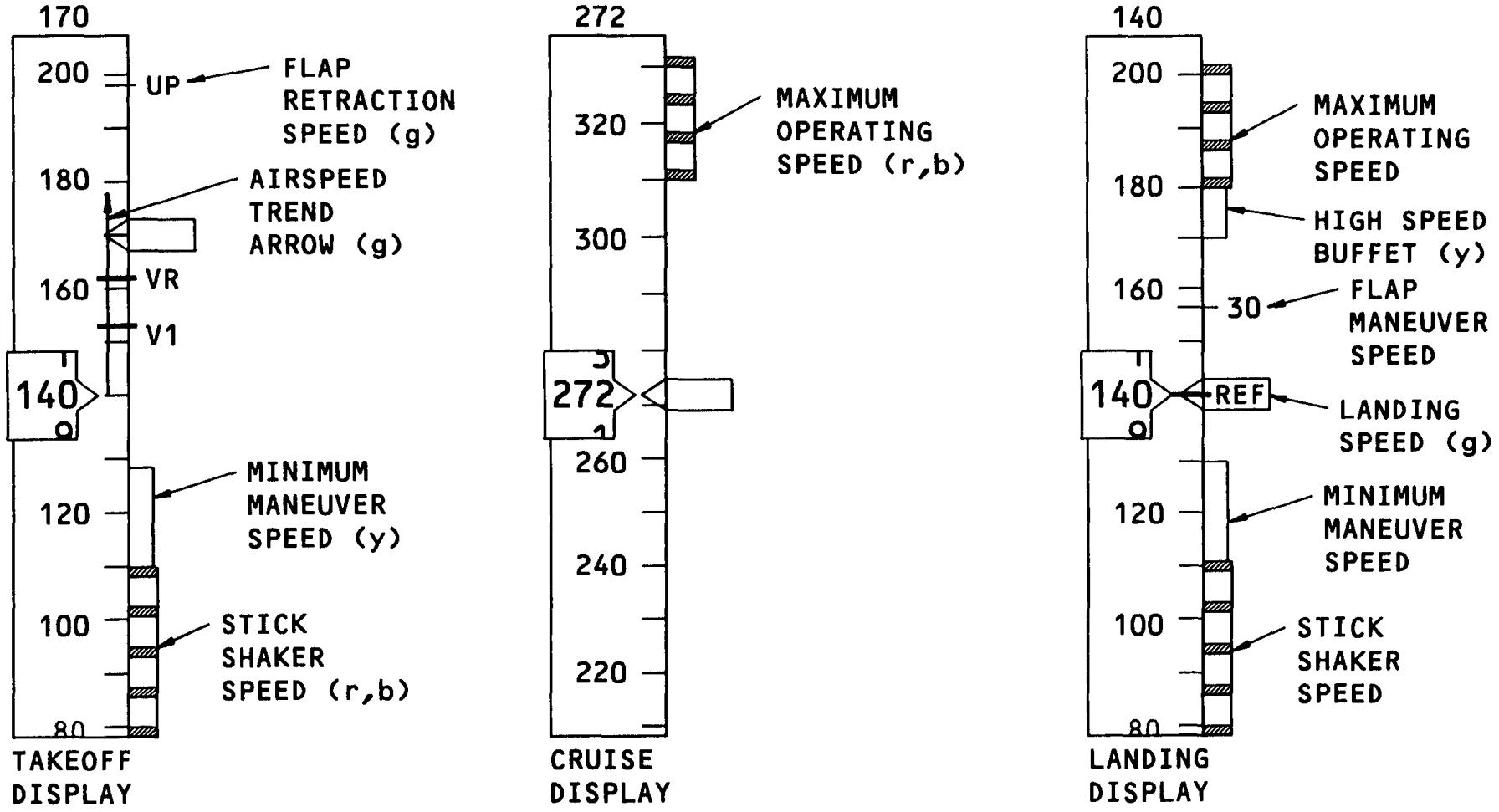


Figure 35 AIRSPEED TAPE AND SYMBOLS

MAG/TRU ANNUNCIATION

The MAG annunciation is green an the PFD and the ND. A transition from TRU to MAG shows a green mode transition box for ten seconds, an the ground or in the air.

The TRU annunciation an the ground is green with a yellow box.

In the air, there are two possible annunciations, normal and advisory.

- Normal: TRU is green with a white box

- Advisory: When the descent rate is greater than or equal to 800 fpm and there is an altitude change of 2,000 ft, the white box changes to yellow and blinks for ten seconds. A climb rate greater than or equal to 500 fpm and an altitude change of 2,000 ft, changes the box back to white.

When the display unit switches to true data because of NCD mag data or if the HEADING REFERENCE switch is placed to the true position, the *annunciation* at the top of the ND shows TRU.

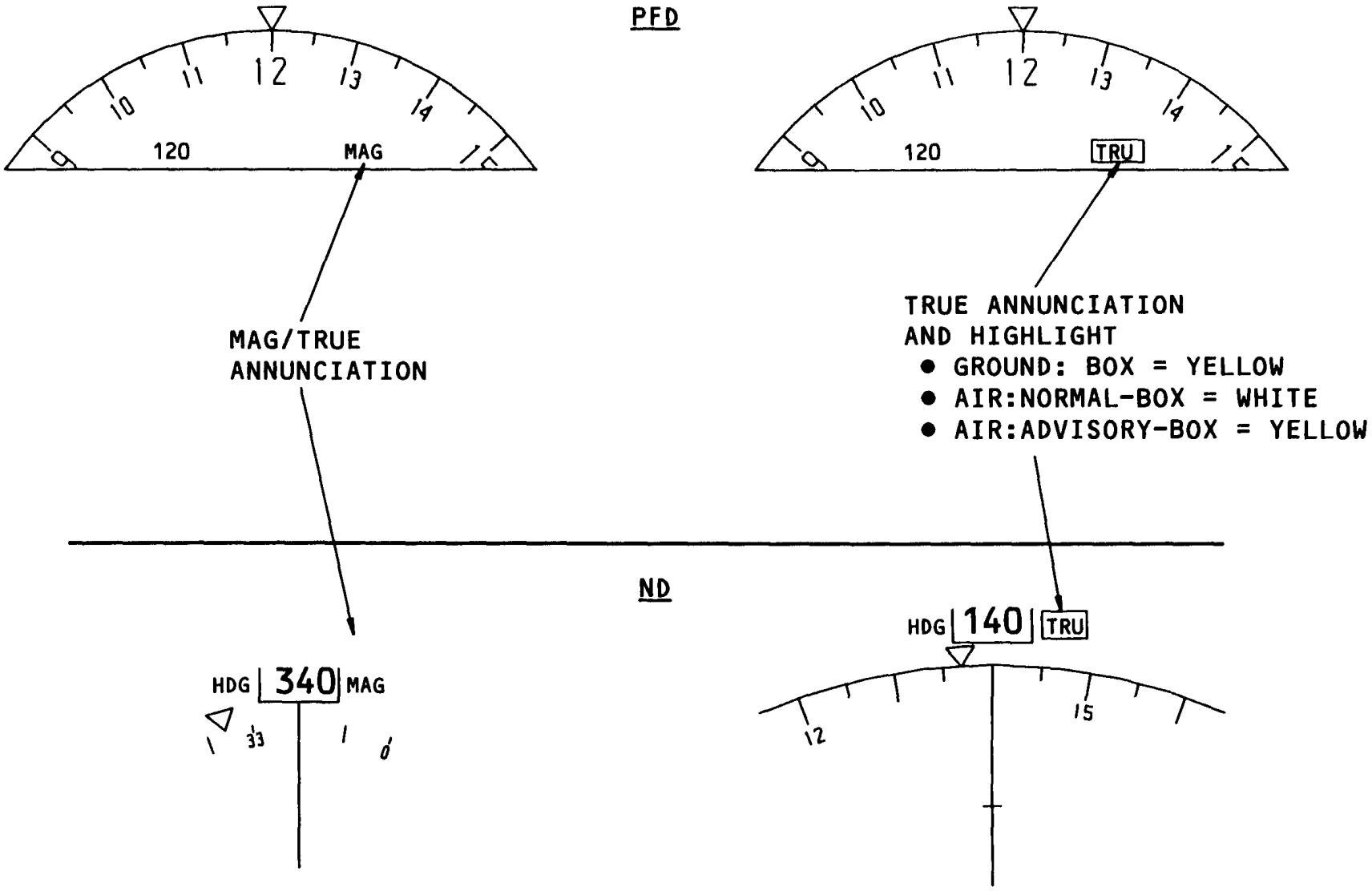


Figure 36 MAG / TRU ANNUNCIATION

MAP MODES

There are two types of MAP mode formats:

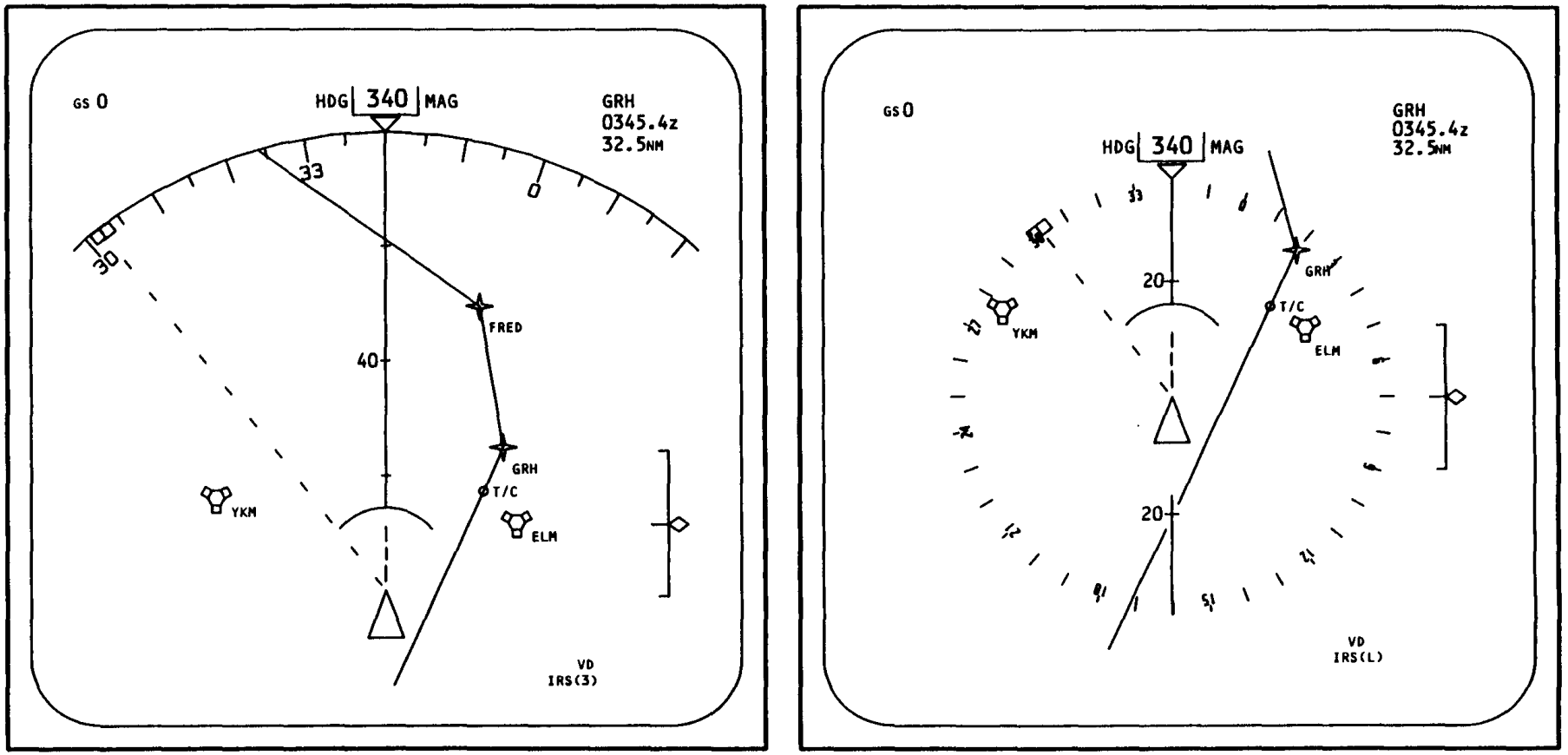
- Expanded MAP mode
- Center MAP mode

Most of the data in the map mode is supplied by the flight management computer. The display is a dynamic display, which shows airplane movement along the flight path. The data available in the MAP modes is:

- Track
- Heading
- Selected heading
- Flight plan and waypoints
- Origin and destination airports
- Altitude profile points
- Range to altitude
- Vertical deviation
- Curved trend vector
- Manually tuned navaids
- Waypoint data
- FMC/IRS update mode
- FMC/Radio update mode

Other map symbols can show when selected an the EFIS control panel.

The FMC updates map data to the ND once every 5 seconds, during this time movement of the map display is done by the ND. The ND uses groundspeed and track angle data to calculate the map display movement.



EXPANDED MAP MODE

CENTER MAP MODE

NOTE: THIS DISPLAY IS FOR ILLUSTRATION PURPOSES ONLY

Figure 37 MAP MODES

ORIGIN/DESTINATION AIRPORTS

The origin and destination airport show as part of the flight plan.

The symbol first shows as just a circle when selected as part of the flight plan. When a runway is selected, the symbol then shows the runway direction and the identifier.

The airport symbol shows in two ways:

- A circle for ranges greater than 40 nm
- A runway symbol for ranges less than 80 nm

On the circle, the runway direction shows by the line that extends from the circle.

The runway symbol also shows the proper direction an the map. A white, 14 nm runway extension shows from each end of the runway symbol.

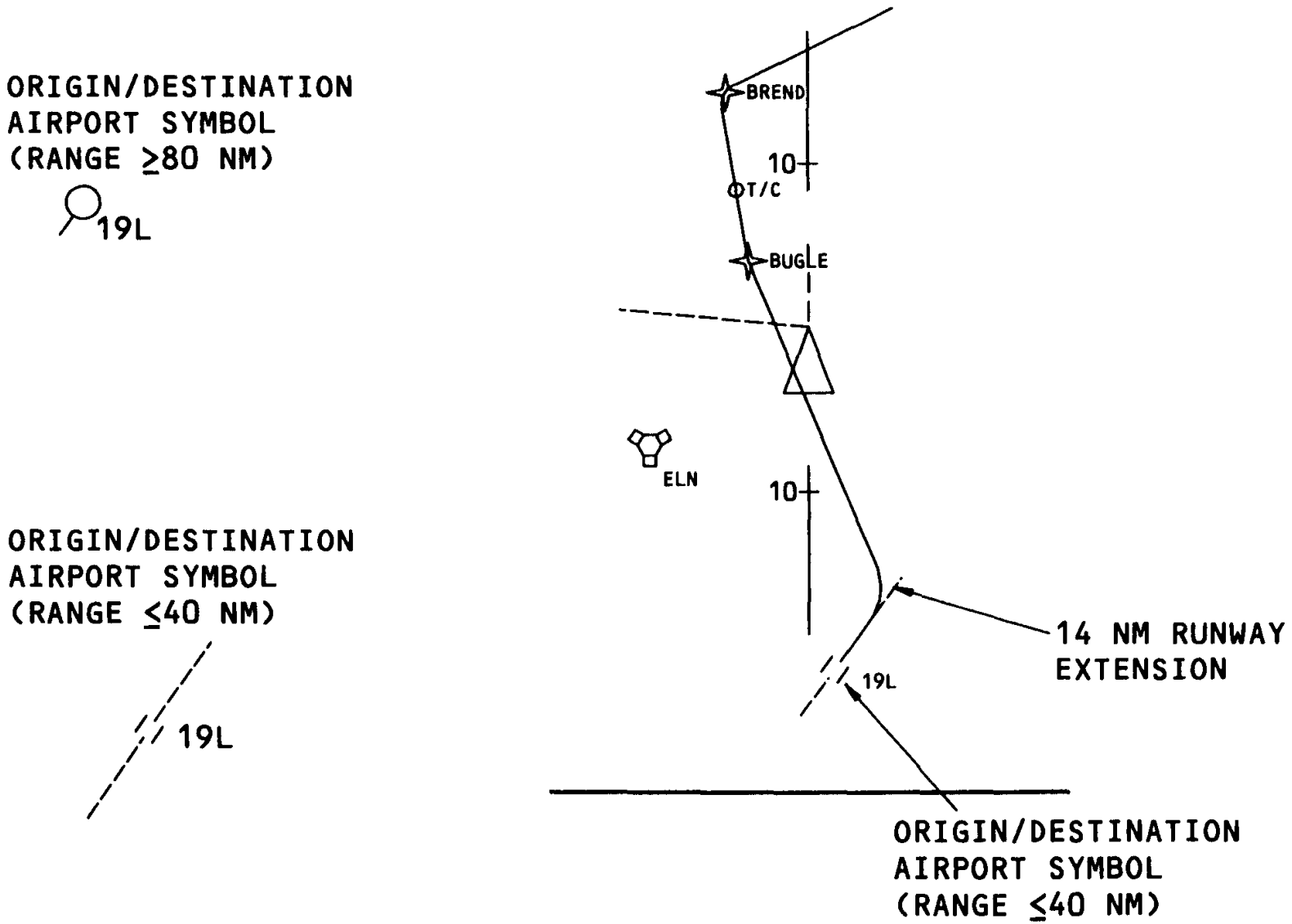


Figure 38 ORIGIN / DESTINATION AIRPORTS

STATION SELECTION

General

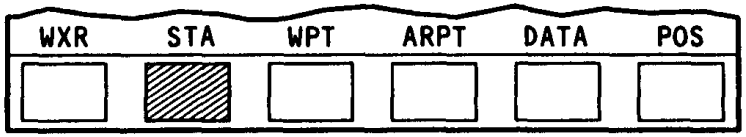
Switches an the lower part of the EFIS control panel add data to the map mode display.

The Station (STA) map data selector switch causes the FMC to transmit the location, type, and identification of all navigation aids (in the selected map range) to the ND. The ND then Shows the correct symbol an the map. The navigation aids that can Show are:

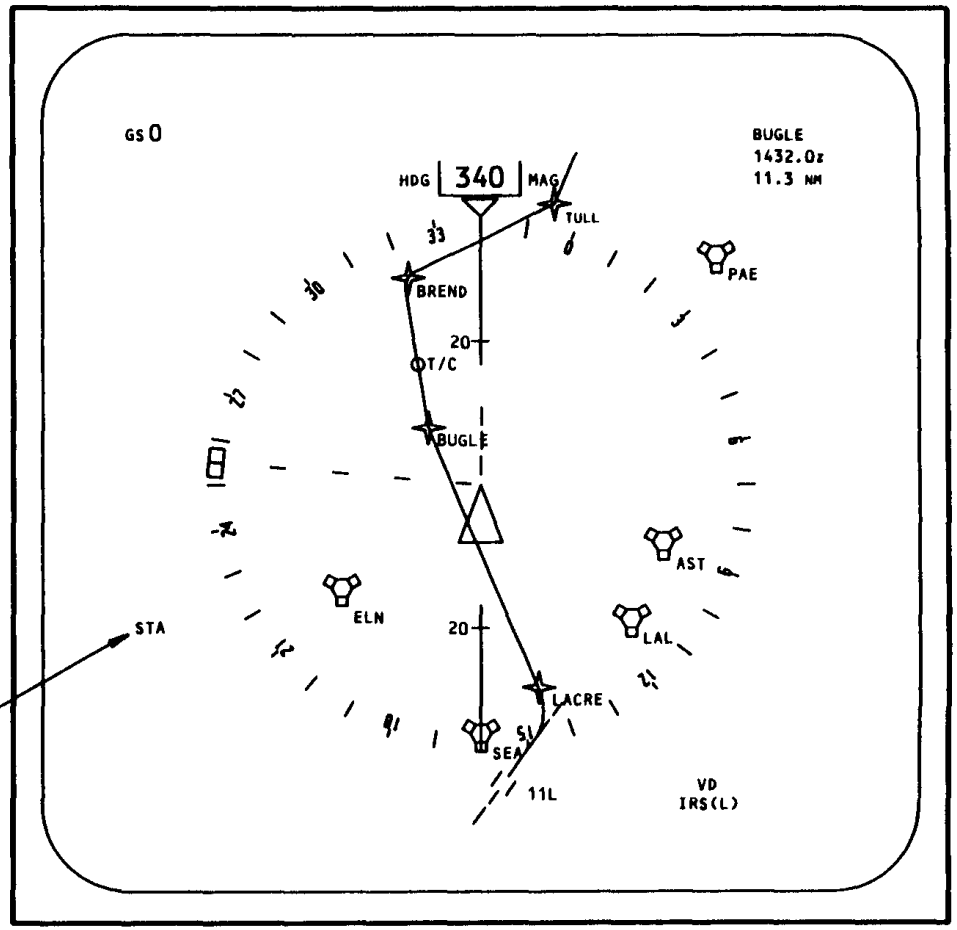
- VOR
- DME/TACAN
- VORTAC

Each type of navigation aid is a different symbol. The left part of the ND Shows the Station selected annunciation (STA) when the Station map data selector switch is pressed.

The stations that Show, when selected an the EFIS control panel, are cyan. A tuned station Shows in green.



EFIS CONTROL PANEL



VOR SYMBOL

DME/TACAN SYMBOL

VORTAC/VOR DME SYMBOL

STATION SELECTED ANNUNCIATION

NOTES: TUNED NAVAIDS ARE GREEN, ALL OTHERS ARE CYAN

THIS DISPLAY IS FOR ILLUSTRATION PURPOSES ONLY

Figure 39 STATION SELECTION

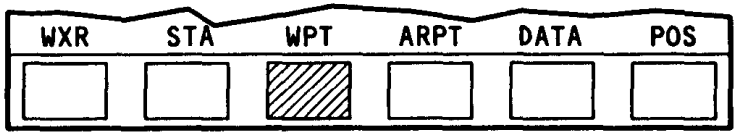
WAYPOINT SELECTION

The EFIS control panel waypoint (WPT) map data selector switch causes the FMC to transmit the location and identification of all ground reference points (in the selected map range) to the ND. The ND then shows the cyan ground reference point an the map. The waypoint can be any one of these ground reference points:

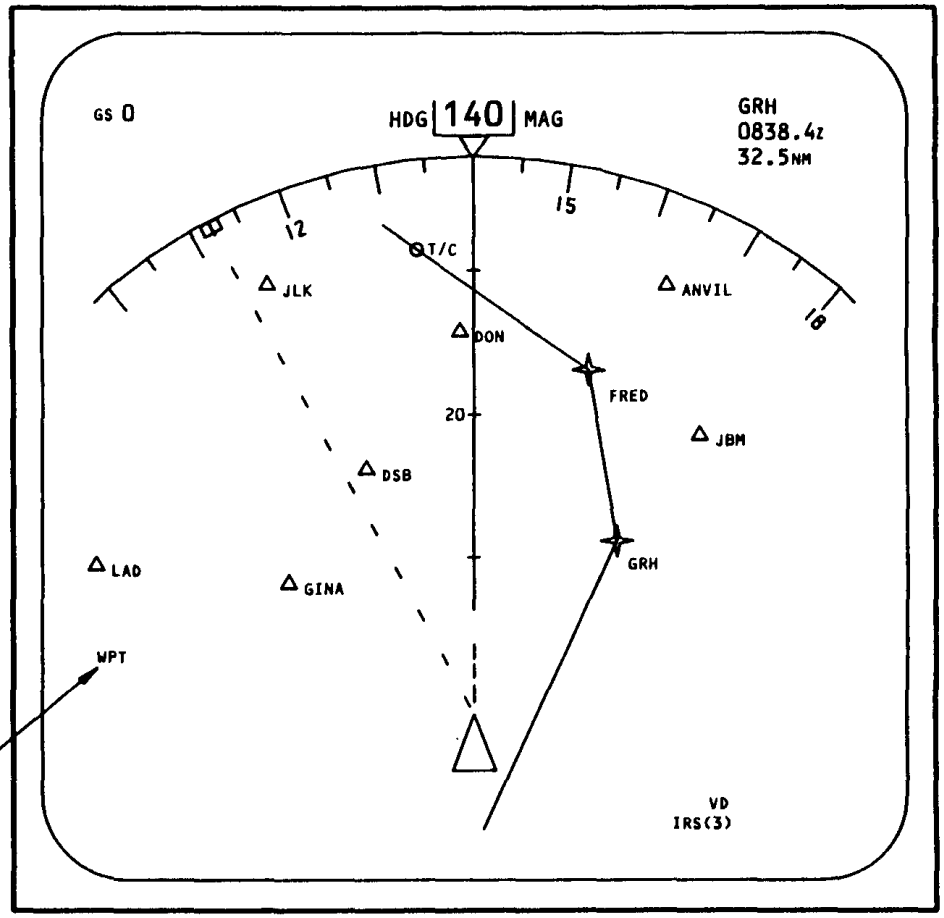
- Intersections of airways
- Intersections of radials
- Specified airway locations
- Visible terrain features
- Any specified location

The waypoints only show in ranges of 40 nm or less.

The left part of the ND shows the waypoint selected annunciation (WPT) when the waypoint map data selector switch is pushed.



EFIS CONTROL PANEL



△ GROUND REFERENCE POINT SYMBOL

WAYPOINT SELECTED
ANNUNCIATION

NOTE: THIS DISPLAY IS FOR ILLUSTRATION PURPOSES ONLY

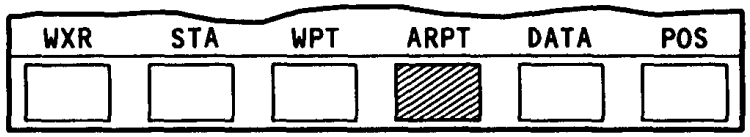
Figure 40 WAYPOINT SELECTION

AIRPORT SELECTION

The EFIS control panel airport (ARPT) map data selector switch causes the FMC to transmit the location and identification of all the airports (in the selected map range) to the ND. The ND then Shows the cyan airport symbol with the four-letter identification an the map.

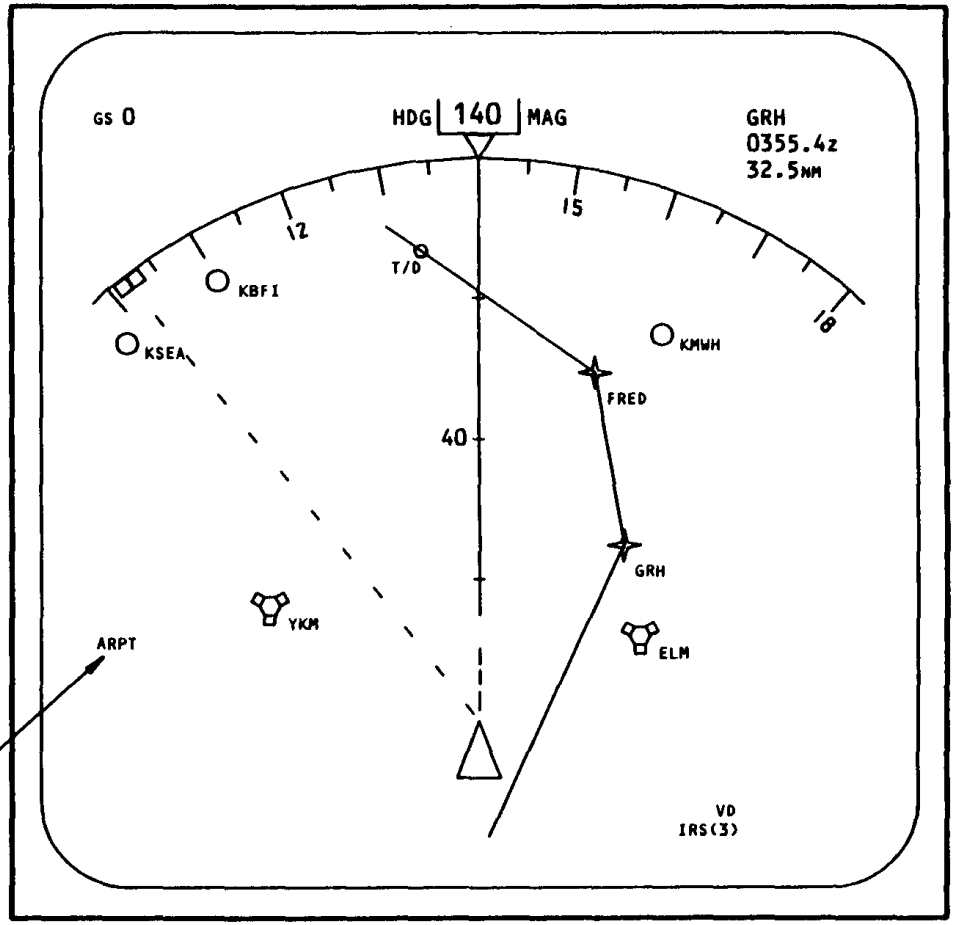
The airports that Show are not part of the flight plan.

The left part of the ND Shows the airport selected annunciation (ARPT) when the airport map data selector switch is pushed.



EFIS CONTROL PANEL

○INACTIVE AIRPORT SYMBOL



AIRPORT SELECTED ANNUNCIATION

NOTE: THIS DISPLAY IS FOR ILLUSTRATION PURPOSES ONLY

Figure 41 AIRPORT SELECTED

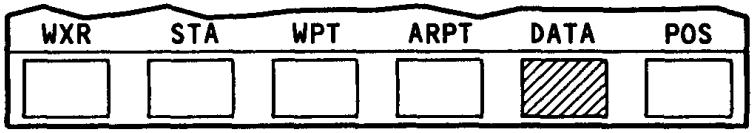
ROUTE DATA SELECTION

The EFIS control panel route data (DATA) map data selector switch causes the FMC to transmit the ETA and crossing altitude restrictions (if applicable) of all the flight plan waypoints within the selected range, to the IDU. The IDU then shows the ETA and crossing altitude below the waypoint identification. The active waypoint's route data will show in magenta. All others show in white. These are examples of the four types of altitude restrictions:

- 1000 = at 1000 feet
- 1000A = at or above 1000 feet
- 1000B = at or below 1000 feet
- 1000A2000B = between 1000 and 2000 feet

The active waypoint identification, ETA, and distance to the active waypoint are shown in magenta an the upper right corner of the ND.

All times displays include the letter Z to show Universal Coordinated Time.



EFIS CONTROL PANEL

CROSSING ALTITUDE EXAMPLES:

- 1000
  AT 1000 FEET
- 1000A
  AT OR ABOVE 1000 FEET
- 1000B
  AT OR BELOW 1000 FEET
- 1000A 2000B
  AT OR ABOVE 1000 FEET AND
  AT OR BELOW 2000 FEET

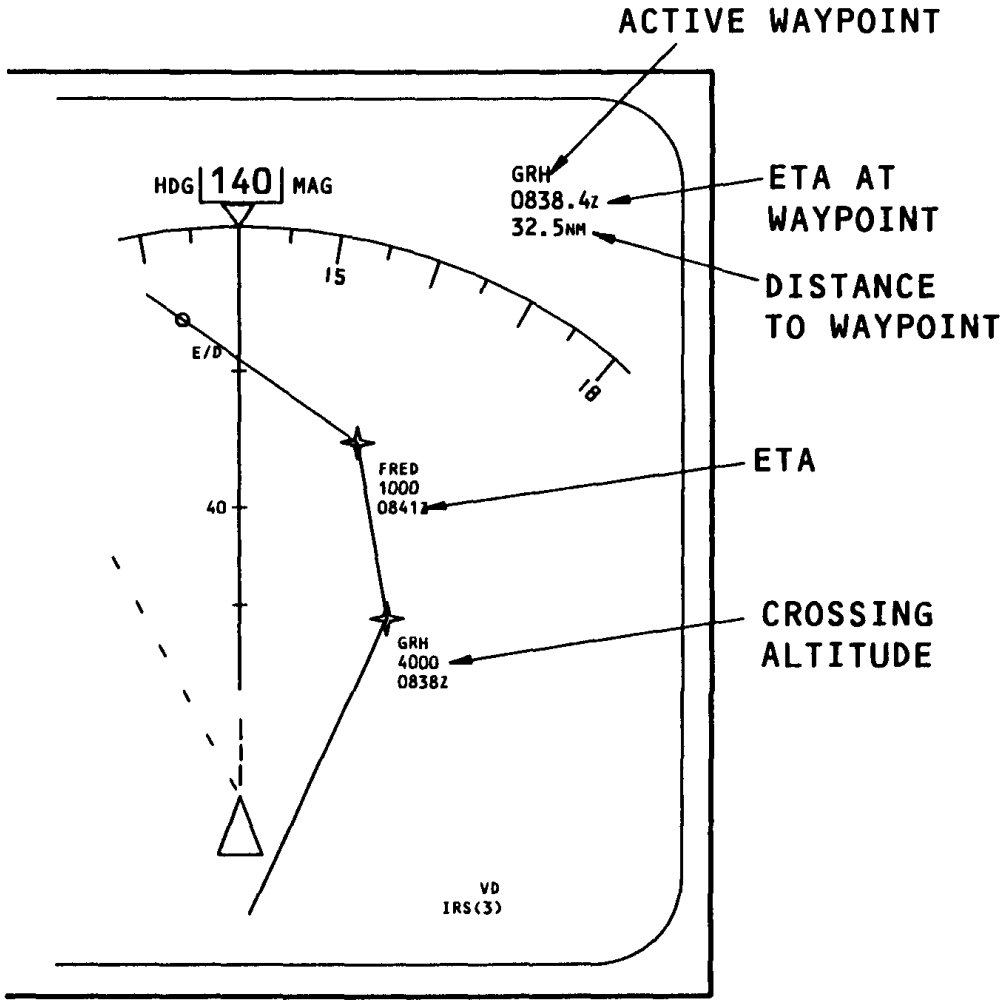


Figure 42 ROUT DATA SELECTION

BACK
TOC
TOF
NEXT

POSITION DISPLAY

The EFIS control panel position display (POS) map data selector switch causes the FMC to transmit IRU position data to the ND.

The position display contains:

- Inertial reference unit positions
- VOR bearings to the airplane
- Corrected DME distances

The position display helps the crew to determine how accurately airplane position is put an the map. Each symbol is put an the map relative to the calculated airplane position. With the data used to calculate the airplane position shown, the airplane position relative to *navigation* aids can be monitored for accuracy. The IRU drift error is also easily determined with the position display. The IRU positions are shown as white stars. The green radials shown extend from the airplane symbol to the navigation aid at the radial angle received from the VOR receiver. The radial angle from the navigation aid to the airplane

shows along the radial in green numbers.

The end point of the radial is determined by the corrected DME distance. Corrected DME distance is calculated with FMC barometric altitude, the slant range distance received from the DME interrogator, and the navigation aid altitude.

If DME distance cannot be calculated by the FMC, the radial will continue off of the display at the specified angle.

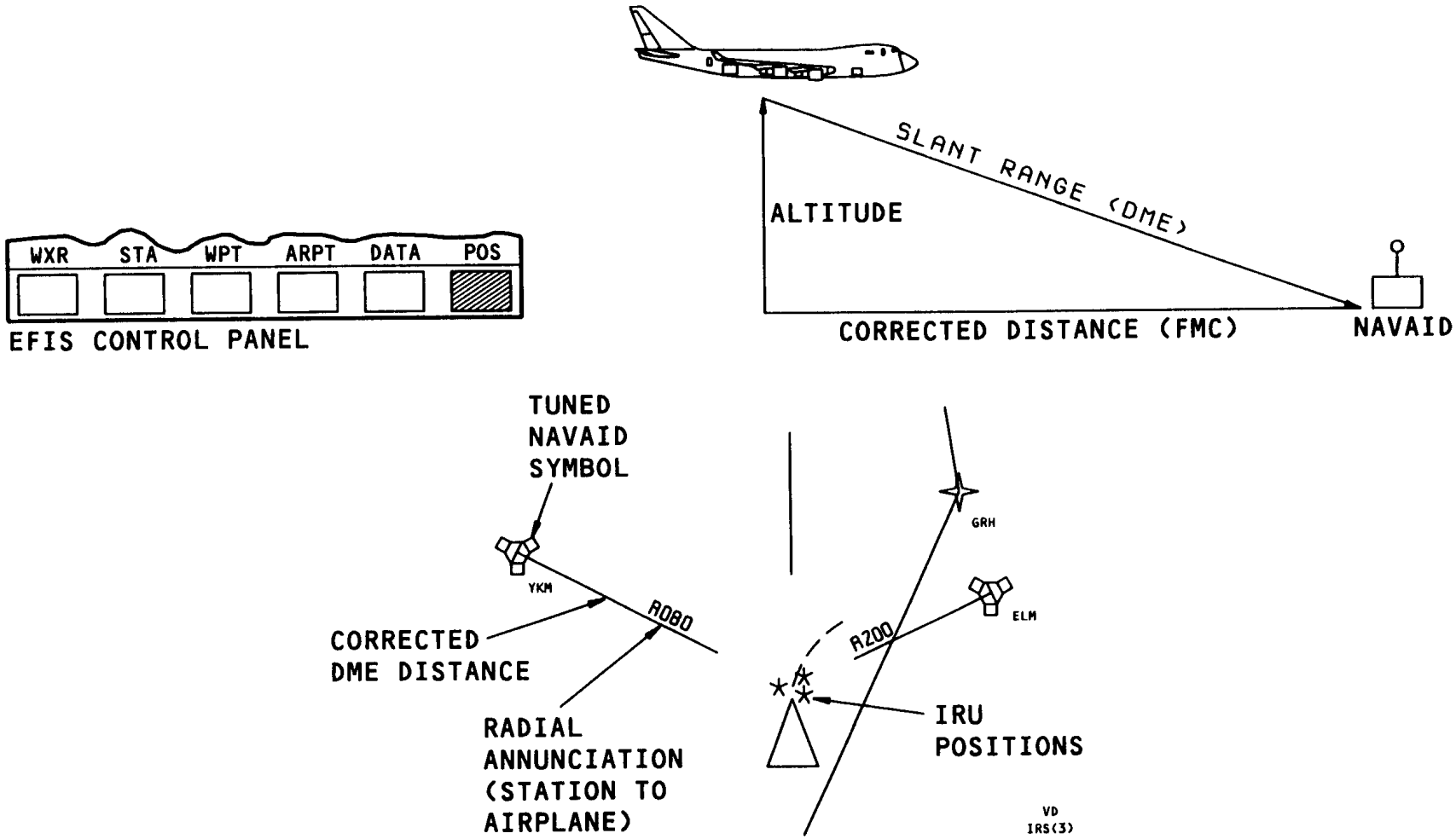


Figure 43 POSITION DISPLAY

MAP DATA FAILURE DISPLAY

A failure of the selected FMC causes many displays in the map and plan modes to disappear, and a map failure flag to show. This information blanks during a FMC failure:

- Flight plan and waypoints
- Selected map data
- Curved trend vector
- Radio and IRS position update mode
- Active waypoint, ETA, and distance
- Vertical path

Ground speed, wind data, and track data defaults to the selected IRU if a FMC failure occurs.

Another source for the map display can be selected using the on-side NAV source select switch.

If the FMC present position data is NCD or invalid, or the FMC map background data is invalid, show the VTK flag and continue to show the map display for 35 seconds based an the last valid FMC map background data and the valid track and groundspeed data. After 35 seconds, blank the map display and show the MAP flag.

If the selected source for the track and groundspeed is invalid, continue to show the map display for 1 second and then blank the map display and show the failure flags.

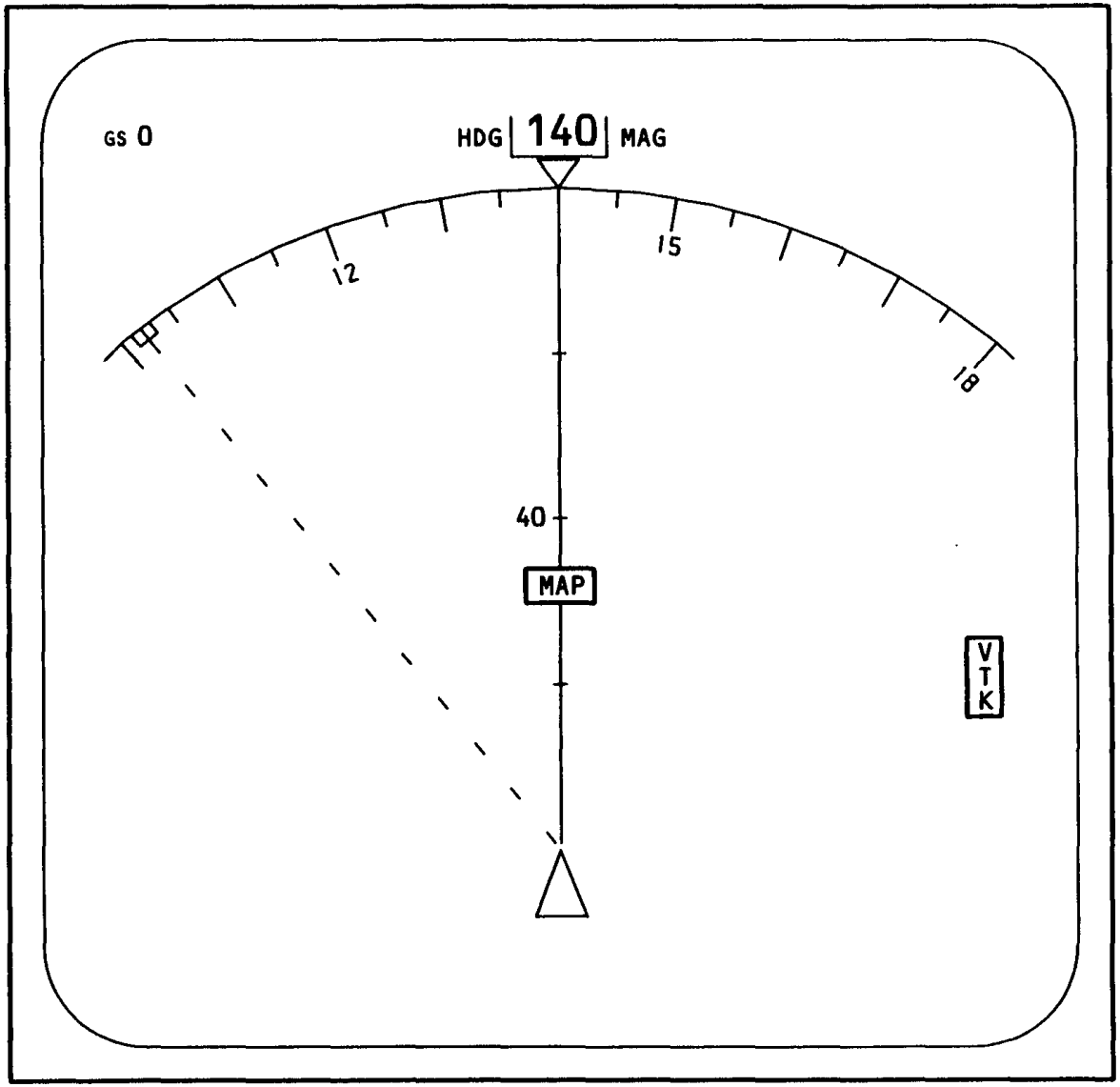


Figure 44 MAP DATA FAILURE DISPLAY

RANGE DISAGREEMENT

The ND receives range data for the map and plan modes, and for weather radar processing, from three possible sources:

- The onside EFIS control panel
- The selected FMC
- The operating weather radar R/T If range from the above sources is valid, but not the Same, a range disagreement exists. A range disagreement can occur in the map or plan modes, and modes that Show weather radar.

When a valid range is received from all three possible sources, and the EFIS control panel range is not the Same as the FMC range for:

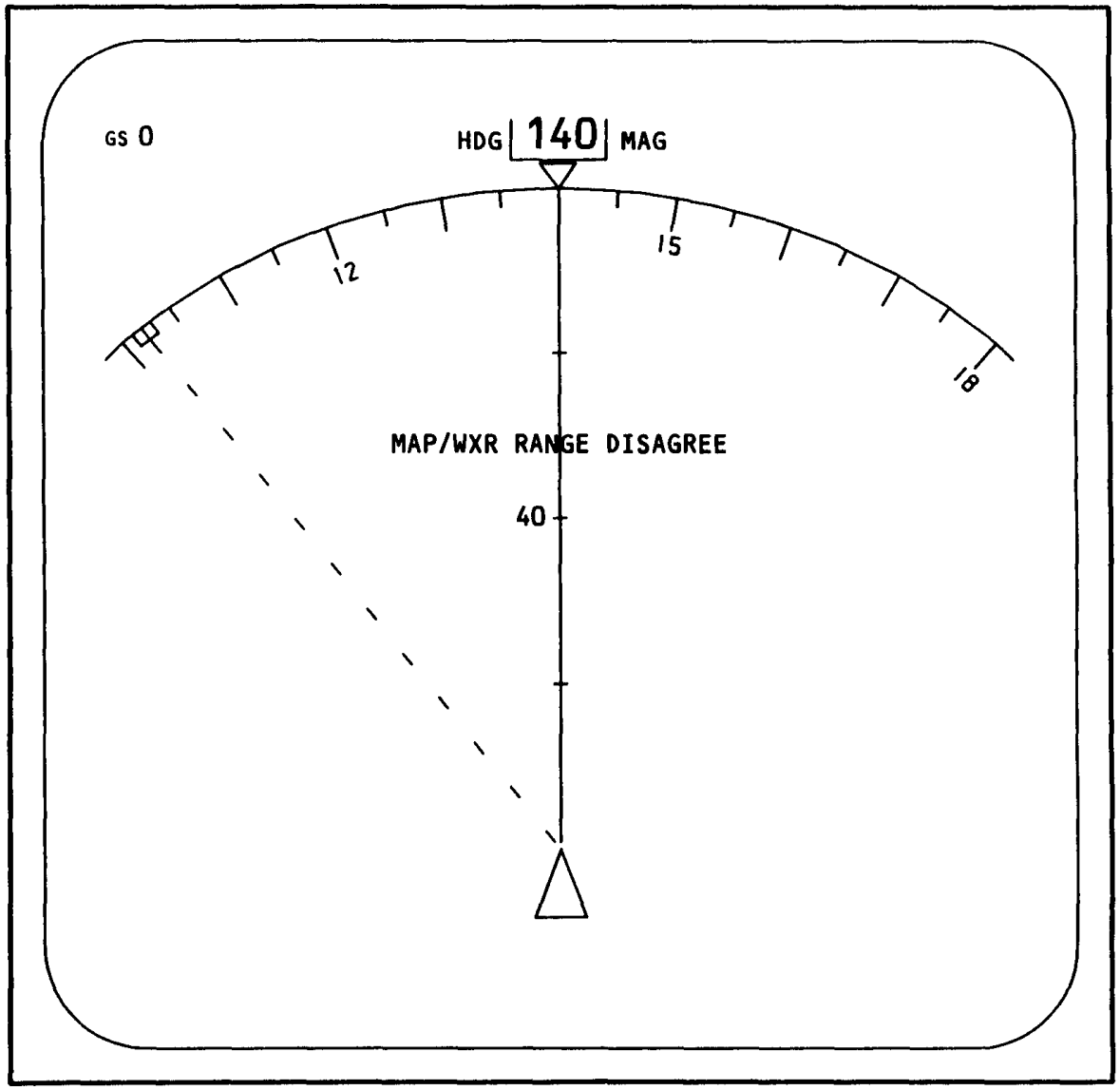
- Less than 10 seconds, the map still shows, but the range annunciation an the track line blanks.
- Greater than 10 seconds, the map will blank, the range annunciation (from the EFIS control panel) and the message MAP RANGE DISAGREE shows..

If the weather radar range is also not the saure as the EFIS control panel range, the message MAP/WXR RANGE DISAGREE Shows.

When range is valid from only the FMC and the weather radar, but they are not the Same for:

- Less than 10 seconds, the map still Shows, but the range annunciation and weather radar display blanks.
- Greater than 10 seconds, the map, range annunciation (from the selected FMC), and the message MAP/WXR RANGE DISAGREE Shows, but the weather radar display blanks.

In the expanded VOR, expanded approach, and map modes, if the range from the EFIS control panel is not the Same as the weather radar range for greater than 10 seconds, the weather radar display blanks, and the message WXR RANGE DISAGREE shows. In any of these modes, the range annunciation still shows.



OTHER POSSIBLE MESSAGES:

MAP RANGE DISAGREE

WXR RANGE DISAGREE

Figure 45 RANGE DISAGREEMENT

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