

AN/APG – 68 (V5) Operations Guide

This guide is written for eFalcon 109 – EPAF + Chevron patches enabled

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Introduction

The AN/APG-68(V5) is currently used in the Lockheed Martin F-16C aircraft. The radar is a direct development of the AN/APG-66 radar that was used in earlier models of the F-16. It is a pulse Doppler radar operating in the I/J band and can operate four distinct frequencies out of a total of sixteen, and is fully pilot selectable. Within the aircraft systems the AN/APG-68(V5) is referred to as the Fire Control Radar (FCR).

The AN/APG-68(V5) consists of six Line-Replaceable Units (LRUs). These are: antenna, transmitter, low-power Radio Frequency (RF) unit, programmable signal processor (PSP), computer and control panel. The new PSP is based on VHSIC technology, allowing a greater programmability and reliability than the AN/APG-66. The radar has six air target detection modes, and three ground target detection modes.

Air Target Detection Modes	Ground Target Detection Modes
Range While Search (RWS)	Ground Mapping (GM)
Track While Scan (TWS)	Ground Moving Target (GMT)
Velocity Search (VS)	Sea borne Target scan (SEA)
Air Combat Manoeuvring (ACM)	
Situational Awareness Mode (SAM)	
Single Target Track (STT)	

The AN/APG-68(V5) can also operate low, medium and high PRFs, to allow greater discrimination of targets in lookdown or lookup situations.

Information from the radar returns is initially placed into a storage area called the 'bin', this information is kept until the radar has enough information to be sure that the return is actually a target. Target classification and screening is also accomplished at this stage, screening to remove ground targets and other unwanted returns. The system then passes the information to the PSP, where it is interpreted and passed onto the Fire Control Computer (FCC). The FCC in the F-16 receives this information, and displays the appropriate information in the Radar MFD, and the HUD if required.

AN/APG-68(V5) Mechanisation – Air Target Modes - Common

The operation of the AN/APG-68(V5) is achieved through the Multi-function displays and the radar controls on the HOTAS. The AN/APG-68(V5) displays radar returns using a 'B' scope, rather than the more standard classic arc style of display. The differences between the two are shown below.

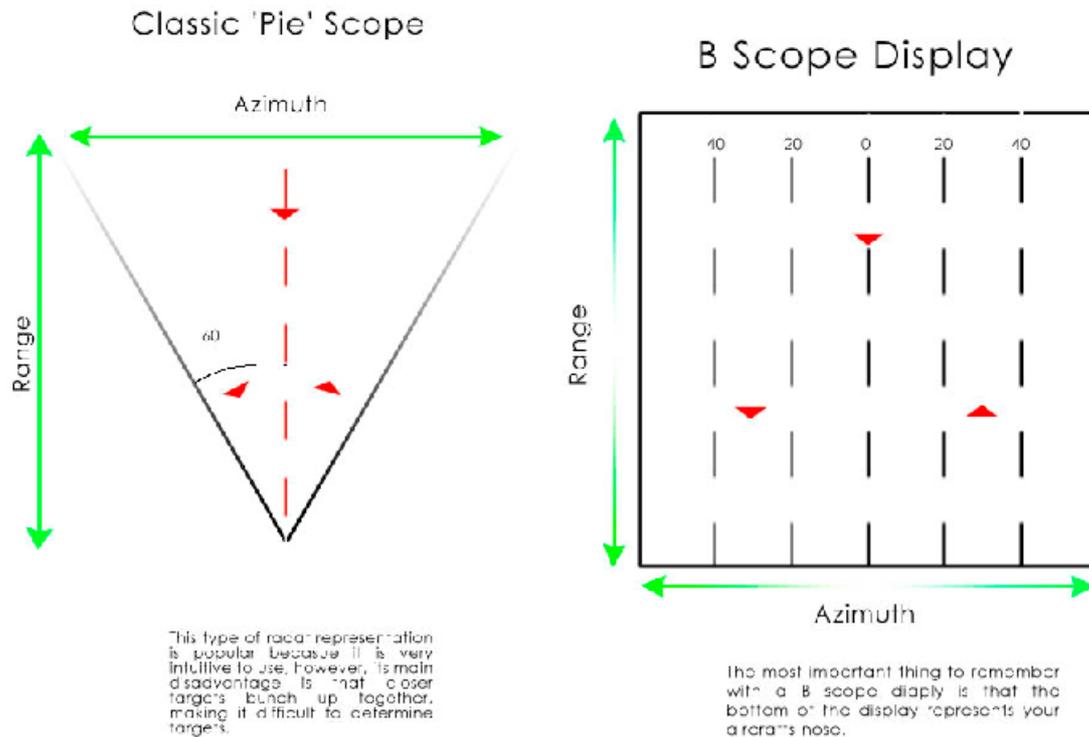


Fig 1

The pie scope is a very straight forward idea, it simply reproduces the radar returns inside a representation of the horizontal (or vertical) coverage of the radar. An aircraft is approaching on a collision course if it is moving towards the point at the bottom, which represents your aircraft's nose. The AN/APG-68(V5) however uses the B scope in the air to air modes, this carries with it the advantage that closer targets do not clutter the display, making it easier to use in closer combat.

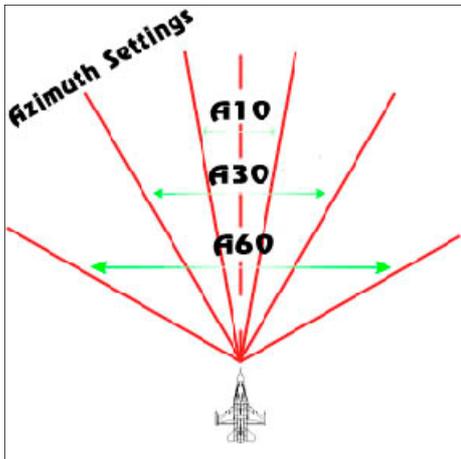
In the diagrams above are three red triangle, these represent aircraft in different situations. The one to the left is an aircraft at 30° of the nose, the point on the triangle here is used to indicate the direction of the target. In the pie scope, it is pointing towards the point at the bottom of the radar view. Notice on the B scope the contact points straight down to the bottom of the radar screen, representing that the aircraft is coming straight at you. The target in the centre is straight in front of the aircraft. It is also pointing

directly at the nose of your aircraft, note how the representation is identical in both the Pie and B Scope display. Finally the target on the right is at 30° off the nose, but this time to the right. The target is this time pointing away from the nose of the aircraft, it is heading in the same direction as you are, so is not facing your aircraft – the pointy end of the arrow faces away from the bottom of the radar screens.



The AN/APG-68(V5) can look 120° by 120° in front of the aircraft, it cannot however cover all of this area at once, even if it could, it would not be very useful because of the time that it would take to accomplish a full scan. To get around this problem the radar allows you some control over where the radar is pointing, and where it is scanning.

Azimuth



The first of these is the Azimuth setting. This controls the amount of horizontal scan that the radar performs. There are four settings for the azimuth, these being +/- 60°, +/- 30°, +/- 25°, and +/- 10°. The first setting of +/- 60° gives you a complete scan of all 120° that the radar can scan in the horizontal. The latter settings gradually reduce the amount that the radar scans in front of the aircraft (see the diagram to the left)

The (F8) key changes between these settings when available.

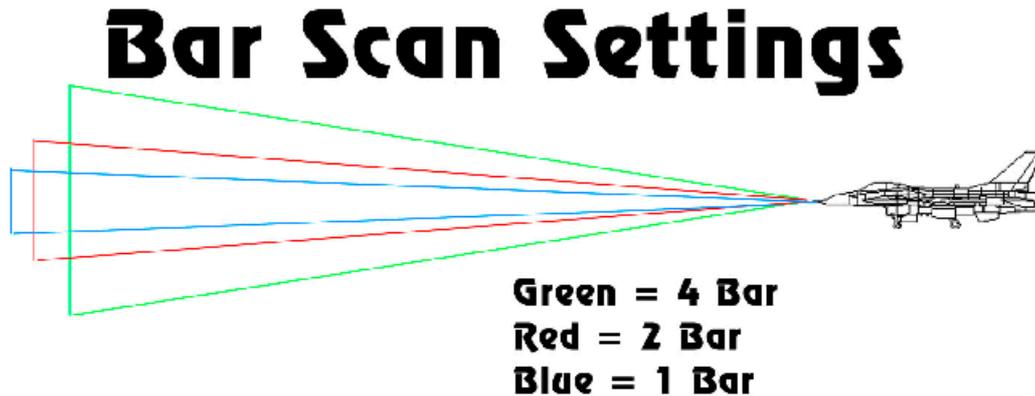
Azimuth information is represented by the scale at the bottom of the radar screen(see diagram to the right). The scale is split into 20° marks, and represents the full 120° that the radar can scan. The cyan tick mark shows the current location of the antenna along the horizon. The information on the current azimuth setting is also represented by two Azimuth Gates that appear in cyan on the radar screen (see below)



When operating in the restricted azimuth scan patterns, you can alter the horizontal direction that the radar is pointing by moving the Target Acquisition Cursors (explained later) left and right in the direction you wish the radar to look.

Bar Scan

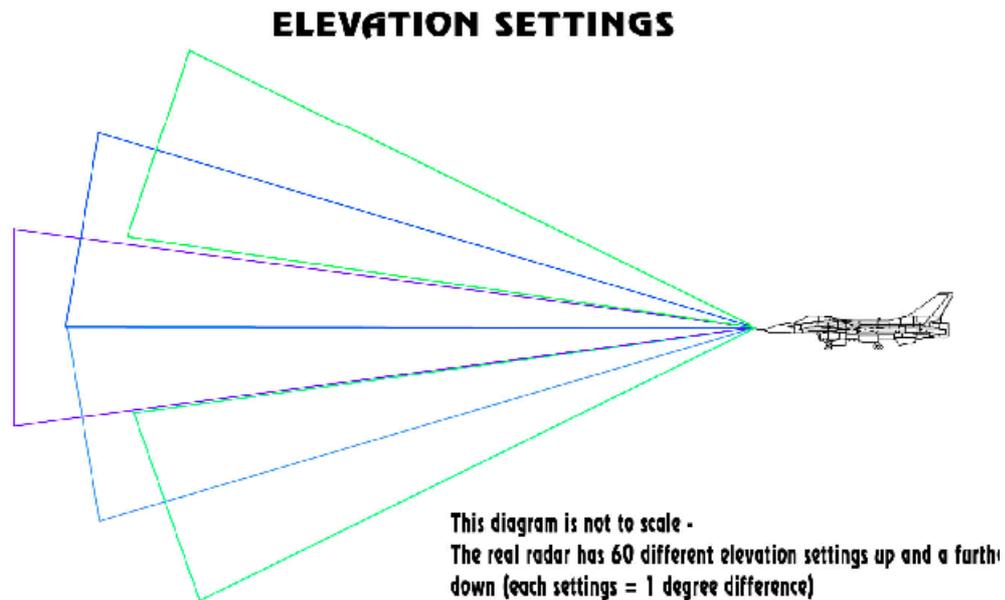
The next control that the radar allows is the Bar scan setting. The AN/APG-68(V5) scans the horizon by physically moving the antenna. The beam that the antenna normally emits is not able to scan more than 4.9° in the vertical.



The Bar Scan function effectively removes this situation by moving the radar up 2.2° at the end of each scan in the horizontal. The amount of extra 'bars' in the scan are indicated by the bar scan control. With this set to 1, the radar will scan just the single 4.9° slice of airspace; set to 2, the radar will scan 2 bars of airspace; set to four it will scan four bars. The diagram above shows this pictorially and makes it much easier to understand.

The disadvantage to using the Bar Scans however is the increase in time to perform a complete sweep of the area. It takes 2.5 seconds to scan one bar, and another 0.5 seconds to move the antenna up and start on the next bar, so a full 4 bar scan will take 12 seconds, whereas a 1 bar scan will take just 2.5 seconds. Whether to use the bar scan function is highly dependant on the situation. If you are using the radar to search for targets, then put it into 2 or 4 bar scan, if you have a target that you are interested in, then select the 1 bar scan and use the elevation controls (discussed next). The (Shift+F8) key cycles through the available bar scan options.

Elevation Controls



The final method of adjusting the scan in the vertical is the adjustment of antenna elevation. The antenna can be tilted up or down whilst it is scanning, this changes the 'middle' of the scan up or down. This has the effect of angling the radar down towards the ground, or up towards the sky allowing you to scan higher or lower altitudes at closer distances. This setting is one of the most used in the radar system. Tilting the radar down allows you to look for low flying aircraft that are hiding in valleys or are trying to avoid detection by flying underneath your radar cone.



Elevation setting information is presented in on a scale on the left of the radar screen (it is represented to the left). There are a total of seven green tick marks, each of these represents a 20° angle either up or down. The cyan marker just to the left of the elevation marks denotes the current antenna scan setting.

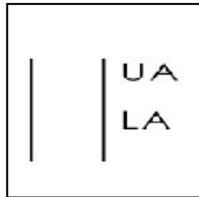
Tilting the antenna up allows you to search for highflying aircraft such as bombers and high-altitude reconnaissance aircraft. The antenna elevation is controlled through the (F5 , F6 and F7) controls on the keyboard. F5 tilts the antenna down, F6 will centre the control, and F7 will tilt the antenna up.

Range



The final control that you can use with the radar is the range setting. This adjusts the display to show only targets that are within a certain range. This control does NOT reduce the power of the radar, and so does not reduce your chance of being detected by enemy forces electronic warning systems. The current maximum range is display on the top left of the display. The (F3 & F4) keys decrease and increase radar range respectively.

Target Acquisition Cursor



The Target Acquisition Cursors (TAC) are the main method that is used to designate and find out information about contacts whilst using the radar. It appears as two small bars in the radar screen (shown left). The bars themselves are there to allow you to investigate a contact further by 'bugging' it (this tells the radar to pay more attention to this contact). The UA, and LA shown left are indicative of the upper and lower altitude limits that the radar is scanning at that spot.

Search Altitude Display



The search altitude display appears underneath the contact symbol whenever the Target Acquisition Cursors are over that contact. This number indicates the contacts altitude in thousands of feet. (e.g. 07 = 7000ft, 10 = 10,000ft, 25 = 25,000ft).

Attitude Indicator

The radar display also has an aircraft attitude display, these 'wings' in the radar can be used to judge you pitch and roll relative to the horizon. When the wings are parallel to the bottom and top of the radar screen you are level. The 'wings' will also move up and down the display to give you information on aircraft pitch. This can be referenced with the range markers on the right hand side of the display, and indicate 30° of pitch for each tick mark. When

Jamming



If a contact is currently using Electronic Counter Measures (ECM) to prevent you locating and locking on to it, this will show up on the radar as two small chevrons, the chevrons will not however always show the correct range to a target because they are based on jamming power, but they will show the correct bearing, if you detect an aircraft that is jamming, you will not be able to lock it up until you are close enough to burn through the jamming, at which point you can proceed as normal, beware though that the lock that you have on an aircraft that is jamming is not as strong as a normal lock, so any heavy manoeuvring by you or the target is likely to break the lock.

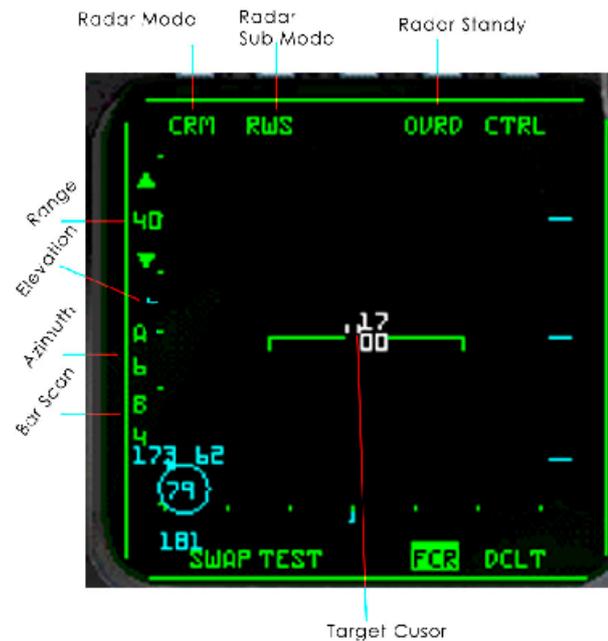
Weapon Specific Information

When you have an air-to-air weapon specific information will be overlaid on the HUD and on the Radar Screen this information is covered in the respective operations guides (OG-AIM9, OG-AIM120 and OG-F16BACSYS).

The 'Combined Radar Mode'

The radar groups all of the non ACM radar modes under a group designated CRM (Combined Radar Modes). This is simply a nomenclature for the group.

AN/APG-68(V5) Mechanisation – Range While Search



The Range While Search Mode of the AN/APG-68(V5) is designed to return as many targets in as quick a time as possible. It is a general-purpose search mode, and shows all airborne contacts that the radar can detect. It is the most basic of the search radars in terms of information about each contact. All of the systems for controlling the radar are available to use in the RWS mode. The main labels for the radar MFD page have been identified – make note of where the azimuth, bar scan and range settings are. The elevation indicator is situated on the left side of the radar display (the cyan tick mark). The elevation here is above the centre tick mark, and so is indicating that the antenna is tilted up.

Before we continue on to discuss how to use the RWS mode, take note of a few of the extra labels at the top of the Radar screen. The CRM and RWS tell you that the radar is in an Air target mode, the RWS tells you that the radar is Range While Search. Finally the OVRD control allows you to put the system into standby, and stops the radar emitting (it does not switch it off though).

Target Tracks

In RWS mode, the contacts appear as small yellow squares, each contact represents one radar return. A contact can be either friendly or enemy; the radar makes no discrimination as to the friend/foe nature of a contact. The horizontal position of the target in relation to the bottom of the radar screen represents their azimuth off the nose of you aircraft. The distance from the bottom of the screen indicates their range – use the range scale on the right of the radar screen to gauge how far away they are. The scale represents $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$ range of that selected as the maximum display range.



The diagram to the left shows a simulated set of targets all at different ranges and azimuths.

1. Is at roughly 0 degrees azimuth (and so straight in front of the jet) and at around 25nm.
2. Is at 40 degrees azimuth to the right, so is off to the right of the aircraft, he is about 26.7nm out.
3. The third contact is at 30degrees azimuth, and is 20nm away.
4. The last contact is a lot closer than the other three, it is around 10nm out, and at 25 degrees

Whilst you are in the RWS mode you can use the radar to search out any targets that are in front of you within the radars scan limits.

Target Acquisition

In RWS mode, you can select a target to bug by moving the target acquisition cursor over the contact you wish to 'bug'.

To designate a contact, move the target acquisition cursor over the contact, and then press the designate target button (Num0).

When you designate you move into a special RWS sub mode called the Situational Awareness Mode (RWS-SAM).

Target Histories

One useful feature that you can use is the target history. Every time that a contact is updated, the previous position is kept in memory and displayed as a slightly faded image, by default the radar will display the past four target histories, this is changeable in the radar control page, accessed by pressing the MFD button labelled CTRL. The menu will allow you to change the amount of target histories displayed from 1 through to 4.

Target histories can be useful to you, by observing the location, and spacing of the histories you can estimate the direction and speed that the target is moving. If the target histories are moving up the screen (as in 1 below) then the contact is moving towards you. If the target histories are moving down the screen (as in 2 below), then the target is moving away from you. This however does not give you information on whether a target is actually FACING you. If you detected a target that was straight in front of you and was heading in the same direction, and say it was travelling at 200kts, whilst you were travelling at 420kts, the target histories will move up the screen because the contact is moving closer to you due to you overtaking it by going faster.

Range While Search – Situational Awareness Mode (RWS-SAM)



The situational awareness mode is a special sub mode that is designed to give more information on a specific target, but at the same time not remove the knowledge of the location of other contacts. Moving into RWR-SAM will increase the chances of the contact detecting you via a radar-warning receiver. However you do get a lot more information.

Moving to RWR-SAM mode adjusts a few items on the radar display; the most important one is the replacement of the contact square with a hollow square with a line protruding from it. This line represents two things, one and most importantly the direction that the contact is heading, and secondly how fast the contact is travelling. The first is important, because not only can you see where the contact is heading, you can also see the aspect of the target (whether he is facing towards/away from you.)

The RWS-SAM mode also gives you fairly accurate target aspect, target heading, target airspeed and closure information, allowing you to assess the threat which it poses, and to plot an effective intercept if required.

In RWS-SAM mode, the azimuth gates will adjust to show the current scanning area for the radar, the reduced azimuth scan area is the price that you pay for the increased information about a target. When you move the TAC the azimuth gates will change as the radar searches in the direction that the TAC are situated, the further you move the TAC away from the bugged target, the smaller the azimuth area that can be scanned will be. The radar screen above right shows what happens when you move the TAC away from the target.



The final difference between this and the standard mode is the Dynamic Launch Zone (DLZ) scale will appear on the right of the radar screen when you have air-to-air missiles selected. This DLZ is sized to correspond to the range display in the radar screen, and you can use the range ticks to gauge

distances for weapons employment. (More information on the DLZ can be found in operations guides – OG-AIM7, OG-AIM9, OG-AIM120, OG-F16FCC)

If you designate the bugged target again whilst in RWR-SAM mode you will transition to the Single Target Track (STT) sub mode of the radar. This mode is described below. To lock up another target whilst in RWS-SAM, simply place the TAC over the contact you wish to bug, and press the designate target key (Num 0). To return the radar to a general search (the standard RWS mode), press the return to search key (Num Del).

Range While Search – Single Target Track



The single target track sub mode is a specialist mode that is designed to support BVR missile launches, in particular the AIM-7 Sparrow when so equipped. The advantages of the STT sub mode are three fold – One it removes all other contacts, allowing you to concentrate on a single target. Two it provides the most accurate information of all the radar modes and the target track is updated continuously, finally the STT mode provides the most secure lock onto an enemy aircraft that the radar can produce by concentrating all of the

available power onto the contact. The catch here is that if you lock someone up in this mode, they will know about it and will probably become aware of you and most likely guess you intentions.

In the STT mode, the contact symbol acquires a circle around it, and the radar will automatically adjust its range to maintain the contact within the middle $\frac{1}{2}$ of the display.

Collision Antenna Train Angle

One new tool that becomes available in the STT sub mode is the Collision Antenna Train Angle steering cross (CATA). This small little circle provides and automated solution cueing you to the most effective intercept path. Turn you jet so that the CATA is in the middle of the radar screen. This will set you up on a direct collision course with the contact (hence the name). Be warned that you have to be careful how far you turn away from the target, any more than 60° and you will loose the lock, and loose the CATA steering information.

Why and When to use Range While Search

As its name implies, RWS is primarily a search mode for finding contacts. It is best at providing information quickly. It is handy to use in situations where you need information that is reasonably accurate, and concise. RWS won't give you all the information that you need to plan an attack on a target, nor will it let you gauge the aspect or hostility of the target, but it does provide contact information that will enable you to start building your Situational Awareness. Probably the best way of using it is when you are performing Sweeps or air to ground strike missions, it will allow you to find out what's out there, without running too great a risk of giving yourself away to enemy radar warning receivers (RWR).

In the RWS-SAM mode, you do increase the chance of being detected by an enemy RWR, so spend your time in this mode wisely, don't keep a target locked up for very long, get the info that you need, then return the radar to the standard search mode. You can gather information very quickly in the RWS-SAM mode because the scan time is reduced due to the azimuth gate limits becoming smaller.

In the STT mode, you WILL alert the enemy to your presence if they have a RWR. Try to use the STT mode only to attack targets, it is not required to enter STT mode to gain extra information on a target, no new information is presented in this mode. The only difference is that the lock will be stronger and harder for the contact to break. It also drastically improves update speed.

At the end of the day, STT mode needs to be used sparingly so that a contact will be unaware of your presence.

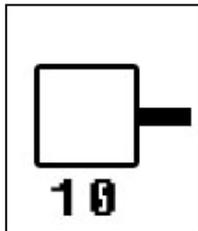
AN/APG-68(V5) Mechanisation – Track While Scan



The track while scan mode is a unique and very useful mode that the AN/APG-68(V5) offers pilots. This mode enables pilots to get extra information from contacts that are within the radar cone. It can scan and track 16 targets at the same time, providing altitude, aspect, and heading and to some extent speed information.

There is a catch to TWS however, and that lies in its speed and ability to detect new targets. TWS is a lot slower than RWS at displaying new targets. It has to get the basic information from each contact, process this information then display it. When the radar is tracking 16 targets It has a lot of work to accomplish. The TWS mode also reduces the ability of the radar to detect new contacts because it reduces the maximum Bar Scan setting to 3, reducing the total area that the radar can search at any one time.

The advantages however are important, and these are; increased information about contacts (16 max), increased situational awareness and all this with a reasonably low detection probability.



The TWS contact symbols are yellow hollow squares, with a tadpole marker representing the direction that the contact is heading. The length of the tadpole marker indicates the contacts speed. Underneath the contacts is the search altitude display, indicating the contacts altitude in 1000's of feet (e.g. 10 = 10,000ft. 25 = 25,000ft)

If you require more detailed information on a contact you can bug it the same way as you can in RWS, just place the TAC over the contact, and press the designate target key (Num 0). The system then provides more information on that selected contact. The radar will continue to scan the surrounding area for other contacts, and return the same information on these that you got before in the TWS mode before bugging a target. When you bug a target in TWS, the azimuth range that the radar can scan is reduced to 25° to accommodate the collection of the extra information. The Azimuth scan area cannot be moved in TWS, whilst you have a contact bugged. You have to return the radar to search mode first. Remember that bugging a target might alert them to your presence if they have a RWR.

Expand Mode

The TWS mode has one of the most useful functions that the radar provides, that being the ability to expand a small area of the screen to allow you to more clearly see closely grouped contacts. The EXP button at the top of the screen shows the current state of the EXP function

The EXP function allows you to separate out a group of contacts to accomplish two tasks, a) to find out how many there are in a group, and b) most importantly to designate a particular member of that group as a target. The EXP function does not do anything special, and is not another radar mode; it simply 'zooms' in on a 4nm area.

If you currently have a bugged target, the EXP function will zoom in on that contact. If you don't have a contact bugged the EXP box can be scrolled around the radar to provide an expanded view of the area around the cursors. This takes a little getting used to, but is very useful.

The thing to remember is that the expand box indicates what portion of the radar display that is not expanded you are viewing. The diagram below show the EXP mode in its three possible states 1= OFF, 2 = On, but with no bugged target (note how the TAC is in the middle of the exp box) 3 = EXP on and a bugged target, note how the box is centred around the target, and not the TAC.



You can see whether the EXP mode is on by seeing if it is highlighted – if it is on it will flash. The EXP box will change in size depending on the radar range that is set, and is always to a scale 4nm.

Why and When to use Track While Scan

TWS can be used as a search mode, however it is simply not as good as RWS for this. The basic principle of why to use TWS is simple, you gain so much in situational awareness that it in many cases outweighs any disadvantages. When to use is more difficult, It may be best to use TWS when you have identified some contacts in RWS but want some more information on those contacts without tipping them off to your presence. TWS would be of great help here, especially if you are up against a group of contacts as you can separate them with the EXP command. Another way of using the TWS is as the main radar mode, which is a popular way of using this mode in real-life because it allows you to more easily sort threats from the other contacts. At the end of the day it depends what you need. If you are flying escort then it would be best to use TWS as it allows you to keep track of what your flights are doing, it will also be useful to use on Combat Air Patrols, allowing you to see which direction contacts are heading, allowing you to decide whether to intercept or not.

AN/APG-68(V5) Mechanisation – Velocity Search.

Velocity Search is a very misunderstood radar mode, and is considered by many to be a joke, however it can be used in certain situations very effectively. VS is a single mode, it does not have any sub modes of its own. When you designate a target using the TAC, you will transition directly to the STT mode of the radar (this mode is explained in the RWS section).

The premise behind VS is that the fastest contact that are heading towards you are usually your biggest threat. VS will only display targets that are heading towards you.

A major difference in VS is that the range scale on the right hand side of the screen becomes a velocity indicator, and that you have no ability to select a range. The VS radar mode scans out to 80nm. Contacts at the bottom of the screen DO NOT denote that they are closer to you, but indicate that they are approaching at a low speed. Contacts further up the screen indicate that they are approaching at a much higher speed.

Another major problem is that VS scans for contacts with positive closure that means that if you are overtaking another aircraft they will appear on the screen as well, even if they are not facing you. See below for an example of how a contact will appear on the screen.

What is VS useful for?

VS can be used to fish out high speed, high aspect targets. It can help you decide whether to fight, or run away – a target with very high closure on you is most likely going to be hostile. Other than that specific task it is not that useful.

AN/APG-68(V5) Mechanisation – Air Combat Manoeuvring

The ACM modes of the AN/APG-68(V5) are designed to be used in close during a dogfight, or in snap defence situations. There are four different modes that suit particular situations.

The ACM modes all have a few things in common

- 1> They all have a fixed maximum range of 10nm
- 2> They all lock up the first contact that they find
- 3> They all start with the radar off.

The ACM modes can be real lifesavers in a dogfight situation because they are an automated search system designed to work without user input (apart from switching them on). The ACM modes are tied in closely to the Dogfight override switch. The Switch will take you to the last selected ACM mode, or the HUD mode. The different modes are covered below. The ACM modes (with the exception of the SLEW mode) do not allow the user to adjust any of the scan settings. This section is quite short because the ACM modes are 'point and shoot' and don't require user interference.

The ACM modes can be switched on by either pressing their shortcut key again, or by pressing (Ctrl + R).

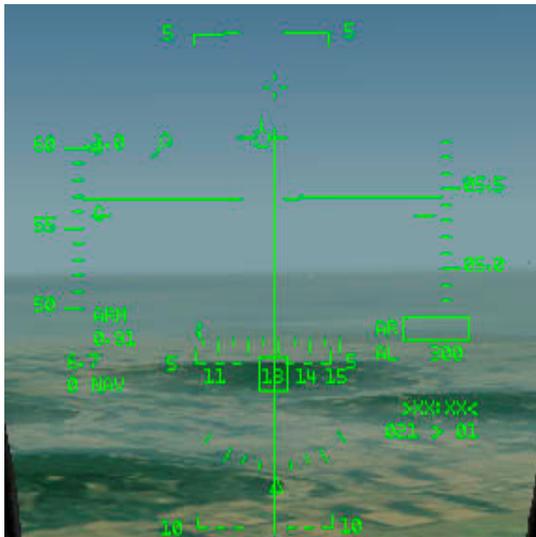
ACM – HUD

The HUD mode of the ACM scans an area that is roughly the same as the HUD area (20°x30°) is the most general of the automatic search patterns and is good when you know that an adversary is in front of you but don't know where exactly. This mode is therefore useful during the merge phase of a fight. The HUD mode does not place any specific information on the HUD when in use, so double check that you have selected it by checking the Radar mode indicator on the top left of the radar screen. The white box represents the radars search area



ACM – Vertical Scan

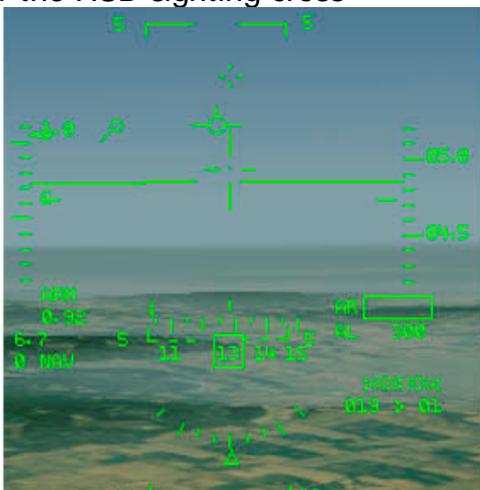
Vertical Scan mode is a very narrow scan pattern, but is very tall. (10°x60°) so is not suited to ‘searching’ for a target. Vertical Scan looks from about 10° below the gun cross on the HUD up to about 50° straight up along the lift line of the aircraft. For this reason this mode is ideally suited to turning dogfights and engagements. It allows you to ‘look up’ at the target that you have on your lift line, enabling high off bore sight radar tracking. See below for a diagram of the area coverage and the HUD symbology that is associated with this mode.



ACM - Vertical Scan

ACM – BORE

The bore sight mode is the ‘tweezers’ of the radar, this mode performs no scanning of any kind, and concentrates all of the radar energy directly forward, locking onto the first thing that it detects. This mode is great to use if you need to pick an enemy aircraft out of a crowded sky, leave the radar off, place the bore sight cross over the target, then switch it on. See below for the HUD sighting cross



ACM BORE Mode

ACM – SLEW

The SLEW mode is a useful tool when used right. The SLEW mode basically gives you direct control of where the radar is looking. The system adds a slew pointer around the TAC, and in the HUD. The principle behind the slew mode is that you can point the radar beam wherever you want, essentially scanning manually within the confines of the radar gimbal limits. When you move the TAC up and down you are controlling the elevation of the radar beam, when you move the TAC left/right you are adjusting the horizontal position of the beam. See Below for the associated symbology.



ACM SLEW mode

The small circle and the cross represent where the radar is currently looking in relation to the front nose of the aircraft.

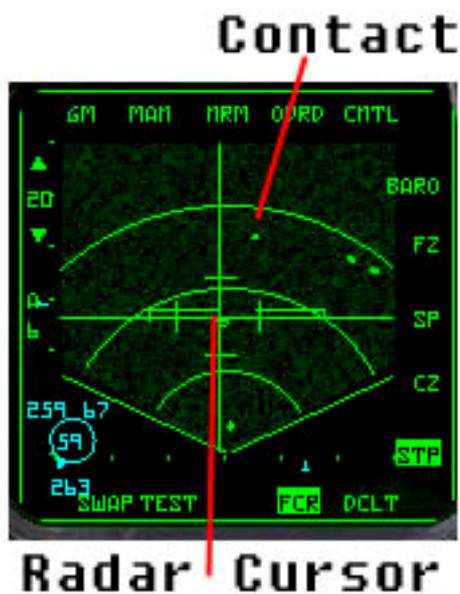
AN/APG-68(V5) Mechanisation – Ground Target Modes

The ground target modes are the key for precision strikes against the enemy, the AN/APG-68(V5) offers three ground target modes to use in different situations.

- 1) GM – Ground Mapping mode
- 2) GMT – Ground Moving Target mode
- 3) SEA – Specialist Ship mode for use when over water.

The Radar can be switched into standby by pressing the MFD button labelled OVRD.

The Ground Radar Display



The radar displays the ground target modes differently to that of the air to air modes. Rather than distorting the radar returns into a b scope, the radar uses the arc style of scope instead, giving you a 'top down' view of the radar contacts. Once again range is represented by the relative distance up or down the scope in reference to the max range setting.

The radar screen displays contacts as small dots. The screen to the left illustrates this.

The ground map does not use the same target acquisition cursor as the air to air mode. Instead of two small bars, the ground modes use a moveable cross that splits the radar into four. The radar does not allow you to control elevation or azimuth in the ground modes; the radar will always scan the full 120° within the gimbal limits of the radar. The contacts that the radar returns is entirely dependent on the mode that the radar is operating in. Whilst using the target cursors you might find that you want them to return to the centre of the display, or the steerpoint if in steerpoint mode. You can reset the cursors by simply pressing the CZ button on the MFD.

Radar Gain

One of the tools you get to use in the ground modes is the radar gain. This is a great tool as it adjusts the 'brightness' of the non-contact section of the radar display. When the radar is operating with a low gain setting you see what is shown above, the contacts are bright, but you get a green cast behind. This cast is actually radar returns from the ground that the radar is screening out. By increasing the gain, you lessen the screening effect, thereby letting the terrain features start to show. See below for an example of the terrain features showing.

When the gain control is turned up, you can use the radar to view possible valleys and flat areas for low-level flight, allowing you to pre-empt where to fly. Take a look at page 30 to see how the gain settings change the display. The darker elements on the display are roads and rivers.

Steerpoint Mode (STP)

The AN/APG-68(V5) offers two methods of using the radar, Steerpoint and Snowplow. The two differ in where the radar looks, and how much it displays.

In the steerpoint mode, the radar looks at the currently selected steerpoint and tracks an area around that. The size of this area is dependent on the currently selected range. The area is always roughly half the size of the currently selected radar range, for example, if you have a radar range of 40nm selected, the area around the target will be 20x20nm. If the steerpoint is beyond the limits of the radar, the screen will be blank.

The steerpoint mode is also ground stabilised, meaning that the target cursor will stay over a particular spot on the ground; this is useful because it allows you to manoeuvre without losing track of a contact. It also becomes invaluable when using the expanded field of view options (these are explained later).



You can tell if the radar is in steerpoint mode because the STP label on the MFD is highlighted like the one on the left. The steerpoint is the mode of choice on strike missions because the radar and the target cursors are usually right on your target, it removes the need to search for the contact and makes night strikes a lot simpler.

Snowplow Mode (SP)

The Snowplow mode does not concentrate on one area, it scans all of the space in front of you. It is NOT ground stabilised, so when you move the cursors they do not stay over one spot, but 'travel' over the ground, for example, you set the radar cursor over a point that is 20nm away, then you leave them, the cursor will stay at that 20nm setting until you move it, it will not follow a point on the ground unless it is locked on to a target.

The Snowplow mode is more natural to use than the steerpoint mode simply because it returns what is in front of the aircraft. This reason also makes it more useful in a variety of situations, in particular if you are searching for moving targets, or ships that might be some distance from a steerpoint. Another very handy use is to scan ahead of the aircraft for moving targets to avoid, as these will almost always be equipped with Man Portable Air Defences (MANPADs). Finally you can use the snowplow mode for ingress or egress at very low altitude, place the range scale at 10 or 20nm and turn up the radar gain, this will allow you to see the lye of the land.

You can tell if the SP mode is selected by looking at the SP label, if it is highlighted, then it is the current mode. You can swap between STP and SP by pressing the buttons located next to the labels.

Freeze Mode

The freeze mode of the radar is yet another valuable tool. When activated the freeze mode will freeze the radar picture and stop the radar from emitting. This allows you to use the radar to find, then designate a target, then to shut off the radar without losing that lock. When you press the freeze button, the radar will work out the relative position of the locked target, and remember that in the navigational computer. This means that you can locate the targets without running the risk of being detected, enabling a stealthy ingress

The catch to the freeze mode is the obviously it does not update itself. It is not advisable to use the freeze mode when attacking moving targets, as there is a strong possibility that by the time you have reached them, they will have moved. You can tell if you have the freeze mode switched on by looking at the FZ label on the radar screen, if it is highlighted, then it is switched on. You can toggle the freeze on/off by pressing the MFD button next to the FZ label.

AN/APG-68(V5) Mechanisation - Ground Mapping Mode

The Ground mapping mode of the AN/APG-68(V5) allows you to find and designate non moving ground targets such as buildings and bridges. The mode allows a great deal of forward planning to take place before attacking a target because of its extensive 'zoom' facilities.

The ground-mapping mode is the mode to use when you are on a strike, you can use the radar to find and locate your target and then use that information to cue your weapons.

Expanded Field of View (FOV) options

The GM radar mode allows three distinct expanded view systems, when none of the expanded FOV modes are enabled, the view reverts to the normal mode (NRM).

EXP

Doppler Beam Sharpening mode1 - DBS1

Doppler Beam Sharpening mode2 – DBS2

The FOV options behave differently based on whether or not a target is locked up. The table below shows the effects that the expanded FOV modes have when a target is locked up.

Mode	Expanded FOV ratio over NRM	Resolution
EXP	4:1	No Increase in Res.
DBS1	4:1	8:1 over NRM
DBS2	8:1	64:1 over NRM

The EXP mode expands the view by four to one over the normal view. The DBS1 mode does not expand the view any further, but does provide a higher resolution view of the area of interest. The DBS2 mode provides a field of view that's is 8:1 over that of the NRM. DBS2 also generates a much higher resolution view the target than any of the other modes.

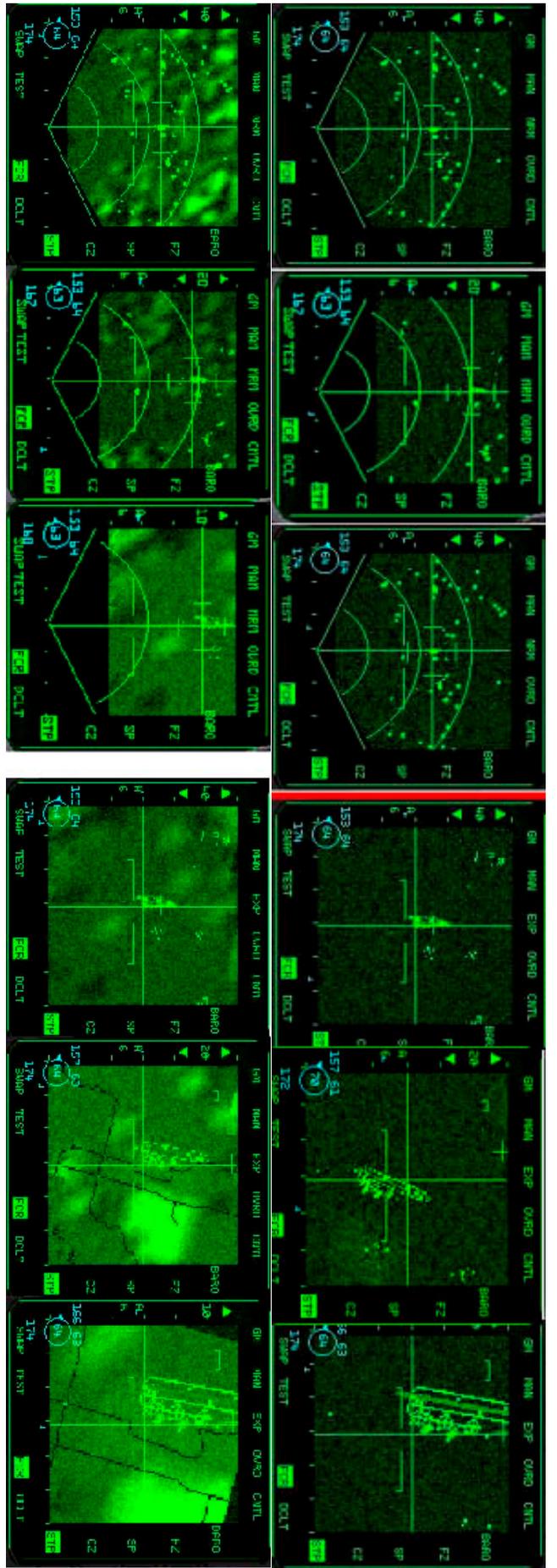
This increase in resolution is important when targeting targets that are in close proximity as in other modes they can become merged into one radar return. When a target is locked whilst in the EXP modes, the radar will adjust the range scale automatically to keep the contact within the middle ½ of the NRM display, even when you are viewing the expanded FOV options. The side effect of this is that as you approach the target the apparent scale and detail will increase steadily. The best way to work out the scale of the display whilst in the expanded FOV modes is to use the ¼ mile reference in the top left of the display. This will size itself to represent ¼ of a mile automatically.

If there is no lock, when operating the expanded FOV modes you can use the range setting to zoom in or out to get a closer view of the target. The EXP and DBS modes expand the area by one fourth of the range scale. This does not affect the total area being scanned, it simply zooms the display. This is a very useful tool when using the GM radar to lock up a target in close proximity to others, as the magnification that you can generate is impressive. It is advisable to use this method of targeting only when the radar is in the STP mode or the ground map mode can not keep up and process the display quick enough, making the target cursor jump and the radar screen unreliable.

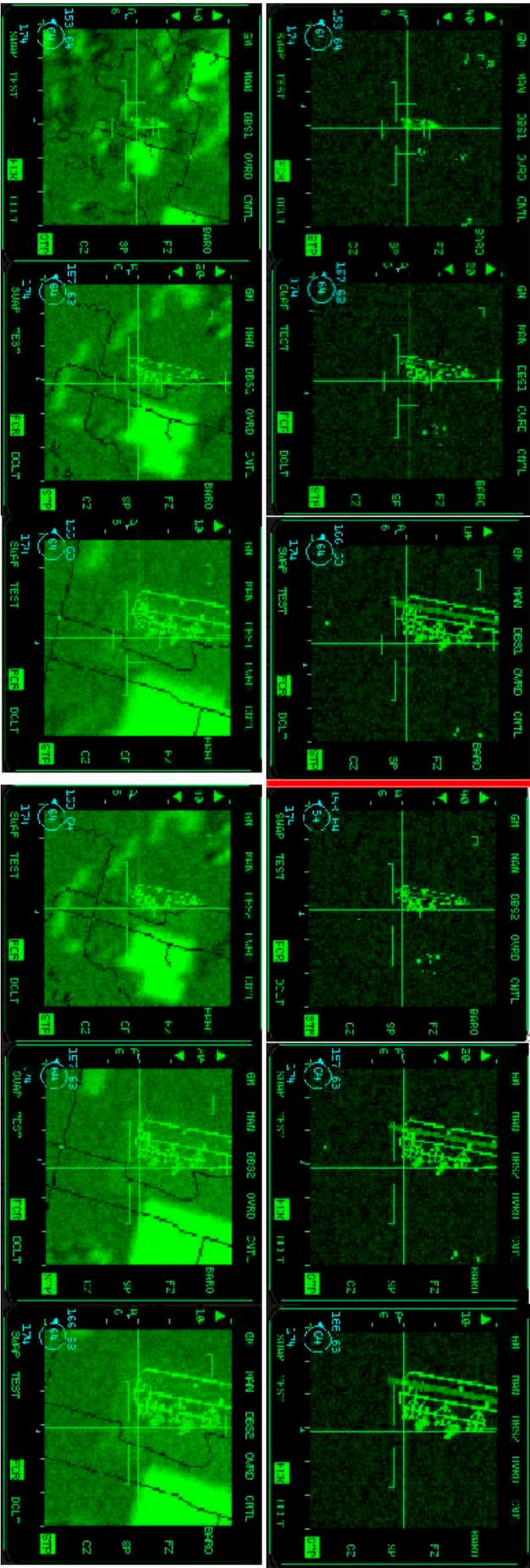
When used in conjunction with the radar gain, the Expanded FOV options allow you to locate your targets, and prepare well before you reach them, allowing you plenty of time to accomplish pre-strike chores. The next FOV step closer is represented by a set of crosshairs located on the target cursor.

When in the exp modes the target cursor behaviour is dependent on whether the radar mode is operating in STP or SP mode, the effect that this has on the cursor is described above in their respective sections. Whilst in the expanded FOV modes, the cursor does not actually move itself and is locked in the centre of the display, using the cursor controls moves the actual expanded view area instead. The radar also places a small thin cross on the display; this is designed to show you the correct azimuth when using the expanded FOV options. The cross is representative to where the radar cursors would be located if the radar was still in NRM mode.

The next page has a full set of pictures showing the differences in FOV, Range setting and gain settings. Take a close look and note the difference between each combination.



*Comparison Between Betwæen Different Zoom Ratio's
in the expanded Field of View Modes*



AN/APG-68(V5) Mechanisation - Ground Moving Target Mode

The GMT mode of the AN/APG-68(V5) is the primary method of locating ground forces. In this mode the radar filters out any returns that are not moving targets (in F4 that means any ground unit, regardless if it is actually moving). This enables you to decide what type of ground target to engage.

The radar returns are the same as those in the GM mode, small dots. However unlike in the GM mode, you do not have access to the DBS1+DBS2 expanded FOV modes. However all other expanded field of view operations work the same.

You can use the GMT radar as an early warning indicator as to the presence of ground troops. This is particularly handy near the forward line of troops (frontline), as it allows you to make low altitude ingress, whilst avoiding short range air defence (SHORAD) and man portable air defences (MANPADS) such as the SA-7. To use the radar like this, simply place it into SP (snowplow) mode.

The other main use for GMT mode is when you are tasked with interdiction sorties, allowing you to locate and destroy enemy targets. Use in STP or SP mode for this task and it will allow you to allocate targets to your flight more effectively.

The radar gain controls can be useful in this mode, some of the ground units will be following roads whilst moving, you can use the radar gain to show you the location of roads and plan ahead to ensure maximum damage to the targets.

AN/APG-68(V5) Mechanisation – SEA mode

The SEA mode of the radar is specially developed to allow the radar to work effectively over water, which would normally disrupt the radar from working correctly. The system works in an identical manner to the Ground Moving Target mode, so it will not be covered again.

AN/APG-68(V5) - Appendix**Keyboard based Radar Controls Sorted By Key**

Key	Function
F1	Cycle through all Air Radar Modes
F2	Cycle through all Ground Target Modes
F3	Decrease Range Setting
F4	Increase Range Setting
F5	Antenna Tilt Down
F6	Centre Antenna
F7	Antenna Tilt Up
F8	Azimuth Selection
F9	GM FOV
F10	GM Freeze
Shift+F3	Decrease Radar Gain
Shift+F4	Increase Radar Gain
Shift+F8	Radar Bar scan setting
Shift+F10	GM SP/STP toggle
Ctrl+F5	ACM Bore sight Mode
Ctrl+F6	ACM HUD Mode
Ctrl+F7	ACM SLEW Mode
Ctrl+F8	ACM Vertical Mode
Ctrl+R	Radar to Standby
V	FOV
Cursor Key Up	Radar TAC up
Cursor Key Left	Radar TAC left
Cursor Key Right	Radar TAC right
Cursor Key Down	Radar TAC down
Num0	Designate Target
Num Del	Return to Search

Keyboard based Radar Controls Sorted By Function

Function	Key
ACM Bore sight Mode	Ctrl+F5
ACM HUD Mode	Ctrl+F6
ACM SLEW Mode	Ctrl+F7
ACM Vertical Mode	Ctrl+F8
Antenna Tilt Down	F5
Antenna Tilt Up	F7
Azimuth Selection	F8
Centre Antenna	F6
Cycle through all Air Radar Modes	F1
Cycle through all Ground Target Modes	F2
Decrease Radar Gain	Shift+F3
Decrease Range Setting	F3
Designate Target	Num0
FOV	V
GM FOV	F9
GM Freeze	F10
GM SP/STP toggle	Shift+F10
Increase Radar Gain	Shift+F4
Increase Range Setting	F4
Radar Bar scan setting	Shift+F8
Radar TAC down	Cursor Key Down
Radar TAC left	Cursor Key Left
Radar TAC right	Cursor Key Right
Radar TAC up	Cursor Key Up
Radar to Stanby	Ctrl+R
Return to Search	Num Del

Air Radar Modes Symbology

	RWS	TWS	US
Non Bugged Contact	■	□-	—
Bugged Contact	□-	⊕	N/A
Single Track Mode	⊕	N/A	⊕

Air Radar Modes Reference

Radar Mode	Azimuth	Bar Scan	Range
RWS	10°,30°,60°	1,2,4	10-160
RWS-SAM	Limit As Required	1,2,4	10-160nm
STT	2°	1	As Required
TWS	10°,30°,60°	1,2,3	10-160nm
VS	10°,30°,60°	1,2,4	80nm
ACM-HUD	30°	20°	10nm
ACM-SLEW	5° (user adjustable)	5° (user adjustable)	10nm
ACM-Vertical	10°	60°	10nm
ACM-BORE	5°	5°	10nm

Ground Radar Mode EXP options reference

Expanded FOV options

Radar Mode	EXP	DBS1	DBS2
GM	Yes	Yes	Yes
GMT	Yes	No	No
SEA	Yes	No	No

Expanded area:

Range	EXP/DBS1 area	DBS2 area
10	2.5 x 2.5nm	1.25 x 1.25nm
20	5 x 5nm	2.5 x 2.5nm
40	10 x 10nm	5 x 5nm
80	20 x 20nm	10 x 10nm

Acronyms Used in this Guide.

ACM – (????)	Air Combat Manoeuvring – (Respective Modes)
AIM	Air Intercept Missile
CATA	Collision Antenna Train Angle
CRM	Combined Radar Mode (Air to Air Modes)
CTRL	Control (switch to enter the control page for the radar)
CZ	Centre Cursor (switch to return the radar cursor to the centre)
DBS1	Doppler Beam Sharpening – mode 1
DBS2	Doppler Beam Sharpening – mode 2
DLZ	Dynamic Launch Zone
ECM	Electronic Counter Measures
EXP	Expanded FOV mode
FCC	Fire Control Computer (Aircraft Avionics)
FCR	Fire Control Radar (The Radar as a whole)
FOV	Field of View
GM	Ground Mapping (Radar Mode)
GMT	Ground Moving Target (Radar Mode)
HOTAS	Hand-On Throttle and Stick (Aircraft Controls)
HUD	Heads-Up-Display (Aircraft Avionics)
LRU	Line-Replaceable-Unit (modular components for fast turn around + maintenance)
MANPAD	Man Portable Air Defence
MFD	Multi-Function Display (Aircraft Avionics)
NRM	Normal FOV
OVRD	Override (switch to place radar in standby)
PRF	Pulse Repetition Frequency
PSP	Programmable Signal Processor (the main component in translating radar returns into something useful)
RF	Radio Frequency transmitter (what the radar emits)
RWR	Radar Warning Receiver
RWS	Range While Search (Radar Mode)
RWS-SAM	Range While Search- Situational Awareness Mode (Radar Mode)
SEA	GMT-SEA (Radar Mode)
SHORAD	Short Range Air Defence
SP	Ground Radar Snowplow Mode
STP	Ground Radar Steerpoint Mode
STT	Single Target Scan (Radar Mode)
TAC	Target Acquisition Cursors
TWS	Track While Scan (Radar Mode)
VHSIC	
VS	Velocity Search (Radar Mode)

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eTeam 1.09 Dash1	eTeam	Froglips, Snowman, Cooler
Falcon 4.0 Users Manual	Microprose	-
Federation of American Scientists (FAS)	FAS	www.fas.org
Janes F-15 Expert Flight Manual	Electronic Arts	-
Prima's Official Strategy Guide – Falcon 4.0	Prima	Pete Bonnani
Vipers in the Storm	McGraw Hill	Keith Rosenkranz

Links

www.frugalsworld.com

www.delphi.com/falcon4
eteam.frugalsworld.com

www.falcon40.com
www.falcon40.co.uk

The Ultimate Flight sim website, check out the forums, and browse the articles, its all top stuff.
 Falcon4 forum on Delphi – very busy
 Official eTeam website – run by Brownsnake
 Excellent resource for all files falcon
 Jagstangs website, excellent artwork mods are here

Authors Ramblings

This is the first in a series of guides that I hope will eventually provide comprehensive coverage of all of the avionics and the weapons systems that are modelled in eFalcon. The documentation is split up into smaller operations guides, and they will be updated with every release of eFalcon. The reason for splitting them up is that it is much easier in my own opinion to have a number of smaller specialist guides than one humongous block.

Finally I would like to thank the Falcon community for making Falcon4.0 what it is today – special thanks go to the eTeam, the realism patch group and to Frugal and Vexx – thank you all.

If you have any comments you can contact me via :

Email – stefrench@ntlworld.com

ICQ – 110775319 (announce that you are a falcon player please)

IRC – Check to see if im around in the #falcon4 IRC channel.

Thanks – Stephen ‘HotDogOne’ French

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