

**M21**

**Russian Air Defence Forces  
Voyska Protivo Vozdushnoy Oborony**



**M41**

**Во́йска ПВО Voyska PVO  
and related stations**



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- M21 - Russian Air Defense morse transmissions
  - M21a - Morse variant of M21
  - M21b - Russian Air Defense voice transmissions
  - M21c - Voice transmissions of M21a
  - M41 - Morse stations, related to M21
- 

*Colonel Alexander Drobyshevsky told RIA Novosti that the Russian Air Defense has tracked 102,288 airborne targets in 2001, amongst them were 58,240 foreign aircraft, including 861 fighters and 297 reconnaissance aircraft. Russia's air space has been violated 325 times last year.*

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## **- BACKGROUND**

Shortly after World War II, Protivo Vozdushnoy Oborony (PVO) became a separate branch of the Soviet armed forces. PVO can be translated as Anti-Aircraft Defense.

After various minor changes, a major reorganization of the Soviet Air Force and Air Defence Forces took place between 1978 and 1980. PVO was reorganized in 1981 and its name was changed to Voyska PVO (Air Defense Troops). The Voyska PVO lost its separate command and control system in the reorganization and about half of the fighters and the majority of the flying training system was transferred to the Air Force.

As a part of a drastic reorganization in 1998, the Air Defense Force was merged with the Air Force. There are now PVO units with Head Quarters in St.Petersburg, Rostov-on-Don, Chita, and Khabarovsk. The former Moscow Military District had a mixed Air Force/PVO corps. Although this is not confirmed this corps has merged with the former Leningradsky District in 2010.

In the mid 1990's, Voyska PVO operated 20 Il-76 aircraft configured for airborne early warning and command and control, 380 MiG-23 and L-39 aircraft. It's troops manned ca 12,000 missile launchers at 1,400 sites in the USSR. The estimated numbers now are ca 2,400 launchers in some 250 sites in Russia.

Radio technical troops operate thousands of air surveillance, early warning, height finding, and fire control radars. They also man 6 large phased-array radars for ballistic missile detection.

**Note:**

In the past the air defense systems of the other Warsaw Pact countries were integrated in the Soviet network. As a result of that you can still hear similar stations from other Eastern European countries (M21a, M21c).

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- **M21 MORSE TRANSMISSIONS**

Most of the tracking is satellite based now. Most, but not all....

The Morse stations that we can hear on HF prove that there is still some terrestrial activity. The HF Morse systems are partly used as a backup for the satellite systems and probably they are also used for training purposes. Indeed, if you want to keep radar people on the ground up to scratch, this kind of reporting gets in a LOT of training for a lot of people (including Morse).

During the cold war NATO used to fly aircraft parallel to the then Soviet Union borders to deliberately prod the radar tracking stations into activity. This was a good means of quickly recovering grid number changes in the plot messages that the tracking stations transmitted. This gave the NATO monitors a chance to figure out where to start.

How? Well actually it is not as difficult as it looks like. Say you find a lot of tracks starting and finishing in the same place, then obviously there is an airfield there. From there it is just a matter of identifying which airfield. Once you have that, you have a fair idea where to start building your grid. Always a good place to start in the old days was Sheremetyevo Airfield in Moscow; callsign RFNV, on 11312 kHz. It is still there, and still active, though mostly on voice now. However, they famously transmit a weather forecast at hour+10 and hour+40. It was a good station to keep an eye on because of all the aircraft were using it.....and as lucky aside, the Russian Long Range Bomber Force flew exercises on Tuesdays and Thursdays and some of them could be counted on to talk to RFNV.

Later on, the Soviets modernized their equipment which implied that the number of morse and voice transmissions decreased substantially. The new equipment had NATO designation G3C, or SWAMP. This system worked on the principle that the radar operator simply put a light pen on the trace on his radar screen, and this was automatically transformed into a signal that gave the same information as a manual plot, but much faster. It was read automatically by the controlling station and again, plotted automatically on a master screen. Thus the controlling station had a very quick overall view of the sector it was responsible for. The signal was roughly built up as shown in the graphic below.

**Gabala Radar, Azerbaidjan**



## The Morse plots explained.

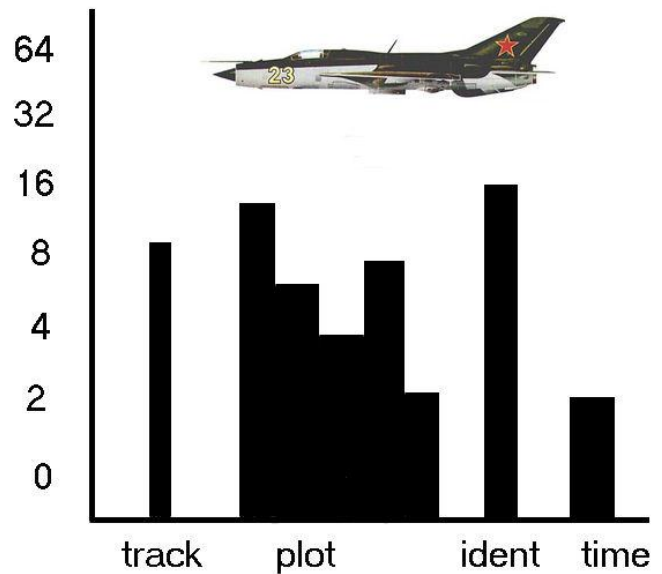
Note: zero is transmitted as 'T'.

In the Soviet days the messages were longer than they are now, namely 22 characters versus 15 characters now. This automatically means that the layout of the message is now different than back in the yesteryears.

In the past you sometimes had to wait quite a while before you could copy a complete plot. This was caused by the fact that the info in the messages was shortened after it had been sent a couple of times. The first plot messages consisted of a number of codes representing:

- tracking station
- track number
- 7-digit grid
- identification (friend, foe, unknown, and other designations)
- flight level in hectometres
- time

Each track report started with =00



- EXAMPLES (see also the graphics below)

First an oldie:

= 00 1234 7214328 71 10 2315

= 1234 14329 16

= 1235 14329 16

= 34 14324 17

= 35 14324 17

The initial track report is signified by the "00". The track is designated by the particular tracking station (12) and by track (34 and 35). The track is identified initially as unknown (71), it is flying at a height of 10,000 hectometers (10), and plot is timed at 2315 local time.

In the next two lines, the full track idents are given, but to speed things up, the major and minor square numbers are dropped, as is height info.

In the next two lines, the tracks are abbreviated to just the track numbers, the minimum grid information, and the minutes part of the time.

Lots of variations have been used over the years. For instance, plots on busy stations being given as just the last two digits. Hostile, friendly, passenger. They used a number of digraphs, enough to cover just about every flying object.

Obviously it's an inefficient method of tracking, but it worked well enough to see Gary Powers shot down. It is said that the system is accurate down to about 1 kilometer. For security, once or twice a week the numbers of all the major, minor, and sub-minor squares are changed.

Imagine that the next 6 sections are segments of a map. First we zoom in on one segment and then zoom in on a smaller part of that particular segment, etc. until we are down to the 6th level. The plot in this example would be 7214328

1	2	3
8	9	4
7	6	5

major (1 digit, e.g. 7)

1	2	3
8	9	4
7	6	5

minor (1 digit, e.g. 2)

1	0	1	2	3	4	5
2	1	0	9	8	7	6
3	2	3	4	5	6	7
4	3	2	1	0	9	8

sub-minor (2 digits, e.g. 14)  
(X/Y coordinate, row 1, column 4)

1	2	3
8	9	4
7	6	5

sub-minor more detailed (1 digits, e.g. 3)

1	2	3
8	9	4
7	6	5

sub-minor more detailed (1 digits, e.g. 2)

1	2	3
8	9	4
7	6	5

sub-minor more detailed (1 digits, e.g. 8)

Now the modern 15-character messages. The samples were all logged during the past year. The main difference is that they don't start with =00 anymore. Also missing is the code for "friend or foe". The codes for the tracking station (2 digits), track code (3 digits), grid (7 digits), and the time (2 digits, minutes only) are still there. The altitude also does not appear anymore in the morse version, but can still be heard on the voice channels. So, how should it be read? As you can see in the following explanation, all the assumed missing information is still there.

The messages look like this when sent by the PVO stations:

=13209813134224  
 =13641176513420  
 =23643901070030  
 =10117115618152  
 =4135113514????  
 =10478541048146  
 =20207501100908"

The following is how the messages should be read:

= 1 3209 8131342 24  
 = 1 2641 1765134 20  
 = 2 3643 901 07 00 30  
 = 1 0117 1156181 52  
 = 4 1351 1351 4  
 = 1 0478 5410481 46  
 = 2 0207 501 10 09 08

The figures 1,2,4 etc are codes which reflect the info.

- 1 is tracking on the four fig track number: 1 3209 8131342 24.
- 2 is track amplification: 2 3634 901 07 00 30
- 901 = 1 aircraft of type/ident 9. (9 = Negative IFF)
- 07 is height 00 is speed (none reported at this time)
- 08 is bearing from radar station: 2 0207 501 10 09 08

Similarly 501 is 1 aircraft of type/ident 5 (5 = scheduled airliner)  
10 is height. 09 is speed and 08 is bearing from radar station.  
4 1351 1351 4 = Track dropped on track number 1351.

Idents:

71 (701) is practice traffic  
41 (401) is friendly aircraft simulating hostile  
21 (201) is positive IFF  
31 (301) is border violator  
81 (801) is hostile aircraft  
51 (501) is scheduled airliner  
61 (601) is special interest  
91 (901) is negative IFF

On the older format 511 was speed and 510 was height. 190 was track lost. 192 was tracked dropped.

A final note regarding the grid figures (see graphic above). The "Major" part is now always the first two figures of the grid.

Example: 00 1234 5678294 21 80 1645

56 is Major  
7 is Minor  
8 row  
2 column  
9 is a swiss roll effect within that box  
4 is a further swiss roll effect within that specific box

In between the track reports the PVO stations send time stamp messages. The time used is most of the time the current Moscow time (UTC+3 or UTC+4), but also times from other time zones have been noted. Because the number of digits needed for these messages are far less than the standard 15 characters, a number of question marks are filling the space.

There is apparently no standard layout for the time stamp message as several variations appear. They always start with =99. Despite the differences, the sequence of the items is the same: =99, time, id.



The variations: =99?1312??????  
=992156??0?????  
=990030??6?????  
=99?1310??8???  
=99?0056?9?????

The codes (0, 6, 8, 9) represent the four regional PVO head quarters; St. Petersburg, Chita, Khabarovsk, and Rostov-on-Don. The one without a code might be Moscow. I don't know which code belongs to each station.

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## - M21 VARIANTS

The following messages are all M21 variants. As far as I know these messages are not Russian but originate from various former-Warsaw Pact countries or former-Soviet republics. Because of their common past, a number of countries in Central Europe are using systems similar to the Russian PVO system. The problem with the used format is the time. Only the minutes are part of the message, so you cannot see in what time zone they are.

### M21a: Variant 1

9910449815600 9911249815800 9912249815800 9913249814700  
9914249814600 9915249814800 9916249813600 9917249814400  
9918249814300 9921249818300 9906249069300 9908249825956  
9908249018856 9907241763356 9907241763958 9909249018358  
9908249017258 9906249069958 9906249068400 9908249014102  
9920245897802 9911245897802 9912245897802 9913249814502  
9914249814502 9915249814402 9916249811802 9917245891802  
9918245891902 9918245088900 9910245088900 9919245099702  
9920245089802 9921249814702 9922249814702 9923249815202  
9923249814602 9922249815102 9923249814602 9922249815104  
9921249814704 9916249814104 9917249814304 9915245898004  
9914245898904 9912245897404 9911245897404 9910245897404  
9920245099904 9909249814304 9908249814104

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### M21a: Variant 2

6861037295315  
6862037.....  
6863037287515  
6864037381415  
6865037392915511800  
6866037391415  
6861037267317  
6862037294417  
6863037287117  
6864037381817510900  
ar ar ar ar ar



### M21a: Variant 3

CQ CQ CQ =311091236236 k  
CQ CQ CQ =934609826372 k  
CQ CQ CQ =631212736274 k

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## - M21 VOICE STATIONS

M21b Voice stations:

5097 kHz, 0830 UTC, 16 January 2006.

Mode: USB. Female operator in Russian.

Text: 00 0001 384 92 in 59 2160 for 1129  
438 0001 0484  
0484 92 in 64 in 30  
438 0484 0483  
0483 29 in 69 for 31  
0483 92 in 68 for 32 511 0483 700 50  
0483 92 in 74 for 33  
0483 92 in 79 for 34  
0483 92 in 78  
2160 for 1135  
0483 384 96 in 54 for 36  
0483 96 in 52 for 37  
0483 96 in 46 510 38... break 510 50 for  
38  
0483 96 in 47 for 39  
0483 96 in 99 for 44 510 0483 20  
<etc>

Note: the M21c stations are similar to M21b



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## - M41 MORSE STATIONS

M41 belongs to the same family as M21. The format is similar to the various M21 variants as described in the document but there are some differences.

The main differences are:

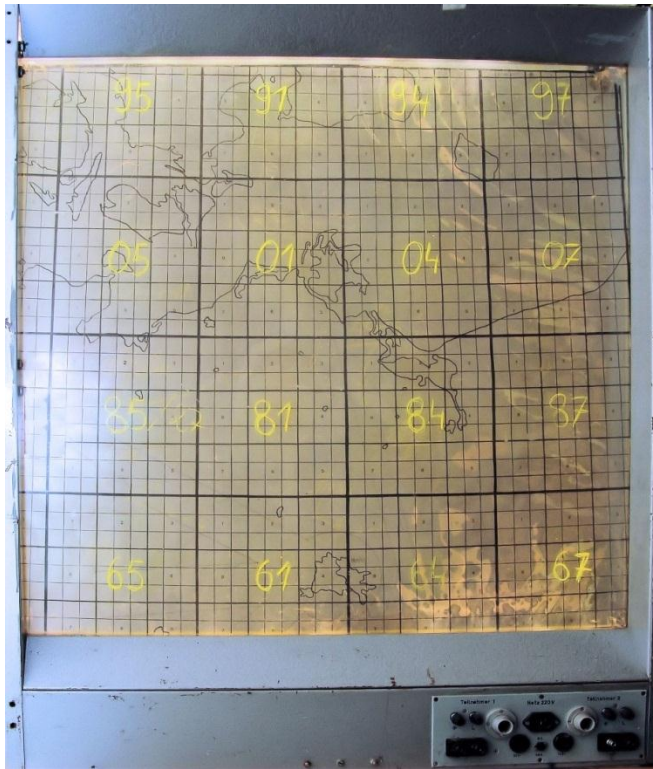
- The use of tactical callsigns
- The use of the abbreviations WZD and ABV

WZD stands for the Russian word Wozduh ( Воздух ) which means AIR and is a radar plotting system. It is also a priority code when it is mentioned in a standard Russian military message.

ABV means "I repeat".

Examples:

- This one has it all; WZD, ABV and a callsign. This is a typical plot message "LF20 LF20 LF20 ar LF20 LF20 LF20 WZD 722 3002 235 499971 90 05 ABV 722 3002 235 499971"
- This one is a standard military message with WZD as priority code: "RCJG de RIW QTC 828 22 4 2240 828 = wzd =" followed by 5 figure groups.



The following callsigns have been noted in the past few years:

8NNO, EQM2, 5EQB, GWKT, FNTO, YTX2, WLSB, LF20, F6UC, GOK2, 8XT2, QJ9M, YMG8, YJW3, 4K7U, WLSB, VQK4, EBXJ, XL1A, NOFJ, EHJR, ANSJ, KUQJ, PSNN, 4SCH, ON8A, GDSS, PMZW.

Picture: Wozduh screen

#### SAMPLE MESSAGES

- EQM2 EQM2 EQM2 EQM2 646667833328 49647
- wzd 72219 49964 15523 11128 72100 1805 abv 72219 49964 15523 11128 72100 1805...
- GWKT GWKT GWKT = ZOP ZDF +
- VVV 3AWH WZD 199499725 4984 212 etc
- RZTK WZD 72266 70655 5F ABV 72266 etc
- LF20 LF20 LF20 ar LF20 LF20 LF20 WZD 722 3002 235 499971 90 05 ABV 722 3002 235 499971 90 05 511 3002 8000 6 ar
- WZD 850258056 2302 8XT2 WZD 850258056 3204 ...
- vvv vvv QJ9M QJ9M QJ9M wzd 7221...
- vvv vvv WLSB wzd 7221959979389 abv 7221959979389..... WLSB WLSB WLSB +

9600248507517 9601248564617 9602875983617 96636000000  
 9606245875817 9607245063117 9600248565119 9600248569919  
 9602874592219 9603874596519 9604874519119 9605874518519  
 9606245865419 9607245064419 9600248564719 9600248564719  
 9602874687819 9603874095221 9606245867521

FOR ZMB ZMB 444406 = 44972290 rpt  
 FOR ZMB ZMB 444406 = 44972290 ar

#### Note:

Sometimes it sends QTCs and XXX messages; no time stamps; time even or odd; no identifier; sometimes messages are preceded by a prefix.

The messages unraveled: 9908249814104

Preamble	Operator	Coordinates	Time
99	082	4981 41	04

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8703242592424	8706242533124	8705241.95124	8706242862424
8708242846224	8709242042324	8710242899724	4871087104
8703242599226	4870387034	8704242523826	4870487044
870524258.826	8706242863726	8708242548826	8709242042926
8705242596728	4870587052	870824284.828	8705242042628
8708242897730	8709242046.30	4870987094	

The messages unraveled: 8703242599226 4870387034

Preamble	Station	Operator	Coordinates	Time
	87	032	4259 92	26
4	87	038	7034	

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..... 7761617 43TT 15 17/  
722194 94T97 37 9731287 ...T 15 18/  
722194 95T82 38 8195167 4TTT 15 19/  
722194 95T92 38 T612617 434T 15 2T K



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... 1949918233251312871270 0730 J73X J73X J73X ar

---

XL1A XL1A wzd 7221949579 ... k  
NOFJ NOFJ wzd 722194950 ... k  
EHJR WZD 72219499601555 54 12872120 1754  
= 722 194997115520 7312872300 ...  
758 722 1949962 155 274716571 0901 756 K. K84 EEEEE EHJV EEEE

---

xxx paba 17821 poseredryj 9524  
xxx paba 17821 poseredryj 9524  
xxx paba 17821 poseredryj 9524  
xxx kwow don 789 k  
xxx kwow tir 703 k  
8705268682820  
8706268487820  
8701268686420  
8702368684222



- FREQUENCIES

M21	M21	M21	M21a	M21b	M21c	M41
2219.5	4558	5837.5	3430	3374	2762	2507.5
2222	4559	5860.5	3770	4144	3314	2738.5
2317	4560	5873	5223.5	4800.5	4460.5	3182.5
2738.5	4574.5	5877	5366.5	5097	5131	3301
3199	4577	5918.5	7402	5190	5260.5	3835
3213	4613	5920	7689	5293	5765	4055
3222.5	4627	5921.5	7804.5	5680		4397.5
3228	4631	6321.5		5696		4418
3228.5	4631.5	6330		5899		4444.5
3246.5	4632	6374		6195		4484.5
3259.5	4639	6425.5		6268		4485
3281	4802.5	6776		6593		4603
3289	4811	6807.5		6864		4626.5
3292.5	4831	6823.5		7211		4959
3294	4864	6828				4968
3301	4865.5	6864.5				4985
3314	4868	6881.5				4993
3322	4885	6906.5				5078
3323	4950	6935				5125.5
3330	4951.5	6956.5				5210.5
3360.5	4959	6978				5372
3361	5011	6979.5				5400
3363	5015	7000				5402.5
3386	5063	7166				5733.5
3561.5	5097	7190.8				5774
3651	5131	7311.5				5792
3737	5139.5	7373				5804.5
3801	5141.5	7439				7046
3838	5154	7558.5				7048
3947	5195	7633				7664
4013	5198	7794				7782
4014	5201	7808				10158
4015	5220	7834				13482
4032	5221.5	7913.5				
4071.5	5230	7914				
4082.5	5254	7950				
4096	5313	7987				
4133	5315	7994				
4145	5330	8015				
4165	5357	8156				
4171.5	5367.5	8701				
4172	5371	9164				
4191.5	5372	9222				
4246	5468.5	9278				
4391	5690	9951.5				
4496	5731.5	10316				
4505	5772	10336				
4505.5	5784	11096				
4542	5820	12337				

## – SOURCES

WUN, UDXF and various radio monitors <http://www.udxf.nl>

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