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MSSR-1 Radar

System Description

Y7400A

ELDIS

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1 Abbreviations and Term Definitions

TSSR	Block of the interrogator transmitter/receiver
ISSR	Monopulse plot block extractor + post processing
PSSR	Interrogator power supply block
SSR	Secondary surveillance radar
SUM	Main (sum) antenna beam
DIF	Differential antenna beam
OMEGA (SLS)	Approximately omnidirectional beam with the drop in the direction of the beam maximum (SUM side lobes suppression)
LCMS	Local control and diagnostic system
RCMS	Remote control and diagnostic system
RMM	Maintenance display of secondary radar
RF	Radio frequency
LVA	Antenna with great local aperture
GPS	Receiver of satellite navigation (time information)
I/R	SSR interrogator/receiver/plot processor (Interrogator/Transponder)
EPS	Switching panel
ASTERIX	Message format
ACP	Azimuth Change Pulses
ARP	Azimuth Rectification Pulse
ASSR-35	LVA antenna with 35 vertical structures
MSSR-1	Monopulse secondary surveillance radar, MSSR-1 type
Transponder	Receiving part of the SSR (receiver, extractor, plot processor
PLA	Programmable Logic Array
PLD	Programmable Logic Device
PUI	Flag of the angle information validity
CHUI	Flag of the angle information error
NULD	Synchronizing signal of zero range
CINB	Synchronizing signal of range gate
CLK	Range quantum clock
UI	Angle information
FIFO	Buffer memory of first-in-first-out type
DRAM	RAM dynamic memory

NV RAM	RAM static memory with duplicated power supply
UART	Controller of asynchronous serial transmission
SDRAM	RAM synchronous dynamic memory
SRAM	RAM static memory
SIMM	Module of DRAM memory chips
SIO	Serial input/output transmission
SDRAM	RAM synchronous dynamic memory

2 Introduction

The Monopulse Secondary Surveillance Radar (MSSR) system is fully ICAO-compliant for civil air traffic control systems, military air traffic control, and air defence operations. The MSSR/Mode S system also meets Eurocontrol requirements. The MSSR can operate both autonomously (stand-alone), and co-mounted with a primary radar. The entire system is highly modular dual redundant system.

The MSSR basic configuration has the capability of operating in ICAO modes 1, 2, 3/A and C. The Basic Configuration can be easily upgraded to ICAO and Eurocontrol compliant Mode S by the insertion of modules. Mode S capabilities are available at the following levels:

- Elementary Surveillance or Level 1 – is the All call capability for interrogating aircraft transponders with Mode 1, 2, 3/A, C capabilities and interrogating ICAO-compatible, Mode S-equipped aircraft with Surveillance Identified Code (24-bit address) and automatic reporting of Aircraft Identification and Altitude reporting to an accuracy of 25 feet.
- Enhanced Surveillance Level 2 - is the additional capability to Downlink Airborne Parameters (DAP) (such as values for Speed, Heading, Roll angle, selected altitude, etc) from an ICAO Level 2, Annex 10 compliant transponder to the ground Mode S station for ATC purposes.

The MSSR is available in multiple configurations in terms of coverage range and functionality.

There is a possibility to choose the antenna rotation from 5 rpm to 10 rpm.

All radar subsystems are supplied from the TN-S, (TN-C-S) network 3×230/400 V 50 Hz.

Configuration of particular subsystems and their interconnection is resolved so that the entire system of the MSSR-1 combined radar fully duplicated.

Each channel can operate in any of the three operating modes as follows:

- Active: the equipment is used for the operation of the station
- Stand-by (if available): the equipment is switched on and normally available for operation, i.e. a reconfiguration, automatic or controlled, can take place.
- Maintenance: the equipment is under maintenance and is not available for operation.

3 Theory of surveillance secondary radar operation

3.1 Basic principles of secondary surveillance radar

Secondary surveillance radar system contains both ground and on-board active elements in contrast to primary radar system. String structure of secondary surveillance radar system is shown at figure Fig. 1 “MSSR 1 system elements”.

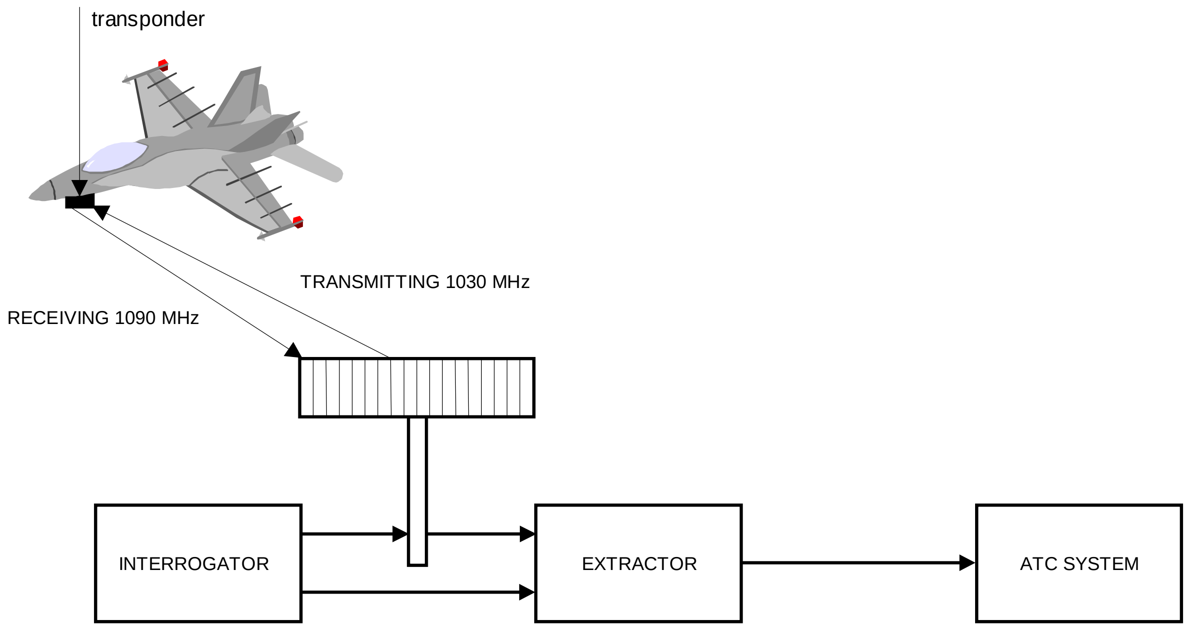


Fig. 1: MSSR-1 system elements

Ground station transmits HF pulse on frequency 1030 MHz through rotating beam antenna. When beam antenna is pointing to airplane then airborne equipment, transponder, detect emitted signal and generate its reply which is transmitted on 1090 MHz frequency and detected in ground station and processed in extractor. Extractor detects identification codes (1, 2, and 3/A mode), flight level (C mode) and alternatively IFF identity information or S mode, what is depending on interrogating mode.

Ground antenna system use three antenna beams - SUM, DIFF and OMEGA. Antenna pattern of interrogating radar is shown in Fig. 2 “LVA antenna pattern”.

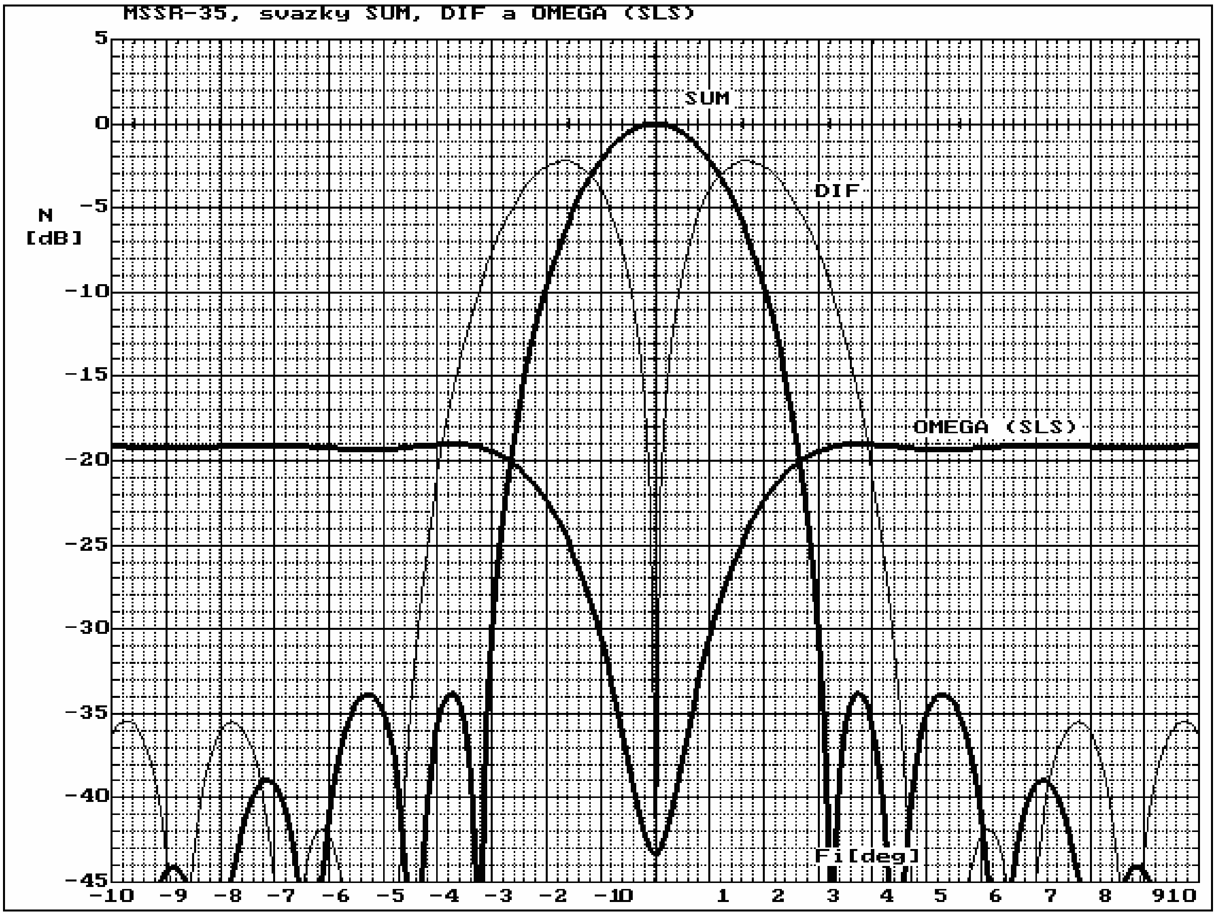


Fig. 2: LVA Antenna pattern

The emitted transponder signal is received by all of antenna pattern. The secondary surveillance radar processes only these signals, which are satisfying the following conditions:

- The received signal power by SUM antenna beam is higher than received signal power by OMEGA antenna beam
- The received signal power by SUM antenna beam is higher than received signal power by DIFF antenna beam

Final SSR antenna azimuth beam width depends on K-factor setting. K-factor parameter determines minimal ratio of received reply signal by SUM antenna to the received reply signal by DIFF antenna. The received reply signals must satisfy the above mentioned conditions. Only these signals should to be evaluated by signal and reply processing subsystems of the radar.

3.2 SIF modes of operation theory

SIF mode is the common denotation for interrogation modes 1, 2, 3/A and C. The mode 1 and 2 are used of military identification, mode 3/A is the common identification and mode C represents altitude of flight determination. The basic philosophy is based on the application of the SIF interrogation-reply protocol.

The SIF interrogation consists of three interrogation pulses P1, P2 and P3. P1 and P3 pulse are transmitted through SUM antenna beam and P2 pulse is transmitted through OMEGA antenna beam. The P1 to P3 time interval determines the interrogation mode of operation. This time interval is different for individual mode of operation. The P2 pulse is used as a sidelobe suppression pulse. Airplane transponder evaluate ratio among P1, P2 and P3 pulse. If the airplane is in main antenna beam than signal power of P2 is lower than signal power of P1 and P3 pulse and transponder will begin transmit corresponding reply with reply code. When signal of P2 pulse is higher than signal of P1 and P3 pulse then airplane is out of main antenna beam and transponder does not transmit the reply.

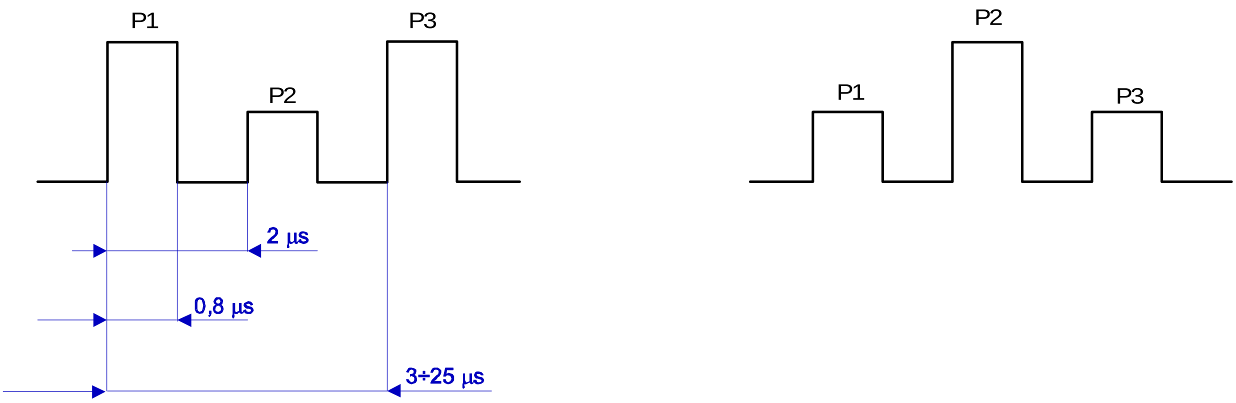


Fig. 3: Interrogating signals

Time interval between P1 and P2 interrogating pulse is equal. Between P1 and P3 pulse interval alternate in depending on interrogating mode.

Mode	P1-P3 interval (microseconds)	Application
1	3	Identification
2	5	Identification
3/A	8	Identification
C	21	Barometric pressure altitude

After interrogation in main antenna beam on-board transponder will begin transmit corresponding reply code.

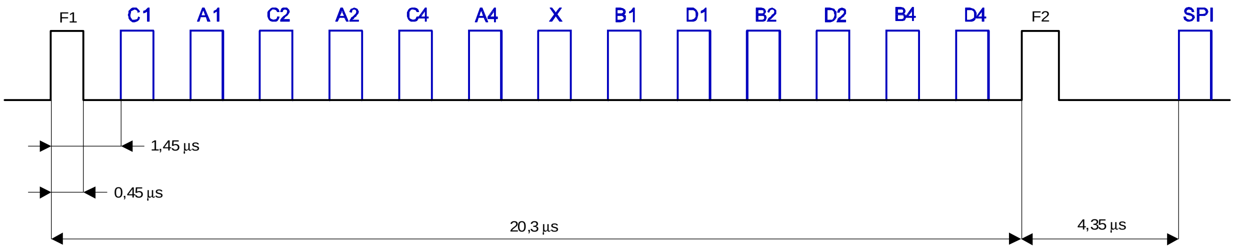


Fig. 4: Reply structure

This reply-code contains F1 and F2 bracket pulses and they are always present. The information pulses are between bracket pulses F1 and F2. Information contains four digits marked as A, B, C, D and these digits are coded in octal notation. This means they are composed of three bits marked 1(LSB – lowest significant bit), 2 and 4 (MSB – most significant bit). X pulse is not used at present. Sometime after reply SPI special code pulse is transmitted. This pulse is used to identification of communication between airplane and flight controller. This pulse transmission is hand-switched on in cockpit when flight controller call for it. After processing of this pulse in radar data processing system flight controller has got definite identification to which airplane he is communicating.

3.3 Intermode theory of operation

Intermodes represent the transition between SIF interrogation modes and Mode S interrogations. The basic philosophy is presented on the following picture "*Interrogation data formats*".

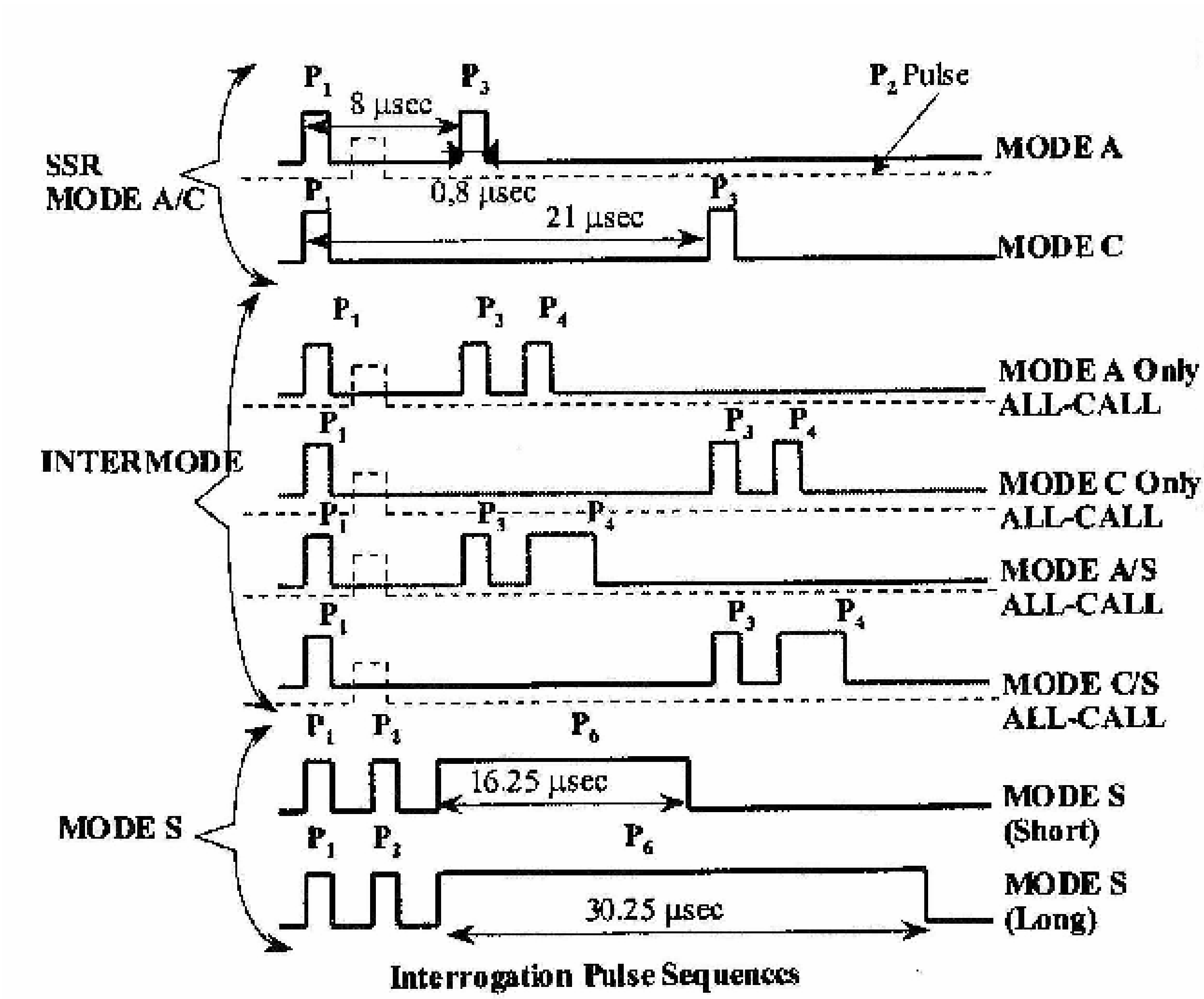


Fig. 5: Interrogation data formats

The standard SIF interrogation modes are represented on the picture by Modes A and C. The intermodes are derived from the standard modes A and C. The difference is that additional pulse P4 is transmitted. The P4 pulse is transmitted 2 microseconds after the leading edge of the P3 pulse. Two type of P4 pulses are utilized – short P4 pulse (0.8 microseconds) and long P4 pulse (1.6 microseconds). The transponder replies to these interrogations according to the rules mentioned in the following table:

P4 pulse	Interrogation type	SIF transponder	ModeS transponder
Short	3/A/S	3/A reply	No reply
Short	C/S	C reply	No reply
Long	3/A/S	3/A reply	Mode S DF11 reply with II=0
Long	C/S	C reply	Mode S DF11 reply with II=0

3.4 Mode S theory of operation

The main reason for Mode S development and application is to reduce fruit and target replies overlapping. There are two types of interrogation period used by mode S ground interrogator, an all-call period and a Mode S period (also known as roll-call period). All-call interrogations are sent in the all-call period (acquisition). Selective interrogations are sent during the Mode S period.

The all-call period is used for broadcast signals, which are sent to acquire and detect targets:

- Detection and surveillance on Mode 3/A and Mode C targets
- Detection and acquisition of Mode S targets

The Mode S period is used for communication with acquired Mode S targets and includes:

- Mode S surveillance protocol
- Mode S Data Link Protocols

The selective interrogations of the target are applied in the case, when target track is established. The position of target is known, so the time to reach by interrogation signal that target (speed of light) is known. Predefined processing time exists and the response time is the same as the send time. Deciding a suitable, non-overlapping “schedule’ is complex issue.

The several Mode S interrogation protocol exist to improve RF environment:

- All-call interrogation Lockout
- Roll-call interrogation

3.4.1 Mode S data formats

The mode S data formats consist of two types of data formats, which differs one to one by used type of modulation:

- Interrogation data format
- Reply data format

3.4.1.1 Interrogation data format

Interrogation data format is used to interrogate the transponder. The basic timing diagram is depicted on the following figure "*Interrogation data format*".

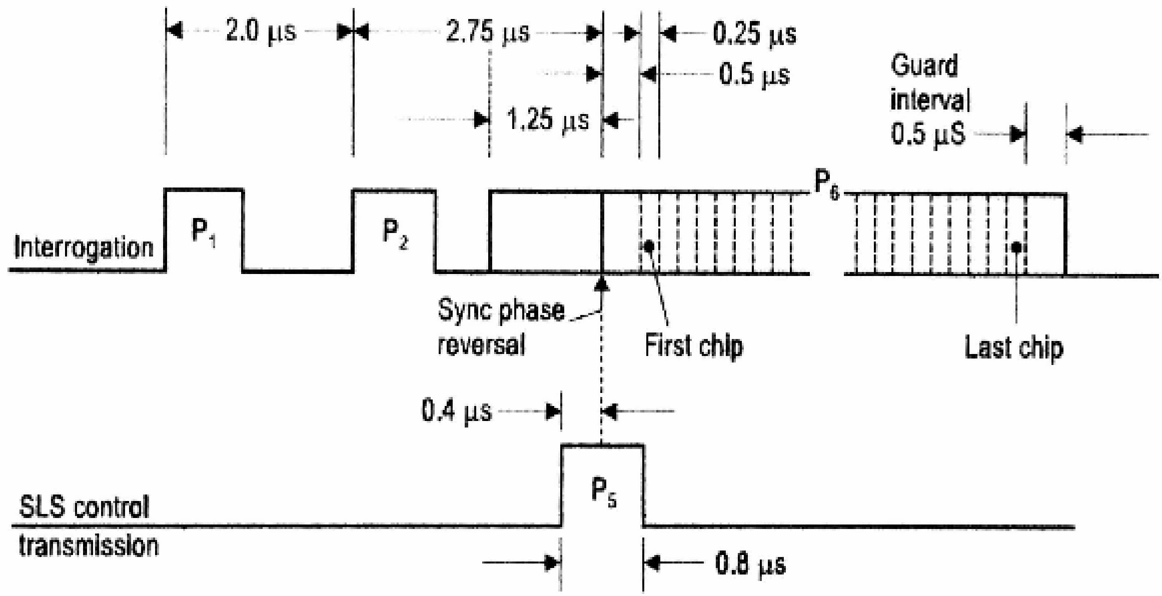


Fig. 6: Interrogation data format

The Mode S interrogation data format shall consist of three pulses: P1, P2 and P6

- P6 is preceded by a P1 - P2 pair which suppresses replies from Mode A/C transponders to avoid synchronous garble due to random triggering by the Mode S interrogation.
- The sync phase reversal within P6 is the timing mark for demodulation of a series of time intervals (chips) of 0.25 microsecond duration.
- This series of chips starts 0.5 microseconds after the sync phase reversal and ends 0.5 microseconds before the trailing edge of P6.

The P6 pulse can have two different lengths:

- The 16.25-microsecond *P*6 pulse shall contain at most 56 data phase reversals.
- The 30.25-microsecond *P*6 pulse shall contain at most 112 data phase reversals.

The last chip, that is the 0.25-microsecond time interval following the last data phase reversal position, shall be followed by a 0.5-microsecond guard interval.

The P6 pulse has the DPSK internal modulation. This modulation application is mentioned on the following figure "*P6 pulse modulation*".

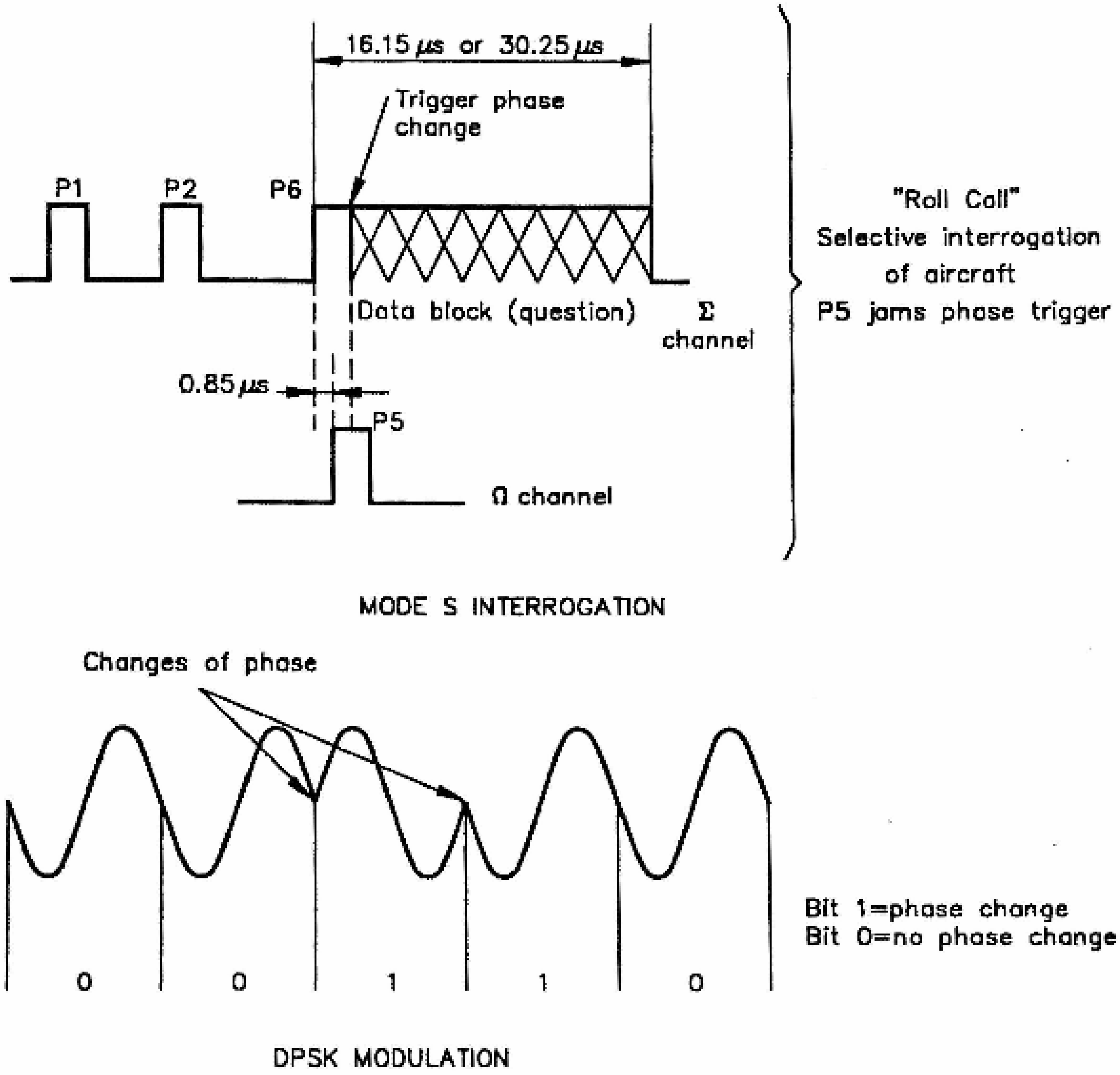


Fig. 7: P6 pulse modulation

The P5 pulse produces the “interference” to the trigger phase change. The level of this “interference” determines if aircraft is interrogated in the main antenna lobe or if the aircraft is interrogated in the side antenna lobe.

The standard interrogation data formats used by mode S ground station are:

- UF11 – used for all-call interrogation
- UF4, UF5 – used for surveillance
- UF20, UF21 – used for surveillance plus data message transfer from ground to the airborne
- UF24 – used for data message transfer from ground to the airborne

Mode S all-call UF11

1–5	6–9	10–13	14–16	17–32	33–56
UF	PR	IC	CL	spare	AP

The format of this interrogation shall consist of these fields:

Field Reference

- UF uplink format (for details please refer to the Annex 10 - 3.1.2.3.2.1.1)
- PR probability of reply (for details please refer to the Annex 10 - 3.1.2.5.2.1.1)
- IC interrogator code (for details please refer to the Annex 10 - 3.1.2.5.2.1.2)
- CL code label (for details please refer to the Annex 10 - 3.1.2.5.2.1.3)
- spare — 16 bits (shall be set to zero)
- AP address/parity (for details please refer to the Annex 10 - 3.1.2.3.2.1.3)

Mode S surveillance UF4, UF5

1–5	6–8	9–13	14–16	17–32	33–56
UF	PC	RR	DI	SD	AP

The format of this interrogation shall consist of these fields:

Field Reference

- UF uplink format (for details please refer to the Annex 10 - 3.1.2.3.2.1.1)
- PC protocol (for details please refer to the Annex 10 - 3.1.2.6.1.1)
- RR reply request (for details please refer to the Annex 10 - 3.1.2.6.1.2)
- DI designator identification (for details please refer to the Annex 10 - 3.1.2.6.1.3)
- SD special designator (for details please refer to the Annex 10 - 3.1.2.6.1.4)
- AP address/parity (for details please refer to the Annex 10 - 3.1.2.3.2.1.3)

The UF4 uplink data format is used for altitude request; the UF5 uplink format is used for identity request.

Mode S COMM-A UF20, UF21

1	6	9	14	17	33	89
UF	PC	RR	DI	SD	MA	AP
5	8	13	16	32	88	112

The format of this interrogation shall consist of these fields:

Field Reference

- UF uplink format (for details please refer to the Annex 10 - 3.1.2.3.2.1.1)
- PC protocol (for details please refer to the Annex 10 - 3.1.2.6.1.1)
- RR reply request (for details please refer to the Annex 10 - 3.1.2.6.1.2)
- DI designator identification (for details please refer to the Annex 10 - 3.1.2.6.1.3)
- SD special designator (for details please refer to the Annex 10 - 3.1.2.6.1.4)
- MA message, Comm-A (for details please refer to the Annex 10 - 3.1.2.6.2.1)
- AP address/parity (for details please refer to the Annex 10 - 3.1.2.3.2.1.3)

The UF20 uplink data format is used for altitude request plus data transfer from the ground to the airborne; the UF21 uplink format is used for identity request plus data transfer from the ground to the airborne.

Mode S COMM-C UF24

1	3	5	9	89
UF	RC	NC	MC	AP
2	4	8	88	112

The format of this interrogation shall consist of these fields:

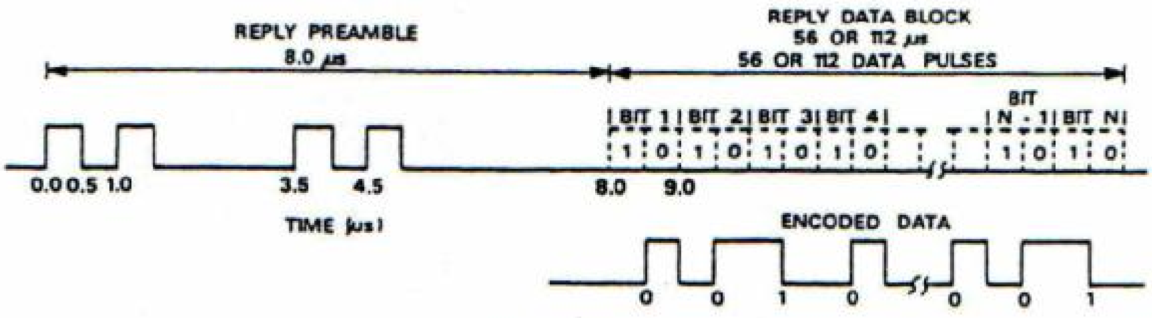
Field Reference

- UF uplink format (for details please refer to the Annex 10 - 3.1.2.3.2.1.1)
- RC reply control (for details please refer to the Annex 10 - 3.1.2.7.1.1)
- NC number of C-segment (for details please refer to the Annex 10 - 3.1.2.7.1.2)
- MC message, Comm-C (for details please refer to the Annex 10 - 3.1.2.7.1.3)
- AP address/parity (for details please refer to the Annex 10 - 3.1.2.3.2.1.3)

3.4.1.2 Reply data format

Reply data format is used to transfer data of reply from the aircraft transponder to the ground.

The reply data format is depicted on the following figure “Reply data format”.



Mode S reply format.

Fig. 8: Reply data format

The reply data format contains the following parts of data format:

- Reply preamble phase, which contains four preamble pulses located on the fixed positions
- Reply data block, which contains the reply data block. This data block could be 56 or 112 microseconds long. The length of this data block depends on the number of data pulses forming the data block.

The standard reply data formats used by mode S transponder are:

- DF11 – used for all-call reply to the all-call or intermode interrogations
- DF4, DF5 – used for surveillance
- DF20, DF21 – used for surveillance plus data message transfer from airborne to the ground
- UF24 – used for data message transfer from airborne to the ground

Mode S all-call DF11

1	6	9	33
DF	CA	AA	PI
5	8	32	56

The reply to the Mode S-only all-call or the Mode A/C/S all-call interrogation shall be the Mode S all-call reply, downlink format 11. The format of this reply shall consist of these fields:

Field Reference

- DF downlink format (for details please refer to the Annex 10 - 3.1.2.3.2.1.2)
- CA capability (for details please refer to the Annex 10 - 3.1.2.5.2.2.1)
- AA address announced (for details please refer to the Annex 10 - 3.1.2.5.2.2.2)
- PI parity/interrogator identifier (for details please refer to the Annex 10 - 3.1.2.3.2.1.4)

Mode S surveillance DF4, DF5

1	6	9	14	20	33
DF	FS	DR	UM	AC	AP
5	8	13	19	32	56

This reply shall be generated in response to an interrogation UF 4 or 20 with a RR field value less than 16. The format of this reply shall consist of these fields:

Field Reference

- DF downlink format (for details please refer to the Annex 10 - 3.1.2.3.2.1.2)
- FS flight status (for details please refer to the Annex 10 - 3.1.2.6.5.1)
- DR downlink request (for details please refer to the Annex 10 - 3.1.2.6.5.2)
- UM utility message (for details please refer to the Annex 10 - 3.1.2.6.5.3)
- AC altitude code (for details please refer to the Annex 10 - 3.1.2.6.5.4)
- AP address/parity (for details please refer to the Annex 10 - 3.1.2.3.2.1.3)

The UF4 downlink data format is used for altitude reply; the DF5 downlink format is used for identity reply.

Mode S COMM-B DF20, DF21

1	6	9	14	20	33	89
DF	FS	DR	UM	AC	MB	AP
5	8	13	19	32	88	112

This reply shall be generated in response to an interrogation UF 4 or 20 with an RR field value greater than 15.

The format of this reply shall consist of these fields:

Field Reference

- DF downlink format (for details please refer to the Annex 10 - 3.1.2.3.2.1.2)

- FS flight status (for details please refer to the Annex 10 - 3.1.2.6.5.1)
- DR downlink request (for details please refer to the Annex 10 - 3.1.2.6.5.2)
- UM utility message (for details please refer to the Annex 10 - 3.1.2.6.5.3)
- AC altitude code (for details please refer to the Annex 10 - 3.1.2.6.5.4)
- MB message, Comm-B (for details please refer to the Annex 10 - 3.1.2.6.6.1)
- AP address/parity (for details please refer to the Annex 10 - 3.1.2.3.2.1.3)

The UF20 downlink data format is used for altitude reply plus data transfer from the airborne to the ground; the DF21 uplink format is used for identity reply plus data transfer from the airborne to the ground.

Mode S COMM-D DF24

1		4	5	9	89
DF	Spare	KE	ND	MD	AP
2			8	88	112

The format of this reply shall consist of these fields:

Field Reference

- DF downlink format (for details please refer to the Annex 10 - 3.1.2.3.2.1.2)
- Spare — 1 bit
- KE control, ELM (for details please refer to the Annex 10 - 3.1.2.7.3.1)
- ND number of D-segment (for details please refer to the Annex 10 - 3.1.2.7.3.2)
- MD message, Comm-D (for details please refer to the Annex 10 - 3.1.2.7.3.3)
- AP address/parity (for details please refer to the Annex 10 - 3.1.2.3.2.1.3)

3.4.2 All-call interrogation Lockout

Mode S all-call only interrogation request and reply sequence is a special Mode S protocol. It used for Mode S aircraft detection and acquisition. All targets would reply without limitations. All-call reply would defeat the purpose of selective interrogation if all targets reply to every all-call interrogation.

The possibility exists to avoid this problem. When target has been detected and its airframe address is obtained, the responsibility for surveillance of this aircraft is to “transfer” this target into Mode S period data “extraction”. The selective surveillance interrogation will be applied instead of all-call surveillance interrogation.

The special control field is used as a part of the selective interrogation to ensure that the aircraft is “locked-out”. This will prevent the target from continually replying to all-call interrogations from the same ground interrogator, which has been acquired and it reduce the loading of the RF environment and potential different target replies overlapping.

The implementation of this all-call lockout procedure reduces the interference and aids the acquisition processing during the all-call period only.

The ground interrogator constantly resets the lockout timer, which is implemented as a part of the airborne transponder, and timeout occurs where lockout is dropped if the interrogator has not reset it for more than 18 seconds.

3.4.3 Roll-call interrogation

The basic principle of the roll-call interrogation is based on the application of the selective interrogation. The selective interrogation means that interrogation is dedicated only to the one target, which replies to this selective interrogation. The determination of the interrogated target is defined by 24-bits technical Mode S address, which is a part of the uplink interrogation data format. The each target receives the selective interrogation uplink data format and it is decoding this data format and compares the 24-bits technical Mode S address with its own airframe address. If these addresses are different, the aircraft is silent and it is not replying. If these addresses are equal, the aircraft will reply by downlink reply data frame, which contains the requested information.

3.4.4 Interrogator range

The operating interrogator range will depend largely on the type of the surveillance that it is supported by radar and the antenna rotation speed. Typically, the En-route radar will operate with slower rotation approximately in the range 6 seconds to 10 seconds per one antenna rotation and to the long range 200 nautical miles (Nm) to 256 Nm. The airport surveillance radar operates usually with faster update rate (4 seconds or 5 seconds per antenna rotation) and shorter range. The antenna rotation speed determines the time, when the main antenna beam points the target. This limited time is shared by all-call interrogation period and Mode S interrogation period.

The interrogation types could be divided into three main zones:

- Maximum RF range
- Operational range
- Lockout range

3.4.4.1 Maximum RF range

The maximum RF range refers to the maximum-instrumented range of the interrogator. It is commonly up to 256 Nm. It is variable and it is depending on many factors like the atmospheric attenuation effect, transmitter power, receiver sensitivity, an antenna gain and radar system losses, etc.

3.4.4.2 Operational range

The operational range refers to the maximum range at which recorded plots are used by ATC system for the processing and support of the ATC operations. The maximal operational range is less than maximal RF range. It is defined as the range up to which target replies would be normally expected to be reliable to use in the operational ACT environment.

3.4.4.3 Lockout range

Lockout range is a range at which the interrogator may “lockout” target. Lockout can be applied only to the target with Mode S capability. Mode S interrogators initiate it. The purpose of lockout is to prevent a Mode S target to continuously to reply to Mode S all-call interrogation during the all-call period. The lockout range is site depending parameter. It is defined as a part of the radar configuration file and it could differ in the individual azimuth sectors depending on the required lockout radar coverage and operational requirements.

3.4.5 Interrogator coverage

The interrogator coverage is site depending parameter and it is determined by many of factors like the radar performance, cone of silence, terrain effects, etc. The functional principles of Mode S are defining the interrogator coverage responsibility. The coverage responsibility defines the functions, which must be ensured by the interrogator in different parts of the airspace from the Mode S functionality point of view. The following types of the radar coverage responsibility are defined:

- Surveillance
- Lockout
- Datalink

The surveillance coverage responsibility defines the cells or area where an interrogator holds responsibility for extracting surveillance reports on targets in this part of the airspace.

The lockout responsibility defines the cells or area where an interrogator holds responsibility for initiating and maintaining all-call lockout on the targets appearing in that cell.

The datalink responsibility defines the cells or area where an interrogator holds responsibility for performing datalink activities with targets in this cell.

The responsibility definition is broken down to the individual coverage maps, which define the interrogator responsibility for different above-mentioned types of responsibility. These maps are divided in to small sectors based on the range-azimuth principles or Cartesian based, depending on the application requirements.

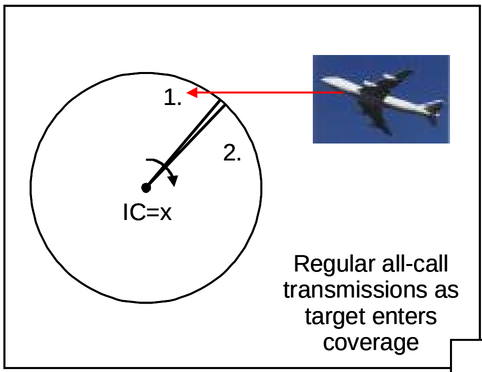
3.4.6 Mode S target acquisition and lockout

The application of Mode S target all-call lockout can reduce the garbling and fruit and unnecessary replies from the target that have been already acquired to the Mode S all-call. The lockout is applied as appropriate setting of the certain control field in the data format used by selective interrogation. Application of this control allows Mode S ground interrogator to instruct the Mode S transponder not to reply to all-call interrogations.

The specific sequence of events that occur when selected aircraft is acquired and locked out as implemented in MSSR-1 radar is explained bellow, including the graphic explanation in the following figure “Mode S target acquisition and lockout”.

Note to the following figure:

The all-call interrogation are shown as dotted lines on the figure. The selective interrogations and all replies are shown as solid lines on the figure.



Mode S Target enters radar operational range

- Lockout = no All-call reply
- first All-call reply 18 seconds after last selective interrogation

All-Call Lockout is Initiated

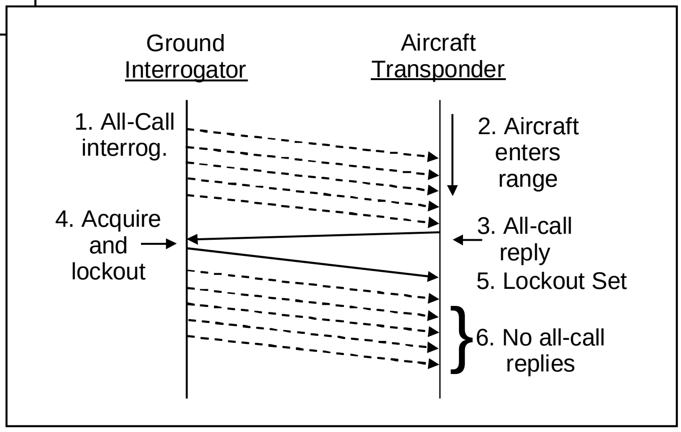


Fig. 9: Mode S target acquisition and lockout

The following sequence of events will occur, when target will enter to the operational range of the radar:

1. The Mode S interrogator interrogates with Mode S all-call, Mode 3/A and Mode C only during the all-call period.
2. Aircraft enters to the interrogator coverage area and receives the all-call interrogations with II=x (interrogator identifier).
3. Aircraft transmit Mode S all-call replies to each interrogation. Each all-call reply contains 24-bits aircraft technical address and II=x, which has been transmitted as a part of the interrogation data format. II=0 for the case, if interrogator is using for all-call interrogations the interrogation intermodes 3/A/S or C/S.
4. Interrogator receives reply and decodes the 24-bits aircraft technical address and identifies that the reply is intended for it (II contained in reply must be the same as II contained in the interrogation).
5. The sequence continues by point 1) up to the moment, when track is established and aircraft is in the lockout range of radar. When aircraft is in the lockout range and target track is established, the sequence continues by point 6).
6. The ground interrogator generates selective interrogation with adjusted control field to lockout the aircraft and interrogates the selected aircraft.
7. Aircraft is receiving the selective interrogation. Transponder decodes aircraft technical address, II code, control field and other content of the interrogation data format. If aircraft technical address differs to the airframe address, the aircraft is not replying and is silent. If aircraft technical address is equal to the airframe address, the transponder is locking out for the II and reset the timer dedicated for received II code.

The transponder after that generates and transmit appropriate reply with data content according to the to the selective interrogation requirement.

8. The transponder will ignore after this moment all-call interrogations for II=x for 18 second.
9. Interrogator will periodically reset the lockout timer dedicated to the II=x by other selective interrogation or data link interrogation.
10. The lockout period will expire automatically after 18 second if no selective interrogation will be received by the transponder. The all-call replies will be automatically generated to the all-call interrogation after this moment.

Note:

The transponder contains independent timer for each II codes (15 timer for II=1 to II=15) and SI codes (63 timer for SI=1 to SI=63). Transponder contains totally 63 timers.

3.4.7 Mode S selective interrogation transaction scheduling

Principles of Mode S selective interrogation transaction scheduling are shown on the following figure “Mode S selective interrogation transaction scheduling”.

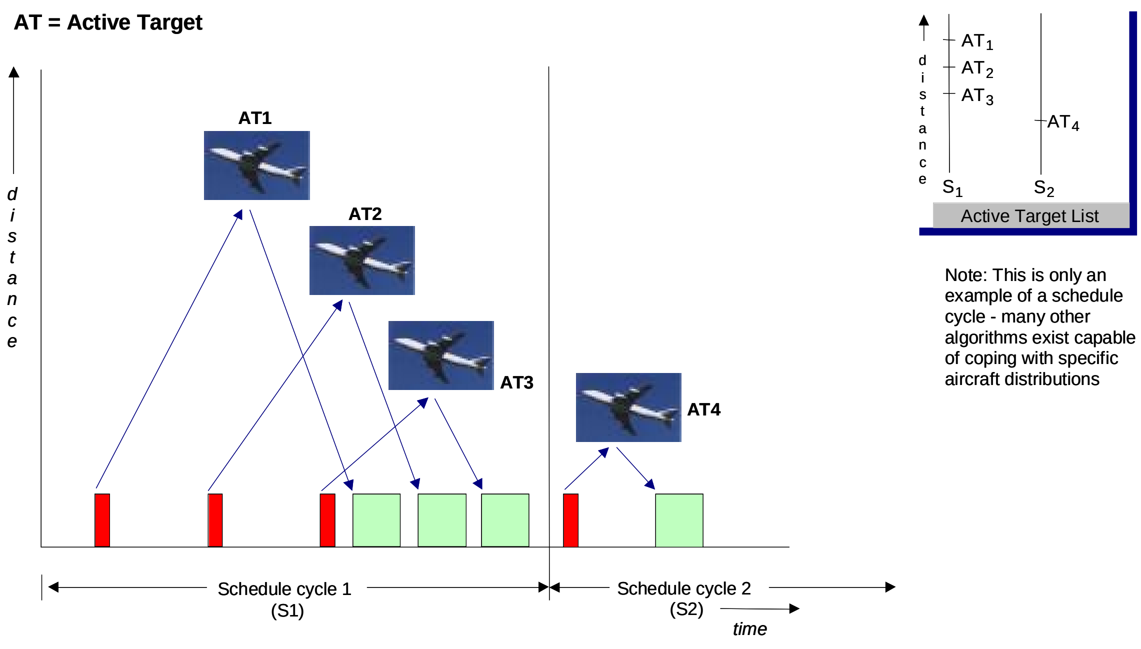


Fig. 10: Mode S selective interrogation transaction scheduling

Mode S selective interrogations are scheduled in order the unique time channel is dedicated for each interrogation transaction of individual aircrafts. The unique time channel is reserved in the ground interrogator for transmission on uplink channel and listening time slot is reserved for corresponding reply on the downlink frequency.

The scheduling algorithms are based on the fact, that target position is known with acceptable position precision based on the tracking of the aircraft trajectory. The scheduling algorithms can determine the estimated time of reply arrival on the receiver input. This time is determined as a time for interrogation to reach aircraft + time to process interrogation and initiate the reply + time for reply to reach interrogator.

The more complex algorithms, which are involved in the MSSR-1 radar, have the capability to schedule several interrogations in one selective interrogation sequence to interrogate several aircrafts. The basic rule of these algorithms is to receive the individual replies of aircrafts with minimal time separation between individual replies to avoid potential replies overlapping and garbling.

3.4.8 Mode S data exchange transaction

Mode S data exchange transaction could be divided into following categories:

- All-call exchange transaction
- Surveillance transaction
- Surveillance and communication transactions
- Communication transaction

The basic Mode S data transaction concept principles are shown on the following figure "Mode S data transaction concept principles".

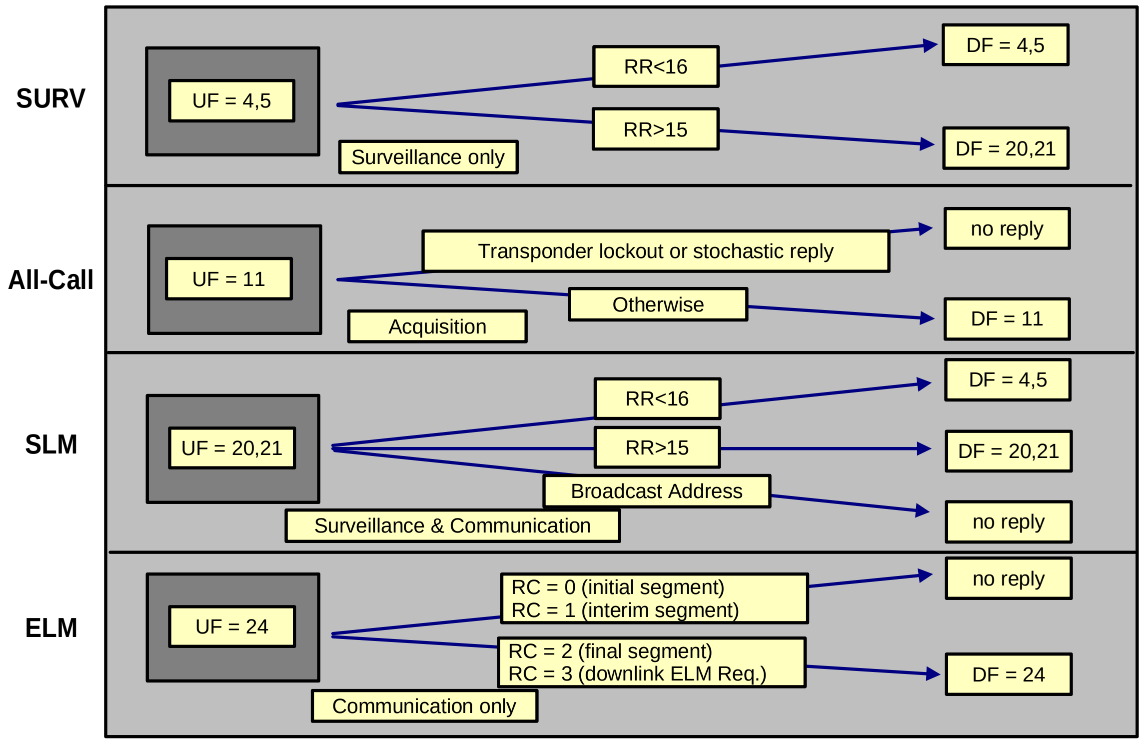


Fig. 11: Mode S data transaction concept principles

3.4.8.1 All-call exchange transaction

All-call exchange transaction is used during the acquisition phase of the target by Mode S radar station. The interrogator interrogates the aircraft by uplink format UF11. The target transponder replies according to the lockout stage condition. If target is locked out, it is not replying to the interrogator, otherwise the target replies to the interrogator by downlink format DF11.

3.4.8.2 Surveillance transaction

Surveillance transaction is used to collect the surveillance information from the airborne avionics. The interrogator initiates the surveillance transaction by uplink formats UF4 or UF5. The RR control field of these uplink formats determines, which replies will be initiated. If RR field value is less than 16, the transponder replies by downlink formats DF4 or DF5. If RR field value is higher than 15, the transponder replies by downlink formats DF20 or DF21, which contains the data field, which contains additional surveillance information extracted from transponder BDS register.

3.4.8.3 Surveillance and communication transactions

Surveillance and communication transactions are used to exchange the user data between the ground and the airborne. The interrogator initiates the surveillance and communication transaction by uplink formats UF20 or UF21. The user data transmitted to the airborne are as the part of the user data field of UF20 or UF21. The RR control field of these uplink formats determines, which replies will be initiated. If RR field value is less than 16, the transponder replies by downlink formats DF4 or DF5. If RR field value is higher than 15, the transponder replies by downlink formats DF20 or DF21, which contains the data field, which contains additional surveillance information extracted from transponder BDS register.

3.4.8.4 Communication transaction

Communication transaction is used to exchange the user data between the ground and the airborne. The interrogator initiates communication transaction by uplink formats UF24. The RC control field of this uplink format determines, which type of the communication transaction will be initiated – uplink transaction or downlink transaction. The RC field value 0 or 1 indicates transmission of the initial or interim uplink data segment. The RC field value 2 indicates transmission of the final uplink data segment, which is after that confirmed by the transponder with downlink format DF24. The RC field value 3 initiates the start downlink communication transaction.

3.5 Mode S surveillance and data link protocols

The Mode S radar station provides several types of protocols, which ensure functional requirement to the surveillance or data link applications. The basic protocol types integrated in the MSSR-1 radar are:

- All-call protocol
- Surveillance protocol
- Data link protocol

The all-call protocol and surveillance protocol are relatively very simple protocols, there for they not described in detail in the following part of the protocols description. The data link protocols, which are implemented in the MSSR-1 radar, could be divided into the following types of the data link protocols:

- Single segment uplink or downlink standard length message (SLM)
- Multiple linked segments uplink or downlink standard length message (SLM)
- Uplink and downlink broadcast
- Single segment uplink or downlink extended length message (ELM)
- Multiple linked segments uplink or downlink extended length message (ELM)

The uplink and downlink broadcast protocols are mainly used by the ACAS system or by the extended squitter system. The broadcast protocol control is very simple, because the broadcast protocols are one-way protocols without any acknowledgement. The following description is focussed mainly to the description of the data link protocols, which are implemented and used by the MSSR-1 radar station application in the real ATC operation and which control is more complicated and sophisticated. The control of above-mentioned protocols is maintained at any time by the MSSR-1 radar.

3.5.1 Uplink single segment SLM frame (COMM-A)

The uplink single segment SLM frame is the simplest of the data link protocols. The basic control flow is shown on the following figure “Uplink single segment SLM frame”.

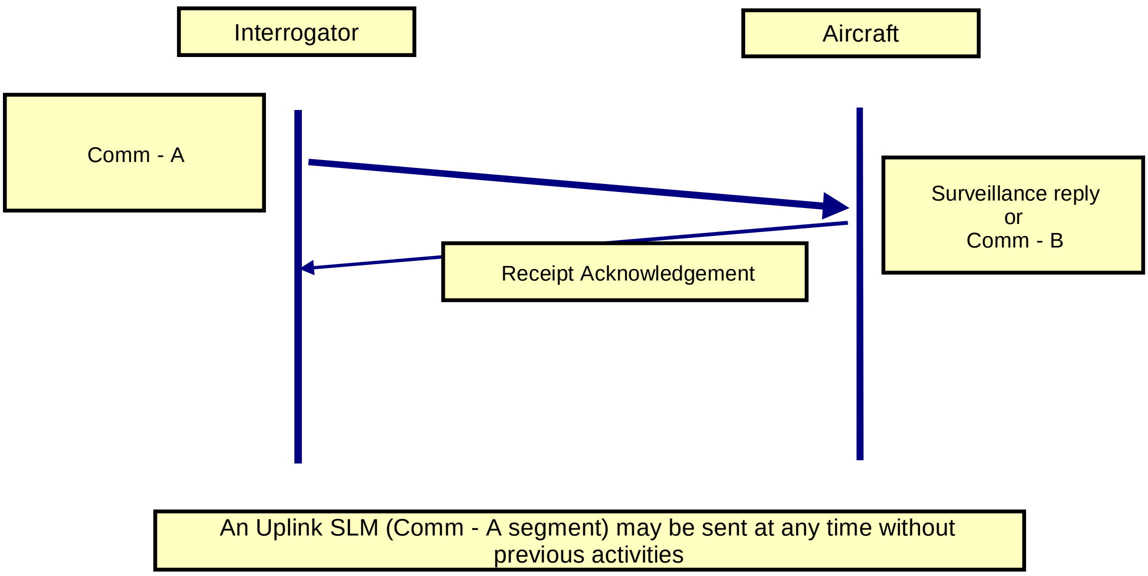


Fig. 12: Uplink single segment SLM frame

The USLM (Uplink Standard Length Message) can be sent at any time. The control flow is following:

1. The ground sends an uplink COMM-A interrogation with 56-bits user data to the airborne transponder. The user data are contained as a MA data field, defined in UF20 or UF21 uplink data format.
2. The transponder replies to the ground with control field to signal reception acknowledgment. The control field is defined in the surveillance or COMM-B downlink format definition. The surveillance or COMM-B downlink reply format selection depends on the content of the other control fields in the uplink interrogation format.

Note 1: There is no transponder response in the case when COMM-A is sent as broadcast COMM-A (broadcast Mode S technical address).

Note 2: The COMM-A transaction between interrogator and site monitor system control transponder is used for diagnostic of DLF function. The results of each transaction are indicated on the CMS display.

3.5.2 Ground initiated COMM-B (GICB) – single segment

The ground initiated COMM-B (GICB) – single segment is the simplest of the data link protocols, which transfer the date from airborne to the ground. The basic control flow is shown on the following figure “Ground initiated COMM-B (GICB) – single segment”.

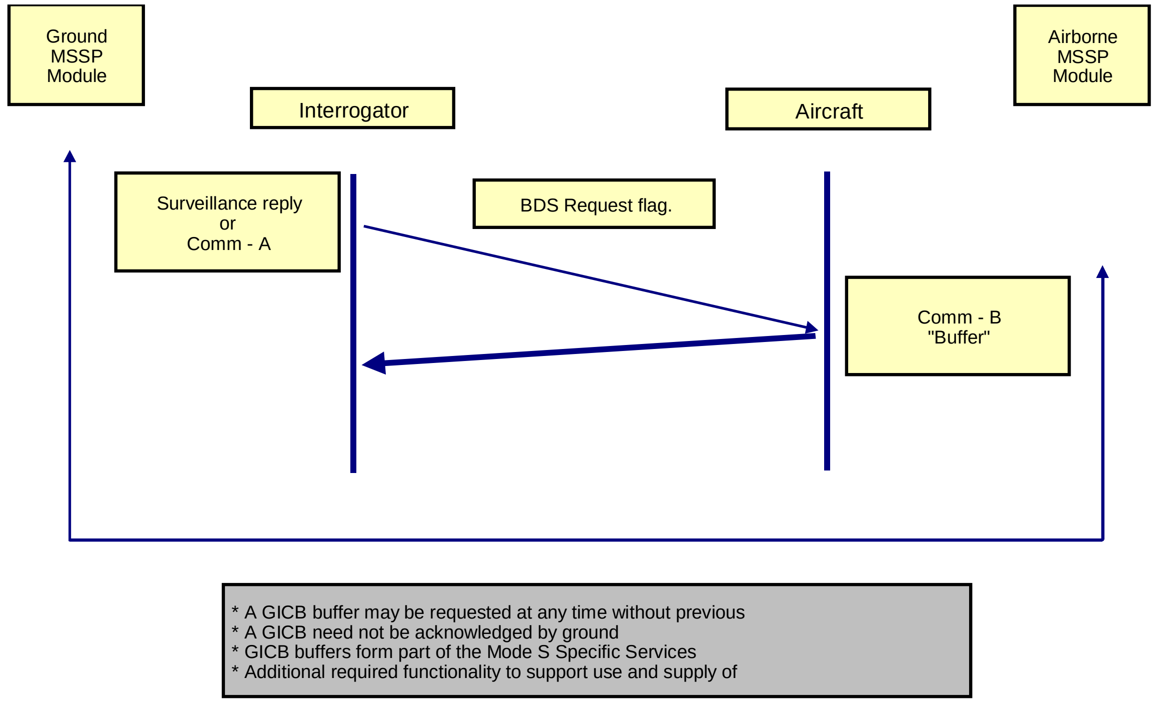


Fig. 13: Ground initiated COMM-B (GICB) – single segment

The GICB (Ground initiated COMM-B) can be requested at any time. The GICB is the basic data protocol, which forms the integral part of elementary or enhanced surveillance. This protocol is used to extract the content of pre-defined the data buffers in the airborne transponder. The control flow is following:

1. The ground interrogator sends an uplink interrogation (surveillance or COMM-A). The control field is encoded to signal a GICB request and the required GICB register, which data content is required by the ground to be transferred.
2. The transponder replies with COMM-B downlink reply. The COMM-B downlink format contains the downlinked user data in MB data filed of the reply format DF20 or DF21.
3. No uplink acknowledgment of transaction is required to be sent. If the reply is not received, the ground interrogator will simply schedule the same interrogation again.

3.5.3 Linked uplink SLM frame

Linked uplink SLM frame type of Mode S protocol can transfer up to the airborne up to 4-linked SLM frames, which are logically linked together into one message.

The maximal data message length is 224 bits of user data. The airborne side must contain the data link processor, which is capable to compile up to 4 logically linked SLM segments in to the original message, which will be sent by the ground to the airborne. All segments are sent by COMM-A transaction. The philosophy of the linked uplink SLM frame is to acknowledge each individual segment separately. The basic control flow is shown on the following figure “Linked uplink SLM frame”. If segment transfer is not successful, the interrogator repeats this interrogation again.

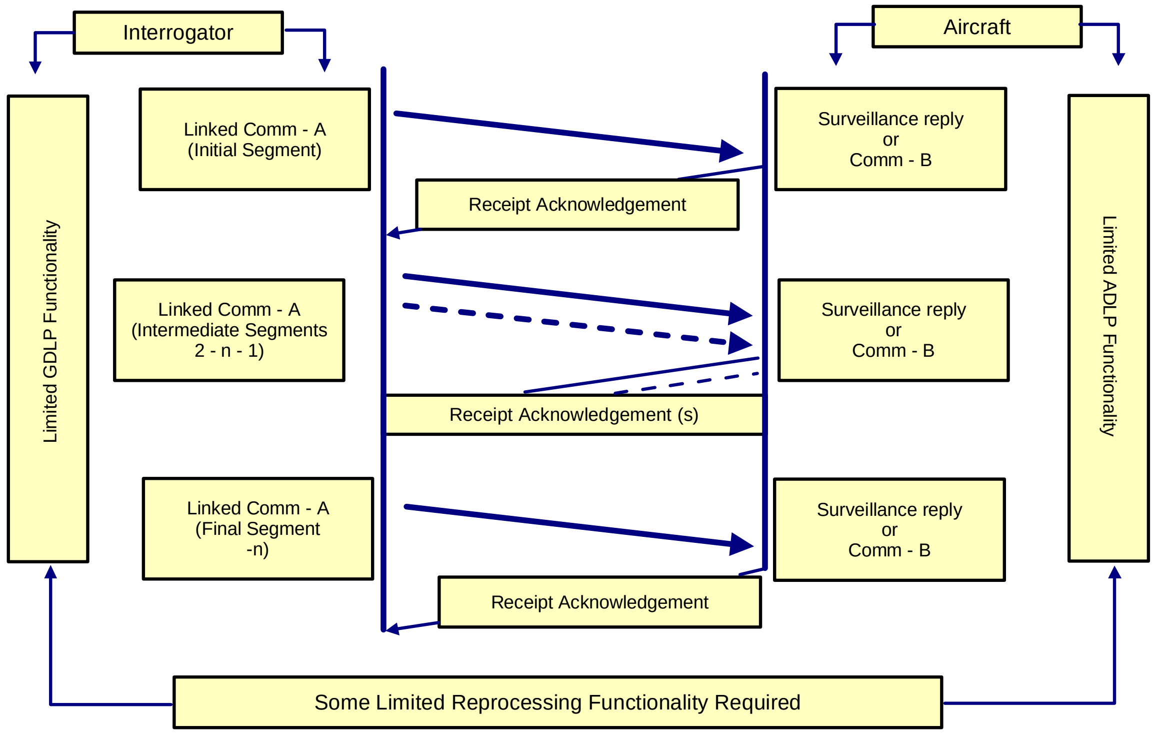


Fig.14: Linked uplink SLM frame

The control flow of the linked uplink SLM frame is following:

1. The interrogator sends the first segment to the airborne by COMM-A. The control field of the COMM-A indicates the first segment transfer.
2. The airborne transponder acknowledges the first segment reception by surveillance or COMM-B reply. The control field content of COMM-A interrogation controls the selection of the surveillance or COMM-B reply.
3. The interrogator sends the interim segments to the airborne by COMM-A. The control field of the COMM-A indicates the interim segment transfer.
4. The airborne transponder acknowledges the interim segment reception by surveillance or COMM-B reply.
5. The interrogator sends the final segment to the airborne by COMM-A. The control field of the COMM-A indicates the final segment transfer.
6. The airborne transponder acknowledges the final segment reception by surveillance or COMM-B reply.

3.5.4 Linked downlink SLM frame

Linked downlink SLM frame is commonly known as an AICB (Air Initiated COMM-B). This type of Mode S protocol can transfer down to the ground up to 4-linked SLM frames, which are logically linked together into one message. This type of the protocol is divided into two parts:

- First segment transfer is using AICB protocol
- Further 3 segment transfers are using GICB protocol

The maximal data message length is 222 bits of user data. The airborne side must contain the data link processor, which is capable to split the original message up to 4 logically linked SLM segments, which will be sent to the ground.

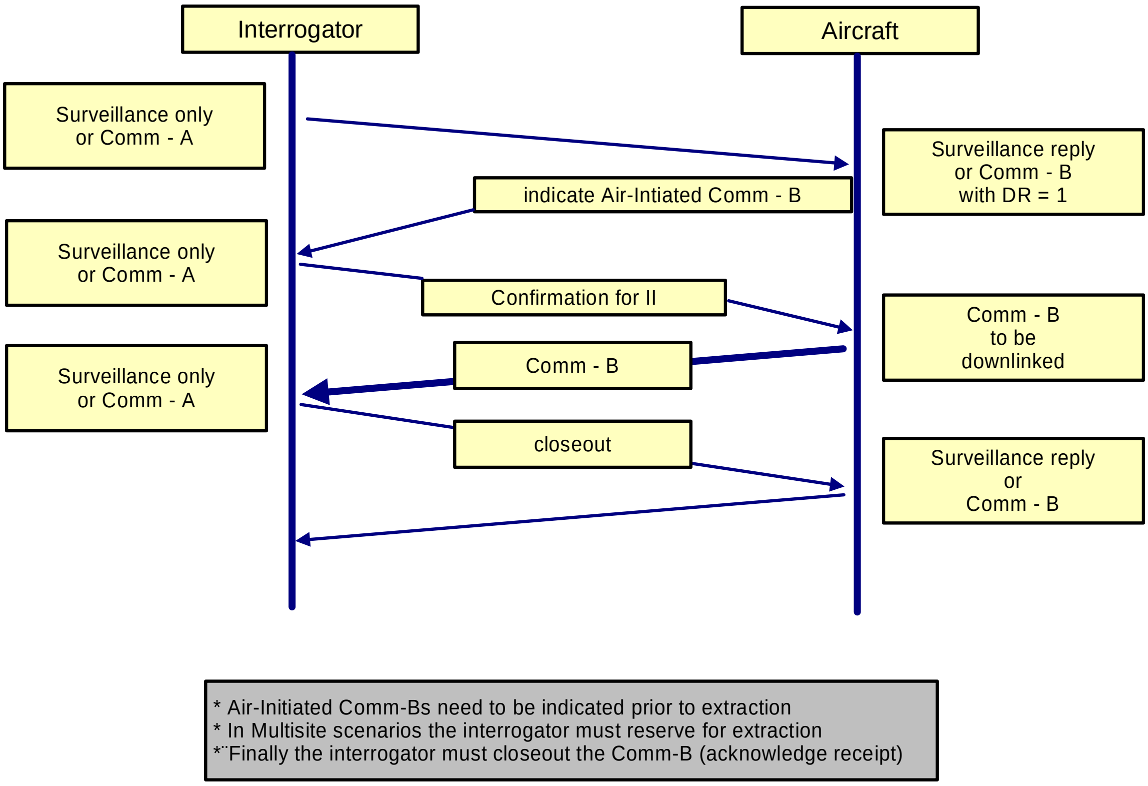


Fig.15: Linked downlink SLM frame

The control flow is following:

1. The airborne transponder indicates during surveillance or COMM-B reply a request to transfer user data to the ground.
2. The interrogator processes a reply and recognises the request for AICB in the reply. The interrogator sets the control field during the next interrogation to confirm that AICB data should be sent and reserves the communication for its own II.
3. The transponder sends the first data segment as a part of COMM-B reply. The MD field of the COMM-B reply contains the user data and number of message segments.
4. The next data segments are extracted via GICB protocol.
5. If the interrogator receives all segments of the message, the control field of the next interrogation is set to closeout the communication for given II.

3.5.5 Uplink ELM frame

Linked uplink ELM frame type of Mode S protocol can transfer up to the airborne up to 16-linked ELM frames, which are logically linked together into one message.

The maximal data message length is 1216 bits of user data. The airborne side must contain the data link processor, which is capable to compile up to 16 logically linked ELM segments in to the original message, which will be sent by the ground interrogator to the airborne. All linked up segments are sent by COMM-C. The philosophy of the linked uplink ELM frame is to acknowledge each segment separately in the control field of the COMM-D transaction, when final COMM-C segment is received. The basic control flow is shown on the following figure "Uplink ELM frame". If some segment transfer is not successful, the interrogator repeats this interrogation procedure again.

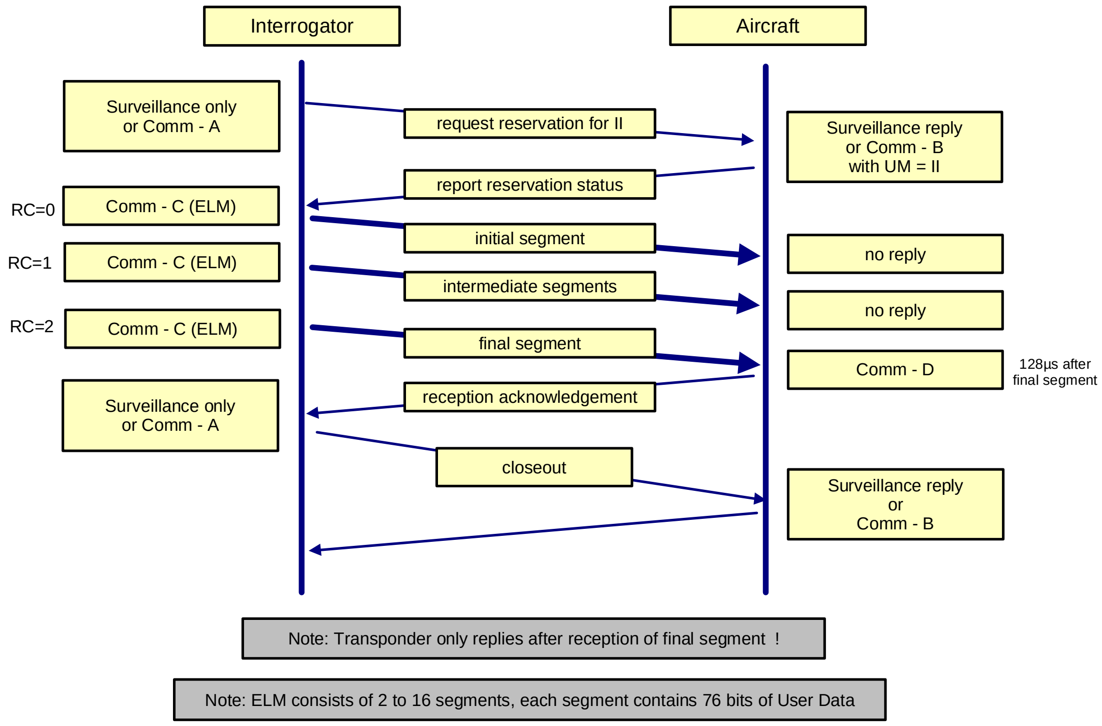


Fig.16: Uplink ELM frame

The control flow of the linked uplink ELM frame is following:

1. The interrogator requests the reservation of the ELM frame transfer during the surveillance or COMM-A interrogation for given II.
2. The transponder reports the status reservation for given II in the surveillance or COMM-B reply.
3. The interrogator sends the initial ELM segment by COMM-C. Control field of the COMM-C indicates the initial segment transfer. The data control field contains number of ELM segments to be transferred between the ground and the airborne.
4. The transponder does not reply to this interrogation.
5. The intermediate segments are sent by COMM-C. Control field of the COMM-C indicates the intermediate segment transfer. The data control field contains ordinal number of ELM segment, which is transferred in this COMM-C interrogation.
6. The transponder does not reply to these interrogations. Sequences 5 and 6 are continuing up to the final segment transaction.
7. The interrogator sends the final ELM segment by COMM-C. Control field of the COMM-C indicates the final segment transfer. The data control field contains number of ELM segments to be transferred between the ground and the airborne.

8. The transponder replies by COMM-D reply, which acknowledges the uplink ELM frame. The COMM-D reply contains the control field, which is a part of MD user data. This control field is 16-bits long. Each bit is assigned to the individual ELM segment and it indicates the correct reception of individual ELM segments.
9. If the interrogator receives acknowledgement of all segments of the message, the control field of the next surveillance or COMM-A interrogation is set to closeout the communication for given II.

3.5.6 Downlink ELM frame

Downlink ELM frame is air initiated communication activity. Linked downlink ELM frame type of Mode S protocol can transfer down from the airborne to the ground up to 16-linked ELM frames, which are logically linked together into one message.

The maximal data message length is 1280 bits of user data. The airborne side must contain the data link processor, which is capable to split the original message up to 16 logically linked ELM segments in to the original message, which will be sent by the airborne transponder to the ground interrogator. All linked down segments are sent by COMM-D. The philosophy of the linked downlink ELM frame is to acknowledge correct reception of all segments in the control field of the surveillance or COMM-A transaction, when final COMM-D segment is received. The basic control flow is shown on the following figure “Downlink ELM frame”. If some segment transfer is not successful, the interrogator sends to the airborne the COMM-C interrogation with the request to repeat the transfer of the aggrieved segments again. The aggrieved segments are indicated in the control field, which is the part of MC user data of the COMM-C.

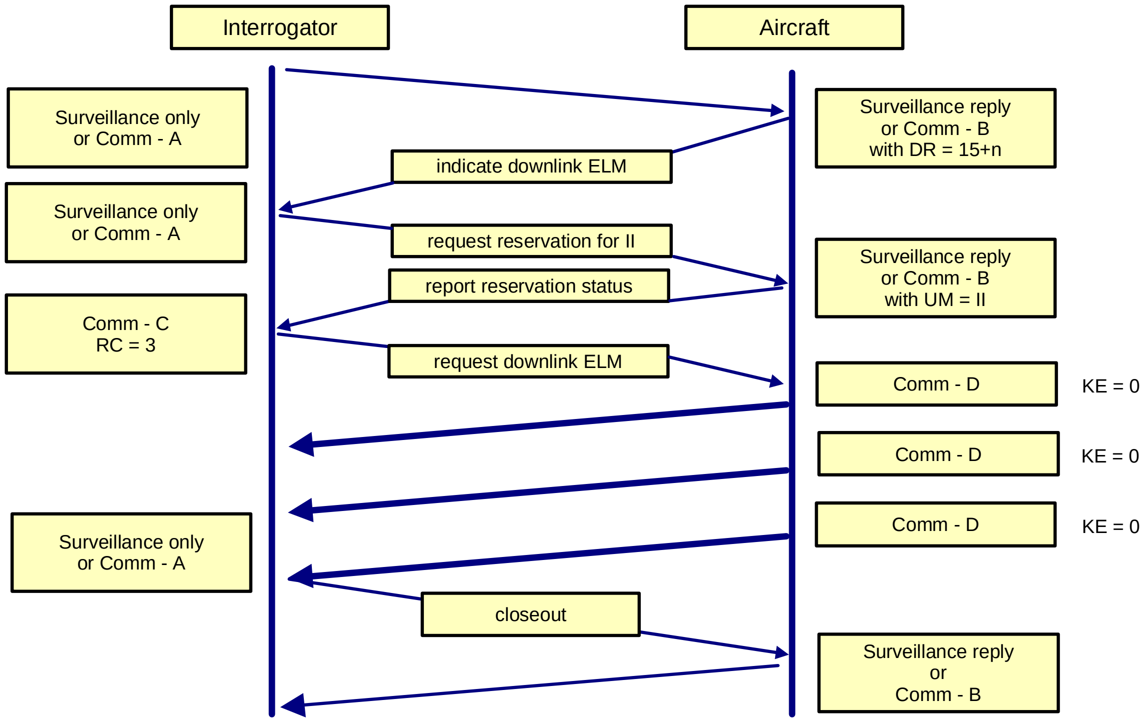


Fig. 17: Downlink ELM frame

The control flow of the linked downlink ELM frame is following:

1. The airborne transponder indicates during surveillance or COMM-B reply a request to transfer user data to the ground by downlink ELM transaction. The control field of the surveillance or COMM-B reply contains the number of ELM segments to be transferred to the ground.
2. The interrogator requests the reservation of the ELM frame transfer during the surveillance or COMM-A interrogation for given II.
3. The transponder reports the status reservation for given II by the surveillance or COMM-B reply.
4. The interrogator sends COMM-C interrogation, which contains a request to start ELM transfer transaction to the ground. The used data MC field contains the control field, which indicates the ELM segments to be transmitted from the airborne to the ground.
5. The airborne transponder sends the ELM segments by COMM-D.
6. If the ground interrogator receives all segments of the message correctly, the control field of the next surveillance or COMM-A interrogation is set to closeout the COMM-D communication for given II.
7. The interrogator sends to the airborne COMM-C interrogation in the case that some segment is received as aggrieved. The MC user data field of the COMM-C contains bit-oriented control filed, where each individual bit is assigned to the individual ELM segment. Each individual bit indicates the request to send appropriate COMM-C segment again.

3.6 Mode S Surveillance Functional Description

The following description relates to functional description of mode S in configuration of distributed activity without interrogation coordination with other radars in frame of the interrogating cluster. This functional configuration is possible to be used for following activities conditions:

- Elementary surveillance
- Enhanced surveillance – static mode of operation
- Enhanced surveillance – dynamic mode of operation

3.6.1 Elementary surveillance

The elementary surveillance represents the basic Mode S application. The elementary surveillance is used to extract basic airborne data. The data extracted via elementary surveillance functionality are listed bellow:

- Aircraft identification – call sign (BDS 2,0)
- 24-bit technical identification
- Continued availability of mode A code
- Transponder capability reports
    - § Data link capability report (BDS 1,0)
    - § Common usage GICB report (BDS 1,70)
- Altitude reporting in 25ft (Mode C)
- Flight status (airborne/on the ground)
- Including Emergency situations + SPI
- SI-Code functionality

3.6.2 Enhanced surveillance – "Static mode" of operation

In the "Static mode", the airborne parameters (or rather buffers) to be extracted are pre-configured in the Mode S ground station and the extracted parameters are broadcast to all users of the sensor. The basic concept of this mode of operation is shown on the following figure "*Enhanced surveillance – static mode of operation*".

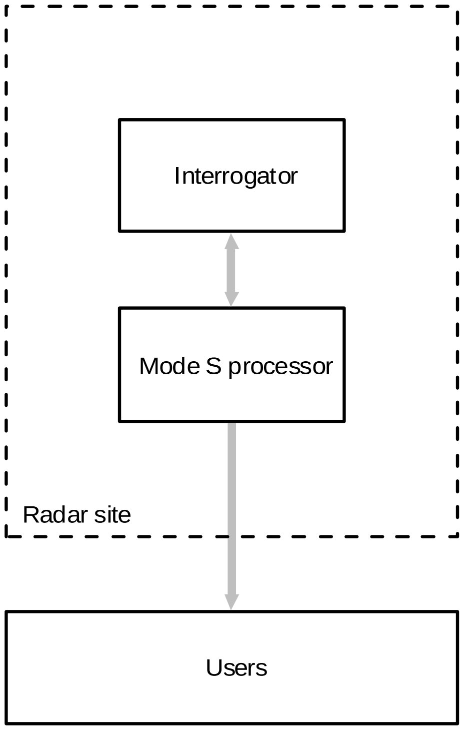


Fig. 18: Enhanced surveillance – static mode of operation

The enhanced surveillance – static mode of operation represents in principle one-way data transfer between radar site and users. The user has not possibility to control the airborne data parameters extraction. This configuration can be used in the system with limited communication infrastructure. Programming of the parameters or buffers to be extracted would require the ground station to be reprogrammed or reconfigured. The configuration file contains the definition of parameters and BDS extraction. The Mode S processor contains this configuration file on hard disc, where it is installed as a part of the installed Mode S processor software.

3.6.3 Enhanced surveillance – “Dynamic mode” of operation

Enhanced surveillance – dynamic mode of operation allows to the user to use the pre-defined configuration for airborne data extraction and simultaneously to change this configuration for individual aircraft via controller working position.. The basic concept of this mode of operation is shown on the following figure “*Enhanced surveillance – dynamic mode of operation*”.

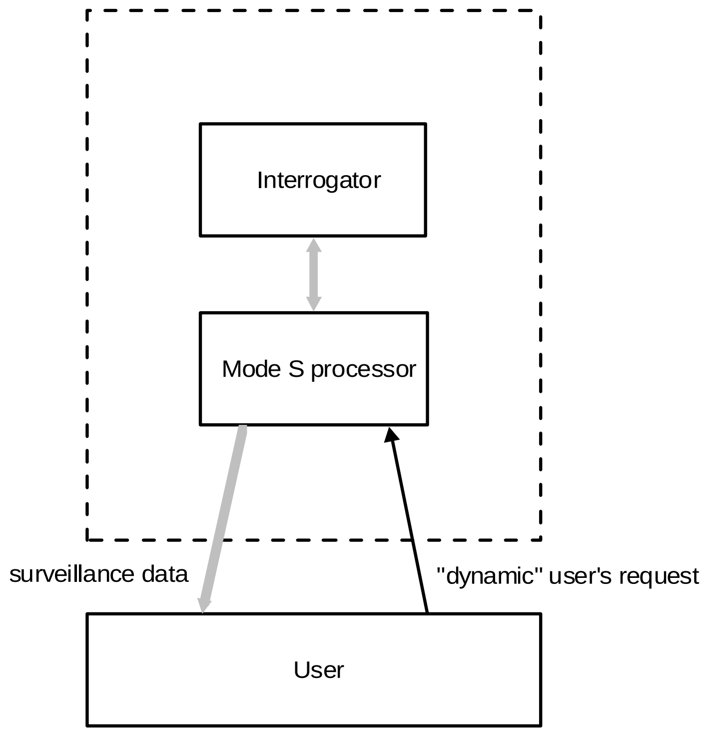


Fig. 19: Enhanced surveillance – dynamic mode of operation

The enhanced surveillance – dynamic mode of operation requires two-way communication infrastructure. The basic operation is based on predefined airborne data extraction as defined in the configuration file in Mode S processor. The dynamic mode of operation allows to the user to require via coordination interface the extraction of additional information for selected individual aircraft or to change the extraction time period of individual DAPs (down linked aircraft parameters) of individual aircraft. This “dynamic” user’s request is sent via data link function messages interface. This interface uses the ASTERIX category 018 data format as standardised by EUROCONTROL. The user special interface can be adopted also.

Application of the enhanced surveillance – dynamic mode of operation strategy estimates the capabilities of ATM system to generate control and co-ordination messages to radar.

3.7 Theory of antenna diagram side lobes suppression techniques

The antenna diagram side lobe suppression is very important to minimize the reception of unwanted signals via antenna beam side lobes. The antenna beam side lobe suppression is used due two main reasons:

- Reduce the interrogation of transponder via beam side lobes
- Minimize the number of multiple target reports produced by anomaly signal propagation in the real space or by reception of target replies via beam side lobes

The antenna diagram side lobes suppression utilizes two different techniques to improve the unambiguity of received and detected information:

- Side lobes suppression during the interrogation phase
- Side lobes suppression during the receiving phase

Both techniques are discussed in the following text.

3.7.1 Antenna diagram side lobes suppression during the interrogation phase

The transmitter transmits during standard SSR interrogations (modes 1, 2, 3/A and C) and interrogation intermodes (3/A/S and C/S):

- Via SUM antenna channel the pulses P1 and P3 and in the case of intermode interrogation, the additional pulse P4
- Via DIFF antenna channel pulse P2

The transmitter transmits during Mode S interrogation:

- Via the SUM antenna channel pulses P1, P2 and P6
- Via the DIFF antenna channel the pulse P5

The energy radiated outside the SUM main lobe by the OMEGA antenna channel is higher than the energy radiated by the SUM antenna channel side lobes.

The energy radiated by the SUM antenna main lobe is higher than the energy radiated by the SUM antenna side lobe.

For following text understanding, please, refer to the figure "*Interrogation side lobe suppression principles*".

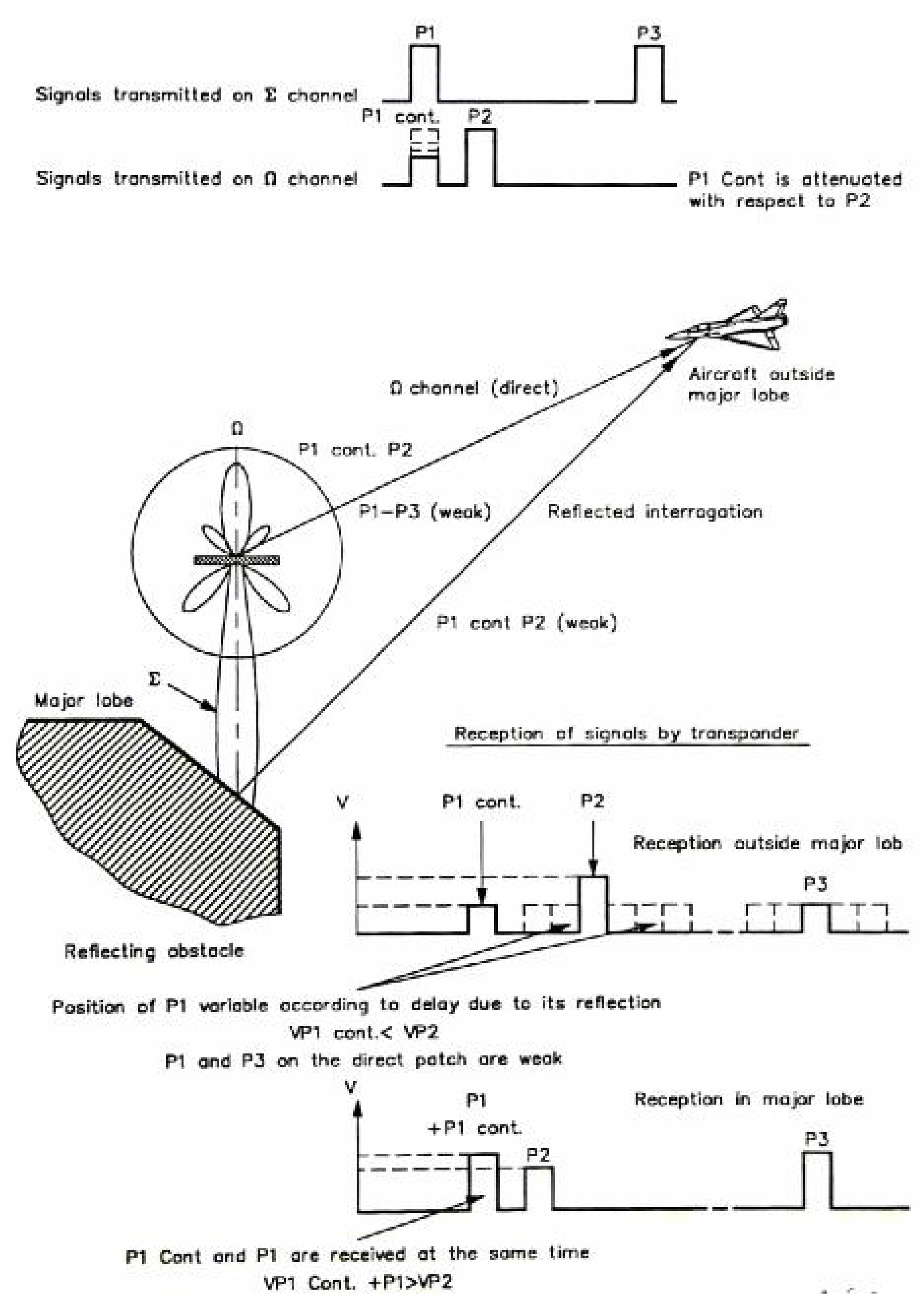


Fig. 20 : Interrogation side lobe suppression principles

3.7.1.1 Intermode or standard SSR interrogation side lobe suppression

The transponder receives pulses P1 and P3, plus the pulse P4 if it is a Mode S transponder interrogated by intermode,(P1, P3 and P4 are radiated via SUM antenna channel) and the pulse P2 (radiated via OMEGA antenna channel). The transponder replies to the interrogation in the case if the power level of pulses P1 and P3 is higher than power level of P2 pulse; in other case, if the power level received on P2 is higher than the power level on P1 and P3, it means that the interrogation occurred via a side lobe and the aircraft does not reply.

3.7.1.2 Mode S interrogation side lobe suppression

The transponder receives pulses P1, P2 and P6 (radiated via SUM antenna channel) and the pulse P5 (radiated via OMEGA antenna channel). If the power level of P1, P2 and P6 pulse is higher than the power level of P5 pulse than the transponder detects the synchronization phase reversal of the P6, decodes P6 and replies to the interrogation in the case, when Mode S aircraft address contained in the interrogation data format is matching to the Mode S aircraft address of the interrogated aircraft.

If the power level of the P5 pulse is higher than the power level of the P6 pulse, the synchronization phase reversal of P6 is masked than it means that the interrogation occurred via side lobe of the antenna and the aircraft does not reply.

The ISLS processing (presence of P5 pulse transmitted via OMEGA antenna channel) is used for Mode S all-call and for Mode S roll-call interrogations.

3.7.1.3 IISLS (Improved Interrogation Side Lobes Suppression)

To understand the following text, please, refer to the above mentioned figure "*Interrogation side lobe suppression principles*".

In some cases of the radar installation, the ISLS interrogation pulses of the main lobe of the SUM antenna channel are reflected by a large obstacle (mountain, buildings located in the airport, etc.) and interrogate an aircraft which is not located in the main antenna lobe. In some cases, the transponder may take these ISLS interrogations into account and transmit a reply to the interrogation. A $P1_{cont}$ (control) (or P'1) is also transmitted on the OMEGA channel. The main interrogator normally transmits pulses P1 and P3. The pulse $P1_{cont}$ is synchronous with the pulse P1 and has a lower power level than P2 (adjustable attenuation of $P1_{cont}$). When the aircraft is not in the main lobe the transponder first receives the pulse $P1_{cont}$ (as the OMEGA channel is omni-directional, the signal radiation path is direct). The pulse P2, with normal amplitude, arrives 2 µs later (preceded or followed by P1, depending of the delay due to the reflected path). The transponder compares the first received pulse ($P1_{cont}$, with attenuated amplitude) to the second normal amplitude pulse (P1 or P2 depending on delay) and, in the same way as for ISLS, does not reply. If the aircraft is in the main antenna lobe, the pulses $P1_{cont}$ and P1 will arrive at the same time with a level greater than P2; the transponder then replies to the interrogation. When the transponder rejects an interrogation due to interrogation on a secondary lobe or failure to comply with standards, it is self-inhibited for 35 µs. Any other interrogation arriving during this period (in particular the reflected attenuation) will receive no reply. If several MSSR radars are operating adjacent to one another, these dead times can cause difficulties for the detection of the targets by other radar. To eliminate this drawback, the MSSR radar equipment is equipped with a system enabling it to interrogate in the IISLS mode only in sectors pre-programmed by the operator in order to minimize the transponder inhibition times.

3.7.2 Antenna diagram side lobes suppression during the receiving phase

The antenna system used with the equipment includes three channels (SUM, DIFF and OMEGA); each channel has a different directivity of antenna pattern, which are depicted on the following figure "*MSSR antenna pattern*".

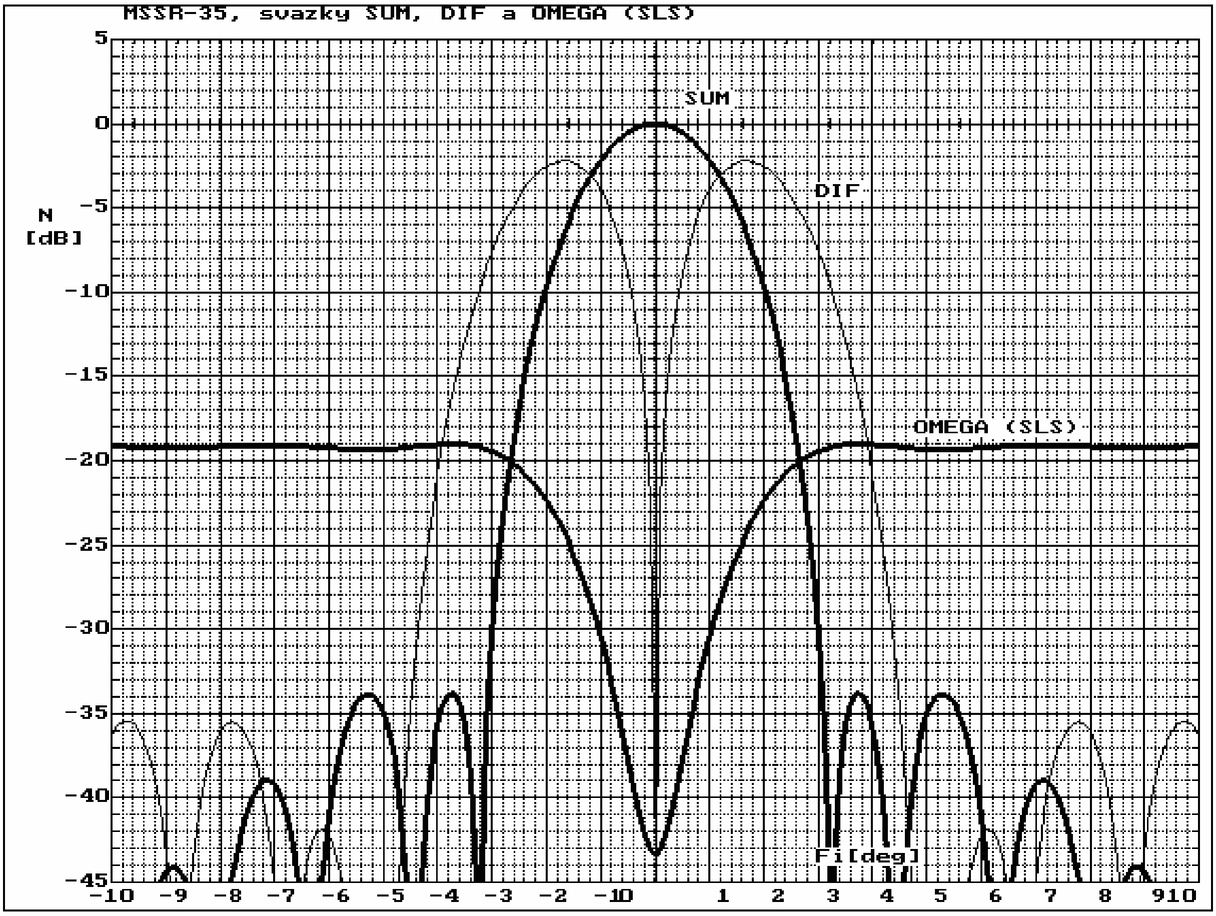


Fig.21: MSSR antenna pattern

The OMEGA channel has more or less the same gain in all directions; at least, it is higher compared to the gain of the SUM pattern main side lobes.

The main lobe of the SUM channel has a gain higher than the OMEGA channel of the antenna system.

The receiver compares the amplitude of the signals received via SUM and OMEGA antenna channels.

- If received power of signal via SUM channel is higher then power of signal received via OMEGA channel, it is estimated that the signal is from the main antenna lobe
- If received power of signal via SUM channel is lower then power of signal received via OMEGA channel, it is estimated that the signal is from the antenna side lobe

The receiver part of the radar equipment can attribute to the OMEGA channel a coefficient T1 which can be adjusted between 0 and + 40 dB, so that the gain in this channel is substantially higher than the gain of all the SUM channel side lobes. This coefficient is adjusted via control and monitoring system of the radar (the threshold setting in receiver submenu).

3.7.2.1 K-factor

In addition, it includes a SUM channel main lobe refining device, so that only replies received on a small part of the main lobe are taken into account. The parameter, which controls this main lobe refining, is K-factor. The basic principles of K-factor are depicted on the following figure "*Principles of K-factor*".

The picture depicts the basic relations between K-factor value and antenna beam width. The higher values of K-factor are leading to the narrower antenna beam, which determines the number of received and processed replies.

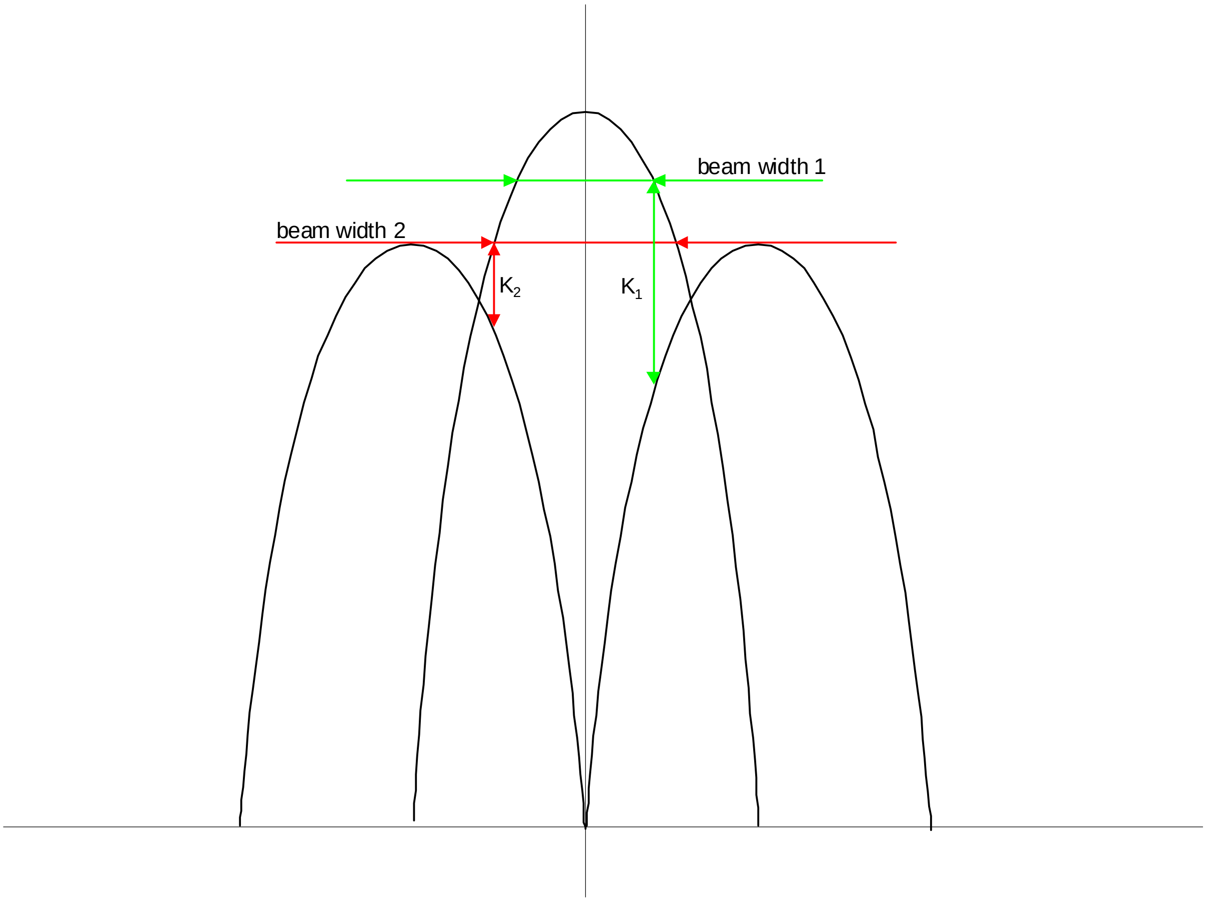


Fig.22: Principles of K-factor

The K-factor determines the minimal signal power ration between received signal power via SUM channel and received signal power via DIFF channel.

- The gain of the SUM channel is maximal in the antenna electrical axis
- The gain of the DIFF channel is minimal in the antenna axis.

The signal power ratio of pulses received on the two channels is maximal when the replies come from the antenna axis.

When the K-factor is set to the 0 (zero), then antenna beam width is determined by azimuth distance between two points, where SUM and DIFF patterns are intersecting. If the K-factor is >0 than final antenna beam is more narrow.

3.7.2.2 GTC (Gain Time Control)

The receiver equipment includes a system which eliminates the replies whose levels are too low in the nearby zone or which are received due anomaly signal propagation in the space.

This system works by only validating replies if they exceed a threshold voltage varying with time. The GTC principles are depicted on the following figure “*GTC principles*”.

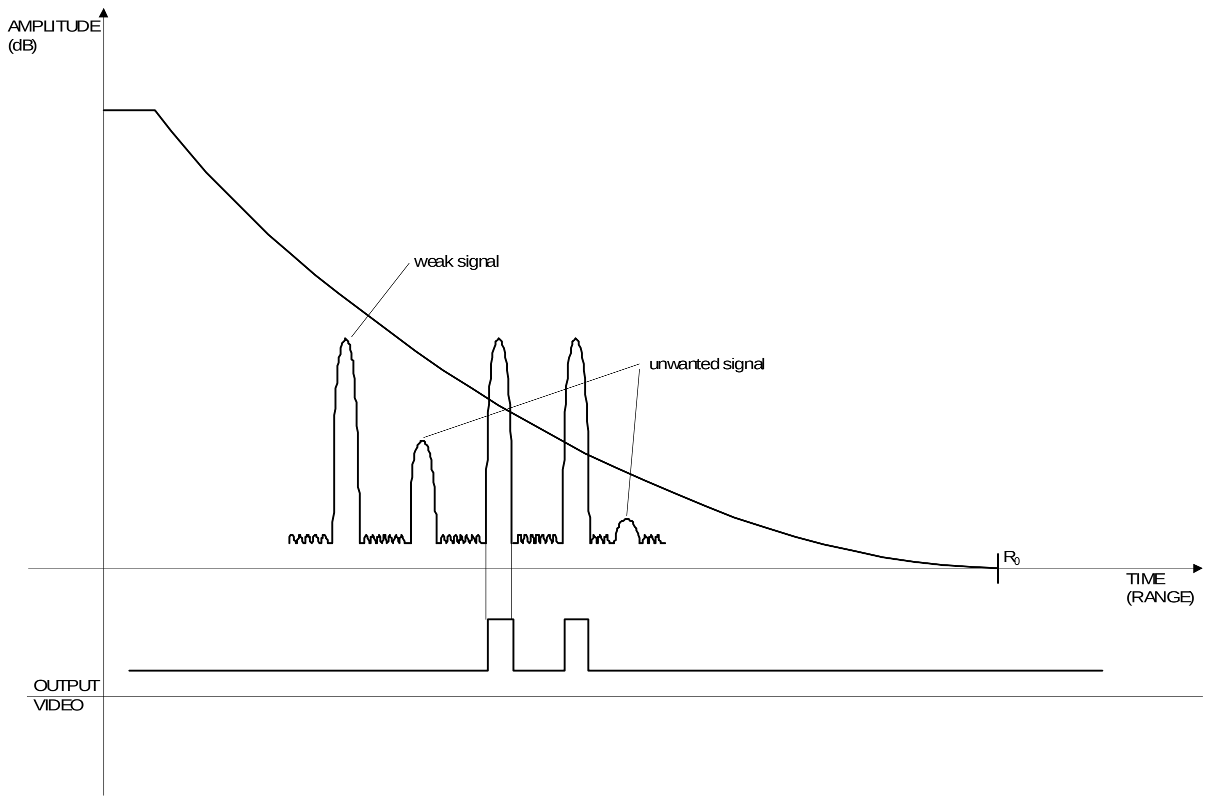


Fig. 23: GTC principles

The operator can select one GTC law from the set of the 16 GTC laws. The selection of required GTC law is programmed via control and monitoring system of the radar, which can be programmed fully independently for individual azimuth sector. The each azimuth sector determines GTC parameters selection:

- The maximal range of the GTC law application (parameter R_0)
- The GTC slope

These laws decrease by “n” dB per decade, corresponding to propagation losses in space. The following GTC laws are available in the radar equipment.

Ordinal number of GTC law	GTC slope
0	5 dB / decade
1	6 dB / decade
2	7 dB / decade
3	8 dB / decade
4	9 dB / decade
5	10 dB / decade
6	11 dB / decade
7	12 dB / decade
8	13 dB / decade
9	14 dB / decade
10	15 dB / decade
11	16 dB / decade
12	17 dB / decade
13	18 dB / decade
14	19 dB / decade
15	20 dB / decade

3.7.2.3 Receiver unwanted signals suppression

The receiver equipment has complex function integrated to suppress the unwanted signals, which could be received via antenna diagram side lobes or due the anomaly propagation of the signal in the space. The following figure "*Unwanted signals suppression*" depicts the functional structure of complex unwanted signal suppression circuits.

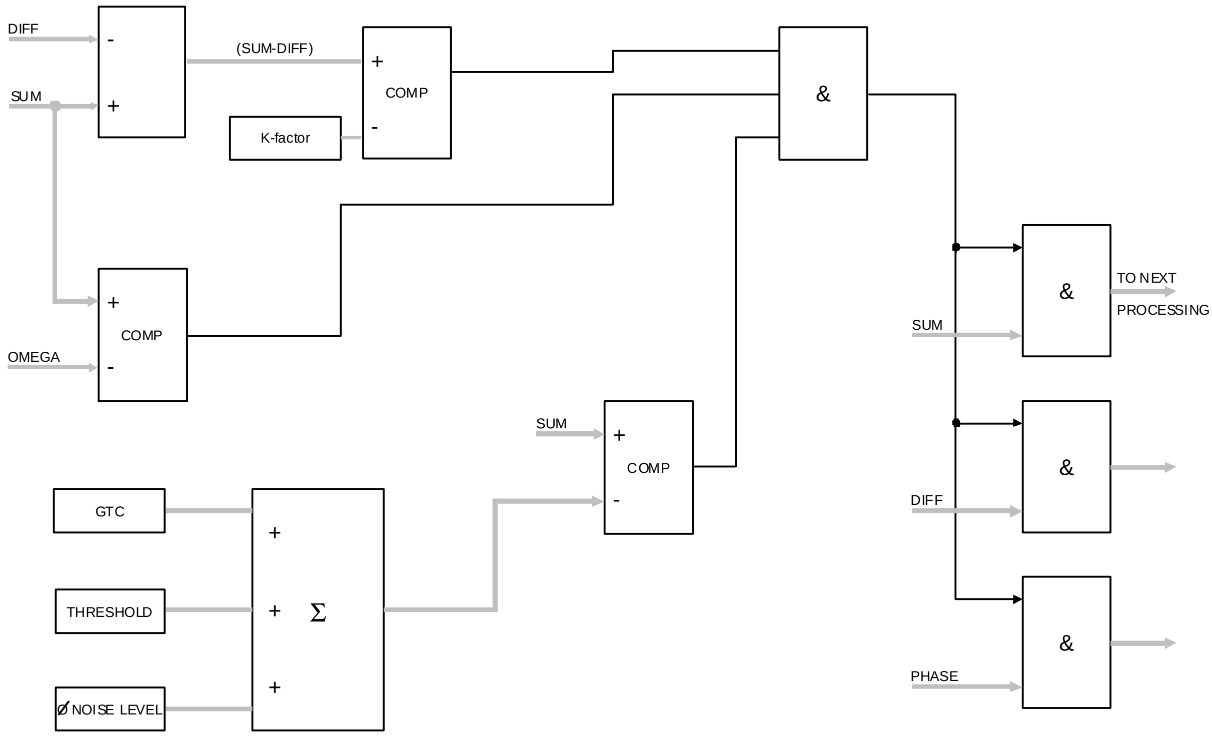


Fig. 24: Unwanted signals suppression

The unwanted are suppressed by three independent ways:

- RSLS threshold
- K-factor threshold
- GTC threshold

The RSLS threshold is determined as the received power ratio between SUM and OMEGA antenna channels. If the SUM signal power is higher than the OMEGA signal power, than the first condition for next signal processing is complied.

The K-factor threshold defines the minimal power ration between SUM and DIFF antenna channels. If the SUM signal power is higher than the DIFF signal power, than the second condition for next signal processing is complied.

The GTC threshold is determined initially from the three sources:

- GTC law
- Fixed adjusted threshold
- Average receiver noise level

These three inputs are added to form the final GTC threshold value. If the SUM signal power is higher than the GTC threshold value, than the third condition for next signal processing is complied.

The SUM, DIFF and PHASE signal samples are passed to the next signal processing only in the case, when all of three conditions are complied.

4 MSSR-1 System Overview

4.1 Overall System Survey

MSSR-1 system can be divided in several subsystems as follows:

1. Radar tower intended for Antenna-Pedestal
2. Antenna-Pedestal subsystem
    a. LVA ASSR-35 antenna with tilting gear and guarding at the repair
    b. Machine part of the antenna (two engines, gear box)
    c. Two sensors of the angle information
    d. Three-channel rotary joint
    e. Mast body
3. Radar room
    a. Two reserved interrogators
        i. Power supply block
        ii. Solid state transmitter/receiver
        iii. Extractor, Surveillance post-Processors
        iv. GPS receiver and time processing system
    b. LCMS reserved system of local control and diagnostics
        i. Diagnostics and control system with maintenance display
    c. SMP S-mode processor
        i. Control and processing of S-mode interrogation and response
    d. RDP-I/II reserved system of digital signal processing
    e. RMM radar maintenance monitor
        i. Scan converter of the maintenance display
    f. Power supply block
    g. EPS block with antenna switch
    h. Reserved system of the antenna scans control
    i. LAN network with the data communication system with technical room
4. Maintenance working positions situated in the control tower technical room
    a. Reserved system of the RCMS reserved system of the remote control and diagnostics
        i. Diagnostics and control system with maintenance display
    b. RMM radar maintenance monitor
        i. Scan converter of the maintenance display
    c. Data communication – interconnection with modems

Block diagram of the monopulse secondary surveillance radar is shown in Fig. 5 “Block diagram of monopulse secondary surveillance radar”.

MSSR-1 radar contains two equivalent interrogators labeled file “A’ and file “B”. Duplicated blocks and blocks, function of which does not bear on file “A” and/or “B”, are labeled by the symbol “1” and “2”.

Antenna of the monopulse secondary surveillance radar is mechanically connected to the antenna system rotation gear. This antenna system rotation gear is driven by electric motors.

Only a single frequency converter is functioning, which supplies one or two motors. The other converter serves as a reserve.

In case of the converter failure, the system automatically changes over the drive to the reserve frequency converter. Particular motors can be remote connected and disconnected from just operating frequency converter (from the control menu).

Angle information system is fully duplicated with two Azimuth angle information encoders. Antenna system of the monopulse secondary surveillance radar is interconnected via rotary joint with Radio-Frequency (RF) switch. RF switch changes over power outputs of both interrogators to the antenna system.

In case of an interrogator output power failure during transmission, the other interrogator transmission shall be automatically turned on after the HF relay changeover on the EPS block.

Consequently, this arrangement ensures the continuity of radar service in case of the failure of a single interrogator transmitter. Both interrogators are connected to the local radar communication system. They receive commands from the radar control and diagnostics system of this local communication system, and transfer all diagnostic and status messages to this system. In addition, both interrogators transmit data on detected targets to the local radar communication system. These data are recorded or displayed on the radar display for maintenance purposes. The radar data is also forwarded to the communication system, which ensures their transmission to external systems. Interrogators also receive information from the unified Time distribution system, to which two GPS receivers are connected so that full duplication achieved.

Unified Time system synchronizes all circuits and electronic radar subsystems. This unified Time is also intended for the most exact determination of the target detection UTC Time so that these data could be further processed in superior systems of radar data processing, and these data could be transferred to the radar network.

Radar control and diagnostics system controls and monitors all the subsystems in the MSSR. Radar status reports are also made available to external systems such that remote radar maintenance operations can also be conducted.

The MSSR Control & Monitoring Maintenance Display Unit receives and displays following information:

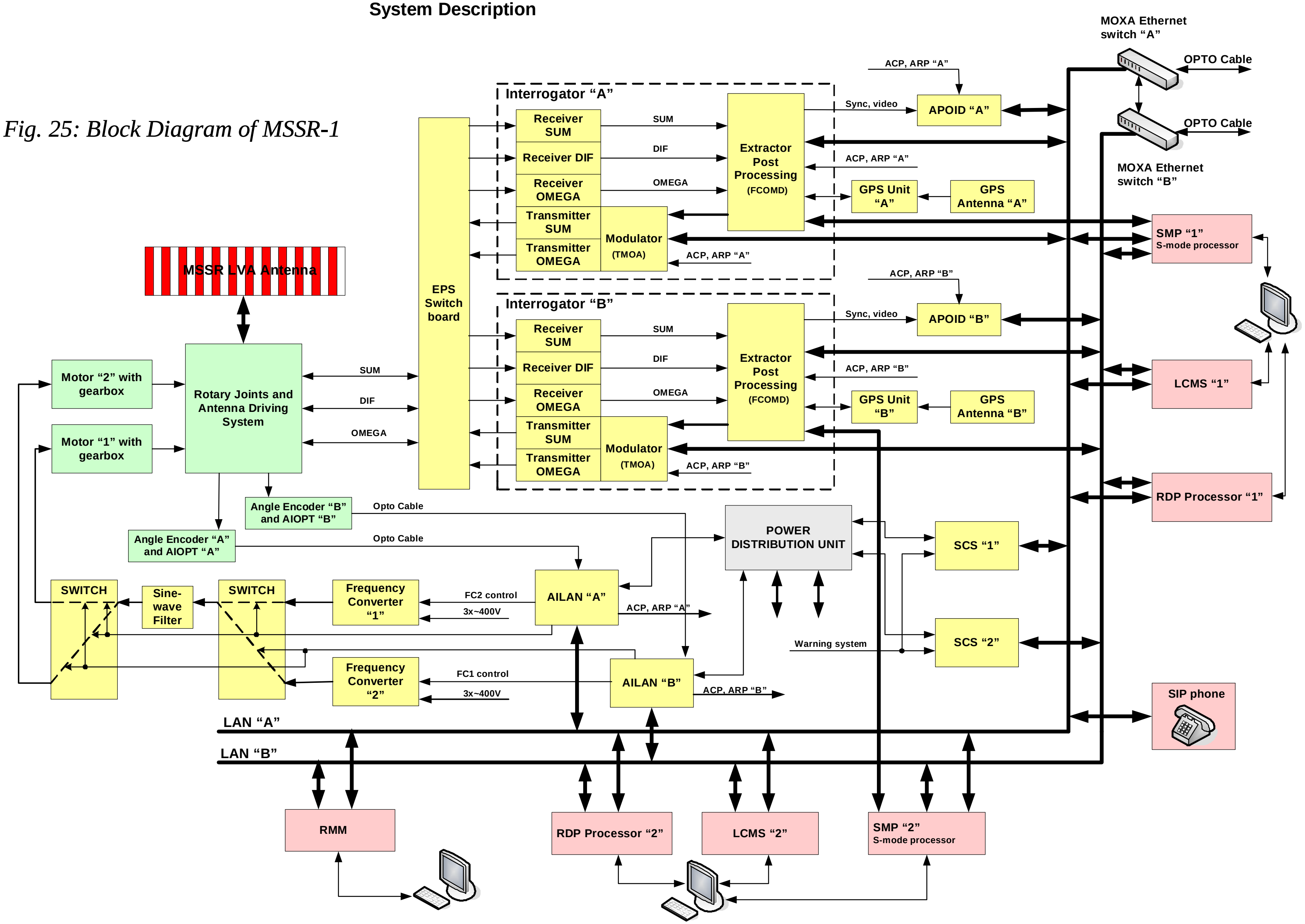
- Video signal of SUM beam
- Detected data of on-board transponder responses to interrogator
- Essential status information from the radar control and diagnostics system
- Status message on recording device

The system records following information:

- Video signal of SUM beam of both interrogators
- Detected data of both on-board interrogator responses
- Control commands for setting and controlling both interrogators
- All diagnostic and status messages captured by the radar control and diagnostics system
- Communication frames for transmitting interrogation commands and interrogator operation control
- Unified Time received from the unified Time distribution system

Radar communication system sends and receives data to/from external systems via optical fibers by means of Ethernet Switches. Communication system serves for bi-directional data transmission between secondary surveillance radar site and superior system of the radar data processing.

Fig. 25: Block Diagram of MSSR-1



4.2 Main Parameters

4.2.1 General

Mode (basic configuration)	1; 2; 3/A; C; MODE-S level 1
Output Transmitter peak power	Min. 2500 W (basic configuration)
Transmitter duty cycle	Average up to 5 %
Transmitter frequency	1030 ±0.01 MHz
Range	From 0.5 NM up to 256 NM
Scan rate - following modes of operation are available and selectable via radar control and monitoring system:	Available RPM from 4.5 until 15 and coverage from 0.5 until 256 NM
Fruit density	Min. 11,000 fruit/sec in main lobe
Pulse Repetition Frequency PRF	50 ÷ 450 Hz
Pulse Width Tmax pro mode A/C	2,4 µs
Maximum Pulse Width Tmax, mode A/C + S	32,65 µs
Transmitter duty cycle TT, mode A/C	0,0011
Transmitter max duty cycle TT, mode A/C + S	0,0147
Antenna rotation speed	5-15 RPM

4.3 Environmental Resistance

Outdoor equipment parts	-40 °C to +50 °C
Indoor equipment parts	0 °C to +50 °C
Limit of temperature	50 °C to +65 °C
Air relative humidity indoor equipment parts	95 % at max. temperature +50 °C no condensation

4.4 Supply Voltages and Power Inputs

Type of supply mains	TN-S
Voltage	3×230/400 ±10 %
Frequency	50 Hz
Maximum input power	17 kVA
Maximum partial input powers:	
Antenna system (motors, heating and switchboard)	13 kVA
Electronic units in radar head cabin	1,5 kVA
MSSR-1 in radar head cabin	2,5 kVA

4.4.1 Proportions and Weight

Proportions and weight max.	**length m**	**width m**	**height m**	**weight kg**
Antenna superstructure	2,37	2,37	2,19	1500 kg
Antenna LVA ASSR-35	8,44	1,2	1,9	850 kg
MSSR-1 in radar site	2,11	1,86	2,2	1000 kg

4.4.2 Climatic Conditions

Ambient atmosphere temperature	external parts –40 °C till +50 °C interior parts 0 °C till +50 °C
Marginal temperature	-50 °C till +60 °C
Relative humidity	95 % at 40 °C, without condensation

4.4.3 LVA Antenna

- Antenna system of LVA type with integrated rotary joint
- Dual 14-bits optical encoders
- Duplicated Azimuth Distribution Unit
- Duplicated drive mechanism, dual motor

Maximum gain	>27 dBi
Azimuth beam width	-3 dB Level: 2.2° -10 dB Level: 4.2°

4.4.4 Target Load

Capacity:

Per scan	Min. 1024 plots
Per 45 deg sector	260 plots
Per 3.5 deg sector	64 plots
Interrogator / receiver Sidelobes suppression	ISLS, IISLS, RSLS
RSLS, GTC, k-factor	Controlled in 1.4° sector steps

4.4.5 Performance Figures

Probability of detection (Pd)	Not less than 99 %
False targets reports ratio	<0.1 %
Multiple target reports	<1 per scan
Code validation (Pv)	>99 %
Validated false code ratio	<0.1 %
Azimuth accuracy	<0.07°
Range accuracy (SSR)	<27 m
Range accuracy (Mode S)	<15 m

4.4.6 Reliability, Availability, Maintainability

MTBCF	>53 890 hrs
Availability (Al)	>99,99 %
Mean time between failures (MTFB)	More than 6000 hrs
Mean time to repair (MTTR)	Less than 0,5 hr
Maintenance works periodicity	Quarterly 2 hrs max.
Failure determination	BITE feature
Standby	Warm standby of main units

5 System of Electrical Parts Addressing, System of Cables Labeling

5.1.1 Description of Labeling System

MSSR-1 radar electronic equipment is labeled A in diagrams, antenna unit is labeled B, technical room equipment is labeled C.

Parts belonging to the MSSR-1 radar electronic equipment are labeled as follows:

1. AA , AB cabinets with TSSR transmitters and receivers, ISSR extractors, AILAN

2. AC cabinet with switchboard 100, frequency converters, SCS1 and 2 computers
3. AD cabinet with RDP1,RDP2, LCMS1, LCMS2,RMM, SMP1, SMP2 electronic units, LAN switches ES1, ES2, KVM1, KVM2 switches, power supplies G1-G4, APOID A and APOID B
4. AE console with drawers and monitors 1, 2 and 3, keyboards, tracballs and SIP telephone
5. EPS switching block
6. 110 overvoltage protection block
7. B1 smoke sensor
8. ST1 thermostat 50 °C
9. H1 hooter
10. TEMP 485 temperature sensor
11. 111 optobox

Parts belonging to the antenna unit are labeled as follows:
1. M1, M2 electromotors
2. E1, E2, E3 and E4 obstruction lights
3. XT1 switchboards
4. S1 blocking switch
5. E5 workplace illumination
6. XC1 socket 230 V
7. Q1 workplace illumination switch
8. B3 oil level sensor in gearbox
9. 112 cabinet of sensors (XT2, XT3 terminal boxes, M3, M4 fans, E6 workplace illumination, AIOPTD A and AIOPTD B angle information processing cards, TA, TB transformers, ST1 thermostat, 113 optobox, AE A, AE B angle information sensors)

Parts belonging to the technical room electronic equipment:
1. CA cabinet with RCMS and RMM, ethernet switches ES1, ES2, power supplies G1-G4, APOID1- APOID4
2. CB console with drawers and monitors 1 and 2, keyboards, tracballs and SIP telephone

5.1.2 Description of Assemblies and Blocks Labeling System

On diagrams and in text, the blocks are labeled either by three-position number in accordance with functional groups:
- 100, 102, 103, 104 switchboards
- 110 overvoltage protection block
- 111, 113 optobox
- 112 sensor box
- 624, 625, 626, 627, 628 – fan units

or by alphabetic labeling derived from the block function:
- RDP1, RDP2, LCMS1, LCMS2, RMM, RCMS, SMP1, SMP2, AILAN A, AILAN B, LCMS/RMM 1 and 2, AIOPTD A and AIOPTD A, EPS

On diagrams, electric components and parts are labeled with following specification:
- clamps and connectors that can be disconnected without an instrument are labeled XC...
- clamps and connectors that can be disconnected with the help of an instrument are labeled XT...

5.1.3 Cables Labeling System

Cables labeling in diagrams:

The cables are labeled by letter W and three-position sequence number maximum – e.g. W9, W30, W135.

Power feeder cables between the radar and antenna unit are labeled by a sequence number W1 – W18.

Power feeder cables in the radar room are labeled by a sequence number W30 – W91.

Power feeder cables in the tower room are labeled by a sequence number W100 – W113.

Cables transmitting safe voltage between the radar and antenna unit are labeled by a sequence number W200 – W321.

Cables transmitting safe voltage in the radar room are labeled by a sequence number W232 – W239.

Cables transmitting safe voltage in the tower room are labeled by a sequence number W250 – W255.

Signal cables are labeled by a sequence number 300 and higher.

Cable labeling:

The cables are labeled on both ends as follows:
- cable sequence number Wxx
- block labeling or component labeling xxx
- labeling of a connector (counterpart), which the connector is to be connected to, e.g. XTx or XCx
- labeling of connecting pin or clamp e.g. 1,….,A,….,L

If a mistake exempted, some labeling may be omitted.

6 Antenna System (Antenna LVA ASSR-35, Pedestal)

Detailed description of technical solution of the antenna system particular parts and their parameters is given in enclosed documents. This documentation involves basic antenna patterns of MSSR-1 antenna.

For easier transport and handling, the antenna unit consists of two parts, namely AU machine part and ASSR-35 antenna with the frame.

Fig. 26: Antenna System

6.1 LVA ASSR-35 Antenna

6.1.1 Main Features of the MSSR Antenna

The antenna used in the MSSR will support Mode S operations; it fulfils the operational requirements of ICAO Annex 10 – Amendment 67.

Fig. 27: Antenna LVA ASSR-35

6.1.2 Description of the MSSR Antenna

The MSSR antenna is composed of 35 vertical columns, back antenna, horizontal dividing network, supporting structure and tilting mechanism.

Each vertical column contains 12 dipoles, which are excited by a strip line power-dividing network. The amplitude and phase distribution in the vertical columns is designed to form a radiation pattern with enhanced coverage in high elevations up to 45°, and optimally sharp cut off in the vicinity of zero elevations. The dipoles of each column are protected by a thin skin radome against weather.

The enhanced coverage in high elevations is compensating drop of sensitivity in small distances due to Gain Time Control (GTC) circuitry in the receiving channels of the interrogator. The sharp cut-off diminishes the beam lobbing due to surrounding terrain, lowers the effective radiated power in zero elevation, and reduces substantially false echoes.

35 vertical columns are connected to the horizontal power divider network containing air strip line dividers. The horizontal-dividing network creates three different amplitude distributions for the SUM, the Difference (DIF) and the Omni (OMEGA) beams.

The back radiation of SUM and DIF patterns is lowered substantially by a reflector placed in the space between adjacent columns. The rests of back radiation are overlaped by a back antenna, which is connected with the OMEGA beam by the rat-race divider.

Antenna has three ports - SUM, DIF and OMEGA, which enable to measure precisely azimuth of targets by the monopulse method.

6.2 Antenna Machine Part Assembly

6.2.1 Description of the Antenna Machine Part Mechanical Assembly

Machine part of the AU is a structure designed for the antenna unit fastening to the antenna mast and its horizontal bedding. It involves parts ensuring the antenna movement (two gearboxes with electric motors and main gearbox with supporting mount), and also parts ensuring the antenna position scanning and transmission of signals from AU to Interrogators. The ASSR-35 antenna with frame is fastened to the rotary flange of the AU machine part.

Main AU machine parts are as follows:

- Mast superstructure
- Main gearbox
- Isothermal cabinet

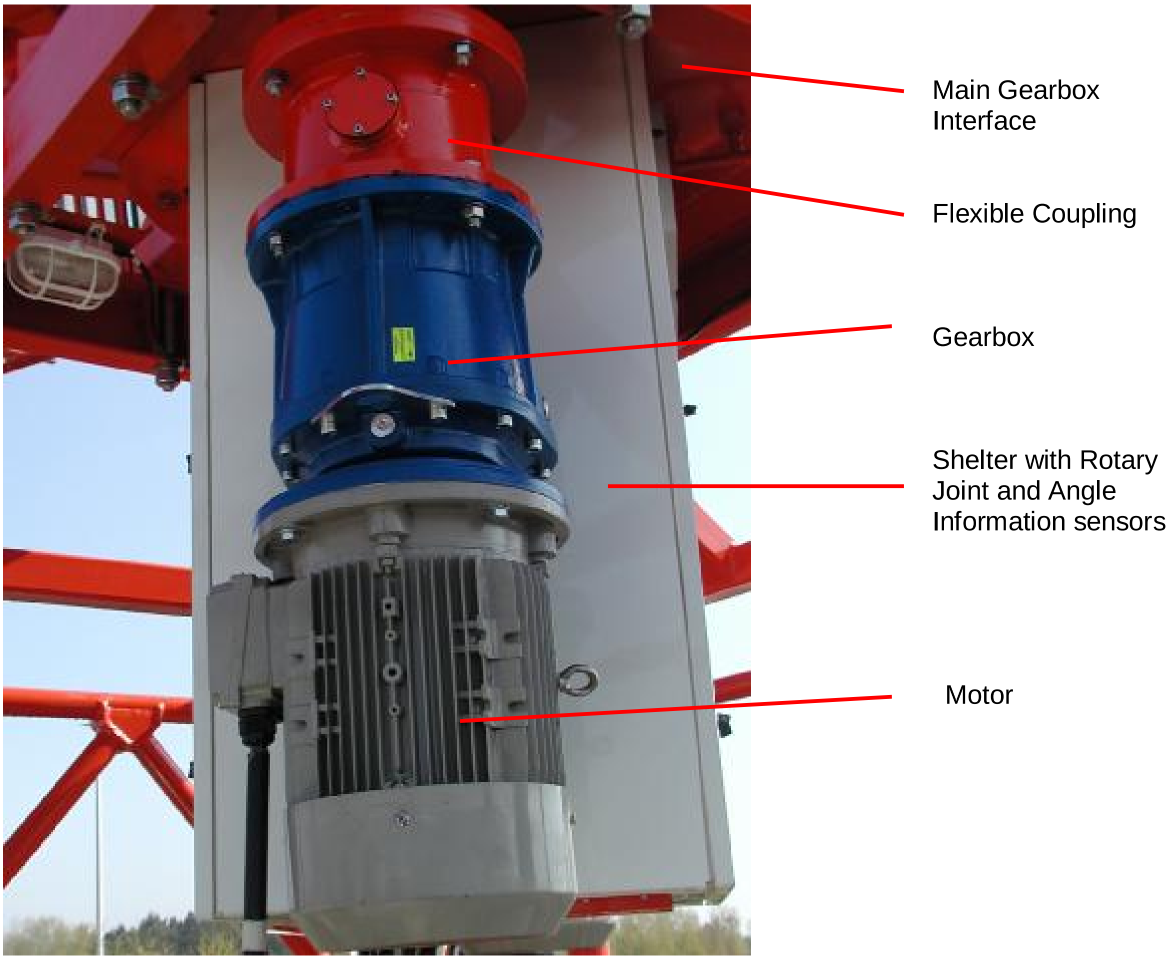


Fig. 28: Antenna drive

6.2.2 Mast Body

The mast superstructure is divided in two parts.

Bottom part is a welded piece from steel circular tubes. The bottom part is provided with bases with holes for eight screws intended for the superstructure attachment to the mast platform. The upper part is outfitted with set screws for the upper superstructure part leveling in horizontal position.

Upper part is a welded piece from steel square closed profiles and U profile. The U profile creates a flange, which the gearbox is fixed to.

The AU delivery involves also mounting parts – screws, nuts and washers enabling the superstructure fastening and leveling (incl. the antenna and entire antenna unit) in horizontal position. This leveling is carried out with the help of a water level situated on the antenna supporting frame.

Basic superstructure bedding shall be performed at the equipment assembly. Further check and possible adjustment must be performed at least twice a year, or more often in early years (height reduction etc.).

6.3 Gearbox

It is a supporting antenna element, which transfers the load from the antenna to the superstructure, and imparts rotary movement to the antenna. It consists from following main parts:

- stationary part
- rotary part
- main bearing with gear
- 2 bodies with bedded shaft, driving wheel and flexible coupling
- 2 gearboxes with electric motors (M1,M2)

6.4 Isothermal cabinet

Isothermal cabinet – cabinet of sensors (112).

It is situated under the stationary part between gearboxes and electric motors. The cabinet protects the parts against external climatic conditions, the cabinet walls are made from an insulation material – polyurethane.

The cabinet comprises following parts:

- thermostat
- transformers for feeding the AIOPTD A and AIOPTD B
- AIOPTD A, AIOPTD B cards process a signal from angle encoders and from the oil level sensor
- fans ensuring the cabinet ventilation
- optobox 113
- angle information encoders)
- 3-channel rotary joint
- socket ~230 V (~220 V)
- fans
- indoor lighting

6.4.1 Rotary Joint

It serves for the energy transmission between the antenna unit fixed and rotary part. Signals of the secondary radar are transmitted via three 50 Ω coaxial channels.These coaxial channels are designed for signals transmission between the secondary radar antenna unit and interrogator.

6.4.2 Angle Information Encoders and AIOPTD Module

AIOPTD module ensures following feaures:

- Power supply of the displacement angle encoder
- Reception and evaluation of the angle encoder signals
- Angle information transmission via optical cable
- Check of the gearbox oil level

Description of angle information processing is described in chapter “Transfer and Processing of Angle Information”. The detail description of AIOPTD board (incl. oil measuring method) is a part of „Antenna system“ technical description with its appendices.

7 Radar Site

7.1 System Interconnection

The cabin system interconnection with the antenna and technical room equipment is shown in Fig. 29.

Data transmission between the radar site and technical room is ensured by two pairs of optical sigle mode cables.

Antenna drives are fed from frequency converters situated below antenna mast. Feeder cables are lead from the switchboard 100 in the radar site to AIOPTD A and AIOPTD B blocks (input from angle encoders / optical output). Information is transferred from angle encoders to AIOPT A and B cards, and then to the radar site via optical multimode cables. Power supplies 24 V in the radar site feed obstacle lights. Three coaxial cables with low attenuation (channel SUM, DIF and OMEGA) are lead between the cabin and antenna, which serve for transmitting interrogations and responses between the MSSR-1 interrogator and antenna. Blocking the antenna gear against movement (mechanical brake) is diagnosed by means of a contact switching over in the antenna gear.

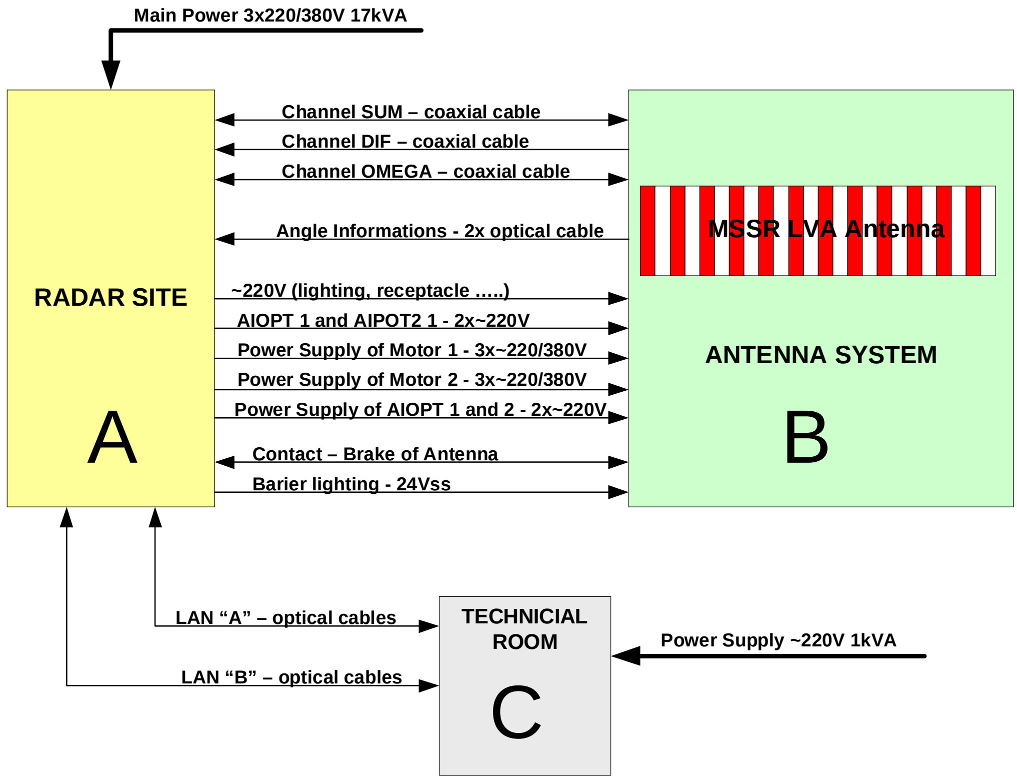


Fig. 29: Radar site system interconnection

7.2 Mechanical Arrangement of the Radar Site

The general arrangement of the Radar Site racks is shown on the consequent picture.

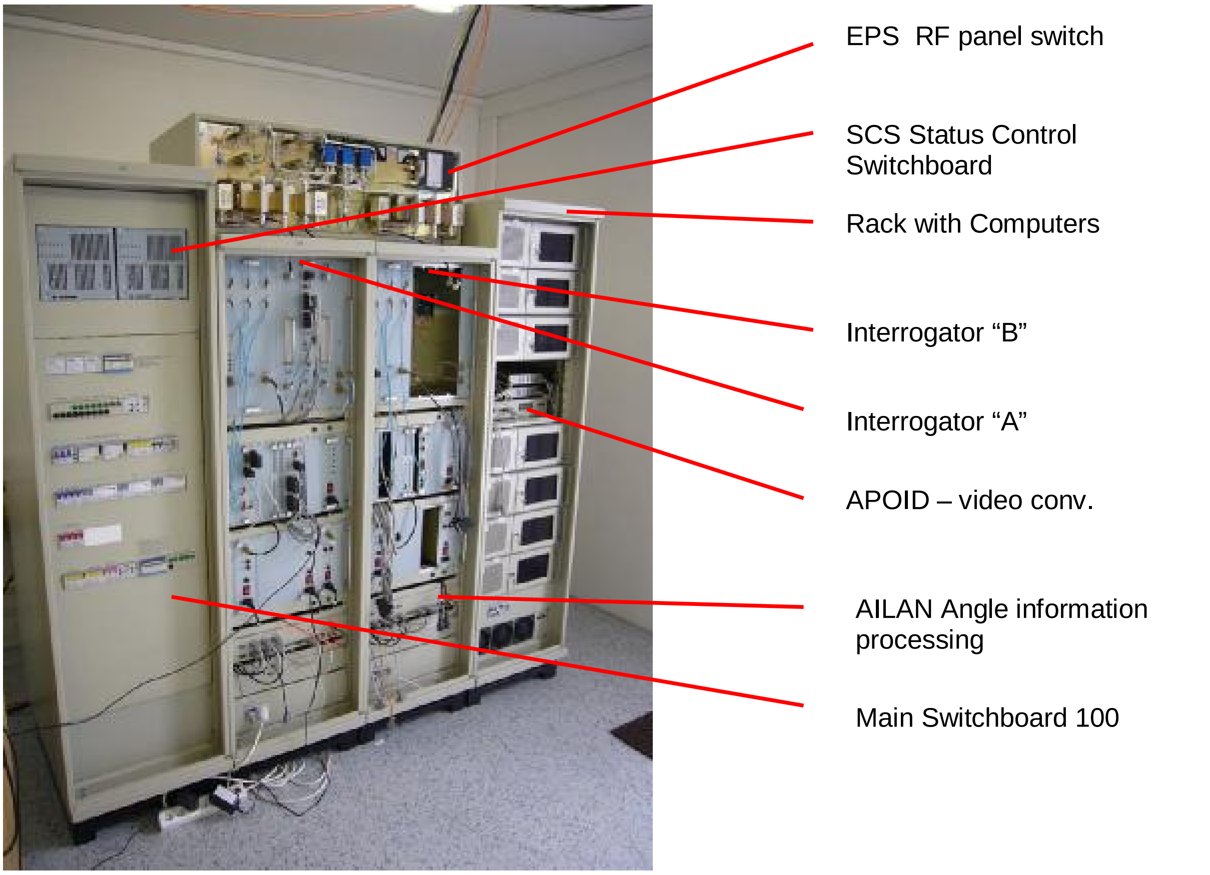


Fig. 30: Radar Site

The radar electronics is located in four AA, AA, AB and AD cabinets arranged in a single line, and AE on the table.

The AC, AA, AB, AD cabinets with all attached parts meet size requirements put on 19″ blocks. The AC and AD cabinets are 40 modules high, the AA, AB cabinets are 36 modules high. The cabinets are autonomous assemblies standing on a welded pedestal fitted with a filter of inlet cooling air. The cabinets are furnished with door ahead and aback; the front door is glazed with smoked glass, the rear door is made from sheet. Cables are lead to the cabinets from the floor to the pedestal rear part, or from above in the rear part of the cabinet upper casing. The cabinet cabling is installed on cable holders in the room behind rear door. All cabinets are provided with upper vent units (624) exhausting heated air from the cabinet.

As regards the AC cabinet, installation is realized both from the front side – switchboard (100), SCS 1 and SCS 2 blocks above, and from the rear side – U1, U2 converters, Z1 and Z2 radio filters, Z3 sinus filters, and L1 and L2 chokes. Vent unit (626) ensures the heat removal from these parts.

AA and AB cabinets are identical and installed at the front side only. Under the vent unit 624 in the cabinet cover, following parts are installed in the cabinet from above:

- TSSR block
- 627 vent unit
- ISSR block
- PSSR block – power supplies for TSSR
- 625 vent unit
- AILAN A block (in AB AILAN B cabinet)
- 102 switchboard underneath

All vent units support natural ventilation – they suck in the air via a filter in the pedestal and exhaust it in the cabinet upper part only.

EPS switching block is installed above the AA and AB cabinets.

The radar electronic units, namely RDP 1, RDP 2, RMM, LCMS 1, LCMS 2, ethernet switch ES1 and ES2, switch KVM1, switch KVM2, SMP 1, SMP2, APOID A and APOID B, switchboard 103 and vent unit 628 are situated in the AD cabinet. Since all electronic units have their own fans sucking the air via a grid in the electronic unit front side and exhausting it through the power supply in the electronic unit rear side, the 628 vent unit in the cabinet bottom part sucks in the air via a filter in the pedestal and forces it to the gap behind the front door to the electronic unit fans. The vent unit in the cabinet upper part is designed for removing heat from the cabinet rear area – from electronic unit power supplies.

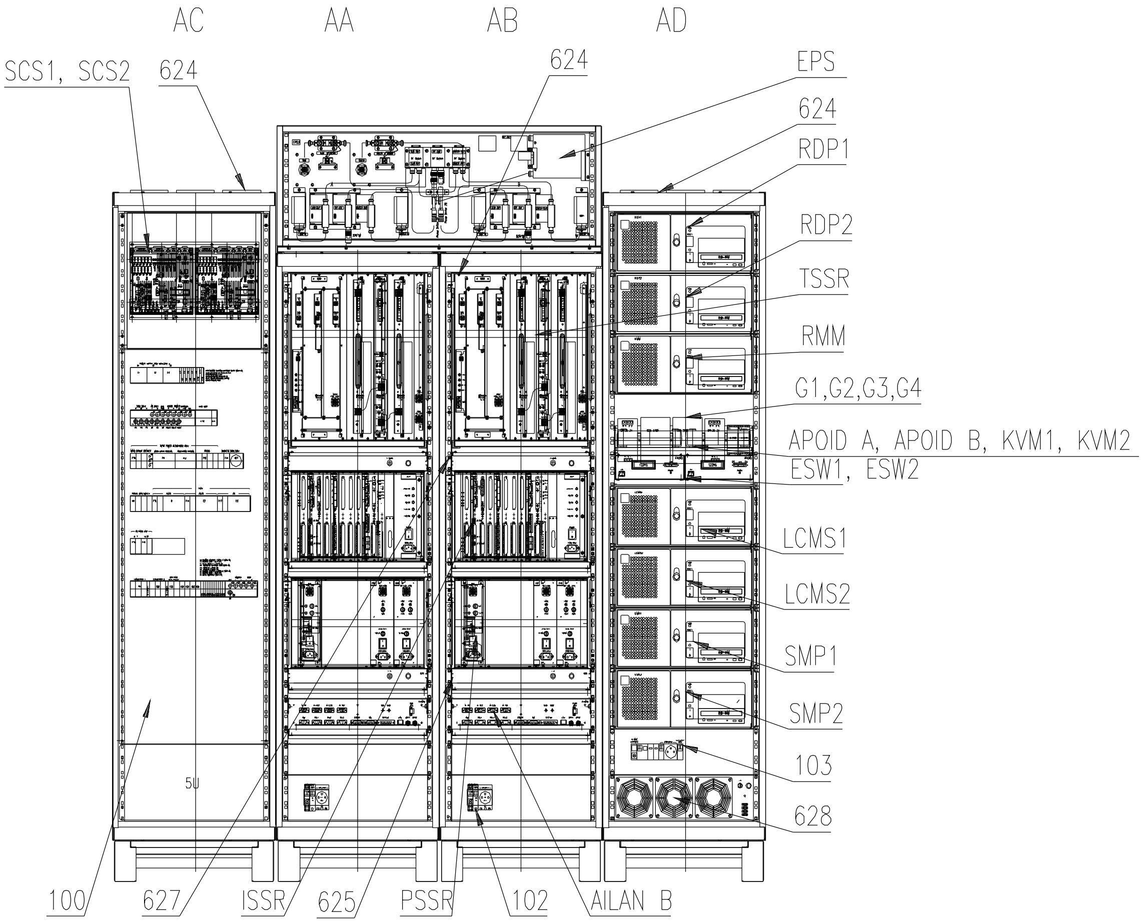


Fig. 31: Mechanical arrangements of the Radar Site

7.3 Power Supply System

7.3.1 Mains Supply

The radar electronics and antenna unit incl. its drive are fed from a switchboard (100), to which the 3x230/400 V 50 Hz mains supply is connected via a circuit breaker situated in the customer’s switchboard. The switchboard (100) is situated in the AC cabinet.

7.3.2 Protection against Dangerous Contact Potential

Essential protection against dangerous contact potential of the radar electronics fed from the switchboard is realized by current protectors Idn<100 mA and enhanced by chaining. Current protectors are situated in the switchboard (100). Leading-in mains conductors from the switchboard panel (100) – XT1 ÷ AX4 via main circuit breaker (F10) – MAIN CIRCUIT BREAKER up to current protectors (F11) – MOTORS CURRENT PROTECTION and (F12) – RACKS CURRENT PROTECTION and indicated by diodes (H9, H10, H11) – MAIN CIRCUIT BREAKER meet the condition of double isolation.

Electronic parts are supplied via current protector (F12) – RACKS CURRENT PROTECTION, switching circuits and antenna drive motors are supplied via current protector (F11) – MOTORS CURRENT PROTECTION. The current protector (F12) is of a standard design, current protector (F12) is of a impact resistant design. Two protectors impede the electronic units turning out in case of the antenna drive circuits failure.

To enhance the protection of persons, single phase sockets 230 V 50 Hz in the radar room (in AA, AB, AC, AD cabinets), socket in the antenna unit in the encoders cabinet (112) designed for portable instruments connection, and socket in the illumination of the antenna unit (E5, E6) are supplied via a current protector with built-in current protection with the In<30 mA (16 A) actuating current (F14) – SOCKETS 230 V 50 Hz.

7.3.3 Circuitry Protection against Overvoltage Generated by Atmospheric Disturbances

7.3.3.1 Mains Circuits

Leading-in 3×230/400 V 50 Hz mains cable in the radar room to the switchboard (100) is provided by overvoltage protection delivered supposedly in switchboard of customer.

Mains circuits between the radar electronics and antenna unit are protected against overvoltage at the radar room entry by protectors (FV1 ÷ FV9) in the overvoltage protection block (110). Description of switchboards of the 110 block is a part of the appendix.

Mains supply of AA, AB, AC cabinets occurs via overvoltage protections (3rd degree of protection) situated in the switchboard (100) (E1 – RACK AA,AD, E2 – RACK AB, AD, E3 – RACK AD).

7.3.3.2 Safe voltage circuits

Safe voltage cables between the radar room and antenna unit are at the radar room entry protected against overvoltage by means of the overvoltage protection (FV10) in the overvoltage protection block (110).

7.3.3.3 Coaxial Cables

Coaxial cables between the radar room and antenna unit are protected by coaxial lightning arresters (FV11, FV12, FV13) in the overvoltage protection block (110) at the radar room entry. They are situated directly on the cable terminals.

7.3.4 Earthing

Prior to the mains supply voltage connection, correct earthing connection of the leading-in cable protective strand (W1) to the switchboard (100) shall be ensured, earthing to the customer’s earthing system from the earthing clamp of the 100 switchboard (W16), earthing of the overvoltage protection block to the earthing clamp of the tower structure (W11), earthing of the antenna unit.

Necessary terrestrial resistance is as follows:

1. To ensure protection against dangerous contact potential R <200 Ω.
2. To ensure protection against lightning and overvoltage protection caused by atmospheric disturbances R <5 Ω.

7.3.5 Description of Switchboards in Radar Site

7.3.5.1 Switchboards

Main Switchboard 100

The switchboard wiring is shown in enclosure, incl. interconnection with other equipment parts. Simplified interconnection with other parts is shown in enclosure as well.

The switchboard is situated in the front part of the AC cabinet. It supplies all cabinets – switchboard 102 in AA and AB cabinets, switchboard 103 in AD cabinet, and parts situated in the antenna unit. Other parts in the radar room are connected to it.

Detailed description of 100, 102, 103 switchboards are a part of the appendix.

7.4 Čidla v místnosti radaru

7.4.1.1 Thermostat

The ST1 thermostat and RS 485 are situated on the wall of the room behind cabinets. The thermostat is set to the temperature of 50 °C.

Thermostat contacts are connected to the 100 switchboard. If the temperature exceeds 50 °C, H7 TEMPERATURE >50 °C indicator shall light on the switchboard, AA, AB cabinets power supply shall be turned out, antenna drive shall be turned out (see description of 100 switchboard) and information on the temperature >50 °C shall be entered to the control computer via SCS1 and SCS2 blocks.

7.4.1.2 Thermal sensor

The RS 485 thermal sensor is connected via the SCS block to the control computer and provides continuously information on the temperature within the room.

7.4.1.3 Smoke sensor

It is situated on the room ceiling. It is fed from the 100 switchboard always at the equipment turning on by 24 VDC voltage. The SCS1 and SCS2 block sends information of smoke in the room to the control computer via the switchboard. If the sensor closed due to the smoke, RESET shall be performed for the performance recovery by the interrupting the supply voltage (the equipment supply interrupted by means of the F13 RACKS CURRENT PROTECTION circuit braker).

7.5 Signal Interconnection of Blocks in the Radar Site

Block structure of the MSSR-1 interrogator is designed like a highly flexible modular system with minimal interconnection and dependence of particular blocks in the Radar Site.

7.6 Parts Design, Used Materials, and Surface Treatment

Parts design, used materials and surface treatment:

AA, AB, AC and AD cabinets are made from steel sheet of 1.5, 1.3 and 1 mm thick. Their surface is treated by powder baking paints based on polyester. Guides, holders, cabling, minute parts and jointing material are zinc coated.

Switchboards are made from steel sheet 2, 1.5 and 1 mm thick, front panel surface is treated by powder baking paint based on polyester, other parts are zinc coated. The switchboards are designed so that a faulty component can be carried out after the front panel disassembly.

Blocks of transmitter (TSSR), receiver (ISSR) and power supply block (PSSR) are manufactured like 19″ blocks for plug-in units assembly (TSSR – 12 modules height, ISSR and PSSR – 6 modules height). Side plates are made from steel sheet 2 mm thick, zinc coated, joined by profiles made from A1 alloys. Guides for inserting replaceable modules are made from plastic. The blocks are inserted to the cabinet in simple steel zinc coated guides facilitating the assembly. At a block repair, its disassembly from the cabinet is not supposed, but the plug-in unit replacement is only supposed. All plug-in units cabling is lead from the front side.

RDP 1, RDP 2, RMM, LCMS 1, LCMS 2, SMP 1 and SMP2 computers are designed like resistant industrial computers.

The computer case is made from steel sheet 1.3 mm thick, the cover is made from steel sheet 1.5 mm thick, rear side and other parts are made from steel sheet 1 mm thick, surface zinc coated. The front face, with the help of which the computer is attached to the pedestal, is a casting from AL alloy. Door enabling the access to the units, switch and reset button are glazed and lockable. The heat from computers is exhausted by a fan situated behind the front cover with offsets, which draws in the air from the computer environs. The computer power supply fan exhausts the air rearwards. Other parts (AILAN, 624, 625, 626, 627 and 628 vent units) are made from steel sheet. Front panels surface is treated by powder baking paint based on epoxy polyester, other parts are zinc coated.

AE console pedestals are made from steel sheet 1.5, 1.3 and 1 mm thick. In the console pedestals, drawers on guides are situated intended for embedding documentation, tools, instruments and spare parts.

Drawers are made from steel sheet, their surface is treated by powder baking paint based on epoxy polyester. The drawers are fitted on furniture guides and lockable.

Other parts (AILAN, 624, 625, 626, 627 and 628 vent units) are made from steel sheet. Front panels surface is treated by powder baking paint based on epoxy polyester, other parts are zinc coated.

7.7 MSSR-1 Interrogator

Basic configuration of the MSSR-1 interrogator is provided with following performance features:

- Two-channel transmitter with capability:
    - To generate interrogations for 1, 2, 3/A, C modes and Mode 4 (extension possibility with S and 5 modes)
    - Transmitter output power setting
    - Interrogator Side Lobe Suppression (ISLS)
    - Integrated Interrogator Side Lobe Suppression (IISLS)
- Three-channel receiver provided with the functions:
    - Of side lobes suppression at the Receiver Side Lobe Suppression (RSLS) reception

- Gain Time Control (GTC)
- K-factor (electronically antenna focusing as a part of RSLS function)

- Radar data extractor provided with functions for detecting and processing replies received from board transponders for 1, 2, 3/A, C and 4 modes, extension possibility with S and 5 modes
- Sophisticated sidelobes suppression functions (SLS), which are distributed to transmitter (ISLS and IISLS) and to receiver (RSLS)

Mode S capability is achieved by the insertion of modules into the Interrogator chassis. The interrogator subsystem meets the ICAO and Eurocontrol requirements.

7.7.1 Function Description

Within the MSSR system, each Interrogator Subsystem contains:

- Receiver which decodes replies from airborne transponders responding to particular interrogation modes,
- Plot extractor for the digital processing of the detected and decoded replies, and
- Control unit for controlling interrogator.

The interrogator output comprises of digital data of detected targets. The data on detected targets are transmitted either to the system of radar data processing, or are processed further for correlation with detected primary targets data, which results in generating combined messages on correlated primary and secondary targets. Information from the interrogator may also be displayed on the local radar display for maintenance diagnostic purposes.

A technician can simply initiate and define the interrogator operational setting with the help of the control and diagnostics system. Accordingly, this operational adjustment of the interrogator shall be stored in the interrogator memory, and refreshed automatically after the interrogator mains supply new turning out and on without the operator intervention.

MSSR interrogator contains two independent solid-state transmitters operating on the frequency of 1030 MHz. Output power of both transmitters can be independently adjusted in sectors by 1.4°.

For Mode S an auxiliary phase modulator generating pertinent phase-modulated signals augments the transmitter. In parallel configuration of two autonomous transmission channels, the MSSR interrogator supports the function of suppressing side lobes using ISLS and IISLS techniques. Transmission and selection of interrogating modes, including their sequence, may be enabled and configured via a control line. This control also enables the suppression of transmission for particular azimuth sectors.

MSSR interrogator comprises a three-channel receiver capable to detect signals received on the frequency 1090 MHz. All receiving channels are fully identical. Channels configuration enables function of suppressing receiver sidelobes by utilizing of RSLS and GTC functions.

MSSR interrogator is provided with built-in functional blocks for processing and filtering video signal of detected replies including defruiting (interference suppressing) with the capability to adjust parameters of this feature. This unit outputs also signals that enable displaying partially processed and detected replies of airborne transponders on the maintenance display in the form of analogue video signals.

MSSR interrogator is equipped with advanced diagnostics with automatic built-in test equipment (BITE) monitoring of the interrogator performance and parameters. The BITE ensures that at least 98 % detection of resulting in the mean Time to repair (MTTR) of less than 20 minutes. Built-in BITE diagnostics operates continually. BITE diagnostics results are continuously displayed on the interrogator front panel and then transmitted to the radar control and monitoring system via serial asynchronous lines.

- MSSR interrogator comprises several input/output interfaces for:
  - control and diagnostics
  - GPS receiver
  - HDLC protocol for outputting detected target data typically in the ASTERIX standard, data category 34 and 48
  - LAN for outputting detected target, control and diagnostic data

MSSR interrogator contains a built-in radar data extractor for the detection and processing replies of airborne transponders for particular modes. The interrogator extractor performs the following functions:

- Replies detection and processing
- Overlaid replies detection and processing – degarbling
- Target reply processing:
  - Validation of reply codes
  - Detection of special indicators and tag pulses – I/P, X-pulse, identification military code, 4X military emergency code, detection and validation of individual codes
  - Target azimuth calculation on the basis of 14-bit azimuth angle information

MSSR interrogator has the capability processing and interrogating in Mode S for Level 1. MSSR interrogator is capable of fast and effective upgrade of Mode S to Level 2, which enables processing, detection, generation and communication on the data messages SLM Level. This Level is the Datalink Level.

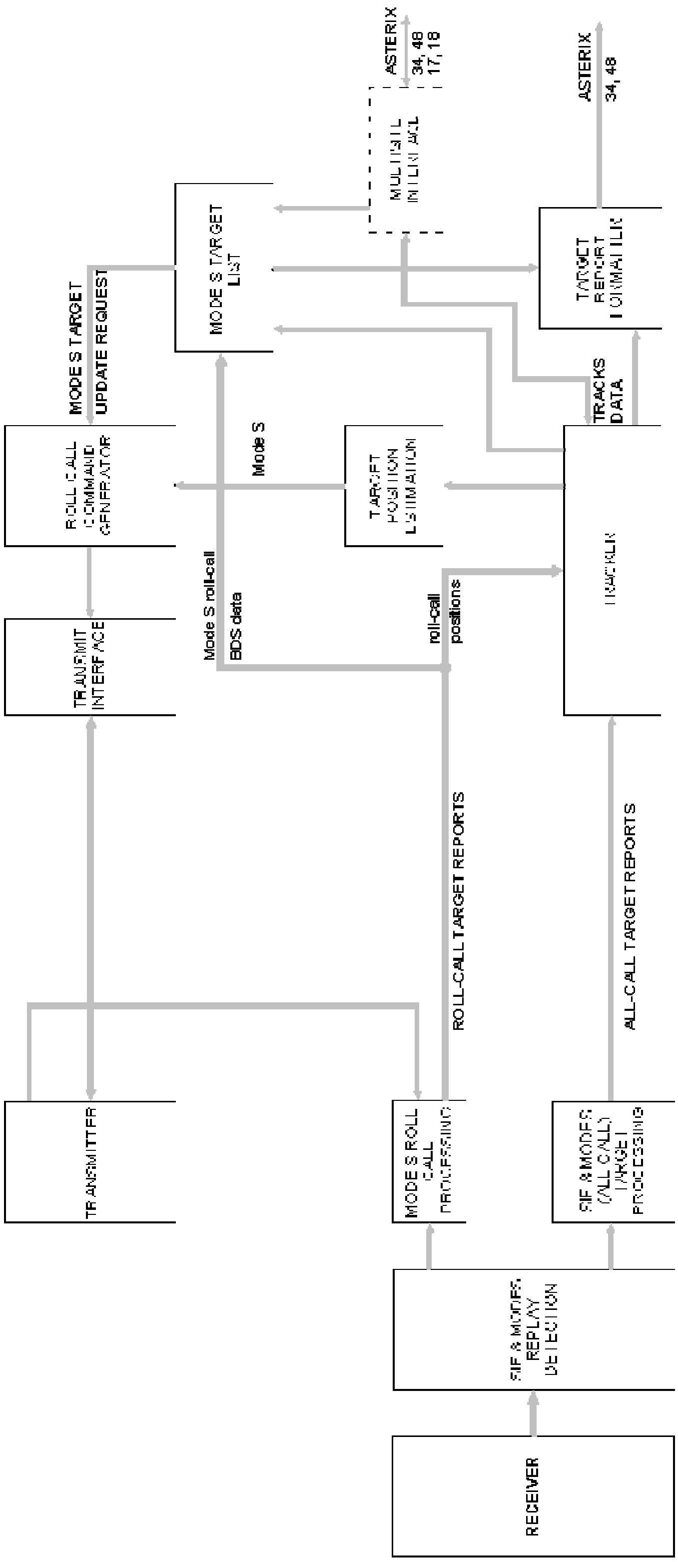


Fig. 32: Functional block diagram

These functional blocks are realized by ISSR, TSSR, PSSR and Mode-S Processor blocks.

ISSR block realizes:

- SIF & Modes Replay Detection
- SIF & Modes (All-Call) Target Processing
- Mode S Roll-Call Processing
- Roll-Call Command Generator
- Transmitter Interface

TSSR block realizes:

- Receiver
- Transnitter

PSSR block realizes power supply for receiver and transmitter.

Mode- S processor block realizes:

- Tracker
- Target Position Estimation
- Mode-S Target List
- Target Report Formatter

MSSR interrogator is powered from the main supply 230 V/50 Hz. Maximum average consumption from the main supply is less than 600 W.

7.7.2 MSSR-1 Interrogator Parameters Specification

7.7.2.1 Transmitter

Operating frequency	1030 MHz
Number of channels	SUM and OMEGA
Pulse power on the output of each channel	2500 W min.
Centre of the receiver operating frequency	1090 MHz
Number of channels	SUM, DIFF and OMEGA
Receiver bandwidth for Level:	
-0.5 dB	1087 MHz min. ÷ 1093 MHz
-3 dB	±5 MHz from the centre of operating frequency
-40 dB	±9 MHz from the centre of operating frequency
-70 dB	±25 MHz from the centre of operating frequency
Sensitivity	Receiver must output a pulse of 10 dB min. above noise Level provided that a pulse with power Level of –83 dBm appears on the interrogator antenna input connector
Dynamic range	70 dB minimum if image and intermodulation products of 2nd and 3rd order suppression included
Image suppression	80 dB min.
Pulse leading edge on receiver output	100 ns max.
Trailing edge on receiver output	100 ns max.

Pulse width on receiver output	it must correspond to the pulse width on antenna RF connector with accuracy better than 50 ns
Pulse Time jitter	less than 50 ns in relation to the input RF pulse on the antenna connector
Selectivity	pulse suppression by at least 80 dB for the frequency off the band ±25 MHz from the operating frequency center
Local oscillator suppression	-75 dBm maximum on terminating resistor of 50 Ω on antenna connectors
Receiver protection	for signals on operating frequency of 1090 MHz: - for external signals up to Level of 10 V_{pp} - average power of 20 dBm on antenna connectors - for signals off the operating frequency of 1090 MHz, 40 MHz min. away from operating frequency - for external pulse up to 1 kW peak power and 2% of relative cycle on antenna connectors

7.7.2.2 Extractor

Range of operating IRF	50 Hz ÷ 450 Hz (programmable with the help of the radar control system)
Instrument range	256 NM max. (adjustable with the help of the radar control system)
Speed of antenna rotation	max. 15 rpm
Range of ACP number per revolution	16384
Number of ARP per revolution	1
Length of ACP and ARP pulses	1 µs up to 32 µs
Probability of reply code validation	Reply code validation is defined like reception of at least two successfully received replies without interference and garbling.
Probability of resolution of two overlaid replies	P_C equals at least 0.45 for correct code extraction of two overlaid SIF replies in the case that F1 pulses of both replies are away less than 20.3 µs.
Number of false target detections	less than 0.1 % per single revolution
Probability of two targets resolution	Two targets with similar centre azimuth, which are away 120 m minimum in inclined range, shall be distinguished like two targets with at least 99 % probability.
Accuracy in range	±27 m r.m.s. w/o board transponder tolerance influence
Resolution in azimuth	Two targets at similar inclined range shall be distinguished, if separated in azimuth at least by effective width of antenna beam plus number of pulses defined by PRP repetition period, which are necessary for leading edge detection in azimuth of particular modes.
Accuracy in azimuth	Accuracy in azimuth is defined by system parameters of the radar, which the interrogator is installed in.
Processing capacity	64 targets max. in antenna beam 520 targets per second minimum
Probability of target splitting	Number of split targets does not exceed 0.1 % of overall detected targets, without influence of surrounding environment

Output data of message on detected targets	ASTERIX data format, category 48 - target position in range and azimuth - reply code for separate modes - indication of validation and garbling of separate reply codes - identification of I/P (SPI) position - indication of identification X-pulse - indication of military emergency and identification - indication of 7500, 7600, 7700 codes
Output data of ARP and sector messages	ASTERIX data format, category 34

7.7.3 Design Solution

MSSR-1 interrogator consists of following blocks:

- Electronics of the TSSR transmitter and receiver
  - RSRA receivers block
  - 2× TFSS – final amplifier
  - TMOS – modulator of transmitter
- Electronics of the receiver digital part and ISSR signal processing
- Block of PSSR power supplies
  - ZSEA and ZSEB power supplies – transmitter feeding
  - ZSV4 – feeding block with RSRA receivers
- GPS system
- Ethernet switch with power supply
- Two vent units 625

Above AA and AB cabinets with interrogators, EPS block with microwave parts is located. Racks are designed for the installation into cabinets corresponding with the 19″ standard.

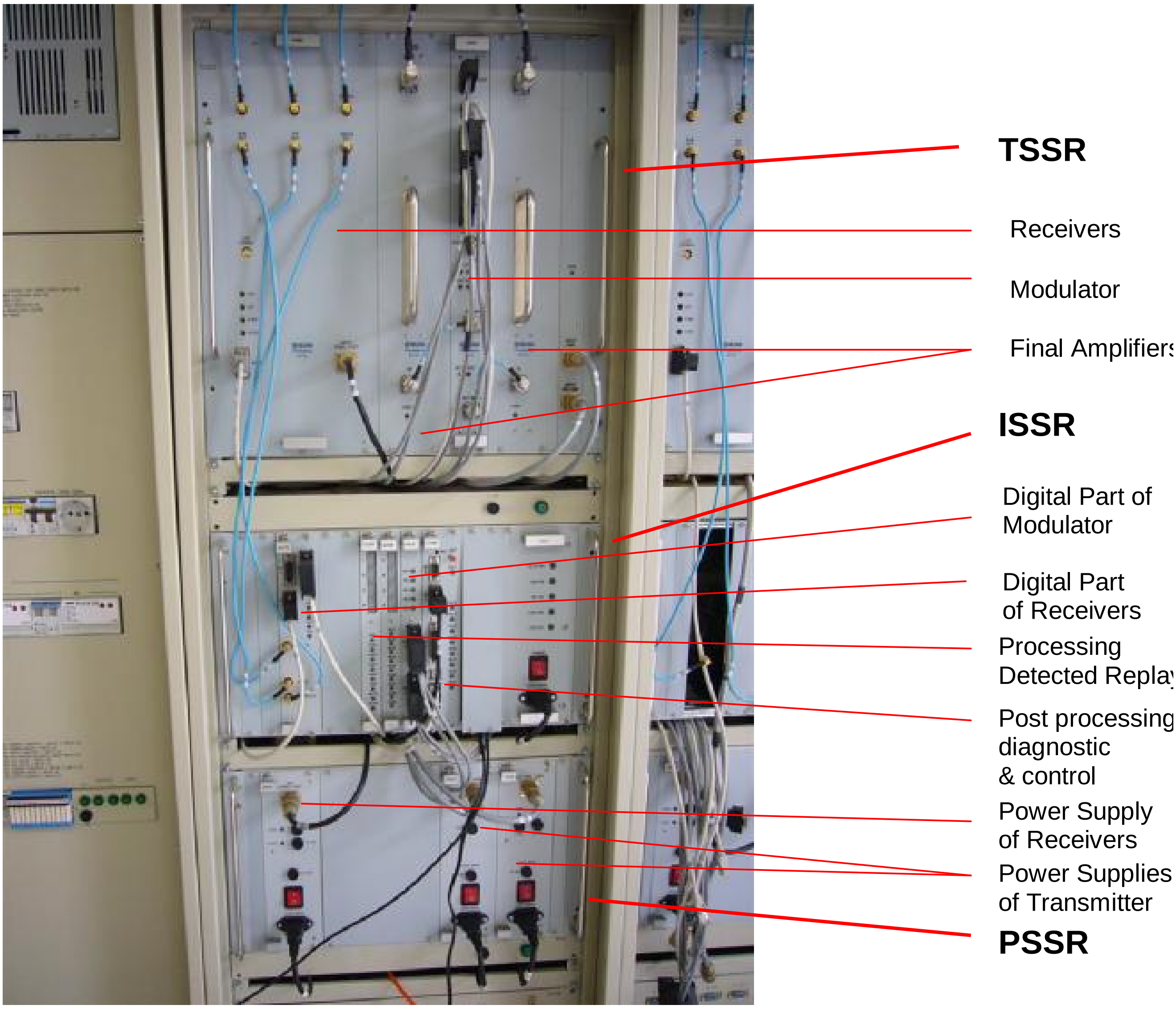


Fig. 33: Mechanical arrangements of Interrogator

7.7.4 System Interconnection

To ensure the highest possible equipment reliability, the system includes two identical and fully operational interrogators, namely MSSR-1 A and MSSR-1 B. Block diagram of these interrogator system interconnection and other radar blocks as well is shown in "*Block Diagram of MSSR-1*".

Concept of MSSR-1 A/B interrogators is designed so that their mutual interconnection and interconnection with other technological radar subsystems is minimal, and their dependence on these technological subsystems as well.

As features and interconnection of MSSR-1 interrogators, complex A and complex B, are system identical with other subblocks, only one of these interrogators shall be described in following text.

Block diagram involving system interconnection of a single interrogator collection is shown in following picture.

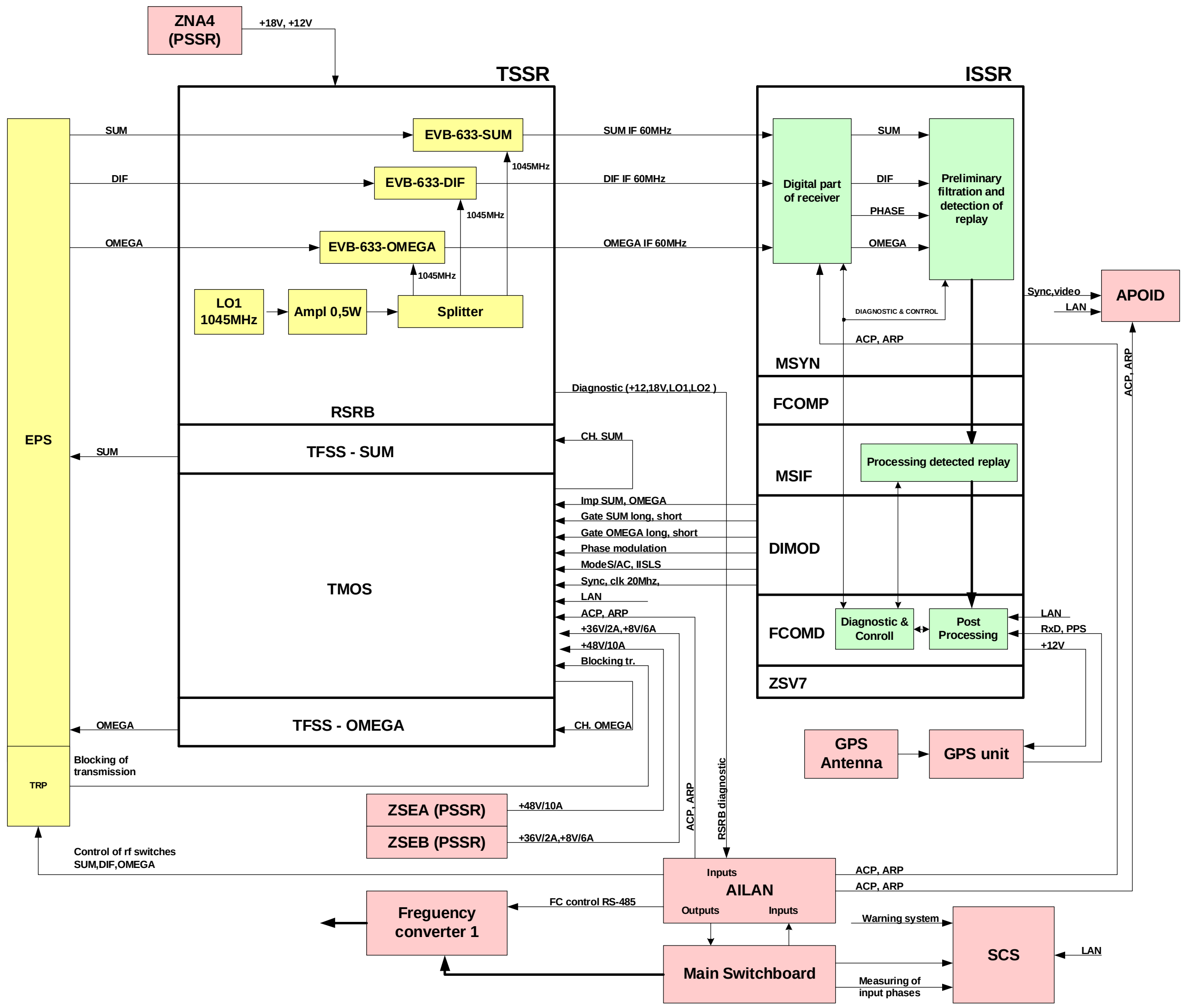


Fig. 34: System interconnection of a single interrogator of MSSR-1

MSSR-1 interrogator is the main component in this secondary radar. The interrogator output contains digital data on detected targets generated for each detected target. These data on detected targets are transmitted to the radar data processing system. Information from this interrogator can be displayed on the maintenance radar display for purpose of check and diagnostics.

Based on the interrogator system division in the “A” collection and “B” collection, a single collection comprises following parts (blocks):

- TSSR - Block of receivers and transmitters
- ISSR – Block of processing
- PSSR - Interrogator Power Supply System
- APOID block – processing and distribution of video signal
- AILAN block – AI distribution, FC control and receiver diagnostics
- AIOPTD card – AI distribution from antenna system

- GPS receiver with antenna

ZSEA and ZSEB power supplies are situated in the PSSR block and serve for feeding transmission part of the TSSR block. The ZNA4 power supply feeds the RSRB receiving part, which is also a part of the TSSR block. The DIMOD card generates format of interrogations distributed to the TMOS card, which is the interrogator transmitter modulator. TFSS terminal modules are identical for SUM and OMEGA channels. These modules amplify signals from the modulator. Amplified interrogation is lead to the EPS panel where filtered, and in dependence on the HF relay switching status, it is distributed to the antenna or directional couplers and loads where a check measurement can be realized.

Signals received to three channels of the ASSR-35 antenna are filtered in the EPS block and lead to the RSRB block where they are amplified and mixed with the frequency of 1030 MHz to the intermediate frequency of 60 MHz. These signals from the SUM, DIF and OMEGA channels are lead to the digital part of the MSYN card signal processing.

AILAN block controls one of two frequency converters feeding two antenna drive motors via the RS-485 serial line. In addition, it controls switching contactors situated in the main switchboard that are connected with the drives control. The AILAN card also evaluates the AI angle information sent from the AIOPTD card of the antenna system. The AI is processed to ACP and ARP signals in the AILAN block. These signals are lead to the MSYN card of the ISSR signal processing block. Information on the supply voltage presence and correct performance of local oscillators is also lead from the RSRB receiver part of the TSSR block to the AILAN block.

Description of APOID, AILAN blocks is a part of this document appendix. Description of the AIOPTD card is a part of the “ANTENNA SYSTEM” document appendix. Manual for the GPS receiver with antenna and manual for the frequency converter are a part of purchased parts documentation.

MSSR-1 interrogator is interconnected with following blocks and subsystems of the radar.

7.7.4.1 TSSR – Block of receivers and transmitters

Transmitter

Transmitter of the MSSR-1 interrogator is designed for generating interrogations, which are transmitted to the space with the help of antenna system, where they are intercepted by aircraft board transponders. The interrogator transmitter is a two-channel transmitter, structure of which is identical for both channels. The transmitter consists of following parts and blocks:

- final stage, driving stage
- local oscillator 1030 MHz
- interrogations modulator
- interrogations generator and synchronizing circuits
- control and diagnostics

Receiver

MSSR-1 interrogator receiver is realized like RSRA block, which is a part of the TSSR electronic unit. RSRB block contains three identical channels, namely SUM, DIF and OMEGA, and consists of following parts:

- 3 × EVB-633 / R6141 microwave receiver, which amplifies signals received on the frequency of 1090 MHz and mixes them with the local oscillator signal to the IF frequency 60 MHz.
- Local oscillator 1030 MHz / EM 1-1030 (common for all channels).
- Amplifier 0.5 W, 1 GHz / R6140 (common for all channels – it amplifies the local oscillator signal).
- Three-way splitter 1 GHz / R6142 (common for all channels – it splits the local oscillator signal into particular microwave receivers).

7.7.4.2 ISSR – Processing Block

The extractor evaluates received signals, amplified, processed and detected by the receiver, and based on the analysis of these signals, it carries out the detection of particular response codes from board transponders and airborne objects detection. Block diagram of the ISSR is shown in the figure Block diagram ISSR. The ISSR consists of following essential functional parts:

- Digital part of receiver
- Input signal processing
- Replay detection
- All Call tatget detection
- Roll Call target detection
- Roll Call generator
- Interrogation generator
- Transmitter interface
- Control and diagnostic unit
- Lan interface

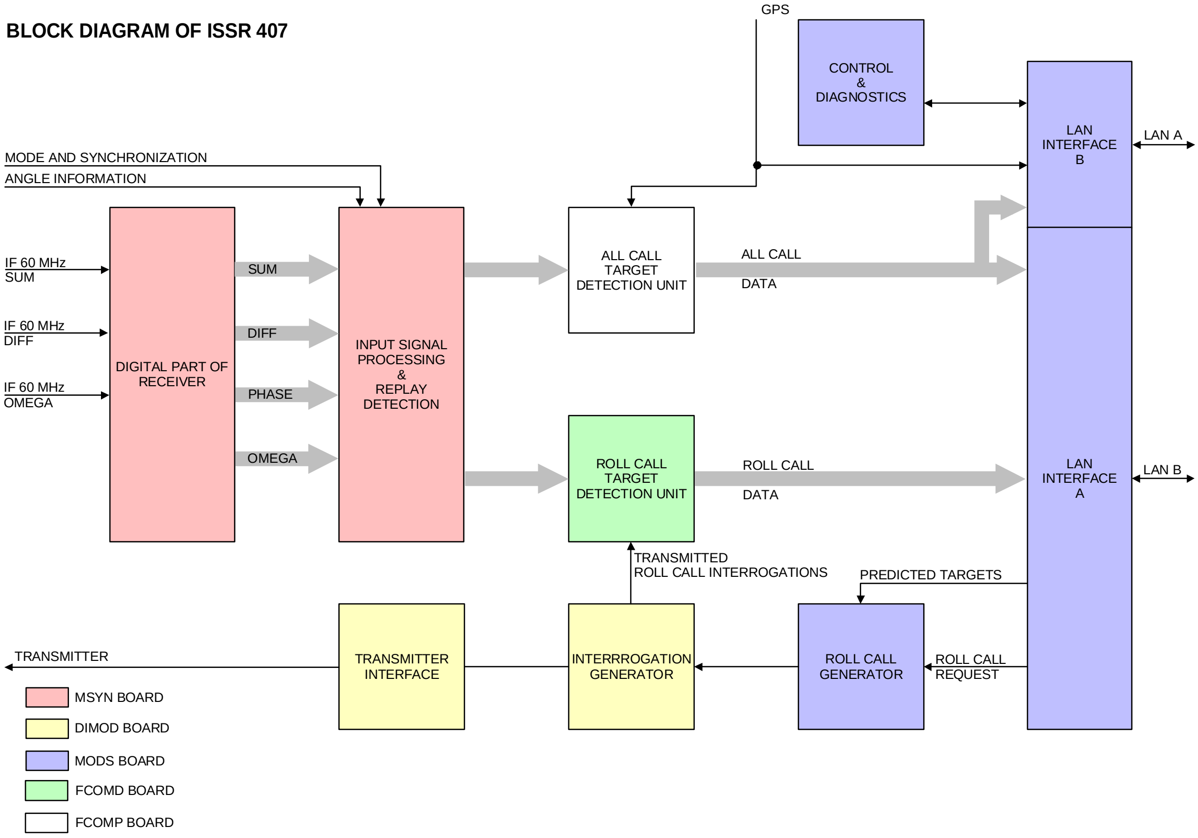


Fig. 35: Block diagram of ISSR

Description of particular functional parts is shown in the „ISSR“ book.

7.7.4.3 PSSR - Interrogator Power Supply System

PSSR block contains two power supplies, namely ZNA4, ZSEA and ZSEB.

ZSEA and ZSEB power supply feeds the TSSR electronic unit transmitter part. Supply voltages +48 VDC are lead via a cable from the ZSEA power supply to the panel of TSSR. Supply voltages +8 VDC and +36 VDC are lead via a cable from the ZSEB power supply to the panel of TSSR as well. TSSR is interconnected with the backpanel of the RSSR block transmitter part. The backpanel ensures distribution of the supply to TMOA and TFSS cards.

ZNA4 power supply generates +18 VDC and +12 VDC supply voltages for the block with RSRA receivers.

ZSV7 power supply serves for the ISSR electronic unit feeding, which is a part of the ISSR block installation.

7.7.4.4 LCMS/RCMS control and diagnostic system

Control and diagnostic system of the LCMS radar is situated in the radar site beside interrogators, and RCMS system – in the technical room. Interrogator is interconnected with this radar control and diagnostic system via LAN network.

7.7.4.5 Maintenance display of the RMM secondary radar

Interrogator is also interconnected with the local radar display. This interconnection is realized on two levels. The first level is represented by the reception of digital data on detected targets that are displayed in the local radar display system for purpose of visual checking and setting radar, including visual check of interrogator detection performance and response codes validity. Local radar display is provided with the secondary video for further enhancement of of the MSSR-1 interrogator control and diagnostics capabilities. This video represents processed video signals of the SUM beam received by the interrogator, or possibly this video represents positional pulses of particular decoded responses.

7.7.4.6 AIOPTD Module

AIOPTD module ensures following features:

- Power supply of the displacement angle encoder
- Reception and evaluation of the angle encoder signals
- Angle information transmission via optical cable
- Measure of liquid lever in speed-change box
- Oil information transmission via optical cable

Detailed description of AILAN block is a part of the “Antenna System” book appendix.

7.7.4.7 AILAN Block

AILAN block ensures following features:

- Angle information reception from optical cable
- Angle information processing and its distribution to particular blocks
- Control of frequency converters
- Antenna drive selection – one motor or two motors
- sump capacity indication
- Control and evaluation of high-frequency relays status
- Transmitter power blocking in the course of HF relay change-over
- Communication with the LCMS/RMM superior system via computer LAN network

Detailed description of AILAN block is a part of the appendix.

7.7.4.8 SMP – S-mode processor

The SMP computer contains following program modules:

- Predictive tracker
- S-mode database
- Output messages formatter
- Check display of results

Detailed description of program modules is shown in the “SMP S-mode processor” book.

8 Description of Functional Blocks

8.1 System of Interrogators Changeover, and EPS Block

During the equipment operation, only a single interrogator signal is interconnected with the ASSR-35 antenna. Change-over of the signal path between interrogator, antenna, microwave loads (SUM, DIF and OMEGA channels) is ensured by OF relay situated on the EPS block (see chapter *Microwave route and EPS block*). The second interrogator can operate in two modes:

1. STAND-BY – interrogation transmission is turned out in this mode. Interrogator can virtually directly take over the function of just turned out interrogator.
2. SERVIS – in this mode, the transmitter sends interrogation whether transmitted power is absorbed microwave load. This mode is intended for service purposes.

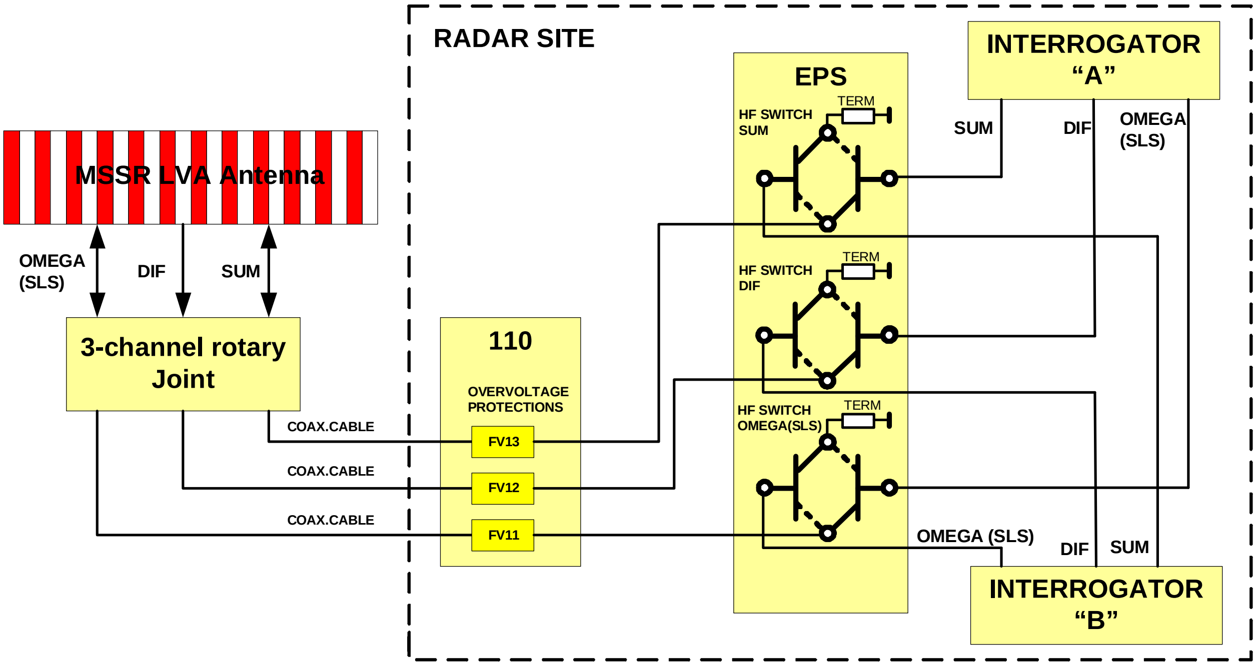


Fig. 36: Block diagram of interrogators and antenna interconnection

Picture *"Block diagram of interrogators and antenna interconnection"* shows the microwave route between "A" and "B" interrogators and ASSR-35 antenna. Panel of EPS signals switching changes over both interrogators of the MSSR-1 complex A B, so that on of them transmits and receives to the antenna, the other works to the load. Accordingly, it is possible to perform measurement and maintenance during operation (SERVIS mode).

Three coaxial cables, namely SUM, DIF and OMEGA are lead from the antenna, which change over to the MSSR-1 A or MSSR-1 B with the help of electrically controlled coaxial switches on the panel input. The other complex is switched to the load. In SUM and OMEGA channels, which the transmission is performed to, there are power loads and specific directional couplers, in which it is possible to measure transmitter output power, and low-power load in DIF channel.

8.1.1 Control and Evaluation of High-Frequency Relays Status

AILAN block ensures control of the EPS change-over block (see AILAN block diagram in the chapter AILAN), which changes over high-frequency power relays so that one half of the radar always operates to the antenna and the other to the loading resistors. As the impedance matching of particular routes not ensured during changing over, transmitters must not transmit during the HF relays in the course of changing over. Transmitters shut down shall ensure operator, remote control computer and AILAN block by means of a special signal from CON-TR connector, which blocks the transmission.

Each relay is controlled by the signal from pertinent REL1, REL2, REL3 connector. Status signals of particular relays are simultaneously lead via these connectors, which enable detect the position, which the relays are situated in. Hereat, AILAN A block can only change over the HF relay so that the radar channel A works to the antenna. AILAN B block can only change over the HF relay so that the radar channel B works to the antenna.

Process of the HF relay changing over is as follows:

1. Remote control computer shall turn out the power of both transmitters.
2. Remote control computer gives the change-over direction to both AILAN blocks.
3. AILAN blocks lock pertinent transmitter till HF relays set to required position.
4. AILAN A or AILAN B block shall transmit change-over pulse to particular HF relays.
5. AILAN A or AILAN B block shall detect condition of the HF relay switching over. If correct relay changing over does not occur, the block shall transmit switch-over pulses again. It is repeated three-times maximum, and then the block reports the HF relay switching error to the control computer.
6. If the relay correct changing-over occurs, AILAN shall release the transmitter locking.
7. Remote control computer shall turn on the power of pertinent transmitter in accordance with the operator instructions.

8.2 Transfer and Processing of Angle Information

Signal processing circuits receive signals of the displacement angle encoder (CHANNEL A, CHANNEL B and REFERENCE PULSE). Particular statuses are counted by means of bidirectional counter after the input filtration of these signals.

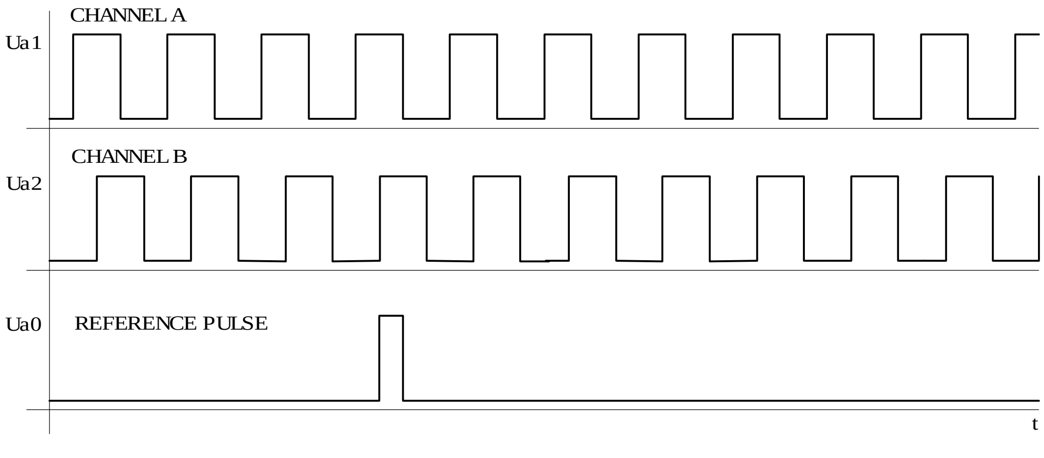


Fig. 37: Angle Information Time Behaviour

Value of rectification constant, entered in menu of the AILAN card control, is added to the counter value. Resulting value is recounted to the range of 0-16383 by means of dividing modulo 16384. In normal operation, the antenna rotates in a single direction, and rectified value of the counter changes from the value 0 to the value 16383, instead of the value 16384 is assumes the value 0, and entire process is repeated. A single ACP pulse is generated at each counter status change, and at the changeover from 16383 to 0, a single ARP pulse is generated.

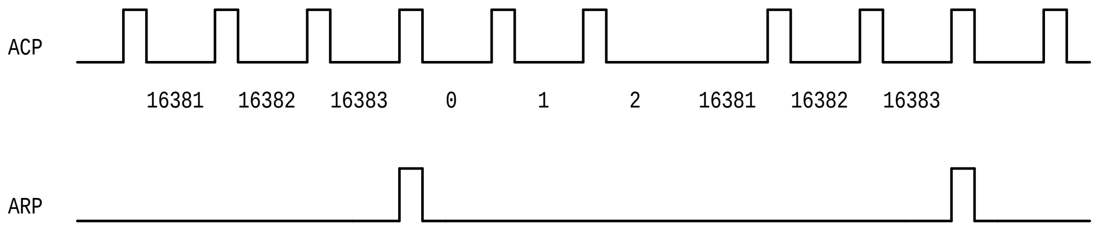


Fig. 38: ACP and ARP Time Behaviour

ACP and ARP signals are lead to AI-TR, AI-REC, AI-EZO and AI-TST connectors via RS422 line drivers. Angle information is lead to the transmitter block from the AI-TR output; the information is lead from AI-REC output to the signal processing circuits and extractor, and to the scan converter block from AI-EZO output. Angle information is transferred from the AI-TST output to the second AILAN block. The angle information can be lead to the adjoining AILAN block from the AI-TST connector, and angle information from adjoining AILAN block is simultaneously received through this connector. It enables the angle information comparison in each block from own and adjacent encoder. Maximum and minimum of the angle information value differences during a scan are then transferred to the control computer. It enables performing rectification of a single replaced encoder in accordance with the encoder value so that the difference maximum and minimum symmetrically around zero. If significant increasing of the maximum and minimum value difference occurs, it indicates a failure or future failure of any encoder.

8.3 Antenna Drive Control

The antenna is put in motion by two main motors, A and B. Supply voltage for motors is fed from A and B frequency converter outputs situated in electronic units cabinet. The first frequency converter is utilized for the antenna drive, the other is ready like a reserve. If the frequency converter A in operation, motor A shall be always connected to its output. In such case, motor B can be connected in parallel to the motor A by means of a command from the LCMS/RCMS electronic unit. If the frequency converter B in operation, motor B shall be always connected to its output. In such case, motor A can be connected in parallel to the motor B by means of a command from the LCMS/RCMS electronic unit.

Frequency converter output is automatically monitored from the viewpoint of output current and voltage, and from the viewpoint of motor/motors insulation integrity including connecting cable between the converter and motor.

Antenna drive and frequency converter status is a part of the status message to the LCMS/RCMS where it is displayed.

Required rotation rate can be set in the AILAN window on the LCMS/RCMS screen. The scan time is measured in tenths of second and displayed on the screen.

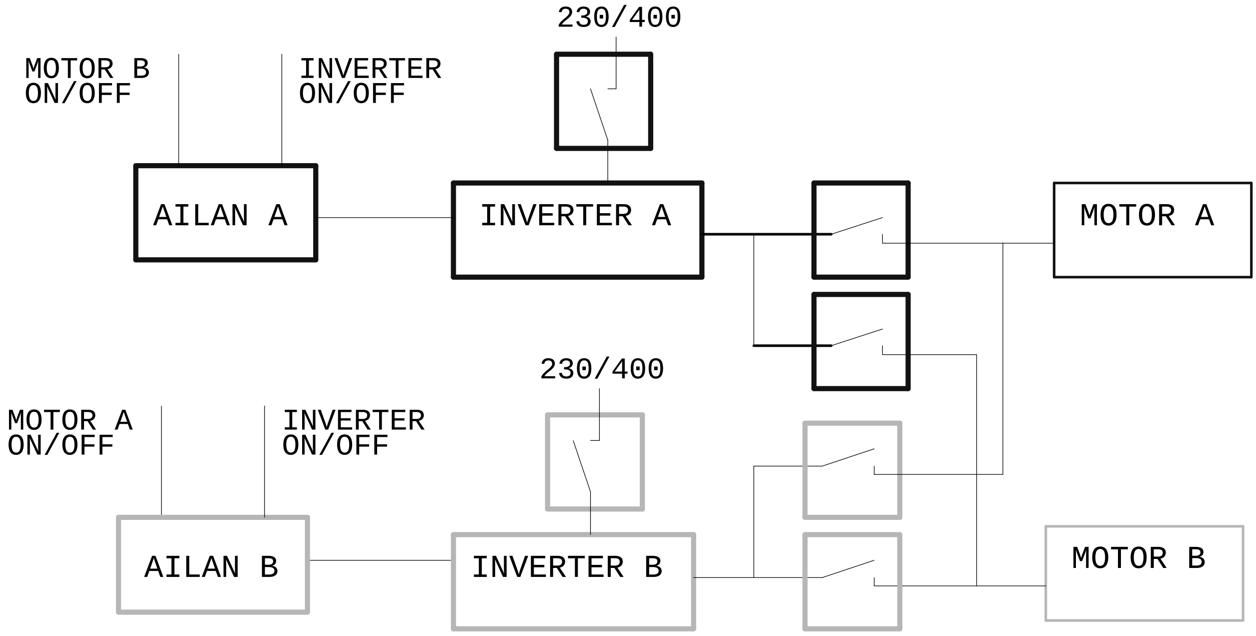


Fig. 39: Antenna Drive Control

Other information of the Antenna Drive Control is given in „AIULAN Block“ and „Switchboard 100“ appendices.

8.4 Unified Time Distribution

Two GPS receivers Garmin of are utilized in the system. Antennas of GPS receivers are situated on the radar site roof and connected via the container 110 passage to antenna inputs of receivers. The first GPS A and GPS B receivers are situated in the AD interrogator cabinet. Each receiver transmits the time information to interrogator. GPS receivers are fed from FCOMD cards. Supply voltage of GPS receivers is combined in particular GPS Splitter, and then is lead to a pertinent GPS receiver. FCOMD cards are provided with fuses protecting this power supply circuitry.

Signals of GPS receiver

GPS receiver signals comprise time specification for the realization of a unified time system within the framework of the radar data processing system. GPS receiver generates two different signal types:

- PPS second pulse
- data frame describing time properties of the PPS signal

Structure and mutual relationship of these signals is shown in Fig. 39.

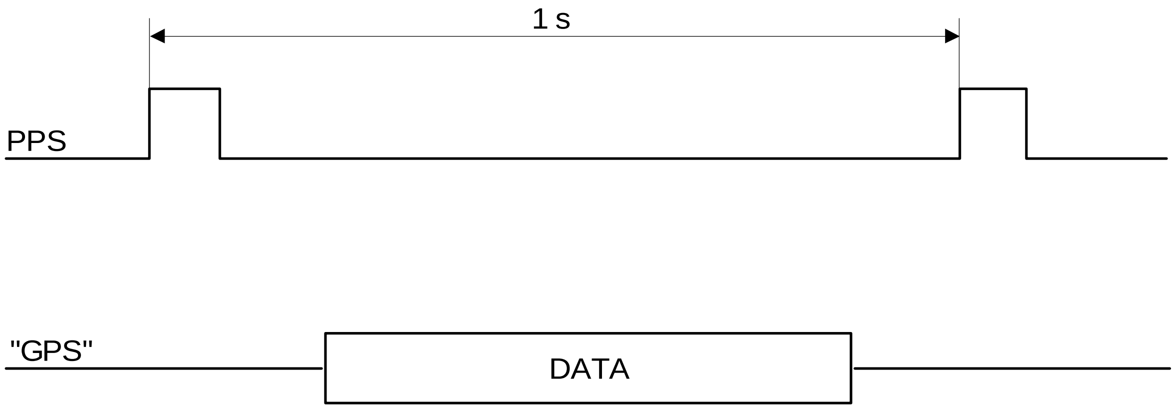


Fig. 40: Time characteristics of signals generated by GPS

Detailed description of the Unified Time Distribution System is shown in the ISSR book.

9 MSSR-1 Radar Engineer’s Check Console

Engineer’s check console is a part of MSSR radar configuration. It involves following devices:

- 2× LCMS/RMM workstations (Local Control & Monitoring System /Radar Maintenance Monitor)

Both workstations include following assembly:

- 3× 21” LCD monitor, 1600×1200
- 3× Keyboard, trackball

These components are situated at the engineer’s console table. This assembly enables:

- Control and monitoring of MSSR-1 radar status
- Control and monitoring of MSSR-1 radar signal processing status
- Interconnection with remote site and capability of control and monitoring from the RCMS and RMM.
- MSSR-1 radar information display
- Recording and replaying following data and information (standard part of this offer):
    - Radar information from both radars output and signal processing output. Recording is enabled including particular video signals from both radars.
    - Particular commands for radar control and signal processing control
    - Status of subsystems and units from both radars and signal processing
    - Time stamp
    - Archiving of above mentioned data on DVD-RAM

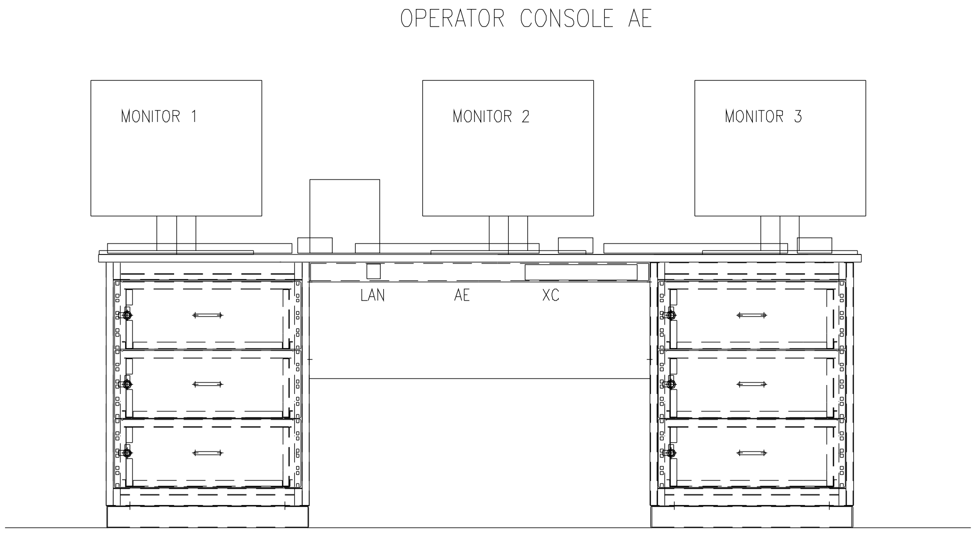


Fig. 39: Engeneer's Check Console

10 Description of LAN and Data Transmission between Radar and Technical Room

10.1 LAN

Complex view of the LAN interconnection within the radar site and technical room is displayed in Fig. 41.

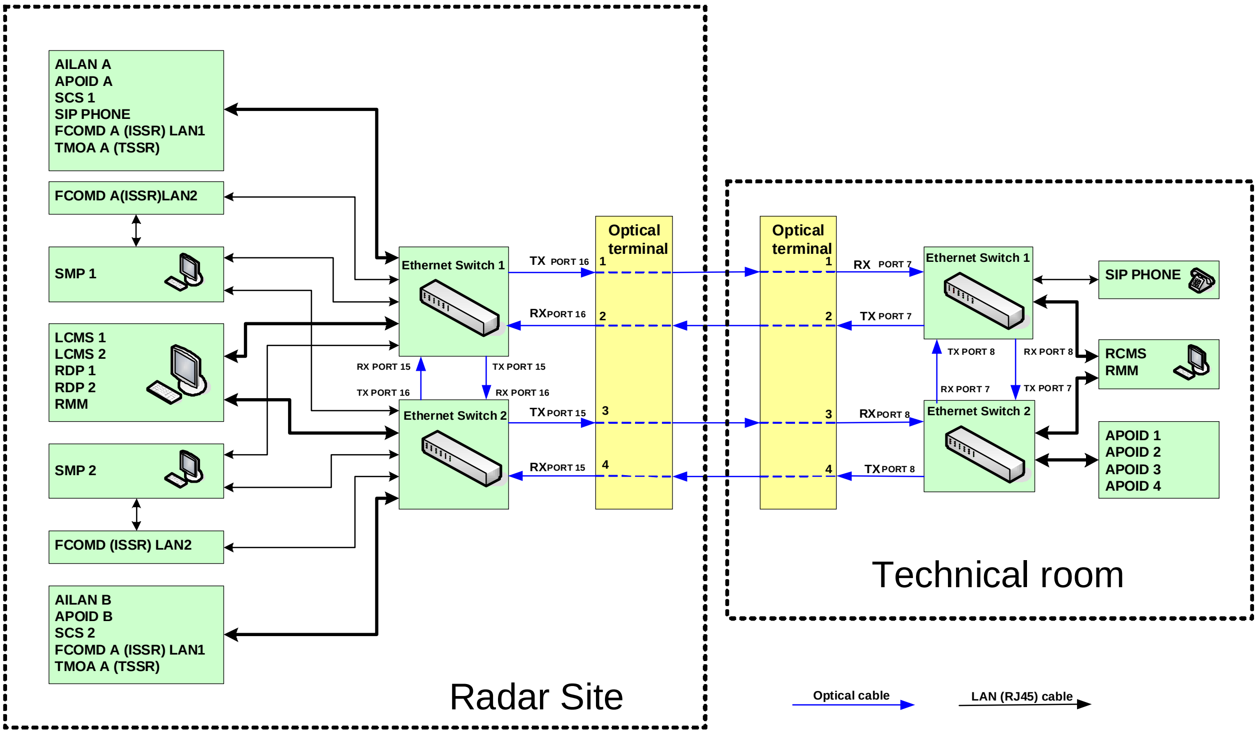


Fig. 41: Block diagram of the LAN distribution

Two 18-port redundant ethernet switches (ES1 and ES2) are situated in the radar site AD cabinet. These switches contain 14 ethernet RJ45 10/100/1000BaseT(X) ports, two ports with the data baud rate o 2 GB and two ports with optical MM interface provided with SC connectors.

TCP or UDP protocol is utilized for the communication between the equipment blocks and ES.

10.2 IP Addresses

Blocks creating the LAN are determined by their specific IP address. This address is a fixed address, set in each communication sub-block. In case of spare parts application that are common for the secondary radar complex A and B and communicate via LAN, it shall be necessary to set correct IP address.

NET	192.168.5.0
NETMASK	255.255.255.0
DEFAULT GATEWAY	192.168.5.254

IP Addresses of Parts in Radar Site

Part	IP address	Port
LCMS “1”	192.168.5.1	
LCMS “2”	192.168.5.2	
RDP “1”	192.168.5.21	
RDP “2”	192.168.5.22	
SMP “1” LAN1,2	192.168.5.23	
SMP “1” LAN3 - S-mode	IP 172.16.0.23 Netmask 255.255.255.0	TCP 0x4210 Request Roll Call TCP 0x3020 Predict. Target
SMP “2” LAN1,2	192.168.5.24	
SMP “2” LAN3 - S-mode	IP 172.16.1.24 Netmask 255.255.255.0	TCP 0x4210 Request Roll Call TCP 0x3020 Predict. Target
RMM	192.168.5.3	
ES MOXA “1”	192.168.5.201	
ES MOXA “2”	192.168.5.202	
SIP PHONE	192.168.5.211	
AILAN “A”	192.168.5.101	
AILAN “B”	192.168.5.102	
FCOMD (ISSR “A”) LAN	192.168.5.103	TCP 0x4000 extractor control TCP 0x4005 DIMOD control Time UDP 192.168.5.255 0x3420 All Call Target
FCOMD (ISSR “A”) LAN2 –S-mode	IP 172.16.0.103 Netmask 255.255.255.0	TCP 0x4220 Roll Call Target UDP 172.16.0.255 0x3420 All Call Target
FCOMD (ISSR “B”) LAN	192.168.5.104	TCP 0x4000 extractor control TCP 0x4005 DIMOD control Time UDP 192.168.5.255 0x3421 All Call Target

FCOMD (ISSR “B”) LAN2 –S-mode	IP 172.16.1.104 Netmask 255.255.255.0	TCP 0x4220 Roll Call Target UDP 172.16.1.255 0x3421 All Call Target
TMOS (TSSR “A”)	192.168.5.105	
TMOS (TSSR “B”)	192.168.5.106	
APOID “A”	192.168.5.107	
APOID “B”	192.168.5.108	
SCS “1”	192.168.5.109	TCP 0x3030 status, control TCP 0x3040 statement from SCS “1”
SCS “2”	192.168.5.110	TCP 0x3030 status, control TCP 0x3040 statement from SCS “2”

IP Addresses of Parts in Technicial Room

Part	IP address
RCMS	192.168.5.41
RMM	192.168.5.42
ES MOXA “1”	192.168.5.203
ES MOXA “2”	192.168.5.204
SIP PHONE	192.168.5.212
APOID “1”	192.168.5.111
APOID “2”	192.168.5.112
APOID “3”	192.168.5.113
APOID “4”	192.168.5.114

Pre-set IP Addresses of Spare Parts

Part	Pre-set IP address
ES MOXA	192.168.5.205
AILAN “A”	192.168.5.101

11 Appendices

Appendix 1: AILAN Block

Appendix 2: Scan Module

Appendix 3: Overvoltage Protections block 110

Appendix 4: Switchboard 100

Appendix 5: Switchboard 102

Appendix 6: Switchboard 103

Appendix 7: SCS – Status and Control Switchboard

Appenidx 8: EPS Module

Appendix 9: Interface Control Document

Appendix10: Signal Cabling Block Diagrams

Appendix 1: AILAN Block

1 AILAN Block

AILAN block ensures following features:

- Angle information reception from optical cable
- Angle information processing and its distribution to particular blocks
- Control of frequency converters
- Antenna drive selection – one motor or two motors
- sump capacity indication
- Control and evaluation of high-frequency relays status
- Transmitter power blocking in the course of HF relay change-over
- Communication with the LCMS/RMM superior system via computer LAN network

1.1 AILAN block description

The block design arrangement is such that it enables installation to the 19″ cabinet. Module height equals 2U. Signal connectors and supply connector are accessible from the front block panel.

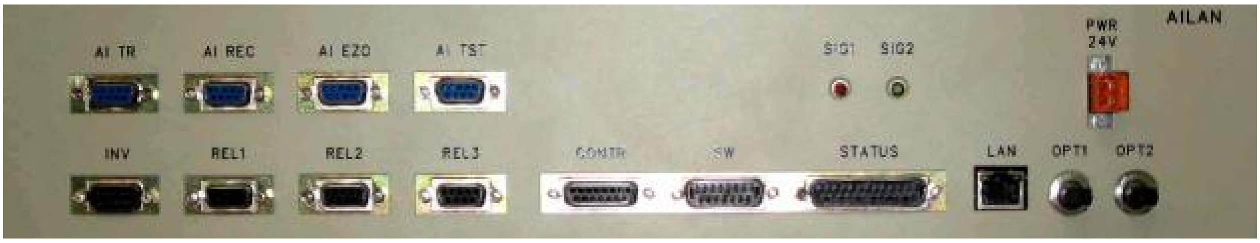


Fig. 1: AILAN block

The block is fed by the voltage of 12 – 30 VDC. Main control voltage of 24 V is used by default for feeding.

1.2 Description of Function Parts

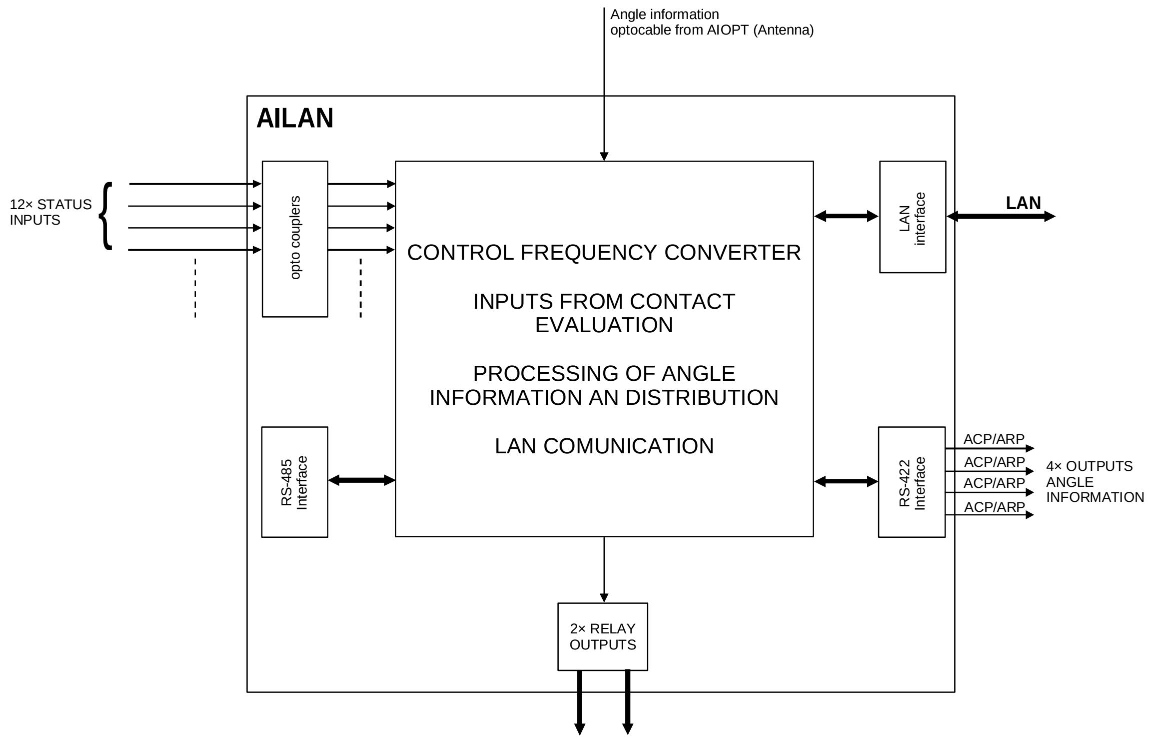
Angle information reception from optical cable

Serial code of current status of the antenna displacement angle encoder transmitted from the AIOPT block via optical fiber is converted to the TTL signal by means of the optical receiver. AIOPT block contain optical connector OPT1.

OPT2 connector is used for the reception of a signal on the oil level state in the antenna gearbox. Serial code transmitted from the AIOPTA module is received by the card internal circuits, and the data are transmitted to the central control computer like a part of the status message.

In case of the oil level drop, a warning message appears on the central computer screen. As soon as the level decreases under specified limit, the antenna movement automatically stops.

Way of control and evaluation of the high-frequency relays status is described in the chapter *Microwave route and EPS block.*



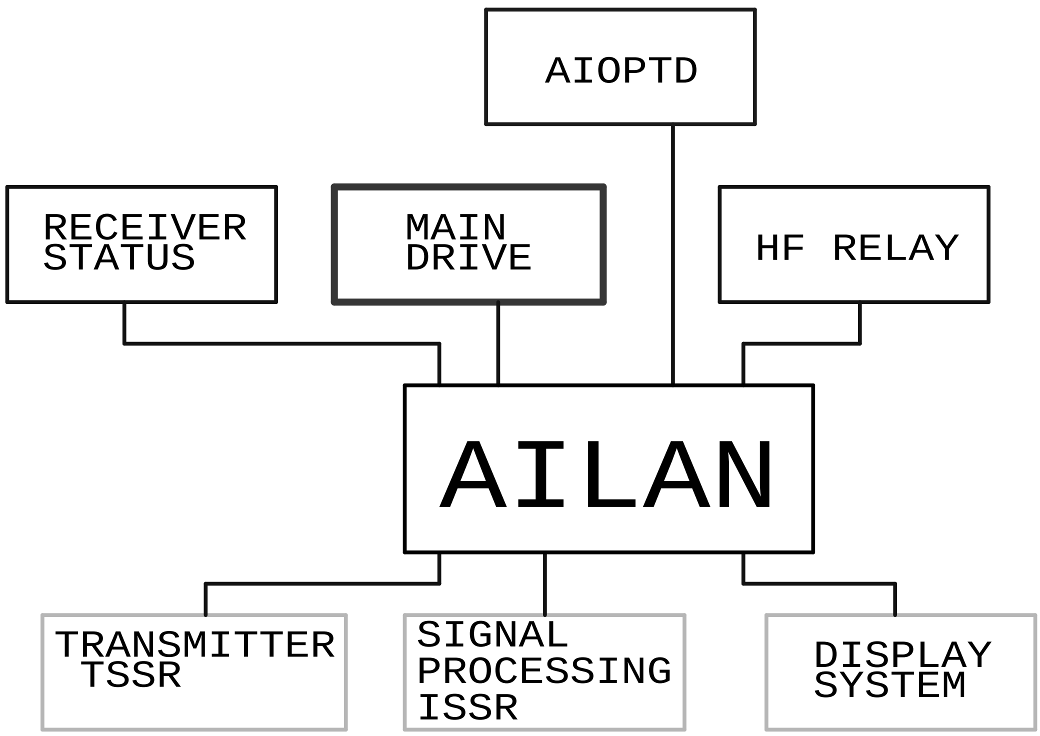
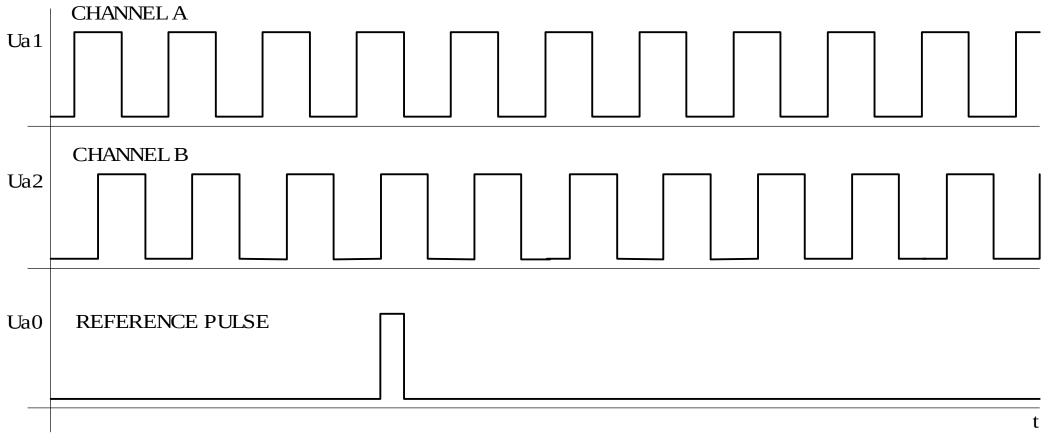


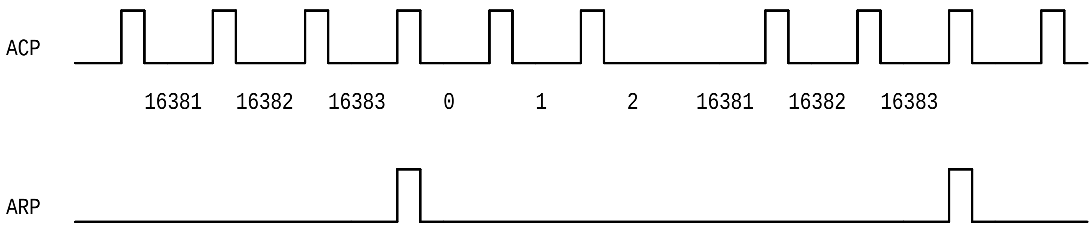
Fig. 2: AILAN block – system interconnection

1.2.1 Angle Information Processing and Distribution to Blocks

Signal processing circuits receive signals of the displacement angle encoder (CHANNEL A, CHANNEL B and REFERENCE PULSE). Particular statuses are counted by means of bidirectional counter after the input filtration of these signals.



Value of rectification constant, entered in menu of the AILAN card control, is added to the counter value. Resulting value is recounted to the range of 0-16383 by means of dividing modulo 16384. In normal operation, the antenna rotates in a single direction, and rectified value of the counter changes from the value 0 to the value 16383, instead of the value 16384 is assumes the value 0, and entire process is repeated. A single ACP pulse is generated at each counter status change, and at the changeover from 16383 to 0, a single ARP pulse is generated.



ACP and ARP signals are lead to AI-TR, AI-REC, AI-EZO and AI-TST connectors via RS422 line drivers. Angle information is lead to the transmitter block from the AI-TR output; the information is lead from AI-REC output to the signal processing circuits and extractor, and to the scan converter block from AI-EZO output. Angle information is transferred from the AI-TST output to the second AILAN block. The angle information can be lead to the adjoining AILAN block from the AI-TST connector, and angle information from adjoining AILAN block is simultaneously received through this connector. It enables the angle information comparison in each block from own and adjacent encoder. Maximum and minimum of the angle information value differences during a scan are then transferred to the control computer. It enables performing rectification of a single replaced encoder in accordance with the encoder value so that the difference maximum and minimum symmetrically around zero. If significant increasing of the maximum and minimum value difference occurs, it indicates a failure or future failure of any encoder.

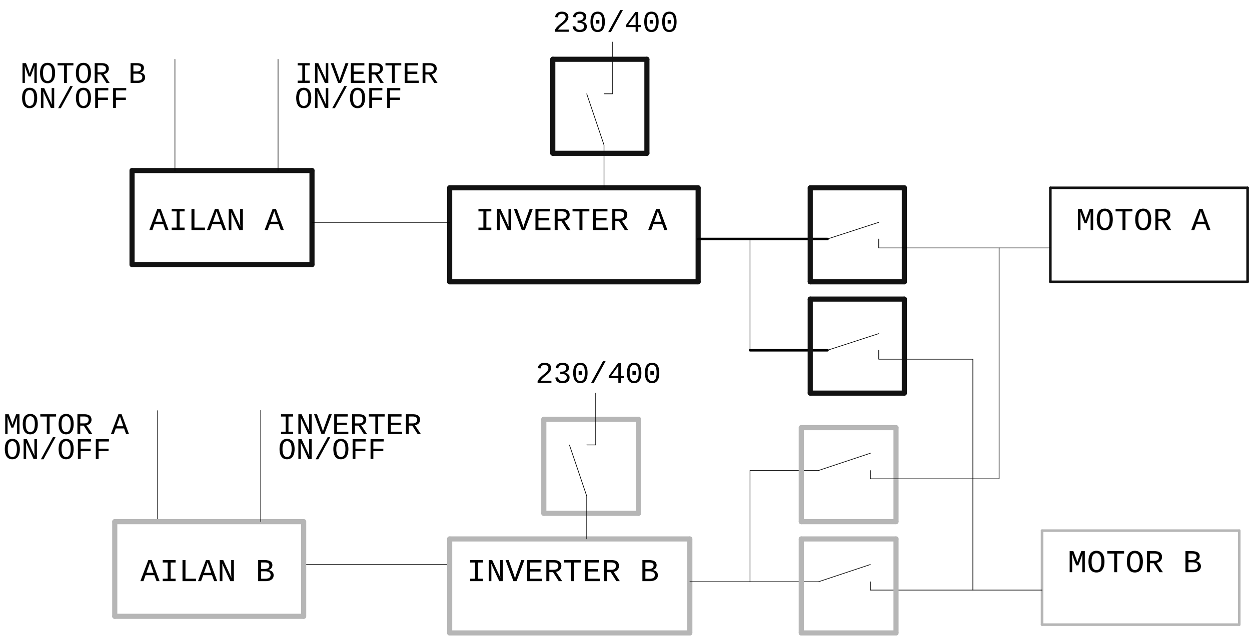
1.2.2 Antenna Drive Control

The antenna is put in motion by two main motors, A and B. Supply voltage for motors is fed from A and B frequency converter outputs situated in electronic units cabinet. The first frequency converter is utilized for the antenna drive, the other is ready like a reserve. If the frequency converter A in operation, motor A shall be always connected to its output. In such case, motor B can be connected in parallel to the motor A by means of a command from the LCMS/RCMS electronic unit. If the frequency converter B in operation, motor B shall be always connected to its output. In such case, motor A can be connected in parallel to the motor B by means of a command from the LCMS/RCMS electronic unit.

Frequency converter output is automatically monitored from the viewpoint of output current and voltage, and from the viewpoint of motor/motors insulation integrity including connecting cable between the converter and motor.

Antenna drive and frequency converter status is a part of the status message to the LCMS/RCMS where it is displayed.

Required rotation rate can be set in the AILAN window on the LCMS/RCMS screen. The scan time is measured in tenths of second and displayed on the screen.



1.3 Connectors on the front panel

Connector **Status** DB25M

PIN	Signal	Note
1/14	Status 1	
2/15	Status 2	
3/16	Status 3	
4/17	Status 4	
5/18	Status 5	
6/19	Status 6	
7/20	Status 7	

8/21	Status 8	
9/22	Status 9	
10/23	Status 10	
11/24	Status 11	
12/25	Status 12	

Connector **REL1, REL2, REL3** DB9F

PIN	Signal	Note
1,2	Switch pulse (command)	
3	GND (command ground)	
6	Position A (status)	
7	Position B (status)	
8	GND (status ground)	

Connector **INV** DB9M

PIN	Signal	Note
1	DataP (positive signal)	
6	DataN (negative signal)	
5	GND (common ground)	

Connector **AI TR, AI REC, AI EZO** DB9F

PIN	Signal	Note
1/2	ACP (angle information pulses)	
3/4	ARP	
5	GND (common ground)	

Connector **AI TST** DB9F

PIN	Signal	Note
1/2	ACP OUT (angle information pulses)	
3/4	ARP OUT	
5	GND (common ground)	
6/7	ACP IN	
8/9	ARP IN	

Connector **SW** DB15M

PIN	Signal	Note
1	SWON 1	
2	SIG PWR	
3	SWOFF 1	
4	SWON 2	
5	SW 2	
6	SWOFF 2	
9	SWON 3	
10	SW 3	
11	SWOFF 3	
12	SWON 4	
13	SW 4	
14	SWOFF 4	

1.3.1 AILAN Card Communication with Superior System

Communication with LCMS/RMM superior system is ensured via LAN computer network.

Communication protocol is as follows:

Data are transferred via LAN. Data structure is transmitted by AILAN card once per second into all control computers connected to it.

R – data item only for reading

W – the item can be controlled and read

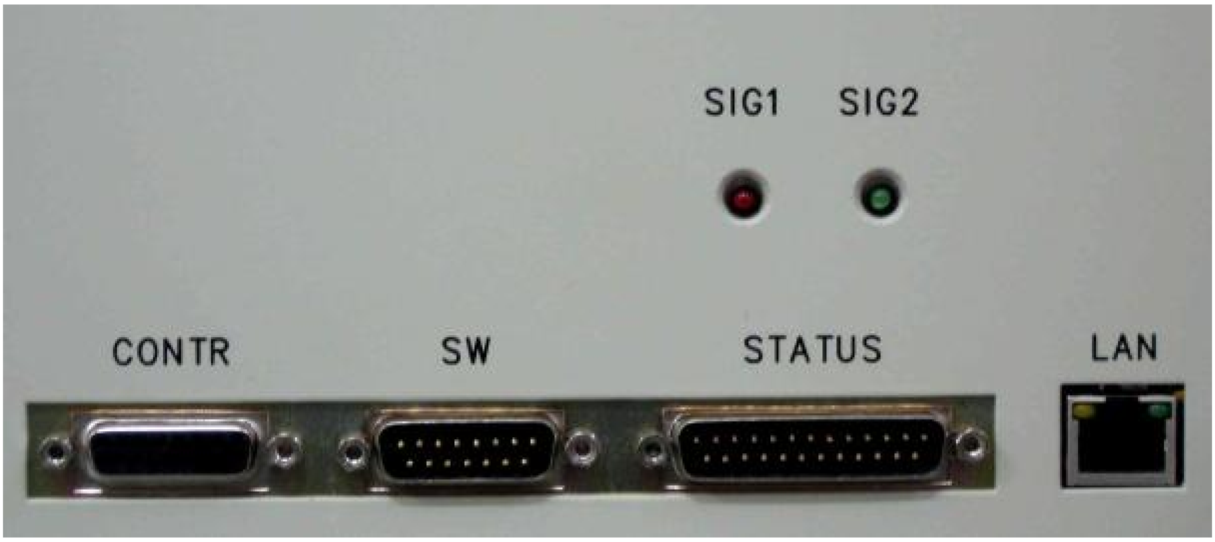
Message length equals 0×1C bytes

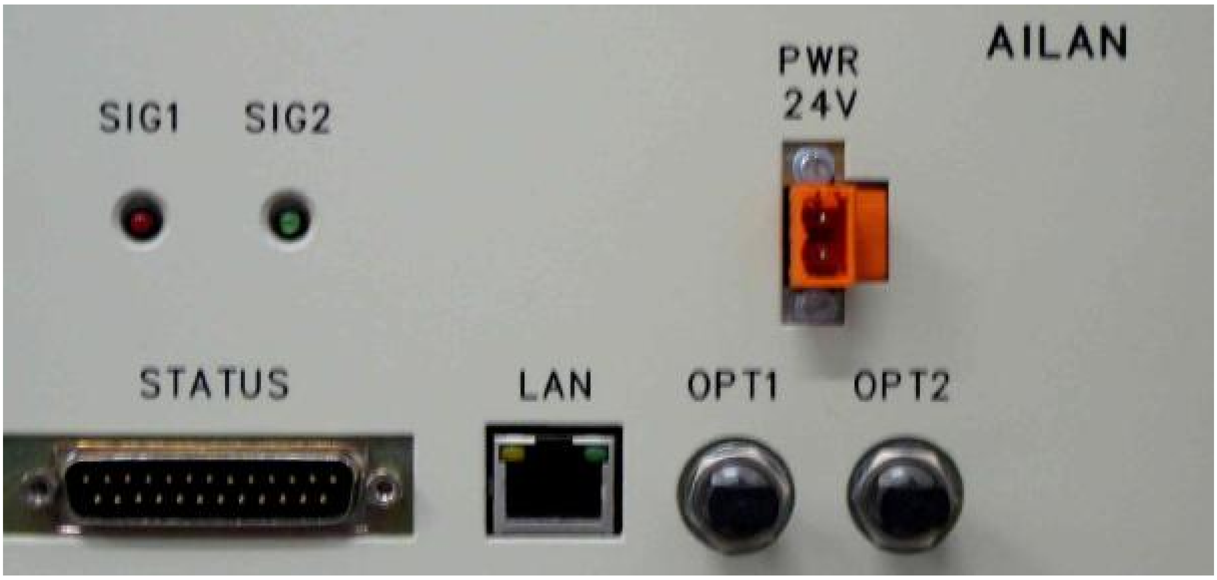
Byte	Function	Meaning
0	R	Overall status D5 in green color, other in red color Command accepted and executed Unknown command 0C Command cannot be executed D0 Block configuration test D1 Reserve D2 Reserve D3 HF relay error D4 Operation blocking

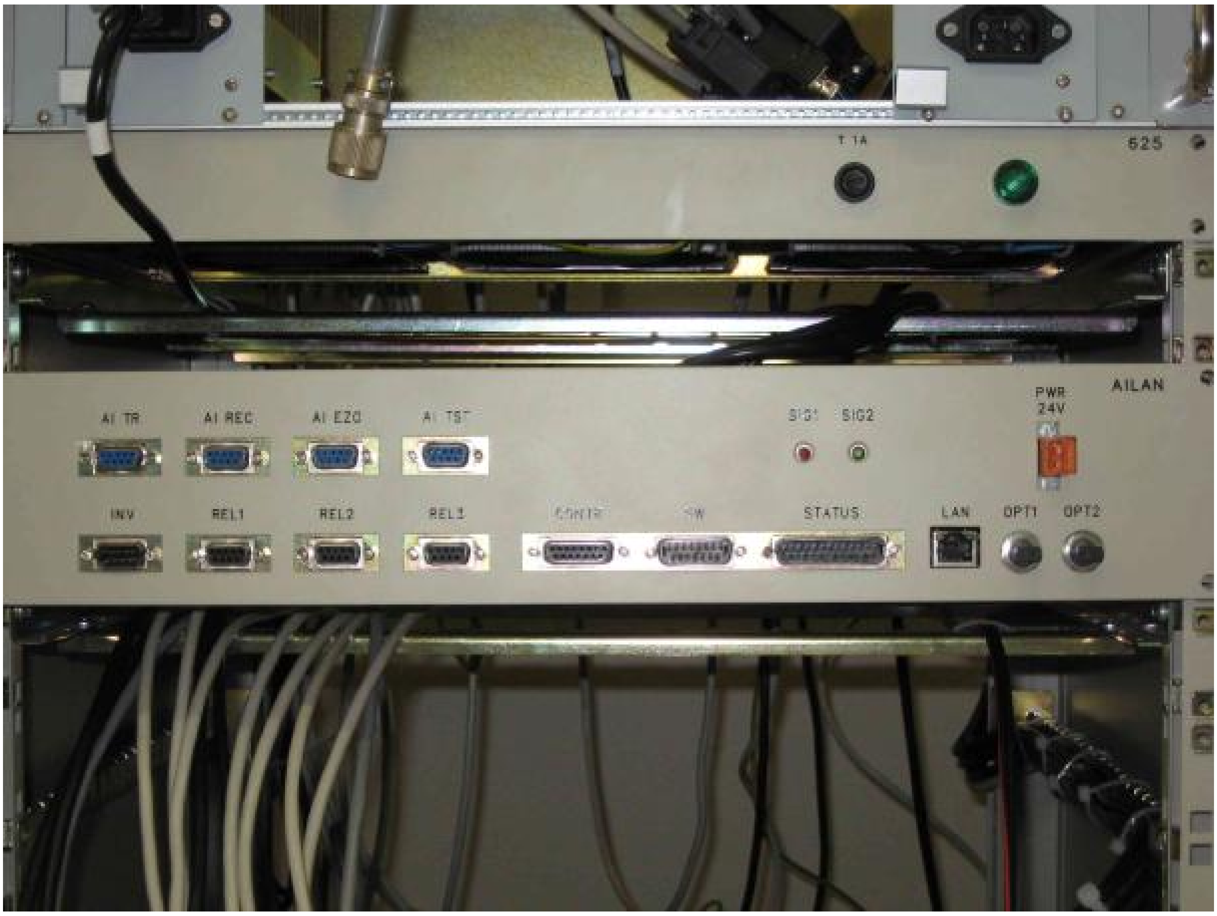
		D5 Operational condition D6-DF Reserve
1	R	Status 1 Bit 0 1= converter supply turned out 1 1= converter output turned on 2 1= motor 1 turned on 3 1= motor 2 turned on 4 1= antenna blocked
2	R	Status 2 0 =1 oscillator 120 MHz ok 1 =1 oscillator 1045 MHz ok 2 =1 receiver supply +18 V ok 3 =1 receiver supply +12 V ok
3	RW	Required status of HF relay R Bit 0 – SUM relay status R Bit 1 – DIF relay status R Bit 2 – OMEGA relay status R Bit 3 – SUM relay error R Bit 4 – DIF relay error R Bit 5 –OMEGA relay error W Bit 7 – required status of all relays
4	R	Angle information status Bit 0 =1 azimuth change pulses of the encoder OK Bit 1 =1 azimuth rectification pulse of the encoder OK Bit 2 =1 azimuth change pulses of adjoining card OK Bit 3 =1 azimuth rectification pulse of adjoining card OK
5	R	Maximum difference of the angle information H
6	R	Maximum difference of the angle information L
7	R	Minimum difference of the angle information H
8	R	Minimum difference of the angle information L
9	R	Current value of the angle information H
0xa	R	Current value of the angle information L
0xb	RW	Rectification H
0xc	RW	Rectification L
0xd	R	The last scan time in tenths of second
0xe	W	Required rotation rate

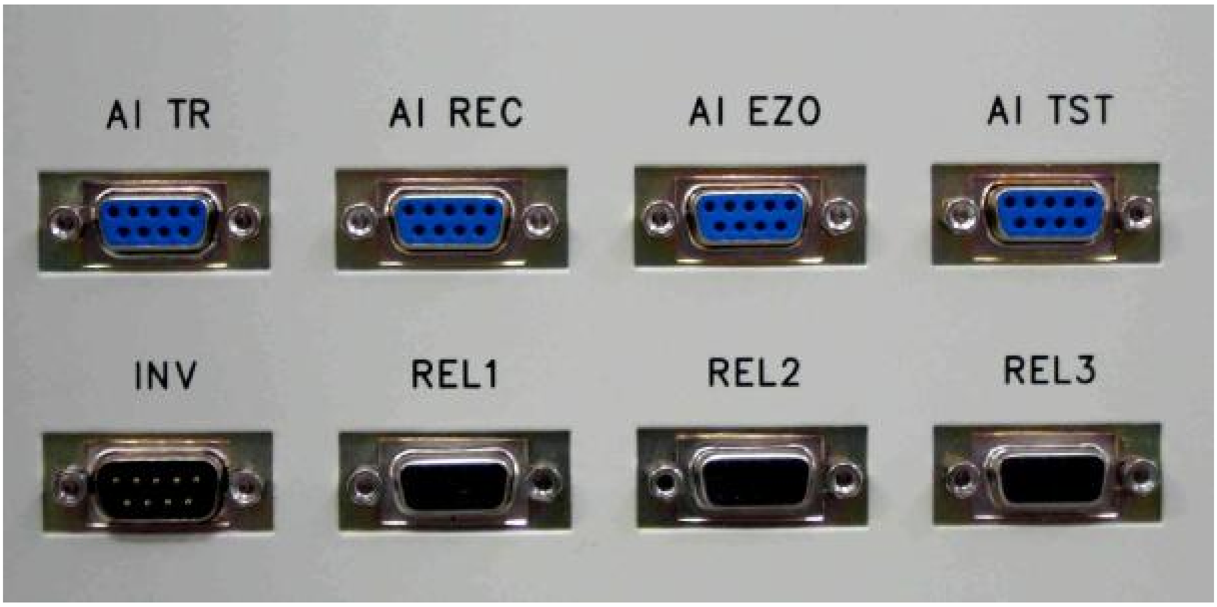
0xf		Start 0 – STOP 1 – START
0x10		Status of inverter 00... Initial status 01... (Reserved) 02...Stop Mode 03...Run Mode 04... Free-run stop (FRS) 05... Jogging 06... DC braking 07... Retry 08...Trip alarm 09... Under-voltage
0x11	R	Converter output frequency in Hz
0x12	R	Output current in tenths of ampere
0x13	R	Output voltage in tens of volts
0x14	R	Overall time of converter heating in hrs H
0x15	R	Overall time of converter heating in hrs L
0x16	R	Overall time of converter turned-on power in hrs H
0x17	R	Overall time of converter turned-on power in hrs L
0x18	R	Oil level
0x19		Reserve
0x1a		Reserve
0x1b		Reserve

Table: Communication frame of AILAN block


SIG1
SIG2
CONTR
SW
STATUS
LAN


AILAN
PWR
24V
SIG1
SIG2
STATUS
LAN
OPT1
OPT2

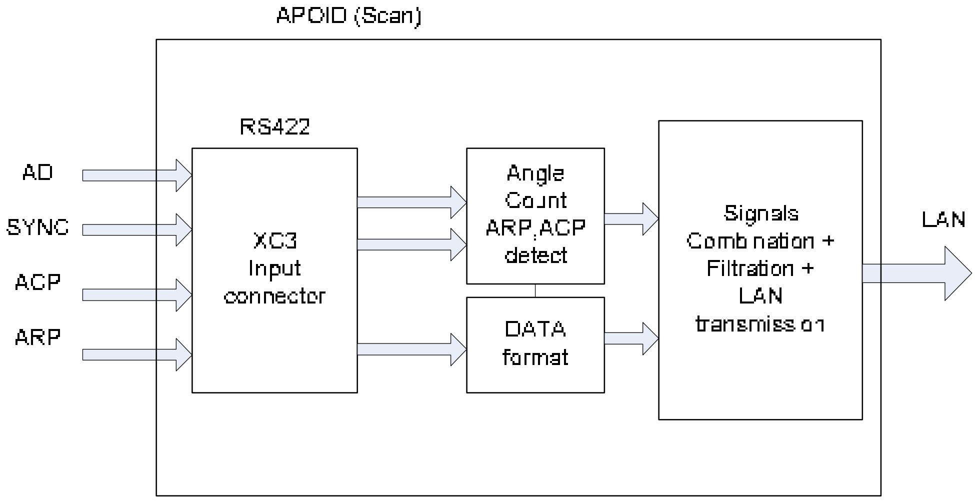

T 1A
625
AI TR
AI REC
AI EZO
AI TST
SIG1
SIG2
PWR
24V
AILAN
INV
REL1
REL2
REL3
STATUS
LAN
OPT1
OPT2


AI TR
AI REC
AI EZO
AI TST
INV
REL1
REL2
REL3

Appendix 2: Scan module

Essential properties of the module:

- Reception of signals via RS422 interface
- Processing input signals from the radar and their conversion to data words
- Transmitting processed data to the LAN network



Block diagram of Scan module

The scan function is ensured by the APOID universal block. It enables the signals reception via the RS422 interface, which is connected with the help of the XC3 external connector. Description of this connector wiring is given in following table.

Pin	Signal
1/14	ACP
2/15	ARP
3/16	SYNC
4/17	AD

XC3 input connector wiring

Received signals are processed and reformatted to 16-bit words of a single-bit video. Strucure of formatting protocol is described in following table.

Organization of 16-bit word:

Word with video signal

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	Ad14	Ad13	Ad12	Ad11	Ad10	Ad9	Ad8	Ad7	Ad6	Ad5	Ad4	Ad3	Ad2	Ad1	Ad0

Word with video signal

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	An13	An12	An11	An10	An9	An8	An7	An6	An5	An4	An3	An2	An1	An0

Word with compression

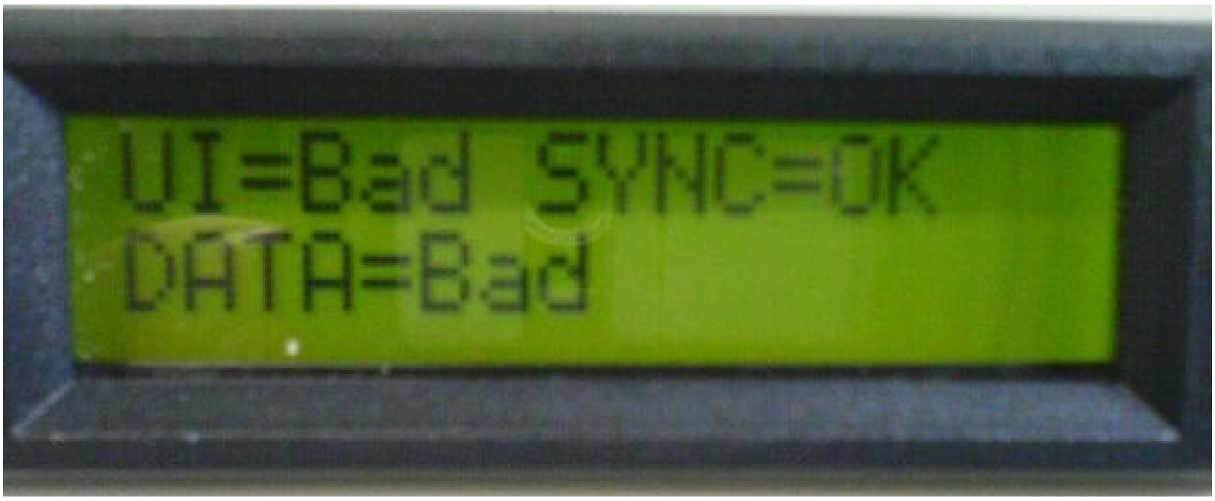
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	0	N12	N11	N10	N9	N8	N7	N6	N5	N4	N3	N2	N1	N0

Word with status

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	1	0	END	X	X	X	X	VCLK	EXT	MTD	AD	ARP	ACP	TRIG

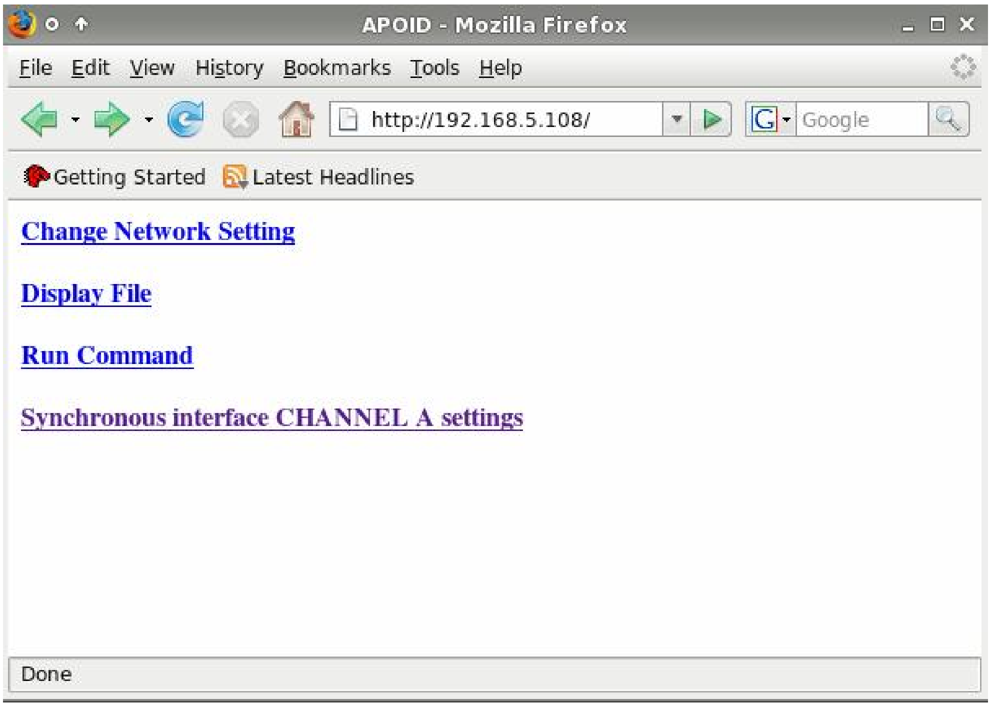
Data packets are created from shown data words and transmitted via the LAN network to display equipment, where they are displayed like video signals.

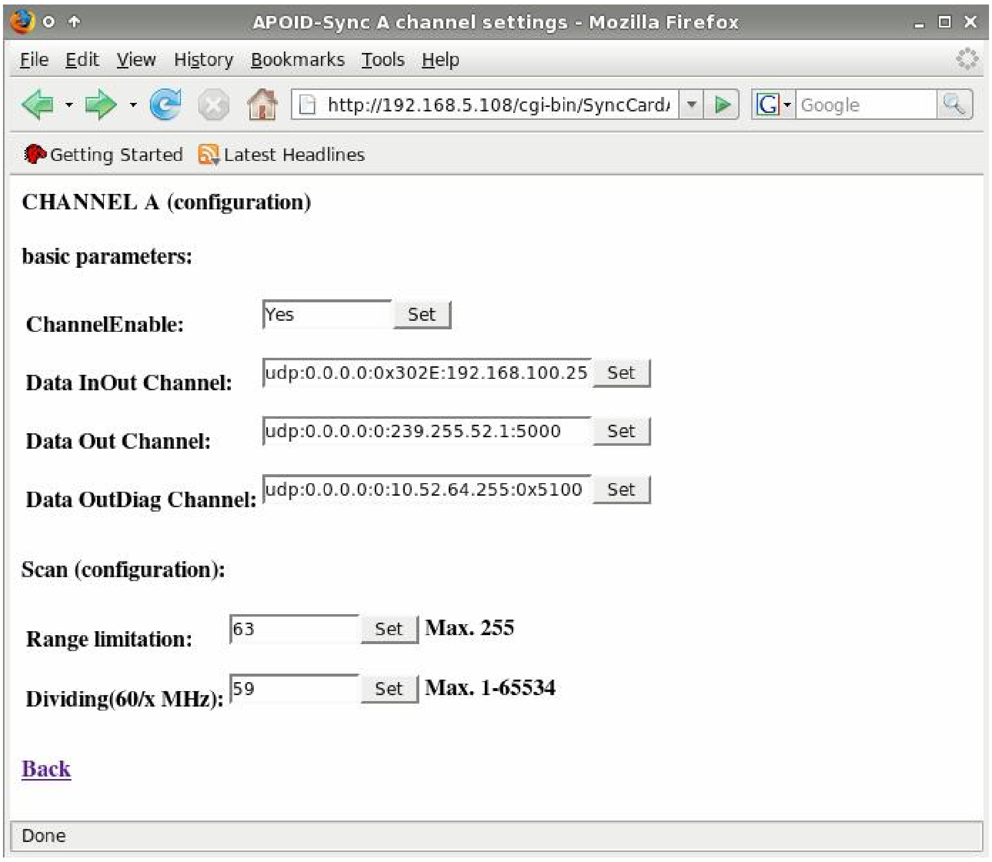
Detailed information on the APOID block is given in the chapter dedicated to the APOID directly. A two-line display is situated on the panel front side displaying statistical information on the status of particular input signals (ARP, ACP, DATA and SYNC). ACP and ARP signals are merged in a single signal, namely “United Information”. If one of them, or both of them inoperative, the signal shall be labeled wrong. Other signals shall be retained and shall not be combined anywhere. If the signal in good order, “OK” shall be displayed on the screen. If the signal damaged or does not arrive at all, “BAD” shall appear. The same information is transmitted via the LAN network to the 0x4110 port and displayed also on the LCMS/RCMS computer screen.



Internet interface

With the help of the internet interface, the APOID enables setting essential parameters of the LAN network on 192.168.5.107 and 192.168.5.108 addresses, as apparent in following pictures. Appropriate parameters are set by manufacturer. Incorrect setting of these parameters may result in malfunction of the video signal display, or the LAN network instability.


APOID - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://192.168.5.108/
Google
Getting Started
Latest Headlines
Change Network Setting
Display File
Run Command
Synchronous interface CHANNEL A settings
Done


APOID-Sync A channel settings - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://192.168.5.108/cgi-bin/SyncCard/
Google
Getting Started
Latest Headlines
CHANNEL A (configuration)
basic parameters:
ChannelEnable:
Yes
Set
Data InOut Channel:
udp:0.0.0.0:0x302E:192.168.100.25
Set
Data Out Channel:
udp:0.0.0.0:0:239.255.52.1:5000
Set
Data OutDiag Channel:
udp:0.0.0.0:0:10.52.64.255:0x5100
Set
Scan (configuration):
Range limitation:
63
Set
Max. 255
Dividing(60/x MHz):
59
Set
Max. 1-65534
Back
Done

Appendix 3: Switchboard 100

Fig. 1 indicates a view of the switchboard front panel. Fig. 2, Fig. 3 and Fig. 4 indicate the switchboard wiring diagram. Interconnection with other equipment parts is shown in the diagrams. Simplified survey diagram of the MSSR-1 radar electronics power supply is shown in Fig. 5.

The switchboard is situated in the front part of the AC cabinet. In the AC cabinet rear part, parts for the antenna movement motors power supply are situated, namely frequency converters (U1 and U2), filters (Z1, Z2, Z3), interference suppressors (L1, L2) and 626 vent unit.

All switchboard components are situated on the DIN 35 mm strip accessible from before the switchboard.

Following light indicators are situated on the switchboard front panel:

Diode indicators

H1 AD 24 V= AILAN A, ES1, ES2 G1 power supply indication in the AD cabinet for ES1, ES2 and AILAN A in the AA cabinet

H2 AD 24 V= AILAN B, ES1, ES2 G2 power supply indication in the AD cabinet for ES1, ES2 a AILAN B in the AB cabinet

H3 OPER. PHASE 23 0V 50 Hz control phase indication for K15, K16 contactors

H4, H5, H6 CHECK POWER L1, L2, L3 3×230 V 50 Hz mains indication after the Q1 RACK MAIN SWITCH turning on

H7 TEMPERATURE>50 °C indication of the temperature exceeding 50 °C in the radar room

H8 24 V= G1, G2 24 V= control voltage indication for the switchboard control

H9, H10, H11 MAIN CIRCUIT BREAKER – 3×230 V 50 Hz mains indication on the switchboard input after the F10, – MAIN CIRCUIT BREAKER turning on

H51 24 V= 24 V= control voltage indication for the antenna drive control

H52 CONVERTER 1 indication of power supply connection to the converter 1 input

H53 CONVERTER 2 indication of power supply connection to the converter 2 input

H54 MOTOR 1 indication of the power supply connection to the M1 antenna motor

H55 MOTOR 2 indication of the power supply connection to the M2 antenna motor

Indication on other switchboard components (100)

G1 POWER SUPPLY 230 V 50 Hz/24 V= G1 indication of 24 V= voltage on the power supply output (for the switchboard control)

G2 POWER SUPPLY 230 V 50 Hz/24 V= G2 indication of 24 V= voltage on the power supply output (for the switchboard control)

G3 POWER SUPPLY 230 V 50 Hz/24 V= G3 indication of 24 V= voltage on the power supply output (for obstacle lights)

K1 to K12 indication of commands and information o the switchboard status to the SCS 1 and SCS 2 control computer

K1 a K7 COMMAND ELECTRONIC UNIT POWER SUPPLY SWITCH – ON

K2 a K8 INPUT POWER 3×230/400 V 50 Hz – OK

K3 a K9 TEMPERATURE T<50 °C

K4 a K10 OVEVOLTAGE PROTECTION – OK

K5 a K11 ANTENNA OBSTRUCTION LIGHTING

K6 a K12 SENZOR – NO SMOKE

K13 CHECK POWER (no red diode may be on), the Un lights only

K14 indication of T<50 °C temperature in the room, mains voltage OK

K51 determines time of the siren sound, Un lights permanently after turning on, and the other diode also lights permanently after 1 minute

K52 indicates interconnection of the power supply from the converter 2 output

K53 turns on the siren in 10 sec cycles. In course of one minute. Un lights one minute, and intermittently also the other diode

K54 antenna is not mechanically blocked

K55 ÷ K66 indication of commands and information on the status in the switchboard via AILAN A and AILAN B blocks to the control computer (antenna movement control)

K55 COMMAND CONVERTER 1 (MOTOR 1) SWITCH-ON

K56 COMMAND MOTOR 2 SWITCH-ON

K57 OUTPUT CONVERTER 1 SWITCH-ON

K58, K64 ANTENNA – MECHANICAL BRAKE OFF

K59, K65 MOTOR 1 SWITCH-ON

K60, K66 MOTOR 2 SWITCH-ON

K61 COMMAND CONVERTER 2 (MOTOR 2) SWITCH-ON

K62 COMMAND MOTOR 1 SWITCH-ON

K63 OUTPUT CONVERTER 2 SWITCH-ON

Fuses

Fuses on the switchboard front panel are checked by following light indicators:

- F1 – 230 V 50 Hz, G1-SCS1,100 - LED on G1 power supply
- F2 – 230 V 50 Hz, G2-SCS2,100 - LED on G2 power supply
- F3 – 230 V 50 Hz, G3-OBSTRUCTION LIGHTING - LED on G3 power supply
- F4 – AD24 V=, AILAN A, ES1, ES2 - LED above fuse
- F5 - AD24 V=, AILAN B, ES1, ES2 - LED above fuse
- F6 – OPER. PHASE - LED above fuse
- F7, F8, F9 – CHECK POWER L1, L2, L3 - LED above fuse
- F51 – 24 V=, G1,G2 - LED above fuse

Setting relay in switchboard

Relay K13 CHECK POWER for the mains voltage check is set as follows: Umax 253 V, Umin 207 V, MEMORY-OFF, OUTPUT – 1, HYSTERESIS – 5 % t2 – 2, ASYM – 15

K51 time relay 1 minute, function a

K53 time relay 10 seconds, function d

Description

1) If all circuit breakers on and fuses OK, however, the Q1 RACKS MAIN SWITCH is off, following parts shall be fed from the switchboard (100):

- in AD cabinet of G1, G2 power supply for ES1, ES2 and AILAN A (in AA cabinet) and AILAN B (in AB cabinet)
- in AC cabinet by 24 V= voltage SCS 1 and SCS 2 blocks
- B1 smoke sensor is fed by 24 V= voltage
- circuit indicating the temperature of T>50 °C is fed only (in the radar room)
- E1 ÷ E4 obstacle lights on the tower structure are permanently fed by the 24 V= voltage

Note:

Obstacle lights power supply can be modified acc. to point 1 or point 2 for permanent lighting at the switchboard (100) power supply turned out

1. At canceling XT59 – XT61 and XT60 – XT64 terminals connection, external supply voltage of 24 V= can be connected to XT61 (+) and XT 64 (-) terminals
2. At canceling XT43 – XT44 and XT45 – XT46 terminals connection, external voltage of 230 V 50 Hz can be connected to XT46 (L), XT 44 (N) terminals – only G3 power supply from the switchboard can be utilized.

2) If all circuit breakers on and fuses OK, and the Q1 RACKS MAIN SWITCH is on, parts acc. to point 1) and also other parts are fed from the switchboard (100):

- 230 V 50 Hz sockets in AA, AB, AC, AD cabinets
- 230 V 50 Hz socket and illumination in the encoders cabinet (112) in the antenna unit

- TA and TB transformers in encoders cabinet (112) in the antenna unit for angle information processing cards from AE A and AE B encoders, and oil level sensor B3 – AIOPTD A and AIOPTD B, venting encoders cabinet (112) – M3 ad M4 fans
- via overvoltage protection, E3 – RACK AD in the switchboard (100) electronics in AD - LCMS 1, LCMS 2, RDP 1, RDP 2, RMM cabinet, 624 and 628 vent units, via AD cabinet, monitors 1, 2, 3 and SIP telephone on the table are supplied.

3) If all circuit breakers on and fuses OK, temperature in the room is T<50 °C, mains voltage OK, Q1 RACK MAIN SWITCH is on, and command for feeding issued from the control computer via SCS 1 or SCS2 card (closed K1 or K7 relay – COMMAND ELECTRONIC UNIT POWER SUPPLY SWITCH-ON), K15, K16 contactors closed, parts acc. to point 1, 2 shall be supplied, and also as follows:

- via E1 overvoltage protection – RACK AA, AD in the switchboard (100), ZNA4, ZSE A and ZSE B power supplies in the AA cabinet are fed in the PSSR block for supplying TSSR. ISSR block, 624, 625, 627 vent units, SMP1 block in AD cabinet and G3 power supply for feeding APOID A block
- via E2 overvoltage protection E2 – RACK AB, AD in the switchboard (100) ZNA4, ZSE A and ZSE B power supplies in the AB cabinet in the PSSR block for feeding TSSR, ISSR block, 624, 625, 627 vent units, SMP2 block in AD cabinet, and G3 power supply for feeding APOID B block
- 3×230/400 V supply voltage to control circuits for the antenna drive is on
- 626 vent unit in the AC cabinet under converters is supplied, and vent unit in the AC cabinet ceiling as well.

Control and switching circuits for the antenna drive (M1 and M2 motors turning on) are situated in the switchboard bottom part. If the antenna not mechanically blocked, K54 relay closed, contactors switching procedure for M2 and M2 motors power supply turning on shall be as follows:

After the command from the AILAN A COMMAND CONVERTER 1 - U1 block, output of the 1 – U1 converter shall be connected via K69 contactor to the Z3 sinus filter input and M1 motor shall be connected to the Z3 filter output by K71 contactor. H1 siren shall be intermittently heard for one minute. Mains voltage of 3×400 V shall be connected to the input of the 1 – U1 converter, and M1 motor fed from the U1 converter. By means of the other COMMAND MOTOR 2 command from the AILAN A block, motor 2 – M2 can be connected with the help of the K72 contactor; in such case, both motors shall be supplied from a single converter.

After the command from the AILAN B COMMAND CONVERTER 2 - U2 block, output of the 2 – U2 converter shall be connected via K70 contactor to the Z3 sinus filter input and M2 motor shall be connected to the Z3 filter output by K72 contactor. H1 siren shall be intermittently heard for one minute. Mains voltage of 3×400 V shall be connected to the input of the 2 – U2 converter, and M2 motor fed from the U2 converter. By means of the other COMMAND MOTOR 1 command from the AILAN B block, motor 1 – M1 can be connected with the help of the K71 contactor; in such case, both motors shall be supplied from a single converter.

Following information is lead to the control computer from the switchboard (100) via SCS 1 (SCS 2) block:

- overvoltage protection OK (check of overvoltage protection (E1, E2, E3) in the switchboard (100) and FV7, FV8, FV9 in overvoltage protection block (110)
- smoke in the room
- warning light supplied
- mains voltage OK and temperature in the room T<+50 °C
- temperature in the room T>+50 °C
- check of the mains voltage 3×230 V 50 Hz L1, L2, L3
- other 7 pieces of information may be added by the customer

Following command is lead to the switchboard (100) from the control computer via SCS 1 (SCS 2) block:

- electronics power supply ON
- other two commands may be added by the customer

Following information is lead to the control computer from the switchboard (100) via AILAN A (AILAN B) block:

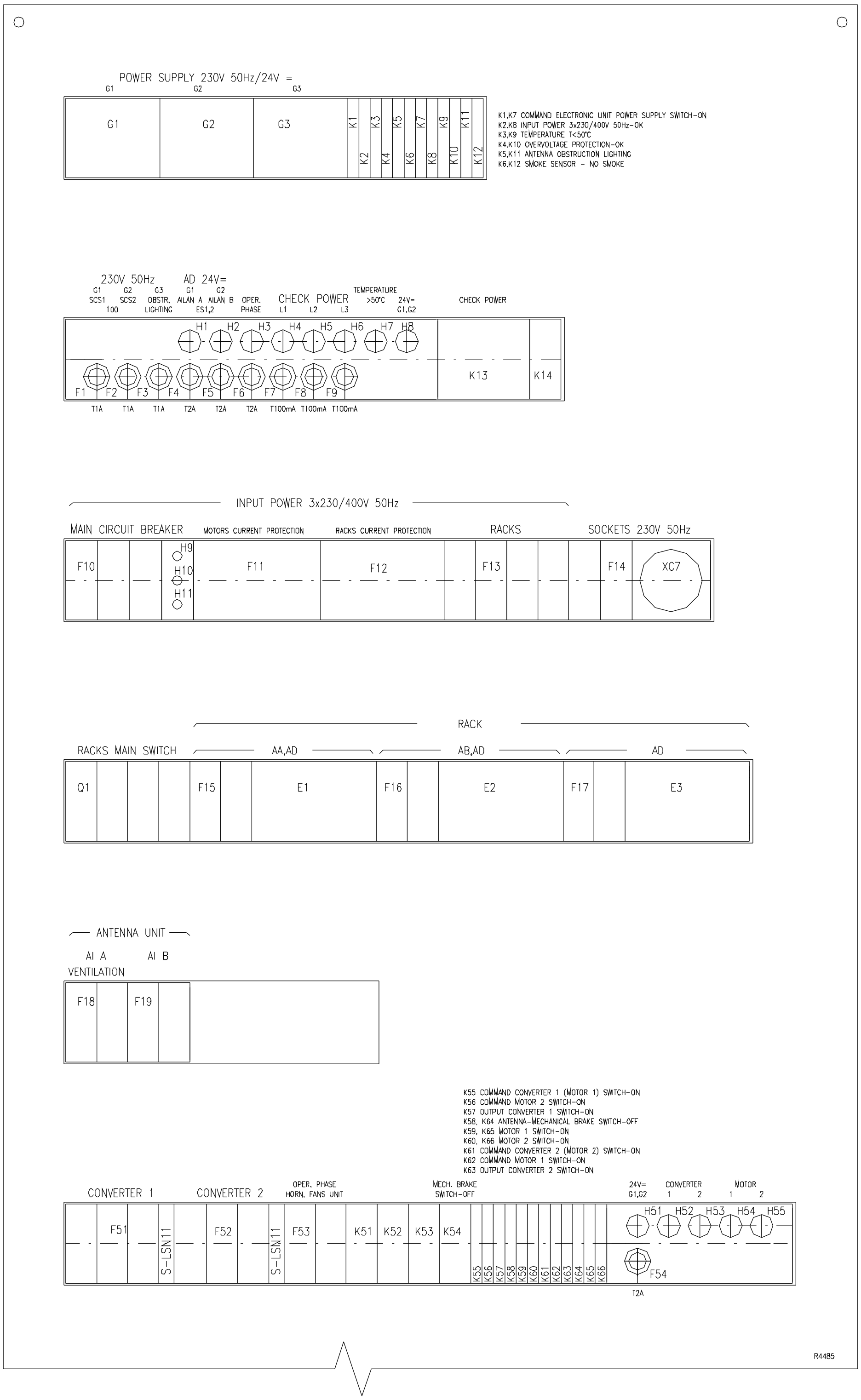
- circuit breaker converter 1 – ON (circuit breaker converter 2 – ON)
- converter 1 output connected (converter 2 output connected)
- motor 1 connected
- motor 2 connected
- antenna mechanically blocked

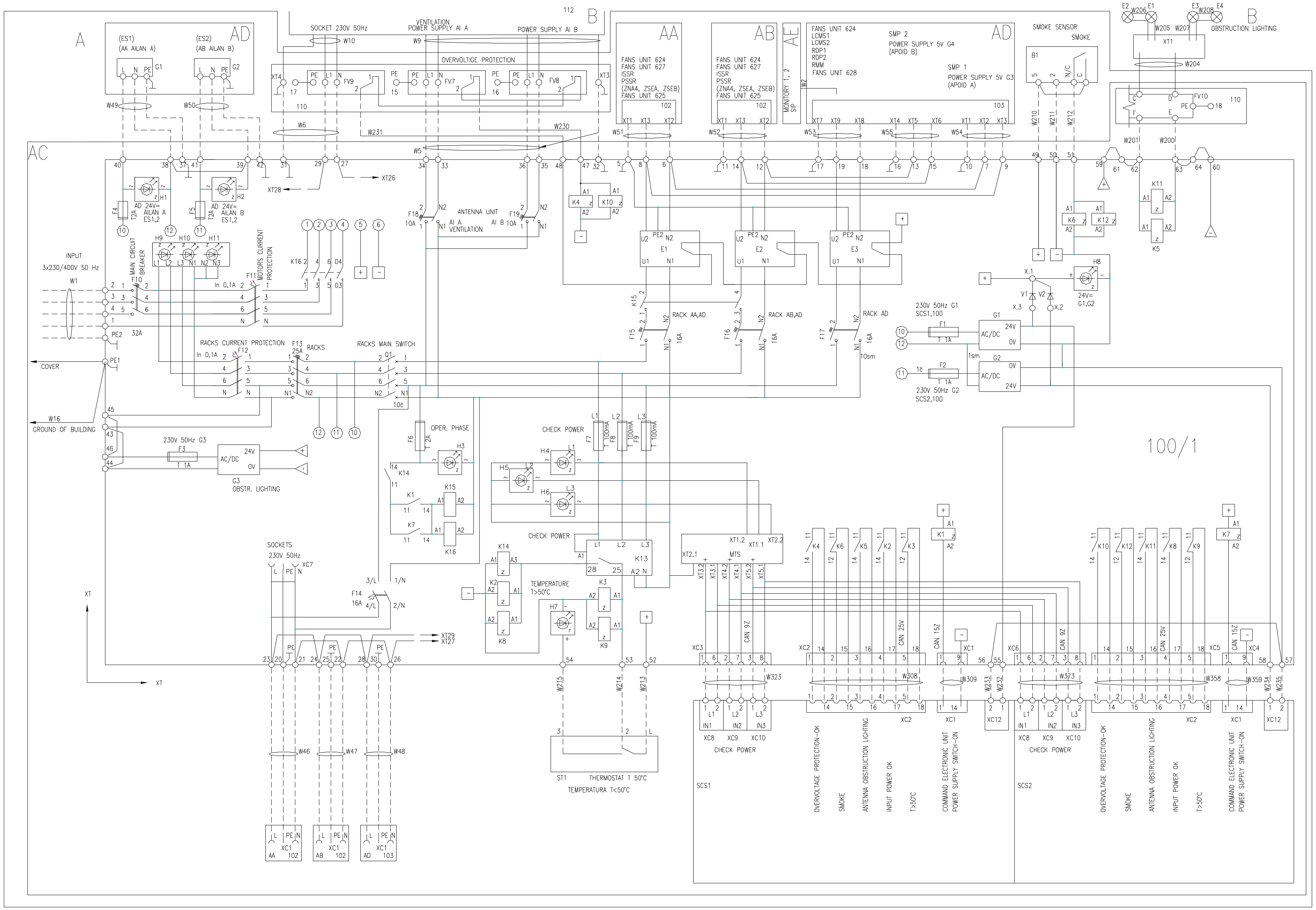
Following commands are lead to the switchboard (100) from the control computer via AILAN A (AILAN B) blocks:

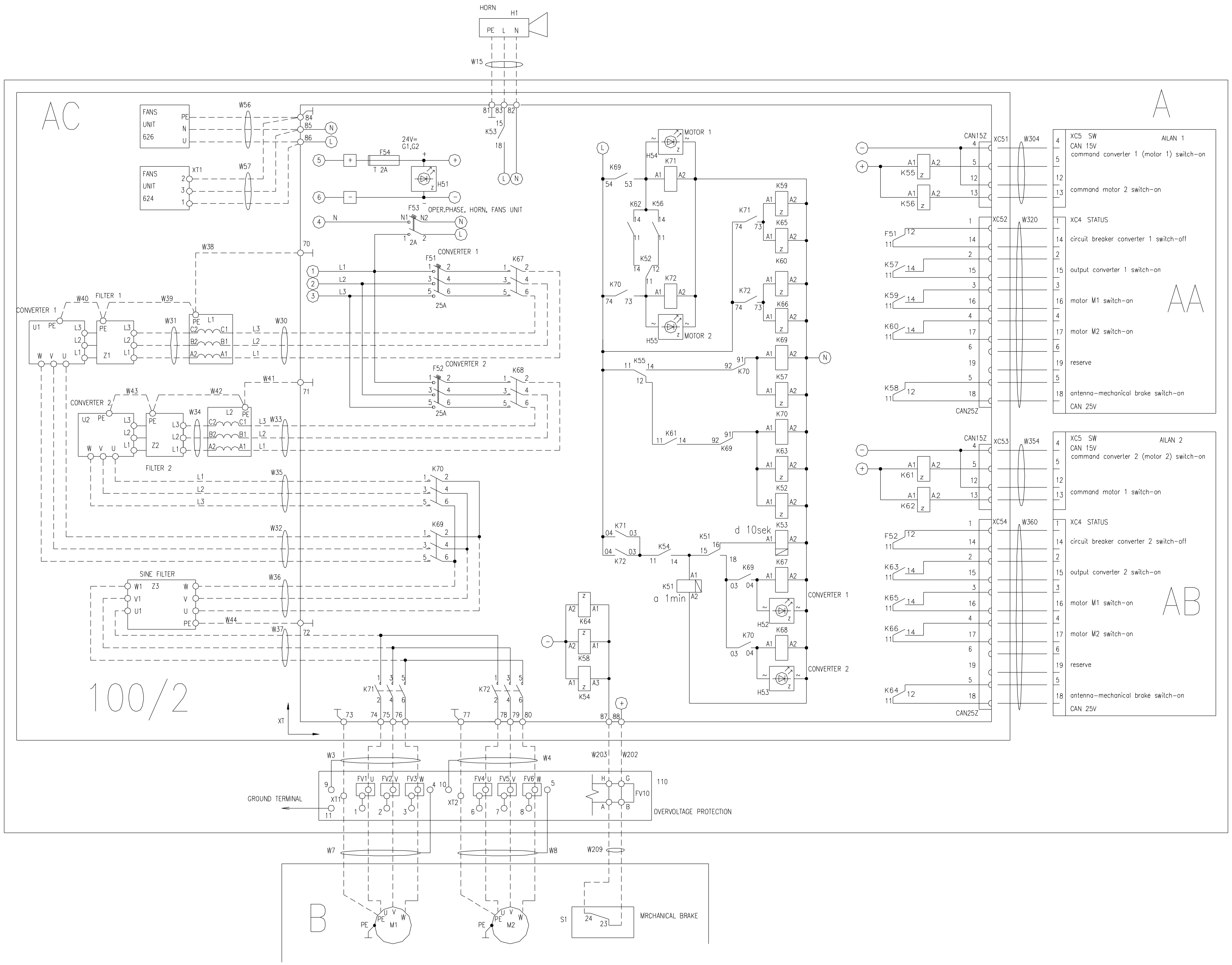
- command converter 1 – ON, motor 1 – ON (converter 2 – ON, motor 2 – ON)
- command motor 2 – ON, (motor 1 – ON)
- in the bottom part switchboard 102

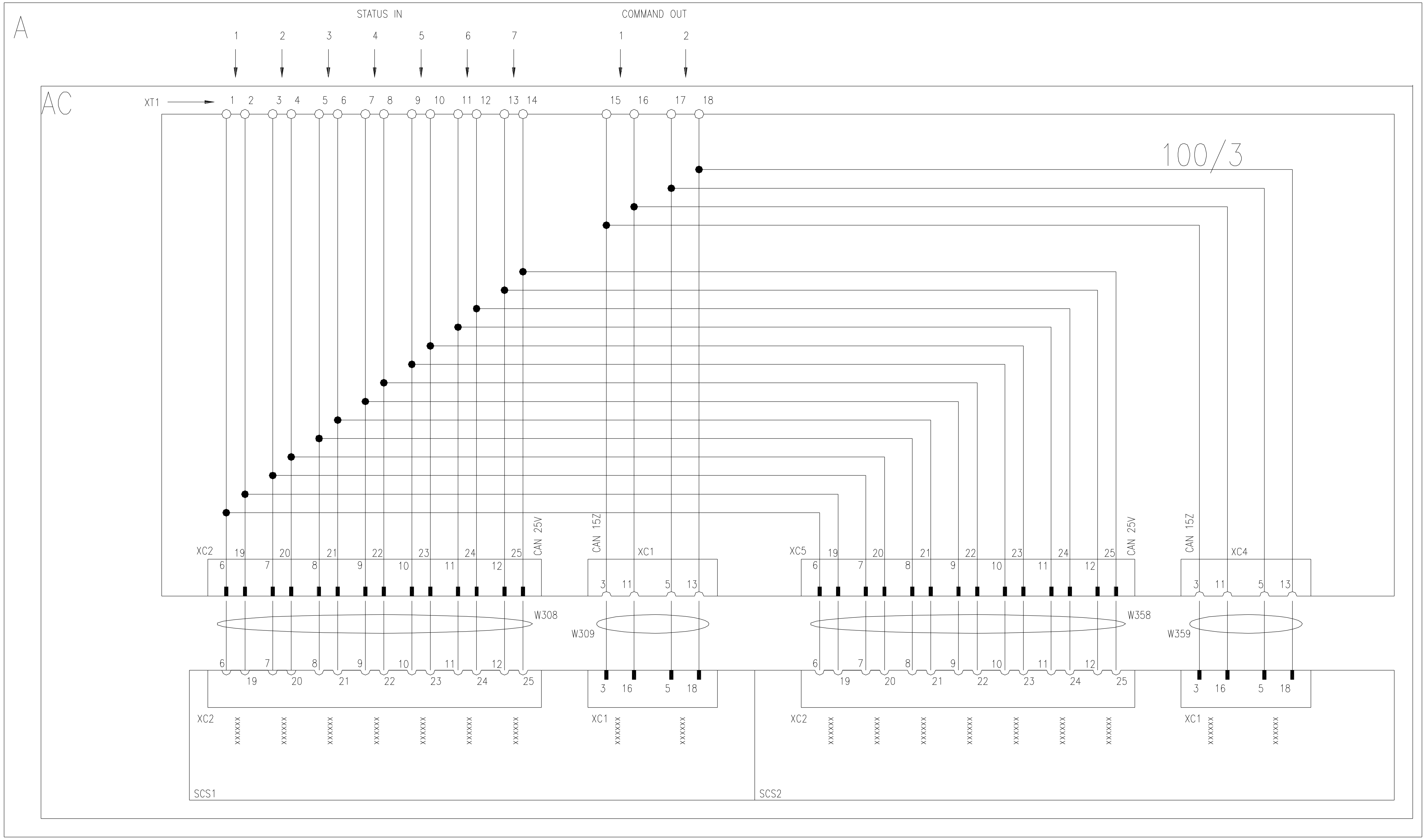
All vent units support natural ventilation – they suck in the air via a filter in the pedestal and exhaust it in the cabinet upper part only.

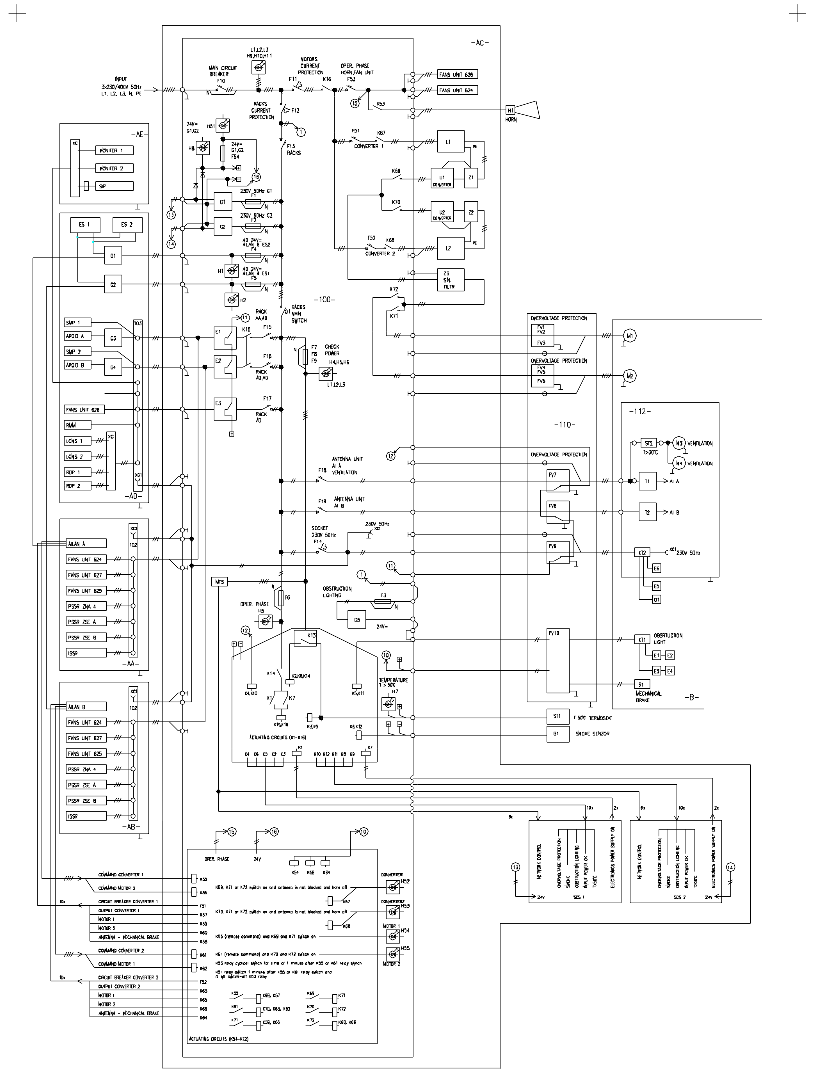
EPS switching block is fastened above AA and AB cabinets.


POWER SUPPLY 230V 50Hz/24V =
G1
G2
G3
K1 K2 K3 K4 K5 K6 K7 K8 K9 K10 K11 K12
K1,K7 COMMAND ELECTRONIC UNIT POWER SUPPLY SWITCH-ON
K2,K8 INPUT POWER 3x230/400V 50Hz-OK
K3,K9 TEMPERATURE T<50°C
K4,K10 OVERVOLTAGE PROTECTION-OK
K5,K11 ANTENNA OBSTRUCTION LIGHTING
K6,K12 SMOKE SENSOR – NO SMOKE
230V 50Hz
AD 24V=
SCS1 SCS2 OBSTR. LIGHTING AILAN A AILAN B ES1,2 OPER. PHASE
CHECK POWER
L1 L2 L3
TEMPERATURE >50°C
24V= G1,G2
CHECK POWER
H1 H2 H3 H4 H5 H6 H7 H8
F1 F2 F3 F4 F5 F6 F7 F8 F9
K13 K14
T1A T1A T1A T2A T2A T2A T100mA T100mA T100mA
INPUT POWER 3x230/400V 50Hz
MAIN CIRCUIT BREAKER
MOTORS CURRENT PROTECTION
RACKS CURRENT PROTECTION
RACKS
SOCKETS 230V 50Hz
F10 H9 H10 H11 F11 F12 F13 F14 XC7
RACK
RACKS MAIN SWITCH
AA,AD
AB,AD
AD
Q1 F15 E1 F16 E2 F17 E3
ANTENNA UNIT
AI A
AI B
VENTILATION
F18 F19
K55 COMMAND CONVERTER 1 (MOTOR 1) SWITCH-ON
K56 COMMAND MOTOR 2 SWITCH-ON
K57 OUTPUT CONVERTER 1 SWITCH-ON
K58, K64 ANTENNA-MECHANICAL BRAKE SWITCH-OFF
K59, K65 MOTOR 1 SWITCH-ON
K60, K66 MOTOR 2 SWITCH-ON
K61 COMMAND CONVERTER 2 (MOTOR 2) SWITCH-ON
K62 COMMAND MOTOR 1 SWITCH-ON
K63 OUTPUT CONVERTER 2 SWITCH-ON
CONVERTER 1
CONVERTER 2
OPER. PHASE HORN, FANS UNIT
MECH. BRAKE SWITCH-OFF
24V= G1,G2
CONVERTER 1 2
MOTOR 1 2
F51 S-LSN11 F52 S-LSN11 F53 K51 K52 K53 K54
K55 K56 K57 K58 K59 K60 K61 K62 K63 K64 K65 K66
H51 H52 H53 H54 H55
F54
T2A
R4485




HORN
H1
W15
A
AC
FANS UNIT 626
FANS UNIT 624
W56
W57
24V= G1,G2
F54
T 2A
H51
F53
OPER.PHASE, HORN, FANS UNIT
CONVERTER 1
CONVERTER 2
F51
F52
25A
K67
K68
FILTER 1
FILTER 2
SINE FILTER
K70
K69
K71
K72
100/2
MOTOR 1
MOTOR 2
d 10sek
a 1min
CONVERTER 1
CONVERTER 2
CAN15Z
CAN25Z
XC51
XC52
XC53
XC54
W304
W320
W354
W360
XC5 SW
CAN 15V
AILAN 1
AILAN 2
command converter 1 (motor 1) switch-on
command motor 2 switch-on
XC4 STATUS
circuit breaker converter 1 switch-off
output converter 1 switch-on
motor M1 switch-on
motor M2 switch-on
reserve
antenna-mechanical brake switch-on
CAN 25V
AA
command converter 2 (motor 2) switch-on
command motor 1 switch-on
circuit breaker converter 2 switch-off
output converter 2 switch-on
AB
XT
GROUND TERMINAL
OVERVOLTAGE PROTECTION
FV10
W3
W4
W7
W8
W202
W203
W209
B
M1
M2
S1
MRCHANICAL BRAKE

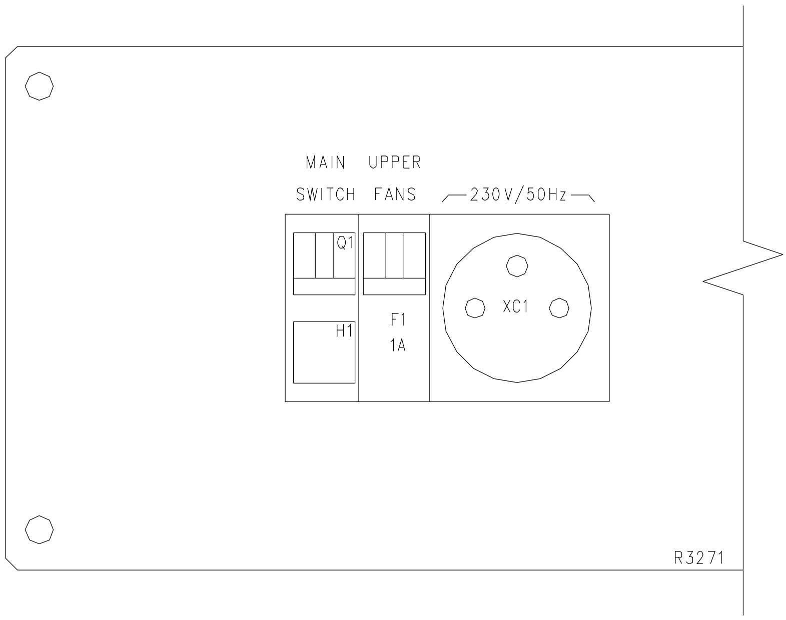

A
STATUS IN
COMMAND OUT
AC
XT1
100/3
XC2
XC1
XC5
XC4
CAN 25V
CAN 15Z
W308
W309
W358
W359
SCS1
SCS2

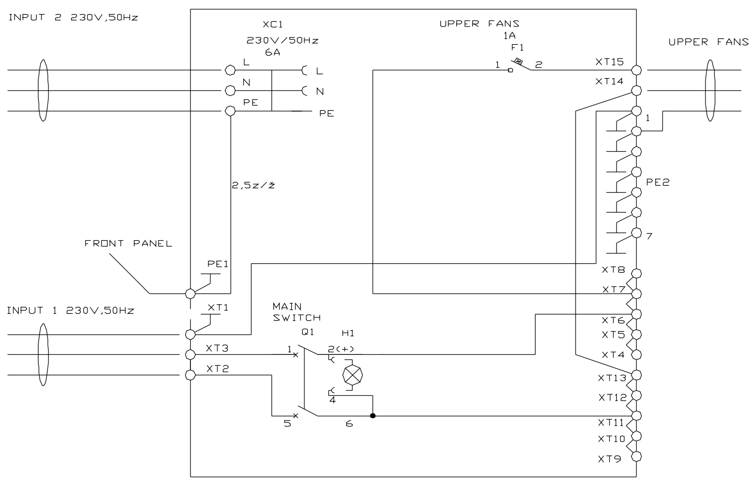


SYNOPTICAL DRAWING OF MSSR-1 POWER SUPPLY

Appendix 4: Switchboard 102

It is situated in the bottom part of the AA and AB cabinet. All blocks in the cabinet are fed via this switchboard. Upper fans (624) are protected by the F1 UPPER FANS circuit breaker. Fans (625, 27) are protected by a fuse in the vent unit block. Presence of the voltage at closed Q1 MAIN SWITCH is indicated by a diode on the switch. XC1 230V 50Hz socket is not turned out by the Q1 switch. It is turned out by the F14 SOCKETS 230V 50 Hz current protector in the switchboard (100) in the AC cabinet.

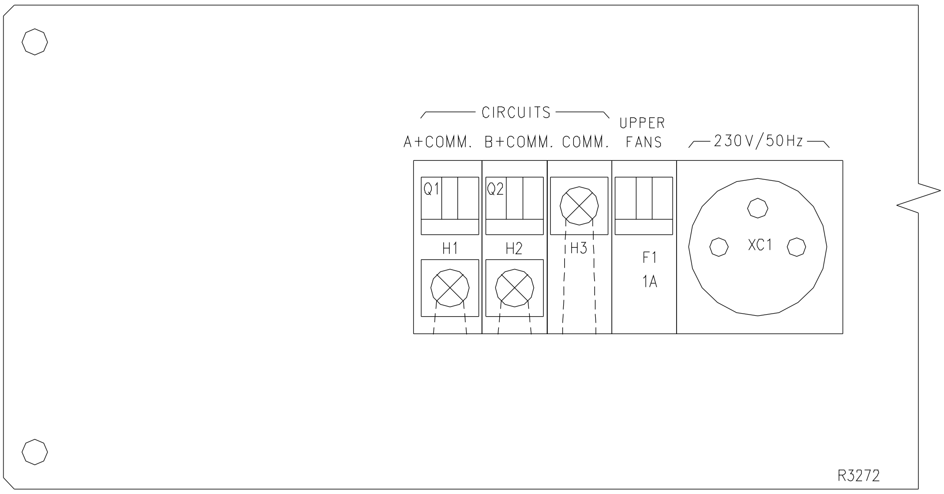


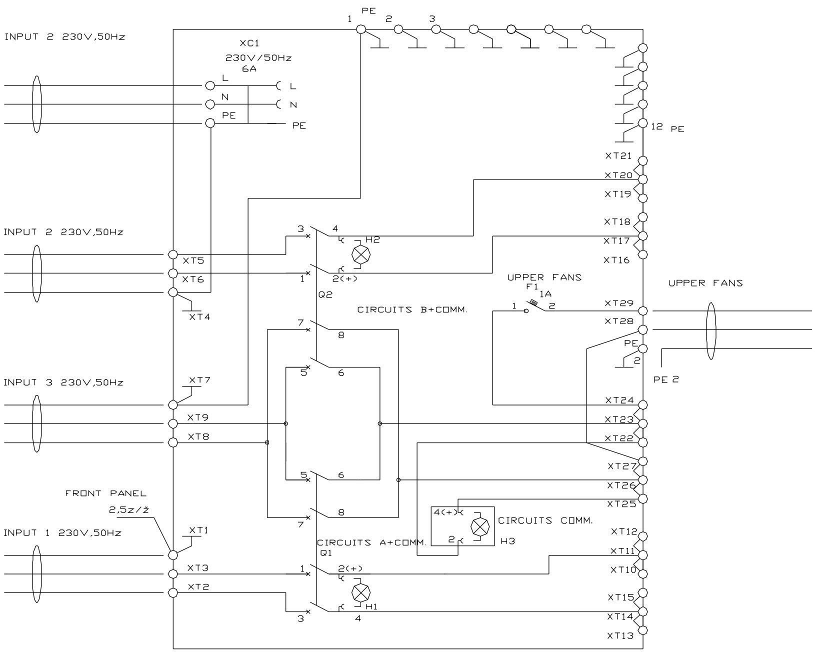


Appendix 5: Switchboard 103

It is situated in the bottom part of the AD cabinet. Via this switchboard, all blocks (except for G1 and G2 power supplies for AILAN A and AILAN B, ES1, ES2 feeding) are supplied and other parts on the AE table as well. LCMS1, LCMS 2, RDP1, RDP2, RMM electronics, 624 vent unit (via F1 – UPPER FANS circuit breaker) and 628 fan unit (protected by a fuse in the block) are fed at closed Q1 A+COMM switch, or closed Q2 B+COMM switch. SMP 1 electronic unit and G3 power supply are fed at closed A+COMM switch. SMP 2 electronic unit and G4 power supply are fed at closed B+COMM switch.

Closing Q1 and Q2 switches is indicated by H1 – A+COMM, H2 – B+COMM, H3 – COMM indicating lamps. The XC1 230 V 50 Hz socket is not turned out by the Q1 and Q2 switches. It is turned out by the F14 SOCKETS 230 V 50 Hz current protector on the switchboard (100) in the AC cabinet.


CIRCUITS
A+COMM.
B+COMM.
COMM.
UPPER
FANS
230V/50Hz
Q1
Q2
H1
H2
H3
F1
1A
XC1
R3272


INPUT 2 230V,50Hz
XC1
230V/50Hz
6A
L
N
PE
INPUT 2 230V,50Hz
XT5
XT6
XT4
INPUT 3 230V,50Hz
XT7
XT9
XT8
FRONT PANEL
2,5z/ż
INPUT 1 230V,50Hz
XT1
XT3
XT2
H2
Q2
CIRCUITS B+COMM.
CIRCUITS A+COMM.
Q1
H1
CIRCUITS COMM.
H3
UPPER FANS
F1
1A
12 PE
XT21
XT20
XT19
XT18
XT17
XT16
XT29
XT28
PE 2
XT24
XT23
XT22
XT27
XT26
XT25
XT12
XT11
XT10
XT15
XT14
XT13

Appendix 6: Overvoltage protections block 110

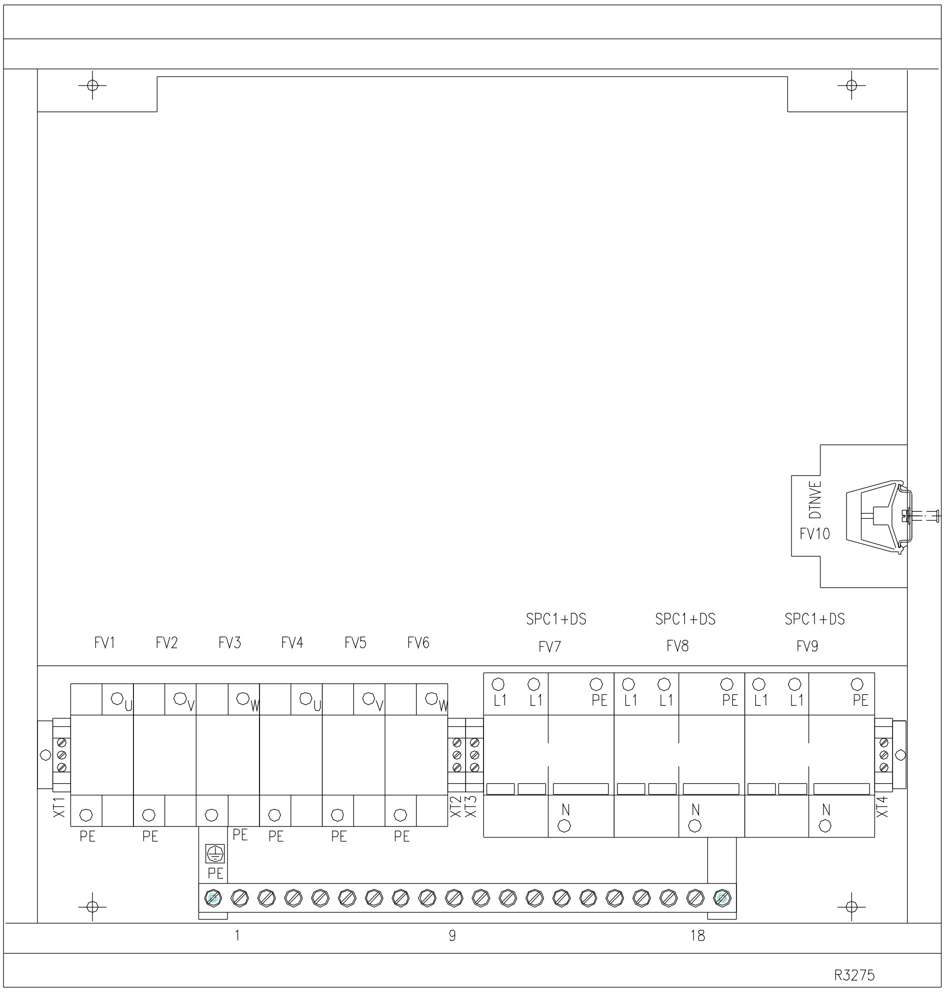
The lock is situated on the inner wall of the room where the antenna unit cables enter the room. Parallel overvoltage protections (FV1 ÷ FV9) serve for the mains circuits in the block. Serial overvoltage protection (FV10) serves for the cables of safe voltage in the block. These overvoltage protections (FV1 ÷ FV10) are fastened to the DIN 35 mm strips. Coaxial cables are protected by overvoltage protections (FV11, FV12, FV13) that are connected directly to the cable terminals. FV1 ÷ FV11 protections in the block 110 are connected by separate conductors to the grounding plate, which shall be connected to the external grounding off the building – by means of a clamp to the tower structure. Grounds of FV11, FV12 and FV13 protections are chained by conductors. FV7, FV8 and FV9 overvoltage protections are provided with a failure indication by ejecting a target and changing over the contact. The protections are connected to the SCS 1 and SCS 2 computer via the switchboard (100).

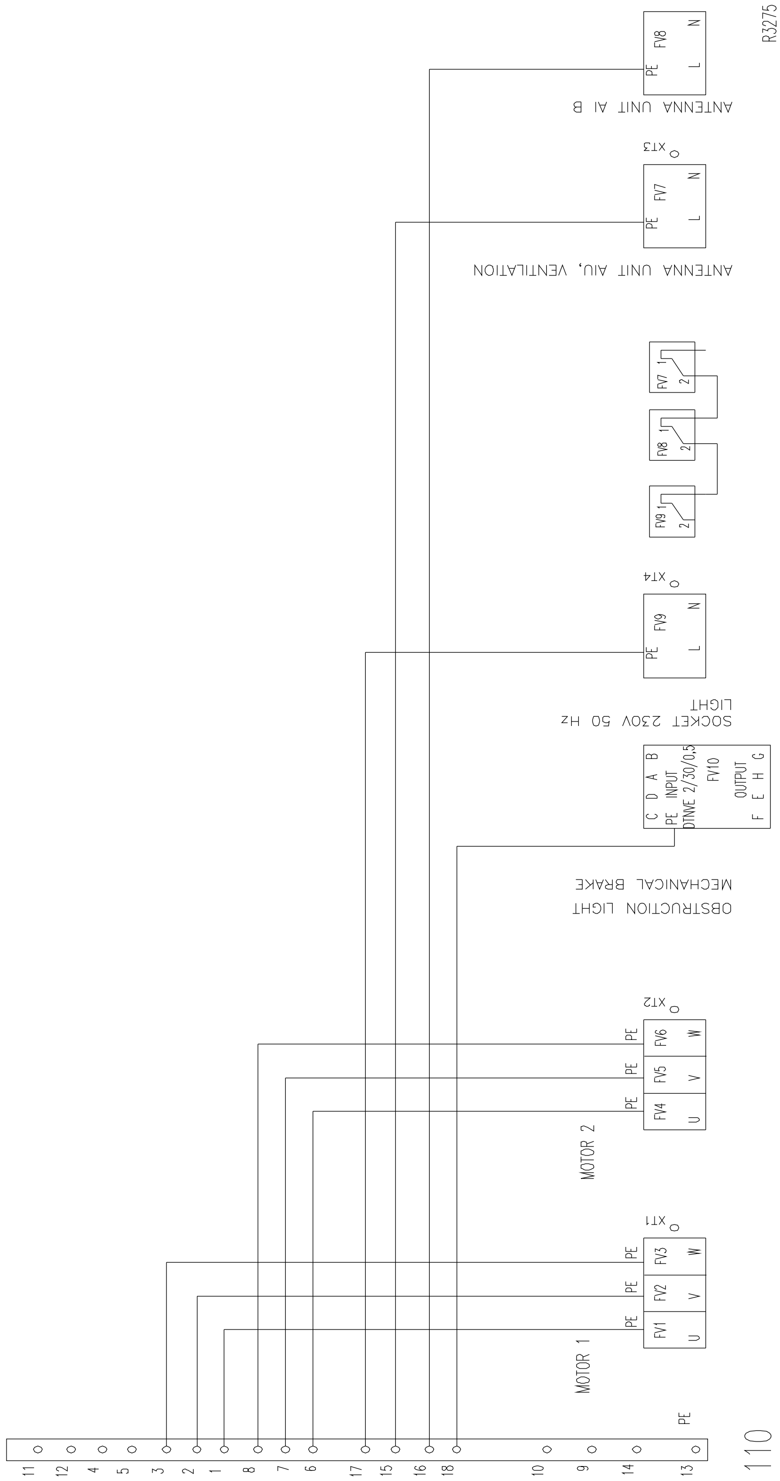
FV1 ÷ FV6 lightning current arrester of the I class

FV7 ÷ FV9 integrated lightning current arresters of the I and II class

FV10 data overvoltage protection

FV11 ÷ FV13 lightning arrester coupling N-N


DTNVE
FV10
SPC1+DS
SPC1+DS
SPC1+DS
FV1
FV2
FV3
FV4
FV5
FV6
FV7
FV8
FV9
U
V
W
U
V
W
L1
L1
PE
L1
L1
PE
L1
L1
PE
XT1
XT2
XT3
XT4
PE
PE
PE
PE
PE
PE
PE
N
N
N
PE
1
9
18
R3275


R3275
ANTENNA UNIT AI B
FV8
XT3
ANTENNA UNIT AIU, VENTILATION
FV7
FV8
FV9
XT4
SOCKET 230V 50 Hz
LIGHT
FV10
MECHANICAL BRAKE
OBSTRUCTION LIGHT
XT2
FV6
FV5
FV4
MOTOR 2
XT1
FV3
FV2
FV1
MOTOR 1
PE
110

Appendix 7: SCS – Status and Control Switchboard

1.1 Card of Radar Site Control

1.1.1 Introduction

SCS (Status and Control Switchboard) cards serve for the control of some radar features and reading status in the radar site. SCS cards are used twice for backup reason and their inputs and outputs are connected in parallel.

1.1.2 Description of Functioning

SCS card serves for radar site statuses reading, and radar site commands control. In addition, it reads the temperature value from up to two external temperature sensors, and a single internal temperature sensor situated directly on the SCS card. The card also measures voltage values of phases of mains. Measured temperature values, phase voltages and status from the radar site, are then lead to the control via the network interface (LAN), from where commands are also received.

1.1.2.1 Connectors

Position of particular connectors on the card is shown in Fig. 1.

Status and command signals are lead to XC1 (commands output) and XC2 (status input) connectors. Meaning of particular status and command signals is given in Table 3 and Table 4.

Contact	Status signal
1/14	Overvoltage protection
2/15	Smoke sensor
3/16	Caution lighting supply
4/17	Status of mains supply voltage 3x230/400V and space temperature
5/18	Space temperature
6/19	Customer signal (XT1.1/2)
7/20	Customer signal (XT1.3/4)
8/21	Customer signal (XT1.5/6)
9/22	Customer signal (XT1.7/8)
10/23	Customer signal (XT1.9/10)
11/24	Customer signal (XT1.11/12)
12/25	Customer signal (XT1.13/14)
13	Not used

Table 3: XC2 (STATUS IN) connector on SCS

Contact	Signal
1/14	Equipment electronics switching on
2/15	Reserved
3/16	Customer command (XT1.15/16)
4/17	Reserved
5/18	Command to customer (XT1.17/18)
6/19	Reserved
7/20	Reserved
8/21	Reserved
9/22	Reserved
10/23	Reserved
11/24	Reserved
12/25	Reserved
13	Not used

Table 4: XC1 (COMMAND OUT) connector on SCS

XC3 connector serves for connecting external thermal sensor № 1, XC4 connector serves for connecting external thermal sensor № 2. These connectors may or may not be used.

Supply voltage is connected to the XC12 terminal board, DC voltage proportional to the mains phase voltage of particular phases are lead to XC8, XC9 and XC10 switchboards (from MTS card).

Via XC7 connector, optical signal is received, optical signal output is situated on the XC6 connector. These connectors are not used.

XC5 connector serves for the card connecting to the LAN network.

1.1.3 Meaning of LED Indicators and Jumpers Setting

Position of particular LED indicators is shown in Fig. 2, jumpers positions is shown in Fig. 1, LEDs meaning is given in Table 7, jumpers setting is given in Table 8.

LED	Description
SW1 ÷ SW12 - Green LED	Indication of closed relays for particular output commands
OPERATION - Green LED	Indication of received data from external thermal sensors (if connected)
OPERATION – Red LED	Indication of any error (see Note 5)
OPERATION – Yellow LED	Not used
OPT – Green LED	Indication of received command via LAN
PWR – Green LED	Indication of supply voltage

Table 7: LEDs on SCS card and their function

JP1	ON	JP16	ON	JP31	ON
JP2	ON	JP17	ON	JP32	ON
JP3	ON	JP18	ON	JP33	ON
JP4	ON	JP19	ON	JP34	ON
JP5	OFF	JP20	OFF	JP35	ON
JP6	ON	JP21	ON	JP36	ON
JP7.2 – JP7.3	ON	JP22	ON	JP37.1 – JP37.2	ON
JP8	OFF	JP23	ON	JP38.1 – JP38.2	ON
JP9	ON	JP24	ON	JP39.1 – JP39.2	ON
JP10	ON	JP25	ON	JP40.1 – JP40.2	ON
JP11	ON	JP26	ON	JP41.1 – JP41.2	ON
JP12	ON	JP27	ON	JP42	OFF
JP13.1 - JP13.2	ON	JP28	ON	JP43.2 – JP43.3	ON
JP14.2 – JP14.3	ON	JP29	ON	JP44	ON
JP15.1 – JP15.2	ON	JP30	ON	JP45.2 – JP45.3	ON

Table 8: SCS card – jumpers setting (ON = jumper inserted, OFF = jumper not inserted)

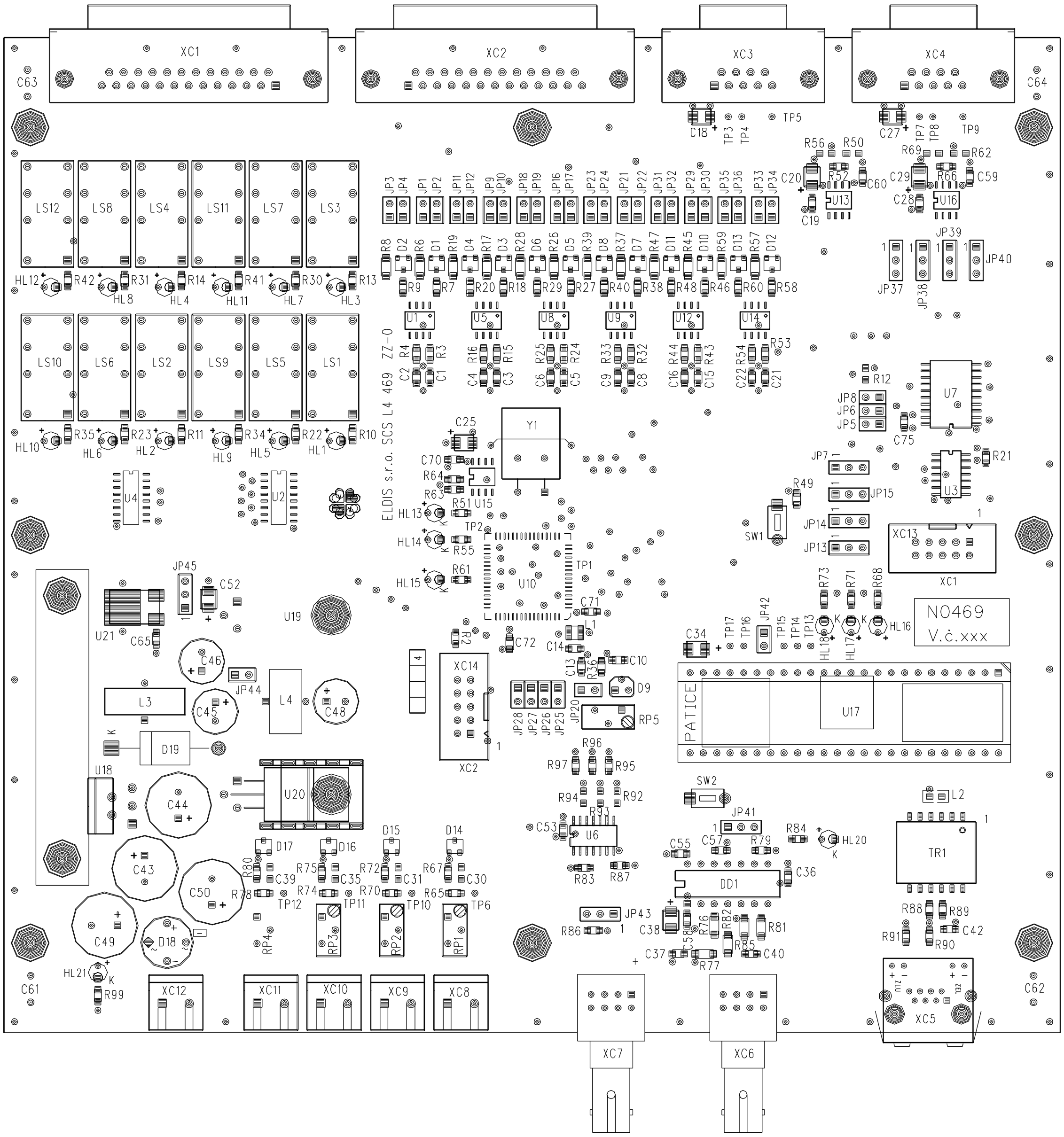


Fig. 1: SCS card

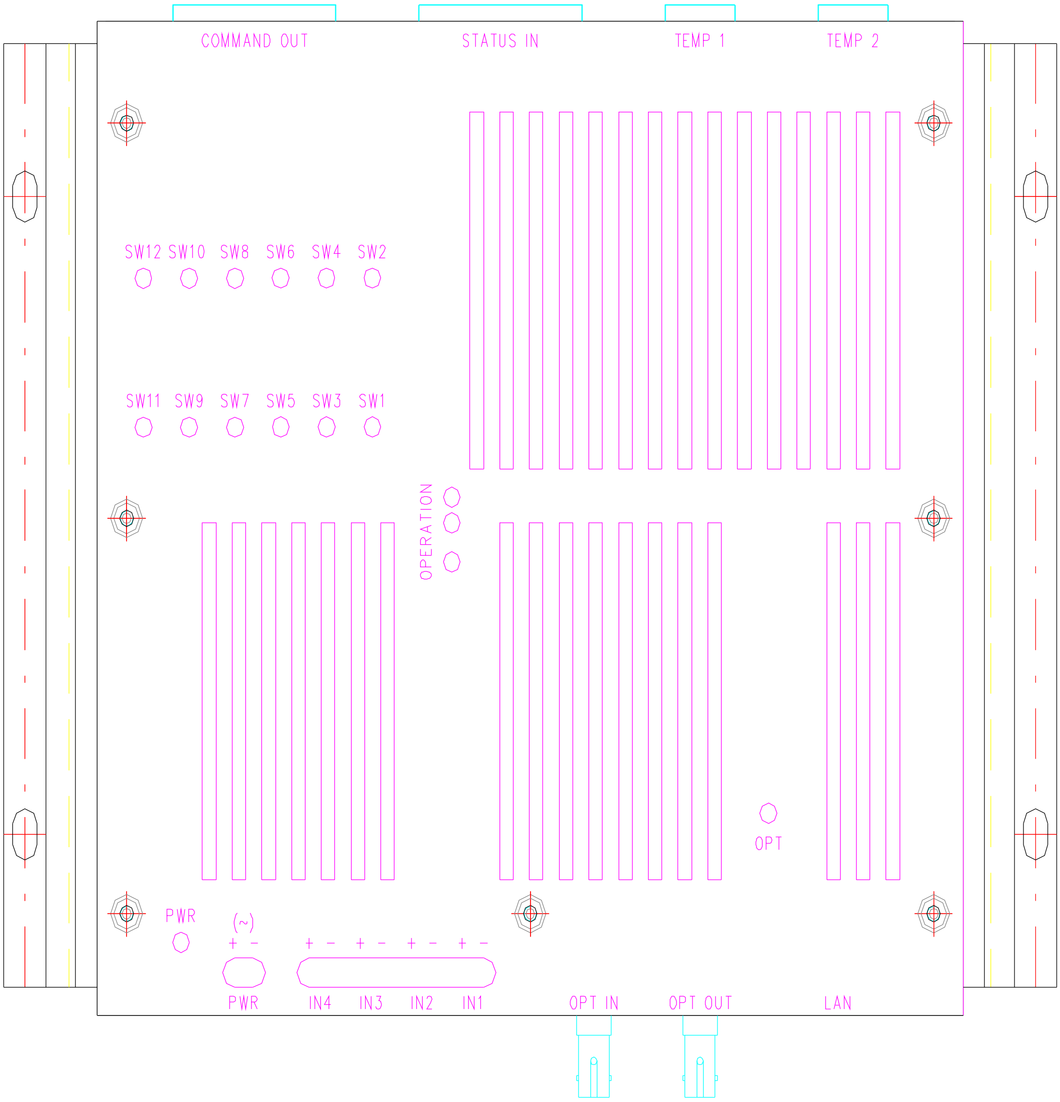


Fig. 2: SCS with cover

1.1.4 Description of Communication

Following text describes communication between the control and the SCS card.

Communication between the SCS card and the control occurs by means of the TCP/IP protocol via LAN network. Identical frame is transmitted in both transmission directions while command items are set by the control, and data items (statuses, temperatures, voltages) are set by the SCS card. The frame bytes and their meaning are given in Table 11.

Byte №	Description (value)	Note
0	Status	5
1	Status (high byte)	2
2	Status (low byte)	2
3	V1 (high byte) – mains voltage of L1 phase	3
4	V1 (low byte) – mains voltage of L1 phase	3
5	V2 (high byte) – mains voltage of L2 phase	3
6	V2 (low byte) – mains voltage of L2 phase	3
7	V3 (high byte) – mains voltage of L3 phase	3
8	V3 (low byte) – mains voltage of L3 phase	3
9	V4 (high byte) – reserved	3
10	V4 (low byte) – reserved	3
11	Temp0 – temperature on SCS card (high byte)	4
12	Temp0 – temperature on SCS card (low byte)	4
13	Temp1 – temperature of sensor №1 (high byte)	4
14	Temp1 – temperature of sensor №1 (low byte)	4
15	Temp2 – temperature sensor №2 (high byte)	4
16	Temp2 – temperature of sensor №2 (low byte)	4
17	Not used (undefined value)	
18	Not used (undefined value)	
19	Not used (undefined value)	
20	Not used (undefined value)	
21	Command (high byte)	1
22	Command (low byte)	1
23	Not used (undefined value)	
24	Not used (undefined value)	

Table 11: Data transmission between the SCS card and the control (bytes 0 ÷ 20 are modified by SCS, bytes 21 ÷ 24 are modified by control)

Notes:

Note 1: Meaning of particular bits of the “Command” item is as follows:

Bit 0: Equipment electronics switching on (1 = switched on)
Bit 1: Reserved - 0
Bit 2: Customer command (XT1.15/16)
Bit 3: Reserved - 0
Bit 4: Customer command (XT1.17/18)
Bits 5-15: Reserved - 0

Note 2: Meaning of particular bits of the “Status” item is as follows:

Bit 0: Overvoltage protection (1 = OK)

Bit 1:	Smoke sensor (1 = smoke detected)
Bit 2:	Caution lighting supply (1 = supply switched on)
Bit 3:	Status of mains supply voltage 3x230/400V and space temperature (1 = mains supply is OK and space temperature is less than 50 °C)
Bit 4:	Space temperature (0 = Temperature is less than 50 °C)
Bit 5:	Customer signal (XT1.1/2)
Bit 6:	Customer signal (XT1.3/4)
Bit 7:	Customer signal (XT1.5/6)
Bit 8:	Customer signal (XT1.7/8)
Bit 9:	Customer signal (XT1.9/10)
Bit 10:	Customer signal (XT1.11/12)
Bit 11:	Customer signal (XT1.13/14)
Bit 12:	Indication of electronic unit power supply switching on (1 = switched on)
Bits 13-15:	Reserved – 0

Note 3: Particular voltages V1 ÷ V4 are given in integer 16-bit format so that, for example, value 2302 corresponds to the voltage of 230.2 V.

Note 4: Particular temperatures Temp0 ÷ Temp2 are given in integer 16-bit format in additional code for negative values, so that, for example, value 2188 corresponds to the temperature of 21.88 °C. Value 0x7FFF means an error of the temperature sensor, value 0x6FFF indicates that given external sensor (Temp1 or Temp2) not connected.

Note 5: Status byte can assume following values:

0xD5: All in good order
0xAA: Command was received
0xE0: Internal error on SCS card
0xE3: Error of internal sensor on SCS card

Appendix 8: EPS Change-over Panel Description

1 EPS Change-over Panel Description

Block diagram of the EPS switching panel is shown in following picture.

Panel of EPS signals switching changes over both interrogators of the MSSR-1 complex A B, so that on of them transmits and receives to the antenna, the other works to the load. Accordingly, it is possible to perform measurement and maintenance during operation.

Three coaxial cables, namely SUM, DIF and OMEGA are lead from the antenna, which change over to the MSSR-1 A or MSSR-1 B with the help of electrically controlled coaxial switches on the panel input. The other complex is switched to the load. In SUM and OMEGA channels, which the transmission is performed to, there are power loads and specific directional couplers, in which it is possible to measure transmitter output power, and low-power load in DIF channel. Phase shifters are in the DIF channel, with the help of which coincidence of SUM and DIF channel phases can be adjusted: phase shifter A is in the DIF channel in the lead from antenna – it tunes tolerance of coaxial cables from antenna, phase shifters B are in both DIF channels behind the switch and serves for tuning phase differences of the DIF signals in both complexes.

Circulators in SUM and OMEGA channels isolate transmitters from receiver inputs. The circulators transmit signals from the transmitter to the antenna and from the antenna to the receiver, and otherwise, they suppress signals between transmitter and receiver. Circulator in the DIF channel is wired like an isolator and decreases returns from coaxial route. Receivers protection is also enhanced by RF filters A with high selectivity that transmit received signal 1090 MHz and suppress transmitted signal 1030 MHz. They are inserted between circulators and receivers.

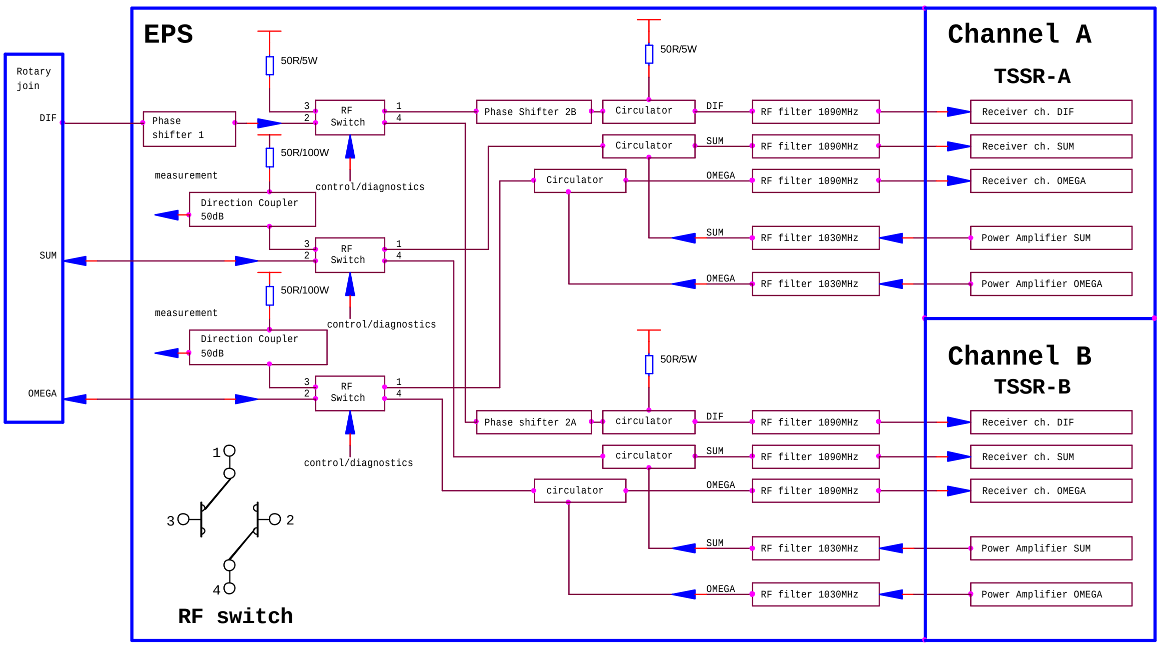


Fig. 1: Block diagram of EPS switching panel and its system wiring

2 Measurement on EPS Panel

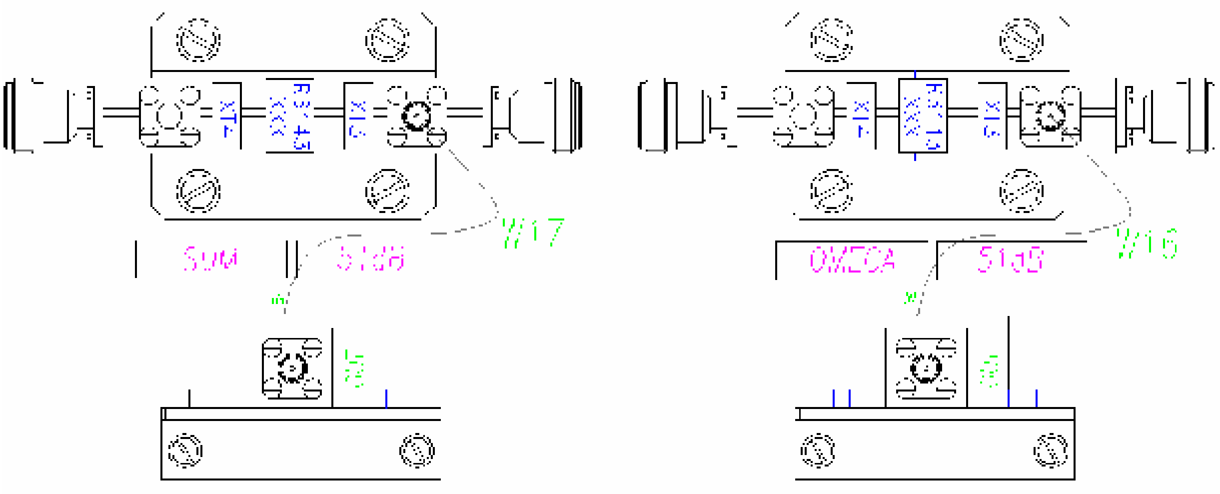


Fig. 2: View of measuring couplers and detectors

On the EPS panel, transmitted power, shape of transmitted pulse, and pulse length can be measured. The R6143 stripline coupler is used for the measurement, different for each transmission channel. Channel label, which the measurement is performed on, is under the coupler, and the route attenuation value from the transmitter up to the XT3 connector on the coupler as well. These measurements are executed on a file transmitting to the load.

2.1 Power Measurement

Transmitted power is measured on the XT3 connector of the R6143 coupler. A probe of the pulse power meter shall be connected directly to the coupler, and the pulse power shall be measured in pulse mode. Measurement occurs in dBm units. Attenuation value in dB shall be added to the measured number. It results in transmitted pulse power in dBm units.

2.2 Measurement of Pulse Length and Shape

The XT3 connector on the R6143 coupler shall be cable connected with the IN connector on the R6193 detector. Signal OUT from the detector shall be lead to the oscilloscope displaying detected negative pulses. The pulse shape and length can be measured, and mutual distance of particular pulses as well. The detector can be also used for the power orientation measurement. The pulse amplitude should be 350 – 450 mV.

3 EPS Panel – Components Layout

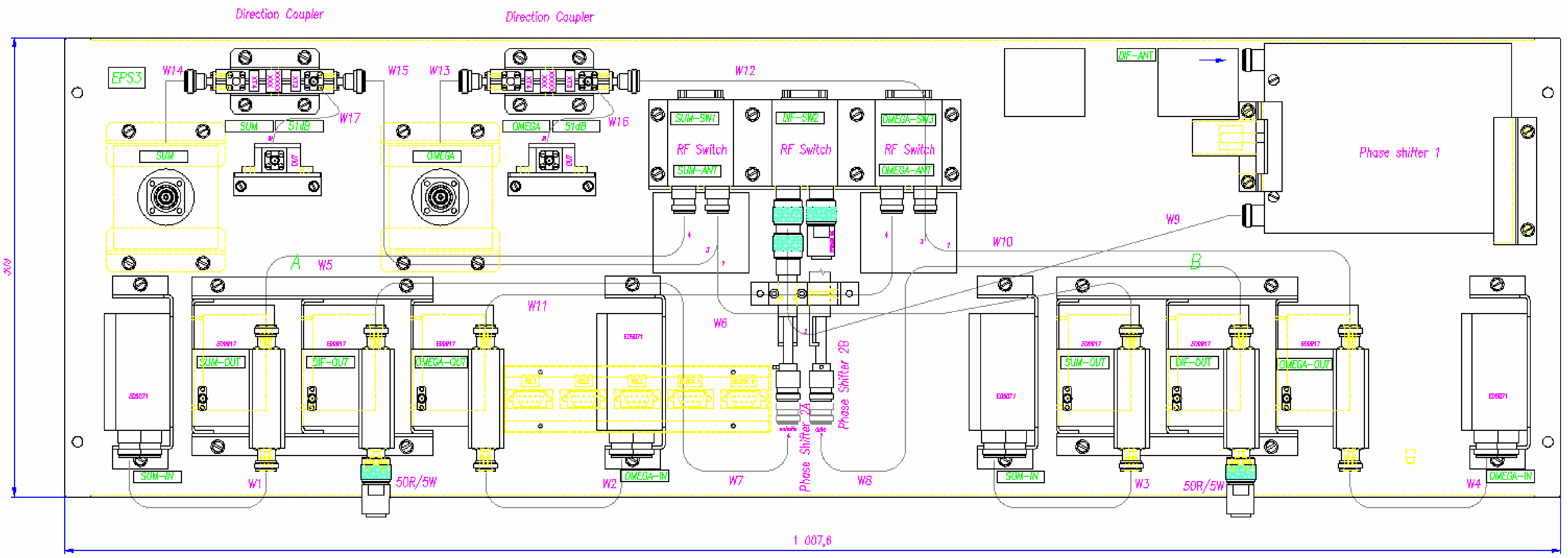


Fig. 3: Front view

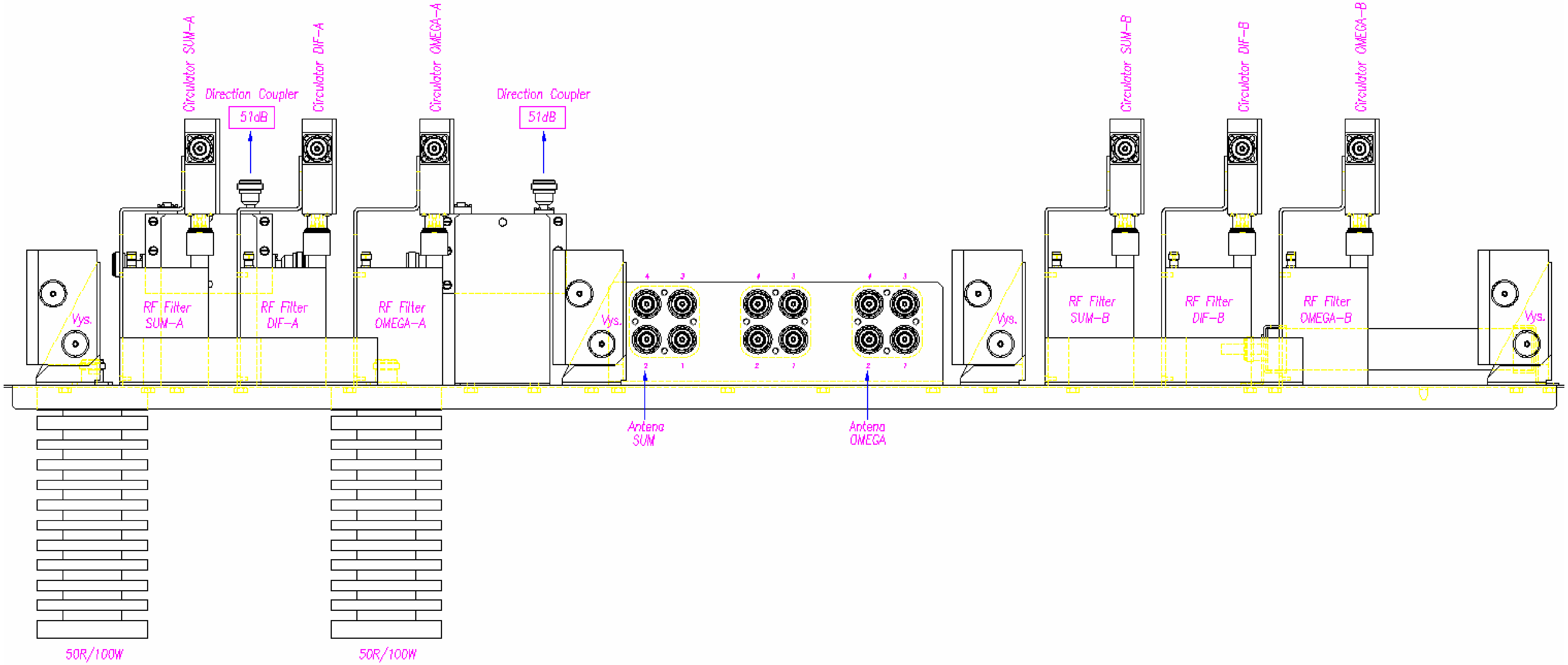


Fig. 4: Bottom view

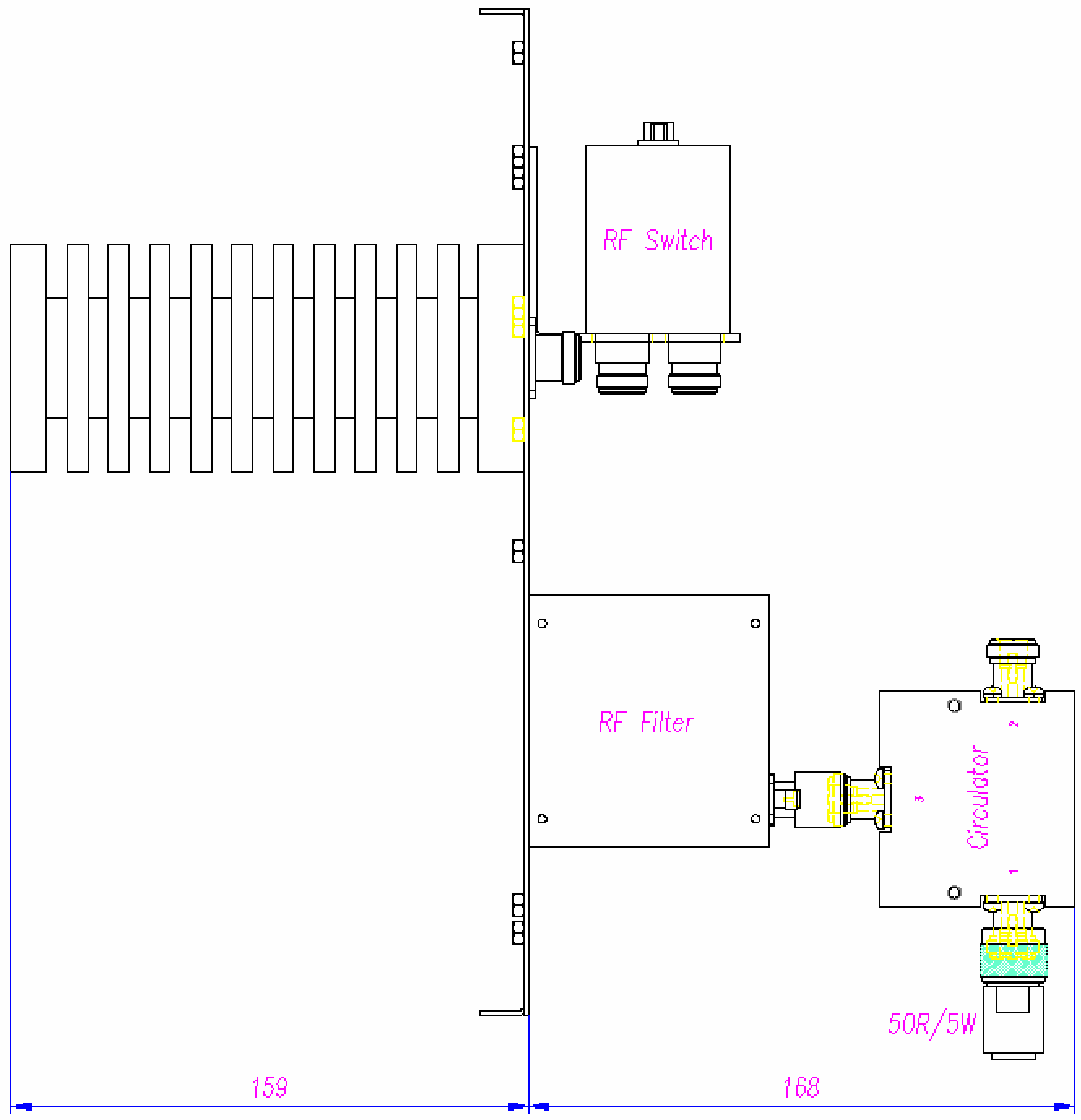


Fig. 5: Side view

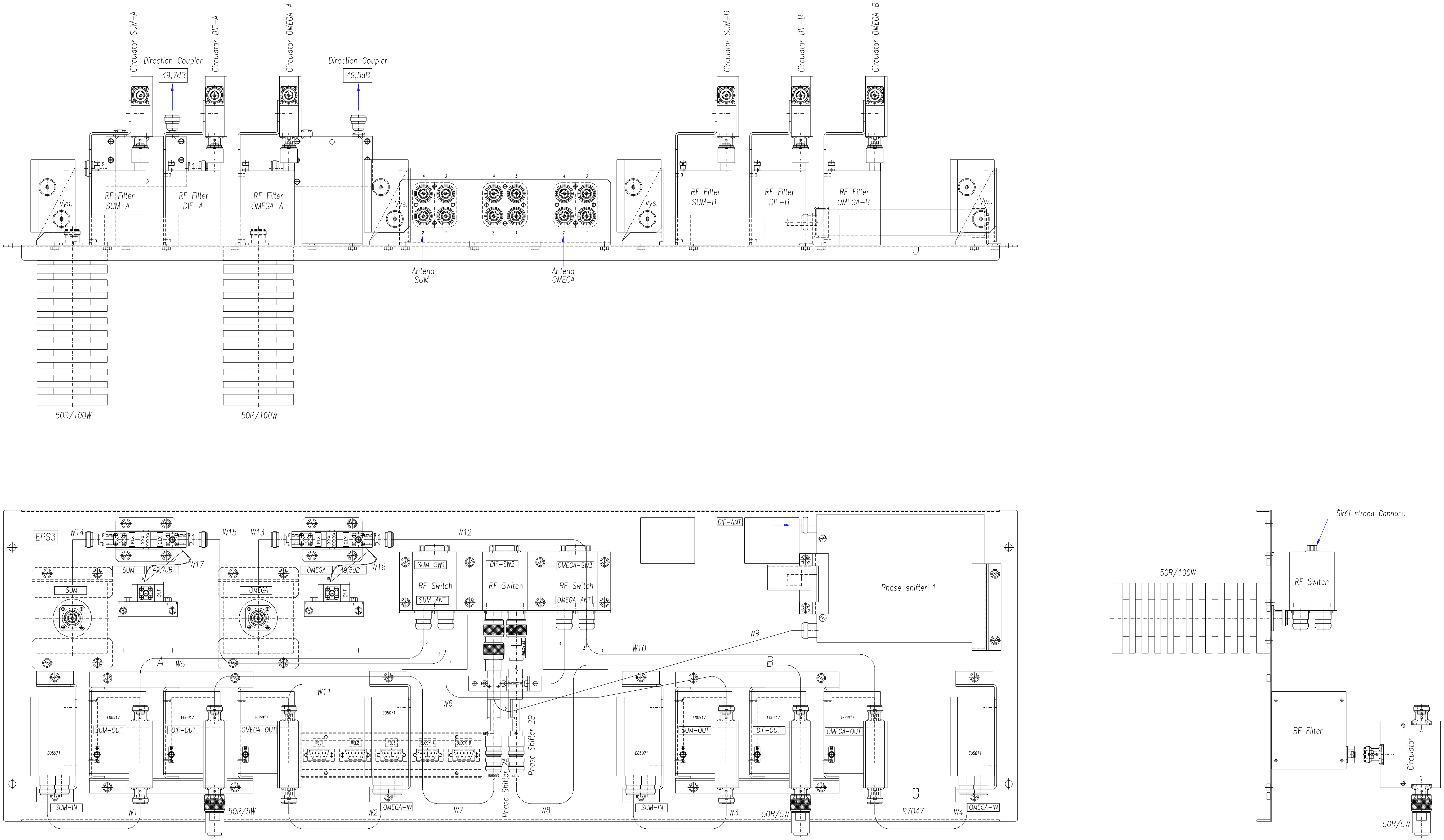


Fig. 6: General view

Appendix 9: Interface Control Document

1 Scope

1.1 Identification

The document is „Interface Control Document“ for system „Monopulse Secondary Surveillance Radar MSSR-1 installed at Ujung Pandang airport.

1.2 Interfaces description

This document deals with target reports for ATC users, on external serial lines.

Target reports are available at the plot output. They are sent to output, on the synchronous serial links.

2 Applicable and referenced documents

2.1 Applicable documents

[1] - Eurocontrol Standard for Radar Data Exchange Part 1 (ASTERIX), Ref.SUR.ET1.ST05.2000-STD-01-01, revision 1.26, November 2000

[2] - Eurocontrol Standard for Radar Data Exchange Part 2a (Cat 1), Ref.SUR.ET1.ST05.2000-STD-02a-01, revision 1.0, November 1997

[3] - Eurocontrol Standard for Radar Data Exchange Part 2b (Cat 2), Ref.SUR.ET1.ST05.2000-STD-02b-01, revision 1.0, November 1997

[4] - Eurocontrol Standard for Radar Data Exchange Part 2b (Cat 34), Ref.SUR.ET1.ST05.2000-STD-02b-01, revision 1.26, November 2000

[5] - Eurocontrol Standard for Radar Data Exchange Part 4 (Cat 48), Ref.SUR.ET1.ST05.2000-STD-04-01, revision 1.14, November 2000

3 Communication Lower layers

3.1 Serial lines

3.1.1 Physical layer

Serial link is configured to:

- RS232 (V.28)
- DTE
- Synchronous mode
- Timing signals (clocks) provided by the DTE or associated DCE
- Speed up to 38400 bit/s are possible

3.1.2 Protocol

The protocol which is used is a subset of HDLC where only Unnumbered Information (UI) frames are transmitted. No logical connection nor error recovery is performed. Nevertheless, transmission errors can be detected by the recipient thanks to the “Frame checking sequence” included in each frame.

The frame structure is described in Ref.1, where:

- Address field (8 bits) is present, but not used,
- Control field (8 bits) is present, but not used,
- Information field (N x 8 bits, with N <= 256) containing the applicative data,
- FCS field (16 bits) is set according to Ref.1

Applicative data are encapsulated into the Information field of HDLC UI frames, and immediately sent. There is at most one data block per Asterix category in a HDLC-UI frame. An Asterix data block is entirely contained in a single HDLC-UI frame.

4 Asterix CAT 01 / CAT 02 format

4.1 Category 01

UAP configuration

The standard User Application Profile to be used for the ”Target report” message formatting is as defined in Ref.2.

Data item summary for secondary plot output

The following table summarises the presence of Cat 01 data items for secondary plots.

FRN	Item	Title	Byte length
1	I001/010	Data Source Identifier	2
2	I001/020	Target Report Descriptor	1+
3	I001/040	Measured Position in Polar Coordinates	4
4	I001/070	Mode-3/A Code in Octal Representation	2
5	I001/090	Mode-C Code in Binary Representation	2
6			
7	I001/141	Truncated Time of Day	2

4.2 Category 02

4.2.1 Message types

The radar outputs two types of cat 02 messages, formatting is as defined in Ref.3.:

- North Marker Message : This message is output once per scan, as quickly as possible after the antenna has crossed the North.
- Sector messages : This message is output every 1/32nd of scan, and is synchronous with internal processing.

4.2.2 Data item summary

UAP configuration

The following table indicates which data items are present for which message :

FRN	Item	Title	Byte length	001 North Marker	002 Sector crossing
1	I002/010	Data Source Identifier	2	M	M
2	I002/000	Message Type	1	M	M
3	I002/020	Sector Number	1		M
4	I002/030	Time of Day	3	M	M
5	I002/041	Antenna Rotation Period	2	M	
6	I002/050	StationConfiguration Status	1+		M

Items marked ‘M’ are always transmitted when they are available.

5 Asterix CAT 048 / CAT 034 format

5.1 Category 048

UAP configuration

The standard User Application Profile to be used for the ”Target report” message formatting is as defined in Ref.5.

Data item summary for secondary plot output

The following table summarises the presence of Cat 048 data items for secondary plots.

FRN	Item	Title	Target report
1	I048/010	Data Source Identifier	M
2	I048/140	Time of Day	M
3	I048/020	Target Report Descriptor	M
4	I048/040	Measured Position in Slant Polar Coordinates	M
5	I048/070	Mode-3/A Code in Octal Representation	M
6	I048/090	Flight Level in Binary Representation	M
7			
FX		Field Extension Indicator	
8	I048/220	Aircraft Address	S
9	I048/240	Aircraft Identification	S
10	I048/250	Mode S MB Data	S
11			
12			
13			
14			
FX		Field Extension Indicator	
15			
16	I048/030	Warning/Error Conditions	M
21	I048/230	Communications / ACAS Capability and Flight Status	S
FX		Field Extension Indicator	

Items marked ‘M’ are always transmitted when they are available.
Items marked ‘S’ are transmitted when they are available, if the radar performs Mode S surveillance (depending on radar hardware configuration and parameter settings).
Other Items are never transmitted.

5.2 Category 034

5.2.1 Message types

The radar outputs two types of cat 034messages,formatting is as defined in Ref.5.:

- North Marker Message : This message is output once per scan, as quickly as possible after the antenna has crossed the North.
- Sector messages : This message is output every 1/32nd of scan, and is synchronous with internal processing.

5.2.2 Data item summary

UAP configuration

The following table indicates which data items are present for which message :

FRN	Item	Title	001 North Marker	002 Sector crossing
1	I034/010	Data Source Identifier	M	M
2	I034/000	Message Type	M	M
3	I034/030	Time of Day	M	M
4	I034/020	Sector Number		M
5	I034/041	Antenna Rotation Period	M	
6	I034/050	System Configuration & Status	M	M
7				
FX		Field Extension Indicator		
8				
9				
10				
11	I034/120	3D-position of source	M	
12				
13				
14				
FX		Field Extension Indicator		

Items marked ‘M’ are always transmitted when they are available.
Other Items are never transmitted.