MAINTENANCE MANUAL
AEGIS MODULE
19D904714G1

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SPECIFICATIONS

INPUT VOLTAGE   VCC = +5 VDC (nominal)
VBAT= +9 VDC (nominal)

DESCRIPTION

The Aegis Module performs speech digitization, Aegis or Voice Guard speech compression, and optional decryption for Aegis-equipped Orion radios. It plugs onto the System Control/IF/AF board of the Orion Transceiver Module, and is secured by a pad attached to the shield covering the System Control/IF/AF board. The interconnections are shown in Figure 1.
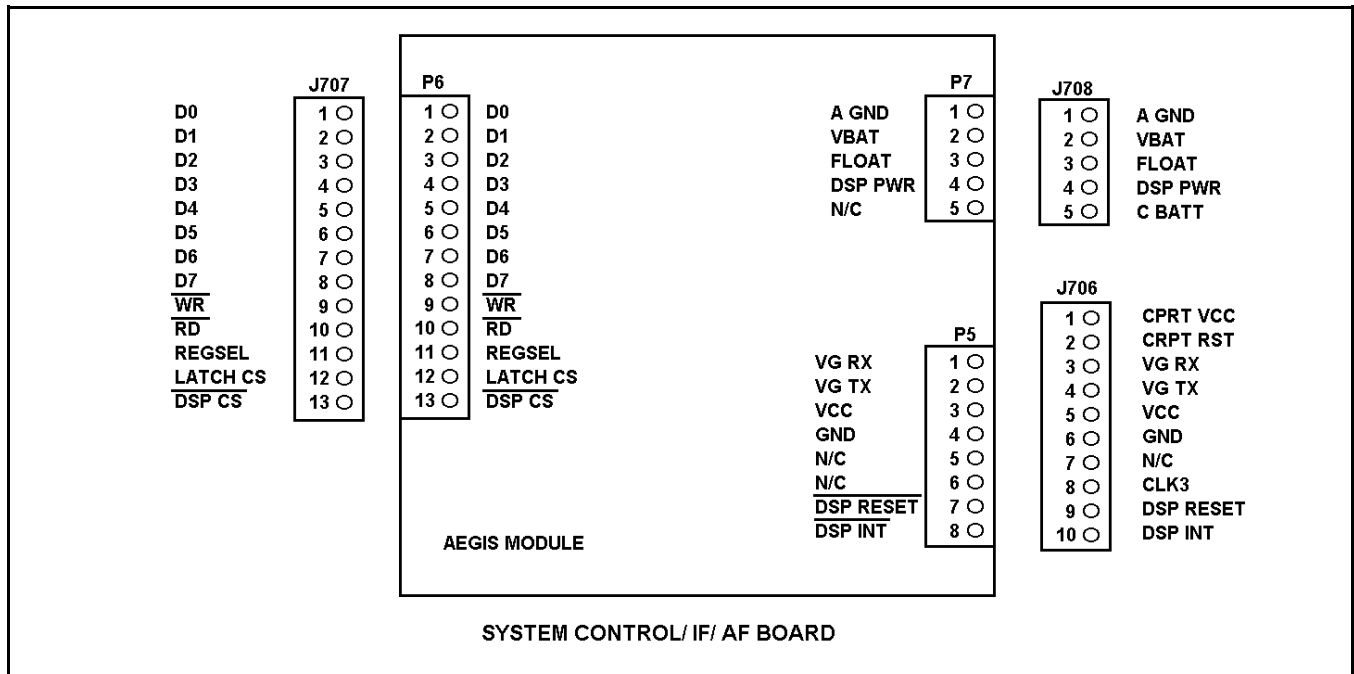

Figure 1 - Interconnection Diagram

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CIRCUIT DESCRIPTION

Most module functions are performed by Digital Signal Processor U1. U1 converts analog speech to and from a compressed digital form, and optionally encrypts the speech data. U1 communicates with the System Control Board's Radio Control Processor (RCP, IC701) through its 8-bit port HD0-HD7, which is connected to the RCP data bus. The $\overline{WR}$, $\overline{RD}$, and $\overline{HSEL}$ signals which control the port are provided by the radio controller. The port requires 3 address inputs to select the registers in the port; however, the interface only provides one (HA0). HA2 and HA1 are latched by bus writes to a separate address latch port. The latch strobe is created by gates U5.1 and U5.2, and the addresses are latched in U4.1 and U4.2.

The $\overline{PWR}$ input of U1 is set low by the radio controller board to power U1 down during standby mode. The FL0 output provides an active-low interrupt to the radio controller RCP processor when speech data is available in transmit mode or requested in receive mode.

Y1, C13, and C14 provide a 9.8304 MHz clock for U1. Op-amp U3.2 provides differential to single ended conversion of the analog speech output from U1. U3.1 provides a half-supply reference for U3.2.

Regulator U2 and associated components provide a regulated +5V supply for the analog portion of U1. The digital portion of U1 is powered by the radio controller digital +5V supply.

DSP U1 contains both ROM (Read-Only Memory) and RAM (Random-Access Memory). Software must be loaded into the RAM memory at powerup, and the controller board's RCP performs this operation each time the radio is powered up. This software is stored separately in the RCP Flash EPROM along with the RCP operating software and radio personality. The software installed in Flash EPROM is specific to the encryption algorithm installed (including unencrypted Aegis), and must match the options enabled in radio feature encryption for proper operation.

The DSP ROM software group number is accessed by displaying the ADI ROM entry in the radio's REVISION menu. The RAM software type and group number is accessed by displaying the ADI xxx entry in the revision menu (the entry after ADI ROM entry). The upper line of the display will display ADI xxx where xxx is NON for unencrypted Aegis and the encryption type for encrypted models. The lower line displays the group number of the DSP RAM software.

CAUTION

Before specifying new DSP software (.ADI file) when programming the radio, verify that the new .ADI software implements the same encryption algorithm as the software installed in the radio.

TRANSMIT OPERATION

In transmit mode, microphone audio is routed through the System Control Board's Audio Signal Processor (ASP, IC601) to J708-4/P5-2. The audio is conditioned by U1's internal input op-amp at VINNORM and VFBNORM. It is digitized, compressed (vocoded), and optionally encrypted by U1. The resulting data is read by the RCP over bus D0-D7 for formatting and transmission. The RCP adds preamble and frame header data to the data stream and loads the data into the modem ASIC (IC703) for serial transmission. Serial data from U703 is filtered by the ASP before being sent to the transmitter modulator.

RECEIVE OPERATION

In receive mode, analog serial data from the receiver discriminator is amplified and limited by the ASP. The logic level data is applied to the serial receive input of the modem ASIC which detects sync patterns within the data and interrupts the RCP. The RCP reads the data from the modem ASIC, removes and analyzes the preamble and frame headers for validity, and writes the remaining speech data to U1. U1 performs optional decryption, decompression (vocoding) and digital-to-analog conversion. The differential analog speech signal is present at VOUTP and VOUTN and converted to single-ended by U3.2. This speech is output on P5-1/J706-3 and routed through the ASP for volume control before being applied to the radio speaker amplifier.

ENCRYPTED OPERATION (OPTIONAL)

Cryptographic keys are stored in non-volatile EEPROM on the System Control/IF/AF board and loaded into the DSP at power-up and other appropriate occasions. Multiple banks of seven keys each may be stored. The radio must be placed in keyload mode (accessed by the KEYLOAD menu) and the desired band selected while loading keys. Keys are loaded into the radio via the RS-232 serial port using a keyloader and appropriate cables.

DATA FORMAT

Preamble

At the start of a transmission (PTT), a preamble consisting of repeated sync, initialization vector (IV) and addressing information is sent before voice encryption begins. The preamble provides a high probability of correct reception of sync, IV and repeater address (see Figure 2).

Frame Header

The encrypted voice data frame header is shown in Figure 3. Information is provided at the beginning of a frame to insure maintenance of data and cryptographic sync and to allow late entry into a conversation during private receive. Following the 112 bits of the frame header are 2040 bits of encrypted SBC voice data. The frame header is then repeated with a new IV.

End of Message (EOM)

In order to signal the end of a transmission, an inverted sync and inverted OA sequence is transmitted for about 50 msec. This allows for a long fade in the signal and still ensures that the receiver decodes the EOM correctly.

TROUBLESHOOTING

Hardware problems can be quickly isolated by swapping the Aegis module with a known good module. If the problem disappears with a new module, the module was defective. If the problem remains, the problem is in the System Control/IF/Audio Board or the radio was programmed incorrectly.

Digital failures are difficult to troubleshoot with field test equipment and board replacement is the most cost-effective solution. Most digital failures result in a DSP ERR message and error code (ERR=xxxx) at power up of the radio unit. The error code indicates the type of failure:

ERR=0851   DSP software was not loaded into the RCP flash EEPROM. This can usually be corrected by reprogramming the radio.

ERR=0852   DSP software in the RCP flash EEPROM had a CRC error. This can usually be corrected by reprogramming the radio.

ERR=0853   The type of Aegis encryption enabled in radio feature encryption does not match the DSP software programmed in the radio. If this option was not enabled or the System Control/IF/Audio Board was changed, feature encryption will not be correct. Obtain new feature encryption data or DSP software.
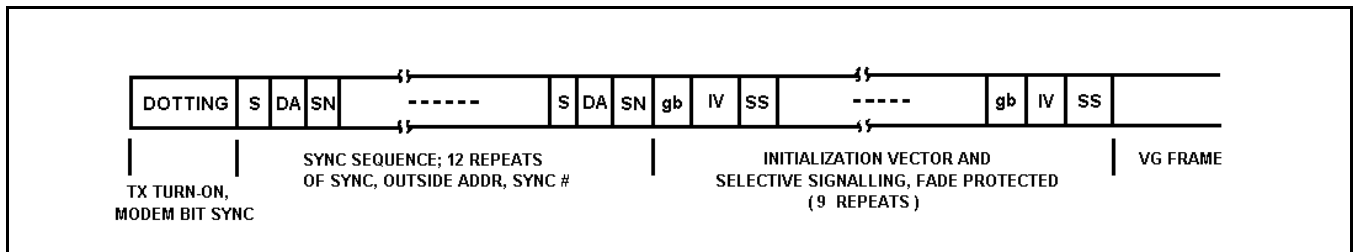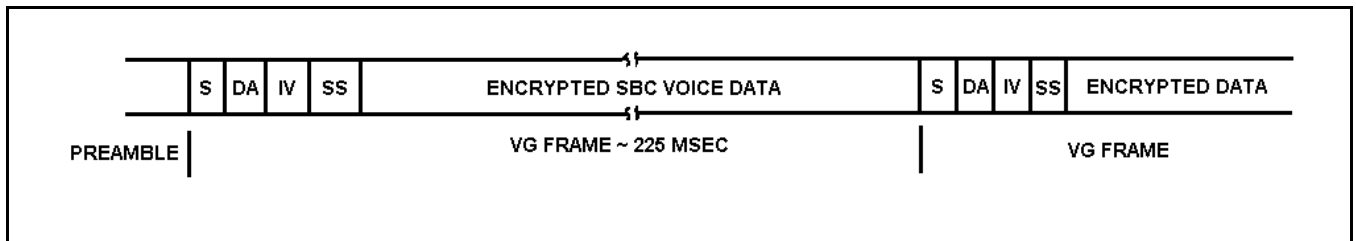

Figure 2 - Preamble Format

Figure 3 - Frame Header Format

NOTE

If Aegis feature encryption is not enabled or the EDACS-3 PC Software Programmer is not greater than V3.0, then no error is displayed at power up and Aegis digital does not work.

ERR=0854 The RCP was unable to successfully load operating software into the DSP. Either the data was corrupted during loading due to a hardware failure or the data stored in flash EEPROM is corrupted. If a board swap indicates the problem is in the System Control/IF/Audio Board, first try to reprogram the radio. Then check signals listed in ERR=0856.

ERR=0855 See ERR=0854.

ERR=0856 The RCP was unable to communicate with the DSP or the DSP failed its power-up tests. If a board swap indicates the problem is in the System Control/IF/Audio Board, check the connectors, power (VCC-5V, VBAT-9V), D0-D7, RD, WR, REGSEL, LATCH CS, DSP CS, DSP RESET and DSP PWR signals.

PROGRAMMING ERRORS

Incorrect programming or improper setting of radio controls typically results in either no audio or unusual sounds at the receiving radio. Typical problems are selecting the incorrect voice compression mode or cryptographic key. Incorrect Outside Address or data polarity may also be programmed in conventional mode.

1. Selecting different compression modes causes a continuous gurgling sound when transmitting from an Aegis radio to a Voice Guard radio, or silence with occasional bangs or chirps when transmitting from a Voice Guard radio to an Aegis radio. The receiving radio will visually appear to be receiving correctly.

2. Selecting different cryptographics keys on the transmitting and receiving units may result in periodic noise bursts on the receiving unit, or general muting with occasional noise bursts. The receiving radio will visually appear to repeatedly start and the stop a conversation at a one to two second rate, if it has an Aegis mode indicator. Verify that both radios are set for the same encryption key, or that both are set for unencrypted operation. Note that these parameters can be programmed on a per-group or per-channel basis.

3. Incorrect conventional Outside Address results in silence if the receiving radio is programmed for receive Channel Guard, or periodic noise bursts if it is not, or if Channel Guard is disabled.

4. Incorrect conventional data polarity results in no audio while receiving if the receiving radio is programmed for Channel Guard, or continuous noise if it is not, or if Channel Guard is disabled. The receiving radio may briefly indicate receipt of Aegis and mute at the end of the message.

AUDIO FAILURES

Audio failures generally will not result in error messages.

Transmit Audio

If there is a transmit audio problem, check for microphone audio at J706-4/P5-2 when transmitting. The level should be approximately 550 mVRMS when the microphone input is adjusted to standard test conditions (1000 Hz tone, level equivalent to 3 kHz analog deviation). If audio is not present, check ASP on the System Control/IF/Audio Board.

Receive Audio

If there is a receive audio problem, check for recovered vocoded audio at J706-3/P5-1. If audio is present, check the ASP on the System Control/IF/Audio Board. The level should be approximately 300 mVRMS when a Aegis signal at the standard test condition level is transmitted.

Aegis Module

If the Aegis module is defective, replacement is recommended. In addition to obvious mechanical damage, the following may be checked before replacing the module.

1. VCCA regulator U2 should produce 4.75 to 5.25 VDC at test point J4.

2. The 9.8304 MHz crystal oscillator operation can be checked at test point TP1. The oscillator should run briefly at power-up and continuously during Aegis transmit or receive operation.

3. If receive audio is absent or highly distorted, check for 2.5 VDC bias at U3-1. If incorrect, check the bias circuit consisting of R11, R12, C16 and U3.1. Also check for recovered audio at U1-57 and -58. If present, check R3-R6 and U3.2

UPGRADING AEGIS MODULE

CAUTION

If the Aegis Module is prior to REV. A, do not upgrade the DSP software (.ADI file) in the radio with software designated for use with REV. A or later boards. Only software specifically designated for the initial release module should be used. The RCP software (.BIN file) can be upgraded; however, certain additional features such as Voice Guard mode or encrypted operation will not be available.

NOTE

The initial release board can be replaced with a REV. A board without upgrading the DSP software (.ADI file) in the radio; however, software upgrade is also required to enable certain additional features such as Voice Guard mode or encrypted operation.

AEGIS MODULE
19D904714G1
ISSUE 2

SYMBOL	PART NUMBER	DESCRIPTION
		- - - - - - - CAPACITORS - - - -
C1 thru C8	19A702052P34	Ceramic: 0.1 µF ±10%, 25 VDCW.
C9	19A705205P17	Tantalum: 4.7 µF ±20%, 20VDCW.
C10	19A705205P6	Tantalum:10 µF,16VDCW;sim to Sprague 293D.
C11	19A702052P34	Ceramic: 0.1 µF ±10%, 25 VDCW.
C12	19A702052P5	Ceramic: 1000 pF ±10%, 50 VDCW.
C13 and C14	19A702061P37	Ceramic: 33 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM/°C.
C15	19A702052P34	Ceramic: 0.1 µF ±10%, 25 VDCW.
C16	19A702052P52	Ceramic: 1.0 µF ±10%, 16 VDCW.
		- - - - - - - - PLUGS - - - - - - - - -
P5	19A704474P6	Connector: 8 position; sim to SAMTEC SEP-13588-02.
P6	19A704474P8	Connector: 13 position; sim to SAMTEC SEP-13588-04.
P7	19A704474P5	Connector: 5 position; sim to SAMTEC SEP-13588-01.
		- - - - - - - - RESISTORS - - - - -
R1	344A3304P1002	Metal film: 10K ohms ±1%, 1/10 w.
R2 thru R4	344A3304P1622	Metal film: 16.2K ohms ±1%, 1/10 w.
R5 and R6	344A3304P1002	Metal film: 10K ohms ±1%, 1/10 w.
R7 and R8	19B801251P103	Metal film: 10K ohms ±5%, 1/10 w.

* COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION
  CHANGES

SYMBOL	PART NUMBER	DESCRIPTION
R11 and R12	19B801251P104	Metal film: 100K ohms ±5%, 1/10 w.
R13	19B801251P222	Metal film: 2.2K ohms ±5%, 1/10 w.
		- - -INTEGRATED CIRCUITS - -
U1*	349A9662G1	Digital Signal Processor.
U2	344A3404P101	Linear: +5.0 Volt Regulator; sim to TL751L05.
U3	344A4591P201	DUAL OP AMP, CMOS; sim to TLC22721.
U4	19A704380P302	Digital: CMOS Dual Data Flip-Flop; sim to 74HC74.
U5	19A703483P302	Digital: Quad 2-Input NAND Gate; sim to 74HC00.
		- - - - - - - CRYSTALS - - - - - -
Y1	19A702511G70	XTAL UNIT: 9.8304 MHz.

PRODUCTION CHANGES

Changes in the equipment to improve performance or to simplify circuits are identified by a "Revision Letter", which is stamped after the model number of the unit. The revision stamped on the unit includes all previous revisions. Refer to the Parts List for the descriptions of parts affected by these revision.

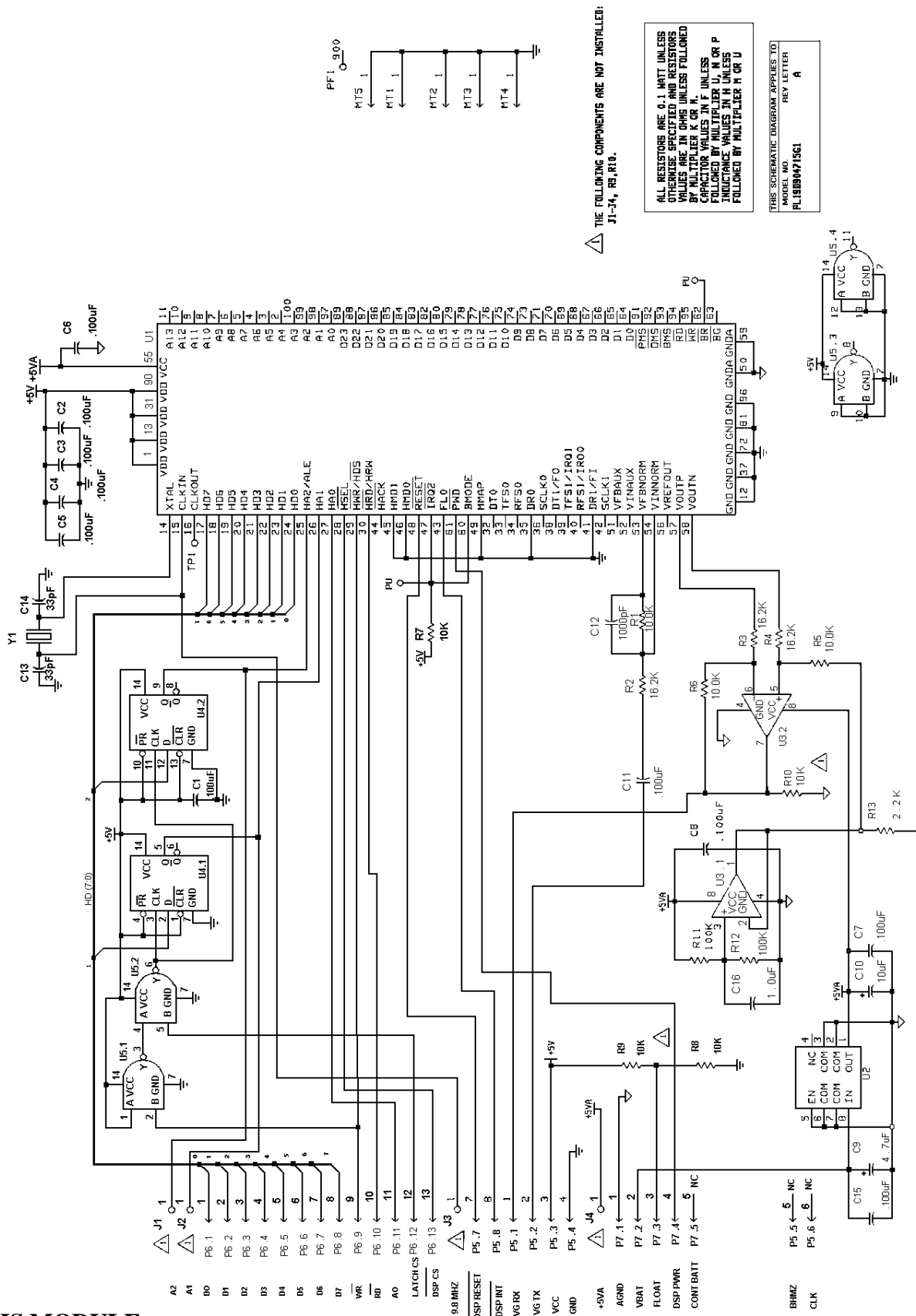**REV. A - <u>Aegis Module 19D904714G1</u>**
     To add capability for encrypted AEGIS, U1 was changed to a ROM/RAM device (349A9662G1).
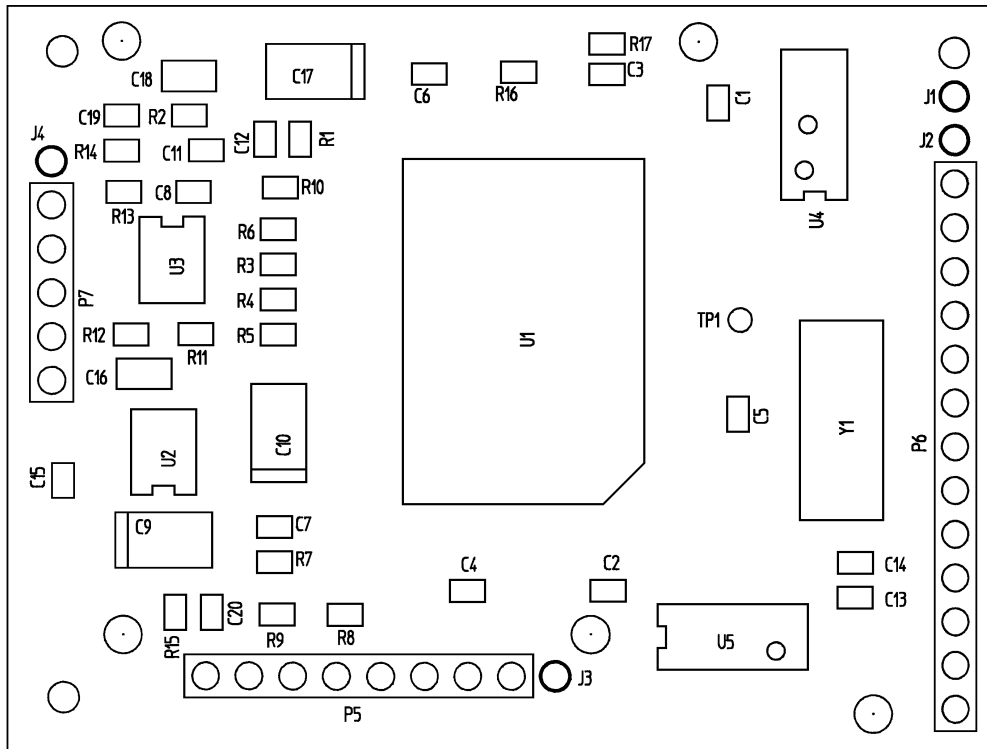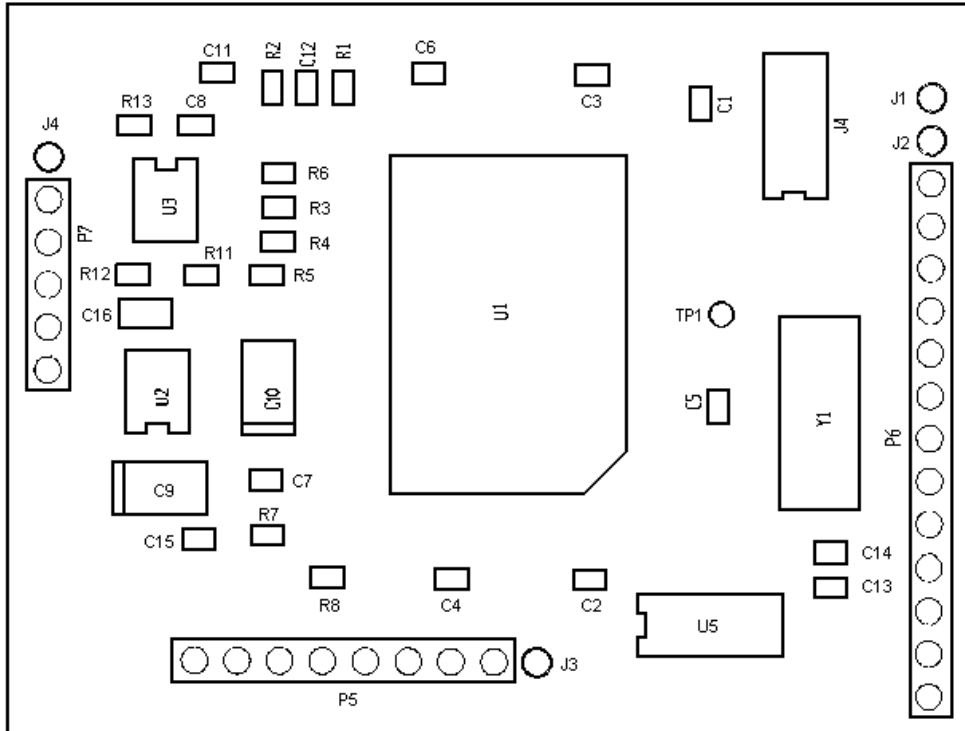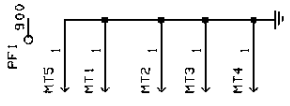
REVISION "A"

AEGIS MODULE
19D904714G1

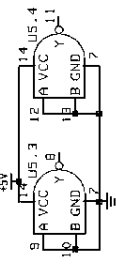(19D904714, Sh. 1 & 2, Rev. 2)

**AEGIS MODULE
19D904714G1**

(19D904715, Rev. 1)

U1
349A9662G1
Digital Signal Processor

TOP VIEW
(PINS DOWN)
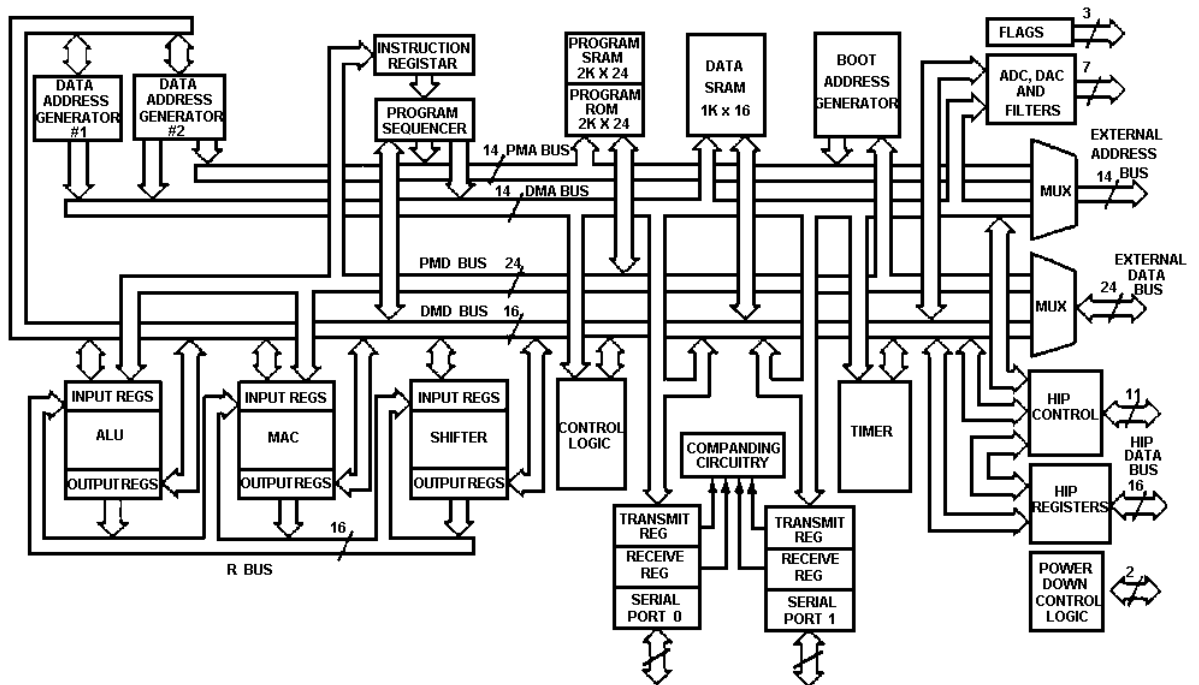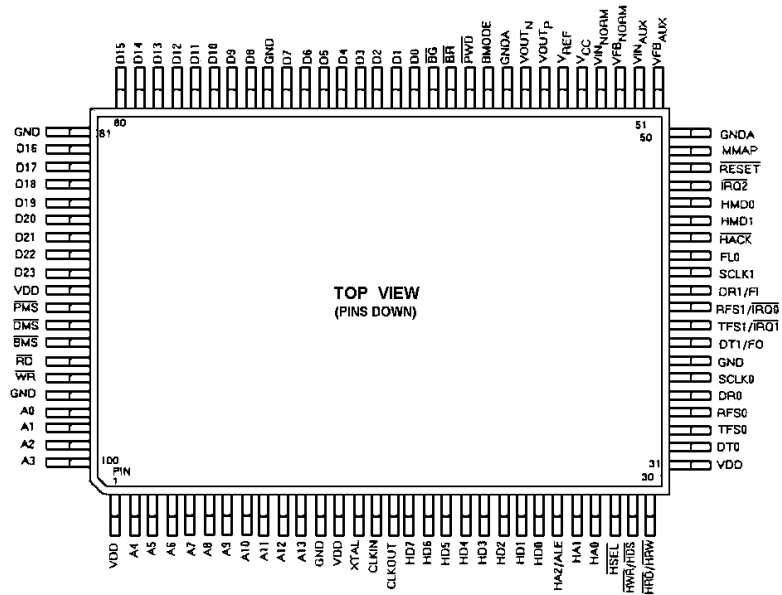
U2
344A3404P101
5 VDC REGULATOR

OUTPUT	1	8	INPUT
COMMON	2	7	COMMON
COMMON	3	6	COMMON
NC	4	5	$\overline{\text{ENABLE}}$

U3
344A4591P201
DUAL OP AMP

1 OUT	1	8	VDD+
1 IN−	2	7	2 OUT
1 IN +	3	6	2 IN −
VDD-/GND	4	5	2 IN +
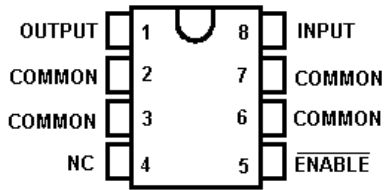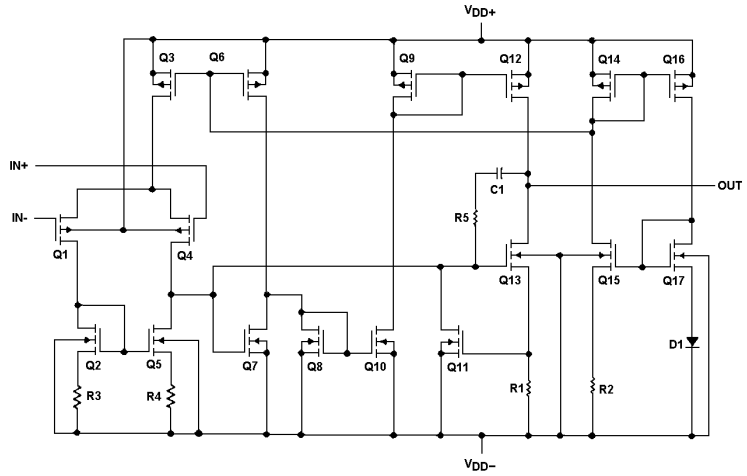
U5
19A703483P302
QUAD 2-INPUT NAND GATE
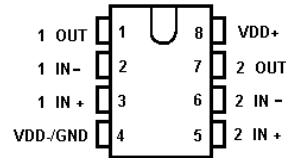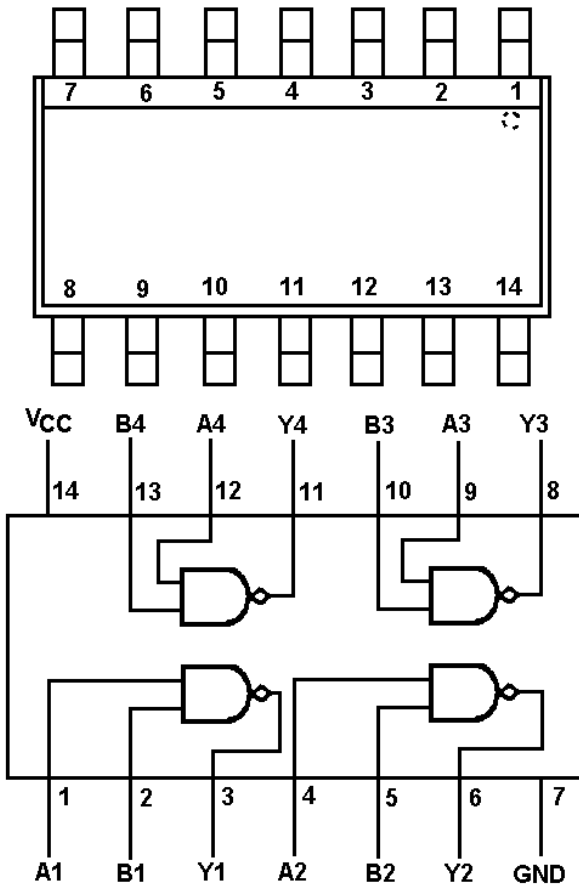
U4
19A704380P301
DUAL DATA F/F

GND = 7
VCC = 14