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DIGITAL EQUIPMENT CORPORATION
MAYNARD, MASSACHUSETTS

ENGINEERING SPECIFICATION DATE 9/26/74

TITLE AR11 System Installation/Acceptance Procedure

REVISIONS

REV	DESCRIPTION	CHG NO	ORIG	DATE	APPD BY	DATE

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ENG	APPD	SIZE	CODE	NUMBER	REV
		A	SP	AR11-Ø-4	

DEC 16-(382)-1079-N971
DRA 107

ENGINEERING SPECIFICATION digital CONTINUATION SHEET

TITLE AR11 System Installation/Acceptance Procedure

1.0 SCOPE

This procedure covers the installation and acceptance of an AR11 in a PDP11 system. It is anticipated that the procedure will be used in one of the following situations:

1.1 Installation and acceptance of an AR11 on a PDP11 system in an in-house FA & T system integration area.

1.2 Add-on installation and acceptance of an AR11 on an existing PDP11 system in the field.

1.3 Acceptance of an AR11 on a new PDP11 system upon installation at a customer site.

1.4 On-going AR11 verification testing at intervals over the life of a given system.

2.0 AR11 MOUNTING/CONFIGURATION CONSIDERATIONS

2.1 The AR11 is a one-module option which interfaces with a PDP11 through a hex SPC slot. A hex SPC slot is one of the following:

2.1.1 One of the two middle slots of a DD11-B, C or E four-slot prewired system unit.

2.1.2 One of the seven middle slots of a DD11-D or F nine-slot prewired double system unit.

2.1.3 Any processor-mounted SPC slot with physical room for a hex module.

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DRA 108

2.2 The AR11 may be mounted in any hex SPC slot and will operate within specification with no configuration restrictions whatsoever regarding physical proximity to processor, memory, or other options. AR11 analog performance may be further optimized beyond specification levels by mounting in an electrically quiet environment. Consequently, if a choice is available in configuring a system, the AR11 should be mounted away from the processor and memory modules.

2.3 Cabling

The AR11 is interfaced to the outside world by means of either a BC08-R flat cable to an H322 distribution panel, a BC11-L Berg-to-open end cable, or a user-built cable. In either of the latter two cases, in a 10½" or 5¼" mounting box, the next slot (on the component side of the AR11) should not contain another hex SPC module, in order to leave room for the AR11 cable to double back and exit past the top of the module.

2.4 Bus Addresses

The AR11 starting address may be set at any address between 760000 and 777760 (in increments of 20) by means of a jumper and switches on the module. The preferred starting address is 770400. Use of any other starting address will necessitate patches to the AR11 diagnostics, as well as to system software (such as RT-11 lab applications and SPARTA) which supports the AR11. The AR11 diagnostics (Test I - logic and Test III - wraparound) support multiple

AR11's automatically, provided that the AR11's occupy a sequential block of addresses 20 apart, and provided that the address following the last AR11 is unused. For example, in a system with a single AR11 at 770400, the address 770420 should not be used; a system with three AR11's should have the AR11's at 770400, 770420 and 770440, with the address 770460 unused. If, in configuring a system, it is necessary to use the address which is 20 higher than the last AR11 address, patches will be necessary to diagnostics Test I and Test III, and these diagnostics will then test only one AR11 at a time. (See section 4 for patches.)

2.5 Vectors

The AR11 vector space may start in increments of 20 up to a maximum of 760 by means of switches on the module. The preferred vector is 340. Use of any other vector will necessitate patches to the AR11 diagnostics, as well as to system software which supports the AR11. For AR11 diagnostics Test I and Test III to work properly with multiple AR11's in a system, the AR11 vectors should be in sequential order, 20 apart. For example, in a system with three AR11's at 770400, 770420, and 770440, the vectors should be 340, 360 and 400 respectively.

3.0 AR11 INSTALLATION

3.1 Based on the above considerations, choose a hex SPC mounting slot, starting address, and vector for the AR11 to be installed.

3.2 Set up the starting address in the following manner:

3.2.1 For addresses between 77ØØØØ and 77776Ø, leave W4 connected. For addresses between 76ØØØØ and 76776Ø, disconnect W4 and connect W4A.

3.2.2 Set up address switches (S1) per figure 1 and figure 2. Switches are set "on" for a Ø and "off" for a 1.

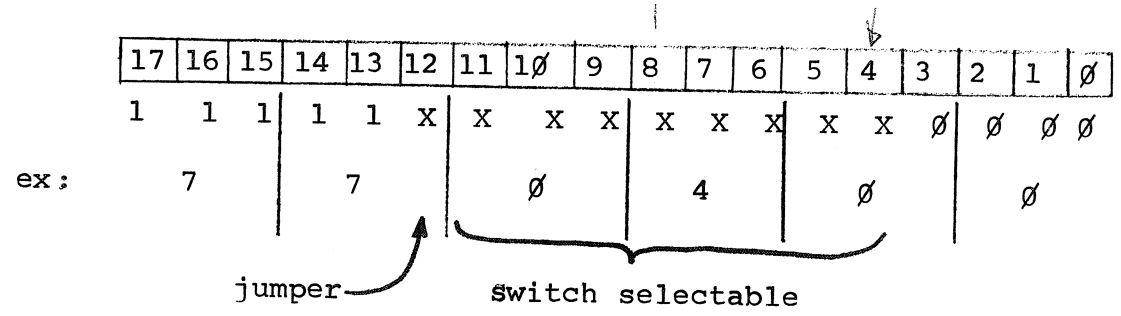


Figure 1: AR11 Address Selection

3.3.3 Example

To set up starting address 77Ø4ØØ, leave W4 connected, set all S1 switches "on" except for the bit 8 switch.

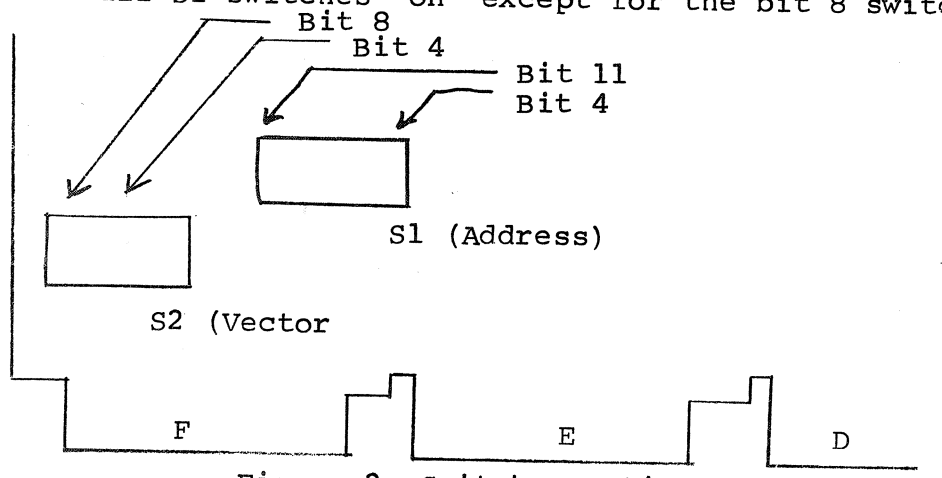


Figure 2: Switch Locations

3.3 Set up the vector in the following manner:

3.3.1 Set up vector switches (S2) per figure 2 and figure 3. Switches are set "on" for a 1 and "off" for a Ø. (Note that this is opposite to the address switches.)

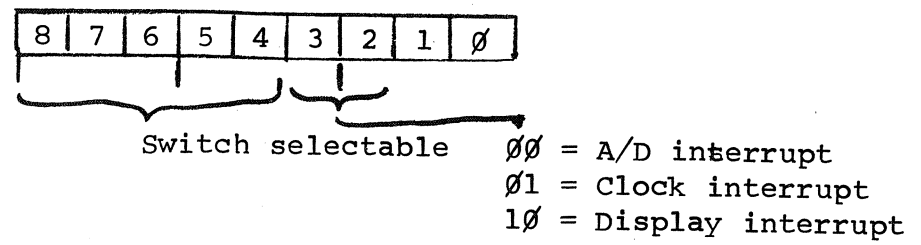


Figure 3: AR11 Vector Selection

3.3.2 Example

To set up a vector of 34Ø, the bit 7, 6, and 5 switches are "on" and the bit 8 and 4 switches are "off".

3.4 Re-install the covers on switch-packs S1 and S2.

3.5 Install the module in the selected hex SPC slot.

3.6 If the system contains an H322 signal distribution panel, connect the AR11 and H322 by means of a BCØ8-R Berg-to-Berg cable. If the system includes a BC11-L Berg-to-open end cable, do not install the cable at this time. Instead, install the BCØ8-R cable which is to be used with the G5036 wraparound module for acceptance testing. The BC11-L is to be installed upon completion of acceptance testing.

3.7 Install the 17-00021 electromagnetic shields on both sides of the AR11.

3.8 Conduct an acceptance test per section 4 below.

4.0 AR11 ACCEPTANCE

4.1 Test Flow

AR11 acceptance testing flow is shown in figure 4.

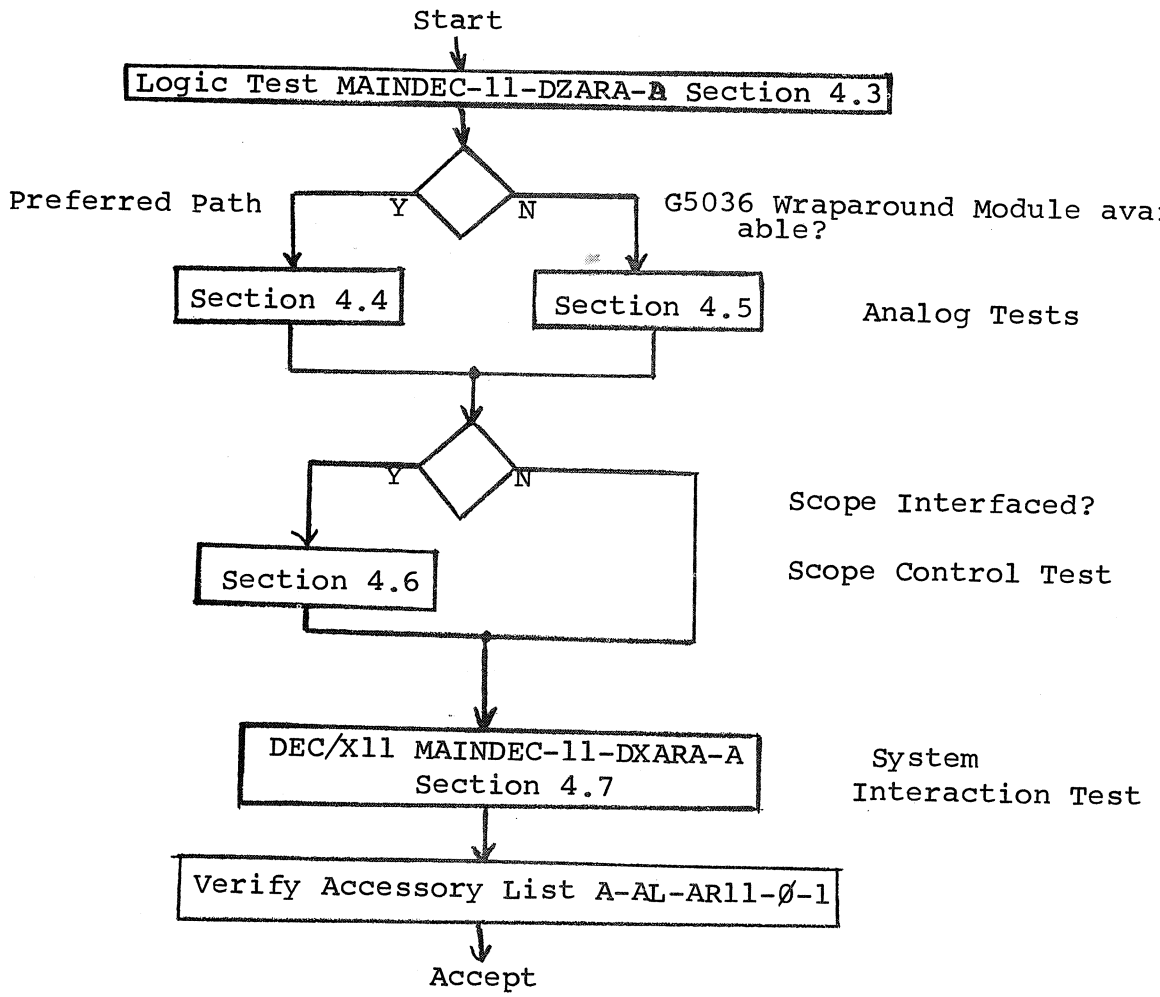


Figure 4: AR11 Acceptance Flow

In every case, AR11 acceptance begins with a complete test of the AR11 logic, described in section 4.3 below.

If a G5036 wraparound module is available, the preferred path is taken for analog testing, described in section 4.4 below. This is the normal path taken for in-house acceptance, field installation acceptance, and on-going AR11 analog verification testing by field service personnel and by users who have purchased the BG5036 maintenance kit. The analog testing path described in section 4.5 below is for on-going AR11 analog verification testing by users who have not purchased the BG5036 maintenance kit.

The scope control test, described in section 4.6, is to be run on those systems in which the AR11 is interfaced to an XY display scope or storage scope.

The DEC/X11 system interaction test, described in section 4.7, is to be run on all systems with AR11. The AR11 DEC/X11 module tests for the presence of the wraparound module and chooses one of two routines accordingly. If the G5036 wraparound module is available, it should be connected to the AR11 during DEC/X11 testing. However, DEC/X11 can be run without the wraparound module without sacrificing validity, by users who have not purchased the BG5036 maintenance kit.

4.2 Equipment and Diagnostics Required

4.2.1 PDP11 system, with AR11 and console device.

4.2.2 Calibrated DC Voltage Source. EDC model MV116 or equivalent.

4.2.3 BG5036 maintenance kit: *

4.2.3.1 G5036 wraparound module

4.2.3.2 BC08-R Berg-to-Berg cable

4.2.4 MAINDEC-11-DZARA-A AR11 Test I (logic)

4.2.5 MAINDEC-11-DZARB-A AR11 Test II (analog)

4.2.6 MAINDEC-11-DZARC-A AR11 Test III (wraparound)*

4.2.7 MAINDEC-11-DXARA-A AR11 DEC/X11 module

*Not required for user's on-going verification testing

4.3 Logic Test

Load and run the logic test diagnostic MAINDEC-11-DZARA-A. Under the following conditions, no patches are required: First (or only) AR11 at address 77Ø4ØØ, vector at 34Ø; additional AR11 addresses and vectors 2Ø apart and sequential, e.g. 77Ø42Ø and 36Ø, 77Ø44Ø and 4ØØ, etc; address 2Ø higher than last AR11 address unused, e.g. 77Ø42Ø in system with one AR11, 77Ø46Ø in system with three AR11's. Otherwise, patch:

a) 136Ø/ AR11 starting address (first AR11)

b) 1362/ AR11 vector (first AR11)

c) 1526/ 5ØØ3 ; inhibit testing more than one AR11.

Without patch (c), the diagnostic automatically tests all the AR11's installed in the system (with sequential addresses 2Ø

apart) in each pass. The diagnostic must complete at least three passes without error with iterations or ten passes without error without iterations (SW11 = 1).

4.4 Analog Tests (using G5036 wraparound module)

4.4.1 For each AR11 in the system connect the AR11 to a G5036 wraparound module by means of a BC08-R Berg-to-Berg cables. For AR11's which are interfaced to H322 signal distribution panels, the BC08-R cable which normally connects to the H322 should be disconnected from the H322 and connected to the G5036. For AR11's without an H322, the BC08-R cable should come out of the processor box and cabinet. Maximum BC08-R cable length should be 12 feet.

*Important Note: The BC08-R cable should be connected "upside-down" at the G5036 end, i.e. A to VV rather than A to A.

4.4.2 Set the switch on the G5036 module to the "E" position. Connect the EDC voltage source signal output to the "E" split lug on the G5036. Connect the EDC voltage source return to the "G" split lug on the G5036. The EDC should be floating to avoid ground loops. The EDC leads should be short and shielded if possible. The EDC output is now connected to the AR11 A/D channel Ø input.

4.4.3 Load the analog test diagnostic MAINDEC-11-DZARB-A. This diagnostic only tests one AR11 at a time. For an AR11 at address 77Ø4ØØ and vector 34Ø, no patches are needed.

Otherwise, patch:

a) 12Ø4/ AR11 starting address

b) 12Ø6/ AR11 vector

Start the program at location 2ØØ, select Test C (calibration test), and when requested, type 'I' for internal A/D starts. Set SW1Ø = 1 to force console printout of the converted value. Select channel Ø bipolar by leaving all other front console switches at Ø.

Set up the EDC for the input voltage indicated in column A and monitor the conversion result. It should be the value in column B, with a ±1 tolerance.

A	B
-1.875 Volts	Ø2ØØ ±1
0	1ØØØ ±1
+1.875 Volts	16ØØ ±1

4.4.4 Set the switch on the G5036 module back to the "Ø" position. The AR11 A/D channel Ø input now sees a ground, the desired input for wraparound testing. The EDC may now be disconnected.

4.4.5 Load and run the wraparound diagnostic MAINDEC-11-DZARC-A. No patches are required if the following conditions are met: First (or only) AR11 at address 77Ø4ØØ, vector at 34Ø; additional AR11 addresses and vectors 2Ø apart and sequential, e.g. 77Ø42Ø and 36Ø, 77Ø44Ø and 4ØØ, etc.; address 2Ø higher than

last AR11 address unused, e.g. 77Ø42Ø in systems with one AR11, 77Ø46Ø in system with three AR11's. Otherwise, patch:

a) 1334 / AR11 starting address (first AR11)

b) 1336 / AR11 vector (first AR11)

c) 145Ø / 5ØØ3 ; inhibit testing more than one AR11.

Without patch (c), the diagnostic automatically tests all the AR11's installed in the system (with sequential addresses 2Ø apart) in each pass. The diagnostic must complete at least two passes without error.

The wraparound diagnostic tests the following:

a) Scope intensify pulse, A/D external start

b) Storage scope hand-shaking logic-erase return, etc.

c) Scope control output logic high and low levels

d) Analog power supply levels

e) Functional check on all 16 channels of A/D input

f) A/D input bias current

g) Calibration of XD/A vs. A/D, YD/A vs. A/D

h) Linearity of XD/A vs. A/D, YD/A vs. A/D

i) Differential Linearity of A/D, XD/A, YD/A

j) A/D inter-channel settling, plus full-scale and minus full-scale

k) Noise levels - rms and peak - A/D bipolar, A/D unipolar, XD/A, YD/A

1) Offset - A/D bipolar, A/D unipolar, XD/A, YD/A

Numerical results of the above tests can be printed out, for the edification of the test operator, by setting front console SW12 = 1.

4.5 Non-wraparound Analog Tests

This section may be performed in lieu of section 4.4 for on-going AR11 analog verification testing by users who have not purchased the BG5036 maintenance kit.

4.5.1 Load the analog test diagnostic MAINDEC-11-DZARB-A. This diagnostic tests only one AR11 at a time. For an AR11 at address 77Ø4ØØ and vector 34Ø, no patches are needed. Otherwise, patch:

a) 12Ø4 / AR11 starting address

b) 12Ø6 / AR11 vector

4.5.2 A/D Calibration and Linearity

Start the program at location 2ØØ, select Test C (calibration test), and when requested, type 'I' for internal A/D starts. If the AR11 is interfaced to a scope, the results will appear on the screen. If the AR11 is not interfaced to a scope, set front console SW1Ø = 1 to force console printout of the converted values.

Connect the EDC output to the input of the A/D channel

to be tested. Connect the EDC return to one of the A/D input grounds. The EDC should be floating to avoid ground loops. The EDC leads should be short and shielded if possible. Select the desired A/D input channel using front console SWØ3:SWØØ.

Set up the EDC for each input voltage indicated in column A and monitor the conversion result. It should be the value in column B, with a ±1 tolerance.

A	B	C
-2.500 Volts	ØØØØ ±1	0
-1.875 Volts	Ø2ØØ ±1	+.625 Volts
-1.250 Volts	Ø4ØØ ±1	+1.250 Volts
-.625 Volts	Ø6ØØ ±1	+1.875 Volts
0	1ØØØ ±1	+2.500 Volts
+.625 Volts	12ØØ ±1	+3.125 Volts
+1.250 Volts	14ØØ ±1	+3.750 Volts
+1.875 Volts	16ØØ ±1	+4.375 Volts

Set front console SWØ5 = 1, for unipolar input range. Set up the EDC for each input voltage indicated in column C and monitor the conversion result. It should be the value in column B, with a ±1 tolerance.

4.5.3 A/D Noise

The AR11 A/D's noise level can be measured in one of two manners. Each involves a burst of 512 conversions. If the average of the 512 conversions is centered within a nominal-width (1 LSB) state, the "tails" of the noise distribution can be observed in the (average +1) and (average -1) states. For

rms noise levels less than the ¼ LSB spec, at least 490 conversions are in the center (average) state.

4.5.3.1 The first method of noise measurement can only be done when the AR11 is interfaced to an oscilloscope. Using this method, it is easy to center the EDC voltage within a single state, but it is necessary to count the number of conversions in the (average +1) and (average -1) states.

Select Test C (calibration test), and when requested, type 'I' for internal A/D starts. Select the desired A/D input channel using front console SWØ3:ØØ. Connect the EDC output to the input of the channel being tested as in section 4.5.2 above. A burst of 512 conversion is displayed across the screen, with four ±8 LSB "markers" superimposed on the trace. Adjust the EDC voltage so that the trace is exactly centered within a state (equal number of plus and minus "glitches"). At this input voltage, set SWØ6 = 1, to discontinue sampling and freeze the last 512-point burst on the screen. Count the number of conversions in the (average +1) and (average -1) states. This number should be less than 22_{10}, i.e. there must be at least 490 conversions in the center state.

4.5.3.2 The second method of noise measurement does not

require the AR11 to be interfaced to a scope.

Select Test D (repeatability test), and when requested, select the desired channel, and select a count spread of Ø, to force printouts of all distributions. Connect the EDC to the desired channel as in section 4.5.2 above. Observe the distributions printed out, and adjust the EDC voltage such that the distribution is centered in the "Av" state, with equal numbers of conversions in the "+1" and "-1" columns. The number in the "Av" column must be 490 or greater.

4.5.4 Inter-channel Settling

Inter-channel settling is tested by connecting two voltages which are at opposite ends of the A/D input range to two different channels. For example, connect -2.4 Volts to the channel Ø input and +2.4 Volts to the channel 1 input and run with bipolar input range (±2.5 Volts) by selecting channels Ø and 1, or connect +.1 Volts to the channel Ø input and +4.9 Volts to the channel 1 input and run with unipolar input range (0 to +5 Volts) by selecting channels 4Ø and 41. In the following description, it is assumed that -2.4 Volts and +2.4 Volts are connected to channels Ø and 1.

Select Test E (recovery test), and when requested, type "Ø, 1" for the positive settling test and "1, Ø" for the negative settling test. A series of eight conversion values is

then typed out. In each case, the first value typed out should be within one count of the average of the remaining seven values. (If the remaining seven values are on the borderline between two states, change the input voltage by 2.5 mV and repeat the test.)

4.6 Scope Control Test

This test is done only if the AR11 is interfaced to an oscilloscope. The analog test diagnostic MAINDEC-11-DZARB-A must be loaded (and patched for proper address and vector if necessary) per section 4.5.1 above. Select Test B (display).

The program will loop through the following eight "pictures": horizontal line, vertical line, square, X, settling test square wave, character set, channel 1 - channel 2, descending horizontal line. Observe these pictures for linearity, dot spacing, and lack of noise or jitter.

Set SWØ8 = 1 to select a fixed "picture". Set SWØ2 = 1 to select the settling test square wave. With SWØ7 = Ø observe settling in the horizontal direction; with SWØ7 = 1 observe settling in the vertical direction. Maximum settling error should be "1 dot".

If the scope which is interfaced to the AR11 is a VR14, with SWØ8 = 1, set SWØ2:ØØ = 6. With the VR14 switched to "both", "Channel 1" and "Channel 2" should appear on the screen. With the

VR14 switched to "channel 1", "Channel 1" should appear on the screen; likewise for "channel 2".

4.7 DEC/X11 System Integration Test

The system exerciser is configured using the AR11 exerciser module MAINDEC-11-DXARA-A along with modules for all other options present. The G5036 wraparound module should be installed per section 4.4.1 above. The AR11 exerciser measures (and compares to spec limits) rms and peak noise levels on A/D, X D/A, and Y D/A. All A/D conversions are started on clock overflow after a random number has been loaded into the clock buffer register. Since the system is being exercised in the background at the time the A/D conversions start, the noise levels measured are true worst case levels, under conditions of full system interaction.

For purposes of on-going verification testing by a user who has not purchased the BG5036 maintenance kit, the DEC/X11 module may be run without wraparound. Under this condition, the program senses the absence of the G5036 wraparound module and goes to a routine which takes conversionson each of the 16 channels and displays them on the screen of the scope driven by the AR11. Each channel is displayed in turn for about three seconds.

5.0 AFTER ACCEPTANCE

5.1 Remove the G5036 wraparound module. It is not shipped with the AR11.

5.2 If the system includes an H322 signal distribution panel, reconnect the BC08-R cable to the H322. If the system does not include an H322, remove the BC08-R cable. It is not shipped.

5.3 If the system includes a BC11-L cable, it should be installed at this time. If the AR11 is in a new version 10½" or 5¼" mounting box, so that the BC11-L cable cannot go straight out the back, the BC11-L cable must double back and exit past the top of the module.

5.4 Verify that all items on the AR11 accessory list A-AL-AR11-Ø-1 are present and properly packed for shipment.