SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The Hewlett-Packard Model 3570A Network Analyzer is a narrow-band tracking detector designed to operate in conjunction with an -hp- Model 3320A/B Frequency Synthesizer or an -hp- Model 3330A/B Automatic Synthesizer. The Synthesizer/Analyzer combination forms a versatile measurement system for precision network analysis in the 50 Hz to 13 MHz frequency range. The 3570A Network Analyzer is an integral part of the 3040A, 3041A and 3042A Systems.

1-3. The Model 3570A is designed to measure the amplitude and phase response of two-port linear networks in the frequency domain. It can be used for measuring the absolute transfer functions of networks or for comparing two networks. The major features of the instrument include two identical measurement channels, 100 dB dynamic range (200 Hz to 13 MHz), selectable bandwidths, (10 Hz, 100 Hz and 3 kHz), two digital readouts for simultaneous amplitude and phase presentations, plus complete programmability of all functions, ranges and settings. These standard features, along with optional group delay measurements, offset measurements, limit tests and digital (Isolated General Purpose Interface Bus) outputs, make the 3570A a truly flexible instrument that is well suited for laboratory, maintenance and production-line applications.

1-4. SPECIFICATIONS.

1-5. Table 1-1 is a complete list of the Model 3570A critical specifications that are controlled by tolerances. Table 1-2 contains general information that describes the operating characteristics of the Model 3570A.

1-6. Any changes in specifications due to manufacturing, design, or traceability to the U.S. National Bureau of Standards are included in Table 1-1 in this manual. Specifications listed in this manual supercede all previous specifications for the Model 3570A.

1-7. OPTIONS.

1-8. There are presently four options available for the Model 3570A. These options are listed in Table 1-3. For further information concerning options, refer to Table 1-2 or Section III in this manual or contact the nearest -hp- Sales and Service Office.

NOTE

The 3570A option numbers used throughout this manual correspond with the 3040A, 3041A and 3042A Systems option numbers listed in Table 1-6.

1-9. ACCESSORIES SUPPLIED.

1-10. Table 1-4 is a list of accessories supplied with the Model 3570A.

NOTE

In addition to the accessories listed in Table 1-4, a spare numeric display module (-hp- Part No. 1990-0329) is included with the instrument. The spare module is plugged into the foam block above the crystal in the A3 card nest and is accessible with the top covers (outer and inner) of the instrument removed.

1-11. ACCESSORIES AVAILABLE.

1-12. Table 1-5 is a list of Hewlett-Packard accessories available for use with the Model 3570A.

1-13. INSTRUMENT AND MANUAL IDENTIFICATION.

1-14. Hewlett-Packard uses a two-section serial number. The first section (prefix) identifies a series of instruments. The last section (suffix) identifies a particular instrument within the series. If a letter is included with the serial number, it identifies the country in which the instrument was manufactured. If the serial number of your instrument is lower than the one on the title page of this manual, refer to Appendix C for backdating information that will adapt this manual to your instrument. All correspondence with Hewlett-Packard should include the complete serial number.

Table 1-1. Specifications.

FREQUENCY RANGE: 50 Hz to 13 MHz

CHANNEL A AND B OUTPUTS:
Output impedance: 50 Ω or 75 Ω ± 2%.
Maximum output: 1 V rms into 50 Ω or 75 Ω.
Transfer accuracy ± 0.4 dB

CHANNEL A AND B INPUTS:
Input impedance: 1 MΩ ± 2% shunted by < 30 pF.
Input signal range: 1 V rms to 1 μV rms.

AMPLITUDE ACCURACY (25°C ± 5°C):
Absolute: No spec - may be calibrated to source using front panel adjustments.
Relative (relative to 0 dB input for 1 V, 0 dBm, and 0.1 V range): A or B "Amplitude Function" (B-A specification determined by sum of Channel A and B accuracies).

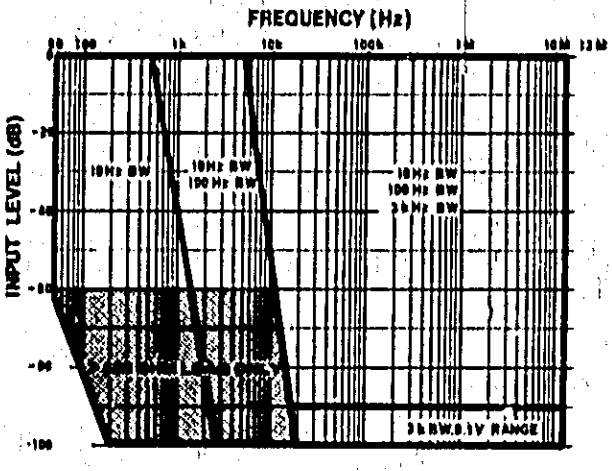
	0 dB	+20 dB	+70 dB	+80 dB	+100 dB
10 Hz BW, 100 Hz BW and 3 kHz BW on 1 V range	± 0.2 dB	± 0.5 dB		± 1.5 dB	
3 kHz BW, 0.1 V range and 0 dBm range	± 0.2 dB	± 0.5 dB	*Not Specified		

*Due to lower noise rejection of 3 kHz BW.

FREQUENCY RESPONSE:
A or B "Amplitude Function": ≤ ± 0.5 dB p-p error.
B - A "Amplitude Function": ≤ ± 0.1 dB p-p error.

DYNAMIC RANGE*

*The following graph is explained in Paragraph 3-59.



RESIDUAL RESPONSES:
Power line related spurious responses (50 Hz or 60 Hz).

0.1 V Range, 0 dBm

Fundamental:	> 70 dB below 0.1 V
2nd and 4th harmonics:	> 85 dB below 0.1 V
3rd harmonic:	> 80 dB below 0.1 V
5th harmonic:	> 80 dB below 0.1 V
6th and 7th harmonics:	> 95 dB below 0.1 V

1 V Range

Fundamental:	> 80 dB below 1 V
2nd harmonic:	> 95 dB below 1 V
3rd harmonic:	> 90 dB below 1 V

RF Feedthru at 100 kHz: < -60 dB

AMPLITUDE STABILITY (8 hr., 25°C ± 1°C after 3 hr. warmup):

	0 dB	+20 dB	+80 dB	+100 dB
100 Hz and 3 kHz BW	± 0.05 dB	± 0.08 dB	Not specified	
10 Hz BW	± 0.08 dB	± 0.15 dB	Not specified	

Temperature coefficient (20° to 30°C):
100 Hz and 3 kHz BW: ± 0.02 dB/°C
10 Hz BW: ± 0.05 dB/°C

PHASE MEASUREMENTS: Phase reference is Channel A.
A/-A reference offset: 180° ± 0.4°
Phase Accuracy (25°C ± 5°C):
Phase linearity: ± 0.2° (Channel B within 6 dB of Channel A)

Frequency Response: (Channels at 0 dB)

± 0.8°	± 0.2°	± 1°

50 Hz 100 Hz 1 MHz 13 MHz

Amplitude Response: (Channel B within 6 dB of Channel A)

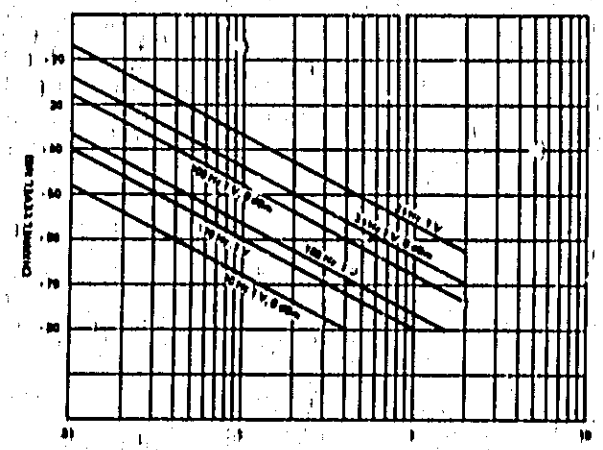
0 dB	+20 dB	+70 dB	+80 dB	+100 dB
± 0.4°	± 0.6°	± 1°	Not specified	

Amplitude Response: (For channels at different levels, specification determined by lowest input)

	0 dB	+20 dB	+60 dB	+70 dB	+100 dB
1 Volt Range 50 Hz–60 Hz	± 1.3°	± 1.6°	± 3.6°	NOT SPECIFIED	
1 Volt Range 60 kHz–13 MHz	± 1.3°	± 1.5°	± 3.6°	NOT SPECIFIED	

*See General Information for operating notes.

PEAK-PEAK-NOISE vs. AMPLITUDE: (dependent on bandwidth



DELAY ACCURACY: (± % of reading + % of measurement range)

0 dB	+40 dB	+80 dB	+100 dB
± (0.2% + 0.2%)	± (0.5% + 0.5%)	Not Specified	

MEASUREMENT RANGE:
5 ranges, 19.999 μs, 199.99 μs, 1.9999 ms, 19.999 ms and 199.99 ms.

Table 1-2. General Information.

INPUTS*

Front Panel Inputs (A and B):

Connectors: female BNC

Impedance: 1 MΩ, shunted by < 30 pF (28 pF nominal)

Maximum (ac) Input Voltage:

Max/Ref Input Voltage Setting	Maximum Input Voltage
1 V	1 V rms
0 dBm	0.2236 V rms (50 ohms) 0.2739 V rms (75 ohms)
0.1 V	0.1 V rms

Overload Protection: 15 V rms

Coupling: capacitive

Maximum (dc) Input Voltage: ± 50 Vdc

DC Isolation: none (inputs referenced to frame ground)

Rear Panel Inputs:

INPUT ○: Triaxial connector mates with hp 11172B RF Input Cable connected to ALT OUTPUT ○ of Synthesizer. Receives 50 Hz to 13 MHz signal input from Synthesizer.

Impedance: 50 ohms (std) 75 ohms (Options 001, 003)

20 - 33 MHz INPUT □: Female BNC connector receives 20 MHz to 33 MHz tracking signal from 20 - 33 MHz OUTPUT □ of Synthesizer.

1 MHz INPUT Δ: Female BNC connector receives 1 MHz reference signal from 1 MHz OUTPUT Δ of Synthesizer.

OUTPUTS*

Front Panel Outputs (A and B):

Connectors: female BNC

Impedance: 50 ohms (std) 75 ohms (Options 001, 003)

Coupling: direct

Maximum Applied Voltage: ± 6 Vdc

Output Level: Equal to level set on Synthesizer when driving a 50 - ohm (or 75 - ohm) load.

Maximum (ac) Output Voltage:

2 V rms (open circuit)

1 V rms (50 - ohm or 75 - ohm load)

Maximum (dc) Output Voltage: ± 10 mVdc (nominal)

Transfer Accuracy: ± 0.4 dB (nominal)

DC Isolation: none (output common connects directly to frame ground)

*NOTE: All instrument connections should use double shielded BNC or TRIAX cables. Cables of excessive length may degrade the ability of the Network Analyzer to meet specifications.

Analog Outputs:

Connectors: female BNC

Resistance: 1 kΩ (nominal)

Amplitude Function Output: Supplies dc voltage proportional to amplitude (A, B or B - A)

Output Level: 0.1 V/dB (0 V to ± 10 Vdc for 0 dB to ± 100 dB)

Phase/Delay Output: Supplies dc voltage proportional to phase and dc voltage proportional to group delay (in Sweep Delay Mode only).

Phase Output Level: 0.05 Vdc per degree (0 V to ± 9 Vdc for 0 to ± 180 degrees)

Delay Output Level: 5 mVdc per count (0 V to ± 10 Vdc for 0 to ± 1,999 counts)

Delay (X - Y Recorder) Output: Supplies dc voltage proportional to group delay in Swept Delay Mode. No meaningful output in Phase or CW Delay Mode. Output is controlled by a sample and hold circuit which retains previous reading if present reading exceeds 2,000 counts.

Output Level: 5 mVdc per count (0 V to ± 10 Vdc for 0 to ± 1,999 counts)

Z Axis Output: Provides markers during frequency or amplitude sweeps. Can be set to intensify eleven points, representing 1, 10 or 100 sweep steps or to intensify only center frequency or center amplitude. During limit tests, only the limit transition points are intensified. Marker intensity can be adjusted using the rear panel INTENSITY control.

Connector: female BNC

Blanking Voltage: + 10 Vdc

Unblanking Voltage: 0 V

Marker Amplitude: 0 V to - 7 V (adjustable)

Output Resistance: 1 kΩ

BANDWIDTHS

Selectable Bandwidths: 10 Hz, 100 Hz and 3 kHz

Shape Factor: 20:1 (nominal)

Rejection Characteristics:

Bandwidth	- 3 dB Points	- 60 dB Points
10 Hz	f_o ± 5 Hz	f_o ± 100 Hz
100 Hz	f_o ± 50 Hz	f_o ± 1 kHz
3 kHz	f_o ± 1.5 kHz	f_o ± 30 kHz

RESPONSE TIME

Typical Settling Time (following 40 dB step):

Bandwidth	90 % Settled	100 % Settled
10 Hz	200 ms	800 ms
100 Hz	20 ms	80 ms
3 kHz	1 ms	4 ms

Table 1-2. General Information (Cont'd).

RANGES

Frequency Range:

Bandwidth	Frequency
10 Hz	50 Hz to 13 MHz
100 Hz	500 Hz to 13 MHz
3 kHz	15 kHz to 13 MHz

Dynamic Range: 100 dB (200 Hz to 13 MHz)

Measurement Range: 120 dB (1 µV rms to 1 V rms in three ranges):

Max/Ref Input Voltage

Setting	Lower Limit	Upper Limit
1 V	10 µV rms	1 V rms
0 dBm	-100 dBm	0 dBm (50 or 75 ohms)
0.1 V	1 µV rms	0.1 V rms

MEASUREMENTS

Amplitude Measurements:

Amplitude Functions: Channel A (dBV, dBm); Channel B (dBV, dBm); B - A (dB)
Display Range (Log A, Log B): 0 dB to - 100 dB
Display Range (B - A): - 100 dB to + 100 dB
Display Resolution: 0.01 dB
Amplitude Reference (Log A, Log B): 0 dB(V) or 0 dB(m), depending on MAX/REF INPUT VOLTAGE setting:

Range	Reference
1 V	1 V rms = 0 dBV
0 dBm	0 dBm (50 or 75 ohms)
0.1 V	0.1 V rms = 0 dBV

Amplitude Reference (B - A (dB)): Channel A is reference channel. A positive reading means that the signal applied to Channel B is greater in amplitude than the signal applied to Channel A; a negative reading means that the signal applied to Channel B is lower in amplitude than the signal applied to Channel A.

Phase Measurements:

Phase Measurement Range: 359 degrees (- 179.5 degrees to + 179.5 degrees)
Due to amplitude and frequency response of phase accuracy and peak-to-peak noise specifications, the width of the indeterminant phase measurement region discussed in Section III is effectively increased whenever input level is decreased or input frequency is increased.
Display Resolution: 0.01 degree
Phase Reference: A or - A
1) Channel A is the reference channel. A negative phase reading means that B lags A; a positive readings means that B leads A.
2) With the PHASE REFERENCE switch set to the A position, the phase reading is direct. With the switch set to the - A position, Channel A is inverted and the phase reading is offset by 180 degrees.

DIGITAL READOUTS

Display: 4 1/2 digits with decimal indicator, polarity sign and annunciators.

Reading Rate (internal sampling): 4 readings per second

Typical A to D Conversion Time (both displays): 400 µsec

FRONT PANEL ZERO ADJUSTMENTS

The AMP ZERO and Ø ZERO adjustments are provided to compensate for slight changes in accuracy that occur due to environmental changes and changes in Bandwidth.

Recommended Input Configuration: Zero adjustments should be performed with the A and B Outputs, terminated in 50 - ohm (or 75 - ohm) load, connected to the A and B Inputs. Synthesizer should be set to 0 dBm (or 0 dBV), 1 MHz.

Frequency of Adjustments: Zero adjustments should be performed on a daily basis and any time BANDWIDTH setting is changed. If 3570A is operated in an uncontrolled environment, more frequent adjustments may be required.

Typical Adjustment Ranges:

Amplitude Zero: ± 6 dB

Phase (Ø) Zero: ± 10 degrees

REMOTE PROGRAMMING

The 3570A will recognize an internally preset "listen" address and accept 7-bit parallel, word serial ASCII-coded instructions.

Programmability: All functions, ranges and settings (except LINE and LIMIT SWEEP RESTART).

Remote Control Connector: The REMOTE CONTROL connector is a 36-pin*, male PC connector located on the rear panel of the instrument. The connector mates directly with the -hp- 11236B Multi-Unit Cable and the -hp- 11235A Adapter (the -hp- 11235A Adapter mates with the -hp- 10631 HP-IB and the -hp- Model 3260A Marked Card Programmer).

*Remote Control Lines: Fourteen lines are required for a complete remote input/output and control capability (remaining lines on 36-pin connector are used for digital communication between the 3570A and the 3330A/B Automatic Synthesizer when the two instruments are interconnected with the -hp- 11236B Multi-Unit Cable). The fourteen remote control lines include:

7 Data lines (LD1 through LD7)
1 Remote Enable line (LREN)
1 Multiple Response Enable line (LMRE)
1 End Output line (LEOP)
3 flag lines:
Data Valid (LDAV)
Ready For Data (HRFD)
Data Accepted (HDAC)
1 ground line

Isolation: The 3570A remote input/output lines are not isolated. All lines are referenced to frame ground (except in Isolated Hewlett-Packard Interface Bus Option U04).

Remote Logic: The 3570A uses standard TTL logic:

State	Requirements
Low	gnd. or 0 V to + 0.4 V (3.2 mA max.)
High	open or + 2.5 V to + 5 V

Table 1-2. General Information (Cont'd).

When a line functions as an input it is normally held at +3 Vdc by an internal pullup. When a line functions as an output it will supply up to 48 mA in the low state and up to 0.6 mA in the high state.

Assertion States: Assertion states are indicated by the prefix "L" (low) or "H" (high). Two flag lines, HRFD and HDAC, have high assertion states; remaining lines have low assertion states.

Timing: Timing is controlled by the LDAV flag from the controller to the 3570A and by the HRFD and HDAC flags from the 3570A to the controller. A maximum of 150 µs is required for the 3570A to accept one data word.

Addresses: The 3570A is shipped from the factory with a "listen" address of 041 Octal and a "talk" address of 101 Octal ("talk" address applies to Option 004 only). Address code must be accompanied by a Multiple Response Enable (LMRE) instruction. Address codes can be changed by changing the position of jumper plugs on Address Recognition Assembly, A33.

GENERAL

Operating Temperature: In order for the 3570A to meet the specifications listed in Table 1-1, the operating temperature must be within the range of +20° C to +30° C. The instrument can be operated where the ambient temperature is within the range of 0° C to +20° C or +30° C to +55° C with degraded accuracy.

Thermal Cutout: The 3570A is equipped with a thermal switch which automatically removes line voltage when internal temperature exceeds +75° C (operating temperature approximately +60° C).

Storage Temperature: -40° C to +75° C

Power Requirements: 100 V, 120 V, 220 V or 240 V -10 % +5 %, 48 Hz to 66 Hz, 230 VA max.

Dimensions:

Heighth (including feet): 140.6 mm (5 17/32 in.)
Overall length: 542.9 mm (21 3/8 in.)
Width: 425 mm (16 3/4 in.)
Width (including mounting strips): 483 mm (19 in.)

OPTIONS

75-Ohm (Options 001, 003): Channel A and Channel B OUTPUTS have 75-ohm impedances; The 0 dBm MAX/REF INPUT VOLTAGE setting is referenced to 75 ohms and the rear panel INPUT O impedance is 75 ohms.

Group Delay Measurements (Options 002, 003): For group delay measurements, the 3570A solves the formula:

$$\tau g = \frac{\Delta\theta}{360\,\Delta f}$$

Delay Modes:

Swept (SWP): In the SWP mode, the 3570A measures phase and computes group delay at each sweep step, providing a total of 10, 100 or 1,000 delay readings depending on the number of steps selected on the 3330A/B Automatic Synthesizer.

Single Frequency (CW): In the CW mode, the 3330A/B Automatic Synthesizer must be programmed to sweep in 10 frequency steps. The 3570A computes group delay based on phase readings taken at F_{min} and F_{max}. The single delay reading represents the mean slope of the phase vs. frequency curve.

The Frequency Increment, Δf: The 3570A offers twenty choices of Δf, ranging from 5 Hz to 200 kHz in decade multiples of 5 Hz, 10 Hz, 16.6 Hz and 20 Hz. The selection can be made using the front panel FREQ STEP controls or by remote ASCII coded instructions.

Delay Measurement Range:

Five Ranges:

19.999 µs
199.99 µs
1.9999 ms
19.999 ms
199.99 ms

Delay Sensitivity: 1 ns to 10 µs, depending on delay range

Offset Feature (Options 002, 003): The 3570A Offset feature permits entry of digital offsets from the front panel or by remote control. Amplitude, phase and delay readings can be offset.

Offset Entry:

Front Panel: Pressing the respective ENTER OFFSET pushbutton enters the present amplitude, phase or delay reading into memory, providing a zero reference when ABSOLUTE/RELATIVE switch is set to RELATIVE (offset) position.

Remote Control: Offsets can be entered remotely by applying an ASCII coded Amplitude or Phase/Delay ENTER OFFSET instruction (same as pressing ENTER OFFSET pushbutton in local) or by a numerical data entry within the range of -199.99 to +199.99.

Limit Test Feature (Option 002, 003): The 3570A Limit Test feature permits a pair of digital test limits (upper and lower) to be entered into memory by remote control. The test limits can apply to amplitude or phase/delay but not both simultaneously. If a reading is within the test limits, the "GO" annunciator illuminates; if a reading is above the upper limit or below the lower limit, the "HI" or "LO" annunciator illuminates.

Limit Sweep Modes:

Limit Sweep Stop Mode: Any transition between "GO", "HI" and "LO" causes the 3330A/B Automatic Synthesizer to stop sweeping. The sweep can be restarted by pressing the LIMIT SWEEP RESTART pushbutton. The Limit Sweep Restart function cannot be programmed remotely.

Limit Sweep No Stop Mode: The 3330A/B Automatic Synthesizer continues to sweep regardless of limit test transitions. Markers available at the Z AXIS OUTPUT can be used to intensify limit transition points on scope trace.

Isolated Hewlett-Packard Interface Bus (Option 004): Instruments equipped with the Isolated HP-IB Two-Way option will transmit ASCII coded amplitude, phase and delay measurement data in a 7-bit parallel, word serial format. In addition, the remote input/output lines are isolated from signal (frame) ground.

DC Isolation: ± 250 Vdc

AC Isolation: 30 dB to 1 MHz

Table 1-3. 3570A Options.

3570A Option (Factory Installed)	Description
001	75 - ohm outputs, 0 dBm Max/Ref Input Voltage setting calibrated to 75 ohms
002	Group delay, offset and limit test (50 - ohm outputs)
003	Group delay, offset and limit test (75 - ohm outputs)
004*	Isolated Hewlett-Packard Interface Bus

*Field Installation kit -hp- 11176A

Table 1-4. Accessories Supplied.

Item	Qty	-hp- Part No.
RF Input Cable	1 ea.	11172B (50 Ω) 11172C (75 Ω)
Multi-Unit Cable	1 ea.	11236B
Accessory Kit Includes the following:	1 ea.	03570-66501
PC Board Extender (25 pin)	1 ea.	03570-66501
PC Board Extender (dual)	1 ea.	03570-66502
PC Board Extender (6 pin)	1 ea.	03570-66503
PC Board Extender (15 pin)	2 ea.	5060-0049
Coax Cable - 50 ohm	2 ea.	8120-1839
Fuse: 1.5A Normal Blow	1 ea.	2110-0043

Table 1-5. Accessories Available.

-hp- Model	Description
11171A*	Front Panel Kit Includes the following: (2) 12" Double Shielded Cables (BNC to BNC) (2) 24" Double Shielded Cables (BNC to BNC) (1) 48" Double Shielded Cable (BNC to BNC) (2) 50 - Ohm Feed-Thru Terminations (1) Screwdriver
5060-8740	Rack Mount Kit
11170A	12" Double Shielded Cable (BNC to BNC)
11170B	24" Double Shielded Cable (BNC to BNC)
11170C	48" Double Shielded Cable (BNC to BNC)
11170D	48" Double Shielded Cable (BNC to BNC) (For 75 Ω System)
11048C	50 - Ohm Feed-Thru Termination
11094B	75 - Ohm Feed-Thru Termination
11095A	600 - Ohm Feed-Thru Termination
1201A/B	Variable Persistance Oscilloscope
3260A	Marked Card Programmer
10004B	Voltage Divider Probe
1120A	Active Probe

* For 75 - ohm systems order -hp- 11171B

Table 1-6. Option Cross Reference.

3570A Option	3040A Option	3041A Option	3042A Option
001	101	DNA	101
002	102	100	102
003	103	101	103
004	104	102	STD