National Semiconductor

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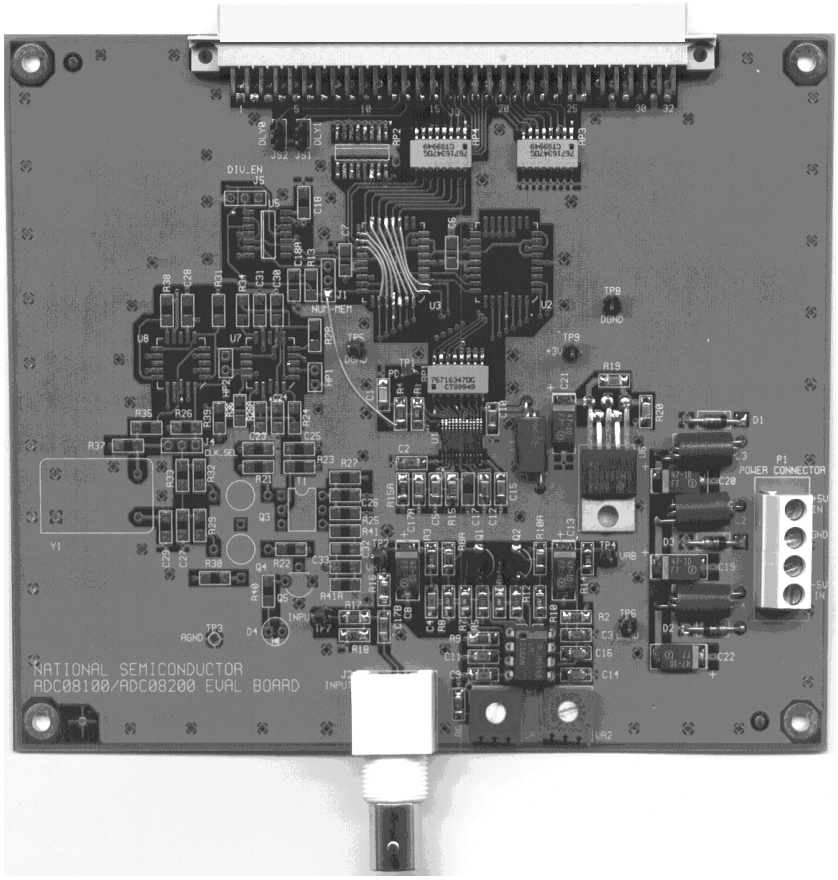
Rev 4

Evaluation Board Instruction Manual

ADC08060 8-Bit, 20 MSPS to 60 MSPS, Analog-to-Digital Converter with Internal Sample & Hold



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1.0 Introduction

The ADC08060EVAL Design Kit (consisting of the ADC08060 Evaluation Board, National's WaveVision software and this manual) is designed to ease evaluation and design-in of Nationals ADC08060 8-bit Analog-to-Digital Converter, which operates at sample rates up to 65 MSPS.

The WaveVision software operates under Microsoft Windows 3.1 or later, but NOT Windows NT. The signal at the Analog Input is digitized and can be captured and displayed on the computer monitor as dynamic waveforms. The digitized output is also available at Euro connector J3.

The software can perform an FFT on the captured data upon command. This FFT display also shows dynamic performance in the form of SNR, SINAD, THD and SFDR.

Evaluation with this system is simplified by connecting the board to the WaveVision Digital Interface Board (order number WAVEVSN BRD 3.0), which is connected to a personal computer through a serial communication port and running WaveVision software operating under Microsoft Windows. Use program WAVEVSN2.EXE.

The signal at the Analog Input to the board is digitized and is available at pins B16 through B19 and C16 through C19 of J3. Pins A16 through A21 of J3 are ground pins.

Provision is made for adjustment of Reference Voltages V_{RT} and V_{RB} with potentiometers VR1 and VR2, respectively. These voltages are not regulated and will vary with the input potential at pin 1 of Power Connector P1.

2.0 Board Assembly

The ADC08060 Evaluation Board may come pre-assembled or as a bare board that must be assembled. Refer to the Bill of Materials for a description of components, to *Figure 1* for major component placement and to *Figure 2* for the Evaluation Board schematic.

3.0 Quick Start

Refer to *Figure 1* for locations of test points and major components.

1. Connect the evaluation board to the Digital Interface Board (order number WAVEVSN BRD 2.0 or WAVEVSN BRD 3.0). See the Digital Interface Board Manual for operation of that board.
2. Install an appropriate crystal on the Digital Interface Board and set it for the appropriate divider ratio.
3. Connect a clean power supply to the terminals of connector P1. Adjust power supply to voltages of ±4.75V to ±5.25V before connecting it to the board. Section 4.7 describes what voltages are needed on each pin of P1. *Figure 1* also shows these voltages. Turn on the power and confirm that there is 3 Volts at TP9.
4. Use VR1 to set the top reference voltage (V_{RT}) for the ADC to 1.9V at TP2. Use VR2 to set the bottom reference voltage (V_{RB}) for the ADC to 0.3V at TP4.
5. Connect a signal of $1.5V_{P-P}$ amplitude from a 50-Ohm source to Analog Input BNC J2. The ADC input signal can be observed at TP7. Because of isolation resistor R17 and the scope probe capacitance, the input signal at TP7 will not have the same frequency response as the ADC input signal.
6. Gather data by pressing CTRL-X on the keyboard. Perform an FFT on the data by pressing CTRL-F. Note that an appropriate filter should be used at the signal input to the board.
7. See the Digital Interface Board Manual for complete data gathering instructions.

NOTE: This evaluation board as shipped is set up for a sample rate of 60 Msps. For other sample rates it may be necessary to put a jumper on JS0 or JS1 or both to capture data properly.

4.0 Functional Description

The ADC08060 Evaluation Board component and test point locations are shown in *Figure 1*. The board schematic is shown in *Figure 2*.

4.1 Input (signal conditioning) circuitry

The input signal to be digitized should be applied to BNC connector J2 through an appropriate filter. This 50 Ohm input is intended to accept a low-noise sine wave signal of 1.5V peak-to-peak amplitude. To accurately evaluate the ADC08060 dynamic performance, the input test signal should be a single frequency passed through a high-quality bandpass filter as described in Section 5.0.

Resistors R15, R15A, R16 and R18 provide the needed input bias to the ADC08060. You can center the input signal to the ADC by adjusting reference voltages V_{RT} and V_{RB} with VR1 and VR2.

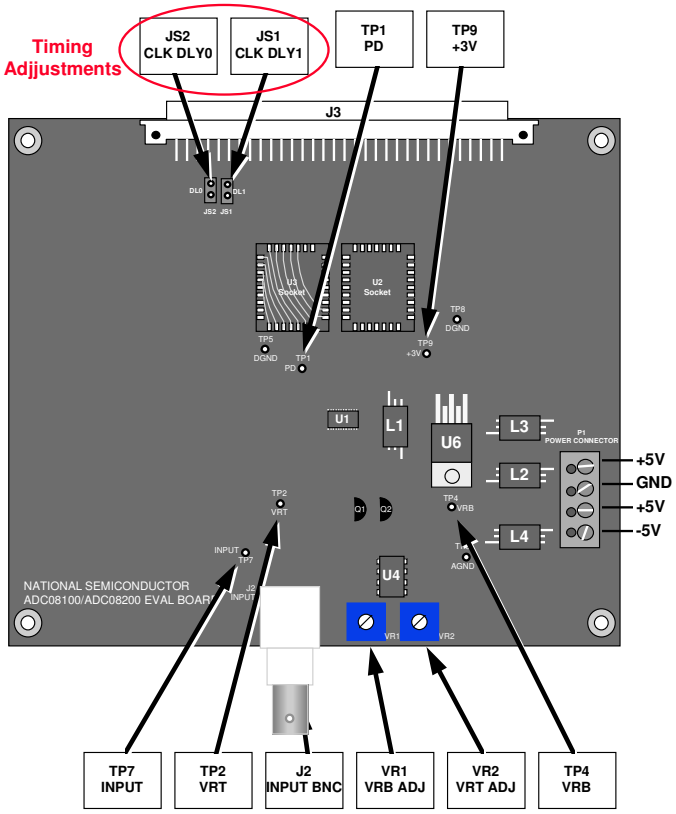

Figure 1. Component and Test Point Locations

4.2 ADC reference circuitry

The reference circuitry will provide nominal reference voltage ranges of 1.3V to 2.6V for V_{RT} and 0V to 1.3V for V_{RB}, Providing for nominal input ranges of 0V to 2.6V peak-to-peak. Note that this is beyond the specified 1.0 to 2.3V range of the ADC08060.

The reference voltages for the ADC08060 can be monitored at test point TP2 and TP4 and are set with VR1 and VR2. Signal offset can be provided by adjusting both of these potentiometers. Note that these voltages are not regulated and are affected by the voltage at pin 1 of Power Connector P1.

4.3 ADC clock circuit

The clock signal applied to the ADC comes from the Digital Interface Board.

R4 and C1 (at the ADC08060 pin 24) are used for high frequency termination of the clock line. A 125 MHz clock oscillator should be used on the Digital Interface Board with that board's clock divider set for 2 to evaluate the ADC08060 at 62.5 MSPS. See the Digital Interface Board manual for details.

Jumper DLY2 is used to ensure noise-free latching of the ADC08060 output data. Shorting the two pins of DLY1 inverts the ADC clock signal from the Digital Interface Board.

For the ADC08060 evaluation board, DLY0 should always be open. DLY1 should be open for ADC clock rates below 50 MHz and shorted for clock rates above 50 MHz.

4.5 Digital Data Output.

The digital output data from the ADC08060 is available at the 96-pin Euro connector J3. The series resistors of RP1 isolate the ADC from the load circuit to reduce noise coupling into the ADC.

4.6 Power Supply Connections

Power to this board is supplied through power connector P1. The only Voltages needed for the ADC08060 evaluation board are ±5V supplies as described in Section 4.7, below.

When using the ADC08060 Evaluation Board with the Digital Interface Board, the 5V logic power supply for the interface board is passed through the ADC08060 evaluation board from pin 3 of Power Connector P1. All supply voltages are protected against reverse polarity with shunt diodes D1, D2 and D3. The +3 Volts needed for the ADC08060 is provided with voltage regulator U6, an LM2931CT.

4.7 Power Requirements

Voltage and current requirements for the ADC08060 Evaluation Board are:

- Pin 1 of P1: +5.0V ±5% at 250 mA
- Pin 2 of P1: Ground
- Pin 3 of P1: +5.0V ±5% at 1Amp
- Pin 4 of P1: - 5.0V ±5% at 250 mA.

The +5V supply at pin 3 of the Power Connector P1 provides the power to the Digital Interface Board, where most of the power through this pin is consumed.

5.0 Installing and Using the ADC08060 Evaluation Board

The evaluation board requires power supplies as described in Section 4.7. An appropriate signal generator (such as the HP3325B, HP8662A or the Tektronix AWG2000 series) with 50 Ohm source impedance should be connected to the Analog Input BNC, J2. A bandpass filter should be inserted between the generator output and the input to the ADC08060 evaluatoin board when evaluating sinusoidal signals to be sure there are no unwanted frequencies (harmonics and noise) presented to the ADC. A cable with a DB-9 connector must be connected between the Digital Interface Board and the host computer. See the Digital Interface Board manual for details.

5.1 Software Installation

The WaveVision software provided requires 300k bytes of hard drive space and will run under Windows 3.1 or later, but will NOT run under Windows NT.

1. Insert the disk into a 3.5" floppy drive.
2. Copy program WAVEVSN2.EXE to the desired subdirectory on you computer's hard disk and RUN it.

5.2 Setting up the ADC08060 Evaluation Board

This evaluation package was designed to be easy and simple to use, and to provide a quick and simple way to evaluate the ADC08060. The procedures given here will help you to properly set up the board.

5.2.1 Board Set-up

Refer to Figure 1 for locations of connectors, test points and jumpers on the board.

1. Connect The ADC08060 evaluation board to Digital Interface Board, WAVEVSN BRD 2.0 or to WAVEVSN BRD 3.0.
2. Connect power to the board per requirements of paragraph 4.7. Confirm that Red LED D1 on the Digital Interface board is on, indicating clock presence.
3. Be sure a 125 MHz crystal is on the Digital Interface Board and that board is set for clock divider or 2.
4. Connect an appropriate test signal source to BNC connector J2 of the ADC08060 evaluation board.
5. Connect a cable with DB-9 connector between the Digital Interface Board connector P1 and a serial port on your computer.

5.2.2 Quick Check of Analog Functions

Refer to Figure 1 for locations of connectors, test points and jumpers on the board. If at any time the expected response is not obtained, see section 5.2.5 on Troubleshooting.

1. Perform steps 1 through 5 of Section 5.2.1.
2. Adjust VR1 for a voltage of 1.9V at TP2.
3. Adjust VR2 for a voltage of 0.3V at TP4.
4. Scope TP7 to be sure the input signal is present.
5. Adjust the signal source at Analog Input J1 for a signal amplitude of approximately $1.5V_{P-P}$ at TP7.

This completes the testing of the analog portion of the evaluation board.

5.2.3 Quick Check of Software and Computer Interface Operation

1. Perform steps 1 through 5 of Paragraph 5.2.2, above.
2. Supply a 1.5 Vp-p sine wave of about 5 MHz at Analog Input BNC J2.
4. Be sure there is an interconnecting cable between the Digital Interface Board and your computer serial port.
5. RUN program WAVEVSN2.EXE.
6. Acquire data by clicking on the ACQUIRE icon or by pressing ALT, P, X or CTRL-X. Data transfer can take a few seconds.

7. When transfer is complete, the data window should show many sine waves. The display may show a nearly solid area of red, which is O.K.
8. With the mouse, you may click and drag to select a small portion of the displayed waveform for better examination.
9. Click on the FFT icon or type ALT, P, F or CTRL-F to calculate the FFT of the data and display a frequency domain plot.

The FFT data will provide a measurement of SINAD, SNR, THD and SFDR, easing the performance verification of the ADC08060.

Note: Be sure to use a bandpass filter between the signal source and this board for accurate dynamic performance measurement.

5.2.4 Getting Consistent Readings

Artifacts can result when we perform an FFT on a digitized waveform, producing inconsistent results when testing repeatedly. The presence of these artifacts means that the ADC under test may perform better than our measurements would indicate. Windowing is a common method of improving FFT results of finite data.

We can eliminate the need for windowing and get more consistent results if we observe the proper ratios between the input and sampling frequencies, forcing the data to cleanly "wrap around" itself, providing coherent sampling. This eliminates the distortion that would otherwise be present in an FFT and greatly increases its spectral resolution. This, in turn, allows us to more accurately evaluate the spectral response of the A/D converter.

When we do this, however, we must be sure that the input signal has high spectral purity and stability and that the sampling clock signal is extremely stable with minimal jitter. Coherent sampling of a periodic waveform occurs when an integer number of cycles exists in the sample window. The relationship between the number of cycles sampled (CY), the number of samples taken (SS), the signal input frequency (f_{IN}) and the sample rate (f_S), for coherent sampling, is

$$\frac{CY}{SS} = \frac{f_{in}}{f_s}$$

CY, the number of cycles in the data record, must be a prime integer number and SS, the number of samples in the record, must be a power of 2 integer.

Further, f_{IN} (signal input frequency) and f_S (sampling rate) should be locked to each other. Then, if they come from the same generator, whatever frequency instability (jitter) is present in the two signals will cancel each other.

Windowing (an FFT Option under WaveVision) should not be used for coherent sampling.

5.2.5 Troubleshooting

"Error Transmitting", "Parallel Port Time Out Error" and/or "Failed to communicate with the board on LPT1" errors mean communication was unsuccessful. Try the following:

- Be sure that the Digital Interface Board is connected to a serial printer port and has power.
- Be sure the proper port is selected (type ALT-O).
- Ascertain that a clock oscillator is properly inserted into the socket at Y1 of the Digital Interface Board.
- Be sure cable connections are solid.
- Be sure that the board to computer cable is not a Null Modem one. If it is, swap the jumpers on Digital Interface Board J8 and J10.
- Reset the evaluation board by pressing button S1 and try again.

If there is no output from the ADC08060, perform the following:

- Be sure that the proper voltages and polarities are present at Power Connector P1.
- Be sure +3 Volts is present at TP9.
- Be sure clock signal is present at ADC08060 pin 24.

N.B.: If the PC displayed waveform appears to be "thready" or noisy, if the FFT plot shows a lot of noise with little or no apparent signal, or if apparent performance is very bad, it may be necessary to adjust the timing of the ADC clock by putting a jumper on JS1, JS2, or both. Different sample rates may require different jumper combinations on JS1 and/or JS2.

6.0 Evaluation Board Specifications

Board Size:	5" x 7" (12.7 cm x 17.8 cm)
Power Requirements:	+ 5V ±5% @ 250 mA
	+ 5V ±5% @ 1 Amp (see Section 4.7)
	- 5V.0 ±5% @ 250 mA
Clock Frequency Range:	20 MHz to 62.5 MHz
Analog Input	
Nominal Voltage:	$1.6V_{P-P}$
Frequency Range	50 kHz to 150 MHz
Impedance:	50 Ohms

7.0 Hardware Schematic

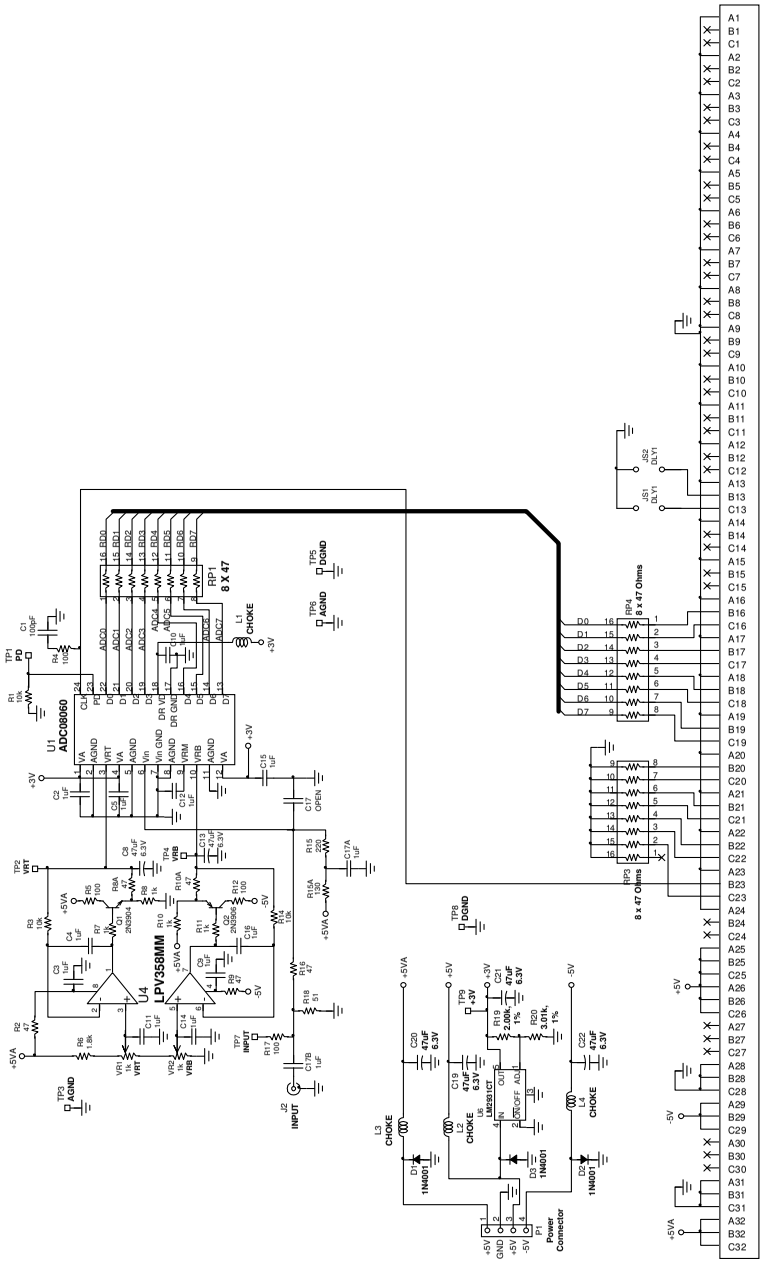

Figure 2. ADC 08060 Evaluation Board Schematic

8.0 ADC08060 Evaluation Board Bill of Materials

Item	Qty	Reference	Part	Source
1	1	C1	100pF	Type 1206
2	13	C2, C3, C4, C5, C9, C10, C11, C12, C14, C15, C16, C17B, C17A	1uF	Type 1206
3	6	C8, C13, C19, C20, C21, C22	47uF, 6.3V	Type 7343 (D Size)
4	-	C17, C6, C7, C17, C17A, C17B, C18, C18A, C23, C24, C25, C26, C27, C28, C29, C30, C31, C32, C33	Open	Not Used
5	3	D1, D2, D3	1N4001	Various
6	1	JS1	2-Pin Post Header	DigiKey # A19350-ND
7	1	JS2	2-Pin Post Header	DigiKey # A19350-ND
8	-	HP1, HP2, J1, J4, J5,	Open	Not Used
9	1	J2	BNC Connector	DigiKey # ARF1177-ND
10	1	J3	96-Pin Female	DigiKey # H7096-ND
11	4	L1, L2, L3, L4	Choke	DigiKey # M2204-ND
12	1	P1	Terminal Block	DigiKey # ED1609-ND
13	1	Q1	2N3904	Various
14	1	Q2	2N3906	Various
15	3	RP1, RP3, RP4	Resistor Pack - 8 x 47	DigiKey # 766-163-R47-ND
16	3	R1, R3, R14	10k, 5%	Type 1206
17	5	R2, R8A, R9, R10A, R16	47, 5%	Type 1206
18	4	R4, R5, R12, R17	100, 5%	Type 1206
19	1	R6	1.8k, 5%	Type 1206
20	4	R7, R8, R10, R11	1k, 5%	Type 1206
21	1	R15	220, 5%	Type 1206
22	1	R15A	130, 5%	Type 1206
23	1	R18	51, 5%	Type 1206
24	1	R19	2.00k, 1%	Type 1206
25	1	R20	3.01k, 1%	Type 1206
26	-	R13, R15, R15A, R16, R18, R21, R22, R23, R24, R25, R26, R26A, R27, R28, R29, R30, R31, R32, R33, R34, R35, R36, R37, R38, R39, R40, R41, R41A, RP2	Open	Not Used
27	-	Q3, Q4, Q5, T1, U2, U3, U5, U7, U8	Open	Not Used
28	1	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9	Breakable Header	DigiKey # S1012-36-ND
29	1	U1	ADC08060CIMT	National Semiconductor
30	1	U4	LM358N	National Semiconductor
31	1	U6	LM2931CT	National Semiconductor
32	2	VR1, VR2	1k	DigiKey # 3386F-103-ND
33	1	8-Pin DIP Socket	For U4	DigiKey # A400-ND
34	1	Shorting Jumper	for JS2	DigiKey #S9601-ND

APPENDIX

Summary Tables of Test Points and Connectors

Test Points on the ADC08060 Evaluation Board

TP 1	Power Down Input. Pull high to power down the ADC08060
TP 2	ADC Top Reference Voltage
TP 3	Ground
TP 4	ADC Bottom Reference Voltage
TP 5	Ground
TP 6	Ground
TP 7	Signal Input test point
TP 8	Ground
TP 9	+3V Supply

P1 Connector - Power Supply Connections

J1-1	+5V	Positive Power Supply
J1-2	GND	Power Supply Ground
J1-3	+5V	Digital Interface Board Supply
J1-4	-5V	Negative Power Supply

J3 Connector - ADC Data Outputs - Connection to WaveVision Digital Interface Board

Signal	J3 pin number
ADC output D0	B16
ADC output D1	C16
ADC output D2	B17
ADC output D3	C17
ADC output D4	B18
ADC output D5	C18
ADC output D6	B19
ADC output D7	C19
ADC output D8	not used
ADC output D9	not used
ADC output D10	not used
ADC output D11	not used
GND	A1 thru A24, A28, B28, C28, A31, B31, C31
Memory Read Clock	B25
Reserved, Signal	B22, C22, C23
Reserved, Power	A25, A26, B25, B26, C25, C26 (+5V Logic Power Supply to Digital Interface Board)
Reserved, Power (–5V)	A29, B29, C29
Reserved, Power (+5V)	A32, B32, C32

The ADC08060 Evaluation Board is intended for product evaluation purposes only and is not intended for resale to end consumers, is not authorized for such use and is not designed for compliance with European EMC Directive 89/336/EEC.

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