ANALOG DEVICES ADRF5716-EVALZ Silicon Digital Attenuator User Guide

Contents

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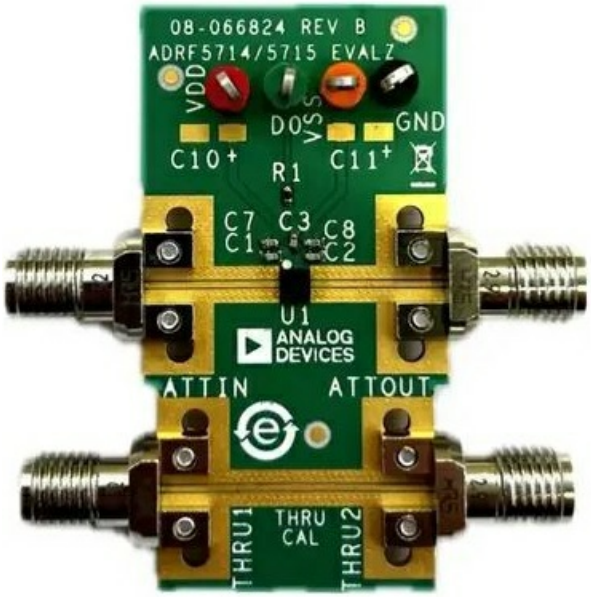

Specifications

- **Product Name:** ADRF5716 Silicon Digital Attenuator
- **Attenuation Control Range:** 48 dB
- **Frequency Range:** 100 MHz to 30 GHz
- **Manufacturing Process:** Silicon on Insulator (SOI)

Product Usage Instructions

Equipment Needed

- DC power supplies
- Network analyzer

General Description

- The ADRF5716 is a 2-bit digital attenuator with a wide attenuation control range. The evaluation board, ADRF5716-EVALZ, allows users to assess the features and performance of the ADRF5716.

Power Supply and Control Inputs

- The ADRF5716 requires +3.3V supply voltage (VDD), -3.3V supply voltage (VSS), control inputs D5 and D6, latch enable (LE), and ground (GND). These pins should be decoupled with a 100 pF capacitor for stable operation.

RF Inputs and Outputs

- The ADRF5716-EVALZ features four edge-mounted 2.92 mm connectors for RF inputs and outputs, providing easy connectivity for testing purposes.

FAQ

- **Q:** What is the frequency range of the ADRF5716?
- **A:** The ADRF5716 operates in the frequency range of 100 MHz to 30 GHz.
- **Q:** How can I calibrate the ADRF5716-EVALZ?
- **A:** Additional thru line is provided on the evaluation board for calibration purposes. Connect your test equipment accordingly for calibration.

FEATURES

- Full-featured evaluation board for the ADRF5716
- Easy connection to test equipment
- Additional thru line for calibration

EQUIPMENT NEEDED

- DC power supplies
- Network analyzer

GENERAL DESCRIPTION

- The ADRF5716 is a 2-bit digital attenuator with 48 dB attenuation control range, manufactured in the silicon-on-insulator (SOI) process.
- This user guide describes the ADRF5716-EVALZ evaluation board, which is designed to simply evaluate the features and performance of the ADRF5716. A photograph of the evaluation board is shown in Figure 1.
- The ADRF5716 data sheet provides full specifications for the ADRF5716. Refer to the ADRF5716 data sheet with this user guide when using the ADRF5716-EVALZ.

ADRF5716-EVALZ EVALUATION BOARD PHOTOGRAPH

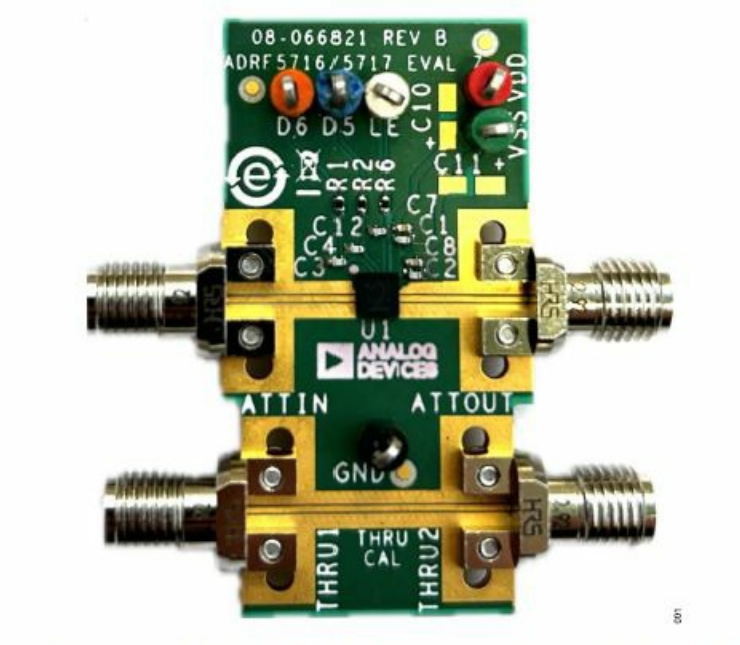

Figure 1. ADRF5716-EVALZ Evaluation Board Photograph

EVALUATION BOARD HARDWARE

OVERVIEW

The ADRF5716-EVALZ is a connectorized board, assembled with the ADRF5716 and its application circuitry. All components are placed on the primary side of ADRF5716-EVALZ. An assembly drawing for the ADRF5716-EVALZ is shown in Figure 8, and an evaluation board schematic is shown in Figure 7.

BOARD LAYOUT

The ADRF5716-EVALZ is designed using RF circuit design techniques on a 4-layer printed circuit board (PCB). The PCB stack-up is shown in Figure 2.

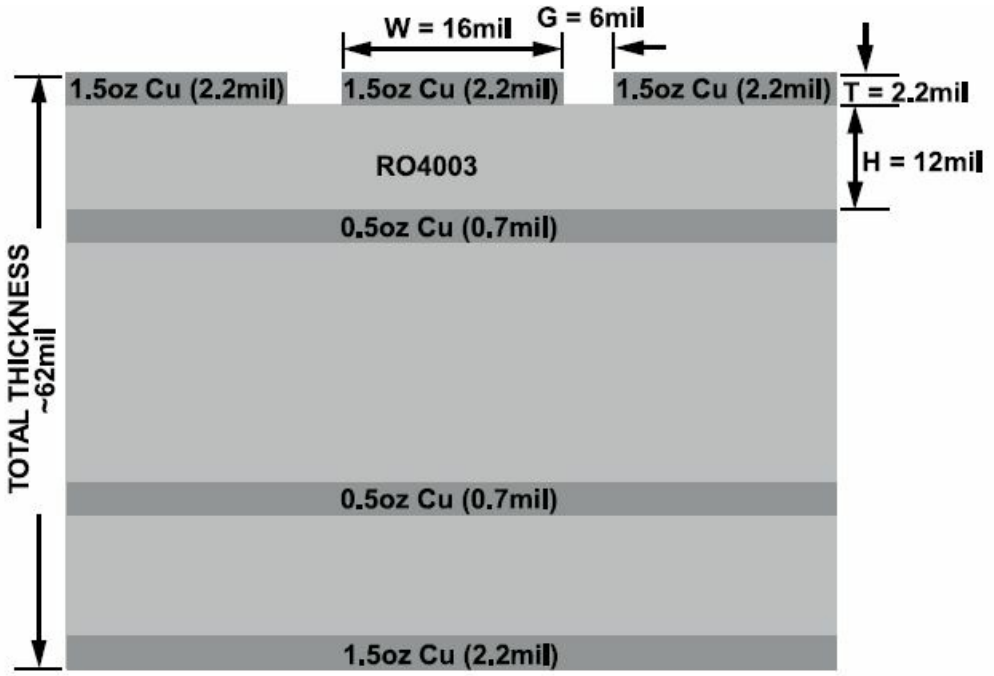

Figure 2. Evaluation Board Stack-Up

The outer copper layers are 1.5 oz (2.2 mil) thick and the inner layers are 0.5 oz (0.7 mil) thick. The top dielectric material is 12 mil Rogers 4003, which provides 50 Ω controlled impedance and optimizes high-frequency performance.

All RF traces are routed on the top layer, and the second layer is used as the ground plane for RF transmission lines. The remaining two layers are also ground planes filled with FR4 material to manage the thermal rise during high-power operations and are supported with dense and filled vias to the PCB bottom for thermal relief. The overall board thickness is approximately 62 mil for mechanical strength.

The RF transmission lines are designed using a coplanar waveguide (CPWG) model with a width of 16 mils and ground spacing of 6 mils to have a characteristic impedance of 50 Ω. Ground via fences are arranged on both sides of the CPWG to improve isolation between nearby RF lines and other signal lines. The exposed ground pad of the ADRF5716, which is soldered on the PCB ground pad, is the main thermal conduit for heat dissipation. The PCB ground pad is densely populated with filled, thru vias to provide the lowest possible thermal resistance path from the top to the bottom of the PCB. The connections from the package ground lead to the ground are kept as short as possible.

POWER SUPPLY AND CONTROL INPUTS

The ADRF5716-EVALZ has two power-supply inputs, three control inputs, and ground, as shown in Table 1. The DC test points are populated on the VDD, VSS, D5, D6, LE, and GND pins. A 3.3 V supply is connected to the DC test points on the VDD pin, and the –3.3 V supply is connected to the DC test points on the VSS pin. A ground reference can be connected to GND. Connect the control inputs, D5, D6, and LE to 3.3 V or 0 V. The typical total current consumption for the ADRF5716 is between 630 mA and 730 mA. The VDD and VSS supply pins and the control pins of the ADRF5716 are decoupled with a 100 pF capacitor.

Table 1. Power Supply and Control Inputs

Test Point	Description
VDD	+3.3 V supply voltage
VSS	−3.3 V supply voltage
D5	Control Input 1
D6	Control Input 2
LE	Latch Enable
GND	Ground

RF INPUTS AND OUTPUTS

The ADRF5716-EVALZ has four edge-mounted, 2.92 mm connectors for the RF inputs and outputs, as shown in Table 2.

Table 2. RF Inputs and Outputs

SMA Connector	Description
ATTIN	Attenuator input
ATTOUT	Attenuator output
THRU1	Thru line input and output
THRU2	Thru line input and output

The ADRF5716-EVALZ is shipped together with a thru line that calibrates out the board loss effects from the measurements determining the device performance at the pins of the IC.

TEST PROCEDURE

BIASING SEQUENCE

To bias up the ADRF5716-EVALZ, perform the following steps:

1. Ground the GND test point.
2. Bias up the VDD test point.
3. Bias up the VSS test point.
4. Bias up the D5, D6, and LE test points.
5. Apply an RF input signal.

The ADRF5716-EVALZ is shipped fully assembled and tested. Figure 3 provides a basic test setup diagram to evaluate the S-parameters using a network analyzer. Perform the following steps to complete the test setup and to verify the operation of the ADRF5716-EVALZ:

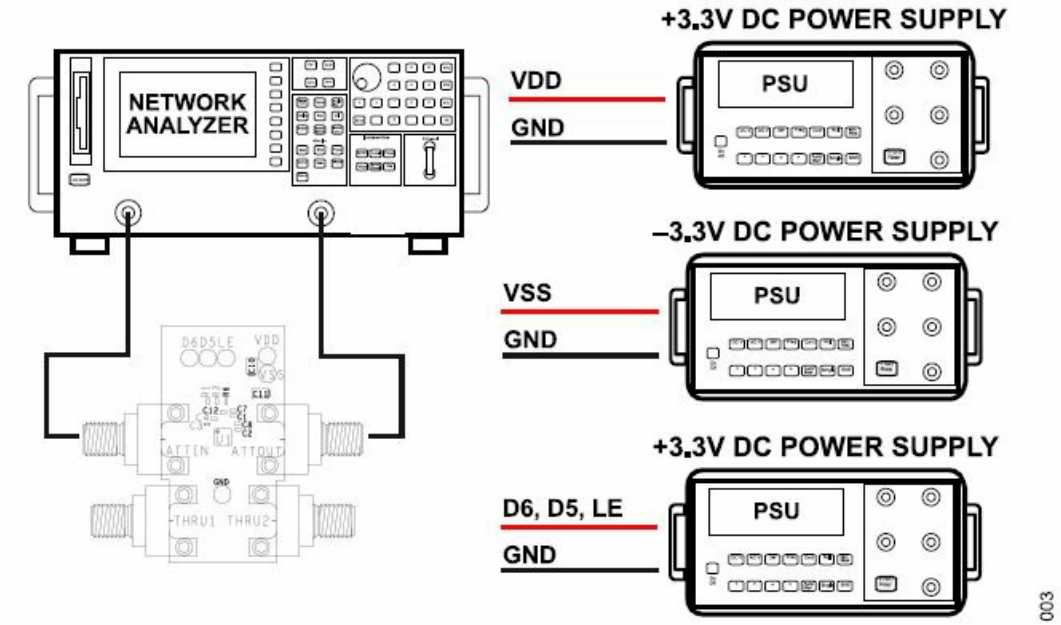

Figure 3. Test Setup Diagram

1. Connect the GND test point to the ground terminal of the power supply.
2. Connect the VDD test point to the voltage output terminal of the 3.3 V supply.
3. Connect the VSS test point to the voltage output terminal of the –3.3 V supply. Note that the current from the VDD test point is approximately 130 µA and from the VSS test point is approximately 500 µA.
4. Connect the D5, D6, and LE test points to the voltage output terminal of the 3.3 V supply. The ADRF5716 can be configured in different modes by connecting the control test points to 3.3 V or 0 V, as shown in Table 3.
5. Connect a calibrated network analyzer to the ATTIN and ATTOUT 2.92 mm connectors. Sweep the frequency from 100 MHz to 30 GHz, and set the power to 10 dBm.
6. The ADRF5716-EVALZ is expected to have an insertion loss of 2.90 dB at 30 GHz. See the expected results in the Expected Results section.

Table 3. Control Voltage Truth Table

D5	D6	Attenuation State (dB)
Low	Low	0
High	Low	16
Low	High	32
High	High	48

Additional test equipment is needed to fully evaluate the device's functions and performance. For third-order intercept point evaluation, use two signal generators and a spectrum analyzer. A high-isolation power combiner is also recommended.

For power compression and power handling evaluations, use a 2- 2-channel power meter and a signal generator. A high enough power amplifier is also recommended at the input. Test accessories, such as couplers and attenuators, must have enough power handling. Note that the measurements performed at the 2.92 mm connectors of the ADRF5716-EVALZ include the losses of the 2.92 mm connectors and the PCB. The thru line must be measured to calibrate out the effects on the ADRF5716-EVALZ. The thru line is the summation of an RF input line and an RF output line that is connected to the device and equal in length.

EXPECTED RESULTS

EXPECTED RESULTS

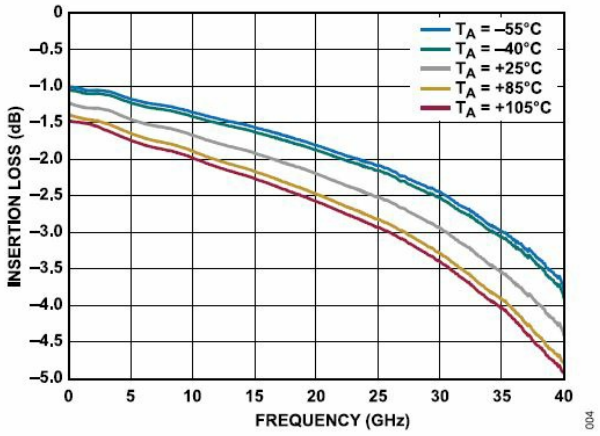

Figure 4. Insertion Loss vs. Frequency over Various Temperatures

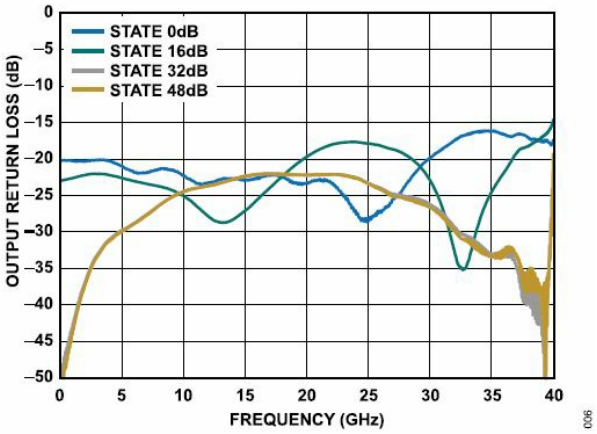

Figure 6. Output Return Loss vs. Frequency

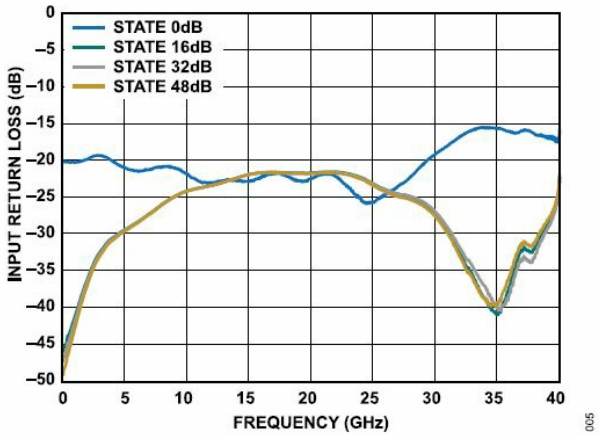

Figure 5. Input Return Loss vs. Frequency

EVALUATION BOARD SCHEMATIC AND ARTWORK

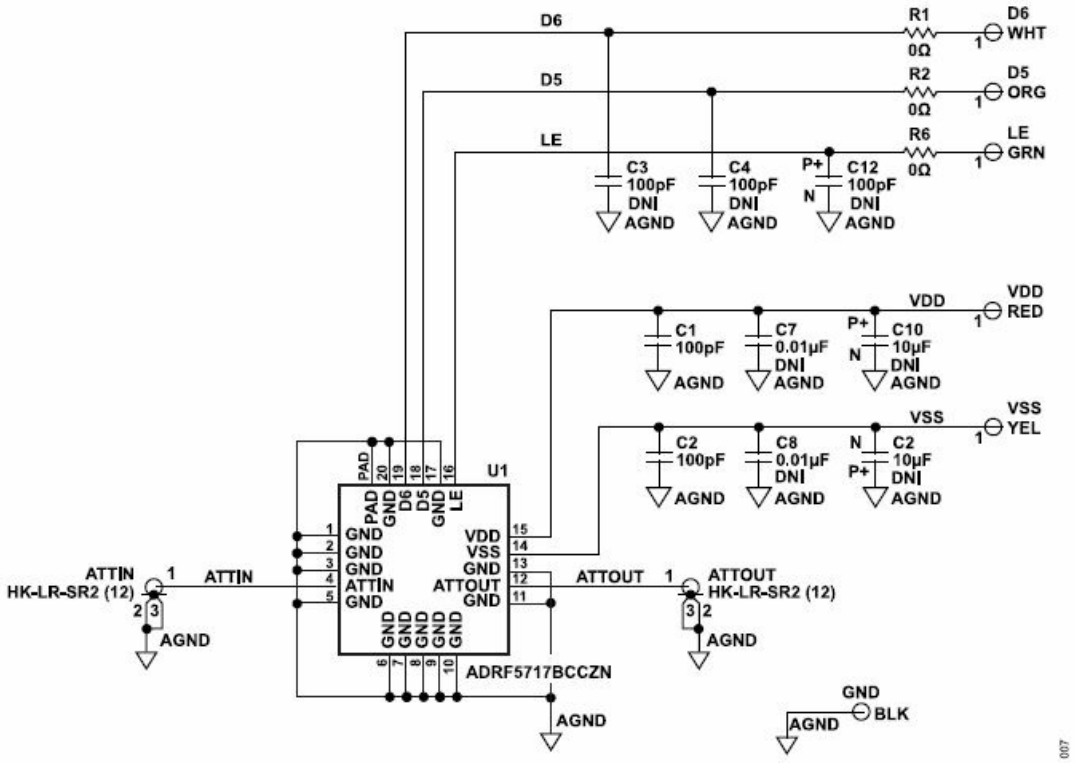

Figure 7. ADRF5716-EVALZ Evaluation Board Schematic

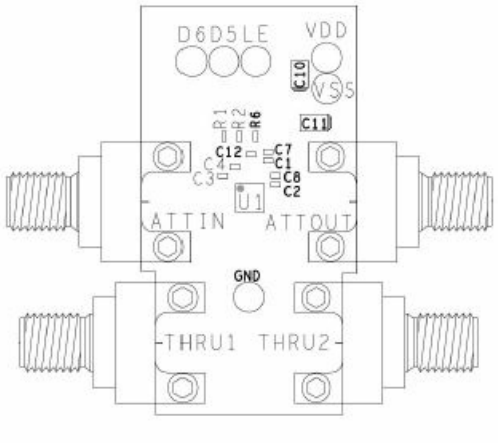

Figure 8. ADRF5716-EVALZ Evaluation Board Assembly Diagram

ORDERING INFORMATION

BILL OF MATERIALS

Table 4. Bill of Materials for ADRF5716-EVALZ

Qty	Reference Designator	Description	Manufacturer	Part Number
2	C1, C2	Capacitors, 100 pF, 50 V, C0402 package	Murata	GCM1555C1H101JA16D
3	R1, R2, R6	Resistors, 0 Ω, 1/10 W, R0402 package	Yageo	RC0402JR-070RL
1	D5	Surface-mount test point	Components Corporation	TP-105-40-03
5	D6, GND, LE, VDD, VSS	Surface-mount test points	Components Corporation	TP-104-01-XX
1	U1	Silicon digital attenuator, 2-bit, 100 MHz to 30 GHz	Analog Devices, Inc.	ADRF5716
1	PCB	Evaluation board	Analog Devices	EVAL-ADRF5716

ESD Caution

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on

devices subjected to high-energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

Legal Terms and Conditions

By using the evaluation board discussed herein (together with any tools, components documentation or support materials, the “Evaluation Board”), you are agreeing to be bound by the terms and conditions set forth below (“Agreement”) unless you have purchased the Evaluation Board, in which case the Analog Devices Standard Terms and Conditions of Sale shall govern. Do not use the Evaluation Board until you have read and agreed to the Agreement. Your use of the Evaluation Board shall signify your acceptance of the Agreement. This Agreement is made by and between you (“Customer”) and Analog Devices, Inc. (“ADI”), with its principal place of business at Subject to the terms and conditions of the Agreement, ADI hereby grants to Customer a free, limited, personal, temporary, non-exclusive, non-sublicensable, non-transferable license to use the Evaluation Board FOR EVALUATION PURPOSES ONLY. Customer understands and agrees that the Evaluation Board is provided for the sole and exclusive purpose referenced above, and agrees not to use the Evaluation Board for any other purpose. Furthermore, the license granted is expressly made subject to the following additional limitations: Customer shall not (i) rent, lease, display, sell, transfer, assign, sublicense, or distribute the Evaluation Board, and (ii) permit any Third Party to access the Evaluation Board. As used herein, the term “Third Party” includes any entity other than ADI, Customer, their employees, affiliates and in-house consultants. The Evaluation Board is NOT sold to Customer; all rights not expressly granted herein, including ownership of the Evaluation Board, are reserved by ADI. CONFIDENTIALITY. This Agreement and the Evaluation Board shall all be considered the confidential and proprietary information of ADI. The customer may not disclose or transfer any portion of the Evaluation Board to any other party for any reason. Upon discontinuation of use of the Evaluation Board or termination of this Agreement, Customer agrees to promptly return the Evaluation Board to ADI. ADDITIONAL RESTRICTIONS. Customers may not disassemble, decompile or reverse engineer chips on the Evaluation Board. The customer shall inform ADI of any occurred damages or any modifications or alterations it makes to the Evaluation Board, including but not limited to soldering or any other activity that affects the material content of the Evaluation Board. Modifications to the Evaluation Board must comply with applicable law, including but not limited to the RoHS Directive. TERMINATION. ADI may terminate this Agreement at any time upon giving written notice to Customer. The customer agrees to return to ADI the Evaluation Board
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Documents / Resources

	**ANALOG DEVICES ADRF5716-EVALZ Silicon Digital Attenuator** [pdf] User Guide ADRF5716-EVALZ Silicon Digital Attenuator, ADRF5716-EVALZ, Silicon Digital Attenuator, Digital Attenuator

References

- **User Manual**