ANALOG DEVICES

High Performance 3½ Digit DPM For System Applications

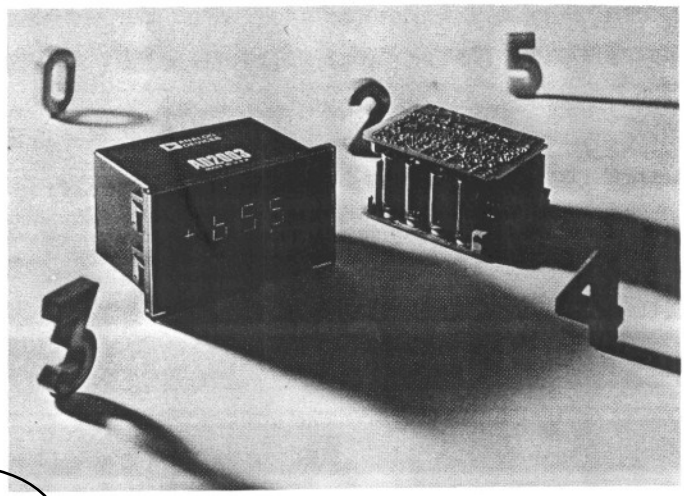
AD2003

FEATURES

- True Differential Input
- High Common Mode Rejection: -80dB Minimum at ±2.5V
- Excellent Data Processing Interfacing
- 0.05% ±1 Digit Maximum Error
- Bright, Sharp Display
- Green, Filtered Display
- Small Size: 1.8"H x 3"W x 2"D
- Tool Free Insertion and Removal
- Low Price: 1-9 $140
  100+ $93

APPLICATIONS

- Strain Gage Bridge Measurement
- Analytical and Scientific Instruments
- Biological Probe Readout



GENERAL DESCRIPTION

Analog Devices' AD2003 is a 3½ digit Digital Panel Meter offering high performance and versatility at a low price, $93 in 100's. The 5VDC powered AD2003 has a differential instrumentation amplifier input, high common mode rejection –80dB minimum at ±2.5V and better than 40dB of normal mode rejection.

Other standard features of the AD2003 include 0.05% ±1 digit maximum error, ±50ppm/°C temperature coefficient, data processing interface capability with fully latched data outputs, 7 segment filament test and a ruggedly designed 1.8"H x 3"W x 2"D aluminum case. The AD2003 provides highly accurate and stable readings of bipolar, differential input signals over a full scale range of 0 to ±199.9mV with automatic overload and polarity indication. Readings can be held indefinitely upon command. Prior to shipment all AD2003's are burned in for a seven day period to assure high reliability.

Typical applications for the AD2003 include: scientific, industrial, and medical instrument designs; measurement, control, and data acquisition systems.

BRIGHT, SHARP DISPLAY

The AD2003 utilizes green filtered RCA Numitron tubes. The green filter provides optimum matching with the optical response of the human eye. The result is a bright, sharp and highly readable display over a wide range of ambient light without operator fatigue. The clean modern look of the lens and case design further enhance the visual attractiveness of the display. This precise digital display offers the added advantage over analog meters of totally unambiguous readings.

Standard features of the display are: programmable decimal points; 7 segment, polarity sign and decimal point filament test; automatic zero; 5 readings/second with external trigger-and-hold feature to allow display rates of up to 16 readings/second.

SYSTEMS INTERFACING

The excellent drift, linearity, and noise rejection capability of the AD2003 makes it a natural choice for extracting and displaying low level signals in the presence of high common mode noise voltages. The AD2003 is an excellent DPM for use with transducers such as thermocouples, strain gage bridges, current shunts and biological probes. The latched BCD outputs and 60ms conversion time also allow the AD2003 to serve as a superior component for data acquisition systems.

SMALL BUT RUGGED

The AD2003's compact size allows it to be easily substituted for conventional analog meters, in many cases requiring even less space than the analog meter. It is housed in an aluminum case providing light weight, structural strength, optimum heat dissipation, and shielding against external noise. As shown in Figure 7 no tools are required for installation. You simply snap in the case, then snap on the filter and lens. Its light weight is ideal for installation in hinged panel equipment.

EASY TO USE IN NEW DESIGNS

The AD2003 was designed with the equipment of the 70's in mind. Its logic levels are compatible with DTL and TTL integrated circuits. The AD2003 can operate from the user's 5VDC system supply eliminating the shielding, decoupling, etc., needed for line-powered units when the AC line must be

(continued on page 3)

Route 1 Industrial Park; P.O. Box 280, Norwood, Mass. 02062
Tel: 617/329-4700 TWX: 710/394-6577

SPECIFICATIONS (typical @ +25°C and +5VDC unless otherwise noted)

DISPLAY OUTPUT
- Display consists of four RCA Numitrons (7 segment incandescent readout tubes) for data digits plus 100% overrange.
- Overload – three data digits display dashes when reading exceeds the input range.
- Decimal Points – selectable at input connector.

INPUT
- Full Scale Range – 0 to ±199.9 millivolts
- Automatic Zero
- Automatic Polarity
- Differential
- Bias Current – 3nA typ., 7nA max.
- Impedance – >100MΩ
- Overvoltage Protection – ±50V sustained without damage.
- Decimal Points (3) – selectable by grounding or logic "0".

DATA PROCESSING SIGNALS

		IN	OUT
• DTL/TTL Compatible	Logic "0"	<0.8V	<0.4V
	Logic "1"	>2.0V	>2.4V

- Inputs

External Trigger – Operation in the External Trigger mode requires that the External Hold input be grounded. A >100ns external trigger pulse (logic "1" to logic "0") is required to start each conversion. This is no limit to the maximum duration of the trigger pulse.

External Hold – When this input is grounded or held at 0.8V max, the last conversion is held and displayed. For a new conversion under internal control, this input must be open or at 5V.

- Outputs

3 BCD Digits (8421 Positive True) – Latched – 3TTL loads.

Overrange – Logic "1" indicates an overrange – Latched – 9TTL loads.

Overload – Logic "1" indicates the input has exceeded the input range – Latched – 9TTL loads.

Status Signal – Logic "1" indicates conversion is complete – 5TTL loads.

Polarity – Logic "0" with positive polarity input – Latched – 9TTL loads (both Polarity and Polarity outputs available).

ACCURACY
- 0.05% of Reading ±1 Digit
- Resolution – 0.1mV
- Temperature Range – 0°C to +60°C operating
- Temperature Coefficient – <±50ppm/°C

CONVERSION TIME
- 60ms max (70ms max for AD2003/E)

SPEED
- External Trigger – 16 conversions per second (14 conversions per second for AD2003/E)
- Internal Conversion – 5 conversions per second
- Hold & Read on Command

NORMAL MODE REJECTION
- 40dB without filter @ 50-60Hz minimum

FILAMENT TEST INPUT
- An external manual switch or power transistor switched to ground will turn on all segments, polarity sign, and decimal points. The switch or transistor must sink 80mA of current. (Lamp test does not operate when unit is in overload.)

SIZE
- 3"W x 1.8"H x 2"D (overall depth for case and connector – 2.8")

POWER
- 5VDC ±5% Regulated Power for Converter – 250mA
  Unregulated Power for Display – 750mA

COMMON MODE REJECTION
- 80dB minimum DC-1kHz with 1kΩ unbalance

COMMON MODE VOLTAGE
- ±2.5V minimum

SINGLE ENDED INPUT
- Connection of Analog Low to Analog Ground will allow single ended input. (Analog Ground and Digital Ground are internally connected in the DPM.)

ORDERING GUIDE
- AD2003 – Standard AD2003 as described above – tuned for peak normal mode rejection at 60Hz and its harmonics.
- AD2003/E – Standard AD2003 as described above – tuned for peak normal mode rejection at 50Hz and its harmonics.

PRICE (AD2003) or AD2003/E) not including connector
- 1-9 $140
- 100+ $93

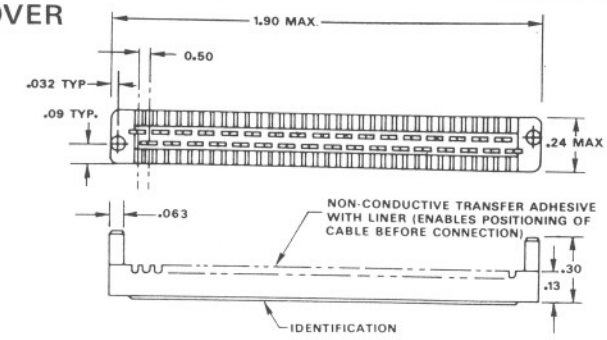
CONNECTOR
- AC1600 Figure 9 – 6 feet of decade coded wire mated with "3M" Connector (Part No. 3414)
  Price 1-9 – $17.00
  100 – $13.40

— or —

- AC1601 Figure 1 – "3M" mating Connector (Part No. 3414) only
  Price 1-9 – $6.80
  100 – $5.10

Specifications subject to change without notice.

COVER



BODY

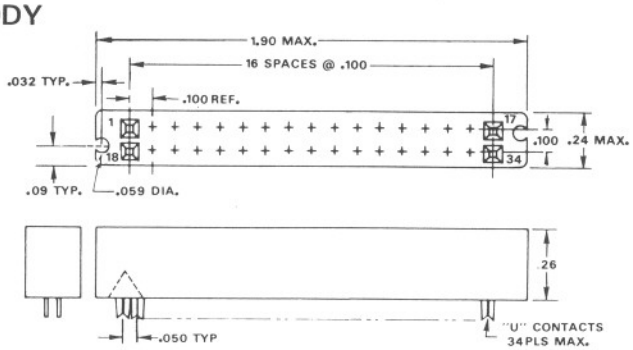


Figure 1. AC1601

TYPICAL PROPERTIES

Self Stripping
Simultaneous Terminations
Positive Pressure Type Connections

PHYSICAL
No. Contacts: 34
Body Material: Glass Filled Nylon
Contact Metal: Beryllium Copper
Contact Plating: Gold Over Nickel
Contact Spacing: Fits Wire on 0.050" Centers
Color: Gray

ELECTRICAL
Temperature Rating: +105°C
Contact Rating: 1 Amp
Withstand Voltage: 500VDC (Sea Level)

WIRE RECOMMENDATIONS
#28 AWG Solid
#28 AWG Stranded (7 Strand)
#30 AWG Solid
Maximum O.D. of Ins. Wire: 0.038"
Insulation: (Most Acceptable) – PVC, Non-Irradiated

(continued from page 1)

routed near signal leads. Separate DC inputs to the converter and the display allow the OEM designer to minimize effects of display transients on conversion accuracy, economize regulated power, and by use of an external circuit, blank the display independently of the converter.

THEORY OF OPERATION

The AD2003 Block and Timing Diagrams (Figures 4 and 5) use essentially a dual-ramp type A/D conversion scheme. When an input signal is applied to the DPM, it is applied to an integrator at the same time a counter is started, counting clock pulses. After a predetermined number of counts (a fixed interval of time, T), the polarity of the input signal is strobed and a reference voltage having opposite polarity is applied to the integrator. At that instant, the accumulated charge on the integrating capacitor is proportional to the average value of the input over the interval T. The integral of the reference is an opposite-going ramp having a slope V_{REF}/RC. At the same time, the counter is again counting from zero. When the integrator output reaches zero, the count is stopped, and the analog circuitry is reset. Since the charge gained is proportional to $V_{IN}T$, and the equal amount of charge lost is proportional to $V_{REF}\Delta t$, then the number of counts relative to the full count is proportional to $\Delta t/T$, or V_{IN}/V_{REF}. The output of the counter is a BCD number, which is displayed as the digital representation of the input.

APPLICATIONS – REDUCING COMMON MODE INTERFERENCE

The specified minimum common-mode rejection of 80dB (CMRR = 10,000) means that a 1V common-mode signal appearing on both input leads will cause an error equivalent to at most 1 digit (100 microvolts). A common-mode signal is a dc or ac voltage, which may be related or unrelated to the input signal, appearing on both input leads. It may be caused in a number of ways (in any combination): In a *balanced* circuit, such as a bridge (Figure 2), receiving excitation from a grounded supply, the output is the difference between two voltages approximately midway between the supply voltage and ground. The average level of the two voltages is the common-mode voltage, $V_{CM} = \frac{1}{2}(V_1 + V_2)$. The desired output is the difference voltage $(V_1 - V_2)$.

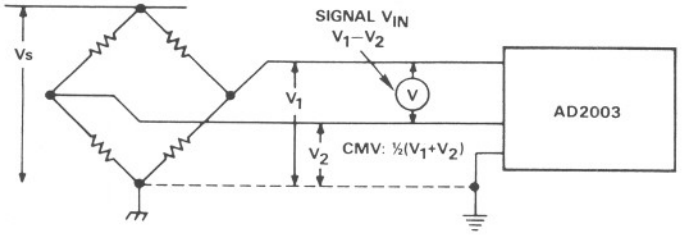


Figure 2. AD2003 Used With Balanced Transducer Bridge Circuit

In a measurement circuit that shares a common "single-ended" system ground, common-mode potentials may be induced thermally, electrically, etc., in series with the ground lead (Figure 3). The differential input capability of the AD2003 allows measurements to be made independently of the actual local ground potential (within ratings).

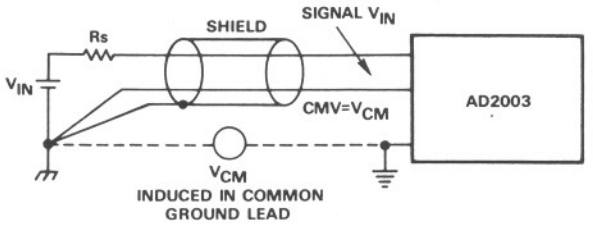


Figure 3. AD2003 Used With an Unbalanced Source

Stray pickup, input circuit impedance, line resistance, and shunt capacitance, if sufficiently balanced, can introduce common-mode errors, even if the measuring device (the meter) has "infinite" CMR. For this reason, the CMR specification is written in terms of a 1kΩ input circuit unbalance and a range of frequencies, dc to 1kHz, to account for a realistic set of electrical conditions. It is good circuit practice to shield the input leads, with the shield connected in *one place only*, either at the common-mode level of the source or to a guard potential at a level close to that of the common-mode voltage. Capacitive unbalance should be kept to a minimum. It can be further reduced by shunt capacitance between the inputs at the meter.*

WHY OPERATE DPM's ON 5VDC?

A DPM designed for 5VDC operation offers the user many advantages over ac-line-powered devices. A few of the benefits for the user are:

- *Lower noise.* Since line voltage can be kept away from the panel, power-frequency interference can be greatly reduced. A separate power supply provides an additional stage of isolation to reduce line transients.
- *Safer equipment.* Line voltage is kept away from low-level signal circuitry. Tests can be conducted in live operation without danger of shock or hazard to nearby circuits. Insulation requirements are less stringent.
- *Lower cost.* Meters without power supplies cost less. A single supply may fan out to a number of meters.
- *Space is saved.* Meters without power supplies occupy less space on and behind the panel. The power supply can be separately placed for most advantageous ventilation.
- *Flexibility.* The separate power supply can be specified to meet the user's unique environmental and supply line conditions, usually off the shelf.
- *Availability.* Power supplies of widely varying capacities and performance levels are available at reasonable cost from many sources, including Analog Devices.
- *Simplicity and Reliability.* A single 5VDC supply is frequently adequate to power the complete data acquisition system. Just connect the DPM like other system logic components.

* More information on circuit practice to minimize common-mode errors in data acquisition can be found in the Analog Devices *Analog-Digital Conversion Handbook.*

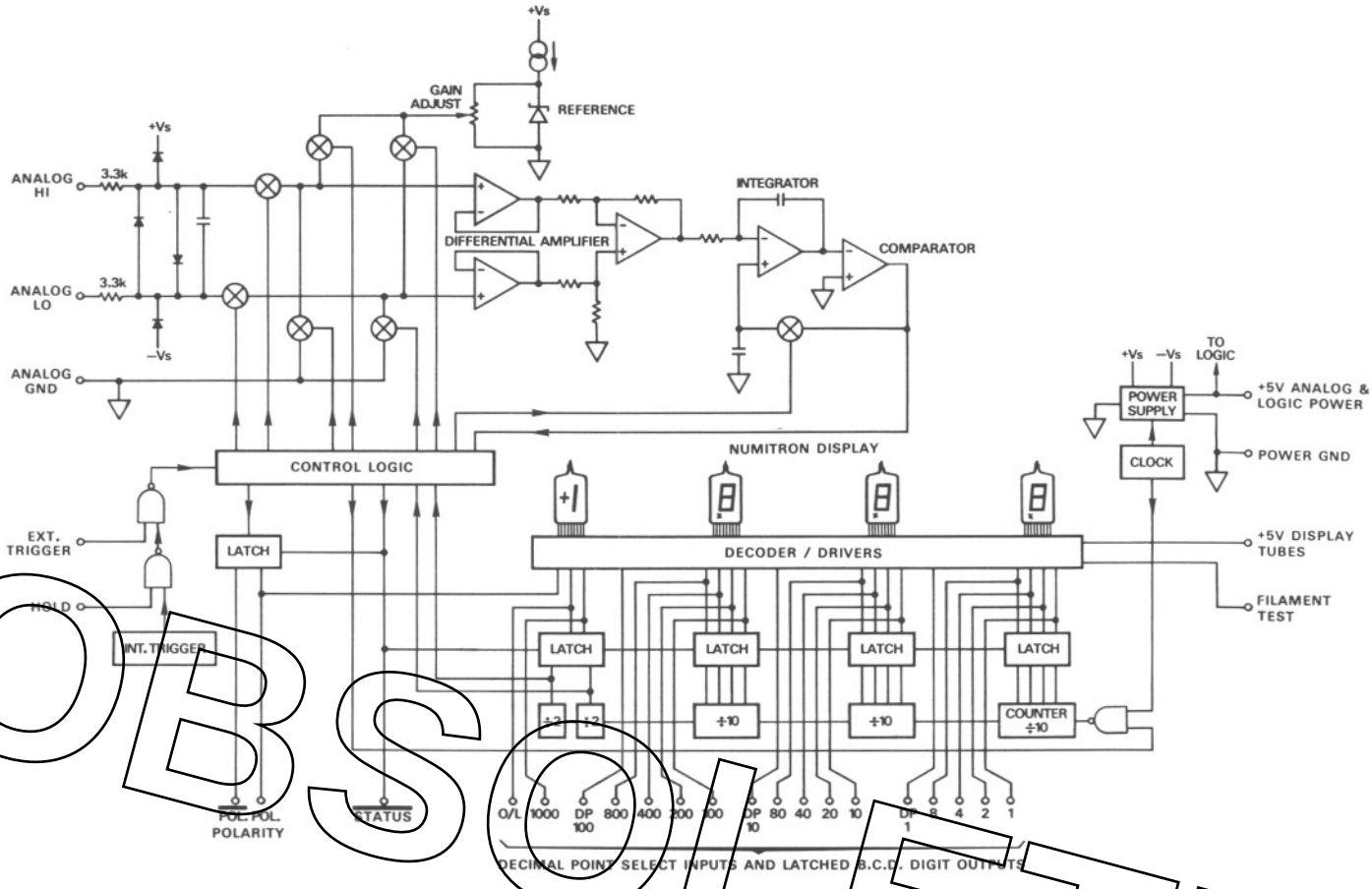
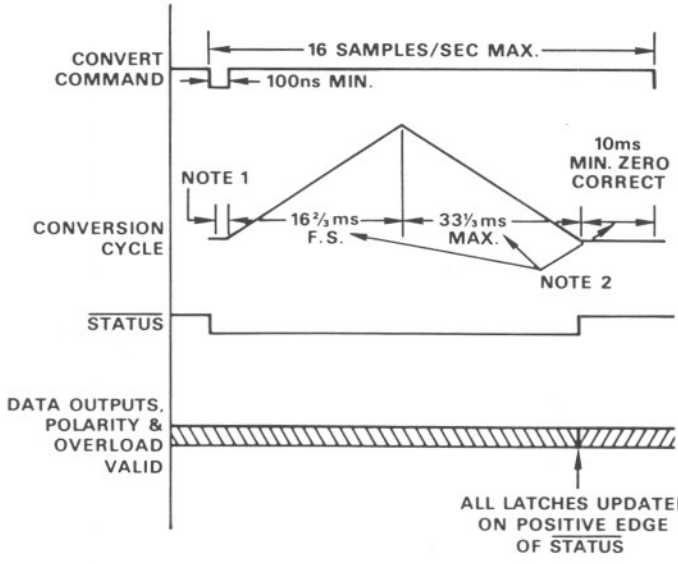


Figure 4. AD2003 Block Diagram



1. MAXIMUM DELAY OF ONE CLOCK PULSE (16 µs) TO SYNCHRONIZE WITH CLOCK.
2. AD2003/E (50 Hz MODELS) TIMING.

RAMP UP	20 ms
RAMP DOWN	40ms MAX.
DRIFT CORRECT	10ms MIN.
MAXIMUM TRIGGER RATE	13/SEC

Figure 5. AD2003 Timing Diagram

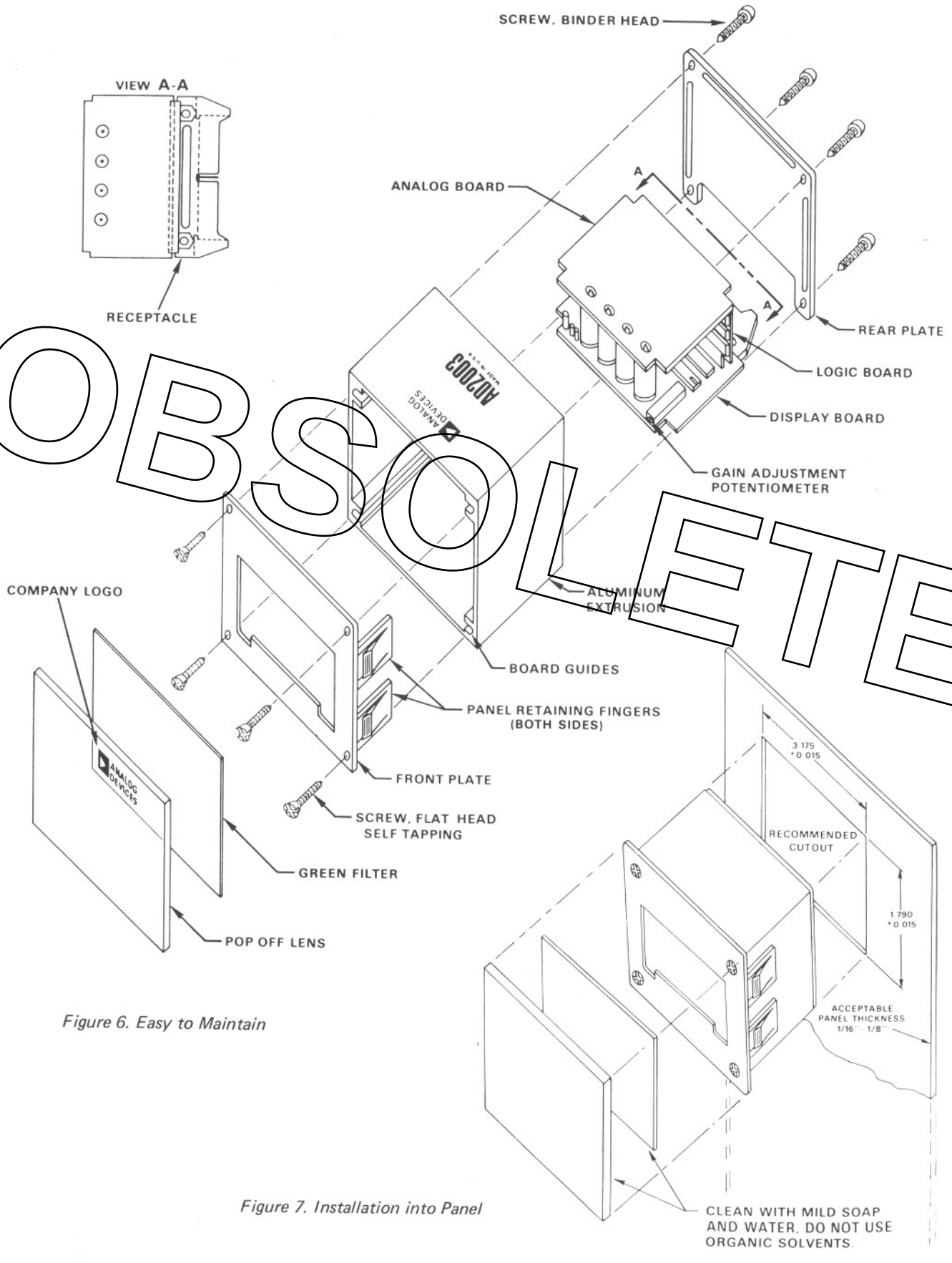
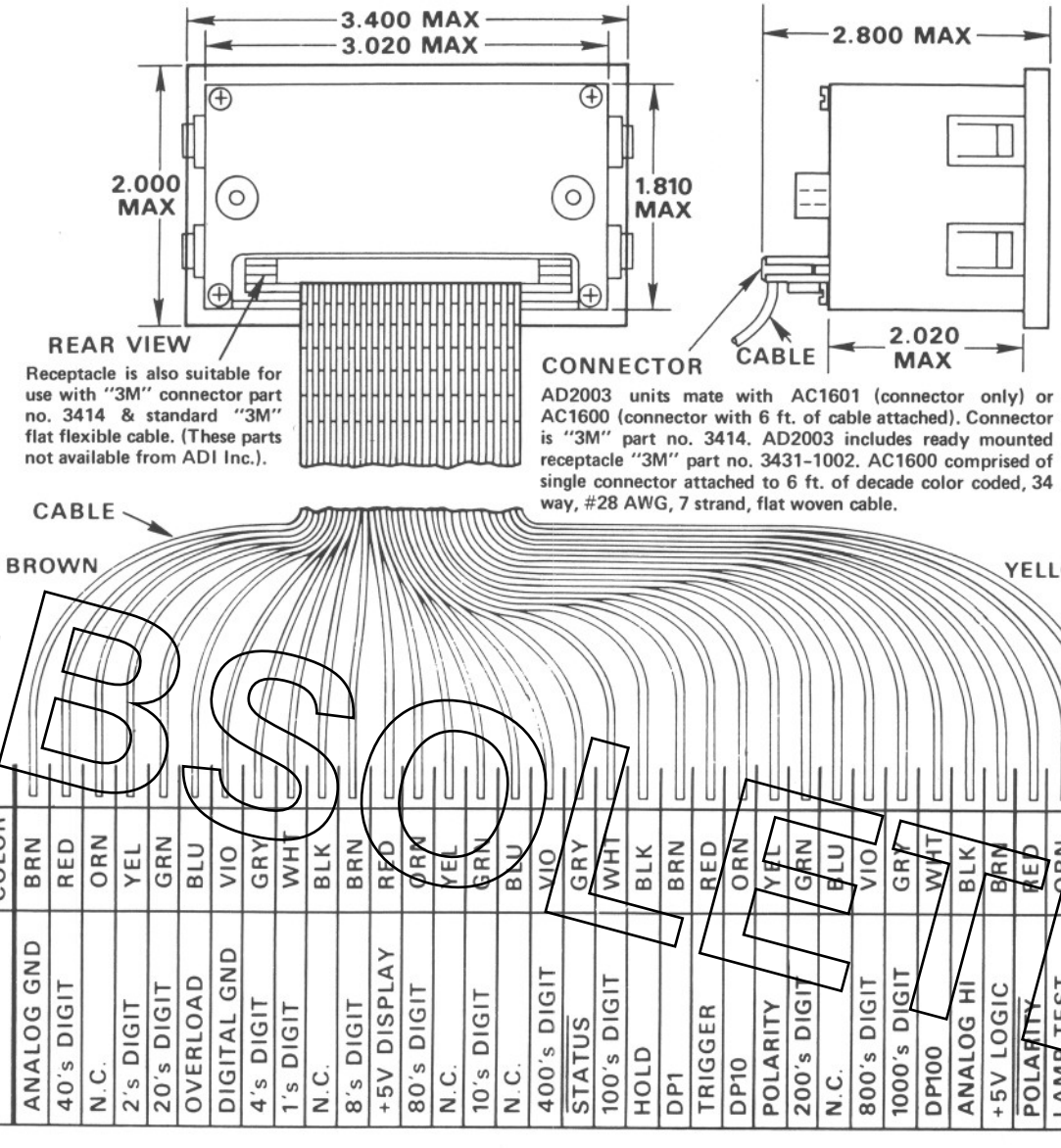


Figure 6. Easy to Maintain

Figure 7. Installation into Panel



FUNCTION	WIRE COLOR
ANALOG GND	BRN
40's DIGIT	RED
N.C.	ORN
2's DIGIT	YEL
20's DIGIT	GRN
OVERLOAD	BLU
DIGITAL GND	VIO
4's DIGIT	GRY
1's DIGIT	WHT
N.C.	BLK
8's DIGIT	BRN
+5V DISPLAY	RED
80's DIGIT	ORN
N.C.	YEL
10's DIGIT	GRN
N.C.	BLU
400's DIGIT	VIO
STATUS	GRY
100's DIGIT	WHT
HOLD	BLK
DP1	BRN
TRIGGER	RED
DP10	ORN
POLARITY	YEL
200's DIGIT	GRN
N.C.	BLU
800's DIGIT	VIO
1000's DIGIT	GRY
DP100	WHT
ANALOG HI	BLK
+5V LOGIC	BRN
POLARITY	RED
LAMP TEST	ORN
ANALOG LOW	YEL

Figure 8. Interconnection Diagram

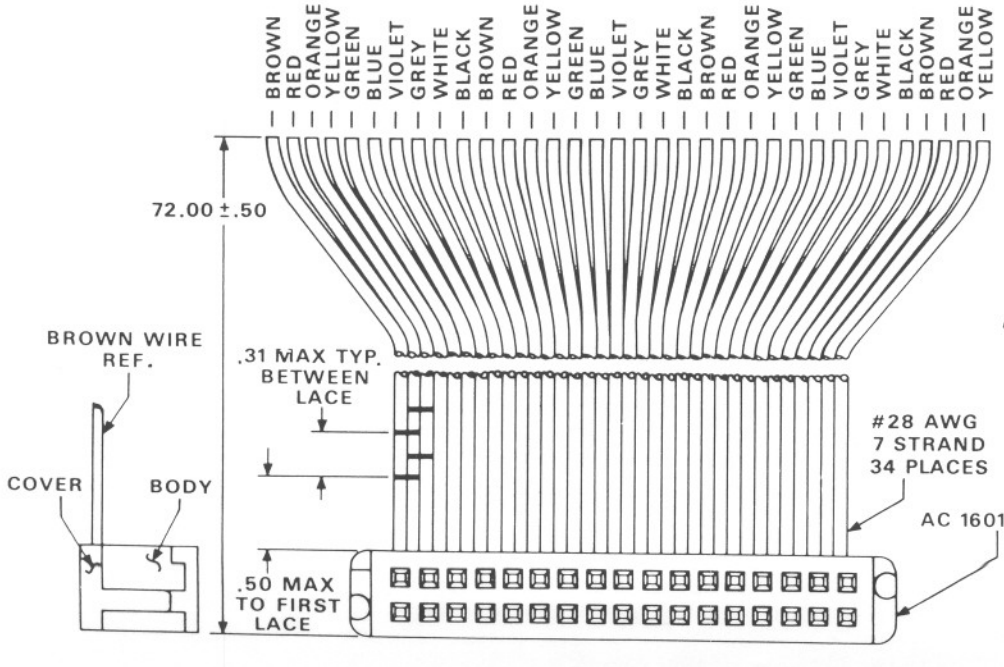


Figure 9. AC1600