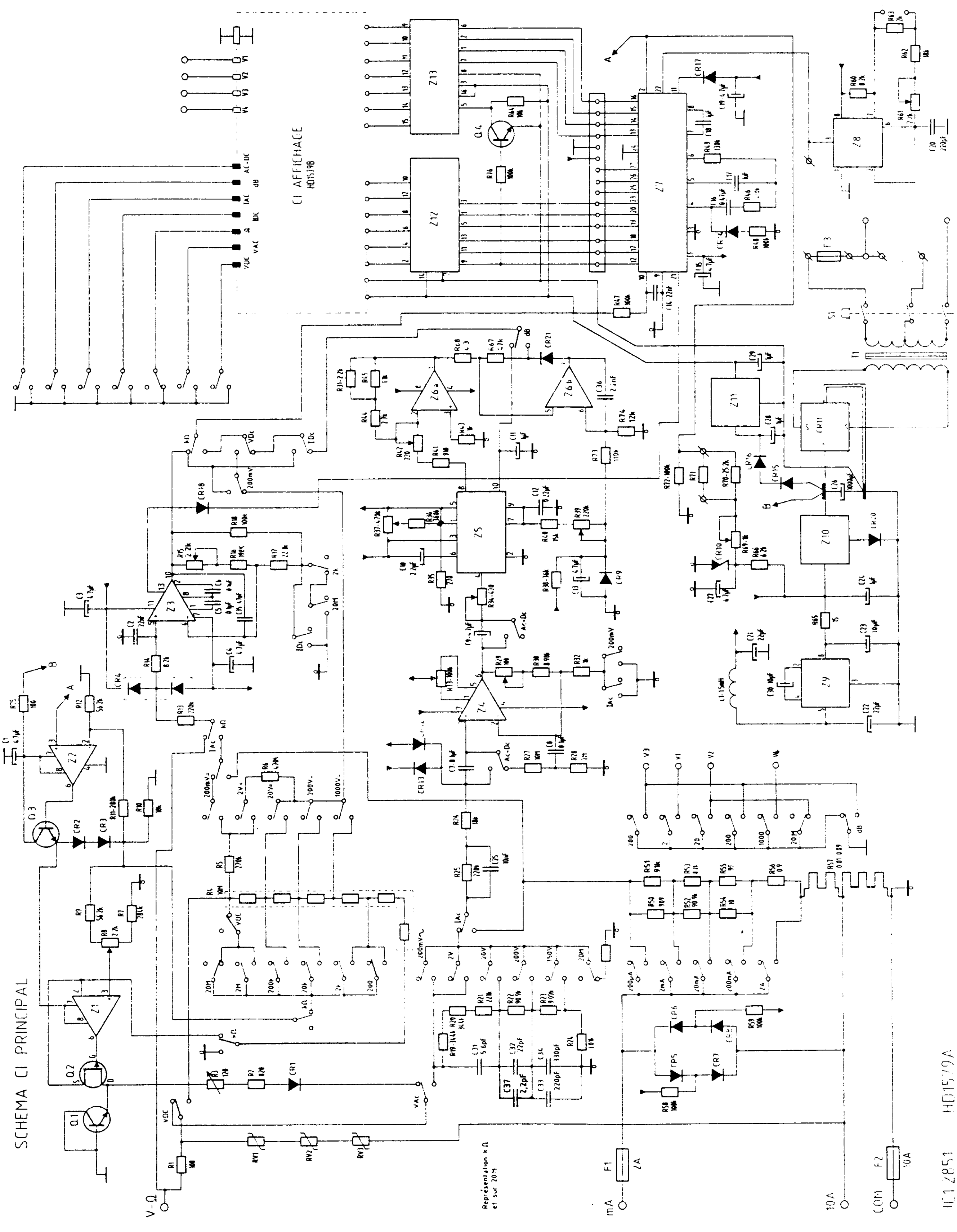
ANNEXE 1

SCHEMA DU MULTIMETRE ET NOMENCLATURE DES COMPOSANTS



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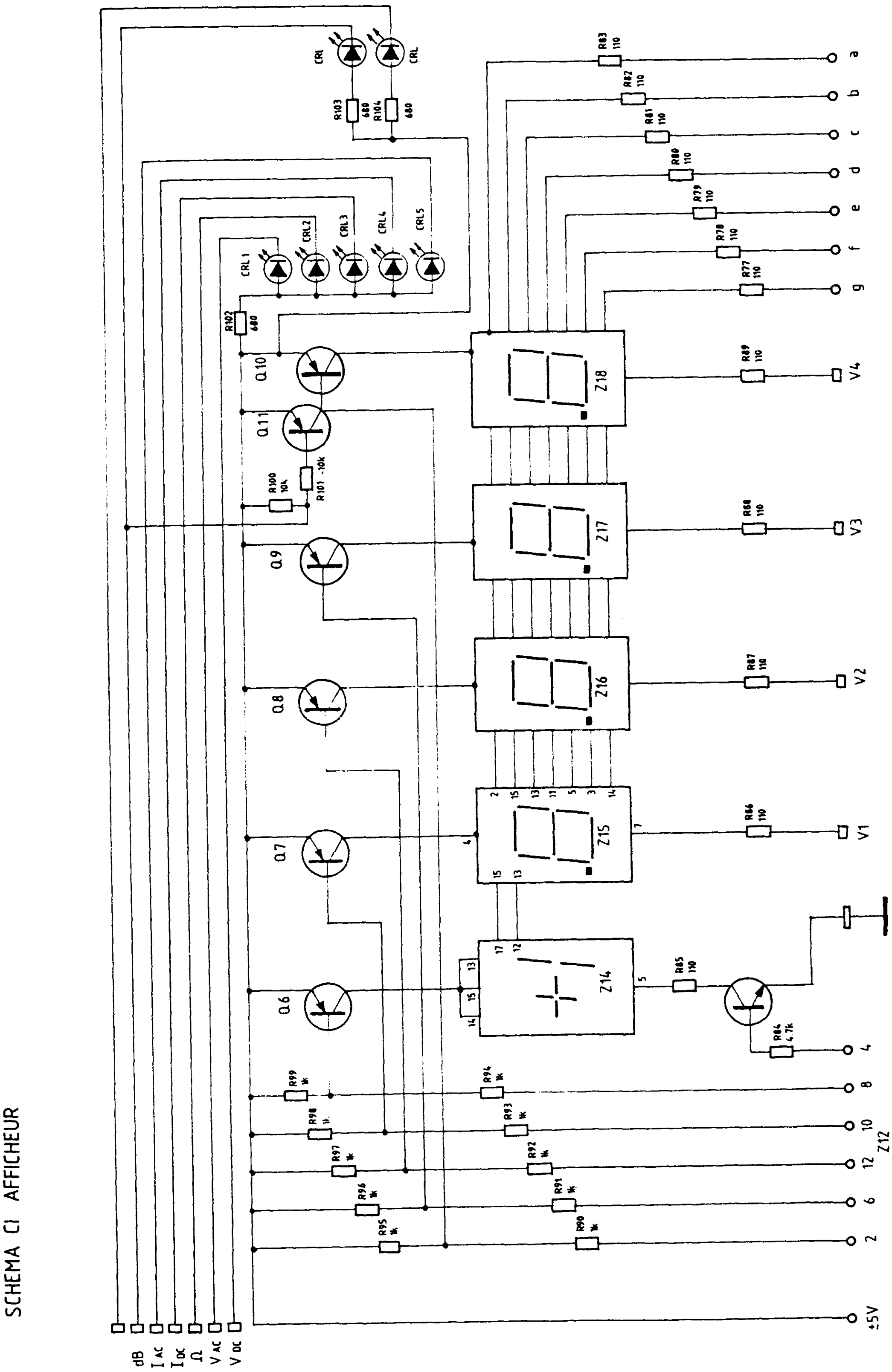
ANNEXE 1 **2/5**

SCHEMA DU MULTIMETRE ET NOMENCLATURE DES COMPOSANTS



SCHEMA DU MULTIMETRE ET NOMENCLATURE DES COMPOSANTS

R104	Réseau 10	MΩ			CE0013
R105	220	kΩ	2%	1W	MBE414
R106	voir CI commutation				
R107	284	kΩ	0,1%	¼W	RN55
R108	2,2	kΩ	20%	Lin.	VA05H
R109	56,2	kΩ	0,1%	¼W 25ppm	RN55E
R110	10	kΩ	2%	¼W	RC2T
R111	280	kΩ	0,1%		RN55
R112	56,2	kΩ	0,1%	¼W 25ppm	RN55E
R113	220	kΩ	2%	1W	MBE414
R114	8,2	kΩ	2%	¼W	RC2T
R115	2,2	kΩ	20%	Lin.	VA05H
R116	198	kΩ	0,1%	¼W 25ppm	RN55E
R117	22,1	kΩ	0,1%	¼W 25ppm	RN55E
R118	100	kΩ	2%	¼W	RC2T
R119	344	kΩ	0,1%	¼W	
R120	344	kΩ	0,1%	¼W	
R121	221	kΩ	0,1%		RN55
R122	90,9	kΩ	0,1%	¼W 25ppm	RN55E
R123	9,09	kΩ	0,1%	¼W 25ppm	RN55E
R124	1,01	kΩ	0,1%	¼W 25ppm	RN55E
R125	220	kΩ	2%	1W	MBE414
R126	18	kΩ	5%	¼W	RC2T
R127	10	MΩ	10%	¼W	
R128	2	MΩ	5%	¼W	
R129	100	Ω	20%	Lin.	VA05H
R130	8,98	kΩ	0,1%	¼W	RN55
R131	CTN 2200	Ω	10%		
R132	1	kΩ	0,1%	¼W	RN55E
R133	100	kΩ	20%	Lin.	VA05H
R134	470	Ω	20%	Lin.	VA05H
R135	270	Ω	2%	¼W	RC2T
R136	360	kΩ	2%	¼W	RC2T
R137	470	kΩ	20%	Lin.	VA05H
R138	36	kΩ	2%	¼W	RC2T
R139	220	kΩ	20%	Lin.	VA05H
R140	15	kΩ	2%	¼W	RC2T
R141	910	Ω	2%	¼W	RC2T
R142	220	Ω	20%	Lin.	VA05H
R143	1	kΩ	2%	¼W	RC2T

R144	2,7	kΩ	2%	¼W	RC2T
R145	1,1	kΩ	2%	¼W	RC2T
R146	470	kΩ	2%	¼W	RC2T
R147	100	kΩ	2%	¼W	RC2T
R148	100	kΩ	2%	¼W	RC2T
R149	130	kΩ	2%	¼W	RC2T
R150	909	Ω	0,1%		RN55
R151	91	kΩ	2%	¼W	RC2T
R152	90,9	Ω	0,1%		RN55
R153	8,2	kΩ	2%	¼W	RC2T
R154	10	Ω	0,1%		RN55
R155	90	Ω	0,5%	¼W	RS63Y
R156	0,9	Ω	0,5%	2W	GEKA
R157	Shunt	2A / 10A			
R158	100	kΩ	2%	¼W	RC2T
R159	100	kΩ	2%	¼W	RC2T
R160	8,2	kΩ	2%	¼W	RC2T
R161	2,2	kΩ	20%	Lin.	VA05H
R162	18	kΩ	2%	¼W	RC2T
R163	2	kΩ	2%	¼W	RC2T
R164	10	kΩ	2%	¼W	RC2T
R165	15	Ω	2%	¼W	RC2T
R166	6,2	kΩ	2%	¼W	RC2T
R167	47	kΩ	2%	¼W	RC2T
R168	4,3	kΩ	2%	¼W	RC2T
R169	1	kΩ	20%	Lin.	VA05H
R170	25,2	kΩ	0,5%	1/8W	RS58Y
R171					
R172	100	kΩ	0,5%	1/8W	RS58Y
R173	110	kΩ	2%	¼W	RC2T
R174	12	kΩ	2%	¼W	RC2T
R175	100	Ω	2%	¼W	RC2T
R176	100	kΩ	2%	¼W	RC2T

RV101 GE-MOV II V430 MA3A 430V 15%
RV102 GE-MOV II V430 MA3A 430V 15%
RV103 GE-MOV II V430 MA3A 430V 15%

S101 Interrupteur tripolaire M/A KE1314

SCHEMA DU MULTIMETRE ET NOMENCLATURE DES COMPOSANTS

LISTES DE PIECES ELECTRIQUES

CI PRINCIPAL HD 1579 A

C101	4,7	µF	-10 +50%	35V	CACI
C102	22	nF	±20%	63V	MKS2/5
C103	4,7	µF	-10 +50%	35V	CACI
C104	4,7	µF	±20%	35V	Tantale
C105	0,1	µF	±20%	63V	MKS2/5
C106	0,1	µF	±20%	63V	MKS2/5
C107	0,1	µF	±20%	63V	MKS2/5
C108	0,1	µF	±20%	63V	MKS2/5
C109	4,7	µF	-10 +50%	35V	CACI
C110	2,2	µF	±20%	35V	Tantale
C111	1	µF	±20%	35V	Tantale
C112	0,22	µF	±20%	63V	MKS2/5
C113	4,7	µF	-10 +50%	35V	CACI
C114	22	nF	±20%	63V	MKS2/5
C115	4,7	µF	-10 +50%	35V	CACI
C116	0,47	µF	±10%	160V	PP78A
C117	1	µF	±20%	50V	MKS2/5
C118	1	µF	±20%	50V	MKS2/5
C119	4,7	µF	-10 +50%	35V	CACI
C120	220	pF	± 2%	63V	N750 Ceram.
C121	22	µF	-10 +50%	16V	CACI
C122	22	µF	-10 +50%	16V	CACI
C123	10	µF	±20%	35V	Tantale
C124	1	µF	-10 +50%	35V	CACI
C125	10	nF	±20%	630V	BR7
C126	1000	µF		25V	Chim. V
C127	4,7	µF	-10 +50%	35V	CACI
C128	1	µF	-10 +50%	35V	CACI
C129	1	µF	-10 +50%	35V	CACI
C130	10	µF	±20%	35V	Tantale
C131	5,6	pF	±0,25%	1000V	QAU 606 LCC
C132	22	pF	± 2%	100V	Ceram.
C133	220	pF	± 2%	100v	Ceram.
C134	330	pF	± 2%	100V	Ceram.

CR101	1N4005			1A	600V	DO41
CR102	1N4148					DO35
CR103	1N4148					DO35
CR104	D PAD 10					DO71
CR105	BY 253					DO27
CR106	BY 253					DO27
CR107	BY 253					DO27
CR108	BY 253					DO27
CR109	LM 385		1V235			TO92
CR110	ICL 8069	CCQ	1V33		50ppm	TO52
CR111	110 B2				Pont redresseur	
CR112	J PAD 50					TO106
CR113	J PAD 50					TO106
CR114	1N4148					DO35
CR115	1N4004					DO41
CR116	1N4004					DO41
CR117	1N4148					DO35
CR118	1N4148					DO35
CR119						
CR120	1N4148					DO35
CR121	1N4148					DO35
F101	Fusible 2A		AA2501			
F102	FUSIBLE 10A		AA1440			
F103	Fusible		AA2315			
Q101	2N2222 A				NPN	TO18
Q102	J270				FP	TO92
Q103	BC 237 B				NPN	TO92
Q104	BC 237 B				NPN	TO92
L101	1,5	mH				BF270P
R101	100	Ω		5%	1W	63B GEKO
R102	820	Ω		10% 25°	4W	RB59 RWM4x10
R103	120	Ω	CTP	420V	Q63100	P390 C883

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SCHEMA DU MULTIMETRE ET NOMENCLATURE DES COMPOSANTS

S102	Commutateur fonctions		KE1312
S103	Commutateur calibres		KE1313
T101	Transformateur alimentation		LA1546
Z101	ICL 7611	DCPA	DIL 8
Z102	ICL 7611	DCPA	DIL 8
Z103	ICL 7650	CPD	DIL 14
Z104	TL 071 CP		DIL 8
Z105	AD 536 AJM	Conv. RMS	TO100
Z106	TL 062 CP		DIL 8
Z107	7135	CAN	DIL 28
Z108	ICM 7555	IPA	DIL 8
Z109	ICL 7660	CPA	DIL 8
Z110	78L05 ACP	5V	TO92
Z111	7805	5V/1A5	TO220
Z112	74LS04		DIL 14
Z113	74LS47		DIL 16

CI AFFICHEUR HD 1579 B

CRL101	CQW54
CRL102	CQW54
CRL103	CQW54
CRL104	CQW54
CRL105	CQW54
CRL106	CQW54
CRL107	CQW54

Q105	BC 237 B	NPN	TO92
Q106	MPSA 55	PNP	TO92
Q107	MPSA 55	PNP	TO92
Q108	MPSA 55	PNP	TO92
Q109	MPSA 55	PNP	TO92
Q110	MPSA 55	PNP	TO92
Q111	BC 307 B	PNP	TO92

R177	110	Ω	2%	¼W	RC2T
R178	110	Ω	2%	¼W	RC2T
R179	110	Ω	2%	¼W	RC2T
R180	110	Ω	2%	¼W	RC2T
R181	110	Ω	2%	¼W	RC2T
R182	110	Ω	2%	¼W	RC2T
R180	110	Ω	2%	¼W	RC2T
R184	4,7	kΩ	2%	¼W	RC2T
R185	110	Ω	2%	¼W	RC2T
R186	110	Ω	2%	¼W	RC2T
R187	110	Ω	2%	¼W	RC2T
R188	110	Ω	2%	¼W	RC2T
R189	110	Ω	2%	¼W	RC2T
R190	1	kΩ	2%	¼W	RC2T
R191	1	kΩ	2%	¼W	RC2T
R192	1	kΩ	2%	¼W	RC2T
R193	1	kΩ	2%	¼W	RC2T
R194	1	kΩ	2%	¼W	RC2T
R195	1	kΩ	2%	¼W	RC2T
R196	1	kΩ	2%	¼W	RC2T
R197	1	kΩ	2%	¼W	RC2T
R198	1	kΩ	2%	¼W	RC2T
R199	1	kΩ	2%	¼W	RC2T
R200	10	kΩ	2%	¼W	RC2T
R201	10	kΩ	2%	¼W	RC2T
R202	680	Ω	2%	¼W	RC2T
R203	680	Ω	2%	¼W	RC2T
R204	680	Ω	2%	¼W	RC2T

Z114	Afficheur HDSP 3906
Z115	AFFICHEUR HDSP 3900
Z116	AFFICHEUR HDSP 3900
Z117	AFFICHEUR HDSP 3900
Z118	AFFICHEUR HDSP 3900

CI COMMUTATION HD 1578

R6	470	kΩ	2%	¼W	RC3T

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ANALOG DEVICES

Integrated Circuit, True RMS-to-DC Converter

AD536A

FEATURES

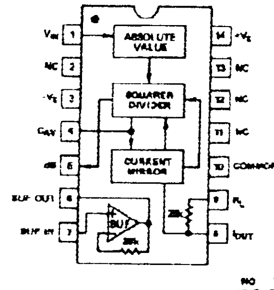
True RMS-to-DC Conversion
Laser-Trimmed to High Accuracy
- 0.2% max Error (AD536AK)
- 0.5% max Error (AD536AJ)

Wide Response Capability:
- Computes RMS of AC and DC Signals
- 450 kHz Bandwidth: V rms > 100 mV
- 2 MHz Bandwidth: V rms > 1 V
- Signal Crest Factor of 7 for 1% Error

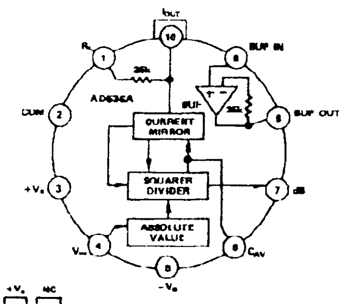
dB Output with 60 dB Range
Low Power: 1.2 mA Quiescent Current
Single or Dual Supply Operation
Monolithic Integrated Circuit
–55°C to +125°C Operation (AD536AS)

PIN CONFIGURATIONS AND FUNCTIONAL BLOCK DIAGRAMS

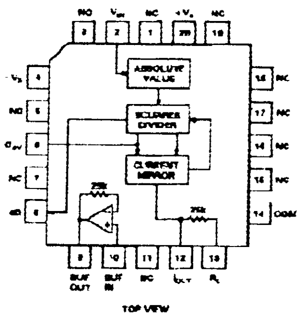
TO-116 (D-14) and Q-14 Package



TO-100 (H-10A) Package



LCC (E-20A) Package



PRODUCT DESCRIPTION

The AD536A is a complete monolithic integrated circuit which performs true rms-to-dc conversion. It offers performance which is comparable or superior to that of hybrid or modular units costing much more. The AD536A directly computes the true rms value of any complex input waveform containing ac and dc components. It has a crest factor compensation scheme which allows measurements with 1% error at crest factors up to 7. The wide bandwidth of the device extends the measurement capability to 300 kHz with 3 dB error for signal levels above 100 mV.

An important feature of the AD536A not previously available in rms converters is an auxiliary dB output. The logarithm of the rms output signal is brought out to a separate pin to allow the dB conversion, with a useful dynamic range of 60 dB. Using an externally supplied reference current, the 0 dB level can be conveniently set by the user to correspond to any input level from 0.1 to 2 volts rms.

The AD536A is laser trimmed at the wafer level for input and output offset, positive and negative waveform symmetry (dc reversal error), and full-scale accuracy at 7 V rms. As a result, no external trims are required to achieve the rated accuracy of the unit.

There is full protection for both inputs and outputs. The input circuitry can take overload voltages well beyond the supply levels. Loss of supply voltage with inputs connected will not cause unit failure. The output is short-circuit protected.

The AD536A is available in two accuracy grades (J, K) for commercial temperature range (0°C to +70°C) applications, and one grade (S) rated for the –55°C to +125°C extended range. The AD536AK offers a maximum total error of ±2 mV ±0.2% of reading, and the AD536AJ and AD536AS have maximum errors of ±5 mV ±0.5% of reading. All three versions are available in either a hermetically sealed 14-pin DIP or 10-pin TO-100 metal can. The AD536AS is also available in a 20-pin hermetically sealed ceramic leadless chip carrier.

REV. A

PRODUCT HIGHLIGHTS

1. The AD536A computes the true root-mean-square level of a complex ac (or ac plus dc) input signal and gives an equivalent dc output level. The true rms value of a waveform is a more useful quantity than the average rectified value since it relates directly to the power of the signal. The rms value of a statistical signal also relates to its standard deviation.
2. The crest factor of a waveform is the ratio of the peak signal swing to the rms value. The crest factor compensation scheme of the AD536A allows measurement of highly complex signals with wide dynamic range.
3. The only external component required to perform measurements to the fully specified accuracy is the capacitor which sets the averaging period. The value of this capacitor determines the low frequency ac accuracy, ripple level and settling time.
4. The AD536A will operate equally well from split supplies or a single supply with total supply levels from 5 to 36 volts. The one milliampere quiescent supply current makes the device well-suited for a wide variety of remote controllers and battery powered instruments.
5. The AD536A directly replaces the AD536 and provides improved bandwidth and temperature drift specifications.

One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106, U.S.A
Tel: 617/329-4700 Fax: 617/326-8703

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AD536A–SPECIFICATIONS (@ +25°C, and ±15 V dc unless otherwise noted)

Model	AD536AJ Min	AD536AJ Typ	AD536AJ Max	AD536AK Min	AD536AK Typ	AD536AK Max	AD536A Min	AD536A Typ	AD536A Max	Units
TRANSFER FUNCTION		$V_{OUT} = \sqrt{avg.(V_{IN})^2}$			$V_{OUT} = \sqrt{avg.(V_{IN})^2}$			$V_{OUT} = \sqrt{avg.(V_{IN})^2}$		
CONVERSION ACCURACY										
Total Error, Internal Trim[1] (Figure 1)			±5 ±0.5			±2 ±0.2			**±5 ±0.5**	mV ± % of Reading
vs. Temperature, T_{MIN} to +70°C			±0.1 ±0.01			±0.05 ±0.005			**±0.1 ±0.005**	mV ± % of Reading/°C
+70°C to +125°C									**±0.3 ±0.005**	mV ± % of Reading/°C
vs. Supply Voltage		±0.1 ±0.01			±0.1 ±0.01			±0.1 ±0.01		mV ± % of Reading/V
dc Reversal Error		±0.2			±0.1			±0.2		± % of Reading
Total Error, External Trim[1] (Figure 2)		±3 ±0.3			±2 ±0.1			±3 ±0.3		mV ± % of Reading
ERROR VS. CREST FACTOR[2]										
Crest Factor 1 to 2		Specified Accuracy			Specified Accuracy			Specified Accuracy		
Crest Factor = 3		–0.1			–0.1			–0.1		% of Reading
Crest Factor = 7		–1.0			–1.0			–1.0		% of Reading
FREQUENCY RESPONSE[3]										
Bandwidth for 1% Additional Error (0.09 dB)										
V_{IN} = 10 mV		5			5			5		kHz
V_{IN} = 100 mV		45			45			45		kHz
V_{IN} = 1 V		120			120			120		kHz
±3 dB Bandwidth										
V_{IN} = 10 mV		90			90			90		kHz
V_{IN} = 100 mV		450			450			450		kHz
V_{IN} = 1 V		2.3			2.3			2.3		MHz
AVERAGING TIME CONSTANT (Figure 5)		25			25			25		ms/µF CAV
INPUT CHARACTERISTICS										
Signal Range, ±15 V Supplies										
Continuous rms Level		0 to 7			0 to 7			0 to 7		V rms
Peak Transient Input			±20			±20			±20	V peak
Continuous rms Level, ±5 V Supplies		0 to 2			0 to 2			0 to 2		V rms
Peak Transient Input, ±5 V Supplies			±7			±7			±7	V peak
Maximum Continuous Nondestructive Input Level (All Supply Voltages)			±25			±25			±25	V peak
Input Resistance	13.33	16.67	20	13.33	16.67	20	13.33	16.67	20	kΩ
Input Offset Voltage		0.8	±2		0.5	±1		0.8	±2	mV
OUTPUT CHARACTERISTICS										
Offset Voltage, V_{IN} = COM (Figure 1)		±1	±2		±0.5	±1			**±2**	mV
vs. Temperature		±0.1			±0.1				**±0.2**	mV/°C
vs. Supply Voltage		±0.1			±0.1			±0.2		mV/V
Voltage Swing, ±15 V Supplies	0 to +11	+12.5		0 to +11	+12.5		0 to +11	+12.5		V
±5 V Supply	0 to +2			0 to +2			0 to +2			V
dB OUTPUT (Figure 13)										
Error, V_{IN} 7 mV to 7 V rms, 0 dB = 1 V rms		±0.4	±0.6		±0.2	±0.3		±0.5	±0.6	dB
Scale Factor		–3			–3			–3		mV/dB
Scale Factor TC (Uncompensated, see Figure 1 for Temperature Compensation		–0.033			–0.033			–0.033		dB/°C
		+0.33			+0.33			+0.33		% of Reading/°C
I_{REF} for 0 dB = 1 V rms	5	20	80	5	20	80	5	20	80	µA
I_{REF} Range	1		100	1		100	1		100	µA
I_{OUT} TERMINAL										
I_{OUT} Scale Factor		40			40			40		µA/V rms
I_{OUT} Scale Factor Tolerance		±10	±20		±10	±20		±10	±20	%
Output Resistance	20	25	30	20	25	30	20	25	30	kΩ
Voltage Compliance		$-V_S$ to ($+V_S$ –2.5 V)			$-V_S$ to ($+V_S$ –2.5 V)			$-V_S$ to ($+V_S$ –2.5 V)		V
BUFFER AMPLIFIER										
Input and Output Voltage Range	$-V_S$ to ($+V_S$ –2.5 V)			$-V_S$ to ($+V_S$ –2.5 V)			$-V_S$ to ($+V_S$ –2.5 V)			V
Input Offset Voltage, R_S = 25 k		±0.5	±4		±0.5	±4		±0.5	±4	mV
Input Bias Current		20	60		20	60		20	60	nA
Input Resistance		10^8			10^8			10^8		Ω
Output Current	(+5 mA, –130 µA)			(+5 mA, –130 µA)			(+5 mA, –130 µA)			
Short Circuit Current		20			20			20		mA
Output Resistance			0.5			0.5			0.5	Ω
Small Signal Bandwidth		1			1			1		MHz
Slew Rate[4]		5			5			5		V/µs
POWER SUPPLY										
Voltage Rated Performance		±15			±15			±15		V
Dual Supply	±3.0		±18	±3.0		±18	±3.0		±18	V
Single Supply	+5		+36	+5		+36	+5		+36	V
Quiescent Current										
Total V_S, 5 V to 36 V, T_{MIN} to T_{MAX}		1.2	2		1.2	2		1.2	2	mA
TEMPERATURE RANGE										
Rated Performance	0		+70	0		+70	–55		+125	°C
Storage	–55		+150	–55		+150	–55		+150	°C
NUMBER OF TRANSISTORS		65			65			65		
PACKAGE OPTIONS										
Ceramic DIP (D-14)		AD536AJD			AD536AKD			AD536ASH		
Metal Can TO-100 (H-10A)		AD5536AJH			AD536AKH			AD536ASH		
LCC (E-20A)								AD536ASE		

NOTES
[1]Accuracy is specified for 0 V to 7 V rms, dc or 1 kHz sine wave input with the AD536A connected as in the figure referenced.
[2]Error vs. crest factor is specified as an additional error for 1 V rms rectangular pulse input, pulse width = 200 µs.
[3]Input voltages are expressed in volts rms, and error is percent of reading.
[4]With 2k external pull-down resistor.

Specifications subject to change without notice.

Specifications shown in **boldface** are tested on all production units at final electrical test. Results from those tests are used to calculate outgoing quality levels. All min and max specifications are guaranteed although only those shown in boldface are tested on all production units.

Applying the AD536A

ABSOLUTE MAXIMUM RATINGS[1]

Supply Voltage
- Dual Supply . . . . ±18 V
- Single Supply . . . . +36 V

Internal Power Dissipation[2] . . . . 500 mW
Maximum Input Voltage . . . . ±25 V Peak
Buffer Maximum Input Voltage . . . . $\pm V_S$
Maximum Input Voltage . . . . ±25 V Peak
Storage Temperature Range . . . . −55°C to +150°C
Operating Temperature Range
- AD536AJ/K . . . . 0°C to +70°C
- AD536AS . . . . −55°C to +125°C

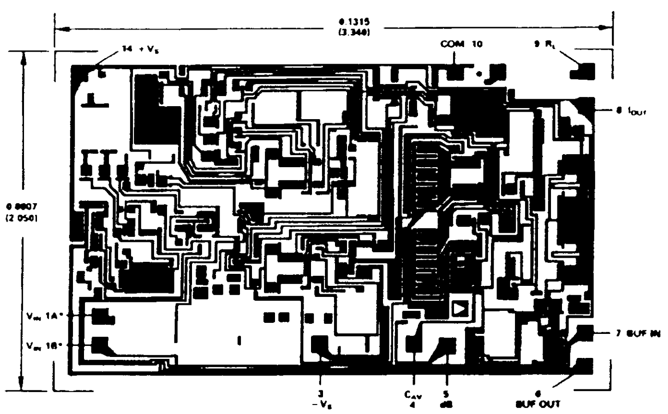
Lead Temperature Range
- (Soldering 60 sec) . . . . +300°C

ESD Rating . . . . 1000 V

NOTES
[1]Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.
[2]10-Pin Header: θ_{JA} = 150°C/W
20-Pin LCC: θ_{JA} = 95°C/W
14-Pin Size Brazed Ceramic DIP: θ_{JA} = 95°C/W.

CHIP DIMENSIONS AND PAD LAYOUT

Dimensions shown in inches and (mm).



PAD NUMBERS CORRESPOND TO PIN NUMBERS FOR THE TO-116 14-PIN CERAMIC DIP PACKAGE

NOTE
*BOTH PADS SHOWN MUST BE CONNECTED TO V_{IN}.
THE AD536A IS AVAILABLE IN LASER TRIMMED CHIP FORM.
SUBSTRATE CONNECTED TO $-V_S$.

ORDERING GUIDE

Model[1]	Temperature Range	Package Description	Package Option
AD536AJD	0°C to +70°C	Side Brazed Ceramic DIP	D-14
AD536AKD	0°C to +70°C	Side Brazed Ceramic DIP	D-14
AD536AJH	0°C to +70°C	Header	H-10A
AD536AKH	0°C to +70°C	Header	H-10A
AD536AJQ	0°C to +70°C	Cerdip	Q-14
AD536AKQ	0°C to +70°C	Cerdip	Q-14
AD536ASD	−55°C to +125°C	Side Brazed Ceramic DIP	D-14
AD536ASD/883B	−55°C to +125°C	Side Brazed Ceramic DIP	D-14
AD536ASE	−55°C to +125°C	LCC	E-20A
AD536ASE/883B	−55°C to +125°C	LCC	E-20A
AD536ASH	−55°C to +125°C	Header	H-10A
AD536ASH/883B	−55°C to +125°C	Header	H-10A

NOTE
[1]"S" grade chips are available tested at +25°C and +125°C. "J" grade chips are also available.

STANDARD CONNECTION

The AD536A is simple to connect for the majority of high accuracy rms measurements, requiring only an external capacitor to set the averaging time constant. The standard connection is shown in Figure 1. In this configuration, the AD536A will measure the rms of the ac and dc level present at the input, but will show an error for low frequency inputs as a function of the filter capacitor, C_{AV}, as shown in Figure 5. Thus, if a 4 µF capacitor is used, the additional average error at 10 Hz will be 0.1%, at 3 Hz it will be 1%. The accuracy at higher frequencies will be according to specification. If it is desired to reject the dc input, a capacitor is added in series with the input, as shown in Figure 3, the capacitor must be nonpolar. If the AD536A is driven with power supplies with a considerable amount of high frequency ripple, it is advisable to bypass both supplies to ground with 0.1 µF ceramic discs as near the device as possible.

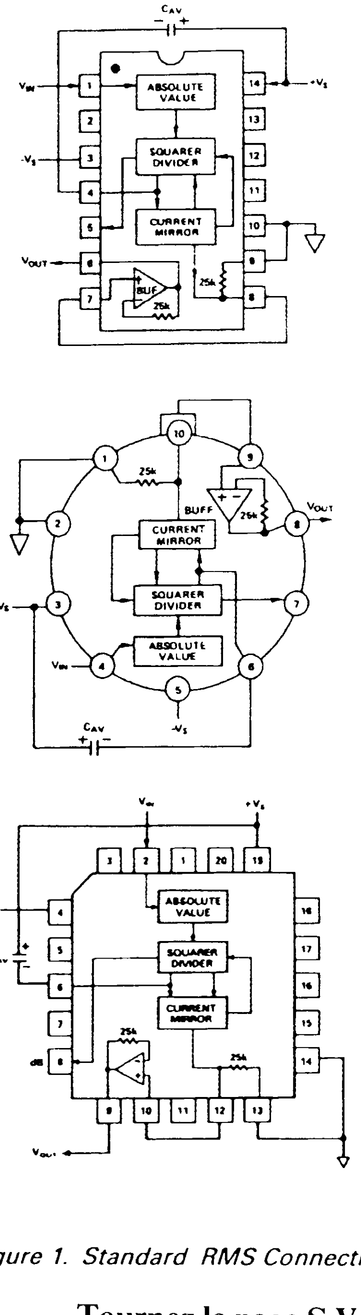


Figure 1. Standard RMS Connection

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AD536A

The input and output signal ranges are a function of the supply voltages; these ranges are shown in Figure 14. The AD536A can also be used in an unbuffered voltage output mode by disconnecting the input to the buffer. The output then appears unbuffered across the 25k resistor. The buffer amplifier can then be used for other purposes. Further the AD536A can be used in a current output mode by disconnecting the 25k resistor from ground. The output current is available at Pin 8 (Pin 10 on the "H" package) with a nominal scale of 40 µA per volt rms input positive out.

OPTIONAL EXTERNAL TRIMS FOR HIGH ACCURACY

If it is desired to improve the accuracy of the AD536A, the external trims shown in Figure 2 can be added. R4 is used to trim the offset. Note that the offset trim circuit adds 365 Ω in series with the internal 25 kΩ resistor. This will cause a 1.5% increase in scale factor, which is trimmed out by using R1 as shown. Range of scale factor adjustment is ±1.5%.

The trimming procedure is as follows:

1. Ground the input signal, V_{IN}, and adjust R4 to give zero volts output from Pin 6. Alternatively, R4 can be adjusted to give the correct output with the lowest expected value of V_{IN}.
2. Connect the desired full scale input level to V_{IN}, either dc or a calibrated ac signal (1 kHz is the optimum frequency); then trim R1, to give the correct output from Pin 6, i.e., 1000 V dc input should give 1.000 V dc output. Of course, a ±1.000 V peak-to-peak sine wave should give a 0.707 V dc output. The remaining errors, as given in the specifications are due to the nonlinearity.

The major advantage of external trimming is to optimize device performance for a reduced signal range; the AD536A is internally trimmed for a 7 V rms full-scale range.

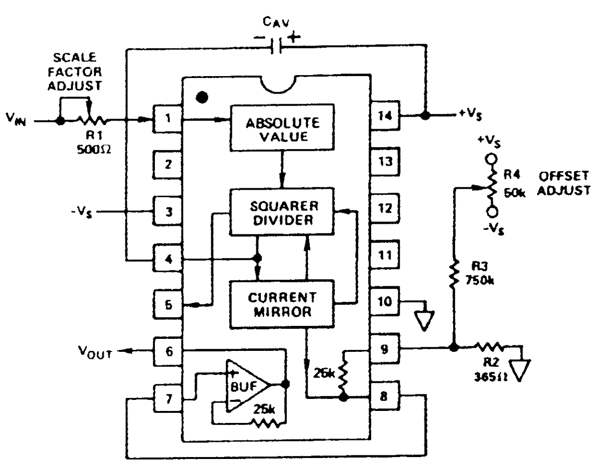

Figure 2. Optional External Gain and Output Offset Trims

SINGLE SUPPLY CONNECTION

The applications in Figures 1 and 2 require the use of approximately symmetrical dual supplies. The AD536A can also be used with only a single positive supply down to +5 volts, as shown in Figure 3. The major limitation of this connection is that only ac signals can be measured since the differential input stage must be biased off ground for proper operation. This biasing is done at Pin 10; thus it is critical that no extraneous signals be coupled into this point. Biasing can be accomplished by using a resistive divider between $+V_S$ and ground. The values of the resistors can be increased in the interest of lowered power consumption, since only 5 mA of current flows into Pin 10 (Pin 2 on the "H" package). AC input coupling requires only capacitor C2 as shown; a dc return is not necessary as it is provided internally. C2 is selected for the proper low frequency break point with the input resistance of 16.7 kΩ; for a cutoff at 10 Hz, C2 should be 1 µF. The signal ranges in this connection are slightly more restricted than in the dual supply connection. The input and output signal ranges are shown in Figure 14. The load resistor, R_L, is necessary to provide output sink current.

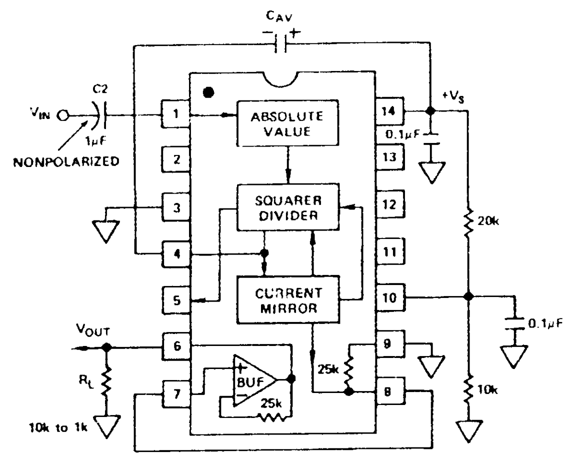

Figure 3. Single Supply Connection

CHOOSING THE AVERAGING TIME CONSTANT

The AD536A will compute the rms of both ac and dc signals. If the input is a slowly-varying dc signal, the output of the AD536A will track the input exactly. At higher frequencies, the average output of the AD536A will approach the rms value of the input signal. The actual output of the AD536A will differ from the ideal output by a dc (or average) error and some amount of ripple, as demonstrated in Figure 4.

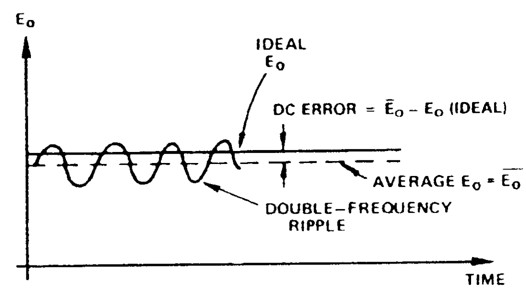

Figure 4. Typical Output Waveform for Sinusoidal Input

The dc error is dependent on the input signal frequency and the value of C_{AV}. Figure 5 can be used to determine the minimum value of C_{AV} which will yield a given percent dc error above a given frequency using the standard rms connection.

The ac component of the output signal is the ripple. There are two ways to reduce the ripple. The first method involves using a large value of C_{AV}. Since the ripple is inversely proportional to C_{AV}, a tenfold increase in this capacitance will affect a tenfold reduction in ripple. When measuring waveforms with high crest factors, (such as low duty cycle pulse trains), the averaging time constant should be at least ten times the signal period. For example, a 100 Hz pulse rate requires a 100 ms time constant, which corresponds to a 4 µF capacitor (time constant = 25 ms per µF).

The primary disadvantage in using a large C_{AV} to remove ripple is that the settling time for a step change in input level is increased proportionately. Figure 5 shows that the relationship between C_{AV} and 1% settling time is 115 milliseconds for each microfarad of C_{AV}. The settling time is twice as great for decreasing signals as for increasing signals (the values in Figure 5 are for decreasing signals). Settling time also increases for low signal levels, as shown in Figure 6.

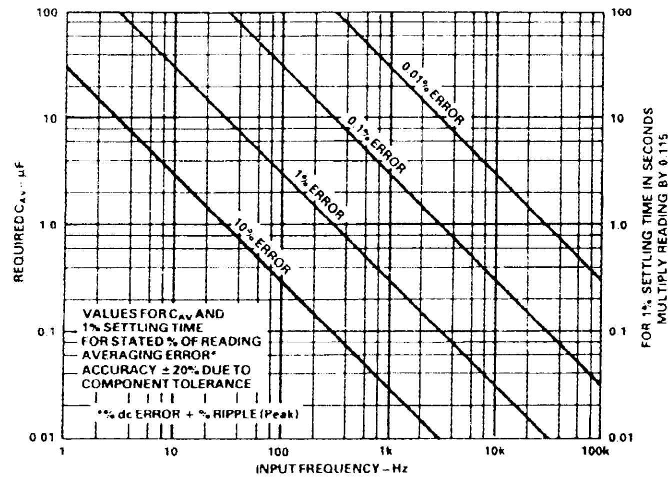

Figure 5. Error/Settling Time Graph for Use with the Standard rms Connection in Figure 1

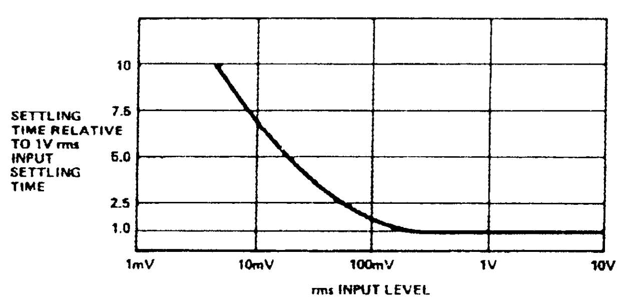

Figure 6. Settling Time vs. Input Level

A better method for reducing output ripple is the use of a "post-filter." Figure 7 shows a suggested circuit. If a single-pole filter is used (C3 removed, R_X shorted), and C2 is approximately twice the value of C_{AV}, the ripple is reduced as shown in Figure 8 and settling time is increased. For example, with C_{AV} = 1 µF and C2 = 2.2 µF, the ripple for a 60 Hz input is reduced from 10% of reading to approximately 0.3% of reading. The settling time, however, is increased by approximately a factor of 3. The values of C_{AV} and C2 can, therefore, be reduced to permit faster settling times while still providing substantial ripple reduction.

The two-pole post-filter uses an active filter stage to provide even greater ripple reduction without substantially increasing the settling times over a circuit with a one-pole filter. The values of C_{AV}, C2, and C3 can then be reduced to allow extremely fast settling times for a constant amount of ripple. Caution should be exercised in choosing the value of C_{AV}, since the dc error is dependent upon this value and is independent of the post filter.

For a more detailed explanation of these topics refer to the *RMS to DC Conversion Application Guide 2nd Edition,* available from Analog Devices.

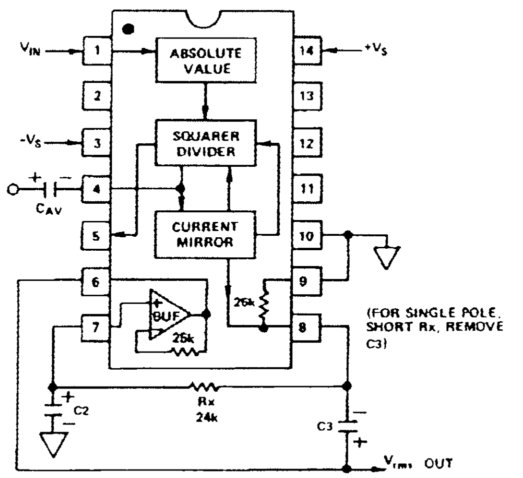

Figure 7. 2-Pole "Post" Filter

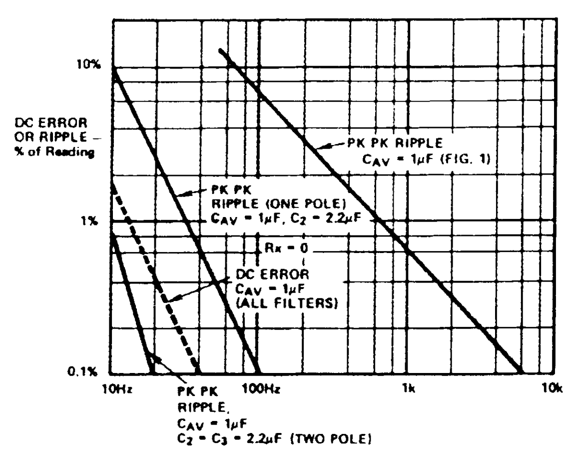

Figure 8. Performance Features of Various Filter Types

AD536A PRINCIPLE OF OPERATION

The AD536A embodies an implicit solution of the rms equation that overcomes the dynamic range as well as other limitations inherent in a straightforward computation of rms. The actual computation performed by the AD536A follows the equation:

$$V\ rms = Avg.\left[\frac{V_{IN}^2}{V\ rms}\right]$$

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AD536A

Figure 9 is a simplified schematic of the AD536A; it is subdivided into four major sections: absolute value circuit (active rectifier), squarer/divider, current mirror, and buffer amplifier. The input voltage, V_{IN}, which can be ac or dc, is converted to a unipolar current I_1, by the active rectifier A_1, A_2. I_1 drives one input of the squarer/divider, which has the transfer function:

$$I_4 = I_1^2/I_3$$

The output current, I_4, of the squarer/divider drives the current mirror through a low-pass filter formed by R1 and the externally connected capacitor, C_{AV}. If the R1, C_{AV} time constant is much greater than the longest period of the input signal, then I_4 is effectively averaged. The current mirror returns a current I_3, which equals Avg. $[I_4]$, back to the squarer/divider to complete the implicit rms computation. Thus:

$$I_4 = Avg.\left[I_1^2/I_4\right] = I_1\ rms$$

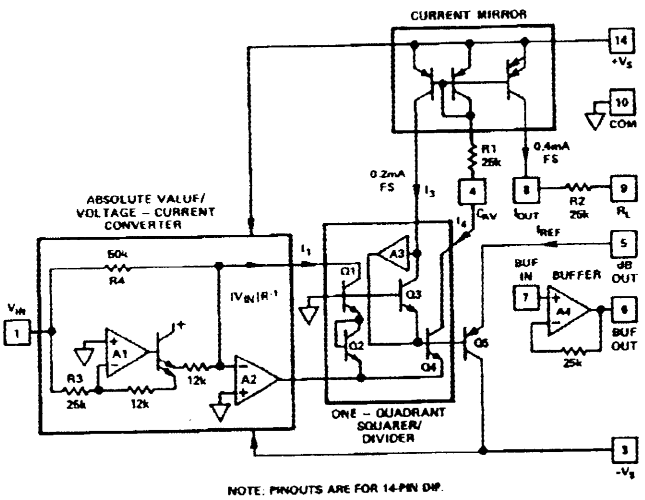

Figure 9. Simplified Schematic

The current mirror also produces the output current, I_{OUT}, which equals $2I_4$. I_{OUT} can be used directly or converted to a voltage with R2 and buffered by A4 to provide a low impedance voltage output. The transfer function of the AD536A thus results:

$$V_{OUT} = 2R2\ I\ rms = V_{IN}\ rms$$

The dB output is derived from the emitter of Q3, since the voltage at this point is proportional to $-\log V_{IN}$. Emitter follower, Q5, buffers and level shifts this voltage, so that the dB output voltage is zero when the externally supplied emitter current (I_{REF}) to Q5 approximates I_3.

CONNECTIONS FOR dB OPERATION

A powerful feature added to the AD536A is the logarithmic or decibel output. The internal circuit computing dB works accurately over a 60 dB range. The connections for dB measurements are shown in Figure 10. The user selects the 0 dB level by adjusting R1, for the proper 0 dB reference current (which is set to exactly cancel the log output current from the squarer-divider at the desired 0 dB point). The external op amp is used to provide a more convenient scale and to allow compensation of the +0.33%/°C scale factor drift of the dB output pin. The special T.C. resistor, R2, is available from Tel Labs in Londonderry, N.H. (model Q-81) or from Precision Resistor Inc., Hillside, N.J. (model PT146). The averaged temperature coefficients of resistors R2 and R3 develop the +3300 ppm needed to reverse compensate the dB output. The linear rms output is available at Pin 8 on DIP or Pin 10 on header device with an output impedance of 25 kΩ; thus some applications may require an additional buffer amplifier if this output is desired.

dB Calibration:

1. Set V_{IN} = 1.00 V dc or 1.00 V rms
2. Adjust R1 for dB out = 0.00 V
3. Set V_{IN} = +0.1 V dc or 0.10 V rms
4. Adjust R5 for dB out = –2.00 V

Any other desired 0 dB reference level can be used by setting V_{IN} and adjusting R1, accordingly. Note that adjusting R5 for the proper gain automatically gives the correct temperature compensation.

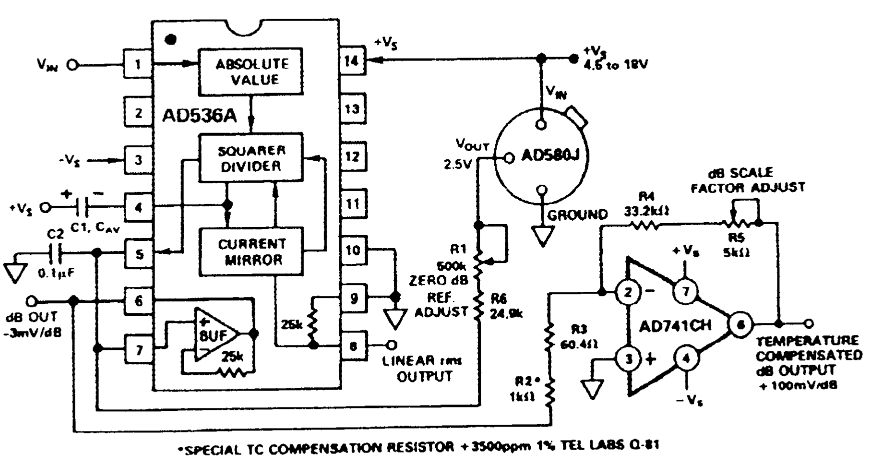

Figure 10. dB Connection

FREQUENCY RESPONSE

The AD536A utilizes a logarithmic circuit in performing the implicit rms computation. As with any log circuit, bandwidth is proportional to signal level. The solid lines in the graph below represent the frequency response of the AD536A at input levels from 10 millivolts to 7 volts rms. The dashed lines indicate the upper frequency limits for 1%, 10%, and 3 dB of reading additional error. For example, note that a 1 volt rms signal will produce less than 1% of reading additional error up to 120 kHz. A 10 millivolt signal can be measured with 1% of reading additional error (100 μV) up to only 5 kHz.

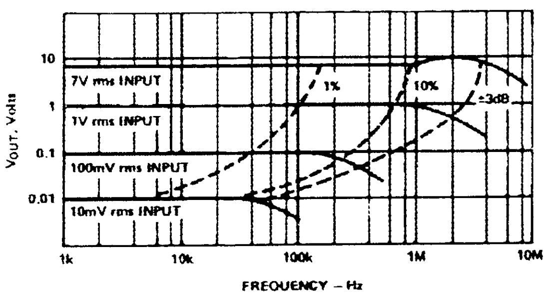

Figure 11. High Frequency Response

AC MEASUREMENT ACCURACY AND CREST FACTOR

Crest factor is often overlooked in determining the accuracy of an ac measurement. Crest factor is defined as the ratio of the peak signal amplitude to the rms value of the signal (CF = V_P/V rms). Most common waveforms, such as sine and triangle waves, have relatively low crest factors (<2). Waveforms which resemble low duty cycle pulse trains, such as those occurring in switching power supplies and SCR circuits, have high crest factors. For example, a rectangular pulse train with a 1% duty cycle has a crest factor of 10 (CF = $1\sqrt{\eta}$).

Figure 12 is a curve of reading error for the AD536A for a 1 volt rms input signal with crest factors from 1 to 11. A rectangular pulse train (pulse width 100 μs) was used for this test since it is the worst-case waveform for rms measurement (all the energy is contained in the peaks). The duty cycle and peak amplitude were varied to produce crest factors from 1 to 11 while maintaining a constant 1 volt rms input amplitude.

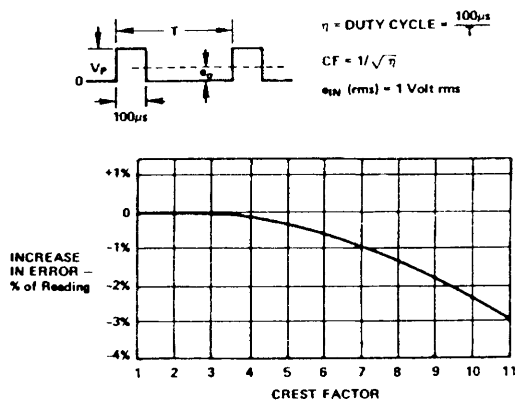

Figure 12. Error vs. Crest Factor

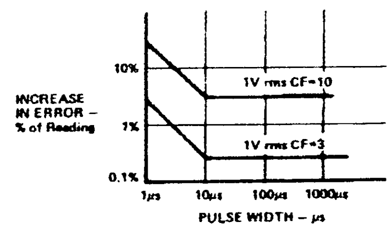

Figure 13. AD536A Error vs. Pulse Width Rectangular Pulse

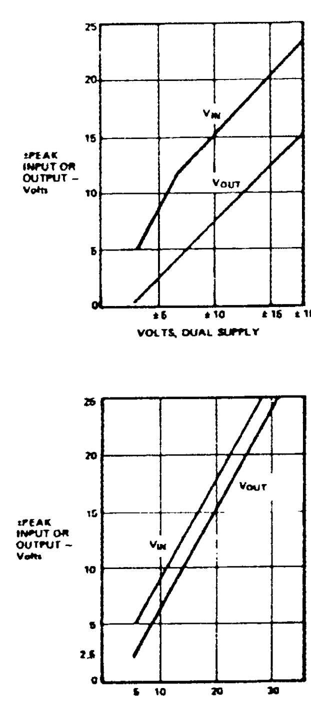

Figure 14. AD536A Input and Output Voltage Ranges vs. Supply

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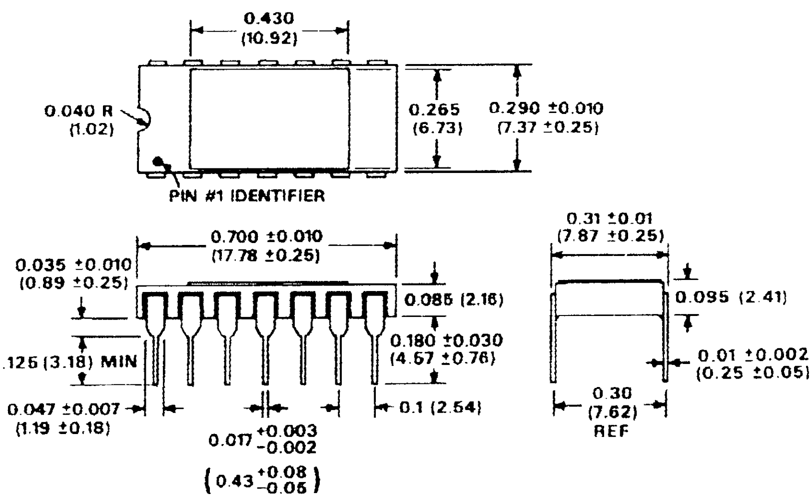
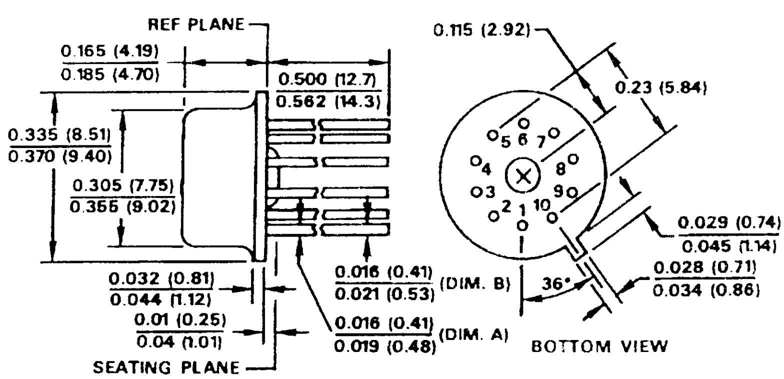
OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).

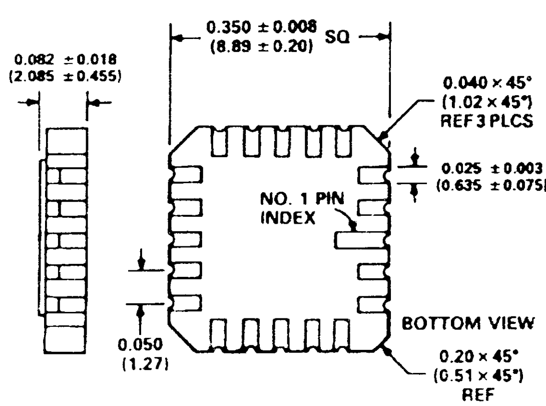
D-14 Package
TO-116



H-10A Package
TO-100

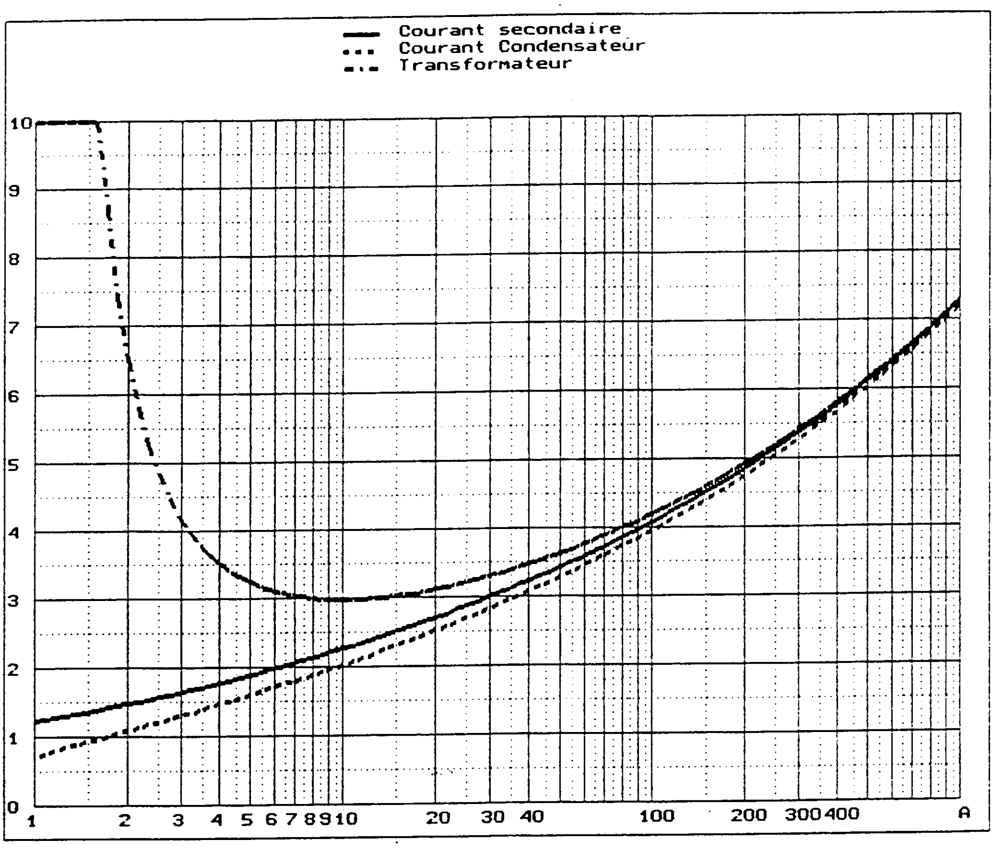


E-20A Package
LCC



ABAQUES

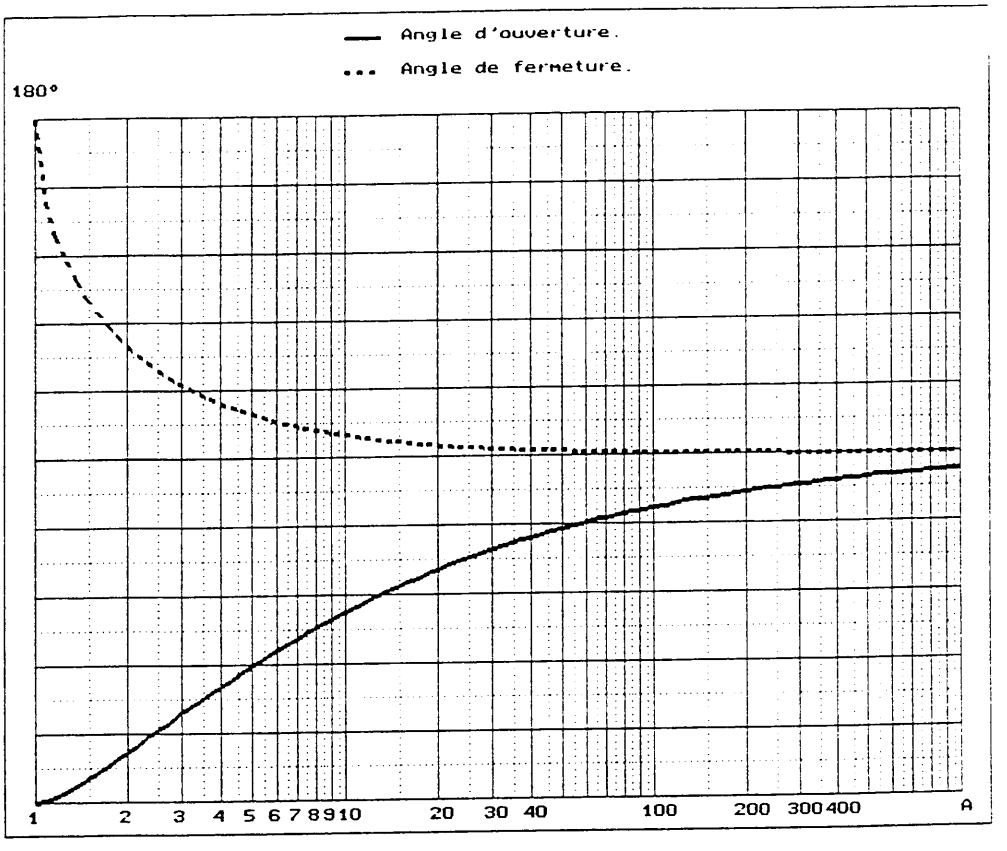
Puissance apparente réduite T(A) en fonction de A



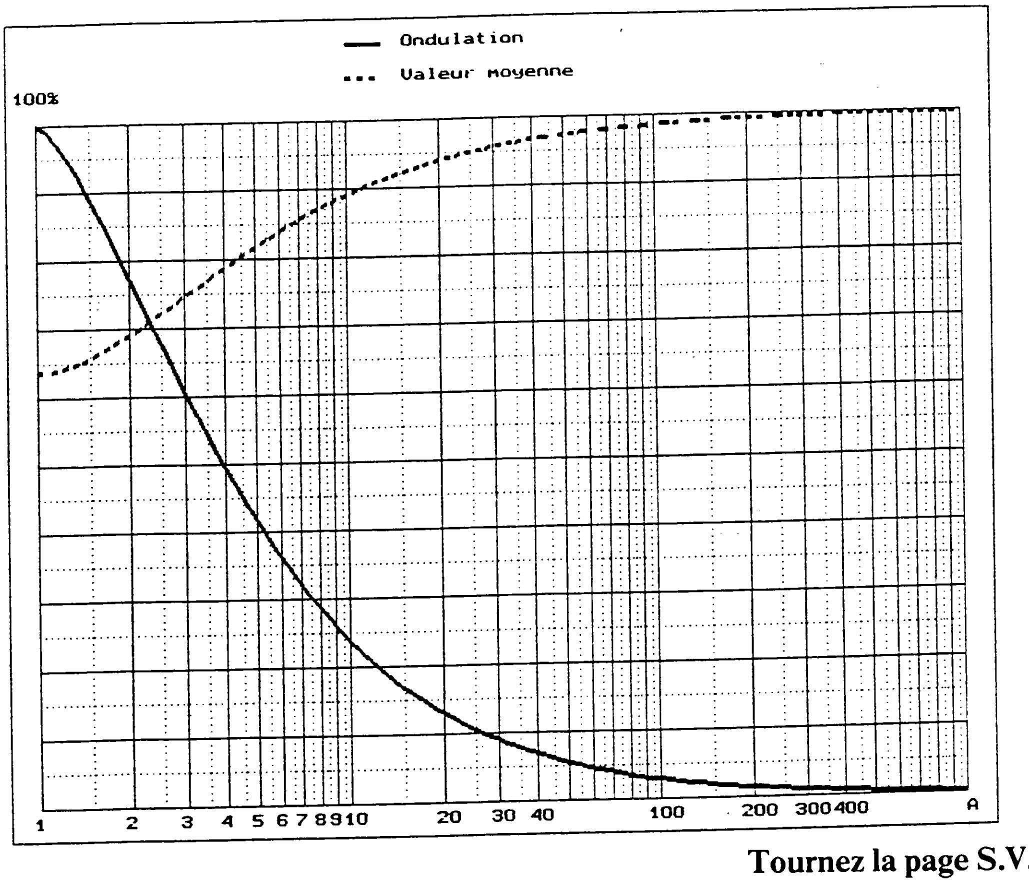
ANNEXE 3

ABAQUES

Angles d'ouverture $\theta 1$ et de fermeture $\theta 2$ fonction de A



Ondulation Δvc/Vs et tension moyenne <vc>/Vs fonction de A



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Annexe 4

Le Bus d'instrumentation IEEE 488 (GPIB)

1. Caractéristiques générales :

Le bus IEE488 ou GPIB est un bus parallèle permettant de relier des appareils de mesure à un calculateur et possédant les caractéristiques principales suivantes :

- 15 appareils au maximum connectés ;
- Câblage en étoile ou en bus sur une longueur maximale de 20 m ;
- 8 lignes de données et 8 lignes de contrôle et de synchronisation ;
- vitesse maximale de 1 Mo/s.

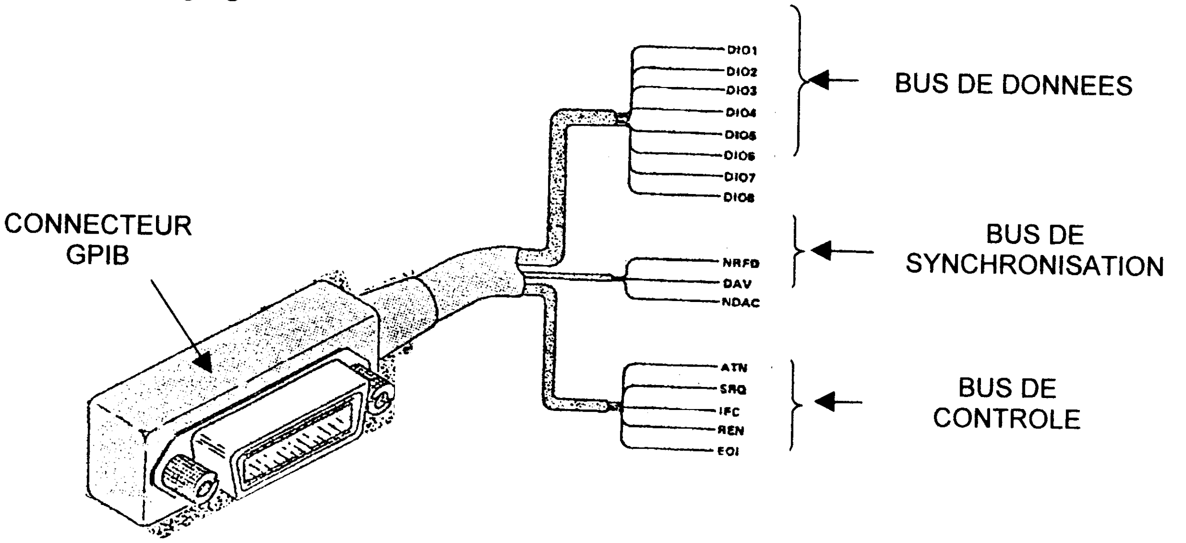
Trois fonctions sont définies sur le bus :

- La fonction **contrôleur**, en général assuré par un calculateur ou un micro-ordinateur, se charge de la gestion des transferts d'information sur le bus.
- La fonction **parleur** (*talker*) est affectée à un appareil à la fois par le contrôleur à un instant donné. Celui-ci envoie ses information aux écouteurs.
- La fonction **écouteur** (*listener*) est attribuée à un ou plusieurs appareils par le contrôleur.

Les échanges peuvent être effectués en mode **commande** (le contrôleur commande les appareils et désigne le parleur et les écouteurs) ou en mode **transfert d'informations** (le parleur envoie ses informations vers les écouteurs)

2. Description physique :

Le bus est physiquement constitué par l'ensemble des câbles de liaison qui transportent les informations d'un appareil à l'autre dans n'importe quel sens. Il s'agit d'un câblage passif de seize lignes, une masse logique, cinq blindages partiels et un blindage général.



Cet ensemble de lignes est composé de trois groupes fonctionnels :

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Annexe 4

a) ***Le bus de données*** : est constitué des lignes DIO1 à DIO8 (DIO = Data In Out) qui servent à transporter les informations proprement dites. Celles-ci peuvent, suivant les circonstances être :

- Des données numériques, alphanumériques ou binaires.
- Des adresses de périphériques.
- Des commandes normalisées (multi-lignes).
- Des mots d'état (*status byte*).

b) ***Le bus de synchronisation (handshake)*** : est composé de trois lignes qui transportent les signaux de contrôle. Ils garantissent la fiabilité du transfert des données circulant sur le bus suivant un protocole de type « poignée de main » *(handshake)*.

Ce protocole possède les particularités suivantes :

- Le transfert des données s'effectue de manière asynchrone. Le taux d'échange s'ajuste automatiquement à la vitesse de l'émetteur et du ou des récepteurs, plus exactement à la vitesse de l'équipement le plus lent.
- Tous les octets sont transmis sur le bus de données suivant ce protocole.
- Un ou plusieurs appareils peuvent accepter les données.
- Lorsque des commandes transitent sur le bus, l'appareil le plus lent déterminent le taux de transfert de ces ordres. Tous les équipements participent à ce protocole.
- La vitesse de transfert peut diminuer, le temps qu'un appareil prenne une lecture et la retourne ensuite pour qu'elle soit entièrement assimilée par le contrôleur.

Les trois lignes du bus sont :

NOM	DESCRIPTION
DAV	DAta Valid (donnée correcte) : cette ligne à l'état bas confirme que les informations présentes sur le bus de données sont valides et peuvent être acceptées en toute sécurité par les équipements concernés. Le contrôleur, comme tout émetteur connecté sur le bus, pilote cette ligne lorsqu'il envoie des octets.
NRFD	Not Ready For Data (pas prêt pour les données) : active à l'état bas, cette ligne permet de signaler qu'un appareil peut ou ne peut pas accepter des informations. Tous les équipements qui reçoivent des commandes, pilotent cette ligne comme les récepteurs auxquels on adresse des données.
NDAC	Not Data ACcepted (données non acceptées) : l'appareil signale, grâce à cette ligne, s'il accepte ou refuse les informations reçues. Une fois encore, tous les équipements sollicités par des commandes contrôlent ce signal, comme les récepteurs destinataires de données. La ligne NDAC ne remonte pas au niveau haut, tant que le dernier et le plus lent des équipements récepteurs n'a pas approuvé les données.

c) ***Le bus de contrôle et commande (contrôle)*** : composé de 5 lignes, il permet à un calculateur spécialisé de gérer les appareils interconnectés. Ces lignes veillent à la circulation ordonnée des informations sur le bus. Il s 'agit de commandes dites u*niligne*, puisqu'elles n'utilisent qu'un seul fil.

Ces cinq lignes sont :

NOM	DESCRIPTION
ATN	**AT**tentio**N** : lors de la validation, tous les instruments deviennent récepteur et participent à la communication. Ils doivent répondre dans un délai de 200 μs. Ce signal signifie aux équipements la présence d'un message de commande ou de donnée sur le bus. Au niveau bas, ATN prévient tous les appareils qu'une commande IEEE 488 se trouve sur le bus (un ordre ou bien une adresse). Seul le contrôleur active cette ligne.
IFC	**I**nter**F**ace **C**lear (Remise à zéro de l'interface) : cette ligne, uniquement pilotée par le contrôleur en charge, permet à ce dernier d'arrêter à tout instant (de manière asynchrone) l'opération en cours sur le bus. Tous les équipements doivent en permanence tester la ligne IFC et répondre, en cas de sollicitation, en 100 μs. Ce signal correspond au *reset* général du bus IEEE 488.
REN	**R**emote **EN**able (pilotage par le bus validé) : son niveau, exclusivement géré par le contrôleur en charge, force chaque appareil concerné à être piloté par le bus
SRQ	**S**ervice **R**e**Q**uest (demande de service) : un appareil utilise cette ligne pour demander la parole et, éventuellement, interrompre l'activité du bus (mise en œuvre d'interruption possible). L'utilisation typique de ce signal, consiste à signaler la disponibilité d'une donnée ou bien avertir le contrôleur d'un problème quelconque sur un instrument. Pour déterminer l'équipement qui réclame son attention, le contrôleur effectue ce que l'on appelle un *polling* (sondage) : il interroge individuellement chaque appareil (*serial poll*) ou bien tous les récepteurs à la fois (*parallel poll*).
EOI	**E**nd **O**r **I**dentify : lorsque la ligne ATN se trouve à l'état haut (FALSE), le contrôleur ou un instrument du bus peut activer la ligne EOI et la passer à l'état haut afin d'indiquer une fin de transmission. • EOI signal la fin des données. • EOI témoigne de la conduction d'un *polling* parallèle. • EOI est activée par l'instrument qui émet.

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Annexe 4

3. Adressage des appareils :

Chaque appareil possède au minimum une adresse d'écouteur (*Listener*) ou de parleur (*Talker*), celle-ci est configurée matériellement (commutateurs) ou logiciellement.
L'adressage des appareils peut être assuré sur deux niveaux, primaire et secondaire. A l'adresse primaire correspond une « fonction simple » mais si celle-ci est « étendue », elle bénéficiera d'un second niveau d'adressage (secondaire). Le système comporte ainsi 31 adresses primaires et autant de secondaires. C'est au contrôleur actif qu'il revient d'adresser les appareils.

Pour cela, il émet en mode commande un octet comportant :

- un bit de parité P (poids fort) ;
- un code sur 2 bits définissant le mode ;
- 5 bits d'adresse.

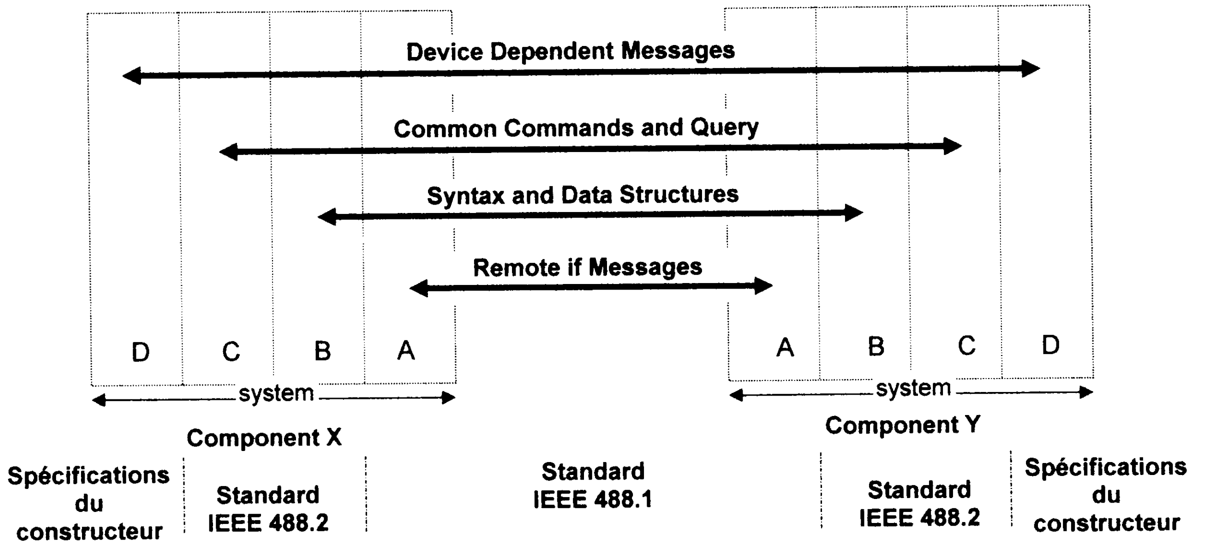
Le code sur deux bits est le suivant :

- 01 indique qu'il s'agit d'une adresse primaire d'écouteur ;
- 10 indique que l'adresse primaire est celle d'un parleur ;
- 11 est formé pour une commande secondaire ;
- 00 pour une commande auxiliaire.

Par exemple, pour un écouteur configuré à l'adresse 9, le code 41 (29 en hexadécimal et 00101001 en binaire) correspondant au caractère ASCII «) » est envoyé par le contrôleur.

Il est évident que si des appareils se voient attribuer une adresse commune, ils seront activés en même temps.
Dans le cas de commandes auxiliaires, un format sur un octet tel que P001XXXX (P étant le bit de parité) est une commande auxiliaire adressée.

4. Normalisation en couches de l'interface IEE 488 :



- **La couche A (*Remote if Messages*)** est la couche la plus basse de l'interface GPIB, elle décrit la partie physique du contrôleur (connecteurs, câblages, signaux électriques...) ainsi qu'un ensemble de commandes de base.
- **Les couche B et C *(Syntax and Data Structures* et *Common Commands and Query*)** représentent les fonctions de communication bas-niveau définis définies par l'IEEE 488.2.
- **La couche D (*Device Dependent Messages*)** définie la syntaxe mise en œuvre par le constructeur pour piloter son équipement, le langage SCPI (*Standard Commands for Programmable Instruments*) en est un exemple.

Les constructeurs fournissent généralement des bibliothèques de fonctions logicielles permettant de transmettre les commandes IEE 488.2 ainsi que les commandes SCPI. La librairie SICL (Standard Instrument Control Library) fournie par HP en est un exemple.

5. Les commandes IEEE 488.1 :

Quatre types de commande peuvent êtres transmises lorsque le bus fonctionne en mode commande (ATN = 1). A chacune de ces commandes correspond un code sur 8 bits.

- Les adresses d'écouteur (LAG : *Listen Address Group*) et de parleur (TAG : *Talken Address Group*) sont décrites précédemment.
- Les commandes multilignes universelles (UCG : *Universel Command Group*)sont reçues par tous les appareils, elles permettent de déclencher une action particulière remise à zéro d'un appareil par exemple).
- Les commandes adressées (ACG : *Addressed Command Group*) concernent les appareils préalablement initialisés comme écouteurs. Elles permettent au contrôleur d'envoyer une commande simultanée, de synchronisation par exemple.
- Les deux commandes non adressées qui peuvent être considérées comme des extensions des adresses d'écouteur et de parleur.

6. Les commandes IEEE 488.2 :

Au niveau supérieur, la norme IEEE 488.2 met en place un certain nombres de commandes acceptées par tous les appareils respectant le standard. Ces commandes sont envoyées sur le bus en mode données (ATN = 0) et correspondent à des chaînes de caractères ASCII (Mnemonic). Certaines commandes sont obligatoires, d'autres optionnelles.

***IDN ?**

IDeNtification query : demande à l'instrument de s'identifier par l'envoi d'un message standard, constitué de quatre champs séparés par des virgules :

- Champ 1 : fabricant Obligatoire,
- Champ 2 : modèle Obligatoire,
- Champ 3 : numéro de série ASCII "0" si non disponible (48 décimal),
- Champ 4 : révision du programme ASCII "0" si non disponible (48 décimal),

Par exemple, HEWLETT-PACKARD, 347A, 2221A01113, A1. La longueur maximale ne peut excéder 72 caractères.

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Annexe 4

***RST**
ReSeT : stoppe toutes les opérations en cours et réinitialise l'appareil dans un état prédéterminé.

***TST ?**
Self Test Query : cette commande ordonne à l'instrument de lancer une procédure d'autotest. Le résultat peut varier de -32 767 à +12 767. Un zéro indique la bonne marche des opérations. La documentation renseignera l'utilisateur sur les causes d'une réponse non nulle.

***OPC**
OPeration complete : demande à l'instrument d'armer le bit 0 dans le registre SESR à la fin du travail en cours. Ainsi, par une programmation adéquate du masque *Service Request Enable Register*, l'équipement déclenchera une demande de service lorsque la commande en cours d'exécution sera achevée.

***0PC ?**
OPeration Complete query : cette instruction impose à l'appareil de placer la valeur ASCII "1" (49 en décimal) dans son tampon de sortie, lorsqu'il a terminé tout travail en cours.

***WAI**
WAIt tu continue : cet ordre force l'appareil à attendre la fin des commandes qu'il a entreprises. Par exemple, lancer une opération de calibration, patienter jusqu'à sa fin par *WAI, puis lancer une mesure.

***CLS**
CLear Status : cet ordre remet à zéro le mot d'état ainsi que toutes les structures de données qui lui sont associées, comme l'Event status Register par exemple. Il initialise également tous les tampons, à l'exception de celui de sortie(Output Queue).

***ESE Standard**
Event status Enable : la commande *ESE permet de sélectionner la participation des événements au bit final ESB. Par exemple, *ESE 36 valide les bits 5 (*command Error*) et 2 *(Query Error*).

***ESE ?**
Event status Enable query : cet ordre lit et retourne le contenu du registre SESR. La valeur évolue entre 0 et 255.

***ESR ?**
Event status Register query : cette commande expédie à l'utilisateur la valeur associée au registre d'événement. Son décodage ultérieur renseignera sur les actions entreprises au sein de l'instrument. Sa lecture initialise à zéro ce registre.

***SRE**
Service Request Enable : cet ordre, suivi d'un masque, déterminera le ou les bits du mot d'état qui déclencheront une demande de service. Par exemple, pour permettre au bit 4 (*Message Available* MAV) de valider un SRQ, on expédiera *SRE 16.

Annexe 5

Extrait de la bibliothèque de fonctions SICL (*Standard Instrument Control Library*)

IONERROR

C Syntax

```
#include <sicl.h>

int ionerror(proc);
void ( *proc)(id, error);
        INST id;
        int error;
```

Description

The ionerror function is used to install a SICL error handler. Many of the SICL functions can generate an error. When a SICL function errors, it typically returns a special value such as a NULL pointer, zero, or a non-zero error code. A process can specify a procedure to execute when a SICL error occurs. This allows your process to ignore the return value and simply permit the error handler to detect errors and do the appropriate action.

The error handler procedure executes immediately before the SICL function that generated the error completes its operation. There is only one error handler for a given process which handles all errors that occur with any session established by that process.

On operating systems that support multiple threads, the error handler is still per-process. However, the error handler will be called in the context of the thread that caused the error.

Error handlers are called with the following arguments:

```
void  proc (id, error);
INST id;
int error;
```

The id argument indicates the session that generated the error.

The error argument indicates the error that occurred. See Appendix A for a complete description of the error codes.

NOTE : The INST id that is passed to the error handler is the same INST id that was passed to the function that generated the error. Therefore, if an error occurred because of an invalid INST id, the INST id passed to the error handler is also invalid. Also, if iopen generates an error before a session has been established, the error handler will be passed a zero (0) INST id.

Return Value

This function returns zero (0) if successful, or a non-zero error number if an error occurs.

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IOPEN

Supported sessions: device, interface, commander

C Syntax

```
#include <sicl.h>

INST iopen (addr);
char  *addr
```

Description

Before using any of the SICL functions, the application program must establish a session with the desired interface or device. Create a session by using the iopen function.

This function creates a session and returns a session identifier. Note that the session identifier should only be passed as a parameter to other SICL functions. It is not designed to be updated manually by you.

The addr parameter contains the device, interface, or commander address.

An application may have multiple sessions open at the same time by creating multiple session identifiers with the iopen function.

NOTE : If an error handler has been installed (see ionerror), and an iopen generates an error before a session has been established, the handler will be called with the session identifier set to zero (0). Caution must be used if using the session identifier in an error handler.

Also, it is possible for an iopen to succeed on a device that does not exist. In this case, other functions (such as iread) will fail with a nonexistent device error.

Creating A Device Session :

To create a device session, specify a particular interface name followed by the device's address in the addr parameter. For more information on addressing devices, see the section on "Addressing Device Sessions" in the "Programming with HP SICL" chapter of the HP SICL User's Guide.

C example:

```
INST dmm;
dmm = iopen("hpib,15");
```

Annexe 5

ITIMEOUT

Supported sessions: device, interface, commander

C Syntax

```
#include <sicl.h>

int itimeout (id, tval);
INST id;
long tval;
```

Description

The itimeout function is used to set the maximum time to wait for an I/O operation to complete. In this function, tval defines the timeout in milliseconds. A value of zero (0) disables timeouts.

NOTE : Not all computer systems can guarantee an accuracy of one millisecond on timeouts. Some computer clock systems only provide a resolution of 1/50th or 1/60th of a second. Other computers have a resolution of only 1 second. Note that the time value is always rounded up to the next unit of resolution.

Return Value

For C programs, this function returns zero (0) if successful, or a non-zero error number if an error occurs.

IPRINTF

Supported sessions: device, interface, commander
Affected by functions: ilock, itimeout

C Syntax

```
#include <sicl.h>

int iprintf (id, format [,arg1][,arg2][,...]);
int isprintf (buf, format [,arg1][,arg2][,...]);
int ivprintf (id, format, va_list ap);
int isvprintf (buf, format, va_list ap);
INST id;
char  *buf;
const char  *format;
param arg1, arg2, ...;
va_list ap;
```

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Annexe 5

Description

These functions convert data under the control of the format string. The format string specifies how the argument is converted before it is output. If the first argument is an INST, the data is sent to the device to which the INST refers. If the first argument is a character buffer, the data is placed in the buffer.

The format string contains regular characters and special conversion sequences. The iprintf function sends the regular characters (not a % character) in the format string directly to the device. Conversion specifications are introduced by the % character. Conversion specifications control the type, the conversion, and the formatting of the arg parameters.

NOTE : The formatted I/O functions, iprintf and ipromptf, can re-address the bus multiple times during execution. This behavior may cause problems with instruments which do not comply with IEEE 488.2.

Re-addressing occurs under the following circumstances:

After the internal buffer fills. (See isetbuf.)
When a \n is found in the format string in C/C++, or when a Chr$(10) is found in the format string in Visual BASIC.
When a %C is found in the format string.

This behavior affects only non-IEEE 488.2 devices on the GPIB interface.

Use the special characters and conversion commands explained in the following subsections to create the format string's contents.

Return Value

This function returns the total number of arguments converted by the format string.

IPROMPTF

Supported sessions: device, interface, commander
Affected by functions: ilock, itimeout

C Syntax

```
#include <sicl.h>

int ipromptf (id, writefmt, readfmt[, arg1][, arg2][, ...]);
int ivpromptf (id, writefmt, readfmt, ap);
INST id;
const char  *writefmt;
const char  *readfmt;
param arg1,arg2,...;
va_list ap;
```

Annexe 5

Description

The ipromptf function is used to perform a formatted write immediately followed by a formatted read. This function is a combination of the iprintf and iscanf functions. First, it flushes the read buffer. It then formats a string using the writefmt string and the first n arguments necessary to implement the prompt string. The write buffer is then flushed to the device. It then uses the readfmt string to read data from the device and to format it appropriately.

The writefmt string is identical to the format string used for the iprintf function.

The readfmt string is identical to the format string used for the iscanf function. It uses the arguments immediately following those needed to satisfy the writefmt string.

This function returns the total number of arguments used by both the read and write format strings.

ICLOSE

Supported sessions: device, interface, commander

C Syntax

```
#include <sicl.h>

int iclose (id);
INST id;
```

Description

Once you no longer need a session, close it using the iclose function. This function closes a SICL session. After calling this function, the value in the id parameter is no longer a valid session identifier and cannot be used again.

NOTE : Do not call iclose from an SRQ or interrupt handler, because it may cause unpredictable behavior.

Return Value

For C programs, this function returns zero (0) if successful, or a non-zero error number if an error occurs.

ISCANF

Supported sessions: device, interface, commander
Affected by functions: ilock, itimeout

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Annexe 5

C Syntax

```
#include <sicl.h>

int iscanf (id, format [,arg1][,arg2][,...]);
int isscanf (buf, format [,arg1][,arg2][,...]);
int ivscanf (id, format, va_list ap);
int isvscanf (buf, format, va_list ap);
INST id;
char  *buf;
const char  *format;
ptr arg1, arg2, ...;
va_list ap;
```

Description

These functions read formatted data, convert it, and store the results into your args. These functions read bytes from the specified device, or from buf, and convert them using conversion rules contained in the format string. The number of args converted is returned.

Also see Notes on Using iscanf for more information.

The format string contains:

White-space characters, which are spaces, tabs, or special characters.
An ordinary character (not %), which must match the next non-white-space character read from the device.
Format conversion commands.

Use the white-space characters and conversion commands explained in the following subsections to create the format string's contents.

Restrictions Using ivscanf in Visual BASIC
White-Space Characters for C/C++
White-Space Characters for Visual BASIC
iscanf Format Conversion Commands
Examples of iscanf Format Conversion Commands
List of iscanf conv chars
Data Conversions

Return Value

This function returns the total number of arguments converted by the format string.

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Programme d'initialisation et d'identification Idn.c

```
////////////////////////////////////////////////////////////////////
// The following simple demonstration program uses the Standard
// Instrument Control Library to query an HP-IB instrument for
// an identification string and then prints the result.
// Edit the DEVICE_ADDRESS line below to specify the address of the
// device you want to talk to.  For example:
//
//    hpib7,0   - refers to an HP-IB device at bus address 0
//              connected to an interface named "hpib7" by the
//              I/O Config utility.
//    hpib7,9,0 - refers to an HP-IB device at bus address 9,
//              secondary address 0, connected to an interface
//              named "hpib7" by the I/O Config utility.
// Note that this program is meant to be built either as a WIN16
// QuickWin or EasyWin program on Windows 95 or Windows 3.1, or as
// a WIN32 console application on Windows 95 or Windows NT.  Also
// note that WIN16 programs must be compiled with the Large memory
// model.
////////////////////////////////////////////////////////////////////

#include <stdio.h>          // for printf()
#include "sicl.h"             // Standard Instrument Control Library routines

#define DEVICE_ADDRESS "hpib7,0"   // Modify this line to match your setup

void main(void)
{
  INST id;              // device session id
  char buf[256] = { 0 };         // read buffer for idn string

// Install a default SICL error handler that logs an error message and
  // exits.  On Windows 95 and Windows 3.1, view messages with the SICL
  // Message Viewer, and on Windows NT use the Windows NT Event Viewer.
  ionerror(I_ERROR_EXIT);

  // Open a device session using the DEVICE_ADDRESS
  id = iopen(DEVICE_ADDRESS);

  // Set the I/O timeout value for this session to 1 second
  itimeout(id, 1000);

  // Write the *RST string (and send an EOI indicator) to put the instrument
  // in a known state.
  iprintf(id, "*RST\n");

  // Write the *IDN? string and send an EOI indicator, then read
  // the response into buf.
  // For WIN16 programs, this will only work with the Large memory model
  // since ipromptf expects to receive far pointers to the format strings.

  ipromptf(id, "*IDN?\n", "%t", buf);
  printf("%s\n", buf);

  iclose(id);
}
```

Annexe 7 **1/1**

Extrait du jeu de commandes du multimètre

Les commandes IEE 488.2 ou les commandes SCPI spécifiques au multimètres sont envoyées sous forme de chaînes de caractères. Un espace entre une commande et son argument est requis.

COMMANDE	*DESCRIPTION*
VAC	Positionne le multimètre en mode Volts alternatifs.
RANGE<gamme>	La mesure est forcée à la gamme indiquée. <gamme> est un nombre compris entre 1 et 7 Gammes disponibles en vitesse de mesure rapide et moyenne : Gamme 1 2 3 4 5 Tension 300mV 3V 30V 300V 1000VDC Gammes disponibles en vitesse de mesure lente : Gamme 1 2 3 4 5 Tension 100mV 1V 10V 100V 1000VDC
RATE <vitesse>	Positionne la vitesse de mesure sur <vitesse>. La <vitesse> est de niveau 'S' pour lent (2,5 lectures/seconde), 'M' pour moyen (5 lectures/seconde) ou 'F' pour rapide (20 lectures/seconde). 'S', 'M' et 'F' peuvent être envoyées en lettres majuscules ou minuscules. Toute autre valeur introduite pour la <vitesses> génère une erreur.
***TRG**	Entraîne le déclenchement d'une mesure par le multimètre lorsque celui-ci est analysé.
VAL1?	Le multimètre renvoie la valeur mesurée et indiquée à l'affichage. Si l'affichage est sans information, la mesure déclenchée suivante est renvoyée.