# SCHEMATIC INDEX (page 1)

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12/30/97
R1 (SEE CHART)

ELECTRONIC PRESSURE CONTROL PUSHPUTTON CIRCUITS.
TWO POSSIBLE CIRCUITS.
ALSO SEE EPC BOARD SCHEMATICS.

+12V
P1 20K

LOCAL SETPOINT PUSHPUTTON

PHONE JACK TO EPC BOARD J2

LED (SEE CHART)

R1 (SEE CHART)

DELCD AND ECD PUSHPUTTON CIRCUITS.
ALSO SEE AMP BOARD SCHEMATICS.

+12V
P1 20K

LOCAL SETPOINT PUSHPUTTON

PHONE JACK TO AMP BOARD J1

ACTUAL PUSHPUTTON

PHONE JACK TO DISPLAY BUFFER AMP SEE PAGE 2

LED (SEE CHART)

R1 (SEE CHART)

PID AND FPD PUSHPUTTON CIRCUITS.
ALSO SEE HVIVO BT BOARD SCHEMATICS.

+12V
P1 20K

ST OR S8

PID OR FPD SPOT ON/OFF SWITCH

LOCAL SETPOINT PUSHPUTTON

PHONE JACK TO HVIVO BT BOARD J2

ACTUAL PUSHPUTTON

PHONE JACK TO DISPLAY BUFFER AMP SEE PAGE 2

LED (SEE CHART)

R1 (SEE CHART)

HEATED ZONE PUSHPUTTON CIRCUIT.
ALSO SEE HEAT BOARD SCHEMATICS.

+12V
P1 20K

LOCAL SETPOINT PUSHPUTTON

PHONE JACK TO HEAT BOARD

LED (SEE CHART)

POWER SUPPLY SECTION

DISPLAY BOARD GROUND

FROM AMP BOARD

HIGH (BRUNCH)

 LOW (BRUNCH)

DISPLAY BOARD GROUND

THE INPUT ON THIS BOARD OPERATE USING +12V ON PIN 4
AND GROUND ON PIN 11.

110 DISPLAY-B
SCHEMATICS

Date: 12/20/97 By: R. Fenske
THE DUAL OVEN BOARD #2 PROVIDES CONTROL
OF OVEN HEATING AND COOLING. THIS PAGE
DEPicts THE POWER SUPPLY CIRCUIT AND
JITTER CIRCUIT.
SEE PAGE TWO FOR OVEN
HEATING AND COOLING CIRCUITS.

CHASSIS COOLING
FAN CIRCUIT
(NOT USED)

DUAL OVEN CONFIGURATION REQUIRES
THE USE OF A STANDARD OVEN PCB
FOR OVEN #1 AND A SECOND
OVEN PCB WITHOUT THE CHASSIS COOLING
FAN CIRCUIT FOR OVEN #2. IF NECESSARY,
A STANDARD OVEN BOARD MAYBE USED FOR
OVEN #2, PROVIDED THAT THE CHASSIS
COOLING CIRCUIT IS LEFT UN-USED.
OVEN-F #2 IS THE SCHEMATIC DIAGRAM
FOR THE OVEN BOARD WITHOUT
THE CHASSIS COOLING CIRCUIT; AS USED
FOR THE SECOND OVEN IN A DUAL
OVEN CONFIGURATION.

VACUUM PUMP OPTION
USES THIS CIRCUIT

OPTIONAL SOLENOID CIRCUIT

FROM AC DISTRIBUTION BOARD
SWITCHED AC1+ (R13)
IN VAO (B11)
GROUND (GND)
TO VAO (GND)
GROUND
SWITCHED AC1- (R15)

POWER SUPPLY SECTION

JITTER CIRCUIT

THE LM324s IN THIS
CIRCUIT OPERATE
USING +12V ON PIN 4
AND -12V ON PIN 11

CAUTION: AC1+ AND AC1
ARE HAZARDOUS VOLTAGES
AND ARE PRESENT ON THIS AND OTHER
CIRCUIT BOARDS. shelter THE E.G.
POWER IS ON.
HEAT CIRCUIT #1

THE HEAT BOARD PROVIDES TEMPERATURE CONTROL OF HEATED ZONES IN THE G.C. (TCE, TAM BLOCK, HEATED INJECTOR, ETC.). EACH HEAT BOARD CONTAINS UP TO THREE TEMPERATURE CONTROL CIRCUITS.

THIS PAGE DEPICTS THE SCHEMATIC OF HEAT CIRCUIT #1. SEE THE NEXT PAGE FOR HEAT CIRCUITS #2 AND #3.
This page depicts the schematics of heat circuits #2 and #3 and of the optional solenoid circuit. The differences between heat circuits #1, #2 and #3 are:

- Circuit #1 has an optional A/D enable of the heat zone and an optional gate signal input for an external triac.
- Also, the summing circuit in each have different op-amp pinouts: heat circuit #1 uses U3 pin 1 and pin 7 outputs. Heat circuit #2 uses U5 pin 1 and pin 7 outputs. Heat circuit #3 uses U5 pin 14 and pin 8 outputs.

Page 2 of 2

Filename: heat-g pg2.tcw

Date: 11/20/97  By: R. Fenske
Rev. Date: 12/11/92  By: M. WATTS
POWER SUPPLY SECTION OF AMP BOARD

POWER SUPPLY #2
FROM AC DISTRIBUTION BOARD OR TRANSFORMER PINS 6, 7 & 8
28 VAC #2 GROUND #2 28 VAC #2
BR1
AC + AC -
BRIDGE RECTIFIER BR905D
C10 1000 uF 35 V
C12 1000 uF 35 V
2
C11 0.1 uF
C13 10 uF 50 V
C14 0.1 uF
VR1 7812 REG.
C11 0.1 uF
+12 V
-12 V
7812 REG.
VR2
POWER SUPPLY #2 IS A +12 V AND -12 V SUPPLY BIASED 24 VOLTS ABOVE GROUND POTENTIAL BY VR3 OF THE BIAS POWER SUPPLY. THIS SUPPLY IS USED BY THE FID, PID, DELCD AND FPD DETECTOR AMPLIFIERS.

BIAS POWER SUPPLY
FROM AC DISTRIBUTION BOARD OR TRANSFORMER PINS 3 & 2
24 VAC BIAS
BR2
AC + AC -
BRIDGE RECTIFIER BR905D
C15 470 uF 50 V
C16 0.1 uF
VR3 7824 REG.
24 VOLT BIAS VOLTAGE
THE BIAS POWER SUPPLY MAINTAINS A 24 VOLT DC POTENTIAL BETWEEN GROUND #1 AND GROUND #2.

POWER SUPPLY #1
FROM AC DISTRIBUTION BOARD OR TRANSFORMER PINS 3, 4 & 5
28 VAC #1 GROUND 28 VAC #1
BR3
AC + AC -
BRIDGE RECTIFIER BR905D
C17 1000 uF 35 V
C19 1000 uF 35 V
C18 0.1 uF
C20 10 uF 50 V
C21 0.1 uF
VR4 7812 REG.
C18 0.1 uF
+12 V
-12 V
7812 REG.
VR5
POWER SUPPLY #1 IS THE PRIMARY POWER SOURCE FOR ALL FUNCTIONS OF THE AMP BOARD AND ALSO PROVIDES +12 V AND -12 V TO THE A/D BOARD. ONLY THE TCD CIRCUIT REQUIRE AN ADDITIONAL AC VOLTAGE INPUT. SEE PAGE 2.

AMPLIFIER BOARD LAYOUT
CHASSIS GROUND 28 VAC #1 GROUND
10 VOLT AC TRANSFORMER
10 VOLT AC BOARD GROUND FROM CHASSIS GROUND BIQU
ECD SECTION TCD SECTION DELCD AMP P/D AMP FID AMP FPD AMP

AMP-E SCHEMATIC
Page 1 of 7
Date: 12/20/97 By: R. Fenske
Rev. Date: 9/27/02 By: M. Watts
Filename: Amp-a1.tcw
SCHMATIC

AMP-E

DIGITIZATION BY THE AD BOARD.
FROM THE COLLECTOR PRIOR TO THE CIRCUITRY AMPLIFIES THE SIGNAL

NOTE MODEL 30 STUDENT TO AMP BOARD

DIGITIZATION BY THE AD BOARD.
FROM THE COLLECTOR PRIOR TO THE CIRCUITRY AMPLIFIES THE SIGNAL

NOTE MODEL 30 STUDENT TO AMP BOARD

TO PROVIDE A LOW GAINED IN FILTERED ACROSS R3, THIS RESISTANCE IS CONSIDERED IN THE CIRCUITRY FOR THE AMPLIFIER
This page depicts the schematics.
THE EPCHI BOARD PROVIDES ELECTRONIC PRESSURE CONTROL OF ONE GAS (page1) AND ALSO PROVIDES THE HIGH VOLTAGE NEEDED TO POWER EITHER THE PID LAMP OR THE FPD PHOTO-MULTIPLIER TUBE (page2). AN EXTERNAL INPUT (10mV/PSI) IS NECESSARY FOR COMPUTER CONTROL OF THE EPC.

THE LM324s IN THIS CIRCUIT OPERATE USING +12V ON PIN 4, GND ON PIN 6, AND -12V ON PIN 11.
CIRCUIT #1 IS THE ONLY SOLENOID CIRCUIT THAT DOES NOT HAVE A NORMALLY CLOSED INPUT.

S1 SOLENOID CIRCUIT

+12V

US MOC3030
(220V-MOC3041)

R21

100 OHM 1 WATT

SWITCHED AC HOT INPUT (BLUE)

R22

100 OHM 1 WATT

SWITCHED ACC INPUT (BROWN)

SCR2 Q6004

AC OUTPUT

POWER SUPPLY

SOLHEAT-A CIRCUIT BOARD LAYOUT

SOLHEAT-A SCHEMATIC

SOLHEAT-A SCHEMATIC

S2 SOLENOID CIRCUIT

S3 SOLENOID CIRCUIT

S4 SOLENOID CIRCUIT

S5 SOLENOID CIRCUIT

S6 SOLENOID CIRCUIT

THIS PAGE DEPICTS THE SCHEMATICS OF SOLENOID CIRCUITS #1 THRU #6 AND OF THE SINGLE HEAT CIRCUIT.
THE C.G. CHASSIS.
ON THE RIGHT SIDE OF 
BOARDS INSTALLED 
CHROMATOGRAPHS AND 
MODEL 310 GAS 
MOST MODEL 810 
CHROMATOGRAPH. 
INSIDE YOUR GAS 
203 A/D BOARDS 
MODEL 202 AND 
MADE TO THE 
CONNECTIONS 
INTERNAL 
DEPicts THE 
THIS DRAWING
FEATURES
- Low Cost
- Operates with Type J (AD596) or Type K (AD597) Thermocouples
- Built-in Set-Point Compensation
- Temperature Proportional Operation - 10mV/°C
- Temperature Set-Point Operation - ON/OFF
- Programmable Switching Hysteresis
- High Impedance Differential Input

PRODUCT DESCRIPTION
The AD596/AD597 is a monolithic temperature set-point controller which has been optimized for use at elevated temperatures such as those found in oven control applications. The device cold junction compensates and amplifies a type J or K thermocouple input to derive an internal signal proportional to temperature. The internal signal is then compared with an externally applied set-point voltage to yield a low impedance switched output voltage. Dead-Band or switching hysteresis can be programmed using a single external resistor. Alternately, the AD596/AD597 can be configured to provide a voltage output (10mV/°C) directly from a type J or K thermocouple signal. It can also be used as a stand-alone voltage output temperature sensor.

The AD596/AD597 can be powered with a single supply from +5V to +30V, or dual supplies up to a total span of 36V. Typical quiescent supply current is 100μA which minimizes self-heating errors.

The AD596/AD597 includes a thermocouple failure alarm that indicates an open thermocouple lead when operated in the temperature proportional measurement mode. The alarm output has a flexible format which can be used to drive relays, LEDs or TTL logic.

The device is packaged in a reliability qualified, cost effective 10-pin metal can and is trimmed to operate over an ambient temperature range from +25°C to +100°C. Operation over an extended ambient temperature range is possible with slightly reduced accuracy. The AD596 will amplify thermocouple signals covering the entire -200°C to +760°C temperature range recommended for type J thermocouples while the AD597 can accommodate -200°C to +1250°C type K inputs.

The AD596/AD597 has a calibration accuracy of ± 4°C at an ambient temperature of 60°C and an ambient temperature stability specification of 0.05°C/°C from +25°C to +100°C. If higher accuracy, or a lower ambient operating temperature is required, either the AD584 (J thermocouple) or AD593 (K thermocouple) should be considered.

PRODUCT HIGHLIGHTS
1. The AD596/AD597 provides cold junction compensation and a high gain amplifier which can be used as a set-point comparator.
2. The input stage of the AD596/AD597 is a high quality instrumentation amplifier that allows the thermocouple to float over most of the supply voltage range.
3. Linearization not required for thermocouple temperatures close to 175°C (+100°C to +540°C for AD596).
4. Cold junction compensation is optimized for ambient temperatures ranging from +25°C to +100°C.
5. In the stand-alone mode, the AD596/AD597 produces an output voltage that indicates its own temperature.

Protected by U.S. Patent No. 4,029,974.
Ultra-Low Bias Current Operational Amplifier

OP-80

FEATURES

- Ultra-Low Bias Current:
  - 150 femtoamps Typ at +25°C
  - 300 femtoamps Typ at +85°C
  - 500 femtoamps Typ at +125°C

- True Single Supply Operation
  - Common-Mode Range Includes Ground
  - Output Swings to Within 200μV of Ground Without Pulldown Resistors
- Low Supply Current: 325μA Max
- Lower Cost Alternative to AD649 and CPA128
- Low Cost
- Inputs Protected Against 700V of Static Discharge
- Available in Die Form

APPLICATIONS

- Electrometer Amplifier Input Stage
- Photodiode and Infrared Detector Preamplifier
- Chemical and Gas Analyzers
- pH Probe Buffer Amplifier
- Fire Detectors
- High Voltage Voltmeters
- Charge Amplifiers

GENERAL DESCRIPTION

The OP-80 is a low cost CMOS operational amplifier offering exceptionally low input currents over a wide operating temperature range. Input current is typically 150 femtoamps at 25°C and increases to only 300 femtoamps at +85°C, with exceptionally high common-mode and differential input impedances. Incorporating a novel input protection design, the OP-80 achieves over 700V of ESD protection while maintaining very low input current.

For systems demanding both high performance at low supply voltages and high input impedances, the OP-80 is a powerful design tool. It is ideal for use in electrometers, portable medical instrumentation, chemical analyzers, smoke detectors, and sensitive current-to-voltage conversion circuits for photodiodes.

The low supply current minimizes thermal power dissipation, virtually eliminating the effects of chip self-heating. The OP-80’s CMOS design gives a good speed/power ratio, permitting a

PIN CONNECTIONS

8-PIN PLASTIC DIP (P-Suffix)
8-PIN SO (S-Suffix)
TO-99 (J-Suffix)
Precision
INSTRUMENTATION AMPLIFIER

FEATURES
- LOW OFFSET VOLTAGE: 50μV max
- LOW DRIFT: 0.25μV/°C max
- LOW INPUT BIAS CURRENT: 2nA max
- HIGH COMMON-MODE REJECTION: 
  115dB min
- INPUT OVER-VOLTAGE PROTECTION: ±40V
- WIDE SUPPLY RANGE: ±2.25 to ±18V
- LOW QUIESCENT CURRENT: 3mA max
- 8-PIN PLASTIC AND CERAMIC DIP, SOL-16

APPLICATIONS
- BRIDGE AMPLIFIER
- THERMOCOUPLE AMPLIFIER
- RTD SENSOR AMPLIFIER
- MEDICAL INSTRUMENTATION
- DATA ACQUISITION

DESCRIPTION
The INA114 is a low cost, general purpose instrumentation amplifier offering excellent accuracy. Its versatile 3-op amp design and small size make it ideal for a wide range of applications.

A single external resistor sets any gain from 1 to 10,000. Internal input protection can withstand up to ±40V without damage.

The INA114 is laser trimmed for very low offset voltage (50μV), drift (0.25μV/°C) and high common-mode rejection (115dB at G = 1000). It operates with power supplies as low as ±2.25V, allowing use in battery operated and single 5V supply systems. Quiescent current is 3mA, maximum.

The INA114 is available in 8-pin plastic and ceramic DIPs, and SOL-16 surface-mount packages, specified for the −40°C to +85°C temperature range.
For Immediate Assistance, Contact Your Local Salesperson

INA117

High Common-Mode Voltage DIFFERENCE AMPLIFIER

FEATURES
- COMMON-MODE INPUT RANGE: ±200V (Vc = ±15V)
- PROTECTED INPUTS: ±500V Common-Mode
  ±500V Differential
- UNITY GAIN: 0.02% Gain Error max
- NONLINEARITY: 0.001% max
- CMRR: 86dB min

APPLICATIONS
- CURRENT MONITOR
- BATTERY CELL-VOLTAGE MONITOR
- GROUND BREAKER
- INPUT PROTECTION
- SIGNAL ACQUISITION IN NOISY ENVIRONMENTS
- FACTORY AUTOMATION

DESCRIPTION
The INA117 is a precision unity-gain difference amplifier with very high common-mode input voltage range. It is a single monolithic IC consisting of a precision op amp and integrated thin-film resistor network. It can accurately measure small differential voltages in the presence of common-mode signals up to ±200V. The INA117 inputs are protected from momentary common-mode or differential overloads up to ±500V.

In many applications, where galvanic isolation is not essential, the INA117 can replace isolation amplifiers. This can eliminate costly isolated input-side power supplies and their associated ripple, noise and quiescent current. The INA117's 0.001% nonlinearity and 200kHz bandwidth are superior to those of conventional isolation amplifiers.

The INA117 is available in 8-pin plastic mini-DIP and SO-8 surface-mount packages, specified for the 0°C to +70°C temperature range. The metal TO-99 models are available specified for the −25°C to +85°C and −55°C to +125°C temperature range.
FEATURES

- Very small, ideal for thru/behind the panel or PC board mounting
- Full size (0.56") digit height
- Packaged in a 12-pin plastic DIP, with a color filter case (0.9"H x 2.1"W x 0.5"D)
- Available in many bright LED colors: red, orange, amber, yellow, green, blue, and aqua
- Super bright versions available
- Low power 50mW models available
- Differential inputs with optional ranges of ±200 mV, ±3V, and ±20V dc
- Factory calibrated to within ±1 count, no external adjustments necessary
- Autozero A/D converter for long term stability with no adjustments
- A +5V supply is the only power required
- "Display Test" pin available
- User-selectable decimal point placement
- Fully encapsulated package well suited for harsh environments
- Many optional support products to cover virtually all possible applications
- Installation tools for easy prototyping available: cut-out punch, retaining clip inserter, evaluation board

GENERAL DESCRIPTION

The DMS-30PC Series is a line of fully operational, self-contained and complete 3 1/2 digit voltimeters. The very small size of these digital voltmeters has been achieved by integrating the display and converter circuitry into one assembly, using the most modern microelectronic hybrid packaging techniques.

The result is a very small and solid digital voltmeter which can be handled like a component unlike awkward PC boards or conventional meters housed in plastic boxes.

CMR to 86 dB, high impedance, differential input, overvoltage protection (to ±250V dc), and a built-in, high stability, double regulated reference circuit allows for extreme accuracy (0.05%, ±1 digit), repeatability and a very long MTBF.

The large (0.56") 3 1/2 digit LED display is available in a wide variety of colors including; red, orange, amber, yellow, green, and blue to suit every application. The DMS-30PC Series meters are available in three voltage input ranges: ±200 mV (DMS-30PC-0), ±2V dc (DMS-30PC-1), and ±20V dc (DMS-30PC-2).

Input impedances are 1,000 megohms for both the ±200 mV and ±2V dc models and 1 megohm for the ±20V dc model, minimizing circuit loading. A single +5V dc supply (no other parts required) makes the DMS-30PC Series fully operational over a very broad temperature range of 0 to +80 °C.

The DMS-30PC Series is ideal for high performance, high reliability measurement systems where low cost and ease of use are paramount.

The built-in bezel, low power drain, fully encapsulated (plastic) case, and small footprint with large LED display were designed for direct PC board mounting, panel mount application, and mobile/portable instrumentation.

APPLICATIONS

- Board-level diagnostics
- Weigh scales
- Automatic test equipment
- Avionics displays
- Lab/test equipment
- Digital thermometers
- Harsh environment usage
- Process monitoring
- Portable/mobile instruments

Figure 1. DMS-30PC Simplified Block Diagram
Panel Cutout Dimensions and Optional Bezel Assembly

MECHANICAL DIMENSIONS

INCHES

Recommended printed circuit board finished hole diameter is 0.042 (1.067), ±0.002 (0.051)

Mounting Clip

ORDERING INFORMATION

DMS-30PC-X-XX

INPUT RANGE

0 = ±200mV
1 = ±2V
2 = ±20V

LED COLOR

YS = Yellow
OS = Orange
AS = Amber
BS = Blue
RS = Red
GS = Green
DS = Aqua
RH = High Intensity Red
RL = Low Power Red
QL = Low Power Green
OL = Low Power Orange

ACCESSORIES

RN-DMS
DMS-30-CP
DMS-BZL1
DMS-BZL2

Gain/Offset potentiometer kit for DMS-EB, DMS-EB-AC/DC, and DMS-EB-DC/DC (see below)
Panel cutout punch
DMS-30 Bezel Assembly
DMS-30 Bezel Assembly with NEMA 4 gasket

ADD-ON APPLICATION BOARDS

DMS-EB
DMS-EB-HTB
DMS-EB-DC/DC
DMS-EB-TCJ
DMS-EB-TCK
DMS-EB-RMS
DMS-EB-AC/DC
DMS-EB-LP

Multipurpose (4-20mA, gain/offset adjust)
High accuracy temperature probe sensing for 200mV models
Provides isolated +5V power
J-type thermocouple inputs for ±2V models
K-type thermocouple inputs for ±2V models
For true RMS measurements of AC voltages
For AC line-powered applications
For 4-20mA loop-powered applications

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LM124/LM224/LM324/LM2902
Low Power Quad Operational Amplifiers

General Description
The LM124 series consists of four independent, high gain, internally frequency compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.

Application areas include transducer amplifiers, DC gain blocks and all the conventional op amp circuits which now can be more easily implemented in single power supply systems. For example, the LM124 series can be directly operated off of the standard ±5V power supply voltage which is used in digital systems and will easily provide the required interface electronics without requiring the additional ±15V power supplies.

Unique Characteristics
- In linear mode the input common-mode voltage range includes ground and the output voltage can also swing to ground, even though operated from only a single power supply voltage
- The unity gain crossover frequency is temperature compensated
- The input bias current is also temperature compensated

Advantages
- Eliminates need for dual supplies
- Four internally compensated op amps in a single package
- Allows direct sensing to GND and Vout also goes to GND
- Compatible with all forms of logic
- Power drain suitable for battery operation

Features
- Internally frequency compensated for unity gain
- Large DC voltage gain: 100 dB
- Wide bandwidth (unity gain): 1 MHz
- (temperature compensated)
- Wide power supply range:
  - Single supply: ±3V to ±32V
  - ±15V to ±15V
  or dual supplies
- Very low supply current drain (700 μA)—essentially independent of supply voltage
- Low input bias current: 45 nA
  (temperature compensated)
- Low input offset voltage: 2 mV
  and offset current: 5 nA
- Input common-mode voltage range includes ground
- Differential input voltage range equal to the power supply voltage
- Large output voltage swing: 0V to V+ – 1.5V

Connection Diagram
Dual-In-Line Package

Top View
Order Number LM124J/883 or LM124E/883
See NS Package Number E29A

Order Number LM124W/883 or LM124W/885
See NS Package Number W14B
LF155/LF156/LF157 Series Monolithic JFET Input Operational Amplifiers

General Description
These are the first monolithic JFET input operational amplifiers to incorporate well matched, high-voltage JFETs on the same chip with standard bipolar transistors (BJ-FET™ Technology). These amplifiers feature low input bias and offset currents, low offset voltage and offset voltage drift, coupled with offset adjust which does not degrade drift or common-mode rejection. The devices are also designed for high slew rate, wide bandwidth, extremely fast settling time, low voltage and current noise and a low 1/f noise corner.

Advantages
- Replace expensive hybrid and module FET op amps
- Rugged JFETs allow blow-out free handling compared with MOSFET input devices
- Excellent for low noise applications using either high or low source impedance—very low 1/f corner
- Offset adjust does not degrade drift or common-mode rejection as in most monolithic amplifiers
- New output stage allows use of large capacitive loads (5,000 pF) without stability problems
- Internal compensation and large differential input voltage capability

Applications
- Precision high speed integrators
- Fast D/A and A/D converters
- High impedance buffers
- Wideband, low noise, low drift amplifiers
- Logarithmic amplifiers
- Photocell amplifiers
- Sample and hold circuits

Common Features
- LF155A, LF156A, LF157A
- Low input bias current: 30 pA
- Low Input Offset Current: 3 pA
- High input impedance: 10^12 Ohm
- Low input offset voltage: 1 mV
- Low input offset voltage temp. drift: 3 µV/°C
- Low input noise current: 0.01 pA/√Hz
- High common-mode rejection ratio: 100 dB
- Large dc voltage gain: 106 dB

Uncommon Features
- Extremely fast settling time to 0.01%
- Fast slew rate: 5 V/µs
- Wide gain bandwidth: 250 MHz
- Low input noise voltage: 20 nV/√Hz

Connection Diagrams (Top Views)

Metal Can Package (H)

Dual-In-Line Package (M and N)

Order Numbers

Order Numbers

See NS Package Number M08A or N08E.
SCC100GS/SZ75400
Special 0 to 100 psig Pressure Sensors for SRI

General Description
The SCC series sensors offer an extremely low cost sensor element with a temperature stable output when driven with a constant current source. These integrated circuit sensors were designed for extremely cost sensitive applications where precise accuracy over a wide temperature range is not required. This part features a protective parylene coating over the sensor element. However, this device type is intended for used with non-corrosive, non-ionic working fluids such as air, dry gases, and the like.

The SZ75400 special for SRI is different than the standard SCC100GS in that it has a special long tube attached for pressure connection. All else is per the standard specifications for the SCC100GS product.

Contact your local SenSym representative or the SenSym factory for additional details.

Features
- Low Cost
- Internal Temperature Compensation
- Small Size
- Gage Pressure
- Reliable Semiconductor Technology

Applications
- Special Sensors for SRI

Revision History
<table>
<thead>
<tr>
<th>Revision</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1-15-96</td>
<td>Original Specification</td>
</tr>
<tr>
<td>1</td>
<td>10-4-96</td>
<td>Change to Closed Bridge</td>
</tr>
</tbody>
</table>

Drawing Approvals
SenSym, Inc.:

<table>
<thead>
<tr>
<th>Printed Name/Title</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
</table>

SRI:

<table>
<thead>
<tr>
<th>Printed Name/Title</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
</table>
Pressure Sensor Characteristics

Environmental Specifications

Temperature Ranges:
- Compensated: 0°C to +50°C
- Operating: -40°C to +85°C
- Storage: -55°C to +125°C

Humidity: 0 to 100% RH

Maximum Ratings

Supply Current \( I_s = 1.5 \text{mA} \)
Lead Temperature (Soldering 2 - 4 sec) \( 250°C \)

Pressure Range Specifications

<table>
<thead>
<tr>
<th></th>
<th>SenSym</th>
<th>SRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>PART NO.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCC100GS/SZ75400</td>
<td>0-100 PSIG</td>
<td>150 PSIG</td>
</tr>
</tbody>
</table>

Performance Characteristics \(^{(1)}\)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>min</th>
<th>typical</th>
<th>max</th>
<th>units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero pressure offset (( @ T_A=25°C ))</td>
<td>-30.0</td>
<td>-10.0</td>
<td>+20.0</td>
<td>mV</td>
</tr>
<tr>
<td>Full scale span (^{(2)})</td>
<td>85</td>
<td>155</td>
<td>225</td>
<td>mV</td>
</tr>
<tr>
<td>Linearity, hysteresis &amp; repeatability (^{(3)})</td>
<td>-0.5</td>
<td>0.1</td>
<td>0.5</td>
<td>%FSO</td>
</tr>
<tr>
<td>Temp. effect on span (^{(4)})</td>
<td>-1.5</td>
<td>0.25</td>
<td>1.5</td>
<td>%FSO</td>
</tr>
<tr>
<td>Temp. effect on offset (^{(4)})</td>
<td>--</td>
<td>45</td>
<td>90</td>
<td>μV/°C</td>
</tr>
<tr>
<td>Long term stability of offset span (^{(5)})</td>
<td>--</td>
<td>0.1</td>
<td>--</td>
<td>%FSO</td>
</tr>
<tr>
<td>Response time (10% to 90%) (^{(6)})</td>
<td>--</td>
<td>0.1</td>
<td>--</td>
<td>ms</td>
</tr>
<tr>
<td>Input resistance (( @ T_A=25°C ))</td>
<td>4.0</td>
<td>5.0</td>
<td>6.5</td>
<td>k</td>
</tr>
<tr>
<td>Output impedance</td>
<td>4.0</td>
<td>5.0</td>
<td>6.5</td>
<td>k</td>
</tr>
</tbody>
</table>

Specification Notes:

Note 1: Reference Conditions (unless otherwise noted): Supply current, \( I_s = 1.0 \text{mA} \); \( T_A = 25°C \).

Note 2: Span is the algebraic difference between the output voltage at full scale pressure and the output at zero pressure. Span is ratiometric to the supply voltage.

Note 3: Linearity is based on best fit straight line. Hysteresis is the maximum output difference at any point within the operating pressure range for increasing and decreasing pressure.

Note 4: Maximum error band of the offset voltage and the error of the band of the span over the compensated temperature range, relative to the 25°C reading. Typical temperature coefficients for span and resistance are -2200 ppm/°C respectively. Temperature effects on offset and span are guaranteed by design. These parameters are not 100% tested in production.

Note 5: Long term stability over a one year period.

Note 6: Response time for 0 psi to full scale span pressure step change

Note 7: If maximum pressure is exceeded, even momentarily, the package may leak or burst, or the pressure sensing die may fracture.
**Electrical Connections**

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vsupply+</td>
</tr>
<tr>
<td>2</td>
<td>N/C</td>
</tr>
<tr>
<td>3</td>
<td>N/C</td>
</tr>
<tr>
<td>4</td>
<td>N/C</td>
</tr>
<tr>
<td>5</td>
<td>N/C</td>
</tr>
<tr>
<td>6</td>
<td>-Vout</td>
</tr>
<tr>
<td>7</td>
<td>Ground</td>
</tr>
<tr>
<td>8</td>
<td>+Vout</td>
</tr>
</tbody>
</table>

**Pin Out (Bottom View)**

**Physical Dimensions (in inches)**

- 0.12 Dia
- 0.25
- 0.5
- 0.63

**Approximate Weight:** 1 gram

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**Fax:** (408) 954-9458
**Internet:** sensym@svpal.org
DESCRIPTION

The MOC303X and MOC304X devices consist of an AlGaAs infrared emitting diode optically coupled to a monolithic silicon detector performing the function of a zero voltage crossing bilateral triac driver.

They are designed for use with a triac in the interface of logic systems to equipment powered from 115 VAC lines, such as typewriters, CRTs, solid-state relays, industrial controls, printers, motors, solenoids and consumer appliances, etc.

FEATURES

- Simplifies logic control of 115 VAC power
- Zero voltage crossing
- dv/dt of 2000 V/μs typical, 1000 V/μs guaranteed
- VDE recognized (File # 49765)
- ordering option V (e.g., MOC3043VM)

APPLICATIONS

- Solenoid/valve controls
- Static power switches
- Temperature controls
- AC motor starters
- Lighting controls
- E.M. contactors
- Solid state relays

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Symbol</th>
<th>Device</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL DEVICE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>T_STG</td>
<td>All</td>
<td>-40 to +150</td>
<td>°C</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>T_OPR</td>
<td>All</td>
<td>-40 to +85</td>
<td>°C</td>
</tr>
<tr>
<td>Lead Solder Temperature</td>
<td>T_SOL</td>
<td>All</td>
<td>250 for 10 sec</td>
<td>°C</td>
</tr>
<tr>
<td>Junction Temperature Range</td>
<td>T_J</td>
<td>All</td>
<td>-40 to +100</td>
<td>°C</td>
</tr>
<tr>
<td>Isolation Surge Voltage^1 (peak AC voltage, 60 Hz, 1 sec duration)</td>
<td>V_ISO</td>
<td>All</td>
<td>7500</td>
<td>VA@pk</td>
</tr>
<tr>
<td>Total Device Power Dissipation @ 25°C</td>
<td>P_D</td>
<td>All</td>
<td>250</td>
<td>mW</td>
</tr>
<tr>
<td>Derate above 25°C</td>
<td></td>
<td></td>
<td>2.94</td>
<td>mW/°C</td>
</tr>
<tr>
<td>Emitter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous Forward Current</td>
<td>I_F</td>
<td>All</td>
<td>60</td>
<td>mA</td>
</tr>
<tr>
<td>Reverse Voltage</td>
<td>V_R</td>
<td>All</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>Total Power Dissipation 25°C Ambient</td>
<td>P_D</td>
<td>All</td>
<td>120</td>
<td>mW</td>
</tr>
<tr>
<td>Derate above 25°C</td>
<td></td>
<td></td>
<td>1.41</td>
<td>mW/°C</td>
</tr>
<tr>
<td>Detector</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Off-State Output Terminal Voltage</td>
<td>V_DRM</td>
<td>MOC3031M/2M/3M</td>
<td>250</td>
<td>V</td>
</tr>
<tr>
<td>Peak Repetitive Surge Current (PW = 100 μs, 120 ppm)</td>
<td>I_TSM</td>
<td>MOC3041M/2M/3M</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>Total Power Dissipation @ 25°C Ambient</td>
<td>P_D</td>
<td>All</td>
<td>150</td>
<td>mW</td>
</tr>
<tr>
<td>Derate above 25°C</td>
<td></td>
<td></td>
<td>1.76</td>
<td>mW/°C</td>
</tr>
</tbody>
</table>

Note

1. Isolation surge voltage, V_ISO, is an internal device dielectric breakdown rating. For this test, Pins 1 and 2 are common, and Pins 4, 5 and 6 are common.
### 6-PIN DIP ZERO-CROSS OPTOISOLATORS TRIAC DRIVER OUTPUT (250/400 VOLT PEAK)

#### ELECTRICAL CHARACTERISTICS (\(T_A = 25^\circ C\) Unless otherwise specified)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Test Conditions</th>
<th>Symbol</th>
<th>Device</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EMITTER</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Forward Voltage</td>
<td>(I_F = 30) mA</td>
<td>(V_F)</td>
<td>All</td>
<td>1.25</td>
<td>1.5</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Reverse Leakage Current</td>
<td>(V_R = 6) V</td>
<td>(I_R)</td>
<td>All</td>
<td>0.01</td>
<td>100</td>
<td></td>
<td>(\mu)A</td>
</tr>
<tr>
<td><strong>DETECTOR</strong></td>
<td>Rated (V_{GRS}), (I_F = 0) (note 1)</td>
<td>(I_{RM1})</td>
<td>All</td>
<td>100</td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>Peak DC Output Voltage, Either Direction</td>
<td>(I_{TM} = 100) mA peak, (I_F = 0)</td>
<td>(V_{TM})</td>
<td>All</td>
<td>1.8</td>
<td>9</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Critical Rate of Rise of Off-State Voltage</td>
<td>(I_F = 0) (Figure 8, note 3)</td>
<td>(dv/dt)</td>
<td>All</td>
<td>1000</td>
<td></td>
<td></td>
<td>V/(\mu)s</td>
</tr>
</tbody>
</table>

#### TRANSFER CHARACTERISTICS (\(T_A = 25^\circ C\) Unless otherwise specified.)

<table>
<thead>
<tr>
<th>DC Characteristics</th>
<th>Test Conditions</th>
<th>Symbol</th>
<th>Device</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LED Trigger Current</strong></td>
<td>Main terminal voltage = 3V (note 2)</td>
<td>(I_T)</td>
<td>MOC3031M/MOC3041M</td>
<td>15</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MOC3032M/MOC3042M</td>
<td>10</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MOC3033M/MOC3043M</td>
<td>5</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td><strong>Holding Current, Either Direction</strong></td>
<td>(I_H)</td>
<td>All</td>
<td>MOC3031M/MOC3041M</td>
<td>400</td>
<td></td>
<td></td>
<td>(\mu)A</td>
</tr>
</tbody>
</table>

#### ZERO CROSSING CHARACTERISTICS (\(T_A = 25^\circ C\) Unless otherwise specified.)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Test Conditions</th>
<th>Symbol</th>
<th>Device</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inhibit Voltage</strong></td>
<td>(I_F = ) rated (I_T), MT1-4T2 voltage above which device will not trigger off-state</td>
<td>(V_H)</td>
<td>All</td>
<td>20</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td><strong>Leakage in Inhibited State</strong></td>
<td>(I_F = ) rated (I_T), (V_{OSR}), off-state</td>
<td>(I_{OSR})</td>
<td>All</td>
<td>500</td>
<td></td>
<td></td>
<td>(\mu)A</td>
</tr>
</tbody>
</table>

**Note**

1. Test voltage must be applied within \(dv/dt\) rating.
2. All devices are guaranteed to trigger at an \(I_F\) value less than or equal to max \(I_F\). Therefore, recommended operating \(I_F\) lies between max \(I_F\) (15 mA for MOC3031M & MOC3041M, 10 mA for MOC3032M & MOC3042M, 5 mA for MOC3033M & MOC3043M) and absolute max \(I_F\) (80 mA).
3. This is static \(dv/dt\). See Figure 9 for test circuit. Commutating \(dv/dt\) is a function of the load-driving thyristor(s) only.
LM35/LM35A/LM35C/LM35CA/LM35D
Precision Centigrade Temperature Sensors

General Description
The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±0.2°C at room temperature and ±0.5°C over a full −55 to +125°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a −55° to +125°C temperature range, while the LM35C is rated for a −40° to +110°C range (−10°C with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C is also available in the plastic TO-82 transistor package.

Features
- Calibrated directly in °Celsius (Centigrade)
- Linear + 10.0 mV/°C scale factor
- 0.5°C accuracy guaranteed (±2°C)
- Rated for full −55° to +125°C range
- Suitable for remote applications
- Low cost due to wafer-level trimming
- Operates from 4 to 30 volts
- Less than 60 µA current drain
- Low self-heating, 0.05°C in still air
- Nonlinearity only ±0.5°C typical
- Low impedance output, 0.1Ω for 1 mA load

Connection Diagrams
- TO-46 Metal Can Package* (TLA/5618-1)
- TO-82 Plastic Package (TLA/5618-2)

Typical Applications
- FIGURE 1. Basic Centigrade Temperature Sensor (+2°C to +150°C)
- FIGURE 2. Full Range Centigrade Temperature Sensor

Order Numbers:
LM35H, LM35AH, LM35CH, LM35CAH or LM35DH
See NS Package Number H03H

Order Numbers LM35GZ or LM35DZ
See NS Package Number Z03A
Precision, Low Power INSTRUMENTATION AMPLIFIERS

FEATURES
- LOW OFFSET VOLTAGE: 50μV max
- LOW DRIFT: 0.5μV/°C max
- LOW INPUT BIAS CURRENT: 5nA max
- HIGH CMR: 120dB min
- INPUTS PROTECTED TO ±40V
- WIDE SUPPLY RANGE: ±2.25 to ±18V
- LOW QUIESCENT CURRENT: 700μA
- 8-PIN PLASTIC DIP, SO-8

APPLICATIONS
- BRIDGE AMPLIFIER
- THERMOCOUPLE AMPLIFIER
- RTD SENSOR AMPLIFIER
- MEDICAL INSTRUMENTATION
- DATA ACQUISITION

DESCRIPTION
The INA128 and INA129 are low power, general purpose instrumentation amplifiers offering excellent accuracy. Their versatile 3-op amp design and small size make them ideal for a wide range of applications. Current-feedback input circuitry provides wide bandwidth even at high gain (200kHz at G = 100).

A single external resistor sets any gain from 1 to 10,000. INA128 provides an industry standard gain equation; INA129’s gain equation is compatible with the AD620.

The INA128/INA129 is laser trimmed for very low offset voltage (50μV), drift (0.5μV/°C), and high common-mode rejection (120dB at G = 100). It operates with power supplies as low as ±2.25V, and quiescent current is only 700μA—ideal for battery operated systems. Internal input protection can withstand up to ±40V without damage.

The INA128/INA129 is available in 8-pin plastic DIP, and SO-8 surface-mount packages, specified for the −40°C to +85°C temperature range. The INA128 is also available in dual configuration, the INA2128.
CA555, LM555

Timers for Timing Delays and Oscillator Applications in Commercial, Industrial and Military Equipment

Features
- Accurate Timing from Microseconds through Hours
- Astable and Monostable Operation
- Adjustable Duty Cycle
- Output Capable of Sourcing or Sinking up to 200mA
- Output Capable of Driving TTL Devices
- Normally ON and OFF Outputs
- High Temperature Stability: 0.005%/°C
- Directly Interchangeable with 555, NE555, MC1555, and MC1455

Applications
- Precision Timing
- Sequential Timing
- Pulse Generation
- Pulse Detector
- Time Delay Generation
- Pulse Width and Position Modulation

Description
The CA555 and CA555C are highly stable timers for use in precision timing and oscillator applications. As timers, these monolithic integrated circuits are capable of producing accurate time delays for periods ranging from microseconds through hours. These devices are also useful for astable oscillator operation and can maintain an accurately controlled free running frequency and duty cycle with only two external resistors and one capacitor.

The circuits of the CA555 and CA555C may be triggered by the falling edge of the waveform signal, and the output of these circuits can source or sink up to a 200mA current or drive TTL circuits.

These types are direct replacements for industry types in packages with similar terminal arrangements e.g. 555, NE555, MC1555 and MC1455, respectively. The CA555 type circuits are intended for applications requiring premium electrical performance. The CA555C type circuits are intended for applications requiring less stringent electrical characteristics.

Technical data on LM branded types is identical to the corresponding CA branded types.

MOUSER ELECTRONICS
NORTHERN CALIFORNIA
370 TOMKINS CT.
GILROY, CA 95020

(408) 842-5522
FAX: (408) 842-7375

Pinouts
CA555, CA555C, LM555C (PDIP, SOIC)

TO-5 Style Package with Formed Leads
CA555, CA555C, LM555C (METAL CAN)

Functional Diagram

File Number 834.2
## Circuit Breakers

<table>
<thead>
<tr>
<th>Series</th>
<th>W28</th>
<th>W58</th>
<th>W33</th>
<th>W23</th>
<th>W31</th>
<th>W6</th>
<th>W9</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td>Thermal</td>
<td>Thermal</td>
<td>Thermal</td>
<td>Thermal</td>
<td>Thermal</td>
<td>Magnetic</td>
<td>Magnetic</td>
</tr>
<tr>
<td><strong>Features</strong></td>
<td>* Replaces slow blow glass cartridge fuse and holder</td>
<td>* Quick connect or screw terminals</td>
<td>* Rocker actuator in various colors</td>
<td>* Push/pull actuation for manual on/off and reset</td>
<td>* Compact design</td>
<td>* Variety of time delay options</td>
<td>* Variety of time delay options</td>
</tr>
<tr>
<td></td>
<td>* Button extends for visible trip indication</td>
<td>* Push-to-reset operation</td>
<td>* Optional lighted rocker</td>
<td>* Models with aux. switch available</td>
<td>* Optional aux. switch</td>
<td>* Optional aux. switch</td>
<td>* Optional aux. switch</td>
</tr>
<tr>
<td></td>
<td>* Push-to-reset operation</td>
<td></td>
<td>* Designed to meet IEC and VDE requirements.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<table>
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<tr>
<th>Approximate Size and Weight (per pole)</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>a</th>
<th>b</th>
<th>c</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dimensions</strong> (inches)</td>
<td>.54 x .53 x .254</td>
<td>.66 x .187 x .188</td>
<td>.98 x .39 x .73</td>
<td>.61 x .187 x .73</td>
<td>.69 x .39 x .73</td>
<td>.75 x .20 x .188</td>
<td>.75 x .20 x .188</td>
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<tr>
<td><strong>Weight</strong> (oz)</td>
<td>12</td>
<td>16</td>
<td>12</td>
<td>7</td>
<td>7</td>
<td>10</td>
<td>10</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>No. of Poles</th>
<th>1</th>
<th>1</th>
<th>1 or 2</th>
<th>1</th>
<th>1</th>
<th>1</th>
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</thead>
<tbody>
<tr>
<td>Circuit Function</td>
<td>Series Trip</td>
<td>Series Trip</td>
<td>Series Trip, both poles or Series Trip, one pole</td>
<td>Series Trip</td>
<td>Series Trip, one pole</td>
<td>Series Trip</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Series Trip w/ or w/o Aux. Switch, Shunt Trip, Relay Trip, Dual Coil Series Trip, Dual Coil Shunt Trip</td>
</tr>
<tr>
<td>Current Rating</td>
<td>0.25-20 Amps</td>
<td>1-35 Amps</td>
<td>5-20 Amps</td>
<td>0.5-50 Amps</td>
<td>0.5-50 Amps</td>
<td>0.25-50 Amps</td>
</tr>
<tr>
<td>Max. Operating Voltage</td>
<td>32VDC 230VAC</td>
<td>50VDC 250VAC</td>
<td>50VDC 250VAC</td>
<td>50VDC 250VAC</td>
<td>65VDC 277VAC</td>
<td>65VDC 277VAC</td>
</tr>
<tr>
<td>Trip Time at 200% of Rating</td>
<td>0.3-2A Models – 4.5 to 25 Sec.</td>
<td>1-4A Models – 10 to 25 Sec.</td>
<td>4-5A Models – 10 to 30 Sec.</td>
<td>0.3-4A Models – 11 to 20 Sec.</td>
<td>0.4-5A Models – 11 to 20 Sec.</td>
<td>0.3-4A Models – 11 to 20 Sec.</td>
</tr>
<tr>
<td></td>
<td>3-15A Models – 2.2 to 15 Sec.</td>
<td>5-35A Models – 6 to 30 Sec.</td>
<td>5-35A Models – 6 to 22 Sec.</td>
<td>5-35A Models – 6 to 22 Sec.</td>
<td>5-35A Models – 6 to 22 Sec.</td>
<td>5-35A Models – 6 to 22 Sec.</td>
</tr>
<tr>
<td>Interrupt Capacity</td>
<td>1,000 A @ 32VDC or 250VAC</td>
<td>2,000A @ 50VDC</td>
<td>1,000A @ 250VAC</td>
<td>2,000A @ 250VAC</td>
<td>2,000A @ 50VDC or 250VAC</td>
<td>2,000A @ 250VAC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2,000A @ 250VAC</td>
</tr>
<tr>
<td>Terminal Options</td>
<td>225° (62°) Quick Connect (Do not solder)</td>
<td>225° (62°) Quick Connect, #6-32 Screw</td>
<td>225° (62°) Quick Connect, #6-32 Screw</td>
<td>220° (62°) Quick Connect, Solder</td>
<td>220° (62°) Quick Connect, #6-32 Screw</td>
<td>220° (62°) Quick Connect, #10-32 Stud</td>
</tr>
<tr>
<td>Mounting Options</td>
<td>Snaps into 5/8&quot; (15.9) panel cutout from the front</td>
<td>17/16&quot;–2A Threaded Bushing, 15/32&quot;–3A Threaded Bushing</td>
<td>Snaps into .375 x .125&quot; (9.5 x 3.2) panel cutout from the front</td>
<td>3/8&quot;–3A Threaded Bushing</td>
<td>15/32&quot;–2A Threaded Bushing</td>
<td>3/8&quot;–3A Threaded Bushing</td>
</tr>
</tbody>
</table>

Specifications and/or agency recognitions do not necessarily apply to all models within a particular series. When multiple ratings are listed, no individual rating may be exceeded by the combination of others.
National Semiconductor

5-Amp Adjustable Regulators

General Description
The LM138 series of adjustable 3-terminal positive voltage regulators is capable of supplying in excess of 5A over a 1.2V to 32V output range. They are exceptionally easy to use and require only 2 resistors to set the output voltage. Careful circuit design has resulted in outstanding load and line regulation—comparable to many commercial power supplies. The LM138 family is supplied in a standard 3-lead transistor package.

A unique feature of the LM138 family is time-dependent current limiting. The current limit circuitry allows peak currents of up to 12A to be drawn from the regulator for short periods of time. This allows the LM138 to be used with heavy transient loads and speeds start-up under full-load conditions. Under sustained loading conditions, the current limit decreases to a safe value protecting the regulator. Also included on the chip are thermal overload protection and safe area protection for the power transistor. Overload protection remains functional even if the adjustment pin is accidentally disconnected.

Normally, no capacitors are needed unless the device is situated more than 6 inches from the input filter capacitors in which case an input bypass is needed. An output capacitor can be added to improve transient response, while bypassing the adjustment pin will increase the regulator's ripple rejection.

Besides replacing fixed regulators or discrete designs, the LM138 is useful in a wide variety of other applications. Since the regulator is "floating" and sees only the input-to-output differential voltage, supplies of several hundred volts can be regulated as long as the maximum input to output differential is not exceeded, i.e., do not short-circuit output to ground. The part numbers in the LM138 series which have a K suffix are packaged in a standard Steel TO-3 package, while those with a T suffix are packaged in a TO-220 plastic package. The LM138A/LM138 are rated for −55°C ≤ Tj ≤ +150°C while the LM338A is rated for −40°C ≤ Tj ≤ +125°C, and the LM338 is rated for 0°C ≤ Tj ≤ +125°C.

Features
- Guaranteed 7A peak output current
- Guaranteed 5A output current
- Adjustable output down to 1.2V
- Guaranteed thermal regulation
- Current limit constant with temperature
- 100% electrical burn-in at thermal limit
- Output is short-circuit protected
- Guaranteed 1% output voltage tolerance (LM138A, LM338A)
- Guaranteed max. 0.015%/V line regulation (LM138A, LM338A)
- Guaranteed max. 0.3% load regulation (LM138A, LM338A)

Applications
- Adjustable power supplies
- Constant current regulators
- Battery chargers

Connection Diagrams (See Physical Dimension section for further information)
Plastic Medium-Power
Complementary Silicon Transistors

- Designed for general-purpose amplifier and low-speed switching applications.
- High DC Current Gain
  - $HFE = 2500$ (Typ) \( @ \ VCE = 4.0 \text{ Vdc} \)
- Collector-Emitter Sustaining Voltage — \( @ \ 30 \text{ mA} \)
  - $VCEO(sus) = 60 \text{ Vdc} \ (\text{Min})$ — TIP100, TIP105
  - $80 \text{ Vdc} \ (\text{Min})$ — TIP101, TIP106
  - $100 \text{ Vdc} \ (\text{Min})$ — TIP102, TIP107
- Low Collector-Emitter Saturation Voltage —
  - $VCE(sat) = 2.0 \text{ Vdc} \ (\text{Max}) \ @ \ IC = 3.0 \text{ A}dc$
  - $2.5 \text{ Vdc} \ (\text{Max}) \ @ \ IC = 8.0 \text{ A}dc$
- Monolithic Construction with Built-In Base-Emitter Shunt Resistors
- TO-220AB Compact Package

**MAXIMUM RATINGS**

<table>
<thead>
<tr>
<th>Rating</th>
<th>Symbol</th>
<th>TIP100/105</th>
<th>TIP101/106</th>
<th>TIP102/107</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-Emitter Voltage</td>
<td>$VCEO$</td>
<td>60</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>Collector-Base Voltage</td>
<td>$VCB$</td>
<td>60</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>Emitter-Base Voltage</td>
<td>$VEB$</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
</tr>
<tr>
<td>Collector Current — Continuous</td>
<td>$IC$</td>
<td>8.0</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Peak</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Base Current</td>
<td>$I_B$</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Total Power Dissipation @ $T_J = 25^\circ C$</td>
<td>$P_D$</td>
<td>80</td>
<td>0.04</td>
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<tr>
<td>Maximum Derate above $25^\circ C$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undamped Inductive Load Energy (1)</td>
<td>$E$</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Derate above $25^\circ C$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Power Dissipation @ $T_A = 25^\circ C$</td>
<td>$P_D$</td>
<td>2.0</td>
<td>0.016</td>
<td></td>
</tr>
<tr>
<td>Maximum Derate above $25^\circ C$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating and Storage Junction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature Range</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_J, T_{JES}$</td>
<td></td>
<td>$-65 \text{ to } +150$</td>
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**THERMAL CHARACTERISTICS**

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<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Max</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Thermal Resistance, Junction to Case</td>
<td>$R_{JAC}$</td>
<td>1.58</td>
<td>°C/W</td>
</tr>
<tr>
<td>Thermal Resistance, Junction to Ambient</td>
<td>$R_{JAE}$</td>
<td>62.5</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

(1) $I_C = 1.7 \text{ A}, L = 55 \mu\text{H}, P.R.F. = 10 \text{ Hz}, V_{CC} = 20 \text{ V}, R_{BE} = 100 \Omega$

**Figure 1. Power Derating**

Preferred devices are Motorola recommended choices for future use and best overall value.

REV 7
Glow Discharge Photoionization Detection Lamp (PID) - Model 108

From the "Pioneers of PID™"
Scientific Services Co., Inc.
P. O. Box 317, Rocky Hill, NJ 08553

108-10.0/10.6
The most popular of our line of PID lamps is the Model 108-10.0/10.6. This model is used in all PID detectors employing glow discharge lamps with the exception of the HNU type*. This Model 108 utilizes a small and efficient envelope (see Dimensional Drawing below). The VUV energy is emitted in spectral lines at 10.0 eV to 10.6 eV.

(*For HNU style instruments, see our original PID lamp Model 103)

Order by calling 609-921-3358 or fax Purchase Order to 609-921-2549
For more product information, see our web site at www.scserv.com or email us at info@scserv.com

"Pioneers of PID" is a trademark of Scientific Services Co., Inc.

Product Warranty
Only Scientific Services offers a three month warranty, provided normal operation does not exceed 1 ma at 250° C. This applies whether purchased direct from us or from one of our distributors. (Excludes Model 109-11.8)
April 1998
METAL PACKAGE
PHOTOMULTIPLIER TUBE
R7400U SERIES

Compact size (16mm diameter, 12mm seated length),
Fast Time response (rise time 0.78ns)

The R7400U series is a subminiature photomultiplier tube with a
16mm diameter and 12mm seated length. A precision engineered
8-stage electron multiplier (composed of metal channel dynodes) is
incorporated in the TO-8 package to produce a noise free gain of
700,000 times (R7400U). Its improved metal channel dynode design
increases photoelectron collection efficiency by 30% than the
previous type. The R7400U series also features excellent response
time with a rise time of 0.78ns. Various types of the R7400U series
are available with different spectral response and gain ranges,
including those selected specifically for photon counting
applications. Hamamatsu also provides a hemispherical lens input
option to the series (R7401 and R7402), effectively doubling the
active area.

FEATURES

- World’s smallest photomultiplier tubes assembled in a TO-8 metal package (1/7th of the Hamamatsu R647).
The necessary components are built into a TO-8 package while retaining full photomultiplier tube performance to create
a new generation of photosensors.
- Increased photoelectron collection efficiency.
The improved metal-channel dynode delivers photoelectron collection efficiency 30% higher than former types R5600U.
- Photon counting types: R7400P series.
The R7400P series is specially selected on account of low noise and high gain for use in photon counting applications.
- Hemispherical lens window types: R7401 (bialkali), R7402 (multialkali).
The hemispherical lens window doubles the effective input area to 12mm in diameter.

SERIES

<table>
<thead>
<tr>
<th>Solar Blind</th>
<th>UV to Visible Range</th>
<th>UV to Near IR Range</th>
<th>Insulation Cover</th>
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</thead>
<tbody>
<tr>
<td>Standard</td>
<td>R7400U/09</td>
<td>R7400U/R7400U-09/R7400U-03/R7400U-06</td>
<td>Yes</td>
</tr>
<tr>
<td>For Photon Counting</td>
<td>—</td>
<td>R7400P/R7400P-03/R7400P-08</td>
<td>R7400P/R7400P-04/R7400P-04</td>
</tr>
<tr>
<td>With Lens</td>
<td>R7401 (Visible Range)</td>
<td>R7402 (Visible to Near IR Range)</td>
<td>Yes</td>
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GENERAL

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description/Value</th>
<th>Unit</th>
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<tr>
<td>Minimum Effective Area</td>
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<td>mm²</td>
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<tr>
<td>Dyode Structure</td>
<td>Metal Channel</td>
<td>—</td>
</tr>
<tr>
<td>Number of Stage</td>
<td>8</td>
<td>—</td>
</tr>
<tr>
<td>Weight R7400U/P Series</td>
<td>Approx. 5.3</td>
<td>g</td>
</tr>
<tr>
<td>Weight R7401/R7402</td>
<td>Approx. 6.3</td>
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</tr>
<tr>
<td>Ambient Temperature R7400U/P Series</td>
<td>-50 to +50</td>
<td>°C</td>
</tr>
<tr>
<td>R7401/R7402</td>
<td>-30 to +50</td>
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VOLTAGE DISTRIBUTION RATIO

<table>
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<tr>
<th>Electrodes</th>
<th>K</th>
<th>Dy1</th>
<th>Dy2</th>
<th>Dy3</th>
<th>Dy4</th>
<th>Dy5</th>
<th>Dy6</th>
<th>Dy7</th>
<th>Dy8</th>
<th>P</th>
</tr>
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<tbody>
<tr>
<td>Ratio</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
<td></td>
</tr>
</tbody>
</table>

Supply Voltage: 800V K: Cathode Dy: Dynode P: Anode

Subject to local technical requirements and regulations, availability of products included in this promotional material may vary. Please consult with our sales office.

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