# AGS STANDARD PACKAGE FOR ELECTRONIC CONTROLS 

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## U.S. Department of Energy <br> USDOE Office of Science (SC)

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AGS Division Technical Note No. 208

AGS STANDARD PACKAGE FOR ELECTRONIC CONTROLS

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October 4, 1984

## Introduction

The computer control and data acquisition systems in the AGS and its surrounding complex operate under what only can be defined as hostile conditions for electronics. Briefly, these conditions can be described as: 1) mechanical stress, such as heat, moisture, and vibration, 2) electrical stress, such as from large magnetic fields, and electrical noise, and 3) general physical abuse due to constant activity in the areas where equipment is located. With these problems in mind, a study group was formed to define a standard package for electronic controls that would tolerate the above conditions as much as possible, still meet the needs of the controls medium, and be of use to other, non-controls specialists who may have similar packaging problems. The following document is a short description of the packaging scheme which evolved as a direct result of the study group's deliberations.

## "Package" Description

## 1. The Chassis

The package consists of a $19^{\prime \prime}$ rack mountable, $0.063^{\prime \prime}$ thick aluminum chassis, approximately $21^{\prime \prime}$ long, 17 " wide and $11-1 / 2^{\prime \prime}$ high. It is designed to be mounted on slides for ease of service to the electronics contents. One can see from the information in Appendix 4 that the
difference in the amount of rf shielding by either aluminum or steel when proper design is used is not enough to compensate for the reduced aluminum weight and the ease of working aluminum. Physically, the chassis is divided into two compartments by a bulkhead, with the front compartment containing power supplies for the electronics which are contained in the rear compartment. If a user has an application that demands more space than the electronic compartment contains, he may dispense with the bulkhead and place his electronics and power supplies at any convenient location in the chassis, keeping in mind the cooling capacity that has been provided. The separate compartment configuration is specifically intended for controls applications. The top and bottom are divided so that access to each compartment can be made separately either from the top or the bottom. The front panel contains handles, an A/C ON light and power supply test jacks, one for each voltage provided by the power supplies. The back panel is a flat sheet approximately 195 square inches and is provided with holes only for the on/off circuit breaker and $a / c$ cord. It is left to the user to punch holes for connectors he wishes to use, in whatever configuration best meets his or her specifications. It is expected that the chassis will be fabricated by an outside vendor and be purchased broken down for ease of storage. It will be assembled by the user. With this in mind, Pemnuts have been used as much as possible for ease of assembly. It should be noted that the chassis is reversible in that holes are provided to interchange the front and rear panels and the compartments so that connectors will then appear at the front of the rack rather than the rear.

## 2. The Electronics Compartment

The electronics compartment is designed to contain various configurations of MULTIBUS crates (card cages), and/or DIN spec. Eurocard crates as follows:
a. Three each, two each, or one each 4 position multibus card crates National Semiconductor Corp. Part No. SBC604. See I11ustration \#3.
b. One each, 3 to 15 position card crate, Electronic Solutions Inc. for multibus cards. -See Illustration \#4.
c. One each, 4 position card crate and one each card frame DIN spec. to accept $3 \mathrm{U} / 220 \mathrm{~mm}$ long cards.

## 3. The Power Supply Compartment

The package is designed so that one of two optional configurations can be specified by the user and placed in the power supply compartment. The power supplies are installed so that they can be easily replaced if failure occurs by simply unplugging the outputs, inputs and removing four screws.
a. The first option is a Power One Inc. Model CP255. This is a multi-output supply with suitable outputs for the multibus standard providing positive 5 and 12 volts at 30 and 4.5 amps, and a negative 5 and 12 volts each at 1.75 amps. See I1Iustration 非.
b. The second option consists of two separate multi-output supplies. Condor Inc. Model $\mathrm{DBB}-105 \mathrm{~W}$ and a Condor Inc., Mode1 BAA-40W. See Illustration 非2. One supply provides 5 volts at 12 amps and plus or minus 12 volts at 1.7 amps, or plus or minus 15 volts at 1.5 amps. The second supply provides plus 5 volts at 3 amps, also plus or minus 15 volts at 0.8 amps. The dual supply option is designed to be used where the supplies need to be isolated from each other for the digital oriented multibus and any linear circuits the package may contain, i.e., cards in the DIN spec. card cage. See Illustration \#2.
c. An rf filter Mallory Part No. 10 VB 1 is part of the package design and is placed immediately after the on/off circuit breaker.

## 4. Package Cooling

Package cooling is provided by fans, four each for the electronics compartment and two each for the power supplies. These are capable of supporting 200 watts of electronics. Tests have been made with the power supplies under full load and the cooling has proven adequate to keep the internal temperatures of the package such that it meets the temperature specifications of most electronics components. See Appendix 2.

## 5. Package Documentation

See Appendix 3 for a list of mechanical drawings for the electronic cooling package.

## Conclusion

The above described standard electronic package is mechanically strong, gives superior RFI/EMI protection, compares very favorably in terms of cost effectiveness to a purchased package with the same specifications, and meets the needs of packaging electronic controls for the present and future in the Accelerator Department.

## Acknowledgments

While the information presented here represents the conclusions of the study group listed in Appendix 1, we acknowledge the many useful suggestions from other interested persons in the Accelerator Department.

## Appendix 1

Study Group
R. Frankel
K. Kohler
W. Leonhardt
D. Pope
L. Sadinsky
F. Toldo

## Appendix 2

Memo to R. Frankel from W. Leonhardt; re: multibus power supply heat transfer, 4/19/84.

## Appendix 3

Reference Print Numbers

```
Job Number: D09-1M-15
Drawing Numbers: D09-M-374-3
    D09-M-375-4
    D09-M-376-3
    D09-M-377-3
    D09-M-378-3
    D09-M-379-3
    D09-M-380-3
    D09-M-381-3
    D09-M-382-3
```


#### Abstract

Appendix 4

Excerpts from "Micro Controller Handbook", Intel Corp., section on "Designing Microcontroller Systems for Electrically Noisy Environments".


mvh

MEmo

TO: R. FRANKEL
FRom: Wi LEonHardot
Re: Multhbus power supply HEAT TRANSFER

I MAGE: RUN AN EXPERIMENT ON THE MULTI-BUS UNI TO ACCESS THE TEMPERATURE RISE of THE powrin supply DURING operation. THIE ONT WAS RUN IN" "A RACK WITH ALL COVERS ON. Powder resistors where connected to this Pouter supply in a pension which causes it to run at "half current", a condition DESIGNED TO DISSIPATE THE MAXIMUM POWER. THERMOCOUPLES WIRE USED TO MEASURE THE INLET $\xi$ OUTLET AIR TEMPERATURES AND TEMPERATURES AT FOUR LOCATIONS ON THE POUTER SUPPLY. AFTER SEVERAL HOURS OF RUNNING WITH AN INLET TEMPERATURE of $29^{\circ} \mathrm{C}$, THE mAx SUPPLY TEMPERATURE WAS READ AT THE UPPER POWER TRANSISTOR PLATE AS $66^{\circ} \mathrm{C}$. THIS THEN REPRESENTS A $37^{\circ} \mathrm{C}$ RISE. OUFR AmbIENT WHICH CAN BE SCALED UP CONSERIATVELY. I ALSO RAN FOR A TIME WITH THE PowEr supply corine off whllih caused the pond supply MAX TTMP TO RISE TO 69-71 ${ }^{\circ} \mathrm{C}$ WITH THE SAME INLET TEMP.

Previous analysis of the card section indicates THAT IT IS THERMALLY OK.

## APPENDIX A-1



Figure 8. PCB with Gridded Ground
but you still get a mathematically optimal distribution of currents in the grid structure, such that the current loop produces less magnetic flux than if the return path were restrained to follow any single given ground trace. The key to attaining minimum loop areas for all the current loops together is to let the ground currents distribute themselves around the entire area of the board as freely as possible. They want to minimize their own magnetic field. Just let them.

## RF SHIELDING

A time-varying electric field generates a time-varying magnetic field, and vice versa. Far from the source of a time-varying EM field, the ratio of the amplitudes of the electric and magnetic fields is always 377 ohms. Up close to the source of the fields, however, this ratio can be quite different, and dependent on the nature of the source. Where the ratio is near 377 ohms is called the far field, and where the ratio is significantly different from 377 ohms is called the near field. The ratio itself is called the wave impedance, $\mathrm{E} / \mathrm{H}$.
The near field goes out about $1 / 6$ of a wavelength from the source. At 1 MHz this is about 150 feet, and at 10 MHz it's about 15 feet. That means if an EMI source is in the same room with the victim circuit, it's likely to be a near field problem. The reason this matters is that in the near field an RF interference problem could be almost entirely due to E-field coupling or H -field coupling, and that could influence the choice of an RF shield or whether an RF shield will help at all.
In the near field of a whip antenna, the $\mathrm{E} / \mathrm{H}$ ratio is higher than 377 ohms, which means it's mainly an E-field generator. A wire-wrap post can be a whip antenna. Interference from a whip antenna would be by electric field coupling, which is basically capacitive coupling. Methods to protect a circuit from capacitive coupling, such as a Faraday shield, would be effective against RF
interferencé from a whip antenna. A gridded-ground structure would be less effective.
In the near field of a loop antenna, the $\mathrm{E} / \mathrm{H}$ ratio is lower than 377 ohms; which means it's mainly an H-field generator. Any current loop is a loop antenna. Interference from a loop antenna would be by magnetic field coupling, which is basically the same as inductive coupling. Methods to protect a circuit from inductive coupling, such as a gridded-ground structure, would be effective against RF interference from a loop antenna: A Faraday shield would be less effective;
A more difficult case of RF interference, near field or far field, may require a genuine metallic RF shield: The idea behind RF-shielding is that time-varying EMI fields induce currents in the shielding material. The induced currents dissipate energy in two ways:. $\mathrm{I}^{2} \mathrm{R}$ losses in the shielding material and radiation losses as they re-radiate their own EM fields. The energy for both of these mechanisms is drawn from the impinging EMI fields. Hence the EMI is weakened as it penetrates the shield.

More formally, the $I^{2} \mathrm{R}$ losses are referred to as absorption loss, and the re-radiation is called reflection loss. As it turns out, absorption loss is the primary shielding mechanism for H -fields, and reflection loss is the primary shielding mechanism for E-fields. Reflection loss, being a surface phenomenon, is pretty much independent of the thickness of the shielding material. Both loss mechanisms, however, are dependent on the frequency ( $\omega$ ) of the impinging EMI field, and on the permeability ( $\mu$ ) and conductivity ( $\sigma$ ) of the shielding, material. These loss mechanisms vary approximately as follows:

$$
\begin{aligned}
& \text { reflection loss to an E-field (in } \mathrm{dB}) \sim \log \frac{\sigma}{\omega \mu} \\
& \text { absorption loss to an } \mathrm{H} \text {-field }(\text { in } \mathrm{dB}) \sim \mathrm{t} \sqrt{\omega \sigma \mu}
\end{aligned}
$$

where $t$ is the thickness of the shielding material.
The first expression indicates that E-field shielding is more effective if the shield material is highly conductive, and less effective if the shield is ferromagnetic, and that low-frequency fields are easier to block than highfrequency fields. This is shown in Figure 9.


Figure 9. E-Field Shielding


Figure 10. H-Field Shielding
Copper and aluminum both have the same permeability, but copper is slightly more conductive, and so provides slightly greater reflection loss to an E-field. Steel is less effective for two reasons. First, it has a somewhat elevated permeability due to its iron content, and, second, as tends to be the case with magnetic materials, it is less conductive.
On the other hand, according to the expression for absorption loss to an H -field, H -field shielding is more effective at higher frequencies and with shield material that has both high conductivity and high permeability. In practice, however, selecting steel for its high permeability involves some compromise in conductivity. But the increase in permeability more than makes up for the decrease in conductivity, as can be seen in Figure 10. This figure also shows the effect of shield thickness.
A composite of E-field and H -field shielding is shown in Figure 1I. However, this type of data is meaningful only in the far field. In the near field the EMI could be $90 \%$ H -field, in which case the reflection loss is irrelevant. It would be advisable then to beef up the absorption loss, at the expense of reflection loss, by choosing steel. A better conductor than steel might be less expensive, but quite ineffective.
A different shielding mechanism that can be taken advantage of for low frequency magnetic fields is the ability of a high permeability material such as mumetal to divert the field by presenting a very low reluctance path to the magnetic flux. Above a few kHz , however, the permeabilty of such materials is the same as steel.

In actual fact the selection of a shielding material turns out to be less important than the presence of seams, joints and holes in the physical structure of the enclosure. The shielding mechanisms are related to the induction of currents in the shield material, but the currents must be


Figure 11. E- and H-Field Shielding
allowed to flow freely. If they have to detour around slots and holes, as shown in Figure 12, the shield loses much of its effectiveness.

As can be seen in Figure 12, the severity of the detour has less to do with the area of the hole than it does with the geometry of the hole. Comparing Figure 12C with 12D shows that a long narrow discontinuity such as a seam can cause more RF leakage than a line of holes with larger total area. A person who is responsible for designing or selecting rack or chassis enclosures for an EMI environment needs to be familiar with the techniques that are available for maintaining electrical continutty across seams. Information on these techniques is available in the references.

Grounds
There are two kinds of grounds: earth-ground and signal ground. The earth is not an equipotential surface, so earth ground potential varies. That and its other electrical properties are not conducive to its use as a return conductor in a circuit. However, circuits are often connected to earth ground for protection against shock hazards. The other kind of ground, signal ground, is an arbitrarily selected reference node in a circuit-the node with respect to which other node voltages in the circuit are measured.

SAFETY GROUND
The standard 3-wire single-phase AC power distribution system is represented in Figure 13. The white wire is earth-grounded at the service entrance. If a load circuit has a metal enclosure or chassis, and if the black wire develops a short to the enclosure, there will be a shock hazard to operating personnel, unless the enclosure itself is earth-grounded. If the enclosure is earth-grounded, a

## $4-3$



Figure.12. Effect of Shield Discontinuity on Magnetically Induced Shield Current
short results in a blown fuse rather than a "hot" enclosure. The earth-ground connection to the enclosure is called a -safety ground. The advantage of the 3 -wire power system is that it distributes a safety ground along with the power.

Note that the safety-ground wire carries , no current, except in case of a fault, so that at least for low frequencies it's at earth-ground potential along its entire length. The white wire, on the other hand, may be several volts off grourid, due to the IR drop along its length.


Figure 13. Single-Phase Power Dlstribution

## SIGNAL GROUND

Signal ground is a single point in a circuit that is designated to be the reference node for the circuit. Commonly, wires that connect to this single point are also referred to as "signal ground." In some circles "power supply common" or PSC_ is the preferred terminology for these conductors In any case, the manner in which these wires connect to the actual reference point is the basis of distinction among three kinds of signal-ground wiring methods: series, parallel, and multipoint. These methods are shown in Figure 14:
The series connection is pretty common because it's simple and economical. It's the noisiest of the three, however, due to common ground-impedance coupling between the circuits. When several circuits share a ground wire, currents from one circuit, flowing through the finite impedance of the common ground line, cause variations in the. ground potential of the other circuits. Given that the currents in a digital system tend to be spiked, and that the common-impedance is mainly inductive reactance, the variations could be bad enough to cause bit errors in high current or particularly noisy situations.

The parallel connection eliminates common ground impedance problems, but uses a lot of wire. Other disadvantages are that the impedance of the individual ground lines can be very high, and the ground lines themselves can become sources of EMI.

Including:

1. Schematic

Parts List
D.C. POWER SUPPLIES

Specification
Outline \& Mounting Drawing
General User Information

## SPECIFICATIONS

INPUT: $100 / 115 / 215 / 230 \mathrm{VAC} \pm 10 \% 47-63 \mathrm{HZ}$
OUTPUT:

| V | I | 0 VP |  |
| ---: | ---: | ---: | ---: |
| +5 V | 30 A | $6.2 \pm$ | .4 |
| -5 V | 1.75 A | -6.2 | $\ddagger$ |
| +12 V | 4.5 A | 15 | $i^{4}$ |
| -12 V | 1.75 A | $15 \pm 1$ |  |

ADJUSTIENT RANGE: $\ddagger 5 \%$ min.
LINE REGULATION: $\ddagger 0.1 \%$ for $10 \%$ line change LOAD REGULATION: $\quad \pm 0.1 \%$ for $50 \%$ load change RIPPLE AND NOISE: Outputs loaded one at a time TRANSIENT RESPONSE: Less than 50 u sec for $50 \%$ load change
REMOTE SENSING: Provided on +5 V at connector STABILITY: ${ }^{ \pm} 0.05 \%$ for 8 hours after $30 \cdot \mathrm{~min}$. warm-up
AMBIENT TEMP: $0^{\circ} \mathrm{C}$ to $70^{\circ} \mathrm{C}$ with 70 CEM moving air
TEMP. COEFICTENT: $0.02 \%$ per ${ }^{\circ} \mathrm{C}$ max TEMP. COEFICTENT: $\quad 0.02 \%$ per ${ }^{\circ} \mathrm{C}$ max.

| OPTIONAL TRANSFORMER CONNECTIONS |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Range | Input | Input <br> Source | Input <br> Return | Connections Required $P 2$ | Fusing |  |
| 103.5-125.5 | 115 | 1 | 2 | 1-3, 2-4. | 5A |  |
| 207-253 | 230 | 1 | 4 | 2-3 | 54 | $\text { to }\left.\frac{\frac{1}{5 \mathrm{GRY}}}{\frac{3 \mathrm{GRY}}{2 \mathrm{RED}}}\left\|\left.\right\|_{\frac{\mathrm{WHT}}{*}} ^{3}\right\|\right\|_{\text {Jumpered at XFMR }}$ |
| 193.5-236.5 | 215 | 5 | 4 | 2-3 | 2.5A |  |
| 90-110 | 100 | 5 | 2 | 1-3*, 2-4 | 2.5A |  |
| *For 100/215 VAC operation, move gray wire from terminalterminal 5 . (For 100 VAC operation, terminal 1 must bejumpered to terminal 3 at the transformer). |  |  |  |  |  |  |

CONNECTOR INFORMATION

| P6. P8 <br> Molex |  |  |  | Molex |
| :--- | :---: | :---: | :---: | :---: |
| 09-50-7071-housing |  |  |  |  |
| $08-56-0106-$ pin |  |  |  |  |
| $15-04-0219-k e y$ | $03-09-2042-$ housing |  |  |  |
| $02-09-2118-$ pin |  |  |  |  |

P8L


| P8U | P8L |  |  |
| :---: | :---: | :---: | :---: |
| $\square$ |  |  |  |
| $\square$ | KEY |  |  |
| $\square$ | GND ( +5 ) | 1 | KEY |
| $\square$ |  | 2 | +12 COM |
| $\square$ |  | 3 | -5V |
| $\square$ | +5V | 4 | +12V |
| $\square$ | +5V | 5 | $+5 \mathrm{~V}$ |
| $\square$ | GND | 6 | $+5 \mathrm{~V}$ |
|  |  | 7 | $+5 \mathrm{COM}$ |

P6: P8

09-50-7071-housing 15-04-0219-key

1. Power Fail (AC low)

Provides a TTL active high signal when AC line fails. Signal is activated at approx. $98 / 196$ VAC and reset at approx. 104/208 VAC. (Open collector output device).
2. Storage

After "AC $_{\text {Afail" }}$ all outputs•will remain in regulation a minimum of $7.5 \mathrm{~m} \sec$ (115 VAC line input).

## ADDITIONAL INFORMATION

This power supply is also available as a CP255-1. The only difference is connector $P-2$ which is made a 5-pin (Molex 03-09-2052) connector instead of the standard $4-p i n$ connector supplied with the CP255. The 5-pin AC connector allows all jumpering for input changes to be done at the connector without removing and rewiring the transformer. NOTE: Intel uses the 4 -wire scheme. National Semiconductor uses the 5-wire scheme.



INTRLL SOLKET FOR U1, 2 .
RIT WAY BETRMAMED INTEST TO HELP SET DYP TD SPECS.





## DC OUTPUTS



DBB CASE
UNIT WEIGHT: 11 lbs .






PRODUCTION NOTES:

.120 DIA x . 50 DEEP 8 HOLES

## 3 TO 26 SLOTS AVAILABLE

Designed To Save You Space


- Accepts iSBX* cards
- Accepts three-level w-w cards.
- Mates directly to Intel's iSBC* Card Cages
- Includes backplane power supply connectors

The MULTI-CAGE® ${ }^{\circledR}$ card cage with mother board backplane is designed to be $100 \%$ compatible with Intel's iSBC* 80 cards and card cages. All MULTI-CAGE ${ }^{*}$ card cages (except the SBC 614) have resistor termination networks for bus signals. The SBC 614 has no termination network but has a female bus expansion connector added. All MULTI-CAGES* ${ }^{*}$ come with a male expansion connector. This connection may be solder plated (no suffix) or gold plated ( $G$

## More Models

We have more models than all our competitors combined. Choose a cage with $3,4,5,6,7,8,9,12,14,15,16,20$, 24 or 26 slots for the right solution to your problem. We have models with either $0.6^{\prime \prime}$ or $0.75^{\prime \prime}$ card centers and can even accommodate wirewrap and iSBX cards.


All models are electrically and dimensionally interchangeable with Intel's iSBC-80 Cages.

## More Warranty

A three year warranty is your assurance of quality.

Electronic Solutions

## STANDARD MODELS



HORIZONTAL RACK MOUNT MODELS


STANDARD MODELS

| Models with . 6 inch Card Centers |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Model | No. of Slats | No. of iSBX cards | $\begin{gathered} \text { No. of } \\ \text { w-w cards } \end{gathered}$ | $\begin{aligned} & \text { Price } \\ & (1-4) \dagger \end{aligned}$ |
| ESBC 604 | 4 | 0 | 1 | \$ 195 |
| ESBC 614G | 4 | 0 | 1 | 220 |
| SBC 604A | 4 | 1 | 0 | 195 |
| SBC 605 | 5 | 0 | 1 | 245 |
| SBC 606 | 6 | 0 | 1 | 295 |
| SBC 608 | 8 | 2 | 2 | 395 |
| SBC 609 | 9 | 1 | 1 | 445 |
| SBC 6012 | 12 | 3 | 4 | 645 |
| SBC 6014 | 14 | 1 | 2 | 745 |
| SBC 6015 | 15 | 0 | 1 | 795 |
| SBC 6016 | 16 | 5 | 5 | 845 |
| SBC 6020 | 20 | 1 | 1 | 1045 |
| SBC 6024 | 24 | 2 | 3 | 1245 |
| SBC 6026 | 26 | 0 | 1 | 1345 |
| Models with 75 inch Card Centers |  |  |  |  |
| Model | No. of Slots: | No. of iSBX cards | No. of w-w cards | $\begin{aligned} & \text { Price } \\ & (1-4) \dagger \end{aligned}$ |
| SBC 753 | 3 | 0 | 1 | \$ 190 |
| SBC 754 | 4 | 0 | 1 | 235 |
| SBC 755 | 5 | 0 | 1 | 270 |
| SBC 757 | 7 | 1 | 1 | 380 |
| SBC 7512 | 12 | 0 | 1 | 705 |
| SBC 7516 | 16 | 1 | 1 | 925 |
| SBC 7521 | 21 | 0 | 1 | 1200 |

For gold expansion connector add $\$ 10$ and use suffix $G$ after Model \#.

## HORIZONTAL RACK MOUNTS

| Models with . 6 inch Card Centers |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Model | No. of Slots: | No. of iSBX cards | No. of w-w cards | $\begin{aligned} & \text { Price } \\ & (1-4) \dagger \end{aligned}$ |
| ESBC 604H | 4 | 0 | 1 | \$ 325 |
| SBC 604AH | 4 | 1 | 0 | 325 |
| SBCC 605 H | 5 | 0 | 1 | 395 |
| SBC 606H | 6 | 0 | 1 | 445 |
| SBC 608H | 8 | 2 | 2 | 545 |
| SBC 609H | 9 | 1 | 1 | 595 |
| Models with . 75 inch Card Centers |  |  |  |  |
| Madel | No. of Slots: | No. of iSBX cards | No. of w-w cards | $\begin{aligned} & \text { Price } \\ & (1-4) \dagger \end{aligned}$ |
| SBC 753H | 3 | 0 | 1 | \$ 320 |
| SBC 754H | 4 | 0 | 1 | 385 |
| SBC 755 H | 5 | 0 | 1 | 420 |
| SBC 757H | 7 | 1 | 1 | 530 |

$\dagger$ For gold expansion connector add $\mathbf{\$ 1 0}$ and use suffix $G$ after Model \#

VERTICAL RACK MOUNTS

| Models with .6 inch Card Centers |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Model | No. ot Slots | No. of iSBX cards | No. of w-w cards | $\begin{gathered} \text { Price } \\ (1-4) \dagger \end{gathered}$ |
| SBC 6012V | 12 | 4 | 4 | \$ 895 |
| SBC 6014V | 14 | 2 | 2 | 995 |
| SBC 6015V | 15 | 1 | 1 | 1045 |
| SBC 6016V | 16 | 5 | 5 | 1095 |
| SBC 6020V | 20 | 1 | 1 | 1295 |
| SBC 6024V | 24 | 3 | 3 | 1495 |
| SBC 6026V | 26 | 0 | 1 | 1595 |
| Models with .75 inch Card Centers |  |  |  |  |
| Model | No. of Slots | $\begin{gathered} \text { No. of } \\ \text { iSBX cards } \end{gathered}$ | $\begin{gathered} \text { No. of } \\ \text { w-w cards } \end{gathered}$ | $\begin{gathered} \text { Price } \\ (1-4) \dagger \end{gathered}$ |
| SBC 7512V | 12 | 0 | 1 | \$ 955 |
| SBC 7516V | 16 | 1 | 1 | 1175 |
| SBC 7521V | 21 | 0 | 1 | 1450 |

tFor gold expansion connector add $\mathbf{S 1 0}$ and use sutfix $G$ after Modet

## P-2 BUS (AUXILIARY BUS)

| Printed Circuit Board Only: |  |  | Assembled with connectors: |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Part Number | Number of Siots | Price Oty 1-9 | Part Number | Number of Slots | Price Oty 1-9 |
| P2-604P-* | 4 | \$37.00 | P2-604C-* | 4 | \$ 97.00 |
| P2-605P- | 5 | 38.00 | P2-605C- | 5 | 113.00 |
| P2-606P- | 6 | 39.00 | P2-606C- | 6 | 129.00 |
| P2-608P- | 8 | 40.00 | P2-608C- | 8 | 160.00 |
| P2-609P- | 9 | 40.00 | P2-609C-_ | 9 | 175.00 |
| P2-6012P- ${ }^{-}$ | 12 | 55.00 | P2-6012C- | 12 | 235.00 |
| P2-6014P- | 14 | 55.00 | P2-6014C- | 14 | 265.00 |
| P2-6015P. | 15 | 55.00 | P2-6015C- | 15 | 280.00 |
| P2-6016P- | 16 | 69.00 | P2-6016C- | 16 | 309.00 |
| P2-6020P- | 20 | 69.00 | P2-6020C- | 20 | 369.00 |
| P2-6024P- | 24 | 74.00 | P2-6024C- | 24 | 434.00 |
| P2-6026P- | 26 | 74.00 | P2-6026C- | 26 | 464.00 |

* Use suffix E for PCB bused Point-to-Point, or use suffix M for PCB bused per Intel Multibus specification 9800683-02


## ACCESSORIES

| P2 Auxiliary Connectors (wire-wrap): |  |  |
| :---: | :---: | :---: |
| EZC 30 DRMD Selective Plated-Gold Contacts only ESC 30 DRMD Gold Plated Pins |  | \$ 7.5 |
|  |  | 8.90 ea. |
| P2 Auxiliary Connectors (Solder Tab): |  |  |
| EZC 30 D | Selective Plated-Gold Coniacts only | 7.50 ea. |
| 09-50-7071 | Molex Mating Connectors, with Pins | 2.50 ea. |
| LM 320T-5.0 | -5V Regulator | 12.00 ea . |
| 8121 R | Reset Switch | 8.60 ea. |
| FMB | Fan Mounting Bracket Kit for SBC 608, 609 and 757 | 12.00 e |
| MK-4 | Spacer Mounting kit to replace rubber feet | 3.00 ea. |
| PPRC-8 | Eight Master Parallel Priority Resolution | 55.00 ea . |
| PPRC-16 | Sixteen Master Parallel Priority Resolution | 70.00 ea. |

## More Information?

l our toll free number
(800) 854-7086

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(714) 292-0242

# Electronic Solutions 


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