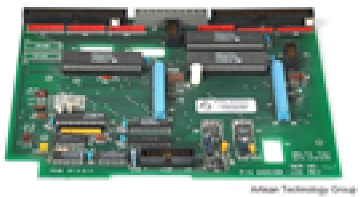
Delta Tau ACC-14

SMCC I/O Expansion Module



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DELTA TAU DATA SYSTEMS, INC. OF CALIFORNIA
9036 WINNETKA AVE.,
NORTHRIDGE, CALIFORNIA 91324
818-998-2095 FAX: 818-998-7807

ACC-14 (SMCC)

USE OF ABSOLUTE PARALLEL BINARY ENCODER OR RESOLVERS

The primary position feedback for SMCC is the incremental A/B quadrature encoder. The maximum pulse rate for the position encoder's A and B inputs is 500 KHz. Even though the SMCC can decode the input by one-, two-, or four-times decoding the maximum count rate the SMCC can measure is only one MHz (not two MHz as might be expected) due to counter limitations in the CPU itself.

The SMCC has a total of four encoder channels, two of which are used for position feedback of the X and Y axes and two for "handwheel" encoder inputs. The handwheel encoder channels do not have a count rate limitation and therefore can count at a rate of two MHz (500 KHz x 4).

All encoder channels are capable of X1, X2, and X4 multiplication with direction sense reversible, and a special mode where instead of A/B quadrature pulses, pulses are accepted in Channel A and direction control in Channel B. All of these operating modes are controlled by i parameters.

In addition to A/B quadrature encoders, the SMCC is able to use absolute parallel binary position input of 8 to 23 bits from an optical encoder or other source, or single or dual resolvers, for position feedback. To accomplish this the SMCC requires ACC-14 for Parallel Binary or ACC-14 with ACC-15 installed for resolvers. Each of these is described below.

1) USING ABSOLUTE PARALLEL BINARY POSITION ENCODER

An Accessory-14 board may be used with SMCC in order to enable it to read and use Parallel Binary data as position feedback input. The number of bits that can be handled is 8 to 23 bits and these must represent the total range of actual position travel of the axis being controlled. The absolute encoder, therefore, rotates one revolution or less for the entire travel of the machine. The source of the data can be any device which generates parallel binary bits indicating position; most commonly this is a single disk absolute binary encoder, or an encoder where two or more encoder disks are combined to provide the total number of bits needed in the application. The SMCC will not accept Gray-scale binary data; data of this form must be converted to Standard binary external to the SMCC and ACC-14. The data can be also be derived from an LVDT or a potentiometer, provided that an external A/D converter is used so that the input voltage from the LVDT or the potentiometer is converted to a parallel binary word.

The assumption is made that the word "Absolute" here refers to the entire travel of the axis so that the binary position data is incrementing from zero to a maximum number. Please note that the zero of the absolute encoder does not have to be mechanically adjusted to be at the actual zero position of the axis since SMCC provides a position bias offset number which can be used to create a zero anywhere along the axis. See i70[i71] for encoder bias description.

The number of parallel binary bits to be used in an application is a function of the required resolution for the axis being controlled. For example, if a 16 bit absolute encoder is used and the total axis travel is 65 inches, then the encoder will provide a resolution of just under .001 inch per bit.

In order to follow the subsequent description, please refer to the "Single Absolute Binary Encoder Connection to SMCC" block diagram. Assume we are to connect two absolute binary encoders to the SMCC for the X and Y axes.

Please note that any combination of encoders can be used for the X and Y axes, such as incremental (A/B quadrature) on X and absolute on Y, or absolute on X and resolver on Y, and so on.

The absolute encoders must have single-ended TTL (0 to +5 volt) output data, eight bits minimum and 23 bits maximum. The data output polarity may either be true logic (1 = +5 volts) or false logic (1 = 0 volts), the SMCC i76[i77] parameters allow the user to invert the data or not before the SMCC uses it. The output data from the encoder must also be controllable by an external signal (strobe) which can be used to "freeze" the encoder data while the SMCC is reading it. i76[i77] also allows the selection of strobe output polarity. The strobe output polarity from SMCC can be specified and as many as eight lines may be paralleled at the ACC-14 in order to stiffen the strobe line's sink capability so as to provide a clean "freeze" command to the encoder. The strobe output from the ACC-14 is one line if a 23-bit encoder is used, two lines if 22 bits are used, and is a maximum of eight lines if a 16-bit or less encoder is used.

Proceed to wire the parallel data lines for the X encoder to the ACC-14 J1 connector using shielded cables and the Y encoder to J3. Use the block diagram and its instructions.

It must be realized that the wiring of the absolute encoder is very critical since this type of encoder is much more subject to noise pickup than an A/B quadrature encoder. It is important to isolate the case of the absolute encoder from the motor case and shaft as well as the machine structure in order to prevent electrical noise pickup; it may be necessary to use non-conducting materials to couple the absolute encoder to the machine's structure. It is also imperative to use well-shielded wiring between the encoder and ACC-14.

The i parameters of the SMCC must be set up to configure the system correctly. Please refer to the SMCC's i parameter section in order to set up the i64 [i65], i70[i71], i72[i73], and i76[i77] parameters properly.

In operation the SMCC will read the actual absolute position of the parallel encoder once upon turn-on or reset and apply the specified position bias to it if one has been entered. It will then set its current desired position to that obtained from the initial reading. This is what sets up the "Absolute" position so that SMCC knows where it is upon power turn-on. Thereafter the SMCC will read only the sixteen least significant bits of the encoder and drive its position incrementally from these bits. The SMCC will also read all specified encoder bits and set the absolute position when it is issued the online "$" Command (Soft Reset).

In all other respects, once configured correctly, the SMCC with absolute parallel binary position feedback can be programmed and operated as if an A/B quadrature encoder were being used.

2) USING RESOLVERS

A resolver is a device which utilizes magnetic coupling principles for its operation. It requires an excitation signal in response to which it outputs sine and cosine signals (90 degrees apart) whose amplitudes are used by the R/D converter to determine the rotating shaft's angular position. Other types of resolvers exist which output phase-shifted sine/cosine where the phase shift is a measurement of angular position; these are not as common, and the SMCC's ACC-15 is designed to operate with the first type described above, where sine/cosine amplitudes are used.

The resolver's best attribute is that it is a passive device (no electronic components are used inside the resolver), so that it is very rugged and can withstand the abusive conditions on a machine, such as high temperature, shock, and vibration. Also, because its outputs are measured in a ratiometric manner, it can also withstand the electrically noisy machine environment better than an absolute encoder. Its cost is generally higher than an encoder system, especially when the conversion electronics, located at the controller, is taken into account.

The resolver is in effect a one-revolution absolute encoder since its current shaft position is immediately known upon power turn-on. Another characteristic of the resolver is that it is available in multi-pole versions such that each revolution of the shaft produces more than one cycle of sine/cosine; these are known as multi-speed resolvers. The following is a summary of commonly available resolvers:

Single-Speed, Two-Pole - Produces one sine wave cycle per revolution

Double-Speed, Four-Pole - Produces two sine wave cycles per revolution

Triple-Speed, Six-Pole - Produces three sine wave cycles per revolution

When an R/D converter is used to determine the shaft angle position of a resolver, each "cycle" or one complete sine wave represents a zero-to-maximum count range. SMCC's ACC-15 has selectable resolution of 10 to 16 bits selectable in increments of two bits, therefore the resolution is:

10 bits - 1024 counts/cycle
12 bits - 4096 counts/cycle
14 bits - 16384 counts/cycle
16 bits - 65536 counts/cycle

If a two-pole resolver is used, one cycle is the same as one revolution, so the count resolution is now based on one revolution of the resolver. A restriction applies to the selection of the encoder or resolver to be used if the SMCC will be doing the actual phase commutation of the motor to be driven. This is that a whole, non-fractional number of encoder or resolver counts is required per electrical revolution of the motor being commutated. When driving a six-pole motor, unless a six-pole resolver is also used, the division by three makes it impossible to obtain a whole number. In all other cases, a single- or dual- speed resolver may be used and a single speed is preferred since one revolution represents one full count cycle and the resolver's zero position can be used as a once-per-revolution marker, the same as the "C" Channel in a quadrature encoder.

Another possibility exists with resolvers in that if a single, directly coupled resolver is used on the motor, only one revolution of the motor provides absolute position. This is sufficient when the amplifier is using the resolver to derive sinusoidal phase commutation for the motor, but it does not provide an absolute position for the machine since usually many revolutions of the motor are required to travel the full length of the machine. In order to obtain absolute position information, a common approach is to use two resolvers and a gear reduction between the "fine" and "coarse" resolver. The "fine" resolver is the one revolving at the same rate as the motor; it is directly coupled to the motor and the "coarse" resolver is gear-reduced 2 to 256 times so that it revolves not more than once over the entire travel of the machine. The SMCC is capable of processing the data obtained from the the two resolvers and deriving an absolute position representing the machine's actual position. Please refer to the "Single Resolver Connection to SMCC" and "Dual Resolver Connection to SMCC" block diagrams for a complete description of all necessary connections to SMCC, the ACC-14 and ACC-15, as well as the i parameters involved in the correct setup of the resolver application. Please refer to the SMCC manual for a detailed description of i parameters.

When using an absolute parallel binary encoder, only an ACC-14 is needed to read the incoming data; to use resolvers, one or more ACC-15s are needed. The ACC-15s plug into the ACC-14s' J6 and J7, iSBX connectors. They provide the necessary excitation (5 KHz sinusoidal at five volts RMS amplitude) and the decoding for the signals from the resolver (which should be a sine and cosine, at two to eight volts RMS amplitude). The decoding resolution of the ACC-15 is software controlled by the SMCC's i parameters and provides 10, 12, 14, or 16 bits of position resolution per cycle (or revolution, if a two pole resolver is used). Please note that as the resolution is increased, the maximum RPM of the resolver is reduced; at ten bits the maximum RPM is 62,000, at twelve bits it is 15,600, at fourteen bits 3,900, and at sixteen bits it is 975 RPM. All of these RPMs coincide with SMCC's maximum input data rate, which is one MHz for position pulses being received.

The ACC-15 provides the decoded position data as a binary 16 bit word so SMCC can read it and establish its absolute position. However, as is done in the case of the absolute encoder, SMCC reads the absolute data from the resolver once upon power turn-on or reset and then relies on an A/B quadrature pulse generator which is on the ACC-15 and which provides incremental pulses derived from the absolute data read by the R/D converter. The SMCC then uses these A/B quadrature pulses as if an incremental encoder were connected to it. This includes the "C" Channel or once-per-revolution pulse found on an encoder. These connections are made from the J2 connector of the ACC-15 to the J1 (J MACH) connector of the SMCC. The actual absolute position may be reloaded by issuing the online "$" Command (Soft Reset) to the SMCC. Here also SMCC provides a position bias adder, i70[i71], which can be used to set the absolute zero position read by the resolvers to coincide with the machine zero without having to physically rotate the resolver to its zero position. Once the resolver(s) has been set up, all operations of SMCC are transparent to the user and the SMCC can be programmed and commanded as if a single A/B quadrature encoder were being used.

3) ACC-14 and ACC-15

Please refer to the individual manual and drawing for these devices. The following is an overview of their usage for parallel binary input data and resolvers.

Each SMCC can support up to four ACC-14s connected in daisy-chain fashion to the J8 (JEXP) connector. The ACC-14 has "E Point" jumper selections, E1 and E2, for allowing it to be placed at one of four address spaces supported by SMCC. The four base addresses are: 64768, 64832, 64896, 64960. Of these, due to hardware limitations, only the last three can be used, so do not use 64768 because it may cause erroneous data to be transmitted to SMCC. The connecting cables should be no longer than 12 inches to ensure proper communications. The SMCC will provide power to the ACC-14s over the cable. If any ACC-15s are used, the SMCC must be provided with +/-15V so these can be passed over the cables as well.

When using ACC-14 to read parallel binary data, the J1 and/or J3 connectors may be used as shown in the block diagram titled "Single Absolute Binary Encoder...". The address for J1 is Base address + 0, and for J3 it is Base address + 3. So, if the ACC-14 were located at address 64896, then the J1 connector's address would be 64896 and that of J3 would be 64899 and these would be the addresses to be used in the i parameters requiring base address specifications. The user may connect the X or Y axis to J1 or J3 as he wishes. As long as the i parameters are specified correctly, the SMCC will receive the correct data.

When using ACC-14 with ACC-15 to read resolvers, the ACC-15s should be plugged into the J6 and J7 connectors of the ACC-14 (iSBX connectors). See block diagrams titled "Dual Resolver ..." and "Single Resolver..." for actual connections. Note that the J6 connector is addressed as Base + 32 and J7 as Base + 16. Therefore, if the ACC-14 were located at 64960, the J6 connector would be at 64992 and the J7 connector at 64976. If both axes, X and Y, of SMCC are to be used with two geared resolvers each, then two ACC-14s must be used each with two ACC-15s. The i parameters are used to tell the SMCC what the configuration is and where to read data for each of the resolvers.

The following chart is a summary of all position-feedback devices that may be used with SMCC. It is provided as an overall guide for selecting a position feedback device for various applications.

MANUALS/ACC-14.SMC

POSITION FEEDBACK DEVICES

DEVICE	TYPE	MAX. DEVICE PULSE RATES	SMCC USAGE/MERIT
A/B Quad. Rotary or Liner Encoder	Incremental	100 to/250 KHz	Direct Connect, Differential or Single Ended Lowest Cost, Most Available Most Widley Used
Absolute/ Encoder Optical	Absolute, 8 bits min. 23 bits max.	100 KHz/to 1 MHz	Use ACC-14 Parallel Data Input Provides Absolute Position Information
Resolver	Absolute/ Incremental Single or Multi-Speed	1 MHz	Use ACC-14 and ACC-15 Very Rugged and Reliable
Laser Inter- feronmeter	Incremental	1 to/64 MHz	Direct Connect. If A/B Quad. Output Provided; or Use ACC-14 If Parallel Data Available. SMCC limits operation to 1MHz for A/B Quad., and 2 MHz for Parallel Input.
Farrand Inductosyn	Absolute/ Incremental Single or Multi-Speed	1 MHz	Highest Resolution, Fastest Speed, Highest Accuracy. Use ACC-14 and ACC-15. May Require Pre-amplifier For Sine/Cosine Feedback Signals. Very Accurate, High Resol.
Sonic Transducer	Incremental	N/A	If Transducer has A/B Quad. Converter, Direct Connect. If Transducer has Parallel Binary Data Output, use Acc-14. SMCC does not support pulse-to-distance conversion. Very Rugged, Used Mostly in Hydraulic Cylinders
Potentiometer	Absolute	N/A	Use Option 7 with 12-bit A/D Converter to Read Position Low Cost, Subject to Wear and Drift
LVDT	Absolute	N/A	Use Option 7 with 12-bit A/D Converter to Read Position Accurate, Reliable, Rugged

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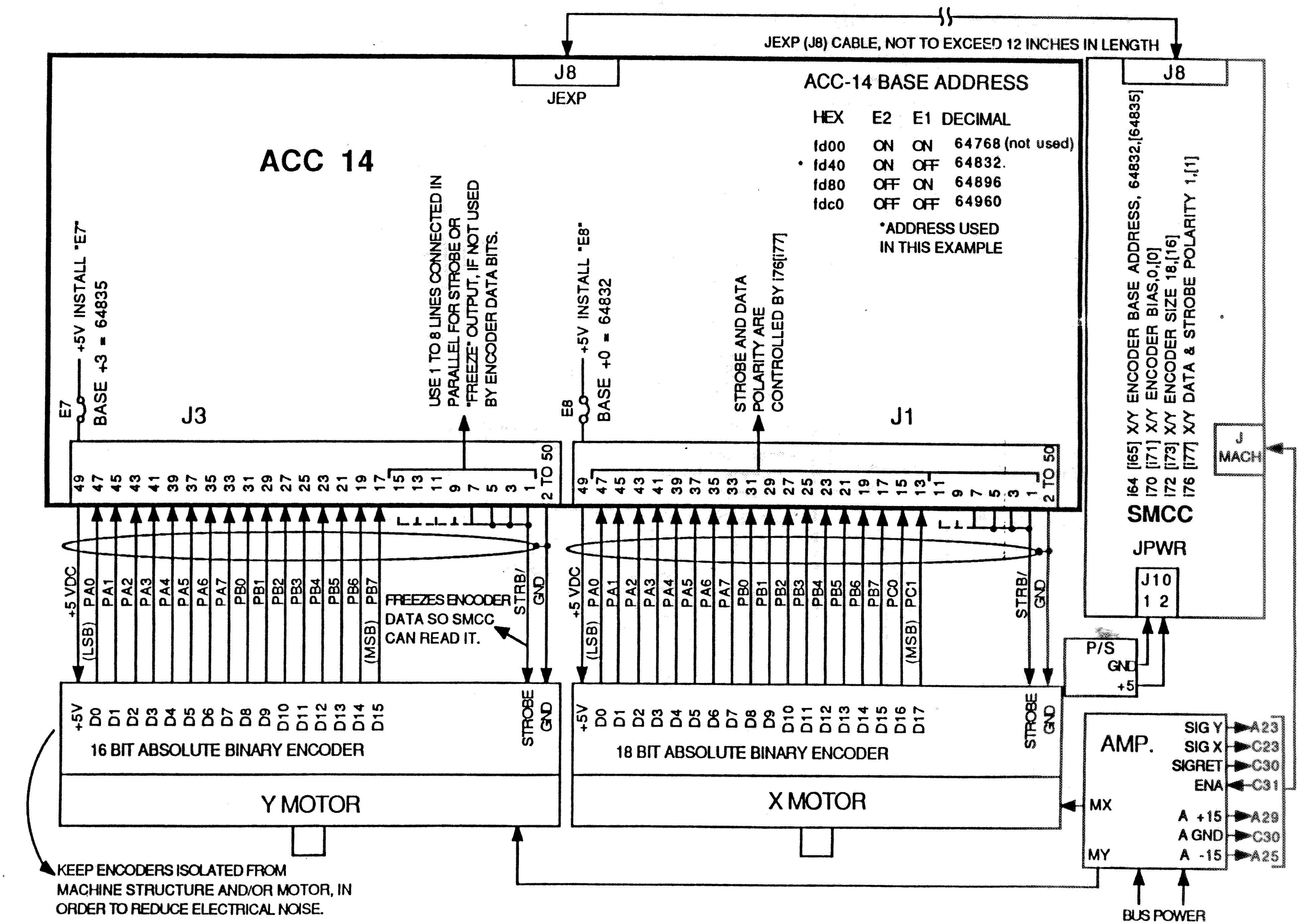
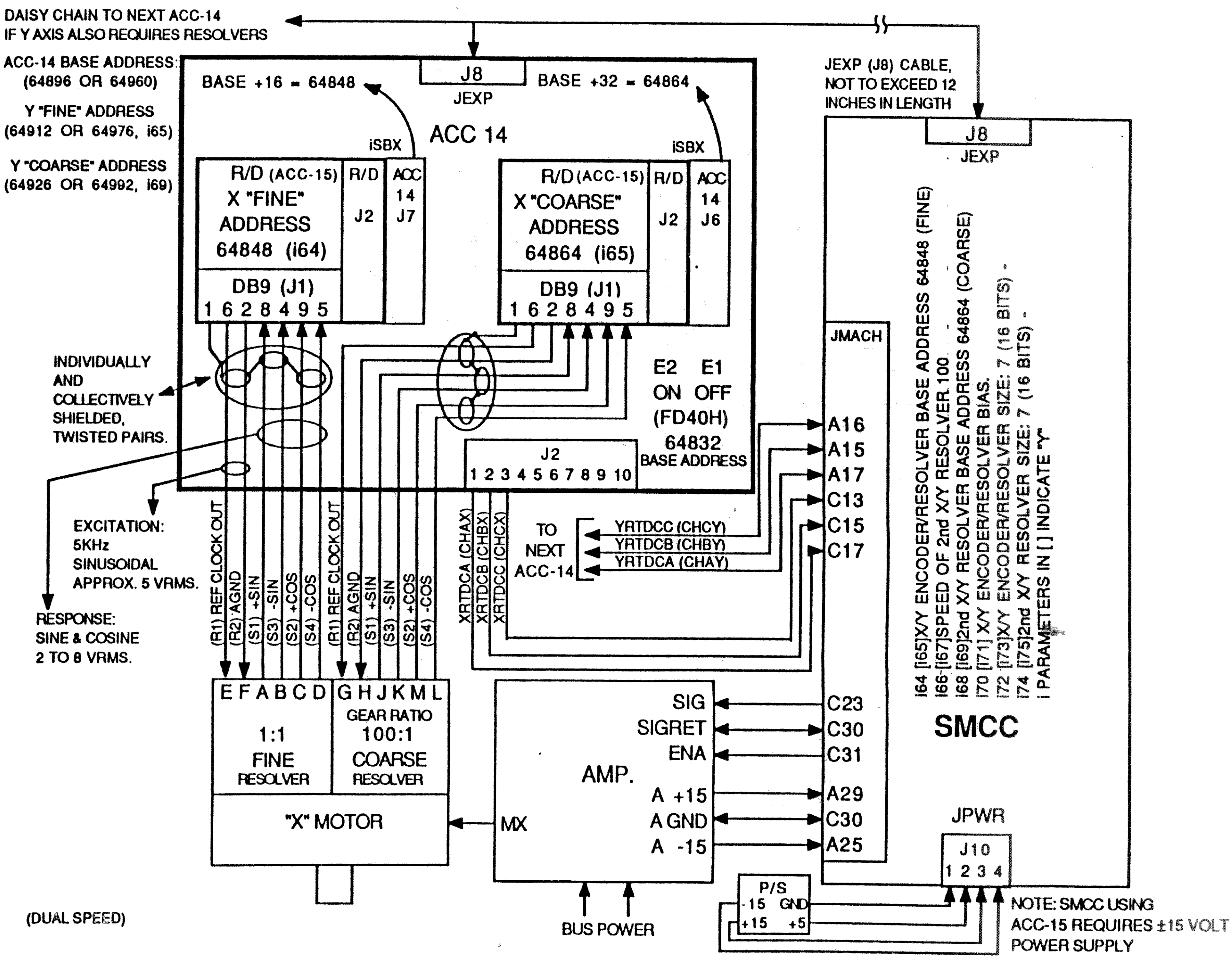
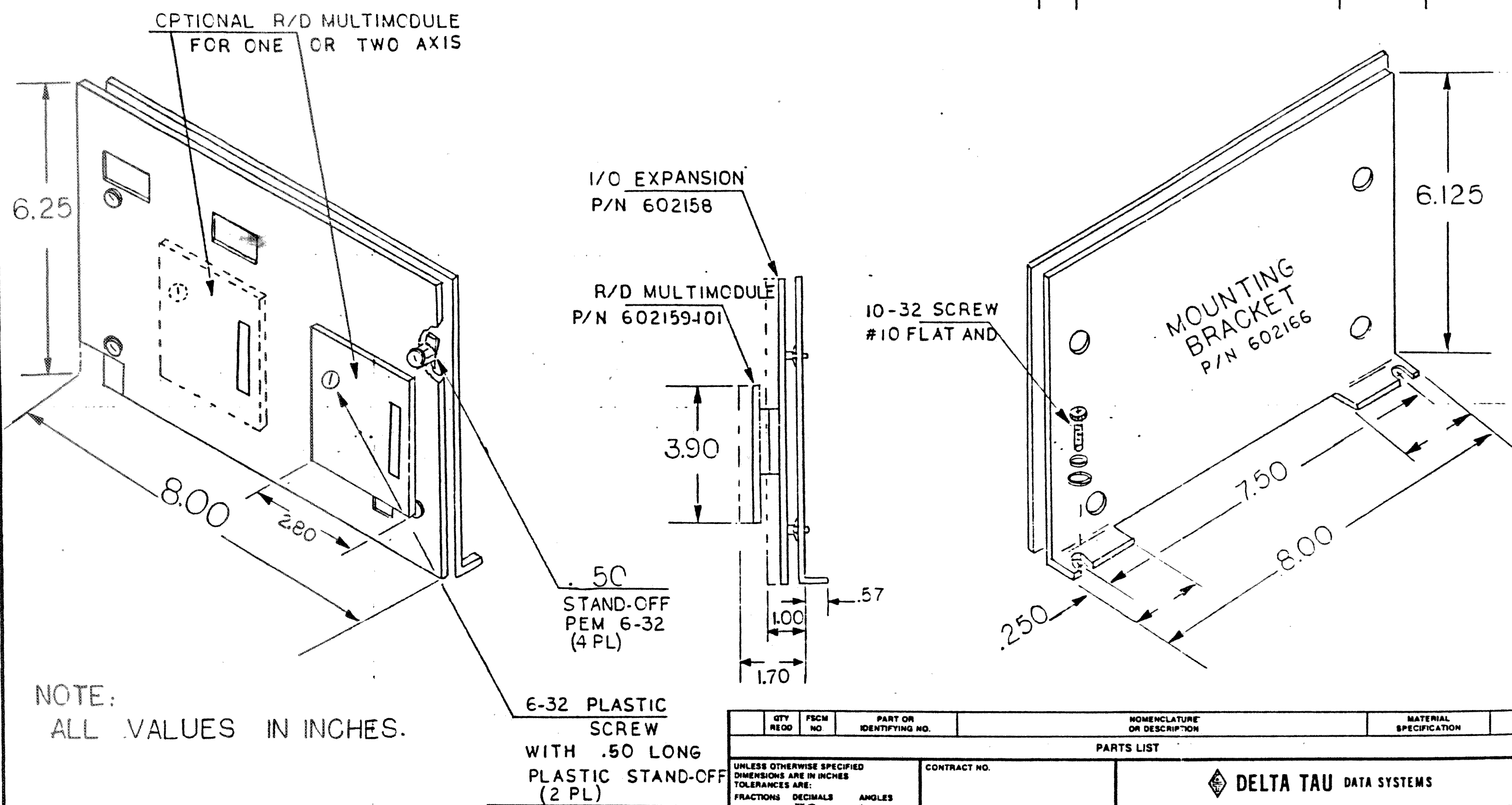
SINGLE ABSOLUTE BINARY ENCODER CONNECTION TO SMCC FOR X &Y AXIS



(binary encoder)

DUAL RESOLVER (GEARED) CONNECTION TO SMCC





NOTE: ALL VALUES IN INCHES.

DWG. NO.	SH	REV.

REVISIONS

REV.	DESCRIPTION	DATE	APPROVED

QTY REQD	FSCM NO	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

CONTRACT NO.

APPROVALS		DATE
DRAWN	Anahid	6-10
CHECKED		
ISSUED		

DELTA TAU DATA SYSTEMS

I/O EXPANSION - R TO D MULTI. TOP ASSY

SIZE	FSCM NO.	DWG. NO.	REV.
B		602175 - 101	N/C

SCALE | SHEET

NEXT ASSY	USED ON

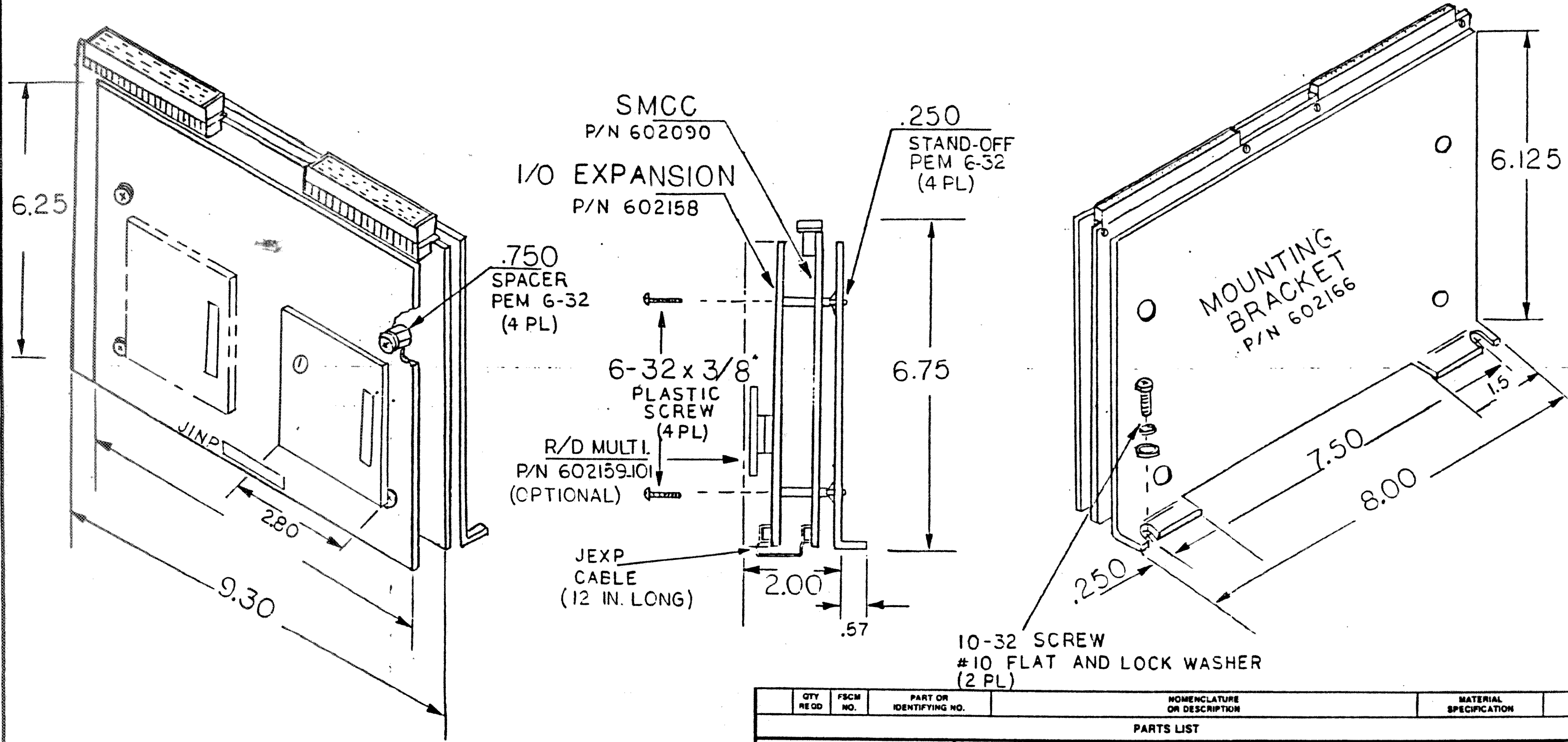
APPLICATION

DO NOT SCALE DRAWING

BISHOP GRAPHICS/ACCUPRESS REORDER NO. A-4343

DWG. NO. | SH | REV.

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED



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DELTA TAU DATA SYSTEMS

SMCC – I/O EXPANSION TOP ASSY.

SIZE B | FSCM NO. | DWG. NO. 602175-100 | REV. N/C

SCALE | SHEET

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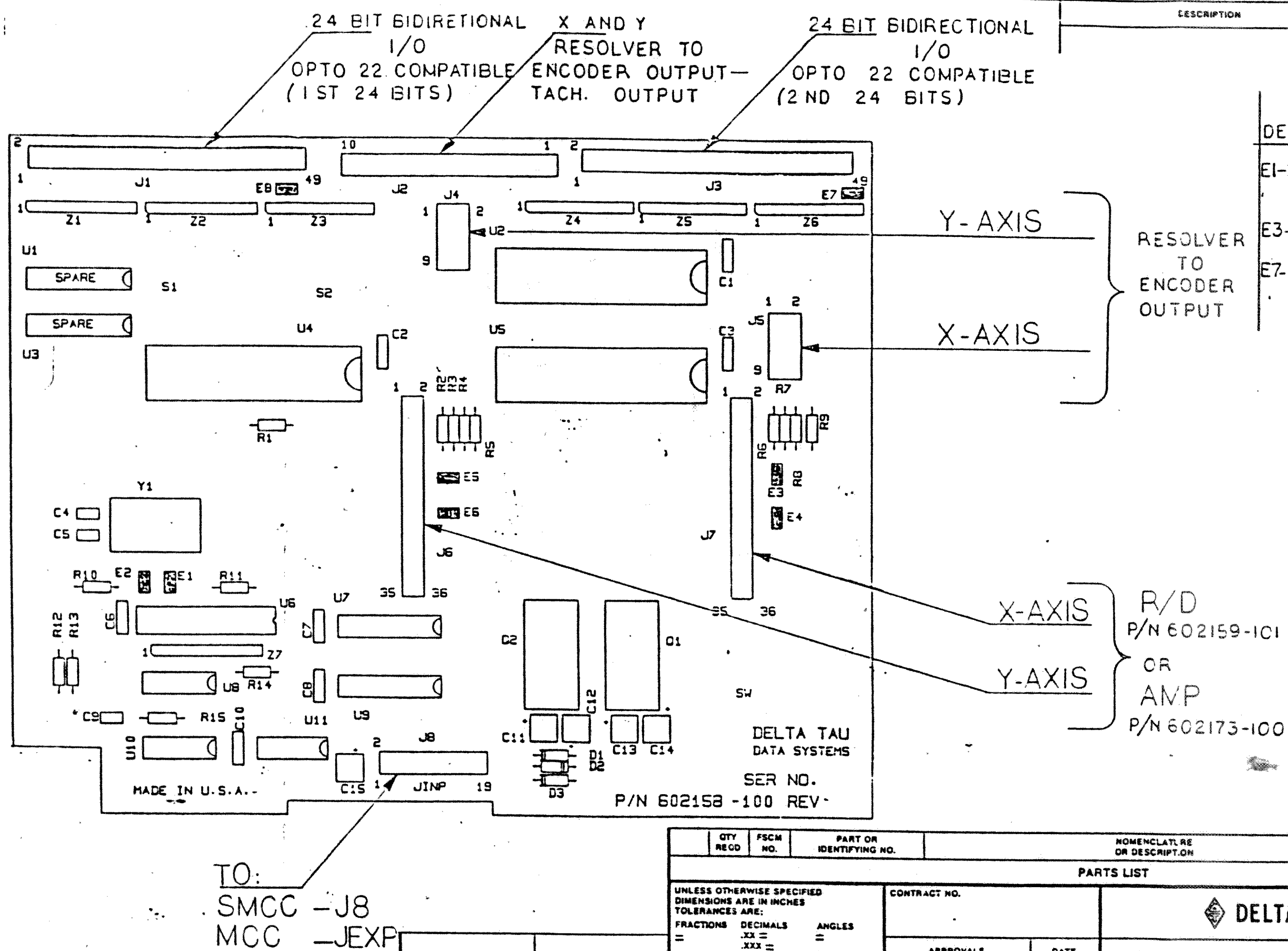

DES.	FUNCTION
E1-E2	BOARD BASE ADDRESS SELECT
E3-E6	INTERUPT CONTROL
E7-E8	5V POWER ENABLE

REVISIONS

DESCRIPTION	DATE	APPROVED

QTY REQD	FSCM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

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MATERIAL

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CONTRACT NO.

APPROVALS	DATE
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NEXT ASSY	USED ON

APPLICATION

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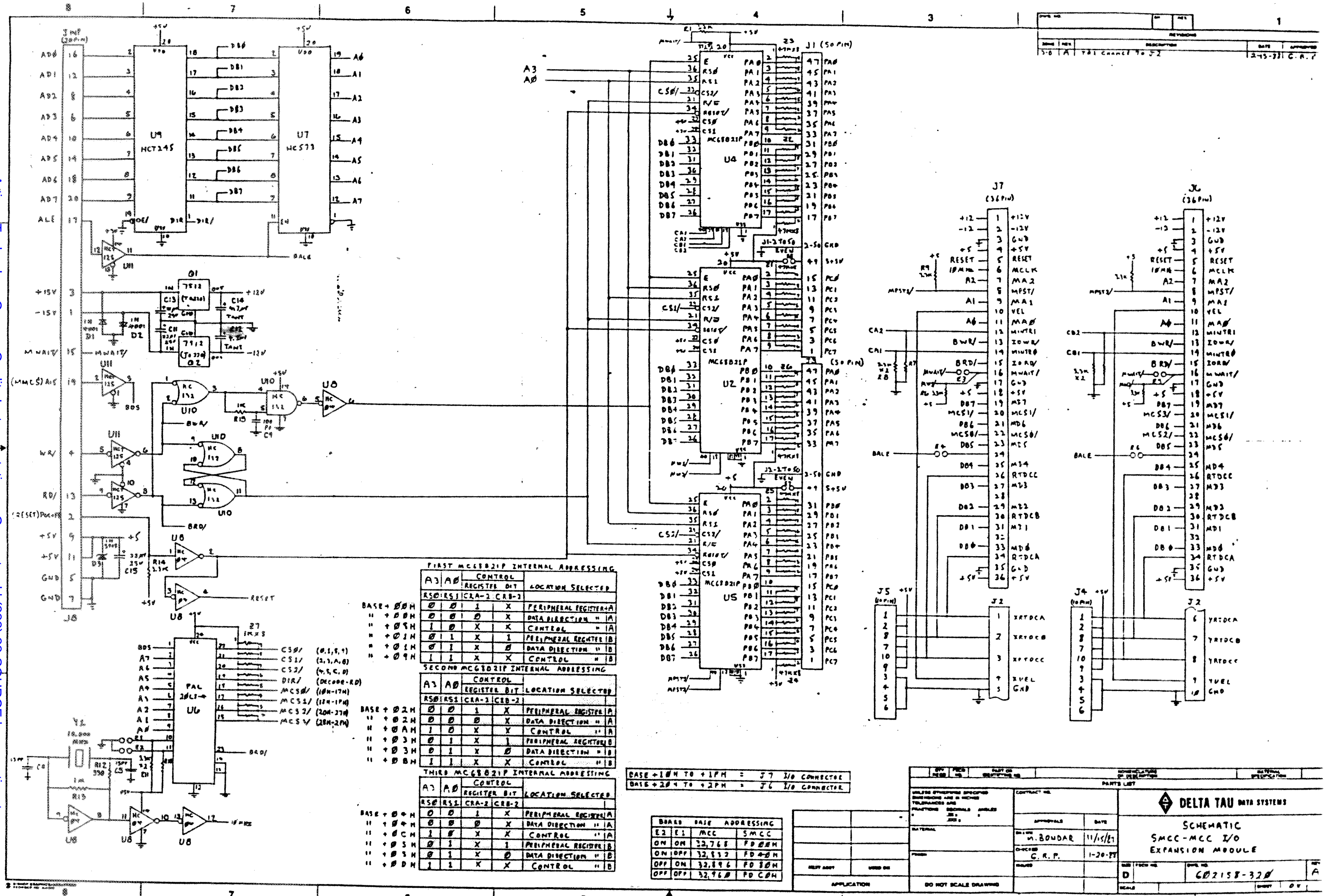
DELTA TAU DATA SYSTEMS

I/O EXPANSION MOD.

SIZE	FSCM NO.	DWG. NO.	REV.
B		602158-100	

SCALE SHEET

DWG. NO. | SH | REV.



FIRST MC6821P INTERNAL ADDRESSING

	A3 (RSØ)	AØ (RS1)	CONTROL REGISTER BIT CRA-2	CRB-2	LOCATION SELECTED
BASE + ØØH	Ø	Ø	1	X	PERIPHERAL REGISTER A
" + ØØH	Ø	Ø	Ø	X	DATA DIRECTION " A
" + Ø8H	1	Ø	X	X	CONTROL " A
" + Ø1H	Ø	1	X	1	PERIPHERAL REGISTER B
" + Ø1H	Ø	1	X	Ø	DATA DIRECTION " B
" + Ø9H	1	1	X	X	CONTROL " B

SECOND MC6821P INTERNAL ADDRESSING

	A3 (RSØ)	AØ (RS1)	CONTROL REGISTER BIT CRA-2	CRB-2	LOCATION SELECTED
BASE + Ø2H	Ø	Ø	1	X	PERIPHERAL REGISTER A
" + Ø2H	Ø	Ø	Ø	X	DATA DIRECTION " A
" + ØAH	1	Ø	X	X	CONTROL " A
" + Ø3H	Ø	1	X	1	PERIPHERAL REGISTER B
" + Ø3H	Ø	1	X	Ø	DATA DIRECTION " B
" + ØBH	1	1	X	X	CONTROL " B

THIRD MC6821P INTERNAL ADDRESSING

	A3 (RSØ)	AØ (RS1)	CONTROL REGISTER BIT CRA-2	CRB-2	LOCATION SELECTED
BASE + Ø4H	Ø	Ø	1	X	PERIPHERAL REGISTER A
" + Ø4H	Ø	Ø	Ø	X	DATA DIRECTION " A
" + ØCH	1	Ø	X	X	CONTROL " A
" + Ø5H	Ø	1	X	1	PERIPHERAL REGISTER B
" + Ø5H	Ø	1	X	Ø	DATA DIRECTION " B
" + ØDH	1	1	X	X	CONTROL " B

BASE + 1ØH TO + 1FH	=	J7	I/O CONNECTOR
BASE + 2ØH TO + 2FH	=	J6	I/O CONNECTOR

BOARD BASE ADDRESSING

E2	E1	MCC	SMCC
ON	ON	32,768	FDØØH
ON	OFF	32,832	FD4ØH
OFF	ON	32,896	FD8ØH
OFF	OFF	32,96Ø	FDCØH