TABLE OF CONTENTS

FORWARD

THANK YOU !

We at ELECTROMOTIVE SYSTEMS, INC. appreciate your purchase of this **IMPULSE•S+** adjustable frequency drive. When properly installed, operated and maintained, the **IMPULSE•S+** will provide a lifetime of reliable operation. It is MANDATORY that the person who operates, inspects, and maintains this equipment thoroughly read and understand this manual.

This instruction manual has been designed to serve as a self-supporting guide for the proper installation, operation, and maintenance of the **IMPULSE•S+** adjustable frequency drive. If you require additional assistance, please feel free to contact either your local supplier or ELECTROMOTIVE SYSTEMS.

DANGER !

Do NOT touch any circuit components while AC main power is on or immediately after the main AC power is disconnected from the unit. You must first wait until the red "CHARGE" lamp on the main circuit board (TM2) is extinguished. It may take as long as 10 minutes for the charge on the main DC bus capacitors to drop to a safe level. Failure to adhere to this warning could result in serious or lethal injury.

SECTION 1: INTRODUCTION

1.1 General

IMPULSE•S+ represents a new age in adjustable frequency motor controls utilizing microprocessor-based digital control of all functions and settings. Any modifications or adjustments are easily performed using on-board switches.

IMPULSE•S+ incorporates a high performance Pulse Width Modulated (PWM) design generating a variable voltage- variable frequency output that closely approximates a sinusoidal current waveform to allow variable speed control of any conventional squirrel cage, three-phase induction motor.

IMPULSE•S+ is a *unique* hardware & software configuration specifically designed for application to crane, hoist, and monorail systems. This product is the direct result of over 5 years experience in applying adjustable frequency drives to satisfy the demanding requirements of this market. Following are a few of the pertinent features:

* Easily configured for conventional pendant station control.
* Can be directly interfaced with 120 VAC control signals.
* User selectable speed control methods, multi-step or infinitely variable.
* User selectable braking methods, controlled decel, coast, or normal stop (using motor brake).

1.2 Receiving

This unit has been put through demanding tests at the factory prior to shipment. Before unpacking please check the following:

* Please read specifications sticker on outside of box. Compare the description of the product found on that sticker with the description of the product on your purchase order.

* Inspect for damage sustained in transit (damage to carton may be indicative of unit damage).

After unpacking, please check the following:

* Specifications sticker (shipped loosely) with the unit matches your application requirement (i.e. current and voltage).

* Check to see that all electrical connections and screws are secure.

* Verify that there is no visible damage to any of the components.

If any part of the **IMPULSE•S+** is damaged or lost, immediately notify both the carrier and ELECTROMOTIVE SYSTEMS, INC.

Special Note: *If you purchased this* ***IMPULSE•S+*** *as part of an ELECTROMOTIVE SYSTEMS, pre-engineered,* ***TCONTROL®*** *motor control panel you should skip Sections 2 and 3 and proceed directly to Section 4.*

SECTION 2: INSTALLATION

2.1 Location

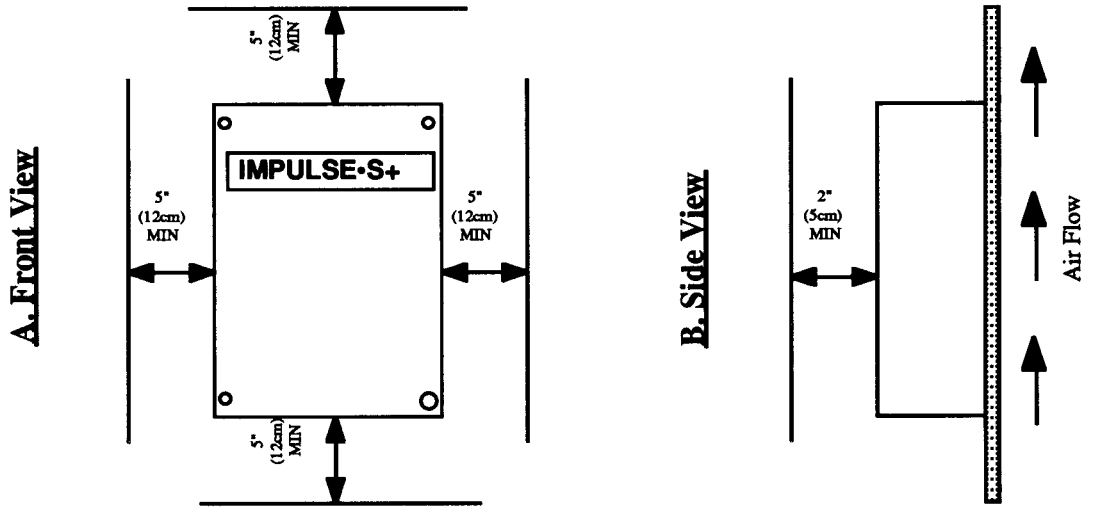
Proper location of the **IMPULSE•S+** is imperative to achieve specified performance and a normal operating life. These units should always be installed in areas where the following conditions exist:

* Ambient operating temperature: + 14 to + 122 ° F (-10 to +50 °C)
  + 14 to 104 °F (-10 to +40 °C) for enclosed type
* Protected from rain and moisture.
* Protected from corrosive gases or liquids.
* Sheltered from direct sunlight.
* Free from metallic particles or excessive airborne dust.
* Free from excessive vibration (see specification sheet).

2.2 Positioning

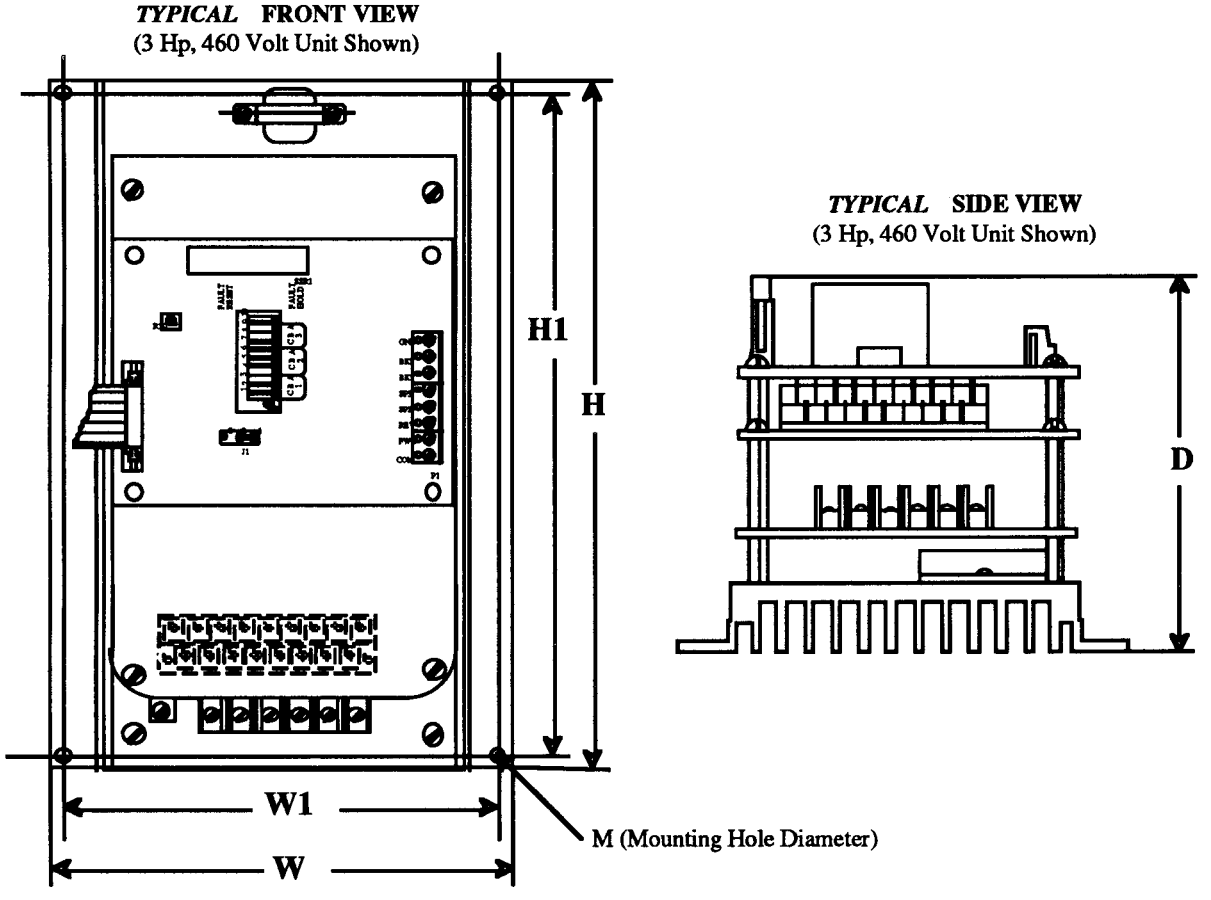
For cooling and maintenance purposes, make sure that there is sufficient clearance around the **IMPULSE•S+** whether it is enclosed in a cabinet or not, as shown in Figure 1. To maintain effective air flow/cooling, **IMPULSE•S+** must be installed with heatsink ribs oriented vertically.

Figure 1
IMPULSE•S+ Clearance Requirements



2.3 Mounting Dimensions

Figure 2: **IMPULSE•S+** Physical Dimensions



MODEL NO.	H	H1	W	W1	D	M
230AFD1-S+	8.66(220)	8.27(210)	5.91(150)	5.51(140)	5.85(150)	0.19(4.8)
230AFD2-S+	9.45(240)	9.06(230)	5.91(150)	5.51(140)	6.36(161)	0.19(4.8)
230AFD3-S+	10.63(270)	10.04(255)	7.09(180)	6.50(165)	7.46(190)	0.22(5.5)
460AFD1-S+	9.06(230)	8.66(220)	5.91(150)	5.51(140)	6.68(170)	0.19(4.8)
460AFD2-S+	9.84(250)	9.84(250)	7.09(180)	6.50(165)	6.95(177)	0.22(5.5)
460AFD3-S+	9.84(250)	9.25(235)	7.09(180)	6.50(165)	6.95(177)	0.22(5.5)
460AFD5-S+	11.81(300)	11.02(280)	8.27(210)	7.68(195)	9.12(232)	0.22(5.5)
460AFD7.5-S+	13.39(340)	12.60(320)	8.27(210)	7.68(195)	9.12(232)	0.22(5.5)
460AFD10-S+	13.39(340)	12.60(320)	8.27(210)	7.68(195)	9.12(232)	0.22(5.5)

2.4 Specifications

MODEL NUMBER		230AFD			460AFD					
		1-S+	2-S+	3-S+	1-S+	2-S+	3-S+	5-S+	7.5-S+	10-S+
MAX. SINGLE MOTOR HP		1.0	2.0	3.0	1.0	2.0	3.0	5.0	7.5	10
MAX. DUAL MOTOR HP (Ea.)		0.33	0.75	1.0	0.33	0.75	1.0	2.0	3.0	4.0
MAX. SINGLE MOTOR AMPS		4.2	7.5	9.7	2.3	4.0	5.5	9.0	13.5	17.5
MAX. DUAL MOTOR AMPS (Ea.)		1.4	2.5	3.25	0.8	1.4	1.9	3.4	4.8	6.4
RATED CURRENT (3Ø Input)		4.2	7.5	9.7	2.3	4.0	5.5	9.0	13.5	17.5
RATED CURRENT(1Ø Input)*		2.0	3.5	5.0	Do Not Use 1Ø Power Supply					
INPUT POWER SUPPLY		208/230 V ±10%			400/440/460/480 V ±10%					
MAX. OUTPUT VOLTAGE		Output V = Input V								
OUTPUT FREQ. RANGE		1.7 to 120 Hz								
FREQUENCY RESOLUTION		0.25 Hz (5 to 60Hz), 0.5Hz (5 to 120Hz)								
FREQUENCY ACCURACY		±0.5% (14°F to 104°F), (-10°C to +40°C)								
OVERLOAD CAPACITY		150% for 2 minutes								
ACCEL/DECEL TIMES		0.35 to 26 Sec. (16 independent selections available)								
BRAKING		100% Torque/ 10% duty cycle by built-in resistor, DC ≤ 3Hz								
APPROX. WEIGHT		5.38	5.83	11.56	12.44	5.39	5.73	11.56	12.44	18.83	19.93
INPUT SIGNAL	For/Rev Run	120VAC Contact Closure (Others available upon request)								
	Freq. Setting	Digital: 120VAC Contact Closures (Selectable Output Hz) Analog: Potentiometer built into TC-SIF-5								
	Reset	Automatic or Manual								
OUTPUT SIGNAL	Brake Interlock	SSR output, ≤ 3 Amps, ≤ 250VAC								
PROTECTIVE FUNCTIONS	Power Loss	Rides through if ≤ 15mS, Base Block if > 15mS								
	Undervoltage	Base Block if input ≤ 170VAC (330VAC)								
	Overvoltage	Base Block if overvoltage during braking								
	Overcurrent	Base Block if short circuit or ground fault before operation								
ENVIRONMENTAL CONDITIONS	Location	Indoor (free from corrosive gases and dust)								
	Ambient Temp.	14°F to 122°F (-10°C to +50°C)								
	Humidity	95% max. relative (non-condensing)								
	Elevation	3300 feet maximum (1000 meters)								
	Vibration	1.0G at≤ 20Hz, up to 0.5G at > 20Hz/≤50Hz								

*Note: When using single-phase power supply, be sure to connect to terminals L1, L2.

Special Note: *if you purchased this* ***IMPULSE•S+*** *as part of an ELECTROMOTIVE SYSTEMS, pre-engineered,* ***TCONTROL*** *motor control panel you should skip Section 3 and proceed directly to Section 4.*

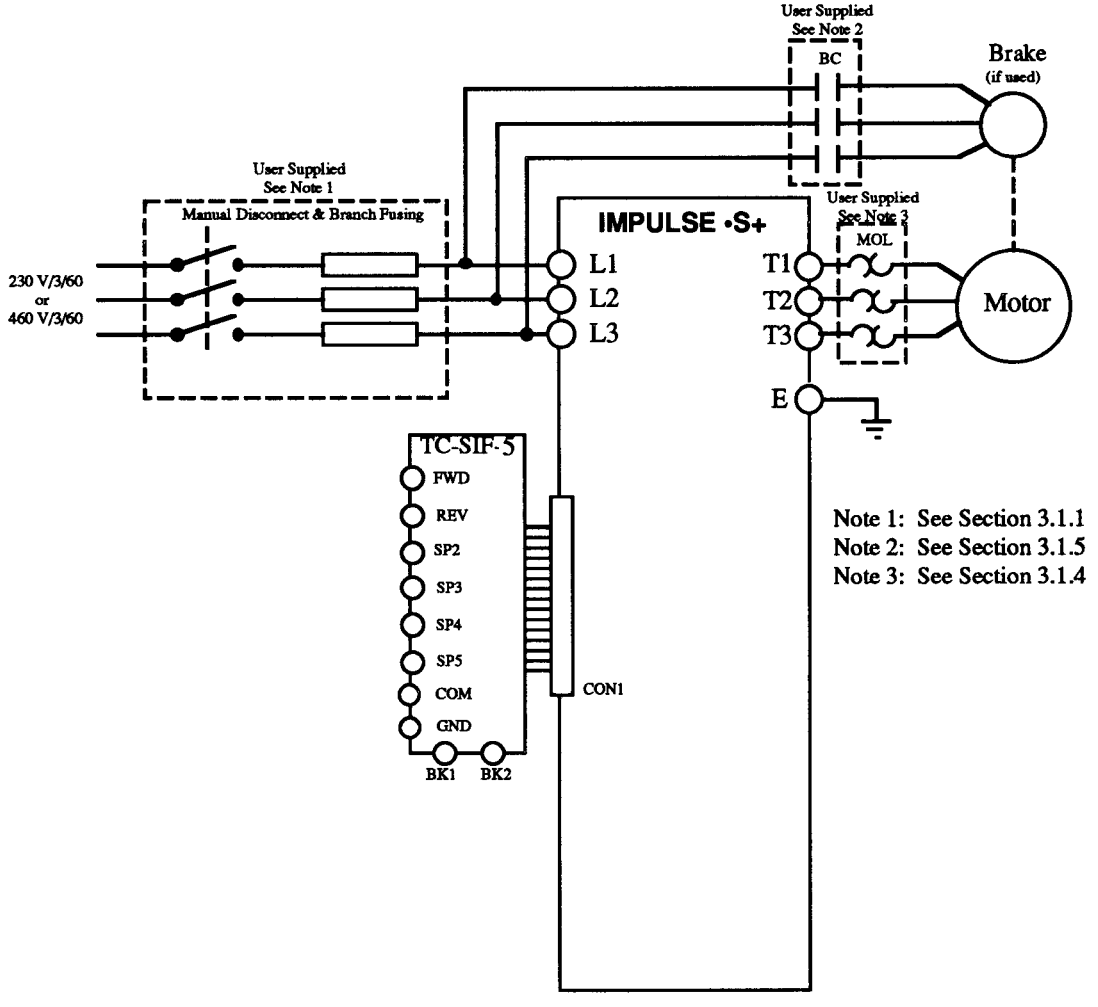
Section 3 provides ELECTROMOTIVE SYSTEMS' recommendations regarding the power and control circuit wiring of the ***IMPULSE•S+*** *unit. We must emphasize, however, that these are only suggestions.* ***You must follow the NEC and your local applicable codes whenever making any of the interconnections to this unit.***

Finally, please read ALL the sub-sections of Section 3 before beginning any of the unit wiring.

SECTION 3: WIRING

3.1 Main AC Power Interconnections

Figure 3: **IMPULSE•S+** Main Power Circuit Connections



3.1.1 Input Fuse or Circuit Breaker Selection

You should have some disconnecting means and branch circuit protection between the incoming three-phase power supply and the **IMPULSE•S+**. This branch circuit protection can either be in the form of a thermal magnetic, Molded Case Circuit Breaker (MCCB) or dual element "slow blow" type fuses. Table 1 shown below provides the suggested ratings for each of the **IMPULSE•S+** ratings.

TABLE 1
MCCB & Fuse Selection

MODEL NO.	230 AFD			460 AFD					
	1-S+	2-S+	3-S+	1-S+	2-S+	3-S+	5-S+	7.5-S+	10-S+
Rated Output Current (A)	4.2	7.5	9.7	2.3	4.0	5.5	9.0	13.5	17.5
Molded Case Circuit Breaker (MCCB) Rating (A)	15	15	20	15	15	15	20	25	30
Input Fuses (A)	5	8	10	3	4	6	10	12	20

Class "CC" Fuses

3.1.2 Wire Size

The wiring used in the main power circuit should be sized according to Table 2 shown below.

TABLE 2
Power Wire Selection

MODEL NO.	230 AFD			460 AFD					
	1-S+	2-S+	3-S+	1-S+	2-S+	3-S+	5-S+	7.5-S+	10-S+
Rated Output Current (A)	4.2	7.5	9.7	2.3	4.0	5.5	9.0	13.5	17.5
Power Circuit Wiring (L1, L2, L3 & T1, T2, T3) Minimum AWG	12 AWG	12 AWG	12 AWG	12 AWG	12 AWG	12 AWG	12 AWG	12 AWG	12 AWG

3.1.3 Grounding

Connect a positive ground using terminal "E" on the TM1 circuit board.

* Wire size should be at least # 14 AWG. The lead length should be kept as short as possible.

* Ground resistance should be 100 Ω or less.

* Never ground the **IMPULSE•S+** along with welding machines, large current machines, etc. Run the ground for the **IMPULSE•S+** in separate conduit.

* Where several **IMPULSE•S+** units are used together all of them should be directly grounded to a common ground pole. Alternatively, connecting all of the **IMPULSE•S+** Earth (E) ground terminals together and running a single wire to the ground pole is also acceptable. Be careful to ensure that you do not form a loop with the ground wires.

Figure 4: Grounding of Multiple **IMPULSE•S+** Units

3.1.4 Motor Thermal Overload Relay

To prevent the motor from overheating, a thermal overload relay (MOL) should be installed between the **IMPULSE•S+** output terminals T1, T2, T3 and the motor (see Figure 3).

Note: a thermal overload relay is not required when using motors with thermal detectors embedded in the windings of the motor. Because operating fan-cooled motors at low speeds may overheat the motor (even at rated current), the use of thermal detectors in the motor is recommended when using **IMPULSE•S+** with fan-cooled motors. Although this is not the case with non-ventilated type motors, thermal detectors will always provide a level of protection not available with conventional thermal overload relays.

* The thermal overload relay should be adjusted to match the motor's full load amp rating.

* When multiple motors are being operated in parallel using a single **IMPULSE•S+**, a separate thermal overload relay should be provided for each motor.

3.1.5 Brake Motor Magnetic Contactor

IMPULSE•S+ generates a variable voltage output (dependent on output frequency). For this reason, a magnetic contactor (BC) must be installed to provide the motor brake with line power (See Figure 3). NOTE: When using a motor brake in conjunction with **IMPULSE•S+**, the brake power supply must be from the commercial supply -- not derived from the **IMPULSE•S+** output terminals.

* Figure 3 shows a typical wiring scheme for use with a 3 phase motor brake. If a single phase (120 VAC or 240 VAC) brake is used, the BK1 to BK2 output on the TC-SIF-5 circuit board can be wired directly to the motor brake coil. This eliminates the need for the brake motor magnetic contactor (BC).

* **We strongly recommend the use of a suitable surge absorber across the brake coil(s) to prevent excessive voltage transients when the coil(s) is de-energized.** For AC coil brakes you should use an R-C type (not MOV type) suppressor. For DC coil brakes you should use a diode type suppressor.

3.1.6 Magnetic Mainline Contactor

Caution: NEVER connect a magnetic contactor between the motor and the IMPULSE•S+ output terminals (T1, T2, T3). Opening of such a contactor while the unit is driving a motor will result in a large transient voltage that could result in power device failure. Closing of such a contactor after the unit is running will result in a large locked rotor, inrush current that could eventually weaken the power devices.

If a mainline, input magnetic contactor is used it should be wired to provide line power to the input terminals of the **IMPULSE•S+** (or multiple units in separate branch circuits) when the contactor coil is energized via a typical momentary/maintained on/off control circuit.

3.1.7 Special Warnings for Power Semi-Conductors

* **Never wire the incoming AC power (230 Volt or 460 Volt) to the output terminals (T1, T2, T3). Applying this voltage to the IMPULSE•S+ output will destroy the unit.**

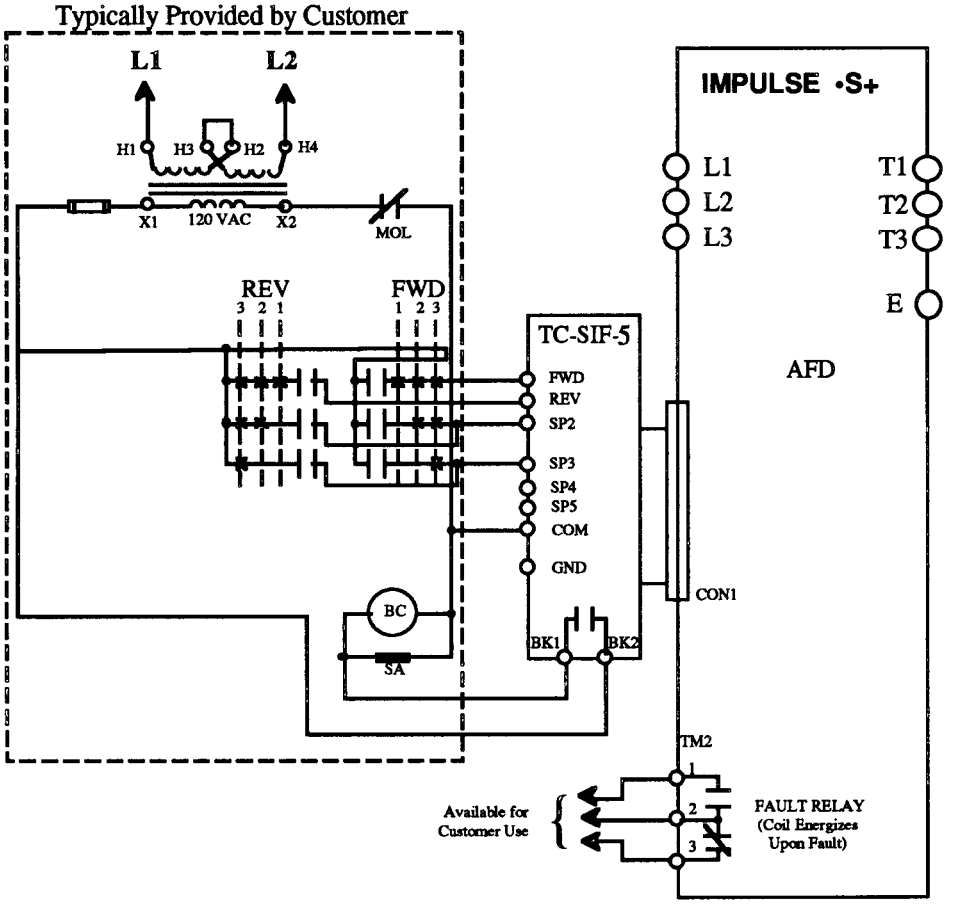
* Never connect power factor correction capacitors across the output terminals (T1, T2, T3) of the unit.

* Ensure there are no short circuits on the **IMPULSE•S+** output terminals.

* Never megger the motor leads while the **IMPULSE•S+** is connected. The power semi-conductors are vulnerable to such high, transient voltages.

3.2 Control Circuit Interconnections

Figure 5: Recommended Control Circuit Interconnections.



3.2.1 Wire Size

All of the control wiring used with the **IMPULSE•S+** unit should be at least 16 AWG.

3.2.2 Direction and Speed Selection Input Commands

The **IMPULSE•S+** has been specifically designed to be directly compatible with 120 VAC input signals. There is no need to add interface relays or isolation circuitry. The **IMPULSE•S+** control inputs are all optically isolated to provide superior immunity from electrical noise, which is so common in the industrial environment.

The control inputs for crane, hoist, and monorail applications are typically provided by means of a remote operator's station or pendant control (i.e. pushbutton station). Figure 5 (shown on the previous page) shows a common control scheme utilizing a "cumulative-type", 5-step control.

IMPORTANT NOTE: The number of input steps required (1, 2, 3, 4, or 5) is dependent upon the chosen method of speed control. Section 4 of this manual outlines the various speed control methods that are available with the **IMPULSE•S+** and lists the number of input steps required to achieve that particular method of speed control. Once the speed control method is known, the actual control circuit interconnection requirements are known. In fact, the power and flexibility of the **IMPULSE•S+** allows the user to change from one speed control method to another without changing any input wires, so long as each method utilizes the same number of input steps. (See Section 4 for more details).

3.2.3 Motor Brake Interlock Output Command

The **IMPULSE•S+** has been specifically designed to provide an output signal that is used to energize the brake contactor coil (BC) and release the motor brake at the same time the unit receives a forward/reverse command (This output is often referred to as a run contact output--See figure 5.)

IMPORTANT NOTE: The state of the brake interlock output signal when the **IMPULSE•S+** receives a stop command is dependent upon the chosen method of braking. Section 4.2 of this manual outlines the two different methods of braking that are available with the **IMPULSE•S+.** Regardless of the braking method, the control wiring does not change. In fact, the power and flexibility of the **IMPULSE•S+** allows the user to change from one braking method to another without changing any wires. (See Section 4 for more details.)

3.2.4 Motor Thermal Overload Relay

A normally closed contact off the thermal overload relay should be wired in series with the (X2) signal lead to stop operation in the event of a motor thermal overload condition. (See Figure 5.)

* When multiple thermal overload relays are being used, the relay contacts should be wired in series with the (X2) signal lead.
* When motors with thermal detectors are used, the overload contact should be wired in series with the (X2) signal lead.
* When only a single direction is to be interrupted by a motor overload condition, the overload relay contact should be placed in series with the appropriate directional input.

3.2.5 Fault Relay Output Contacts

A fault relay Form C contact (Normally open/Normally closed) output is provided on the TM2 circuit board (Terminals 1,2,3). This can be used in a specific control scheme to signal an **IMPULSE•S+** protective fault condition. (See Figure 5.)

3.2.6 Additional Wiring Precautions

An R-C type (not MOV type) surge absorber MUST BE used across the coil of all contactors and relays contained within the same electrical enclosure as the IMPULSE•S+. Failure to do so will result in noise related nuisance fault conditions (see Table 3 for applicable surge absorbers.)

R-C type (not MOV type) surge absorbers are sometimes required to suppress the coils of AC electro-mechanical brakes. Especially be certain to test all functions of the **IMPULSE•S+** system if 3Ø AC brakes are applied (see Table 3 for applicable surge absorbers.) Failure to adhere to this precaution may lead to nuisance noise related fault conditions.

Source KVA MUST BE limited to ≤ 500KVA to protect against premature rectifier assembly failure. If Source KVA exceeds 500KVA, then installation of appropriate reactor is required. If multiple inverters are used, installation of individual reactors is not required--one reactor capable of combined amperage is acceptable (see Table 4 for details.)

3.2.6 Additional Wiring Precautions (Continued)

Table 3: R-C Surge Absorber Specifications

Applied VAC/ General Application	Capacitor	Resistor	Part Number*
120VAC(1Ø)	0.47µFd	100Ω	RCS1G6
For Contactor Coil/	0.47µFd	150Ω	RCS1H6
Magnetic Brake Coils	0.47µFd	220Ω	RCS1A6
240VAC(1Ø)	0.47µFd	100Ω	RCS2G6
For Contactor Coil/	0.47µFd	150Ω	RCS2H6
Magnetic Brake Coils	0.47µFd	220Ω	RCS2A6
480VAC (3Ø)	0.47µFd	100Ω	RCY6G-30
For 3Ø Brake Coils	0.47µFd	220Ω	RCY6A-30

= Electromotive Systems Standard (if A-B brand contactor (IEC type) is used then p/n is A-B 199-FSMA1).

*Note: Part numbers are those of R-K Electronics. These parts are available either from Electromotive Systems, Inc. or R-K. R-K Phone: 513-489-4060.

Table 4: AC Reactor Specifications*

IMPULSE•S+ Model No.	Maximum Cont. Amps	230V Part No.	230V Max. HP	460V Part No.	460V Max. HP
230AFD1-S+	4.0	REA230-1	1		
230AFD2-S+	8.0	REA230-2	2		
230AFD3-S+	12	REA230-3	3		
460AFD1-S+	2.0			REA460-1	1
460AFD2-S+	4.0			REA460-2	2
460AFD3-S+	8.0			REA460-3	3
460AFD5-S+	12			REA460-5	5
460AFD7.5-S+	18			REA460-7.5	7.5
460AFD10-S+	25			REA460-10	10
These sizes for larger inverters/ combinations of multiple low capacity inverters.	25	REA230-7.5	7.5	REA460-15	15
	35	REA230-10	10	REA460-25	25
	45	REA230-15	15	REA460-30	30
	55	REA230-20	20	REA460-40	40
	80	REA230-25	25	REA460-60	60
	100	REA230-40	40	REA460-75	75
	130	REA230-50	50	REA460-100	100

*Note: Reactors are 3% Impedance Type

Customer Notes:

SECTION 4: CONTROL FLEXIBILITY

The **IMPULSE•S+** is a unique combination of hardware and software that provides the user with unparalleled sophistication and flexibility for selection of specific crane/hoist operation modes. These include:

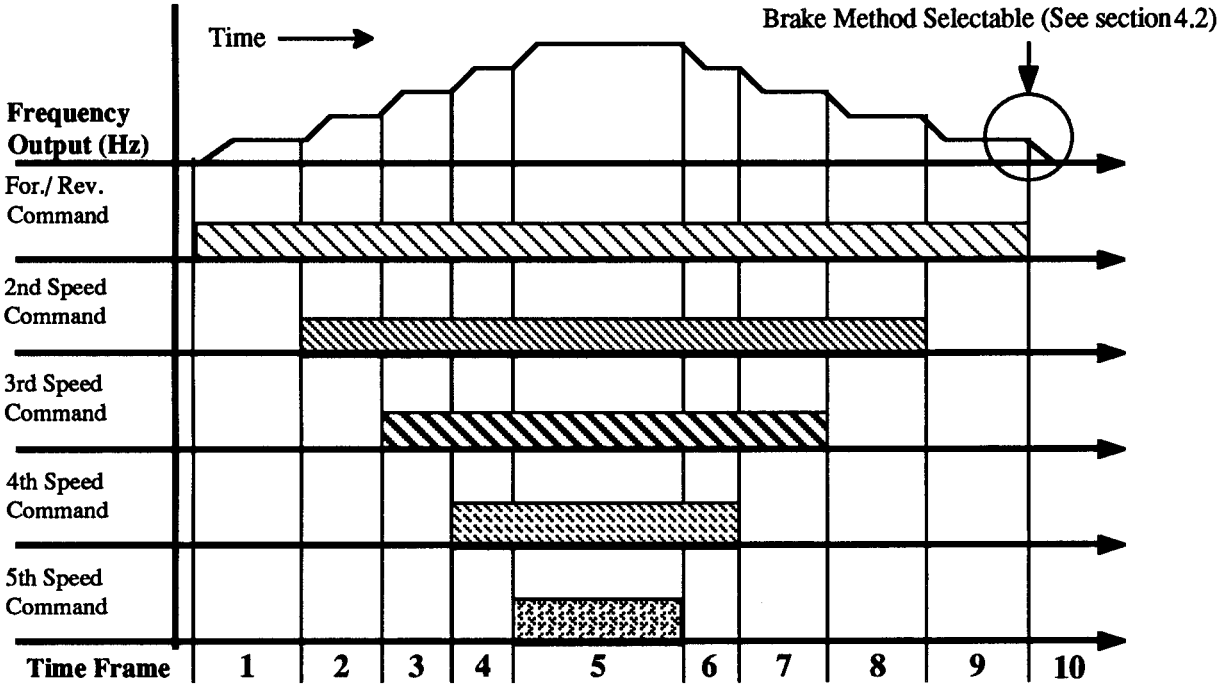
* Speed Control Method Selection
  - Multi-Step Mode
  - 2-Step Infinitely Variable Mode
  - 3-Step Infinitely Variable Mode

* Braking Method Selection
  - Base Block at Stop Command
  - Decelerate at Stop Command

4.1 Speed Control Method Definitions

4.1.1 Multi-Step Speed Control Method

IMPULSE•S+ allows the user to select up to five speed points, the frequency (speed) of each point being selectable from a menu of seven digital (preset) speeds and one adjustable speed. Multi-Step Speed Control is described by the following timing chart:



Time

1 Run Forward/ Reverse at Speed one (1) Command--Freq. output increases to Hz of Speed 1, and continues to run at constant Hz.

2 Second Detent/2nd Speed Command--Freq. output increases to Hz of Speed 2, and continues to run at constant Hz.

3 Third Detent/3rd Speed Command--Freq. output increases to Hz of Speed 3, and continues to run at constant Hz.

4 Fourth Detent/4th Speed Command--Freq. output increases to Hz of Speed 4, and continues to run at constant Hz.

5 Fifth Detent/5th Speed Command--Freq. output increases to Hz of Speed 5, and continues to run at constant Hz.

6 Fourth Detent/4th Speed Command--Freq. output decreases to Hz of Speed 4, and continues to run at constant Hz.

7 Third Detent/3rd Speed Command--Freq. output decreases to Hz of Speed 3, and continues to run at constant Hz.

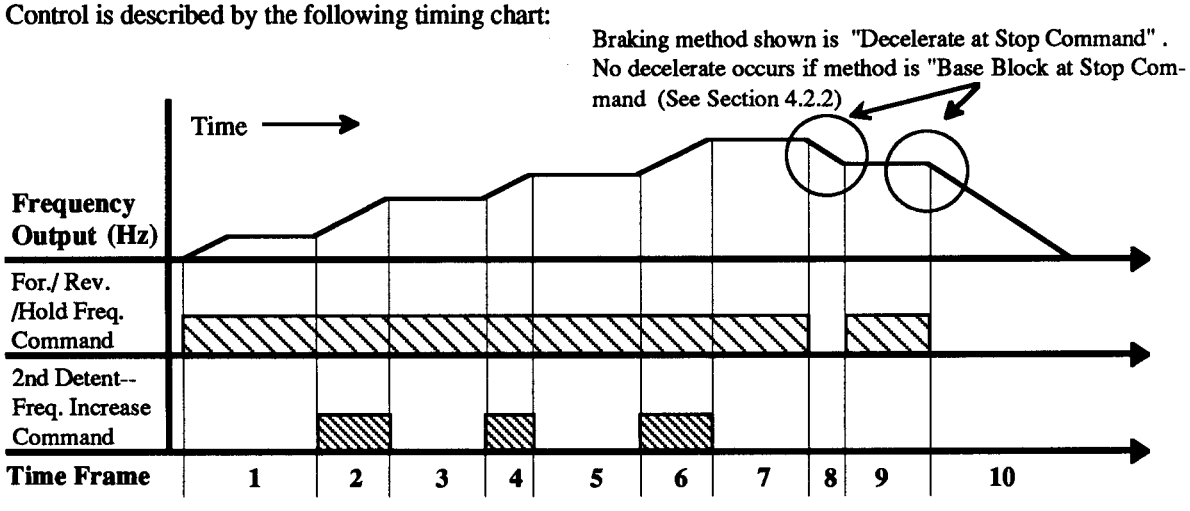
8 Second Detent/2nd Speed Command--Freq. output decreases to Hz of Speed 2, and continues to run at constant Hz.

9 Run Forward/Reverse at Speed one (1) Command--Freq. decreases to Hz of Speed 1, and continues to run at constant Hz.

10 Absence of commands = **STOP** Command. Braking method is selectable (See Section 4.2.)

4.1.2 Infinitely Variable Speed Control Method (2-Step Type)

IMPULSE•S+ provides for true infinitely variable speed control with just two (2) simple 120VAC inputs. This unique software function allows the use of inexpensive two speed pushbuttons. Two-Step infinitely variable is most often used on horizontal travel motions where it is acceptable to decelerate the motor when a STOP command is applied (the control device is returned to the off position.) Two-step Infinitely Variable Speed Control is described by the following timing chart:



Time **1** First Detent--Run Forward (Reverse) at Lower Limit/ Hold Freq. Command--frequency output increases to frequency of lower limit.

2 Second Detent/Freq. Increase Command--Freq. output increases. The longer this contact is closed, the higher the frequency output becomes--limited only to the adjustable upper limit.

3 First Detent/ Freq. Hold Command--Freq. output remains constant.

4 Second Detent/ Freq. Increase Command--Freq. output increases. The longer this contact is closed, the higher the frequency output becomes--limited only to the adjustable upper limit.

5 First Detent/ Freq. Hold Command--Freq. output remains constant.

6 Second Detent/ Freq. Increase Command--Freq. output increases. The longer this contact is closed, the higher the frequency output becomes--limited only to the adjustable upper limit.

7 First Detent/ Freq. Hold Command--Freq. output remains constant.

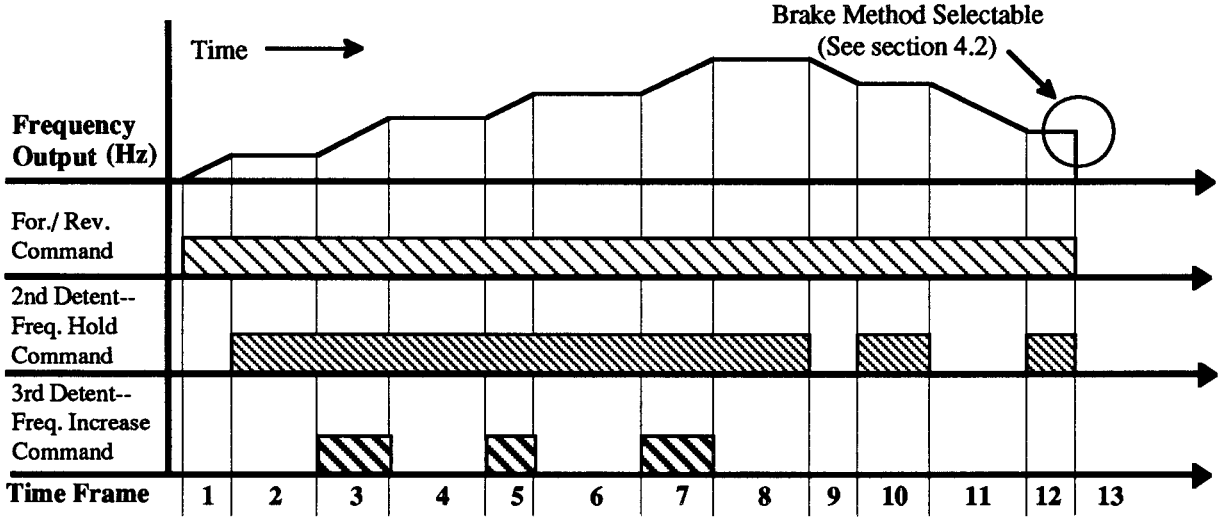
8 Absence of Commands = **STOP** Command. Output frequency descends. The longer this input signal condition exists, the lower the output frequency becomes. Output frequency will go to Zero, and the brake will set automatically if the time of deceleration is met. Braking method is "Decelerate at STOP Command" only! (See Section 4.2.2).

9 First Detent/ Freq. Hold Command--Freq. output remains constant.

10 Absence of Commands = **STOP** Command. Output frequency descends. The longer this input signal condition exists, the lower the output frequency becomes. Output frequency will go to Zero, and the brake will set automatically if the time of deceleration is met. Braking method is "Decelerate at STOP Command" only! (See Section 4.2.2).

4.1.3 Infinitely Variable Speed Control Method (3-Step Type)

IMPULSE•S+ provides true infinitely variable speed control with three simple 120VAC inputs. 3-Step infinitely variable speed control is most often used on hoist motions where it is not acceptable to decelerate the motor when a STOP command is applied. (The control device is returned to the off position.) 3-Step infinitely variable speed control is described by the following timing chart.



Time

1 Run Forward/ Reverse at Lower Limit Command--Freq. output increases to frequency of lower limit.

2 Second Detent/Freq. Hold Command--Freq. output remains constant.

3 Third Detent/Freq. Increase Command--Freq. output increases. The longer this contact is closed, the higher the output frequency becomes--limited only to the adjustable upper limit.

4 Second Detent/Freq. Hold Command--Freq. output remains constant.

5 Third Detent/Freq. Increase Command--Freq. output increases. The longer this contact is closed, the higher the output frequency becomes--limited only to the adjustable upper limit.

6 Second Detent/Freq. Hold Command--Freq. output remains constant.

7 Third Detent/Freq. Increase Command--Freq. output increases. The longer this contact is closed, the higher the output frequency becomes--limited only to the adjustable upper limit.

8 Second Detent/Freq. Hold Command--Freq. output remains constant.

9 Run Forward/Reverse at Lower Limit Command--Frequency output decreases. The longer this input signal condition exists, the lower the output frequency becomes--limited only by the adjustable lower limit.

10 Second Detent/Freq. Hold Command--Freq. output remains constant.

11 Run Forward/Reverse at Lower Limit Command--Frequency output decreases. The longer this input signal condition exists, the lower the output frequency becomes--limited only by the adjustable lower limit.

12 Second Detent/Freq. Hold Command--Freq. output remains constant.

13 Absence of commands = **STOP** Command. Braking method is selectable. (See section 4.2.)

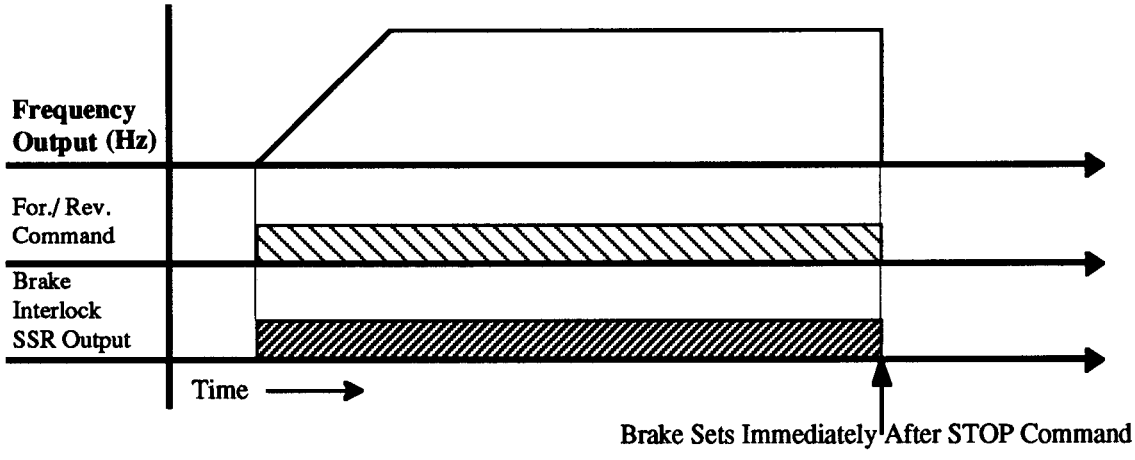
4.2 Braking Method Definitions

IMPULSE•S+ provides for both types of commonly accepted braking methods.

- Base Block at STOP Command
- Decelerate at STOP Command

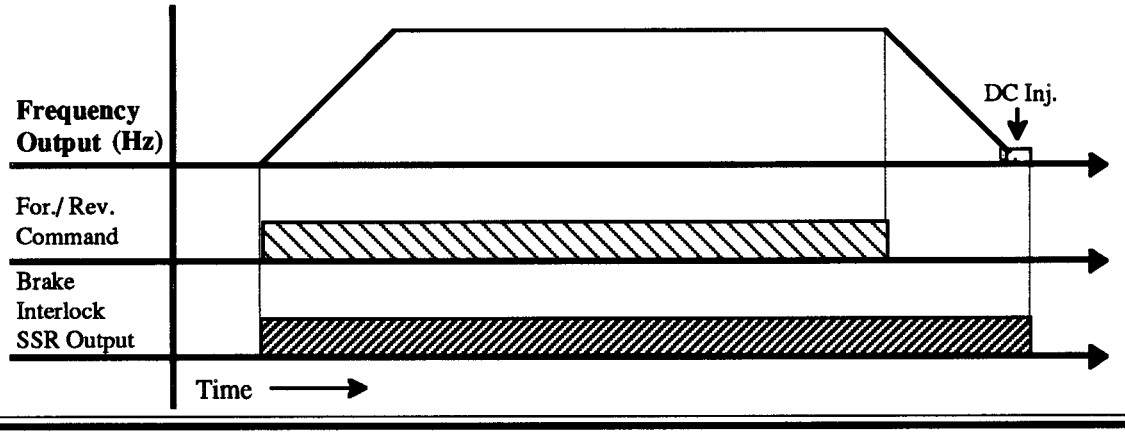
4.2.1 Base Block At STOP Command

Upon **STOP** command, **IMPULSE•S+** base blocks main output transistors (i.e. the motor is electrically disconnected from the drive) and the brake interlock (SSR) sets the motor brake. See below timing chart for operation characteristics.



4.2.2 Decelerate At STOP Command

Upon **STOP** command, **IMPULSE•S+** output frequency decreases to near zero, DC injects for a few mSeconds, and then sets the brake. See below timing chart for operation characteristics.



Special Note: If you purchased this ***IMPULSE•S+*** *as part of an ELECTROMOTIVE SYSTEMS, pre-engineered, TCONTROL motor control panel, actual settings will be those specified by the order--these may be different than those listed in Section 5 as "factory initial values".*

SECTION 5: SETTINGS AND ADJUSTMENTS

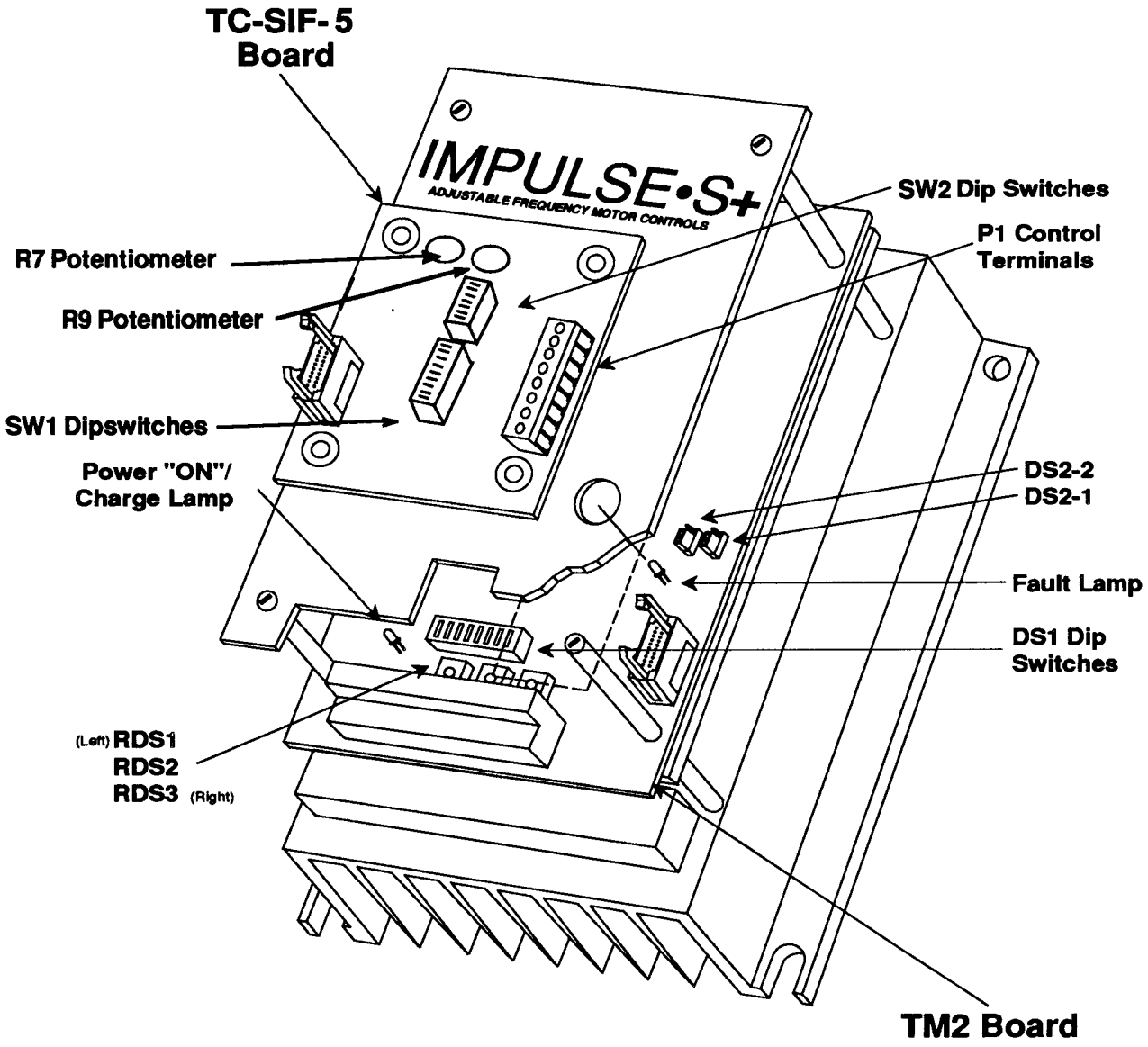
5.1 General Description of Settings and Adjustments

IMPULSE•S+ offers a myriad of specific adjustments and setting capabilities. These adjustments are accessed via 3 groups of "dip" switches. DS1, dip switch # 1 through # 8 is located on the TM2 circuit board. SW1 dip switch # 1 through #9, and SW2 dip switch # 1 through # 7 are located on the TC-SIF-5 circuit board. 3 rotary selector switches (RDS1, RDS2, and RDS3) and 2 shunt connectors (DS2-1, DS2-2) are located on the TM2 circuit board. All of the available adjustments fall into one of two categories/locations:

(1) TM2 Adjustments and Settings
- RDS1 Function: Acceleration Time
- RDS2 Function: Deceleration Time
- RDS3 Function: Voltage/Frequency Output Pattern Selection
- DS1 Functions: Operation Mode Selection
- DS2 Functions: Speed Control Mode Selection

(2) TC-SIF-5 Adjustments and Settings
- SW1 Functions: Soft Inputs
  - Sw1 to Sw9 Functions: Used for speed selection
- SW2 Functions: Soft Inputs
  - Sw1 to Sw6 Functions: Used for speed selection
  - Sw7 Function: Fault Hold/Fault Reset Function
- R7 Functions
  - Infinitely Variable Mode - Upper Limit Function
  - Multi-Step Speed Control Mode - Speed Selection Function
- R9 Function
  - Multi-Step Speed Control Mode - Speed Selection Function

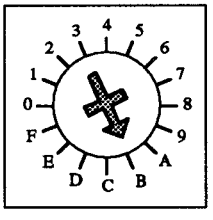
5.2 Location of Adjusting Devices



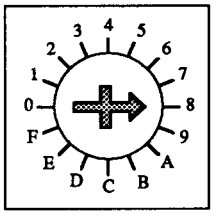
5.3 TM2 Settings & Adjustments

5.3.1 RDS1-Acceleration Time / RDS2-Deceleration Time Adjustments.

The Acceleration time and the Deceleration time can be independently set by rotary selector switches RDS1 and RDS2 (shown below) located on the TM2 circuit card. **IMPULSE•S+** allows the user to select a specific accel/ decel time from one of 16 preset independent ramps (See Table 5.)



RDS1 - Acceleration Time



RDS2 - Deceleration Time

(Both are shown in the factory preset position)

Table 5:
Acceleration/Deceleration Time Settings

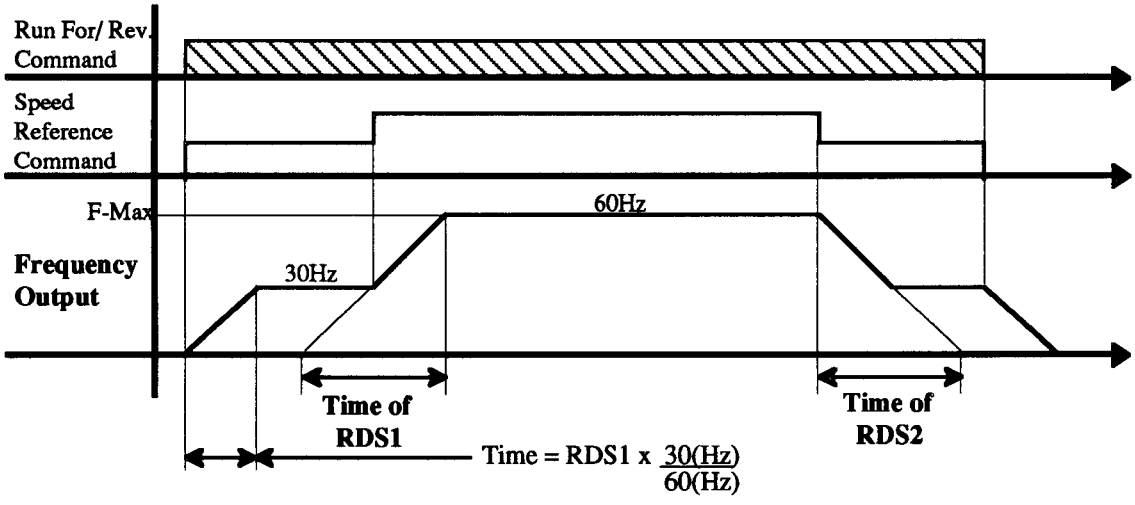
NOTCH SETTING	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
ACCEL/DECEL TIME	0.35	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.30	3.80	4.40	5.30	6.50	8.60	12.8	26.0
DC INJ. TIME	0.09	0.10	0.11	0.12	0.13	0.15	0.16	0.19	0.21	0.25	0.30	0.37	0.50	0.75	1.50	3.00

= **RDS1 (Accel. Time) factory setting**

= **RDS2 (Decel. Time) factory setting**

5.3.1 Acceleration Time /Deceleration Time Adjustments (Continued)

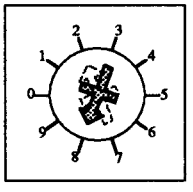
The time indicated by each notch setting in Table 5 (preceding page) is the time to accelerate (decelerate) from zero frequency to maximum frequency (F-max). To determine acceleration to any intermediate frequency, follow the below example. Please note that F-Max is determined by DS1-Sw3 & Sw4 (See Section 5.3.4.)



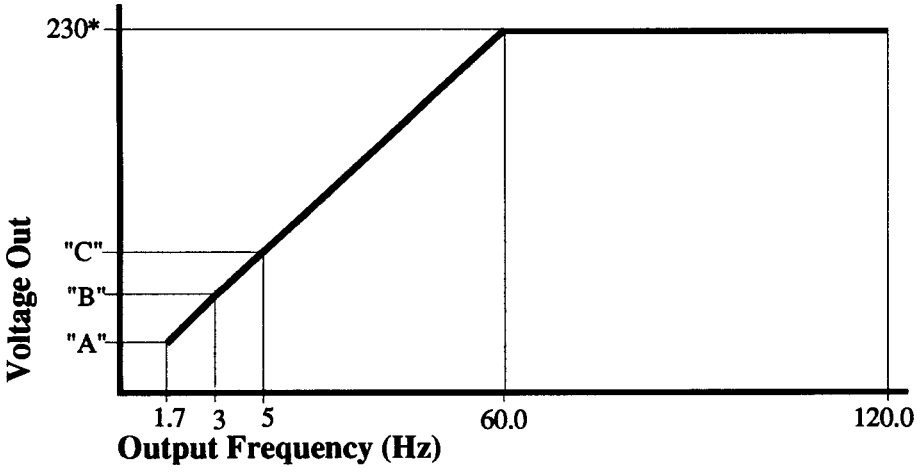
5.3.2 RDS3-Voltage/Frequency Pattern Selection

IMPULSE•S+ offers 10 V/F patterns specially tailored for crane/hoist application. Rotary selector switch RDS3 determines which pattern is applied. RDS3 serves to adjust low speed "torque boost".

Figure 6: RDS3--V/F Pattern Selection



RDS3 - V/F Pattern



NOTCH SETTING	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨
"A" Volts	9.0	10	11	12	13	14	15	16	17	18
"B" Volts	14.4	15.2	16.6	18.6	20.7	22.1	24.8	26.9	28.3	31.1
"C" Volts	21.3	27.6	27.6	31.1	34.5	36.8	41.4	44.9	47.2	51.8

= **Typical Setting for Horizontal App.**

= **Typical Setting for Hoisting App.**

Note: Actual output voltage is dependent upon actual input voltage. Actual output voltage may be calculated as percentage of above numbers--all relationships will be linear.
*Note: Voltage listed on the graph and voltages listed in the table are for 230V series inverters only. Listed values are doubled for 460V series machines.

5.3.3 Voltage/Frequency Pattern Selection Procedure

Application notes for choosing optimum V/F pattern:

1) As a general rule, notches 0 to 4 are considered "horizontal" V/F patterns.
2) As a general rule, notches 5 to 9 are considered "hoisting" V/F patterns.

Procedure:

a) Set lowest notch appropriate for your application (horizontal or hoisting).
b) Run motor under worst case condition--fully loaded hoist, etc.
    - If 125% load test is required, then load for this condition
c) If operation is successful, then setting is good.
d) If operation is not successful, then try again at next higher notch value.

Continue this procedure until operation is satisfactory.

5.3.4 DS1, Sw1 to Sw8, Operation Mode Selection

DS1 series of dip switches control inverter output functions as described below:

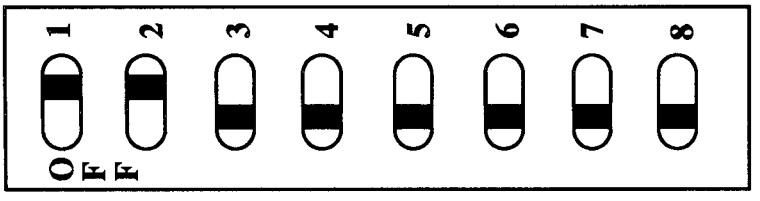


Table 6: Operation Mode Selection

DS1	Description	Setting	Operation Mode	
			Multi-Step Mode	Infinitely Variable Mode
1	Stopping Mode	ON*	Coasts to a Stop (Base Block at Stop Command)	
		OFF	Brakes to a Stop in Time of RDS2	
2	F-Out Lower Limit	ON	5 Hz is output	
		OFF	10 Hz is output	
3	Frequency Output Upper Limit	3-ON, 4-OFF	50 Hz	
		3-OFF, 4-OFF	60 Hz	
4		3-OFF, 4-ON	90 Hz	
		3-ON, 4-ON	120 Hz	
5	F-Out Mult./ Lower Limit	ON	F-Out is per Table 7, Column 5	F-Out at Run is per DS1-2
		OFF	F-Out is per Table 7, Column 4	F-Out at Run is per DS1-2
6	Upper Limit/ Lower Limit	ON	F-Out at Run Comd. is 2 Hz**	Max F-Out is set by R7 Pot
		OFF	F-Out at Run is per DS1-2	Max F-Out by DS1, Sw3/Sw4
7	Analog Freq. Reference Selection	7-OFF, 8-OFF	Freq. set by Freq. Setting Potentiometer or 0 ~ 10Vdc Signal	
		7-OFF, 8-ON	Freq. set by 1 ~ 5Vdc Signal	
8		7-ON, 8-OFF	Freq. set by 4 ~ 20ma Signal	
		7-ON, 8-ON	Analog Freq. setting input is not used	

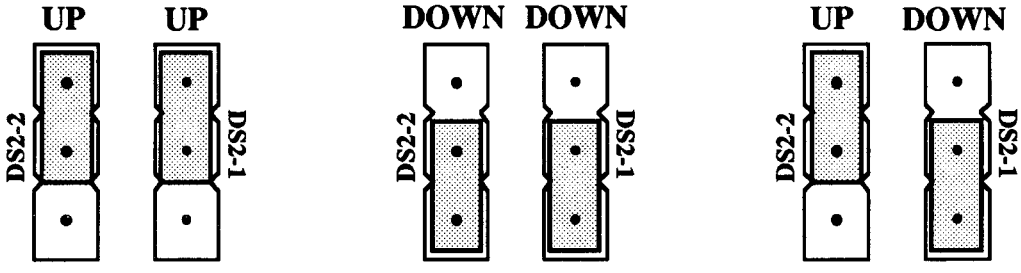
= **DS1 factory settings**

*Note: DS1-Sw1 factory setting is "ON" except when in "2 Step Type Infinitely Variable Speed Mode". When operation mode is specified as "2 Step Type Infinitely Variable Speed Mode", then factory setting is "OFF".

**Note: With Potentiometer

5.3.5 DS2-1, DS2-2 Shunt: Speed Control Method Selection*

The pair of DS2 Shunts change the speed control method of the inverter. There are three valid combinations of the DS2 shunts:



Depending upon the relative setting of this pair of shunts (i.e. "UP" or "DOWN"), the operation characteristics of the inverter change.

		Operation Mode†
DS2-1	UP	Multi-Step Speed Control Method
DS2-2	UP	
DS2-1	DOWN	2 Step Infinitely Variable Speed Control Method
DS2-2	DOWN	
DS2-1	DOWN	3 Step Infinitely Variable Speed Control Method
DS2-2	UP	

†Note: DS2 shunts cooperate with the SW1 (Sw1 to Sw9) and SW2 (Sw1 to Sw7) dip switches to change operation modes. See Section 5.4 for more information.

***For 230AFD1-S+ only, see Appendix III.**

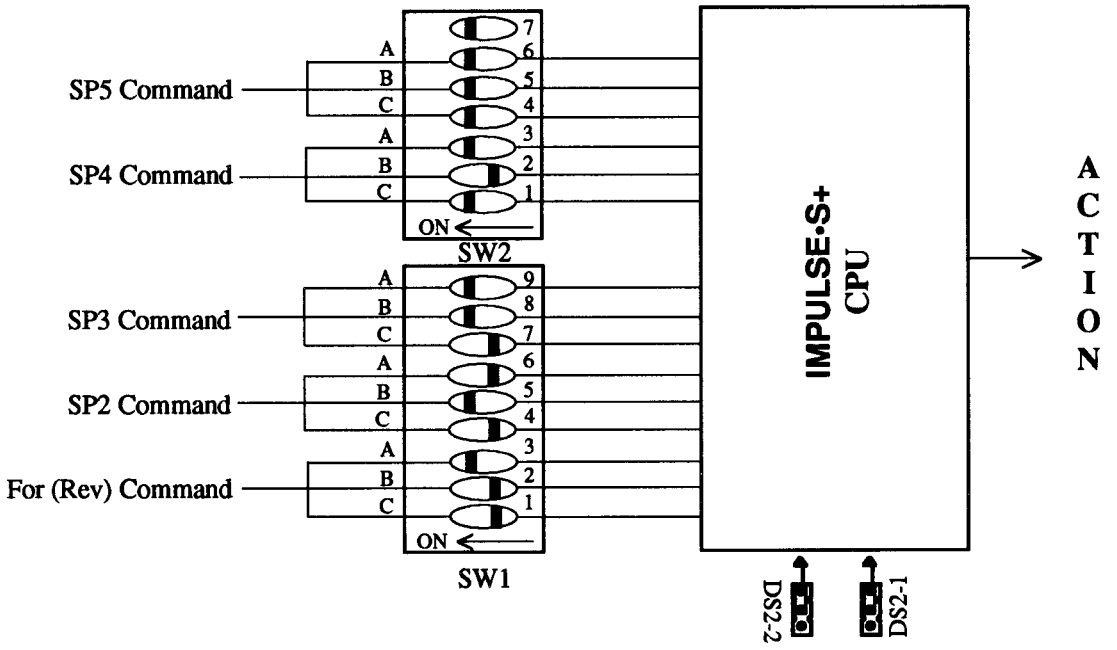
5.4 TC-SIF-5 Settings and Adjustments

The TC-SIF-5 Board offers just 2 adjustment devices:

* SW1 and SW2 Series Dip Switches
  * SW1 (Sw1 to Sw9) and SW2 (Sw1 to Sw7) Function/DS2 Shunt Positions
  * Sw7Function--Fault Hold/Fault Reset Function
* R7 and R9 Potentiometer Functions

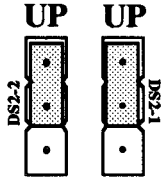
5.4.1 SW1 and SW2 Series Dip Switch Function: Logic Section Inputs

The series of SW1 and SW2 Dip Switches are actually input (i.e. from pendant station) multiplexers. See diagram below:



Note that each input signal line utilizes 3 switches (C, B, A). If the pertinent switch is "ON", the input completes its path to the **IMPULSE•S+** CPU. If the pertinent switch is "OFF", then no signal path to the **IMPULSE•S+** CPU exists. The CPU assembly observes each group of three inputs (C, B, A) as one instruction; considers the settings of the DS2 shunts, and reacts according to the figures and tables found within section 5.4.

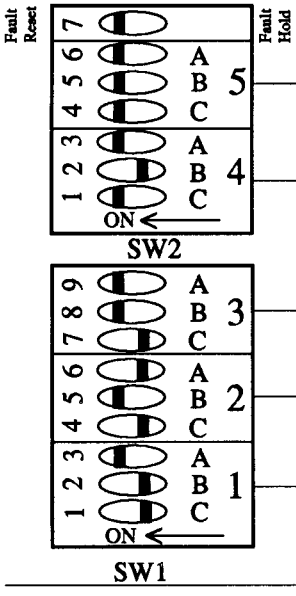
5.4.2 SW1 and SW2 Series Dip Switch Function when DS2-1 "UP", DS2-2 "UP"



Enables Multi-Step Speed Control Method*

SW1 (Sw1 to Sw9) and SW2 (Sw1 to Sw6) Series Dip Switches determine frequency output at each of the 5 possible speed points provided in multi-step speed control mode. Sw1 to Sw9 (SW1) and Sw1 to Sw6 (SW2) are arranged in groups of 3 switches. Each group of three determines the output frequency of an individual speed point. (Sw7 is for fault reset and fault hold.) See Figure 7 and Table 7 below.

Figure 7: SW1 and SW2 Series Dip Switch Function in Multi Step Speed Control Mode



Group 5: The configuration of switches "C", "B", "A" determines the Frequency Output when SP5 Command is input.

Group 4: The configuration of switches "C", "B", "A" determines the Frequency Output when SP4 Command is input.

Group 3: The configuration of switches "C", "B", "A" determines the Frequency Output when SP3 Command is input.

Group 2: The configuration of switches "C", "B", "A" determines the Frequency Output when SP2 Command is input.

Group 1: The configuration of switches "C", "B", "A" determines the Frequency Output when Forward (Reverse) Command is input.

Table 7: F-Out/ "C, B, A" Group Configuration

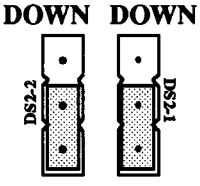
C	B	A	F-OUT DS1-Sw5 "OFF"	F-OUT DS1-Sw5 "ON"
0	0	0	R7 Pot for SW1; R9 Pot for SW2	
0	0	1	5Hz (2Hz)†	10Hz (4Hz)†
0	1	0	10Hz	20Hz
0	1	1	20Hz	40Hz
1	0	0	30Hz	60Hz
1	0	1	40Hz	80Hz
1	1	0	50Hz	100Hz
1	1	1	60Hz	120Hz

0 = OFF, 1 = ON

†Note: 2Hz/4Hz is F-Min when: 1) DS2-1 UP & DS1-6 ON
2) DS2-1 DN & DS1-5 ON

***For 230AFD1-S+ only, see Appendix III.**

5.4.3 SW1 and SW2 Series Dip Switch Function when DS2-1 "DOWN", DS2-2 "DOWN"



Enables 2 Step Infinitely Variable Speed Control Method*

SW1 (Sw1 to Sw9) and SW2 (Sw 1 to Sw6) Series Dip Switches determine the instructions input to the **IMPULSE•S+** CPU. The setting of the SW1 and SW2 switches are fixed per Figure 8 (below). (Sw7 is for fault reset and fault hold.) No variance is permitted to these settings!

Figure 8: SW1 and SW2 Series Dip Switch Function
in 2 Step Infinitely Variable Speed Control Mode

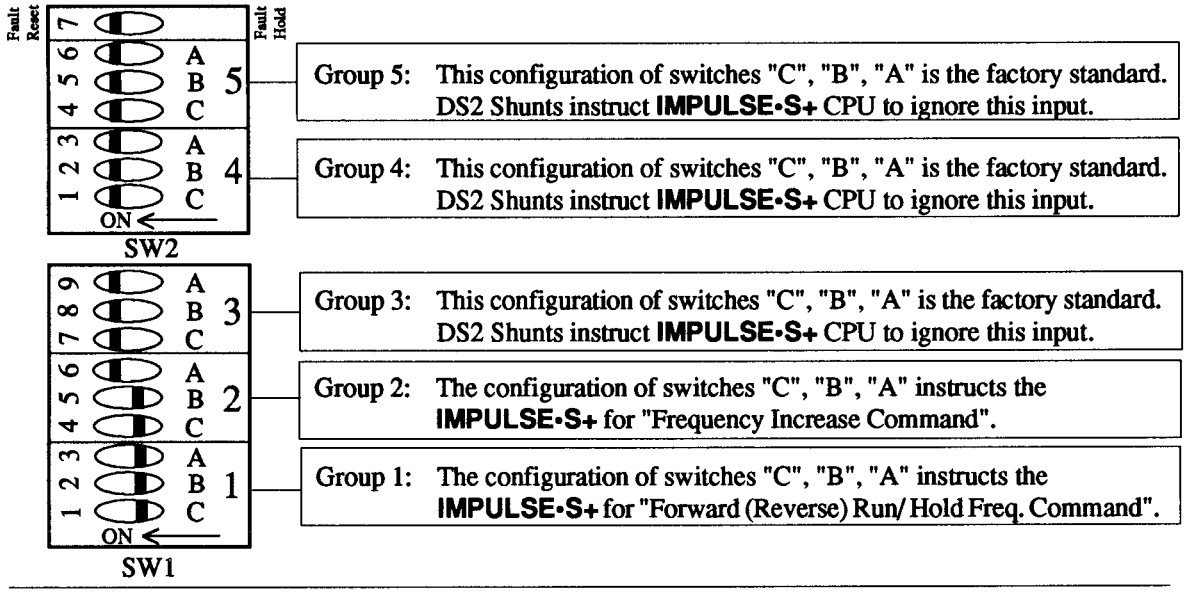


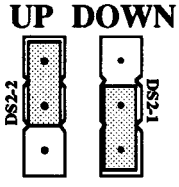
Table 8: Action at "C, B, A" Group Configuration

	C		B		A		
		Sw#		Sw#		Sw#	
Group 1	0	1	0	2	0	3	Instructs Forward (Reverse) Run/ Freq. Hold Command
Group 2	0	4	0	5	1	6	Instructs Frequency Increase Command
Group 3	1	7	1	8	1	9	No Function Command
Group 4	1	1	1	2	1	3	No Function Command
Group 5	1	4	1	5	1	6	No Function Command

0 = OFF, 1 = ON

For 230AFD1-S+ only, see Appendix III.

5.4.4 SW1 and SW2 Series Dip Switch Function when DS2-1 "DOWN", DS2-2 "UP"



Enables 3 Step Infinitely Variable Speed Control Method*

SW1 (Sw1 to Sw9) and SW2 (Sw1 to Sw6) Series Dip Switches determine the instructions input to the **IMPULSE•S+** CPU. The setting of the SW1 switches is fixed per Figure 9 (below). (Sw7 is for fault reset and fault hold.) No variance is permitted to these settings!

Figure 9: SW1 and SW2 Series Dip Switch Function
in 3 Step Infinitely Variable Speed Control Mode

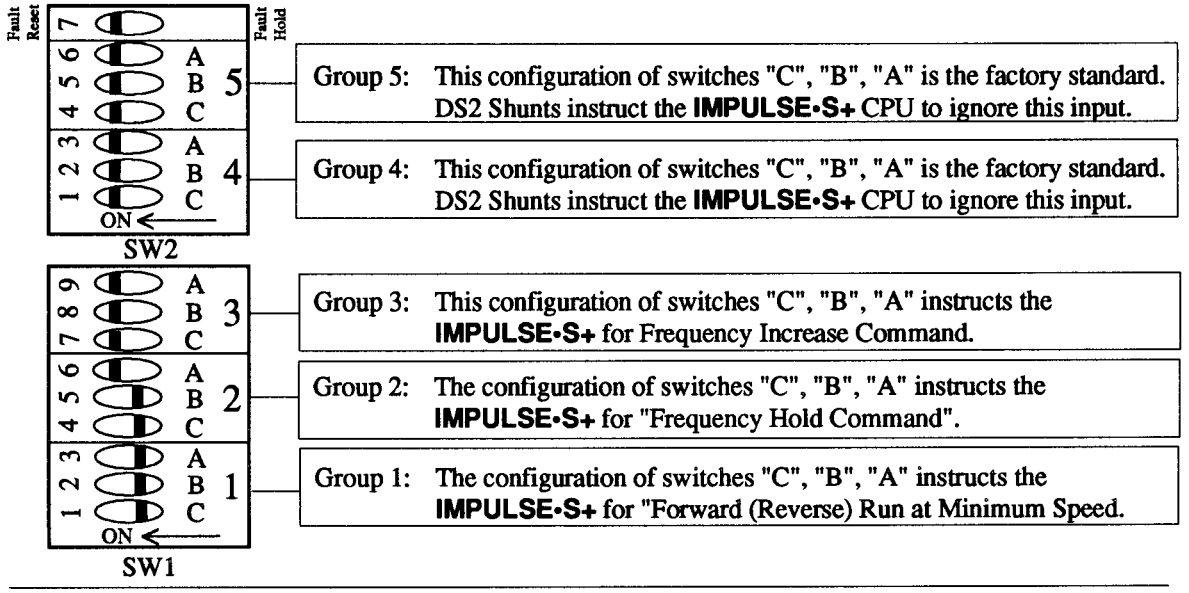


Table 9: Action at "C, B, A" Group Configuration

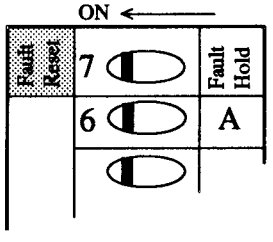
	C		B		A		
		Sw#		Sw#		Sw#	
Group 1	0	1	0	2	0	3	Instructs Forward (Reverse) Run at Minimum Frequency
Group 2	0	4	0	5	1	6	Instructs Frequency Hold Command
Group 3	1	7	1	8	1	9	Instructs Frequency Increase Command
Group 4	1	1	1	2	1	3	No Function Command
Group 5	1	4	1	5	1	6	No Function Command

0 = OFF, 1 = ON

***For 230AFD1-S+ only, see Appendix III.**

5.4.5 SW2 Series Dip Switch Function--Sw7 Fault Hold/Reset Function

The Fault Hold/Fault Reset function is controlled by Switch #7 (Sw7) of the SW2 group located on the TC-SIF-5 circuit board. This function is particularly useful for crane/hoist applications because of the difficulty in manually resetting the **IMPULSE•S+** after a fault has occurred. However, when a specific fault code designation needs to be observed (for troubleshooting, etc.), the **IMPULSE•S+** can easily be set to hold the fault state and coding.



Sw7 "ON" (Factory Setting for Normal Operation)
All faults are automatically reset. **IMPULSE•S+** is awaiting a new "RUN" command. The on-board fault lamp is cleared.

Sw7 "OFF"
Faults are held. The fault designation lamp can now be observed to determine the specific fault condition. There are two methods to reset the drive:
1) Push Sw7 to "ON" position, then push back to "OFF" position.
2) Main power to **IMPULSE•S+** must be turned off, then back on.

5.5 R7 Potentiometer Functions*

The R7 Pot found on the TC-SIF-5 Board serves two possible functions.

* F-Out Upper Limit Function in Infinitely Variable Speed Control Mode
* Speed Selection function in Multi-Step Speed Control Mode (Speed 1, 2, or 3)

The actual operating function is controlled by Sw6 of the DS1 Dip Switches (See section 5.3.4). Please note that Sw6 in only enabled if DS2-1 is "DOWN". See operation chart below:

Table 10: R7 Enabling Factors/Functions

Enabling Factors			R7 Functions
DS2-1	DS1-Sw6	SW1-CBA	
UP	X	All "OFF"†	Speed 1, 2, or 3 Selection
UP	X	Any 1 "ON"	No Function
DOWN	ON	X	F-Out Upper Limit
DOWN	OFF	X	No Function

X = Don't Care
†All "OFF" refers to any single group

***For 230AFD1-S+ only, see Appendix III.**

5.5.1 R7 Pot: Frequency Output Upper Limit Function--Analog Type

Enabled by the settings of Table 10, the R7 Pot sets the Frequency Output Upper Limit. The Frequency output upper limit is the maximum frequency output of the inverter. F-Out upper limit has priority over **any** higher frequency command. R7 upper limit function provides for an unlimited number of maximum speed selections.

5.5.2 R7 Pot: Speed Selection Function in Multi-Step Speed Control Mode

Enabled by the settings of Table 10, the R7 Pot sets the frequency output at any one of the first three speed points(Speed 1, 2,or 3) provided in Multi-Step Speed Control Mode. This function allows one of the first three output speeds to be customized by the user.

5.6 R9 Potentiometer Functions*

Enabled by the settings of Table 11, the R9 Pot sets the frequency output at Speed 4 or Speed 5 provided in Multi-Step Speed Control Mode. This function allows Speed 4 or 5 to be customized by the user.

Table 11: R9 Enabling Factors/Functions

Enabling Factors			R9 Functions
DS2-1	DS1-Sw6	SW2-CBA	
UP	X	All "OFF"†	Speed 4 or 5 Selection
UP	X	Any 1 "ON"	No Function
DOWN	ON	X	No Function
DOWN	OFF	X	No Function

X = Don't Care
†All "OFF" refers to any single group

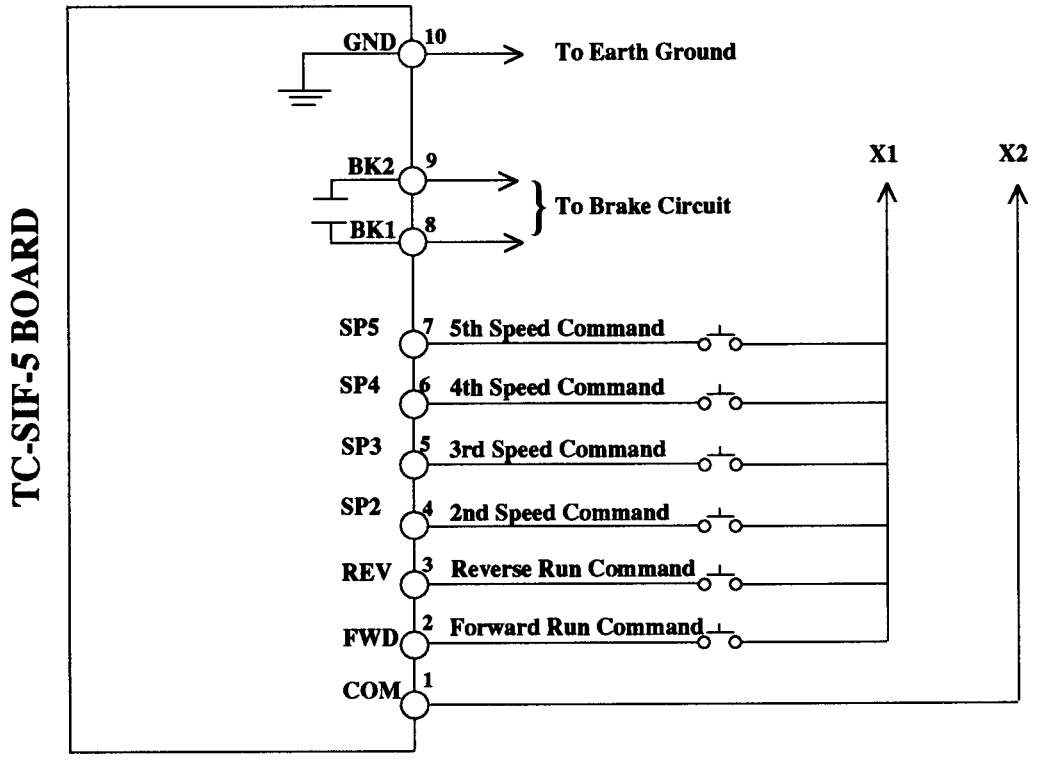
***For 230AFD1-S+ only, see Appendix III.**

SECTION 6: SETTING RECIPES

6.1 Multi-Step Speed Control Method

Specific settings and connections are required to begin "Multi-Step Speed Control Mode" operation. The "recipe" requires both control connections and adjustments to the top circuit board (TC-SIF-5), and adjustments only to the middle circuit board (TM2).

6.1.1 Control Circuit Wiring Diagram (Multi-Step Speed Control Mode)

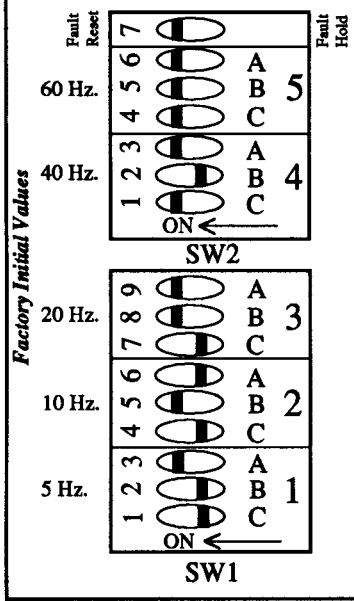


6.1.2 Control Circuit Input Sequence (Multi-Step Speed Control Mode)

	For (Rev) Command	Sp2 Command	Sp3 Command	Sp4 Command	Sp5 Command	Action
"OFF"	0	X	X	X	X	Stops according DS1, Sw1 (See Section 5.3.4)
1st. Detent	1	0	0	0	0	Runs Forward/Reverse at Hz of Group 1 (See section 5.4.2)
2nd. Detent	1	1	0	0	0	Runs Forward/Reverse at Hz of Group 2 (See section 5.4.2)
3rd. Detent	1	1	1	0	0	Runs Forward/Reverse at Hz of Group 3 (See section 5.4.2)
4th Detent	1	1	1	1	0	Runs Forward/Reverse at Hz of Group 4 (See section 5.4.2)
5th Detent	1	1	1	1	1	Runs Forward/Reverse at Hz of Group 5 (See section 5.4.2)

0 = OFF, 1 = ON, X = Don't Care

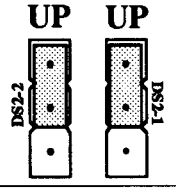
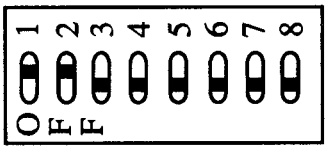
6.1.3 Suggested Settings to TC-SIF-5 Board (Multi-Step Speed Control Mode)*

SW1 and SW2 Dip Switches	Hz Output at Various CBA Combinations	R7 or R9 Potentiometer
		
		Enabled only if "CBA" combination is Off, Off, Off. If enabled, then a potentiometer* sets the output Hz of corresponding Speed Step. Electromotive Systems' Initial Values for "CBA Groups" disable the potentiometers. * R7 Pot corresponds to SW1. R9 Pot corresponds to SW2.
Ref. Section 5.4.2	**Ref. Section 5.4.2**	**Ref. Section 5.5**

C	B	A	Output DS1-Sw5 "OFF"	Output DS1-Sw5 "ON"
0	0	0	R7 Pot: SW1; R9 Pot: SW2	
0	0	1	5 Hz(2Hz)	10 Hz(4Hz)
0	1	0	10 Hz	20 Hz
0	1	1	20 Hz	40 Hz
1	0	0	30 Hz	60 Hz
1	0	1	40 Hz	80 Hz
1	1	0	50 Hz	100 Hz
1	1	1	60 Hz	120 Hz

For 2Hz/4Hz operation, see Page 26.

6.1.4 Suggested Settings to TM2 Board (Multi-Step Speed Control Mode)

DS2 Shunts	DS1 Dip Switches	RDS1, RDS2, RDS3
		
DS2-1: "UP" **DS2-2: "UP"** DS2 shunts are inputs to **IMPULSE•S+** CPU. The DS2 shunts are viewed as a single binary command. This combination commands "Multi-Step Speed Control Mode".	**DS1:** Sw1 ON† Sw2 ON Sw3 OFF Sw4 OFF Sw5 OFF Sw6 OFF Sw7 OFF Sw8 OFF	**RDS1: "B"** **RDS2: "8"** **RDS3: "2" or "8"** Note: "2" Notch is for Horizontal applications. "8" Notch is for Hoisting applications.
Ref. Section 5.3.5	**Ref. Section 5.3.4**	**Ref. Section 5.3.1 & 5.3.2**

†NOTE: Extreme Caution:

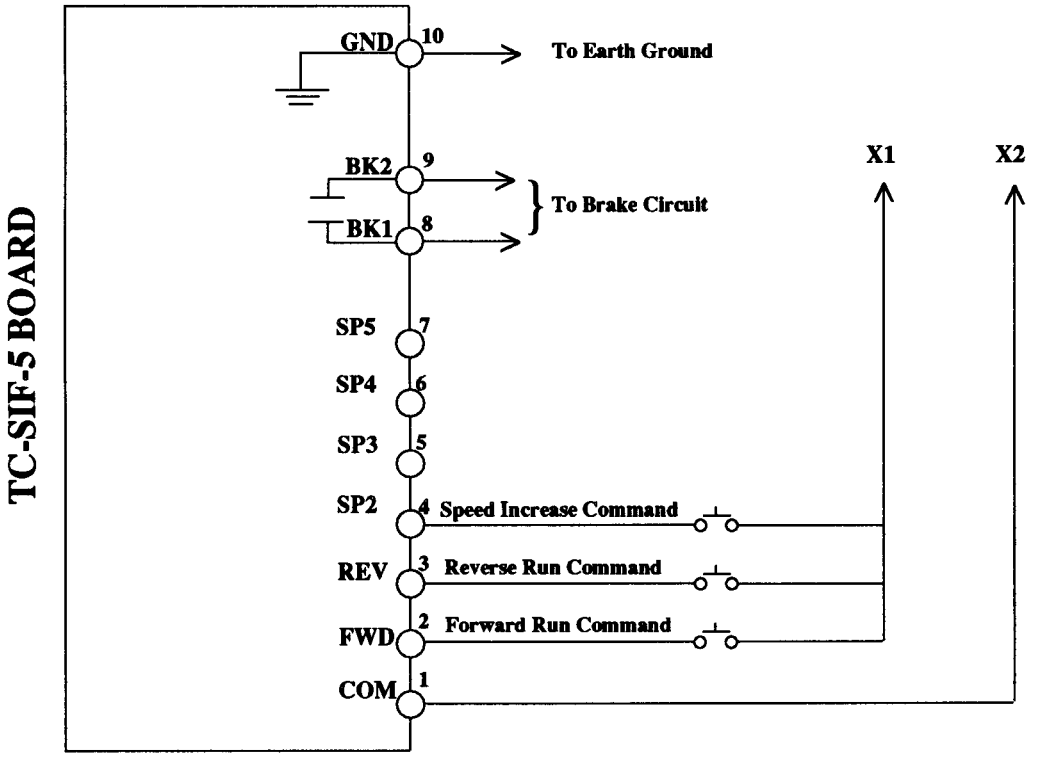
Braking Mode is set for "Base Block at STOP Command "(DS1-Sw1, "ON"). If changed to "Decelerate at STOP Command "(DS1-Sw1, "OFF"), then extreme caution should be used regarding RDS2 (Decel time). If decel time is too long, crane/hoist can crash into endstop device causing damage to equipment or injury to personnel.

***For 230AFD1-S+ only, see Appendix III.**

6.2 Infinitely Variable Speed Control Mode (2 Step Type)

Specific settings and connections are required to begin "2 Step Infinitely Variable Speed Control Mode" operation. The "recipe" requires both control connections and adjustments to the top circuit board (TC-SIF-5), and adjustments only to the middle circuit board (TM2).

6.2.1 Control Circuit Wiring Diagram (2 Step Infinitely Variable Type)

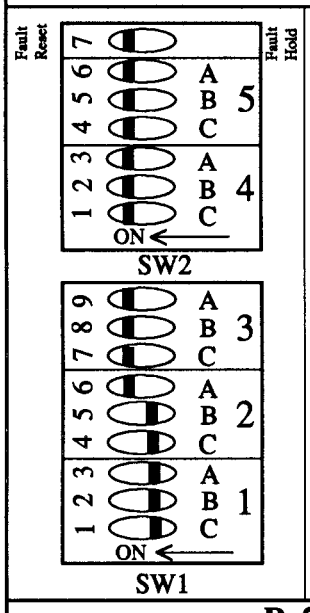


6.2.2 Control Circuit Input Sequence (2 Step Infinitely Variable Type)

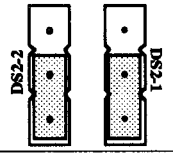
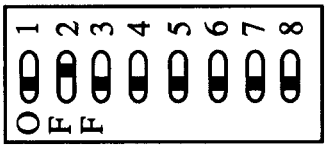
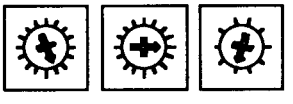
	For (Rev) Command	Sp2 Command	Sp3 Command	Sp4 Command	Sp5 Command	Action
"OFF"	0	X	X	X	X	Stops according DS1, Sw1 (See Section 5.3.4)
1st. Detent	1	0	0	0	0	Runs Forward/Reverse at Hz of DS1, Sw2/Holds Speed
2nd. Detent	1	1	0	0	0	Speed Increases to Upper Limit (DS1, Sw3 & Sw4)

0 = OFF, 1 = ON, X = Don't Care

6.2.3 Suggested Settings to TC-SIF-5 Board (2 Step Infinitely Variable Type)*

SW1 and SW2 Dip Switches			R7 Potentiometer
	**SW1:** Sw1 OFF Sw2 OFF Sw3 OFF Sw4 OFF Sw5 OFF Sw6 ON Sw7 ON Sw8 ON Sw9 ON	**SW2:** Sw1 ON Sw2 ON Sw3 ON Sw4 ON Sw5 ON Sw6 ON Sw7 ON* *See Section 5.4.5	 Enabled only if DS1-Sw6 is "ON". If enabled, then R7 sets maximum frequency output of the inverter (upper limit). (R9 has no function in the infinitely variable mode.) Electromotive Systems' Initial Value for DS1-Sw6 is "OFF"-- potentiometer is not enabled.
	SW1 (Sw1 to Sw9) dip switches must be as shown. Any other combination will result in improper operation or no operation at all. SW2 (Sw1 to Sw6) dip switches have no function in this mode.		
Ref. Section 5.4.3			**Ref. Section 5.5**

6.2.4 Suggested Settings to TM2 Board (2 Step Infinitely Variable Type)

DS2 Shunts	DS1 Dip Switches	RDS1, RDS2, RDS3
DOWN DOWN 		
DS2-1: "DOWN" **DS2-2: "DOWN"** DS2 shunts are inputs to **IMPULSE•S+** CPU. The DS2 shunts are viewed as a single binary command. This combination commands "2 Step Infinitely Variable Speed Control Mode".	**DS1:** Sw1 OFF† Sw2 ON Sw3 OFF Sw4 OFF Sw5 OFF Sw6 OFF Sw7 OFF Sw8 OFF	**RDS1: "B"** **RDS2: "8"** **RDS3: "2" or "8"** Note: "2" Notch is for Horizontal applications. "8" Notch is for Hoisting applications.
Ref. Section 5.3.5	**Ref. Section 5.3.4**	**Ref. Section 5.3.1 & 5.3.2**

†NOTE: Extreme Caution:

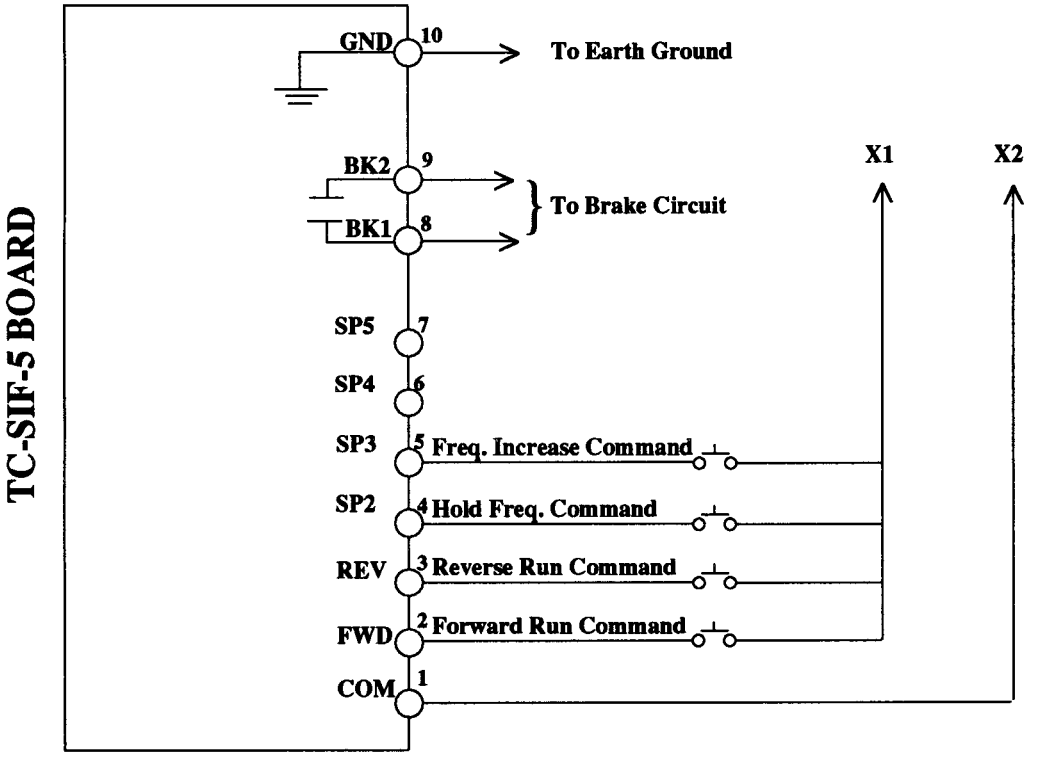
Braking Mode is set for "Decelerate at STOP Command "(DS1-Sw1, "OFF"). **EXTREME CAUTION** should be used regarding RDS2 (Decel Time). If deceleration time is too long, crane/hoist can crash into endstop device causing damage to equipment or injury to personnel.

***For 230AFD1-S+ only, see Appendix III.**

6.3 Infinitely Variable Speed Method (3 Step Type)

Specific settings and connections are required to begin "Infinitely Variable Speed Control Mode" operation. The "recipe" requires both control connections and adjustments to the top circuit board (TC-SIF-5), and adjustments only to the middle circuit board (TM2).

6.3.1 Control Circuit Wiring Diagram (3 Step Infinitely Variable Type)

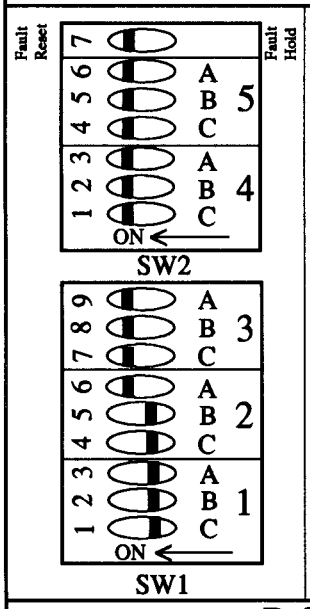


6.3.2 Control Circuit Input Sequence (3 Step Infinitely Variable Type)

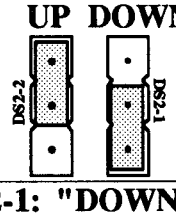
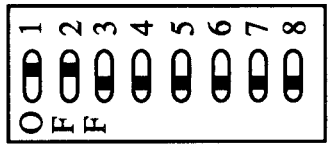
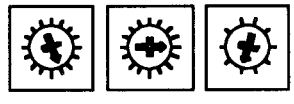
	For (Rev) Command	Sp2 Command	Sp3 Command	Sp4 Command	Sp5 Command	Action
"OFF"	0	X	X	X	X	Stops According to DS1, Sw1 (See Section 5.3.4)
1st Detent	1	0	0	0	0	Runs Forward/Reverse at Hz of DS1, Sw2 (See Sec. 5.3.4)
2nd Detent	1	1	0	0	0	Holds Frequency Steady
3rd Detent	1	1	1	0	0	Frequency Increases to Upper Limit

0 = OFF, 1 = ON, X = Don't Care

6.3.3 Suggested Settings to TC-SIF-5 Board (3 Step Infinitely Variable Type)*

SW1 and SW2 Dip Switches	R7 Potentiometer
	
SW1: Sw1 OFF Sw2 OFF Sw3 OFF Sw4 OFF Sw5 OFF Sw6 ON Sw7 ON Sw8 ON Sw9 ON **SW2:** Sw1 ON Sw2 ON Sw3 ON Sw4 ON Sw5 ON Sw6 ON Sw7 ON* *See Section 5.4.5 SW1 (Sw1 to Sw9) dip switches must be as shown. Any other combination will result in improper operation or no operation at all. SW2 (Sw1 to Sw6) dip switches have no function in this mode.	Enabled only if DS1-Sw6 is "ON". If enabled, then R7 sets maximum frequency output of the inverter (upper limit). (R9 has no function in the infinitely variable mode.) Electromotive Systems' Initial Value for DS1-Sw6 is "OFF"-- potentiometer is not enabled.
Ref. Section 5.4.4	**Ref. Section 5.5**

6.3.4 Suggested Settings to TM2 Board (3 Step Infinitely Variable Type)

DS2 Shunts	DS1 Dip Switches	RDS1, RDS2, RDS3
		
DS2-1: "DOWN" **DS2-2: "UP"** DS2 shunts are inputs to **IMPULSE•S+** CPU. The DS2 shunts are viewed as a single binary command. This combination commands "3 Step Infinitely Variable Speed Control Mode".	**DS1:** Sw1 ON† Sw2 ON Sw3 OFF Sw4 OFF Sw5 OFF Sw6 OFF Sw7 OFF Sw8 OFF	**RDS1: "B"** **RDS2: "8"** **RDS3: "2" or "8"** Note: "2" Notch is for Horizontal applications. "8" Notch is for Hoisting applications.
Ref. Section 5.3.5	**Ref. Section 5.3.4**	**Ref. Section 5.3.1 & 5.3.2**

†NOTE: Extreme Caution:
Braking Mode is set for "Base Block at STOP Command" (DS1-Sw1, "ON"). If changed to "Decelerate at STOP Command" (DS1-Sw1, "OFF"), then extreme caution should be used regarding RDS2 (Decel time). If decel time is too long, crane/hoist can crash into endstop device causing damage to equipment or injury to personnel.

***For 230AFD1-S+ only, see Appendix III.**

SECTION 7: CHECKS BEFORE OPERATION

7.1 Precautionary Checks Before Test Run/Operation

After mounting and interconnections are completed, please re-check for:

* Correct connections.
* Correct input power supply (No voltage drop or imbalance, Source Kva ≤ 500Kva). Please note that 460V input to 230V series control will destroy power section of unit!
* No short circuit conditions.
* No loose screw terminals. (Check especially for loose wire clippings.)
* Proper load conditions.

Precautions:

* Only start the motor if motor shaft rotation is stopped.
* Even with small loading, never use a motor whose nameplate amperage exceeds the inverter rated current.
* When starting and stopping the motor, be sure to use the operation signals (Fwd/Rev), not the magnetic contactor on the power supply side.
* **Special Extreme Caution:**
  Braking Method selection as shipped from Electromotive Systems factory is set for "Base Block at STOP Command" (DS1-Sw1 "ON"). If changed to "Decelerate at STOP Command" (DS1-Sw1 "OFF"), then extreme caution should be used regarding RDS2 (Deceleration Time). If Deceleration Time is too long, equipment can run in to endstop device causing damage to equipment or injury to personnel.

SECTION 8: MAINTENANCE

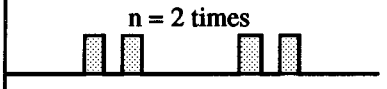
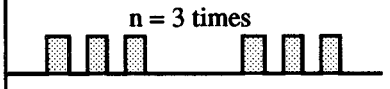
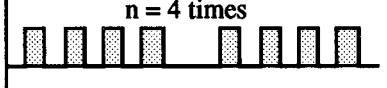
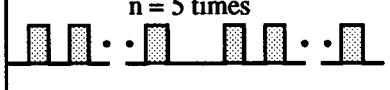
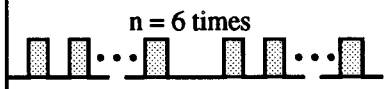
8.1 Maintenance

IMPULSE•S+ requires almost no routine checks. It will function efficiently and longer if it is kept clean, cool and dry, observing precautions listed in Section 2.1. Especially check for tightness of electrical connections, discoloration or other signs of overheating. During servicing inspection, turn off AC main circuit power and wait at least ten (10) minutes before touching any circuit components. The red "CHARGE" lamp must be extinguished before touching any components. Failure to adhere to this warning could result in serious or lethal injury.

SECTION 9: TROUBLESHOOTING

9.1 Failure Indication* of IMPULSE•S+

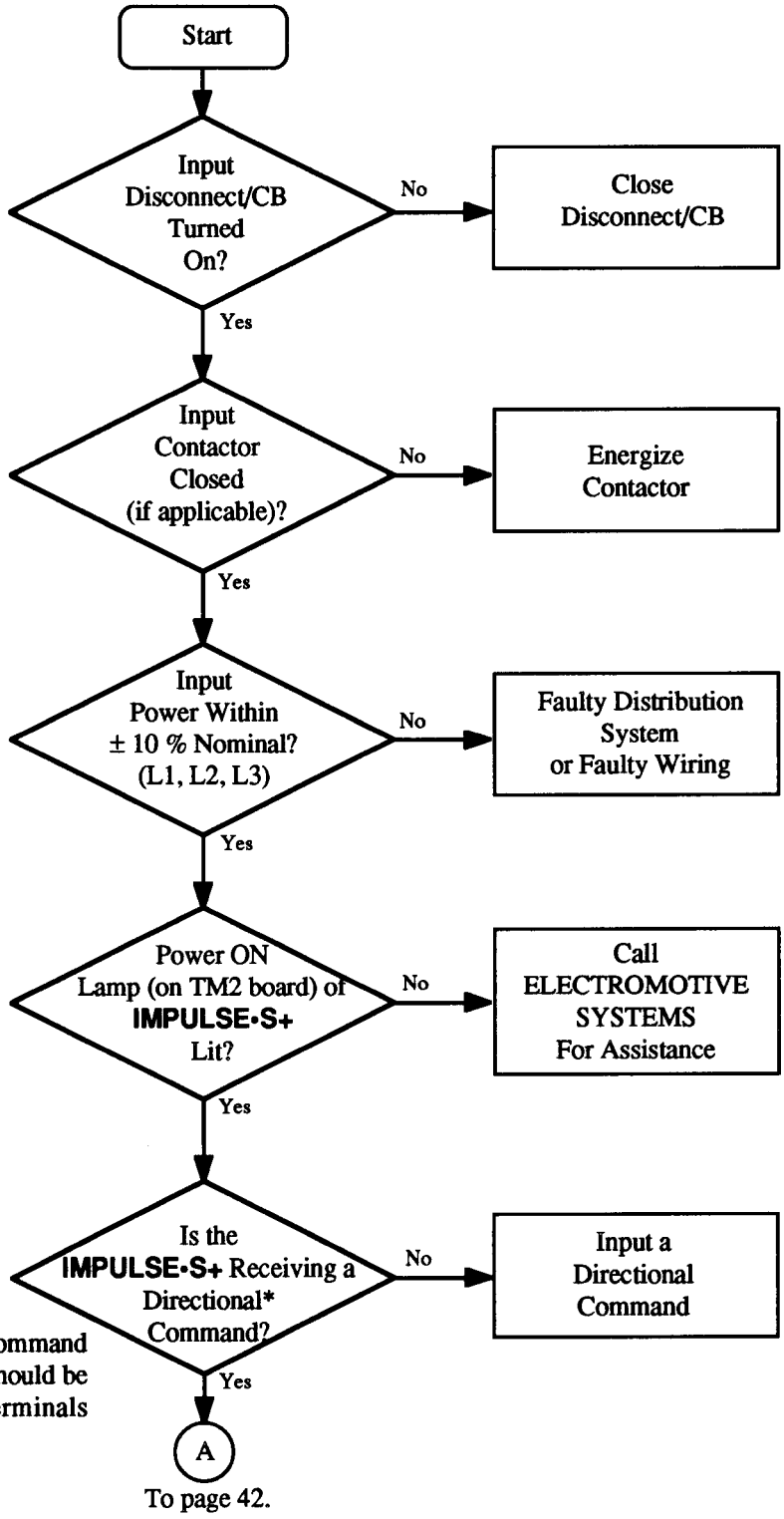
If **IMPULSE•S+** malfunctions, the fault lamp (white LED visible through small hole in plastic cover) blinks on and off. The blinking sequence tells the user the type of fault that has occurred. Please see Section 5.3.1 for "fault hold" vs. "fault reset" function.

Blinking Sequence	Probable Cause	What to Do
	**Instantaneous Overcurrent Protection** • Accel/decel time is set too short. • Load too heavy. • Power factor capacitor connected to **IMPULSE•S+** output. • Incorrect V/F pattern selection. • **IMPULSE•S+** output transistor is shorted or ground fault condition exists.	• Extend accel/decel time. • Run motor without load. Check load conditions. • Remove power factor capacitors. • Select the optimum V/F pattern via RDS-3. • **IMPULSE•S+** output transistor is shorted or motor is grounded. See section for transistor inspection methods.
	**Overvoltage Protection** • Decel time too short. • Input power voltage > specification allows.	• Extend the decel time. • Correct input overvoltage problem.
	**Undervoltage Protection** • Supply voltage < specification allows. • Momentary power failure (>15ms).	• Correct the input power supply problem. Check for single phase problem. • Inspect busbar system for collector bounce.
	**Ground Fault** • Transistor module damaged.	• Replace transistor module.
	**Microcomputer Fault** • Problem always due to high electrical noise environment.	• Install R-C type suppressors on all contactor/brake coils.

*Note: Fault indication requires "fault reset"/"fault hold" function switch (Sw7 of SW2 on TC-SIF-5 circuit board) to be set in the "fault hold" (off) position.

9.2 Troubleshooting Flow Chart

1) Motor will not run.

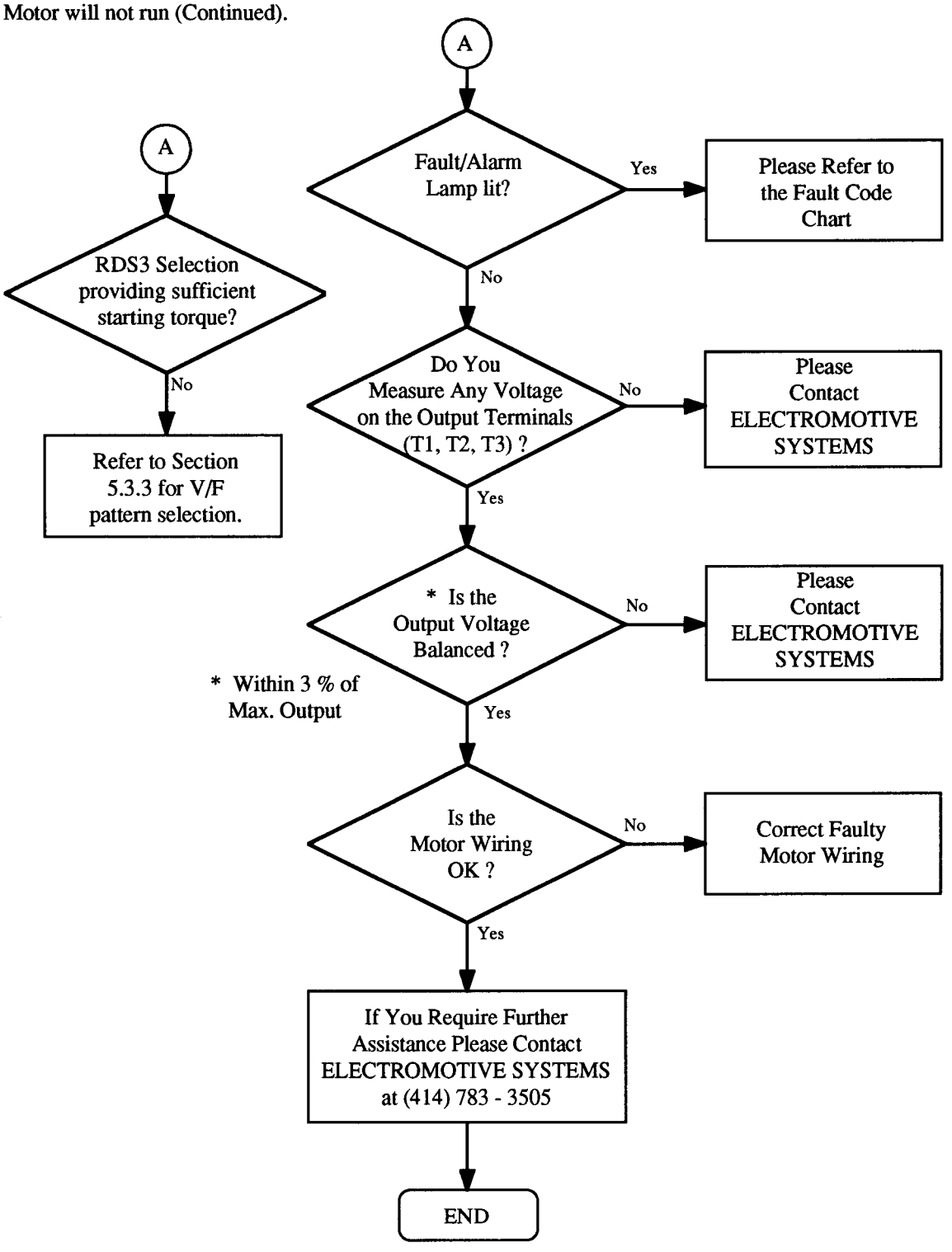


*Note: If directional command is provided, 110Vac should be read on TC-SIF5 terminals 1-2(3).

To page 42.

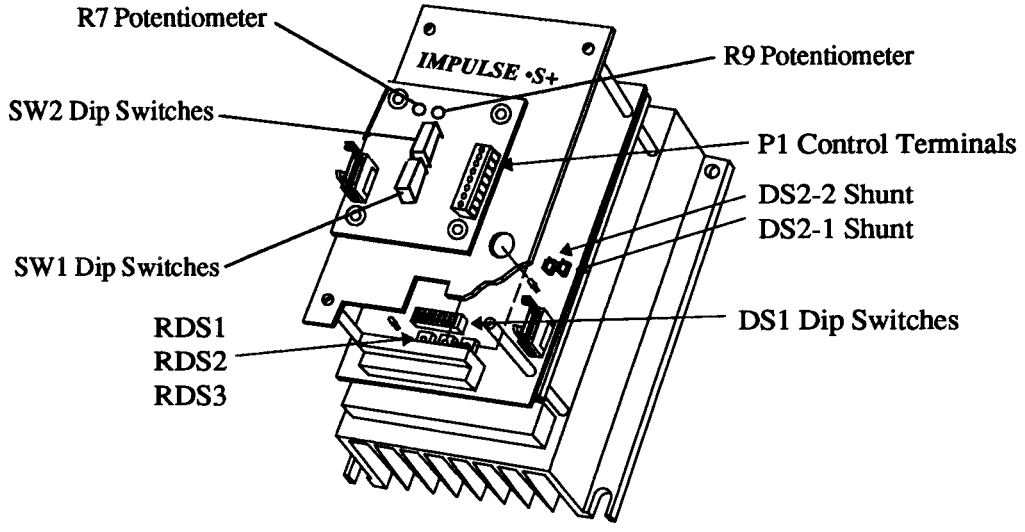
9.2 Troubleshooting Flow Chart (Continued)

1) Motor will not run (Continued).



9.3 Information Check List

IMPULSE•S+ Adjustable Frequency Controls and **TCONTROL** Motor Control Panels are designed to perform their tasks flawlessly. Should you encounter problems with Electromotive Systems' Control Products, we invite you to call our customer service department for personal attention. **Before calling**, please complete this check list. The information hereon is required for successful discussion with Electromotive Systems' personnel.



Control Information:

IMPULSE•S+ Model No.: _____ **TCONTROL** Serial No.: _____

Setting Values:

RDS1: _____
RDS2: _____
RDS3: _____

DS1: Sw1 _____
Sw2 _____
Sw3 _____
Sw4 _____
Sw5 _____
Sw6 _____
Sw7 _____
Sw8 _____

DS2-1: _____
DS2-2: _____

SW1: Sw1 _____
Sw2 _____
Sw3 _____
Sw4 _____
Sw5 _____
Sw6 _____
Sw7 _____
Sw8 _____
Sw9 _____

SW2: Sw1 _____
Sw2 _____ o'clock
Sw3 _____
Sw4 _____
Sw5 _____
Sw6 _____
Sw7 _____

R7: _____ o'clock
R9: _____ o'clock

Fault Alarm* History: (If Any)
#1 _____ (#Blinks/Pause)
#2 _____ (#Blinks/Pause)
#3 _____ (#Blinks/Pause)

*Note: Sw7 of SW2 on TC-SIF-5 must be in "OFF" position. (See Section 5.4.5.)

9.3 Information Check List (Continued)

Application Information:

Hoist: _____ Manufacturer: _____
Trolley: _____
Bridge: _____
Hook Rotate: _____
Clamp Op.: _____

System Information:

Power Supply:
Voltage: L1-L2 _____
L2-L3 _____
L1-L3 _____
Ø: _____ (1Ø, 2Ø, 3Ø?)
Hz: _____
Source KVA: _____

Motor (s) Data
HP: _____ Rated Amps: _____
RPM: _____ Aux. Equipment: _____
Rated VAC: _____ 1) Brake _____
Model No.: _____ 2) Gearbox _____
Manufacturer: _____ 3) Other _____

Electromotive Systems Phone: 1-414-783-3505
Electromotive Systems FAX: 1-414-783-3508

SECTION 10: LIMITED WARRANTY

10.0 Limited Warranty and Terms of Sale

Prices: Subject to Change Without Notice — F. O. B. Electromotive Systems, Inc.
Terms: Net 30 Days — Milwaukee, Wisconsin

Electromotive Systems, Inc., hereafter referred to as Company, guarantees all items sold by it against any defects of material and/or workmanship for a period of one year from the date of shipment. Company makes NO OTHER WARRANTY, EXPRESSED OR IMPLIED, AS TO THE MERCHANTABILITY OR FITNESS OF THE ITEMS FOR THEIR INTENDED USE OR AS TO THEIR PERFORMANCE. Any statement, description or specification in Company's literature is for the sole purpose of identification of items sold by the Company and imparts no guarantee, warranty or undertaking by company of any kind.

Company's sole liability shall be to repair at its factory or replace any item returned to it within one year from date of shipment which Company finds to contain defective material or workmanship. All items to be repaired or replaced shall be shipped to Company (Note: return authorization by Company is required) within said one year period, freight prepaid, as a condition to repair or replace defective material or workmanship. Company's herein assumed responsibility does not cover defects resulting from improper installation, maintenance, or improper use. Any corrective maintenance performed by anyone other than the Company during the warranty period shall void the warranty. Company shall not be liable for damages of any kind from any cause whatsoever beyond the price of the defective Company supplied items involved. Company shall not be liable for economic loss, property damage, or other consequential damages or physical injury sustained by the purchaser or by any third party as a result of the use of any Company supplied items or material.

Company neither assumes nor authorizes any other person to assume for Company any other liability in connection with the sale or use of items sold by Company.

List prices/or discounts are subject to change without notice. Quoted prices will be honored for a period of 30 days from the date of the written quotation unless otherwise stated.

Orders are not subject to alteration or cancellation except upon written consent of Company and payment of proper cancellation charges, when deemed applicable by Company.

Materials or items may not be returned for credit, without the prior written consent of the Company. Any authorized return of materials or items shall be subject to a restocking charge equal to 20% of the net invoiced amount therefor after Company determines that the material or item is in good condition and may be resold without alteration or service.

Terms of payment are NET 30 days. All materials and items are sold F.O.B. Company's shipping point. Company retains a security interest in all items sold by it so long as they remain in Company's possession to secure all obligations of purchaser to Company. A processing fee will be applied to all invoices for requested prepaid freight charges other than UPS. A service charge will be incurred on past due accounts extending beyond the terms of sale described above, at a rate of 1 1/2% per month of the net balance extending beyond 30 days.

Any claim for material or item shortages must be received by Company within 30 days of shipment and must be accompanied by copies of the bill of lading and packing slip.

APPENDIX I: RECOMMENDED WIRING PRACTICES

RECOMMENDED WIRING PRACTICES FOR APPLICATION OF ADJUSTABLE FREQUENCY (AF) DRIVES ON OVERHEAD MATERIAL HANDLING EQUIPMENT

1) Use surge absorbers (R-C networks) on all relay and contactor coils.

2) Shielded cable shall be used for all low level D.C. speed reference signals (0-10VDC, 4-20 mA). Shield should be grounded only at the AF drive side.

3) Use a minimum of #16 AWG for control wiring, and #12 AWG (or larger) for power wiring. Size according to N.E.C. table 310-16.

4) The following is required for all dual motor bridge cranes and suggested for center driven cranes, trolleys and hoists. Upsize the wiring one size for every 25 feet of distance between AF drive and motor to account for voltage drop (which becomes significant at low frequencies).

5) Use time delay fuses for AF drive input protection. They shall be sized at approximately 150% of AF drive continuous rated ampacity.

6) Control and power wiring (including dynamic braking resistor wiring) shall be kept separate on terminal block strip.

7) Keep control (directional and speed command inputs to the AF drive) and power wiring from running together in parallel paths on the panel or in conduit runs. Keep control and power festoon wiring in different cables and separated.

8) If control and power wiring do meet on a panel, cross them perpendicularly.

9) Before applying power to the AF drive, check the output circuit (T1, T2, T3) for possible short circuits or ground faults.

10) Always mount the AF drive in its proper (vertical) orientation with at least 3" of clearance on all four sides. AF drives should be housed in appropriate NEMA rated enclosures for the environment in which they will be used.

11) Keep AF drive heatsink clear of any obstructions (components on panel) to ensure proper cooling air flow.

12) If using externally mounted interface boards, or remotely mounted speed reference signals, use shielded cable from the interface output or remote speed reference to the AF drive control input terminals.

Recommended Wiring Practices

13) On external input devices (control), hard contact inputs are preferred rather than solid state inputs into the control voltage input boards (TC-GIF__, TC-SIF__, TC-SLC__).

14) If the input device is a PLC triac output, a 5K ohm, 10 watt resistor may have to be used between the signal and L2 (X2).

15) AF drives should always have the cover mounted on unit during normal operating conditions to protect the digital operator (Specific to Electromotive Systems IMPULSE•G Series).

16) All ground terminals or screws ("G" or "E") must be grounded back to earth ground.

17) If the power source is greater than 500 KVA, there should be at least 3% impedance in the line between the source and the input to the AF drive.

18) Incoming power supply voltage must be limited to 230 volts ± 10% or 460 volts ± 10%.

19) On existing wound rotor motor applications >25HP, a line reactor of 3% impedance shall be required on the load side of the AF drive. (Specific to Electromotive Systems IMPULSE•G Series.)

20) When using more than one transformer for control power, properly phase each transformer with respect to other(s).

21) All line and ground wiring should be disconnected when any welding is being done on or to the crane.

22) When using the Impulse•S Series AF drive on existing wound rotor motor applications oversizing the drive or installing a load reactor is suggested to avoid over-current conditions upon starting a motor.

23) When supplying single phase input to the AF drive, the ampacity of the drive must be derated by approximately one-half. (Consult Electromotive Systems.)

24) All worm gear box hoist applications require dynamic braking resistors to avoid overvoltage conditions when lowering the hook.

25) Sliding collector bars are not to be used between the drive and the motor. It must be hard wired (i.e. festoon cable).

** If there are any questions, or a further explanation of the above recommendations is needed, please contact Electromotive Systems at 414-783-3500 before proceeding.

** The above recommendations, if followed, will help to ensure trouble free start-up and successful operation of the adjustable frequency drive when applied to overhead material handling equipment.

APPENDIX II: RECOMMENDED MOTOR LEAD CABLE SIZING

Wire Size in AWG for 460 Volts - 5% Max. Voltage Drop

Wiring Distance Between Drive and Motor (in feet)	Full Load Motor Current (Amperes)											
	5	10	15	20	25	50	75	100	125	150	175	200
25	12	12	12	12	12	8	4	2	2	1/0	2/0	3/0
50	12	12	10	10	10	6	4	2	2	1/0	2/0	3/0
75	12	10	8	8	8	4	2	1/0	1/0	2/0	2/0	3/0
100	12	10	8	6	6	4	1/0	1/0	2/0	3/0	3/0	4/0
125	12	8	8	6	6	2	1/0	2/0	3/0	4/0	4/0	4/0
150	10	8	8	4	4	1/0	1/0	3/0	3/0	4/0	250M	350M
175	10	8	6	4	2	1/0	2/0	3/0	4/0	250M	350M	500M
200	10	6	6	4	2	1/0	3/0	4/0	250M	250M	350M	500M

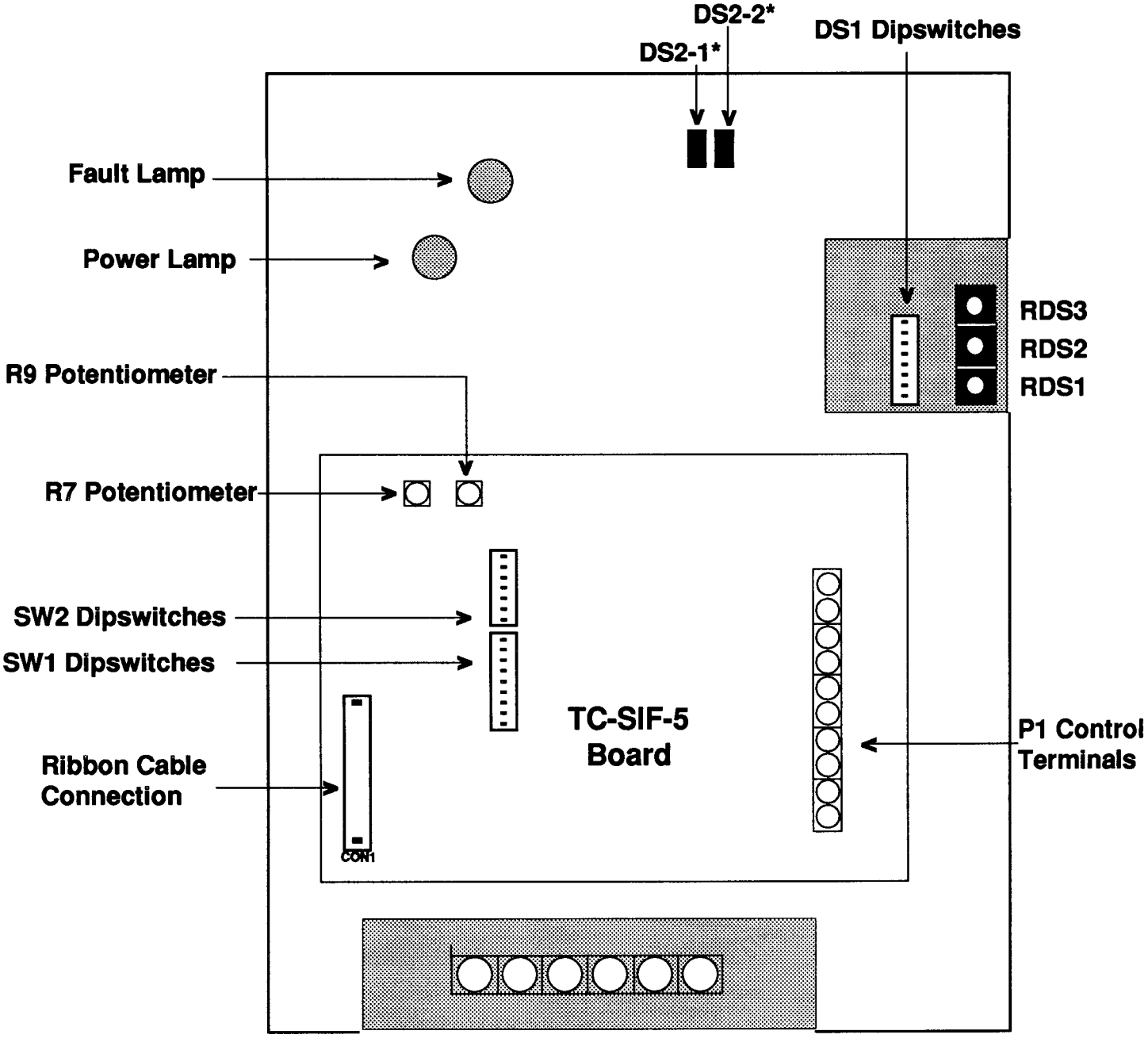
The voltage drop in volts does not change significantly with frequency. For example, if the voltage drop at 60 Hz (460 Volts) is 2.0 Volts, then the voltage drop at 6 Hz (46 Volts) is also 2.0 Volts. Therefore, the motor lead cable must be sized so that the voltage drop at the lowest operating frequency does not exceed 5% of the drive output voltage at that frequency. i.e. @ 6 Hz, voltage is 46 Volts. Therefore:

$$\%\text{Voltage Drop} = \frac{2.0 \text{ Volts}}{46 \text{ Volts}} = 4.3\%$$

This table is applicable to all adjustable frequency drives, not only **IMPULSE** drives, due to the low voltages encountered at low frequencies.

APPENDIX III: 230AFD1-S+ SUPPLEMENT

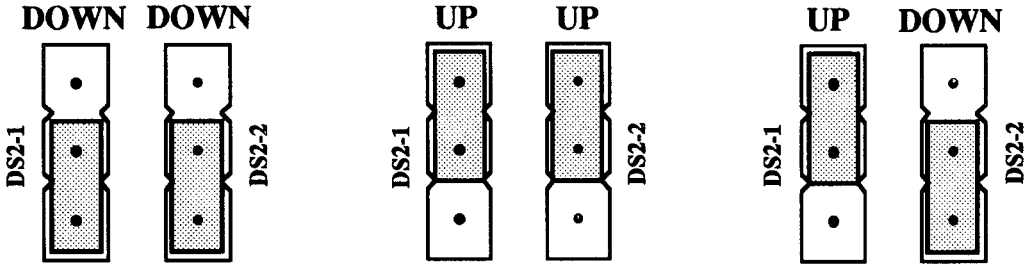
Location of Adjusting Devices - 230AFD1-S+ Only



* Located Under Cover

DS2-1, DS2-2 Shunt: Speed Control Method Selection - 230AFD1-S+ Only

The pair of DS2 Shunts change the speed control method of the inverter. There are three valid combinations of the DS2 shunts:

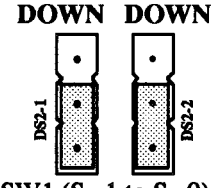


Depending upon the relative setting of this pair of shunts (i.e. "UP" or "DOWN"), the operation characteristics of the inverter change.

		Operation Mode*
DS2-1	DOWN	Multi-Step Speed Control Method
DS2-2	DOWN	
DS2-1	UP	2 Step Infinitely Variable Speed Control Method
DS2-2	UP	
DS2-1	UP	3 Step Infinitely Variable Speed Control Method
DS2-2	DOWN	

*Note: DS2 shunts cooperate with the SW1 (Sw1 to Sw9) and SW2 (Sw1 to Sw7) dip switches to change operation modes. See Section 5.4 for more information.

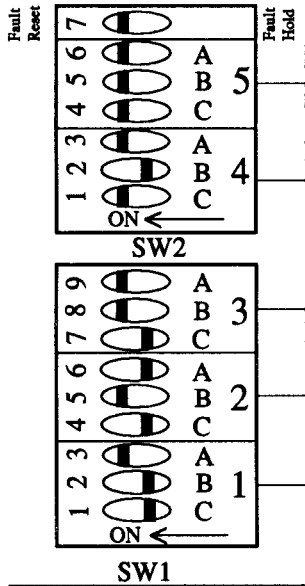
SW1 and SW2 Series Dip Switch Function when DS2-1 "DOWN", DS2-2 "DOWN" - 230AFD1-S+ Only



Enables Multi-Step Speed Control Method

SW1 (Sw1 to Sw9) and SW2 (Sw1 to Sw6) Series Dip Switches determine frequency output at each of the 5 possible speed points provided in multi-step speed control mode. Sw1 to Sw9 (SW1) and Sw1 to Sw6 (SW2) are arranged in groups of 3 switches. Each group of three determines the output frequency of an individual speed point. (Sw7 is for fault reset and fault hold.) See below.

SW1 and SW2 Series Dip Switch Function in Multi Step Speed Control Mode



Group 5: The configuration of switches "C", "B", "A" determines the Frequency Output when SP5 Command is input.

Group 4: The configuration of switches "C", "B", "A" determines the Frequency Output when SP4 Command is input.

Group 3: The configuration of switches "C", "B", "A" determines the Frequency Output when SP3 Command is input.

Group 2: The configuration of switches "C", "B", "A" determines the Frequency Output when SP2 Command is input.

Group 1: The configuration of switches "C", "B", "A" determines the Frequency Output when Forward (Reverse) Command is input.

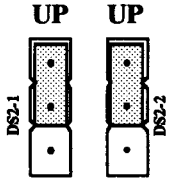
F-Out/ "C, B, A" Group Configuration

C	B	A	F-OUT DS1-Sw5 "OFF"	F-OUT DS1-Sw5 "ON"
0	0	0	R7 Pot for SW1; R9 Pot for SW2	
0	0	1	5Hz (2Hz)*	10Hz (4Hz)*
0	1	0	10Hz	20Hz
0	1	1	20Hz	40Hz
1	0	0	30Hz	60Hz
1	0	1	40Hz	80Hz
1	1	0	50Hz	100Hz
1	1	1	60Hz	120Hz

0 = OFF, 1 = ON

*Note: 2Hz/4Hz is F-Min when: 1) DS2-1 DOWN & DS1-6 ON
2) DS2-1 UP & DS1-5 ON

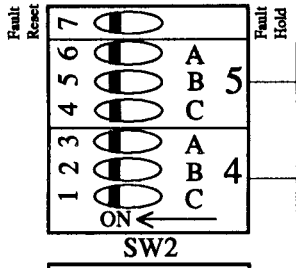
SW1 and SW2 Series Dip Switch Function when DS2-1 "UP", DS2-2 "UP" - 230AFD1-S+ Only



Enables 2 Step Infinitely Variable Speed Control Method

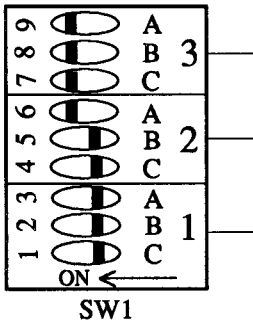
SW1 (Sw1 to Sw9) and SW2 (Sw 1 to Sw6) Series Dip Switches determine the instructions input to the **IMPULSE•S+** CPU. The setting of the SW1 and SW2 switches are fixed (see below). (Sw7 is for fault reset and fault hold.) No variance is permitted to these settings!

SW1 and SW2 Series Dip Switch Function in 2 Step
Infinitely Variable Speed Control Mode



Group 5: This configuration of switches "C", "B", "A" is the factory standard. DS2 Shunts instruct **IMPULSE•S+** CPU to ignore this input.

Group 4: This configuration of switches "C", "B", "A" is the factory standard. DS2 Shunts instruct **IMPULSE•S+** CPU to ignore this input.



Group 3: This configuration of switches "C", "B", "A" is the factory standard. DS2 Shunts instruct **IMPULSE•S+** CPU to ignore this input.

Group 2: The configuration of switches "C", "B", "A" instructs the **IMPULSE•S+** for "Frequency Increase Command".

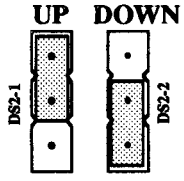
Group 1: The configuration of switches "C", "B", "A" instructs the **IMPULSE•S+** for "Forward (Reverse) Run/ Hold Freq. Command".

Action at "C, B, A" Group Configuration

	C		B		A		
		Sw#		Sw#		Sw#	
Group 1	0	1	0	2	0	3	Instructs Forward (Reverse) Run/ Freq. Hold Command
Group 2	0	4	0	5	1	6	Instructs Frequency Increase Command
Group 3	1	7	1	8	1	9	No Function Command
Group 4	1	1	1	2	1	3	No Function Command
Group 5	1	4	1	5	1	6	No Function Command

0 = OFF, 1 = ON

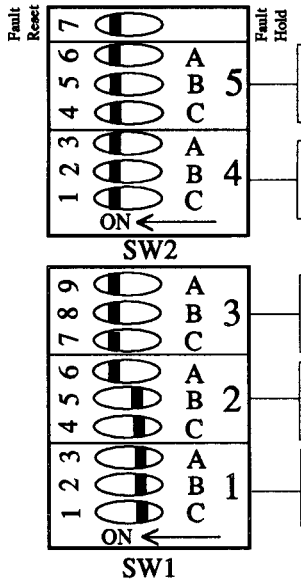
SW1 and SW2 Series Dip Switch Function when DS2-1 "UP", DS2-2 "DOWN" - 230AFD1-S+ Only



Enables 3 Step Infinitely Variable Speed Control Method

SW1 (Sw1 to Sw9) and SW2 (Sw1 to Sw6) Series Dip Switches determine the instructions input to the **IMPULSE•S+** CPU. The setting of the SW1 switches is fixed (see below). (Sw7 is for fault reset and fault hold.) No variance is permitted to these settings!

SW1 and SW2 Series Dip Switch Function in 3 Step
Infinitely Variable Speed Control Mode



Group 5: This configuration of switches "C", "B", "A" is the factory standard. DS2 Shunts instruct the **IMPULSE•S+** CPU to ignore this input.

Group 4: This configuration of switches "C", "B", "A" is the factory standard. DS2 Shunts instruct the **IMPULSE•S+** CPU to ignore this input.

Group 3: This configuration of switches "C", "B", "A" instructs the **IMPULSE•S+** for Frequency Increase Command.

Group 2: The configuration of switches "C", "B", "A" instructs the **IMPULSE•S+** for "Frequency Hold Command".

Group 1: The configuration of switches "C", "B", "A" instructs the **IMPULSE•S+** for "Forward (Reverse) Run at Minimum Speed.

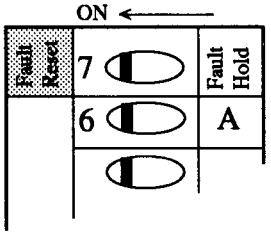
Action at "C, B, A" Group Configuration

	C	Sw#	B	Sw#	A	Sw#	
Group 1	0	1	0	2	0	3	Instructs Forward (Reverse) Run at Minimum Frequency
Group 2	0	4	0	5	1	6	Instructs Frequency Hold Command
Group 3	1	7	1	8	1	9	Instructs Frequency Increase Command
Group 4	1	1	1	2	1	3	No Function Command
Group 5	1	4	1	5	1	6	No Function Command

0 = OFF, 1 = ON

SW2 Series Dip Switch Function--Sw7 Fault Hold/Reset Function

The Fault Hold/Fault Reset function is controlled by Switch #7 (Sw7) of the SW2 group located on the TC-SIF-5 circuit board. This function is particularly useful for crane/hoist applications because of the difficulty in manually resetting the **IMPULSE•S+** after a fault has occurred. However, when a specific fault code designation needs to be observed (for troubleshooting, etc.), the **IMPULSE•S+** can easily be set to hold the fault state and coding.



Sw7 "ON" (Factory Setting for Normal Operation)
All faults are automatically reset. **IMPULSE•S+** is awaiting a new "RUN" command. The on-board fault lamp is cleared.

Sw7 "OFF"
Faults are held. The fault designation lamp can now be observed to determine the specific fault condition. There are two methods to reset the drive:
1) Push Sw7 to "ON" position, then push back to "OFF" position.
2) Main power to **IMPULSE•S+** must be turned off, then back on.

R7 Potentiometer Functions - 230AFD1-S+ Only

The R7 Pot found on the TC-SIF-5 Board serves two possible functions.

* F-Out Upper Limit Function in Infinitely Variable Speed Control Mode
* Speed Selection function in Multi-Step Speed Control Mode (Speed 1, 2, or 3)

The actual operating function is controlled by Sw6 of the DS1 Dip Switches (See section 5.3.4). Please note that Sw6 in only enabled if DS2-1 is "UP". See operation chart below:

R7 Enabling Factors/Functions

Enabling Factors			R7 Functions
DS2-1	DS1-Sw6	SW1-CBA	
DOWN	X	All "OFF"*	Speed 1, 2, or 3 Selection
DOWN	X	Any 1 "ON"	No Function
UP	ON	X	F-Out Upper Limit
UP	OFF	X	No Function

X = Don't Care
* All "OFF" refers to any single group

R7 Pot: Frequency Output Upper Limit Function--Analog Type

Enabled by the settings listed on the previous page, the R7 Pot sets the Frequency Output Upper Limit. The Frequency output upper limit is the maximum frequency output of the inverter. F-Out upper limit has priority over **any** higher frequency command. R7 upper limit function provides for an unlimited number of maximum speed selections.

R7 Pot: Speed Selection Function in Multi-Step Speed Control Mode

Enabled by the settings listed on the previous page, the R7 Pot sets the frequency output at any one of the first three speed points(Speed 1, 2,or 3) provided in Multi-Step Speed Control Mode. This function allows one of the first three output speeds to be customized by the user.

R9 Potentiometer Functions - 230AFD1-S+ Only

Enabled by the settings below, the R9 Pot sets the frequency output at Speed 4 or Speed 5 provided in Multi-Step Speed Control Mode. This function allows Speed 4 or 5 to be customized by the user.

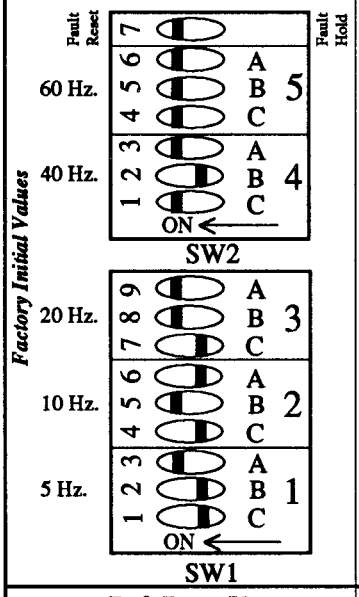
R9 Enabling Factors/Functions

Enabling Factors			R9 Functions
DS2-1	DS1-Sw6	SW2-CBA	
DOWN	X	All "OFF"*	Speed 4 or 5 Selection
DOWN	X	Any 1 "ON"	No Function
UP	ON	X	No Function
UP	OFF	X	No Function

X = Don't Care
* All "OFF" refers to any single group

6.1.3 Suggested Settings to TC-SIF-5 Board (Multi-Step Speed Control Mode) - 230AFD1-S+ Only

SW1 and SW2 Dip Switches

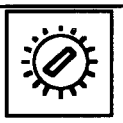


Hz Output at Various CBA Combinations

C	B	A	Output DS1-Sw5 "OFF"	Output DS1-Sw5 "ON"
0	0	0	R7 Pot: SW1; R9 Pot: SW2	
0	0	1	5 Hz(2Hz)	10 Hz(4Hz)
0	1	0	10 Hz	20 Hz
0	1	1	20 Hz	40 Hz
1	0	0	30 Hz	60 Hz
1	0	1	40 Hz	80 Hz
1	1	0	50 Hz	100 Hz
1	1	1	60 Hz	120 Hz

For 2Hz/4Hz operation, see Page 26.

R7 or R9 Potentiometer



Enabled only if "CBA" combination is Off, Off, Off. If enabled, then a potentiometer* sets the output Hz of corresponding Speed Step.

Electromotive Systems' Initial Values for "CBA Groups" disable the potentiometers.

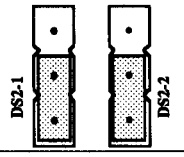
* R7 Pot corresponds to SW1.
R9 Pot corresponds to SW2.

Ref. Page 53 | Ref. Page 53 | Ref. Pages 56 & 57

6.1.4 Suggested Settings to TM2 Board (Multi-Step Speed Control Mode)

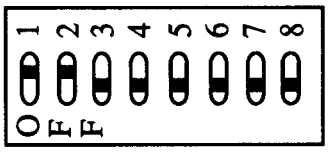
DS2 Shunts

DOWN DOWN



DS2-1: "DOWN"
DS2-2: "DOWN"
DS2 shunts are inputs to **IMPULSE•S+** CPU. The DS2 shunts are viewed as a single binary command. This combination commands "Multi-Step Speed Control Mode".

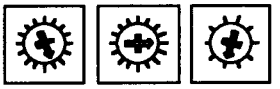
DS1 Dip Switches



DS1:

Sw1	ON*
Sw2	ON
Sw3	OFF
Sw4	OFF
Sw5	OFF
Sw6	OFF
Sw7	OFF
Sw8	OFF

RDS1, RDS2, RDS3

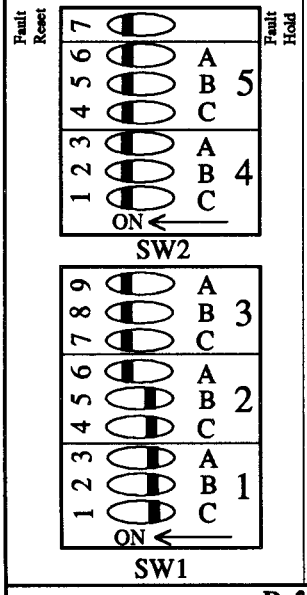


RDS1: "B"
RDS2: "8"
RDS3: "2" or "8"
Note: "2" Notch is for Horizontal applications. "8" Notch is for Hoisting applications.

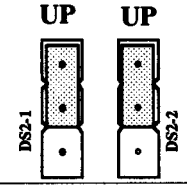
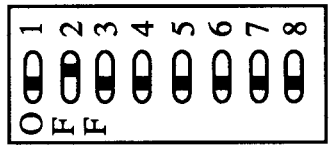
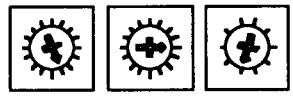
Ref. Page 52 | Ref. Page 26 | Ref. Pages 23 & 24

***NOTE: Extreme Caution:**
Braking Mode is set for "Base Block at STOP Command "(DS1-Sw1, "ON"). If changed to "Decelerate at STOP Command "(DS1-Sw1, "OFF"), then extreme caution should be used regarding RDS2 (Decel time). If decel time is too long, crane/hoist can crash into endstop device causing damage to equipment or injury to personnel.

6.2.3 Suggested Settings to TC-SIF-5 Board (2 Step Infinitely Variable Type) - 230AFD1-S+ Only

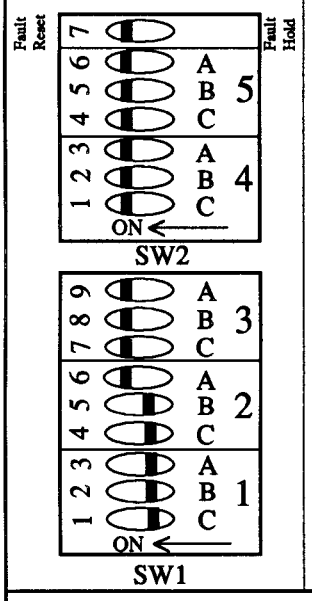
SW1 and SW2 Dip Switches	R7 Potentiometer
	
SW1: Sw1 OFF Sw2 OFF Sw3 OFF Sw4 OFF Sw5 OFF Sw6 ON Sw7 ON Sw8 ON Sw9 ON **SW2:** Sw1 ON Sw2 ON Sw3 ON Sw4 ON Sw5 ON Sw6 ON Sw7 ON* *See Section 5.4.5 SW1 (Sw1 to Sw9) dip switches must be as shown. Any other combination will result in improper operation or no operation at all. SW2 (Sw1 to Sw6) dip switches have no function in this mode.	Enabled only if DS1-Sw6 is "ON". If enabled, then R7 sets maximum frequency output of the inverter (upper limit). (R9 has no function in the infinitely variable mode.) Electromotive Systems' Initial Value for DS1-Sw6 is "OFF"-- potentiometer is not enabled.
Ref. Page 54	**Ref. Page 56**

6.2.4 Suggested Settings to TM2 Board (2 Step Infinitely Variable Type)

DS2 Shunts	DS1 Dip Switches	RDS1, RDS2, RDS3
		
DS2-1: "UP" **DS2-2: "UP"** DS2 shunts are inputs to **IMPULSE•S+** CPU. The DS2 shunts are viewed as a single binary command. This combination commands "2 Step Infinitely Variable Speed Control Mode".	**DS1:** Sw1 OFF* Sw2 ON Sw3 OFF Sw4 OFF Sw5 OFF Sw6 OFF Sw7 OFF Sw8 OFF	**RDS1: "B"** **RDS2: "8"** **RDS3: "2" or "8"** Note: "2" Notch is for Horizontal applications. "8" Notch is for Hoisting applications.
Ref. Page 52	**Ref. Page 26**	**Ref. Pages 23 & 24**

***NOTE: Extreme Caution:**
Braking Mode is set for "Decelerate at STOP Command "(DS1-Sw1, "OFF"). **EXTREME CAUTION** should be used regarding RDS2 (Decel Time). If deceleration time is too long, crane/hoist can crash into endstop device causing damage to equipment or injury to personnel.

6.3.3 Suggested Settings to TC-SIF-5 Board (3 Step Infinitely Variable Type) - 230AFD1-S+

SW1 and SW2 Dip Switches	R7 Potentiometer
	Enabled only if DS1-Sw6 is "ON". If enabled, then R7 sets maximum frequency output of the inverter (upper limit). (R9 has no function in the infinitely variable mode.) Electromotive Systems' Initial Value for DS1-Sw6 is "OFF"-- potentiometer is not enabled.
Ref. Page 55	**Ref. Page 56**

SW1:

Sw1	OFF
Sw2	OFF
Sw3	OFF
Sw4	OFF
Sw5	OFF
Sw6	ON
Sw7	ON
Sw8	ON
Sw9	ON

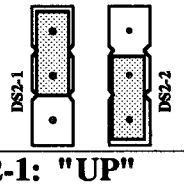
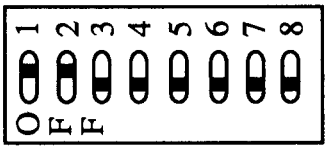
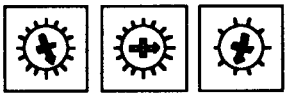
SW2:

Sw1	ON
Sw2	ON
Sw3	ON
Sw4	ON
Sw5	ON
Sw6	ON
Sw7	ON*

*See Section 5.4.5

SW1 (Sw1 to Sw9) dip switches must be as shown. Any other combination will result in improper operation or no operation at all. SW2 (Sw1 to Sw6) dip switches have no function in this mode.

6.3.4 Suggested Settings to TM2 Board (3 Step Infinitely Variable Type)

DS2 Shunts	DS1 Dip Switches	RDS1, RDS2, RDS3
UP DOWN 		
DS2-1: "UP" **DS2-2: "DOWN"** DS2 shunts are inputs to **IMPULSE•S+** CPU. The DS2 shunts are viewed as a single binary command. This combination commands "3 Step Infinitely Variable Speed Control Mode".	**DS1:** Sw1 ON* Sw2 ON Sw3 OFF Sw4 OFF Sw5 OFF Sw6 OFF Sw7 OFF Sw8 OFF	**RDS1: "B"** **RDS2: "8"** **RDS3: "2" or "8"** Note: "2" Notch is for Horizontal applications. "8" Notch is for Hoisting applications.
Ref. Page 52	**Ref. Page 26**	**Ref. Page 23 & 24**

***NOTE: Extreme Caution:**

Braking Mode is set for "Base Block at STOP Command" (DS1-Sw1, "ON"). If changed to "Decelerate at STOP Command" (DS1-Sw1, "OFF"), then extreme caution should be used regarding RDS2 (Decel time). If decel time is too long, crane/hoist can crash into endstop device causing damage to equipment or injury to personnel.