

# SmartFan® Multi SR



Speed Control and Alarm for DC Fans



DC Controls

**SmartFan Multi SR** is a digital fan speed control and alarm that offers an off-the-shelf cooling solution for telecommunications applications. Multi SR accepts and diode ORs dual power feeds in the range from 36 to 75 VDC. Multi SR can control to up to six 24 or 48 VDC fans and operates at a high frequency to achieve maximum power efficiency at minimum size. Fan speed control can be based on temperature, control signal (PWM, DC) or I2C bus. Voltage to the fans is varied using a current mode buck/boost control circuit. Multi SR monitors tach pulses from the fans and provides OR'd outputs to drive LED, logic and audible alarms. Communication of cooling system status is provided via an I2C bus. Designed with versatility in mind, Multi SR's control and alarm parameters can be modified via on-board jumpers and FLASH microcontroller programming.

## FEATURES

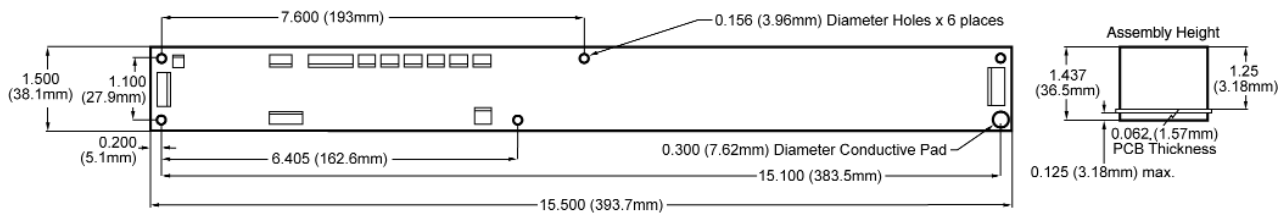
- Accepts and diode ORs dual power feeds
- Includes soft start and current limiting at start up
- Supplies voltage to up to six 24 VDC or 48 VDC fans
- Jumpers allow user selectable settings of:
  - Control temperature
  - Fan alarm trigger speed
  - 24 or 48 VDC operation
  - Isolated on-board power for I2C
- Accepts temperature (thermistor) inputs from up to three OR'd sensors and provides proportional speed control to the fans
- Speed control can also be based on accepting control signals (PWM, DC) or via an I2C bus
- Maximum voltage applied to fans is regulated at 25 VDC for 24 volt fans and 50 VDC for 48 volt fans
- When used with 48 VDC fans, a boost circuit provides voltages greater than the supply voltage when the supply voltage drops below 48 VDC
- Monitors open collector or voltage source tach pulses from the fans and provides OR'd outputs to drive LED, logic and audible alarms
- Additional alarm outputs are provided for multiple failure conditions, over temperature conditions, sensor failure, microcontroller failure and loss of power to the Multi SR
- Provides communication of cooling system status via an I2C bus
- Narrow 1.50" width of the board allows for mounting in fan trays as thin as 1U (1.75") high
- RoHS (6/6) Compliant
- UL Recognized to UL508 and CSA-C22.2, File E100344 
- EN 60950 : 2000 Compliant 

## SPECIFICATIONS

Supply Voltage Range	Maximum Input Current		Output Voltage	Maximum Output Current to any Fan
	200 Ft/Min	Still Air		
36 to 75 VDC	5.0 Amps	4.0 Amps	24 or 48 VDC (jumper selectable)	4.0 Amps

For complete product details visit: [www.controlres.com](http://www.controlres.com)

# SmartFan® Multi SR



## PART NUMBERING SYSTEM

Multi SR	Current Rating <sup>1</sup>	Control Temperature	Number of Temperature Sensors	Control Mode	3.3/5.0 VDC Isolated Power	Fans	Special Features	RoHS
052S	4 = 4 Amps (5 Amps in 200 LFPM air stream)	40 = 40°C MED Control Temp.	3 = 3 Sensors 2 = 2 Sensors 1 = 1 Sensor B = 1 On Board Sensor 0 = No Sensors	T = Temperature Based Control <sup>2</sup> I = I2C Based Control P = PWM/Voltage Based Control	0 = No On Board Isolated Supply 1 = On Board Isolated Supply	1 = 1 Fan 2 = 2 Fans 3 = 3 Fans 4 = 4 Fans 5 = 5 Fans 6 = 6 Fans	X	-F
H117-F	Hardware Pack							

<sup>1</sup>55°C, still air, max current rating.

<sup>2</sup>Sensor required for 1, 2 or 3 Sensors. See sensors page.

## GENERAL FEATURES:

The following features are common to all configurations of the Multi-SR.

**Input Power:** The Multi-SR can accept one or two power sources in the range of 36 to 75 VDC. If two power supplies are used, they are logically OR'd on the Multi-SR so that the operating voltage is equal to the higher of the two supplies. The Multi-SR can supply up to 4.0 Amps to the fan load with natural convection or 5.0 Amps to the fan load with 200 LFPM of forced convection, at 24 VDC or 48 VDC.

**Fan Speed Control:** The speed of all fans is varied by adjusting the fan voltage. Voltage adjustment is accomplished with a current mode buck/boost control circuit. The fan voltage range is 13-25 VDC for 24 VDC fans and 26-50 VDC for 48 VDC fans.

**Active Current Limiting:** The load regulating circuitry is configured with a 10 Amp active current limit. At the initial application of power, a 10 Amp AC transient current having a duration of less than two milliseconds can be expected. This current transient can also be expected during a "hot-plug" condition, where input power is rapidly cycled.

**Input Power Fuse:** A 10 Amp input power fuse is provided to protect the Multi-SR from over-current conditions.

**Soft Start:** The voltage applied to the fans at start-up ramps from 0 to 13 VDC for 24 VDC fans and 0 to 26 VDC for 48 VDC fans. After this period, the fan voltage moves to the commanded voltage. This "soft start" feature limits the current spike common to DC fans at start-up.

**Communication of Alarm Status via I2C Bus:** The status of each fan and the MINOR and MAJOR alarms is available on the I2C Bus.

## SELECTABLE FEATURES:

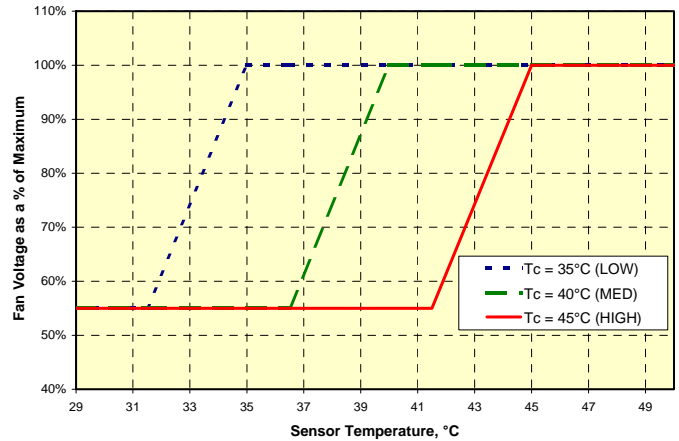
The Multi-SR includes user selectable features that allow it to meet a variety of telecommunication applications. The selectable features that must be specified by the user prior to ordering are listed below. Each Multi-SR is programmed prior to shipment with the features selected.

**Number of Fans:** The Multi-SR can be configured to power and monitor 1 to 6 fans.

## Fan Control Methods:

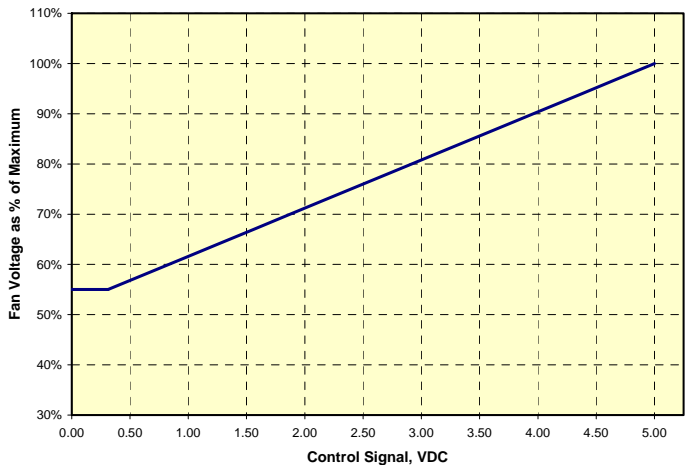
Three methods of controlling the speed of the fans are available: Temperature Sensor input, PWM/0-5 VDC input or I2C Bus input. Following is a description of each control method:

**1) Temperature Based Fan Control:** The speed of all fans is proportional to the highest temperature read by 1 to 3 remote sensors connected to header J17 or the temperature of one board mounted sensor. Chart 1.0 shows fan voltage as a function of sensed temperature. A shunt on header J15 is used to select the control temperature  $T_C$  (The control temperature is the temperature at which 100% fan voltage is applied to the fans.). When temperature based fan control is selected, temperature sensor status is available on the I2C bus.



**Chart 1.0:** Fan voltage vs. sensor temperature for each control temperature setting.

**2) PWM/0-5 VDC Based Fan Control:** The speed of all fans is proportional to the PWM/0-5 VDC signal applied to header J16. Chart 2.0 shows the relationship between the control signal applied at header J16 and the fan voltage.



**Chart 2.0:** Fan voltage vs. control signal input.

**3) I2C Bus Based Fan Control:** When configured for fan control via the I2C Bus, the speed of all fans is mapped to the command sent through the I2C on header J14. See the Operation Section for a full definition of the I2C protocol.

**Number of Temperature Sensors :** When temperature sensor based fan control is specified, the user can choose to control based on 1, 2, or 3 remotely mounted sensors or one board mounted sensor.

**On Board Isolated Power Supply:** The user can choose to supply the 3.3 or 5.0 VDC power required to run the I2C Bus (header J14) or PWM/0-5 input interface (header J16) or specify that an isolated power supply be provided on-board.

### Specialized Configurations of the Multi-SR

The following parameters can be specialized through software modification:

- Relationship between sensed temperature and fan voltage
- Relationship between PWM control signal and fan voltage
- Fan speed control based on differential temperature
- Fan speed alarm trigger point
- Temperature alarm trigger point
- I2C Bus status register
- Fan turn off below XX°C

### Customized Configuration of the Multi-SR

Contact Control Resources' Application Engineering for details.

### Agency Approvals



UL Recognized to UL508 and CSA-C22.2 File E100344



EN 60950:2000 Compliant

## INSTALLATION

### Mounting

Using the PCB support hardware in hardware pack H117-F, or equivalent, mount the Multi-SR on a flat surface using all six mounting holes for maximum support. To minimize EMI, securely mount the unit on a grounded surface using a metal spacer and hardware at the mounting hole that is surrounded by a conductive pad.

**Multi-SR Part Numbering Scheme:** Referring to the part number scheme shown below, select the Multi-SR that meets your application:

Table 1.0: Part Number Scheme		
Format	Description	Options
X	(Blank) = Standard C = Custom	Contact Control Resources' Application Engineering for anything other than standard
XXX	052 = 36 to 75 VDC Supply	
S	S = Multi-SR	
X	4 = 4 Amps (5 Amps in 200 LFPM air stream)	
XX	40 = 40°C MED Control Temp.	
X	Number of Temperature Sensors	3 = 3 Sensors 2 = 2 Sensors 1 = 1 Sensor B = 1 On Board Sensor 0 = No Sensors
X	Speed Control Method	T = Temperature Sensor Based Control I = I2C Bus Based Control P = PWM/Voltage Based Control
X	Isolated Power	0 = No on board isolated 3.3/5.0 VDC supply 1 = On board isolated 3.3/5.0 VDC supply
X	Number of Fans to be monitored	6 = 6 Fans 5 = 5 Fans 4 = 4 Fans 3 = 3 Fans 2 = 2 Fans 1 = 1 Fan
X	Specialized Features	(Blank) = Standard Other = consult factory
-F	RoHS (6/6) Compliant	

Example: **052S4402T15-F** = A Multi-SR rated 36 to 75 VDC @ 4 Amps, 40°C MED control temperature setting, temperature sensor based control from two remote temperature sensors, an on-board isolated supply and capability to monitor the speed of five fans.

The default configuration of the Multi-SR that is stocked is 052S4401T16-F.

## CONNECTIONS

### Connector Pin Assignments:

A description of the function of each connector pin and location is listed in Table 2.0. Depending on the model number and configuration of the Multi-SR, some headers may not need to be populated.

Header Label	Label	Description
J2	+	Ripple Capacitor, Positive Terminal
	-	Ripple Capacitor, Negative Terminal
J3- J8	+	Fan, Positive Terminal
	A	Fan, Tachometer Signal
	-	Fan, Negative Terminal
J9	FAN	Fan Failure LED, Cathode (G)
	FAN	Fan Failure LED, Anode (R)
	TMP	Temperature Alarm LED, Cathode (G)
	TMP	Temperature Alarm LED, Anode (R)
	WD	Watchdog Alarm LED, Cathode (G)
	WD	Watchdog Alarm LED, Anode (R)
	+AUD	Audible Alarm, Positive Terminal
	AUD-	Audible Alarm, Negative Terminal
J12	1	Minor Alarm
	2	Minor Alarm
	C	Major Alarm, Collector Terminal
	E	Major Alarm, Emitter Terminal
J13	+	Power Supply A, Positive Terminal
	A	Power Supply A, Negative Terminal
	+	Power Supply B, Positive Terminal
	B	Power Supply B, Negative Terminal
J14	VCC	Isolated Supply Voltage, Positive
	C	I2C SCL
	D	I2C SDA
	GND	Isolated Supply Voltage, Negative (Two Pins)
J16	+	PWM Speed Input, Signal
	-	PWM Speed Input Signal, Reference
J17	T1	Temperature Sensor 1 (Two Pins)
	T2	Temperature Sensor 2 (Two Pins)
	T3	Temperature Sensor 3 (Two Pins)

### Suggested Connecting Hardware

Use CRI Hardware Pack H117-F containing the following components shown in Table 3.0.

Header	Mfg. & P/N	H117-F Hardware Pack		
		Qty	Description	Mfg. & Part No. <sup>1</sup>
J2	Molex No. 26-60-4020	1	Housing	Molex No. 09-50-8021
		2	Terminal (Tin)	Molex No. 08-50-0106
J3 - J8	Molex No. 22-29-2031	6	Housing	Molex No. 22-01-3037
		18	Terminal (gold)	Molex No. 08-55-0102
J9	Molex No. 22-29-2081	1	Housing	Molex No. 22-01-3087
		8	Terminal (gold)	Molex No. 08-55-0102
J12	Molex No. 22-29-2041	1	Housing	Molex No. 22-01-3047
		4	Terminal (gold)	Molex No. 08-55-0102
J13	Molex No. 26-60-4040	1	Housing	Molex No. 09-50-8041
		4	Terminal (tin)	Molex No. 08-50-0106
J14	Molex No. 22-29-2051	1	Housing	Molex No. 22-01-3057
		5	Terminal (gold)	Molex No. 08-55-0102
J16	Molex No. 22-29-2021	1	Housing	Molex No. 22-01-3027
		2	Terminal (gold)	Molex No. 08-55-0102
J17	Molex No. 22-29-2061	1	Housing	Molex No. 22-01-3067
		6	Terminal (gold)	Molex No. 08-55-0102
Mounting Hardware		6	PCB Support	Richco No. CBS-4-19
		1	Aluminum Spacer	Richco No. ALSS6-2
		1	Screw	6-32 x 5/8
		1	Nut	6-32

<sup>1</sup> Or equivalent

### Input Power Connection to Header J13

Refer to Figure 1.0 for input power wiring. One or two power supplies in the range of 36 to 75 VDC should be connected at header J13. If two power supplies are used, they are logically OR'd on the Multi-SR so that the operating voltage is equal to the higher of the two supplies. The Multi-SR can supply up to 4.0 Amps (still air) and 5.0 Amps (200 LFPM air stream) at 24 VDC or 48 VDC to the fan load.

### External Filter Capacitor Connection to Header J2

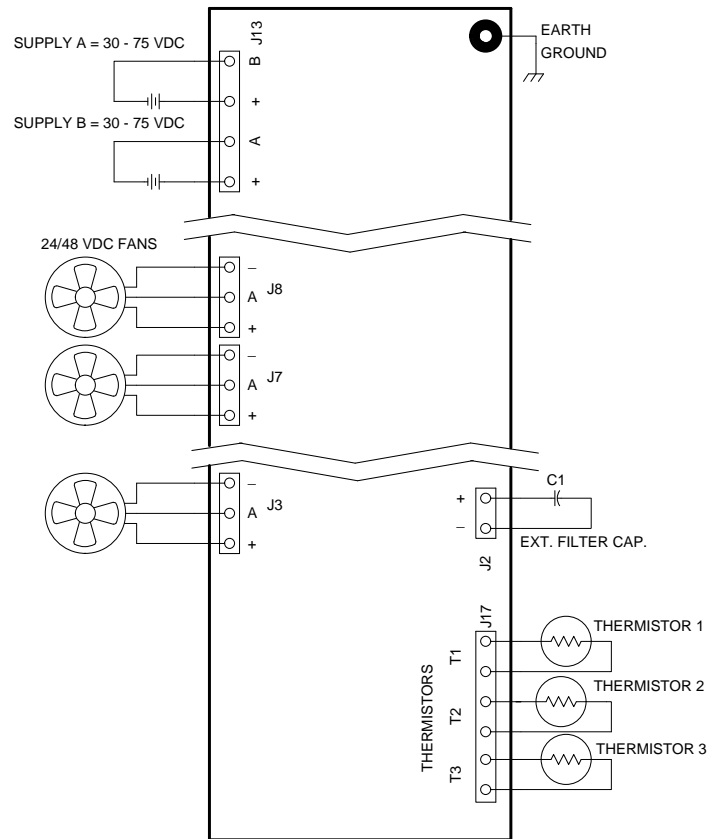
Although it is not required in most applications, an external capacitor (C1) can be installed to provide additional EMI/EMC filtering. Connector J2 is internally connected across the output of the voltage regulator circuitry and in parallel with 960uF of internal filter capacitance. Referring to Figure 1.0, connect an appropriately sized capacitor to header J2.

### Fan Connection to Headers J3-J8

**Six Fans:** The Multi-SR distributes power to and monitors the tachometer signals from six three-wire fans. Referring to Figure 1.0, connect the fans to headers J3 through J8. Fan wires are usually color coded with red for +, black or blue for - and white or yellow for tachometer signal. Fan current at each fan header must not exceed 2.5 Amps. Total current required by the fans connected to the Multi SR must not exceed 4.0 Amps (still air) and 5.0 Amps (200 LFPM air stream) at 24 VDC or 48 VDC.

**Less than Six Fans:** When configured to operate with less than six fans, the Multi-SR is designed to locate the fan headers that have fans connected to them. This means that the position of each fan connection is arbitrary. For instance, when configured for three-fan operation, the three fans can be connected to any three headers, J3-J8.

**CAUTION:** If less or more than the configured amount of fans are connected, a FAN alarm will be activated.



**FIGURE 1.0:** Connection diagram showing input power, fan, filter capacitor and temperature sensor connections for a Multi-SR configured for Temperature Sensor Based Fan Control.

### Connection of Remote Temperature Sensor(s) to header J17

**Temperature Sensor Connection when I2C or PWM Based Control is used:** When configured to operate with either PWM or I2C based speed control, this header is disabled. Therefore, no temperature sensors should be connected to the Multi-SR.

**Remote Temperature Sensor Control using 3 Sensors:** The Multi SR can be configured to operate with a maximum of three remote temperature sensors that are used to provide temperature based fan speed control and alarming. Referring to Figure 1.0, connect the three sensors to header J17. There is no polarity consideration when connecting the sensors. The sensor reading the highest temperature is used for speed control and alarming.

## Remote Temperature Sensor Control using < 3 Sensors:

When configured to operate with less than three remote temperature sensors, the Multi-SR locates the positions that are occupied by the sensor(s), T1, T2 and/or T3. This permits the user to place the one or two sensor(s) at any position. When two sensors are used, the thermistor reading the highest temperature is used for fan control and alarming.

**CAUTION:** If less or more than the configured amount of sensors are connected, a TMP alarm will be activated.

**On Board Temperature Sensor Control:** When configured to operate with an on-board temperature sensor, header J17 is disabled. Speed control is based on the sensor soldered to the Multi-SR.

## Connection of PWM / 0-5VDC Control Signal to header J16

**0-5 V DC or PWM Control Signal:** The Multi SR can proportionally control fan speed based on a PWM or 0-5 VDC control signal. Chart 2.0 shows the relationship between the fan voltage and the control signal input. Referring to figure 3.0, connect the voltage signal to header J16. Header J16 is internally pulled up to VCC with a 47.5k resistor. The voltage applied to J16 must be limited to the isolated VCC. The PWM frequency range is 0.1 to 10 kHz.

**Control Signal Power:** If the Multi SR was ordered with the Isolated Power option (see table 1.0), the Multi SR will power this interface. Otherwise, the isolated power must be provided at the VCC & GND pins at header J14 (see figure 3.0).

**Under Temperature Sensor or I2C based Fan Control:** When configured for temperature sensor or I2C based fan control, header J16 is disabled.

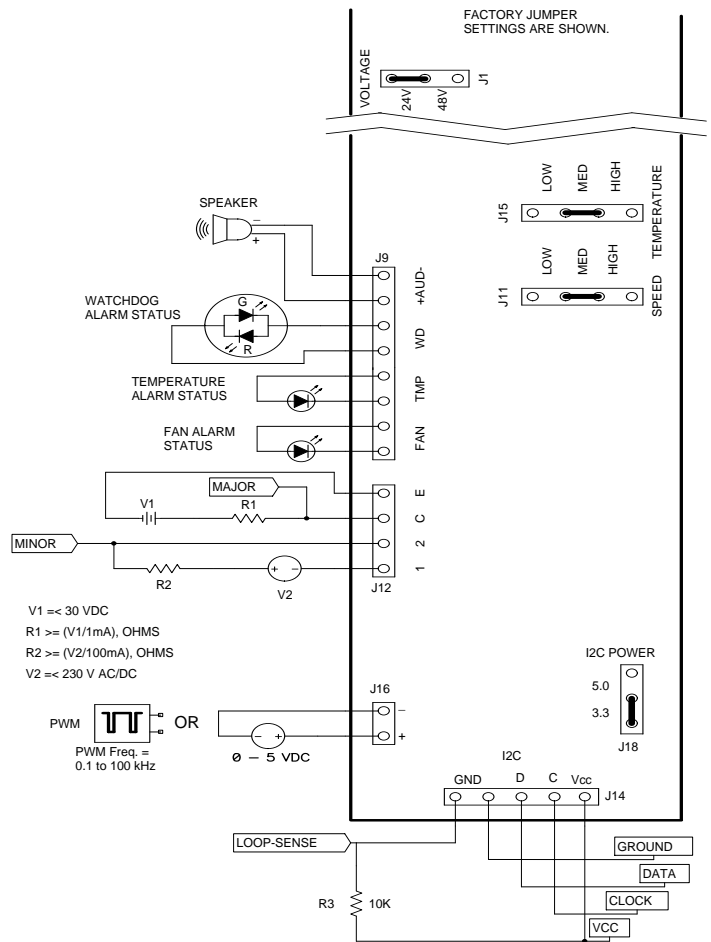
## Connection of I2C Bus to Header J14

**I2C Bus Speed Command Inputs when Temperature Sensor or PWM/0-5 VDC based Fan Control is used :** When configured for temperature sensor or PWM/0-5 VDC based fan control, header J14 will accept I2C Bus speed control inputs but they are ignored by the control circuitry. Temperature Sensor and PWM/0-5 VDC based fan control configurations ONLY support I2C alarm status communication.

**Fan Control and/ or Alarm Status Communication on the I2C Bus:** The Multi-SR can monitor alarm status and control the fan voltage via an I2C Bus. Referring to Figure 3.0, connect serial clock, data, VCC and ground lines to header J14.

**VCC:** For units that feature an internally isolated 3.3/5.0 VDC supply, no connection to J14:VCC is required; all power for the I2C bus is provided by the Multi-SR. When power for the I2C bus is provided by the Multi-SR, the setting of a jumper at J18 determines 3.3 or 5.0 VDC bus operation. For units that use an external bus power source, connect a 3.3 or 5.0 VDC source to J14:VCC. Header J18 is disabled when external bus power is provided.

**GND:** Two ground reference pins are provided for the I2C bus. Note that the additional ground pin has been provided for the optional connection of a loop back detection circuit. The loop back circuit permits detection of a physically broken connection.



**Figure 3.0:** Connection diagram for alarm circuitry, I2C bus and PWM/0-5 VDC input.

### Connection of LEDs to Header J9

Header J9 provides local indication of fan (FAN), temperature sensor (TMP) and watchdog (WD) alarm status. Referring to Figure 3.0, connect alarm LEDs and/or an audible alarm to header J9. **All alarm circuits on header J9 are non-isolated from input power (J13).** Choose single color LEDs or two leaded, bi-color LEDs with a rated forward voltage ( $V_f$ ) between 1.6 and 2.4 VDC at a forward current ( $I_f$ ) of between 15 and 25 mA. Nominal current applied to the LEDs is 8 mA. The audible alarm output (+AUD-) provides up to 20 mA at 5 VDC and is fused with a 0.062 Amp fuse. Choose an audible alarm rated 100 mW at 5 VDC.

### Connection of Remote Alarm Circuits to Header J12

Two optically isolated logic circuit outputs are on header J12 to provide remote indication of alarm status. Referring to Figure 3.0, connect logic circuits to header J12. Both alarm outputs must be current limited as shown in Figure 3.0. The output of C-E, considered a major alarm indicator, is from an open collector phototransistor. The output of 1-2, considered a minor alarm indicator, is from a MOS relay.

## OPERATION

### Remote Sensor Selection (J15)

When configured to operate with remote temperature sensors, the Multi-SR is compatible with Sensors P1 through P9 shown in the SmartFan Catalog. Control temperature is a function of the temperature sensor selected and the position of the shunt (S3) on header J15.

### Board-Mounted Temperature Sensor

In this application, fan voltage is proportional to the temperature sensed by the sensor that is soldered to the Multi-SR. Header J17 is disabled.

### Jumper Settings (J1, J11, J15, J18)

There are four jumper settings that must be reviewed prior to applying power to the Multi-SR: Output Voltage, Control Temperature, Alarm Speed and 3.3/5.0 On-Board I2C Power. Settings are based on application and the configuration of the Multi-SR. Following is a description of each jumper setting.

**1) Control Temperature Setting (J15):** The control temperature is the temperature at which the maximum voltage is applied to the fans. Header J15 allows selection from three different control temperatures. Table 4.0 shows the control temperature value for each jumper setting. If the jumper is removed, the default setting is MED. Chart 1.0 shows fan voltage vs. sensor temperature for each control temperature setting.

NOTE: Header J15 is only applicable to Temperature Sensor based fan control. The setting of this header can be ignored in I2C based and PWM based fan control applications.

Temperature Setting Jumper (J15)	Control Temperature
LOW	35°C
MED (Factory Setting)	40°C
HIGH	45°C

**2) Output Voltage Setting (J1):** The Multi-SR can provide power to either 48 VDC or 24 VDC fans from a 36 to 75 VDC input voltage source. Use header J1 to select the type of fan connected to the Multi-SR. Move the shunt to 24V if 24 VDC fans are being used. Move the shunt to 48V if 48 VDC fans are being used.

**CAUTION: If the shunt is removed, the Multi-SR will operate in the 24 VDC fan mode. It is not recommended that the shunt be removed for any reason. A mix of 48 VDC and 24 VDC fans cannot be connected to the Multi-SR.**

**3) Fan Alarm Speed Setting (J11):** The Multi-SR monitors the tachometer signal inputs of up to six fans and activates the FAN alarm if the speed of one or more fans falls below the trigger speed ( $W_A$ ). One of three trigger speeds can be selected using the jumper on header J11. Each jumper position is defined as follows:

- Position LOW = 1000 PPM
- Position MED = 2000 PPM (Factory Setting)
- Position HIGH = 4000 PPM

Since fan tachometer circuits are designed with one, two or even more pulse outputs per revolution, settings are listed in pulses per minute (PPM) rather than revolutions per minute (RPM). Given the fan's speed under load ( $W$ ) and the number of pulses per revolution ( $N$ ), use the following formula to select the trigger speed ( $W_A$ ):

$$W_A = W \times N \times 0.3$$

For example, a 3300-RPM fan with two pulses per revolution would have a trigger speed of

$$W_A = 3300 \text{ RPM} \times 2 \text{ PPR} \times 0.3 = 1980 \text{ PPM.}$$

Since the 2000 PPM trigger is closest, set jumper J11 to the "MED" position.

The alarm trigger accuracy is +/- 20%.

If the shunt is removed from header J11, the Multi-SR defaults to the factory setting of 2000 PPM.

**4) On-Board Isolated Power Setting (J18):** The Multi-SR can provide isolated 3.3 or 5.0 VDC power for the I2C Bus and PWM/0-5 VDC input interfaces. Use header J18 to select the power required. Move the shunt to 3.3 if 3.3 VDC power is required. Move the shunt to 5.0 if 5.0 VDC power is required. If the jumper is removed from header J18, the Multi-SR defaults to 3.3 VDC power. NOTE: The position of the shunt on header J18 is not applicable when isolated power is sourced externally.

### Local Alarm Status Operation & Logic (J9)

Four alarm outputs, located at header J9, provide visual and audible status of fan, temperature sensors and microprocessor watchdog alarms. The failure criteria are defined in Table 5.0.

Controller Status	Failure Criteria
Fan Status (FAN)	The speed of one or more fans falls below the trigger speed ( $W_A$ ).
Temperature Status (TMP)	The temperature of any sensor is more than 10°C above the control temperature ( $T_C$ ). Any temperature sensor fails open/short.
Watchdog Status (WD)	The microcontroller latches or fails.
General Status (AUD)	Presence of a Fan Failure, Temperature Failure or Watchdog Failure.

Table 6.0 shows the status of each LED output on header J9 for failure and valid conditions based on using single color LEDs. If bi-color LEDs are used, the LEDs would switch color rather than turn ON/OFF.

Status	Only Fan Failure Present	Only Temperature Failure Present	Only Watchdog Failure Present
FAN	ON	OFF	Unknown
TMP	OFF	ON	Unknown
WD	OFF	OFF	ON
+AUD-	ON	ON	Unknown

### Major/Minor Alarm Logic (J12)

Alarm logic for the optically isolated major and minor alarms on header J12 is shown in Table 7.0. The values in the table are based on the circuit configurations shown in Figure 3.0.

Outputs	One Failure Present (Volts)	More than One Failure Present (Volts)	No Failures Present (Volts)	Power or Board Failure Present (Volts)
MAJOR	=< 0.4	V1	=< 0.4	V1
MINOR	=< 0.4	=< 0.4	V2	=< 0.4

"More than one failure" in Table 7.0 is defined as the presence of any of the following conditions:

- One or more sensors read a high temperature or are open and one fan has failed.
- A watchdog failure has occurred.
- Two or more fans have failed.

### Fan Voltage in any Alarm Condition

During the presence of any alarm condition, the maximum fan voltage is applied to the fans.

## I2C Bus Protocol

The I2C Bus is configured as a slave device that can transmit and receive data. When the Multi-SR is configured for I2C based speed control, the user can write speed commands to the Multi-SR and read all alarm status bits except the high temperature status bits. When configured for temperature sensor based control the user can read all alarm status bits from the Multi-SR. When configured for PWM based speed control, the user can read all alarm status bits but the high temperature status bits.

## Specifications

- The bus supports seven-bit addressing and only acts as a slave device.
- The address for the fan controller is 0x0C ('0001100').
- General call support is not provided.
- The fan controller will stretch the clock further if needed.
- The hardware register will support Standard Mode I2C, however, the system is tested at 55kHz clock speed and lower clock speeds are recommended.
- Speed commands (when used) must be updated every 60 seconds or the fan voltage is sent to 100%.

Table 8.0 defines the bits used in the serial bus protocol.

Table 8.0: I <sup>2</sup> C Bus Definitions	
ACK	Acknowledge
<del>ACK</del>	Not Acknowledge (End of Transmission)
A6 – A0	Address for Fan Tray, Bits 6 – 0 ('0001100')
D7 – D0	Data TO/FROM fan tray, bits 7 – 0
D8 – D15	Data from fan tray bits, 8 – 15
P	Stop bit
R	Read Bit (1)
S	Start Bit
W	Write Bit (0)

## Reading Status Information

Table 9.0 provides the definition of each of the sixteen status bits in the I2C protocol. The first byte, bits D7 – D0, provides the status of all fans and minor alarm status. The second byte, bits D15 – D8, provides temperature sensor and major alarm status.

Table 9.0: Status Data Format		
Bits	Description	Comments
D0 – D5	Fan Status (First status Byte)	1 = Fan Failed, 0 = No Fan Failure. D0 = Status of Fan on J3, D1 = Status of Fan on J4, D2 = Status of Fan on J5, D3 = Status of Fan on J6, D4 = Status of Fan on J7, D5 = Status of Fan on J8.
D6	Minor Alarm Status	1 = One failure present, 0 = No failure present
D7	Start of First Byte	Always 0 to indicate this is the first alarm byte
D8 – D10	Open sensor Status	1 = Sensor is open or temperature is < -20°C, 0 = Sensor is present D8 = Status of T1, D9 = Status of T2, D10 = Status of T3.
D11-D13	Over Temperature Status	1 = Over Temperature, 0 = Not Over Temperature. D11 = Status of T1, D12 = Status of T2, D13 = Status of T3.
D14	Major Alarm	1 = More than one failure is present, 0 = Less than two failures present.
D15	Start of Second Byte	Always 1 to indicate the start of the second status byte

“More than one failure” in Table 9.0 is defined as the presence of any of the following conditions:

- One or more sensors read a high temperature or are open and one fan has failed.
- A watchdog failure has occurred.
- Two or more fans have failed.

**Read First Alarm Status Byte:** The following format is used to read the first status byte (D7 – D0). Reading the first status byte can be performed under all configurations of the Multi-SR because it provides fan failure status, a feature common to all configurations.

Format:

S A6 A5 A4 A3 A2 A1 A0 R ACK D7 D6 D5 D4 D3 D2 D1 D0 ~~ACK~~ P

Example: S 0 0 0 1 1 0 0 1 ACK 0 1 0 0 0 0 1 0 ~~ACK~~ P...Shows that the fan connected to J4 has failed and the minor alarm status is active.

**Read First and Second Alarm Status Bytes:** The following format is used to read the first and second status bytes (D7 – D0 & D15 – D8) of alarm status.

Format:

```
S A6 A5 A4 A3 A2 A1 A0 R ACK D7 D6 D5 D4 D3 D2
D1 D0 ACK D15 D14 D13 D12 D11 D10 D9 D8 ACK P
```

The first byte provides the status of each fan, a feature common to all configurations of the Multi-SR. The status information provided in the second byte is dependent on the configuration of the Multi-SR:

**If Configured for Temperature Sensor Based Fan Control,** the second byte of status information provides major and minor alarm status, open sensor and over temperature sensor information.

Example: S 0 0 0 1 1 0 0 1 ACK 0 1 0 0 0 0 0 0  
ACK 1 0 1 1 0 0 0 0 ACK P...Shows no fan alarms, sensors T3 and T2 are reading a high temperature and as a result the minor alarm is active.

**If Configured for PWM or I2C Bus Based Fan Control,** the second byte of status information provides major and minor alarm status and ONLY open sensor status (D10 – D8). Since no sensors should be connected to the Multi-SR (header J17) under this configuration, only the presence of a sensor is monitored as a safeguard. Therefore, each over temperature status bit (D13 – D11) is always 0. But, if a sensor (reading > -20°C) is connected to header J17, the corresponding open sensor status bit will be 0 and minor alarm status bits will read 1.

Example: S 0 0 0 1 1 0 0 1 ACK 0 1 0 0 0 1 0 1  
ACK 1 1 0 0 0 1 1 1 ACK P...Shows thermistors T3, T2 and T1 are open and fans on headers J3 and J5 have failed causing a major and minor alarm to be active.

### Watchdog Status on I2C Bus

The watchdog/microcontroller alarm is not communicated on the I2C Bus. A watchdog failure is a major alarm condition. Therefore, remote detection of a watchdog alarm is available via the major alarm logic circuit output located on header J12.

### Writing Speed Commands

Table 10.0 shows the data format for writing a speed command to the Multi-SR I2C Bus.

Table 10.0: Speed Data Format		
Bits	Description	Comments
D0 – D7	Fan Speed	See Table 11.0

Use the hexadecimal values listed in Table 11.0 to control fan voltage via the I2C Bus. Writing a hexadecimal number to bits D0 – D7 changes fan voltage.

Table 11.0: Speed Data Format	
Fan Voltage as percent of maximum	Value of D0 – D7 (8 bit Hexadecimal)
55%	00
58%	01
61%	02
64%	03
67%	04
70%	05
73%	06
76%	07
79%	08
82%	09
85%	0A
88%	0B
91%	0C
94%	0D
97%	0E
100%	0F
	Values above 0x0F are reserved for future use

### Write Speed Command Byte:

The following format is used to write a speed command to the Multi-SR. Because of the way the I2C Bus is implemented, a speed command is acknowledged by the Multi-SR under all configurations but is ONLY executed when the Multi-SR is configured for I2C Bus fan control. Speed commands must be updated every 60 seconds or the fan voltage is sent to 100%.

Format:

```
S A6 A5 A4 A3 A2 A1 A0 W ACK D7 D6 D5 D4 D3 D2
D1 D0 ACK P
```

Example: S 0 0 0 1 1 0 0 0 ACK 0 0 0 0 1 0 1 0  
ACK P...Shows a write command that sends the Multi-SR to 85% speed.