TELEDYNE ELECTRONIC TECHNOLOGIES

SOLID STATE RELAY DATA BOOK

MILITARY/AEROSPACE SOLID STATE RELAYS

Innovations in Solid State Switching

TELEDYNE ELECTRONIC TECHNOLOGIES
Solid State Relays

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TELEDYNE
ELECTRONIC TECHNOLOGIES
Solid State Relays

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Teledyne Solid State Relays offers an extensive line of solid state relays for use in a wide range of consumer, industrial and high reliability applications. This Data Book contains detailed technical information on a broad line of more than 20 different series and 48 different models of solid state relays designed specifically for high reliability and military product applications.

The Data Book is divided into sections for ease of reference. The first section includes a complete product index. This is followed by the data sheet sections that are divided into four major groups, AC, DC, Bi-directional and Power Controllers.

At the end of the individual data sheet section is a chart that cross references Teledyne part numbers against military QPL numbers and DESC drawing numbers. To assist in your reliability analysis a form is included to allow you to ask Teledyne what the MTBF would be for our relay in your application. Fill it out mail it, or FAX it in, we will be happy to perform the analysis. The last section of this Data Book is to introduce you to our Distributors. They are there to help you in selecting and ordering Solid State Relays.

If you desire information on Teledyne Solid State Commercial and Industrial Relays please call (310) 577-3834.

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Bi-Directional Solid State Relay 3

AC Solid State Relay 4

DC Power Controllers 5

Military Products Cross Reference 6
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TELEDYNE
ELECTRONIC TECHNOLOGIES
Solid State Relays

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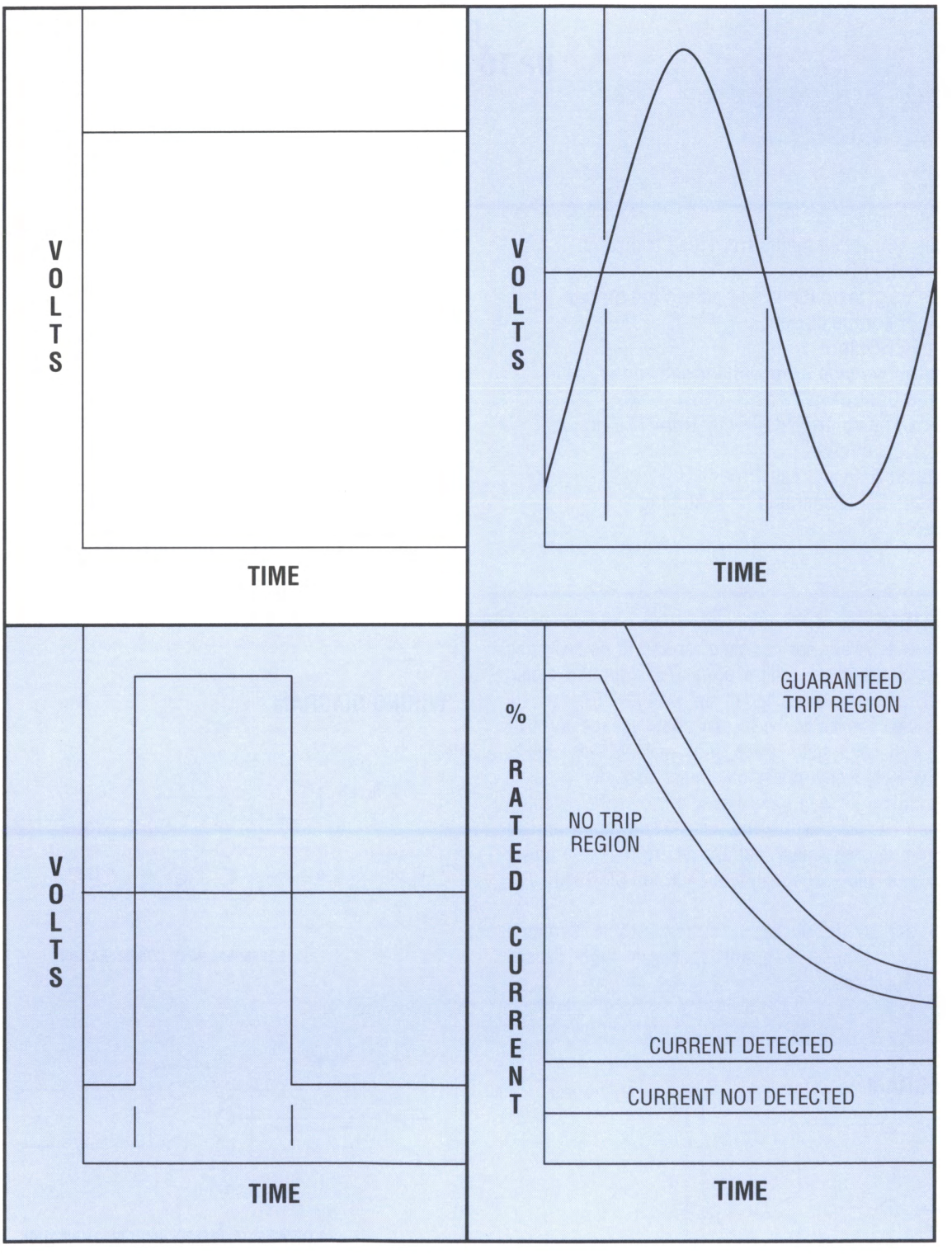
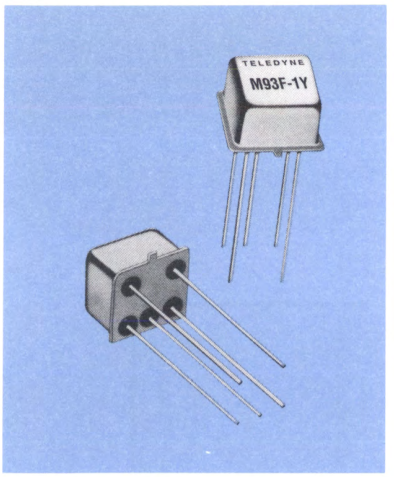




TELEDYNE SOLID STATE

D.C. SOLID STATE RELAY

OPTICALLY ISOLATED
DC OUTPUT
UP TO 350 ma, 400 Vdc

SERIES
M93F

SPST/NO

FEATURES

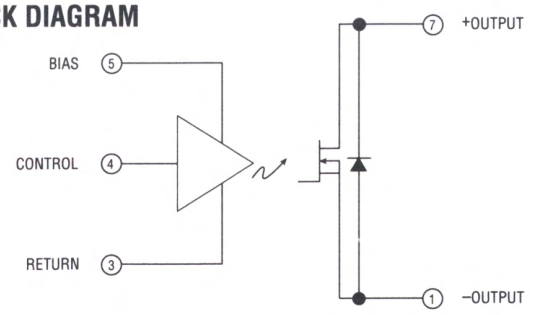
- Optical isolation-
  Isolates control elements from load transients
- Fully Floating Output-
  Eliminates ground loops and allows the output to sink or source current
- Power FET Output-
  low output voltage drop with virtually no offset
- Buffered Control-
  Relay can be controlled directly from TTL or CMOS logic circuits
- Controlled Rise and Fall Times-
  Minimizes EMI generated by switching transients

DESCRIPTION

The M93F series relays are designed for use in dc switching applications. These relays utilize power FETs for the output switch, with blocking capability of up to 400V. The use of power FETs also eliminates the bipolar offset voltage normally associated with solid state relays, thus making these relays ideal for low level signal operation. Optical isolation protects the control logic from load transients and allows the output to sink or source current to the load. The input circuit incorporates a current limiter and a buffer to minimize power dissipation and allow direct operation from CMOS or TTL circuits.

The M93F series are packaged in low profile Centigrid packages which conserve board space in high density packaging applications.

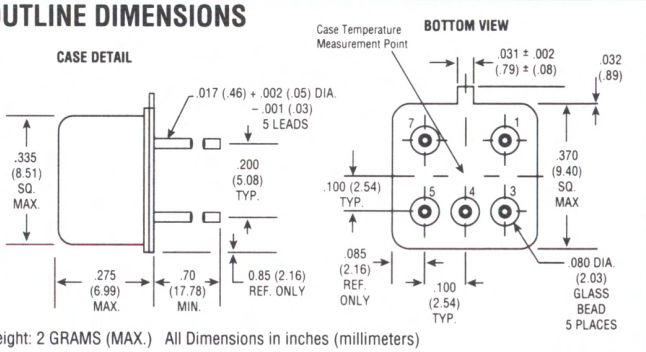
BLOCK DIAGRAM



PART NUMBER*	DESC DRAWING NUMBER	RELAY TYPE
M93F-1W		Solid State Relay 100Vdc
M93F-1Y	85092-001	
M93F-2W		Solid State Relay 400Vdc
M93F-2Y	85092-002	

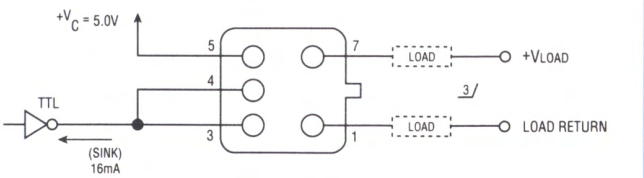
*The Y suffix denotes parameter tests comparable to MIL-R-28750 test methods. The W suffix defines parts screened to Teledyne specifications.

OUTLINE DIMENSIONS

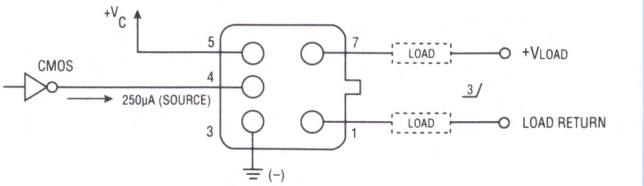


Weight: 2 GRAMS (MAX.) All Dimensions in inches (millimeters)

WIRING DIAGRAM



2 TERMINAL INPUT CONFIGURATION



3 TERMINAL (BUFFERED) INPUT CONFIGURATION

SCHEMATIC (BOTTOM VIEW)

ELECTRICAL SPECIFICATIONS
(-55°C to + 85°C UNLESS OTHERWISE SPECIFIED)

INPUT (CONTROL) CHARACTERISTICS When used in 2 terminal configuration (TTL or direct control) (See Note 2)		MIN	TYP	MAX	UNITS
Input Current @ V_{BIAS} = 5 Vdc See Fig. 1				16	mAdc
Turn-Off Voltage (Guaranteed Off)				1.5	Vdc
Turn-On Voltage (Guaranteed On)		3.8			Vdc
Reverse Voltage Protection				-32	Vdc
Input Supply Range See Note 4		3.8		32	Vdc
INPUT (CONTROL) CHARACTERISTICS When used in 3 terminal configuration (CMOS or open collector TTL) See Fig. 2 (See Note 1)		**MIN**	**TYP**	**MAX**	**UNITS**
Control Current	$V_{CONTROL}$ = 5 Vdc			250	µAdc
	$V_{CONTROL}$ = 18 Vdc			1	mAdc
Control Voltage Range		0		18	Vdc
Bias Supply Voltage Range		3.8		32	Vdc
Bias Supply Current			14	16	mAdc
Turn Off Voltage (Guaranteed Off)		2.8			Vdc
Turn On Voltage (Guaranteed On)				0.35	Vdc
Schmitt Hysteresis		1.0			Vdc
OUTPUT (LOAD) SPECIFICATION (See Note 5)		**MIN**	**TYP**	**MAX**	**UNITS**
Continuous Load Current (See Fig. 2)	M93F-1			350	mAdc
	M93F-2			135	
Leakage Current V_{LOAD} = 80% Max. Rated				50	µA
Continuous Operating Load Voltage	M93F-1			100	Vdc
	M93F-2			400	
On Resistance I_{LOAD} = 100 mA T_J = 25°C	M93F-1			4	Ohms
	M93F-2			25	
Turn-On Time				0.7	ms
Turn-Off Time				1.0	ms
Dielectric Strength		1000			Vac
Insulation Resistance @ 500 Vdc		10^9			Ohms
Output Junction Temperature @ I_{LOAD} = maximum rated current				125	°C
Maximum Junction Temperature				150	°C

ENVIRONMENTAL SPECIFICATIONS*

Temperature (Ambient Operating)	-55°C to Maximum Per Thermal Operating Curve
Temperature (Ambient Storage)	-55°C to 125°C
Vibration	30g, 10 to 3000 Hz
Acceleration	5000 g
Shock	1500g, 0.5 msec

CHARACTERSTIC CURVES

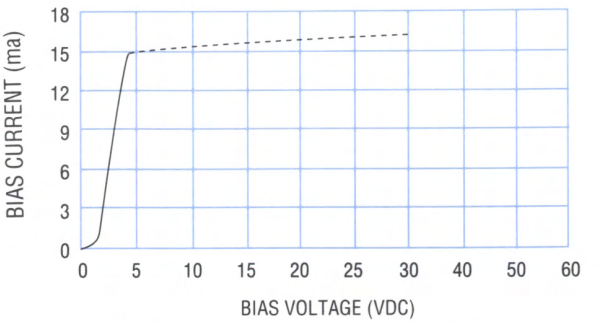


FIGURE 1 – BIAS CURRENT VS BIAS SUPPLY VOLTAGE

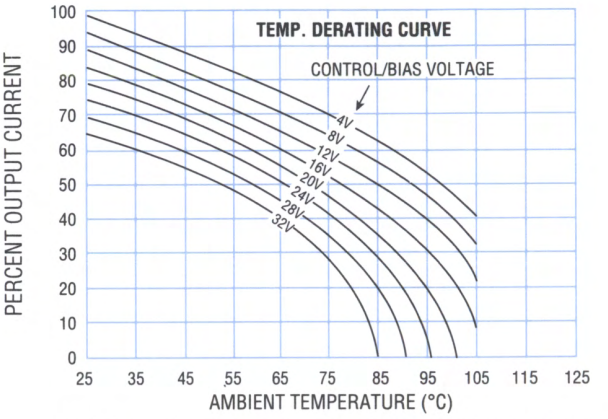


FIGURE 2 – MAXIMUM LOAD CURRENT VS AMBIENT TEMPERATURE

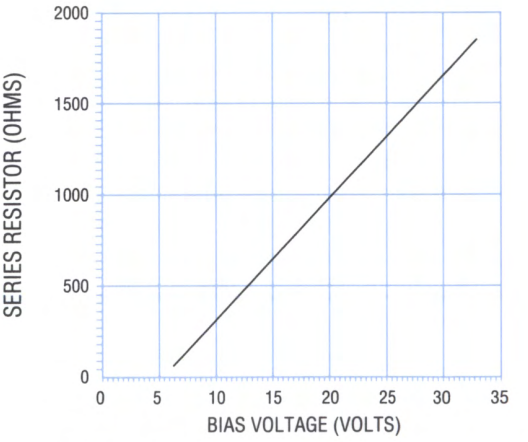


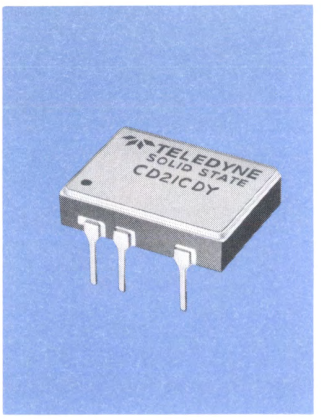
FIGURE 3 – SERIES LIMIT BIAS RESISTOR VS BIAS VOLTAGE

*Contact factory for higher level environmental requirements.

NOTES:

1. With 3 terminal input, the relays provide inversion.
2. In the 2 terminal configuration the relays are non-inverting.
3. Relays may drive loads connected to either positive or negative referenced power supply lines. (Source or sink modes.)
4. If the Series Control/Bias Resistor of figure 3 is used to dissipate Input Power, the derating of Output Current vs. Bias/Control Voltage is not necessary. Curve at 4 volts applies.
5. The rated input voltage is 5V for all tests unless otherwise specified.
6. For on state resistance at temperature other than 25°C, use equation: $R = R_{25} \times e^{0.006 \times T}$ where R25 = resistance at 25°C from table
   R = resistance at new temperature
   T = new temperature -25°C
   e = 2.7182818

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE



TELEDYNE SOLID STATE

DC SOLID STATE RELAY

SHORT CIRCUIT PROTECTED
OPTICALLY ISOLATED
2 A, 60 Vdc

SERIES

CD00CF
CD01CF
CD20CD
CD21CD

SPST/NO

FEATURES

- Available with short circuit/current overload protection
- Available with input status monitor
- TTL and CMOS compatible control
- Low ON resistance power FET output
- Fast switching speed
- Meets 28 Vdc system surge and spike requirements of MIL-STD-704
- Optical isolation
- Low profile hermetic ceramic package
- Built and tested utilizing the test methods equal to or comparable to MIL-R-28750

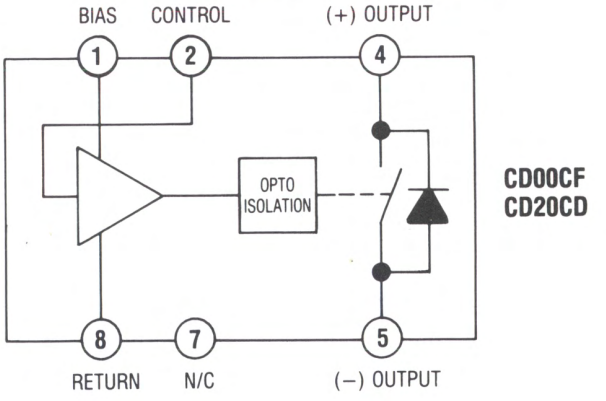
DESCRIPTION:

This all solid state relay utilizes the latest technology to provide a low ON resistance. The control (input) and load (output) are optically isolated to protect input logic circuits from voltage and current transients which can occur on the output supply. The optical isolation also provides a full floating output, thus allowing the load to be connected to either output terminal. The control circuit is buffered to enable the relay to be driven directly from standard CMOS or open collector TTL logic circuits. Available options include short circuit and current overload protection, which provides complete protection for both the relay and the system wiring. This feature not only provides protection should a short or overload occur while the relay is on, but will also provide protection should the relay be switched into a short. In either case, the relay will sense the short circuit condition and then block it indefinitely until the short is removed and the unit is reset by cycling the input control. The second option is a status output, which provides a built-in-test function. This feature checks the input circuitry of the relay and provides a logic (0) low when the input circuit is turned on and operational. Both options are available either together or separately as standard features.

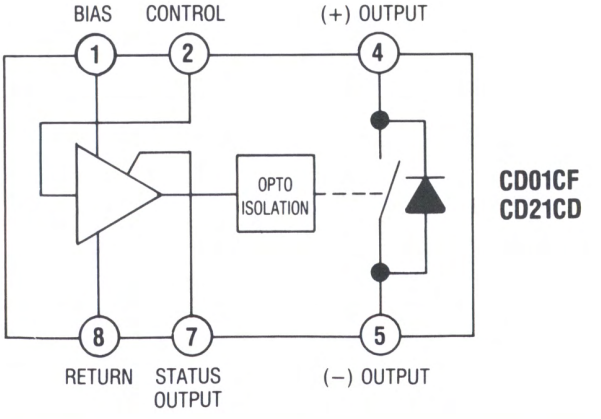
PART NUMBER*	DESC DRAWING NUMBER	RELAY TYPE
CD00CFW		Basic Solid State Relay (SSR)
CD00CFY	90091-008	
CD01CFW		SSR with Control Status
CD01CFY	90091-006	
CD20CDW		SSR with Short Circuit Protection
CD20CDY	90091-004	
CD21CDW		SSR with Short Circuit Protection and Control Status
CD21CDY	90091-002	

* The Y suffix denotes parameters tests utilizing MIL-R-28750 test methods. The W suffix denotes parameters tested to Teledyne specifications.

BLOCK DIAGRAM (BOTTOM VIEW)



CD00CF
CD20CD



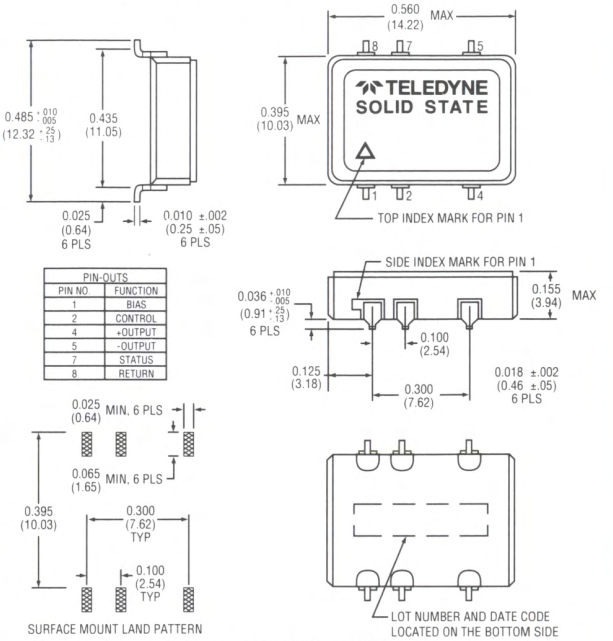
CD01CF
CD21CD

Patent Pending

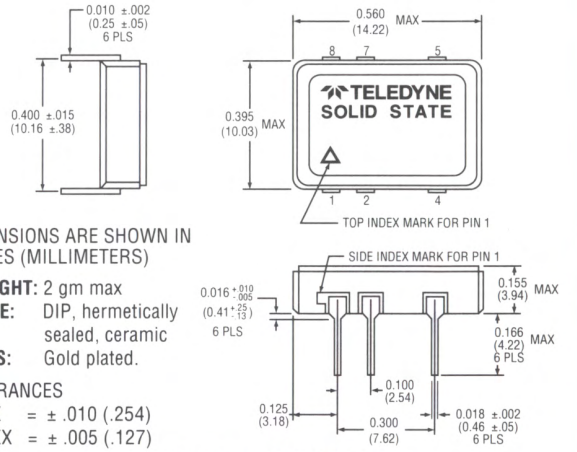
ELECTRICAL SPECIFICATIONS
(-55°C TO 105°C AMBIENT TEMPERATURE UNLESS OTHERWISE NOTED)

INPUT (CONTROL) CHARACTERISTICS When used in 2 terminal configuration (TTL or direct control) (See Fig 1)		**MIN**	**TYP**	**MAX**	**UNITS**
Input Current @ V_{IN} = 5 Vdc (See Fig 2)			14	15	mAdc
Turn Off Voltage (Guaranteed Off)				1.5	Vdc
Turn On Voltage (Guaranteed On)		3.8			Vdc
Reverse Voltage Protection				-32	Vdc
Input Supply Range (See Note 4)		3.8		32	Vdc
INPUT (CONTROL) CHARACTERISTICS When used in 3 terminal configuration (CMOS or open collector TTL) (See Fig 1)		**MIN**	**TYP**	**MAX**	**UNITS**
Control Current	$V_{CONTROL}$ = 5 Vdc			250	µAdc
	$V_{CONTROL}$ = 18 Vdc			1	mAdc
Control Voltage Range (See Note 9)		0		18	Vdc
Bias Supply Voltage Range (See Note 4 & 9)		3.8		32	Vdc
Bias Supply Current @ V_{BIAS} = 5 Vdc			14	15	mAdc
Turn Off Voltage (Guaranteed Off)		3.2			Vdc
Turn On Voltage (Guaranteed On)				0.3	Vdc
OUTPUT (LOAD) SPECIFICATIONS (See Note 2)		**MIN**	**TYP**	**MAX**	**UNITS**
Continuous Load Current (See Fig 3)	CD20CD CD21CD			1.0	Adc
	CD00CF CD01CF			2.0	
Leakage Current @ V_{LOAD} = 60 Vdc				40	µAdc
Output Voltage Drop	CD20CD CD21CD			0.6	Vdc
	CD00CF CD01CF			0.75	
Continuous Operating Load Voltage				60	Vdc
Transient Blocking Voltage (See Note 3)				80	Vdc
ON Resistance Rds (on) at T_J = 25°C I_{LOAD} = 100 mAdc (See Fig 4)	CD20CD CD21CD		0.36	0.45	Ohms
	CD00CF CD01CF		0.16	0.22	
Turn-On Time (See Fig 5)				1.5	ms
Turn-Off Time (See Fig 5)				0.25	ms
dv/dt		-100			V/µs
Electrical System Spike (See Note 3)				±600	Vdc
Output Capacitance at 25 Vdc, 100 KHz				475	pF
Input to Output Capacitance				10	pF
Dielectric Strength		1000			Vac
Insulation Resistance @ 500 Vdc		10^9			Ohms
Output Junction Temperature @ I_{LOAD} = maximum rated current				125	°C
Maximum Junction Temperature T_J (max)				150	°C
Thermal Resistance Junction to Ambient θ_{JA}				80	°C/W
Thermal Resistance Junction to Case θ_{JC}				20	°C/W
STATUS OUTPUT SPECIFICATIONS (CD01CF AND CD21CD)		**MIN**	**TYP**	**MAX**	**UNITS**
Status Supply Voltage (See Note 7)				30	Vdc
Status Leakage Current @ 15 Vdc				4	µAdc
Status (sink) Current (V_{SO} < 0.3 Vdc)				2	mAdc
SHORT CIRCUIT PROTECTION SPECIFICATIONS (CD20CD) AND (CD21CD)		**MIN**	**TYP**	**MAX**	**UNITS**
Surge Current (See Fig 7 and Note 6)			2.4		Adc

MECHANICAL SPECIFICATIONS



SCD SERIES OUTLINE



DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

- **WEIGHT:** 2 gm max
- **CASE:** DIP, hermetically sealed, ceramic
- **PINS:** Gold plated.

TOLERANCES
XX = ± .010 (.254)
XXX = ± .005 (.127)

CD SERIES OUTLINE

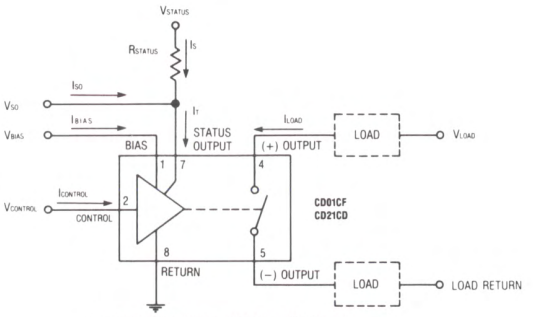
ENVIRONMENTAL SPECIFICATIONS

Temperature Range	Operating	-55°C to +105°C
	Storage	-55°C to +125°C
Vibration		100 g, 10 to 3000 Hz
Constant Acceleration		5000 g
Shock		1500 g, 0.5 ms pulse

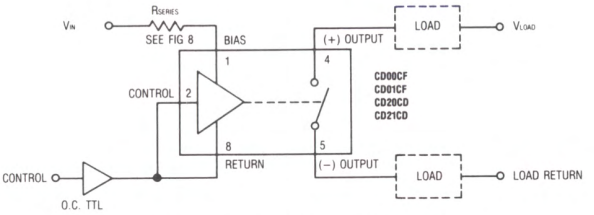
TABLE 1: STATUS OUTPUT TRUTH TABLE (CD01CF AND CD21CD)

CONTROL VOLTAGE	STATUS OUTPUT LEVEL
High	High (V_{SO} = V_{STATUS})
Low	Low (V_{SO} ≤ 0.3 Vdc)

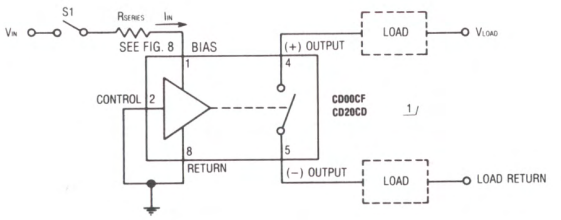
WIRING CONFIGURATIONS



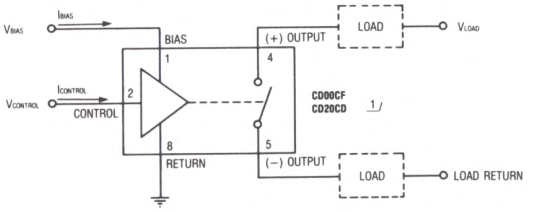
(A) 3 TERMINAL INPUT WITH STATUS (See Note 7)



(B) 2 TERMINAL INPUT (OPEN COLLECTOR TTL DRIVE)



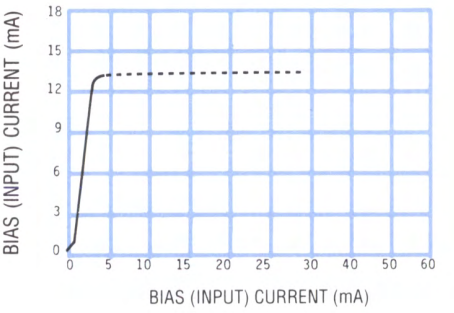
(C) 2 TERMINAL INPUT (DIRECT DRIVE)



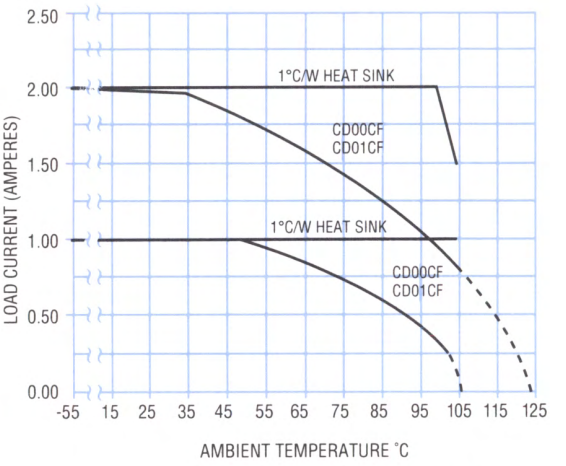
(D) 3 TERMINAL INPUT WITHOUT STATUS

1/ CD21CD AND CD01CF MAY BE WIRED WITHOUT THE STATUS LINE AS SHOWN IN (C) AND (D)

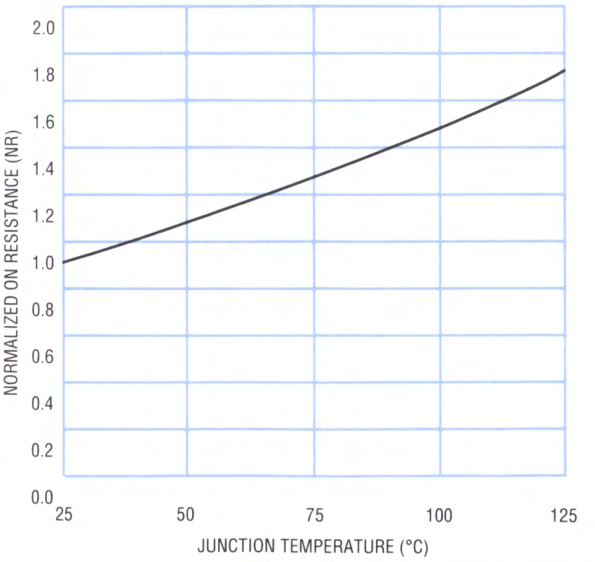
FIGURE 1 (SEE NOTE 8)



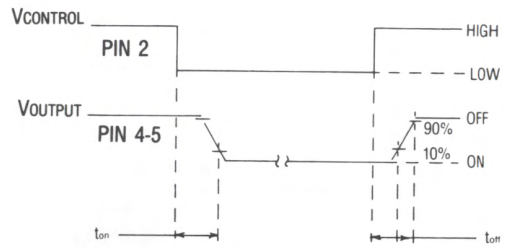
BIAS (INPUT) CURRENT VS BIAS (INPUT) VOLTAGE
FIGURE 2 (SEE NOTE 4)



OUTPUT CURRENT DERATING CURVE
FIGURE 3

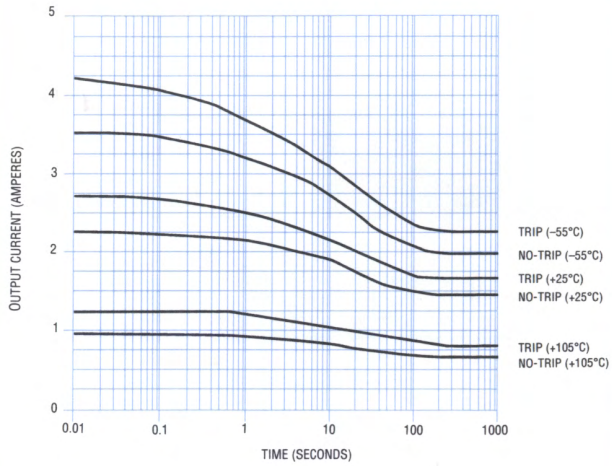


NORMALIZED ON RESISTANCE VS JUNCTION TEMPERATURE
FIGURE 4 (SEE NOTE 5)



OUTPUT TURN-ON AND TURN-OFF TIMING
FIGURE 5

TYPICAL CURRENT TRIP LEVELS CD20CD, CD21CD



TRIP CURRENT VS. TIME (IN STILL AIR)
FIGURE 7 (See Note 6)

NOTES:

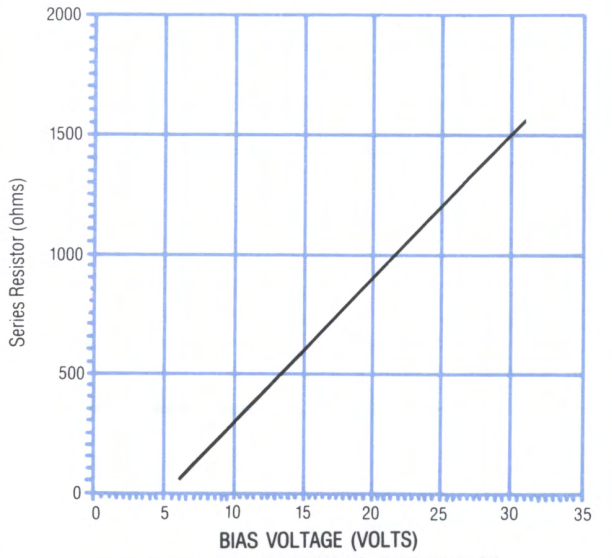
1. Control input is compatible with CMOS or open collector TTL (with pull up resistor).
2. The rated input voltage is 5V for all tests unless otherwise specified.
3. Transient blocking voltage and electrical system spike tests are performed per MIL-STD-704 (28 Vdc systems).
4. For bias voltages above 6V, a series resistor is recommended. Use the standard resistor value equal to or less than the value found from Figure 8.
5. To calculate the maximum ON resistance for a given junction temperature, find the normalized ON resistance factor (NR) from Figure 4. Calculate the new ON resistance as follows:

   (CD00CD, CD01CD) $R_{(ON)} = NR \bullet R_{ON} @ 25°C$
   (CD20CD, CD21CD) $R_{(ON)} = 0.2 \bullet NR + 0.21$

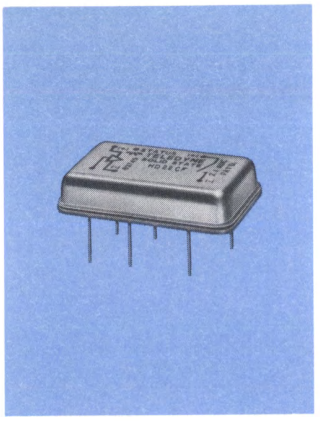
6. Overload testing to the requirements of MIL-R-28750 is constrained to the limits imposed by the short circuit protection characteristics as defined in this specification. Series inductance for "load shorted" mode of operation should be $< 50\mu H$. Maximum repetition rate into a shorted load should not exceed 10 Hz.
7. A status pull up resistor is required for proper operation of the status output. Determine the current (Iso) required by the status interface. Calculate the current (Is) through the status resistor such that the sink current through the status output is 2 mA. Select the status resistor such that it does not allow more than 2 mA to flow through the status output.

$$R_{STATUS} = \frac{V_{STATUS} - 0.3V}{2\ mA - Iso}$$

8. Reversing the polarity of the output may cause permanent damage. Inductive loads must be diode suppressed. Input transitions should be ≤ 1 ms duration and the input drive should be a bounceless contact type.
9. For SSRs with control status (CD01CF, CD21CD), the maximum control and bias voltage is 6 Vdc when the status line is used.



SERIES LIMIT BIAS RESISTOR VS. BIAS VOLTAGE
FIGURE 8 (See Note 4)



TELEDYNE SOLID STATE
DC SOLID STATE RELAY

SHORT CIRCUIT PROTECTED
TRUE OUTPUT STATUS FEEDBACK
2 A, 60 Vdc

MODEL

HD00CF
HD02CF
HD20CF
HD22CF
HD24CF

FEATURES

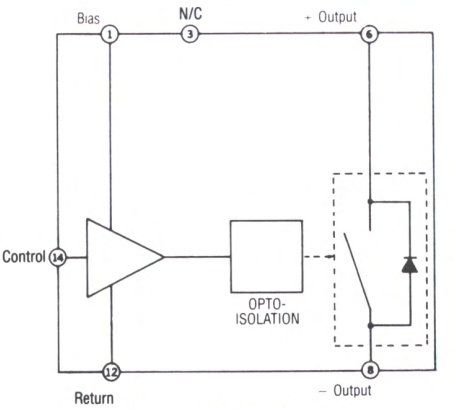
- Available with short circuit/current overload protection
- Available with status output
- TTL and CMOS compatible control
- Low ON resistance power FET output
- Fast switching speed
- Meets 28 Vdc system surge and spike requirements of MIL-STD-704
- Optical isolation
- Low profile hermetic package
- Built and tested utilizing test methods equal to or comparable to MIL-R-28750
- Available to 'W' and 'Y' screening levels

DESCRIPTION

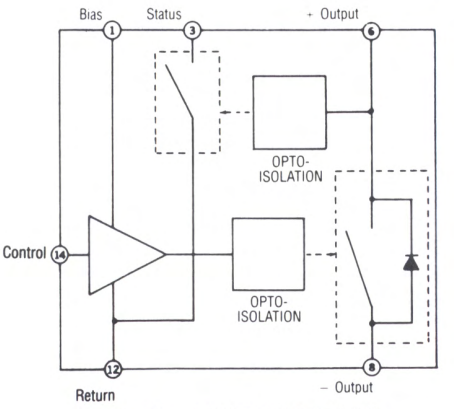
This all solid state relay utilizes the latest technology to provide a low ON resistance and an optically isolated output. The control (input) and load (output) are optically isolated to protect delicate input logic circuits from voltage and current transients which can occur on the output supply. The optical isolation also provides a full floating output, thus allowing the load to be connected to either output terminal. The control circuit is buffered to enable the relay to be driven directly from standard CMOS or open collector TTL logic circuits. Available options include short circuit and current overload protection, which provides complete protection for both the relay and the system wiring. This feature not only provides protection should a short or overload occur while the relay is on, but will also provide protection should the relay be switched into a short. In either case, the relay will sense the short circuit condition and then block it indefinitely until the short is removed and the unit is reset by cycling the input control. The second option is a status output line. This feature is available in either switch status or trip status configurations. Switch status returns the true status of the output switch and is optically isolated from the load. It provides status indication independent of the control circuit of the relay. The status line provides a logic 0 (low) when the output circuit is off and load voltage and load circuit continuity is present. The status line provides a logic 1 (high) when the output is on. Trip status, available only with short circuit protected relays, returns a logic 1 (high) if the output trips off and a logic 0 (low) when the output is in a normal mode (on or off). These options are available either together or separately as standard features.

PART* NUMBER	DESC DRAWING NUMBER	RELAY TYPE
HD00CFW		Basic Solid State Relay (SSR)
HD00CFY	88062-008	
HD02CFW		SSR with Switch Status
HD02CFY	88062-006	
HD20CFW		SSR with Short Circuit Protection
HD20CFY	88062-004	
HD22CFW		SSR with Short Circuit Protection and Switch Status
HD22CFY	88062-002	
HD24CFW		SSR with Short Circuit Protection and Trip Status
HD24CFY		

*The Y suffix denotes parameter tests to MIL-R-28750 test methods. The W suffix denotes parameters tested to Teledyne specifications.



HD00CF AND HD20CF



HD02CF, HD22CF, AND HD24CF

BLOCK DIAGRAM

ELECTRICAL SPECIFICATIONS
(−55°C TO 105°C AMBIENT TEMPERATURE UNLESS OTHERWISE NOTED)

INPUT (CONTROL) CHARACTERISTICS When used in 2 terminal configuration (TTL or direct control) (See Fig 1)	MIN	TYP	MAX	UNITS
Input Current @ V_{IN} = 5 Vdc (See Fig 2)		14	15	mAdc
Turn Off Voltage (Guaranteed Off)			1.5	Vdc
Turn On Voltage (Guaranteed On)	3.8			Vdc
Reverse Voltage Protection			−32	Vdc
Input Supply Range (See Note 1)	3.8		32	Vdc

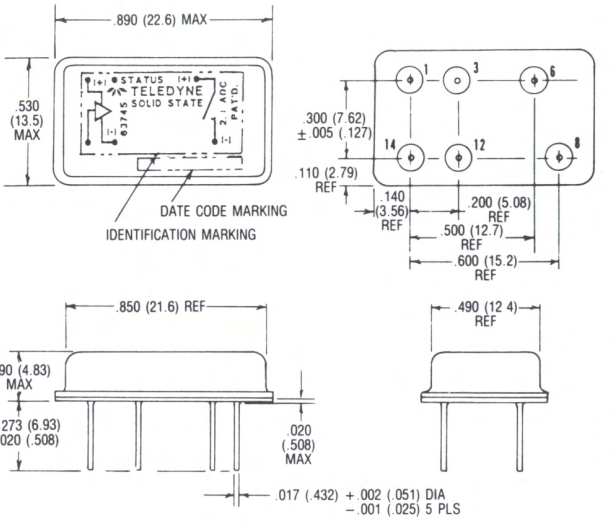
INPUT (CONTROL) CHARACTERISTICS When used in 3 terminal configuration (CMOS or open collector TTL) (See Fig 1)		MIN	TYP	MAX	UNITS
Control Current	$V_{CONTROL}$ = 5 Vdc			250	μAdc
	$V_{CONTROL}$ = 18 Vdc			1	mAdc
Control Voltage Range		0		18	Vdc
Bias Supply Voltage Range (See Note 1)		3.8		32	Vdc
Bias Supply Current @ V_{BIAS} = 5 Vdc			14	15	mAdc
Turn Off Voltage (Guaranteed Off)		3.2			Vdc
Turn On Voltage (Guaranteed On)				0.3	Vdc

OUTPUT (LOAD) SPECIFICATIONS (See Note 2)		MIN	TYP	MAX	UNITS
Continuous Load Current @ 35°C (See Fig. 3)				2.0	Adc
Leakage Current @ V_{LOAD} = 60 Vdc	HD00CF, HD20CF, HD24CF			0.1	mA
	HD02CF and HD22CF			2	mA
Output Voltage Drop				0.5	Vdc
Continuous Operating Load Voltage				60	Vdc
Transient Blocking Voltage (See Note 3)				80	Vdc
ON Resistance R_{ds} (on) at T_J = 25°C I_{LOAD} = 100 mAdc (See Fig 4)				0.15	Ohms
Turn-On Time (See Fig 5)				3	ms
Turn-Off Time (See Fig 5)				1	ms
dv/dt		100			V/μs
Electrical System Spike (See Note 3)				±600	Vdc
Output Capacitance, 25 Vdc, 100 KHz				850	pF
Input to Output Capacitance				10	pF
Dielectric Strength		1000			Vac
Insulation Resistance @ 500 Vdc		10^9			Ohms
Output Junction Temperature @ I_{LOAD} = maximum rated current				125	°C
Maximum Junction Temperature T_J (max)				150	°C
Thermal Resistance Junction to Ambient θ_{JA}				90	°C/W
Thermal Resistance Junction to Case θ_{JC}				25	°C/W

STATUS OUTPUT SPECIFICATIONS (HD02CF AND HD22CF) (SEE NOTE 6)	MIN	TYP	MAX	UNITS
Status Supply Voltage (See Fig 1)	1		18	Vdc
Status Leakage Current @ 16 Vdc			10	μAdc
Status (sink) Current (V_{SO} ≤ 0.4 Vdc)			600	μAdc
Status Turn-On Time (See Fig 6)			3.5	ms
Status Turn-Off Time (See Fig 6)			8.0	ms

STATUS OUTPUT TRUTH TABLE (HD02CF AND HD22CF)		
CONTROL VOLTAGE	OUTPUT (SWITCH) STATE	STATUS OUTPUT LEVEL
High	Off	Low (V_{SO} ≤ 0.4 Vdc)
Low	On	High (V_{SO} = V_{STATUS})

MECHANICAL SPECIFICATIONS



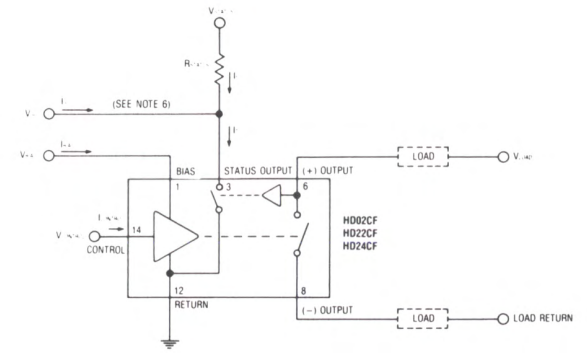
- **WEIGHT:** 5.5 gm max
- **CASE:** Hermetically sealed DIP
- **MATERIAL AND PLATING:**
  CAN: Grade A Nickel
  PINS AND HEADER: Kovar gold plated per MIL-G-45204. Type III, Grade A, Class 1.

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

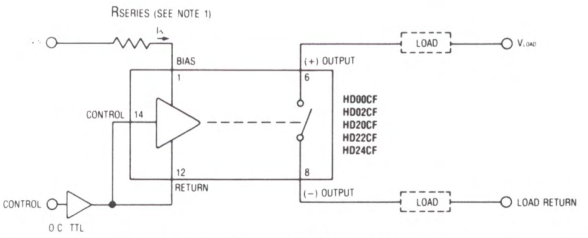
ENVIRONMENTAL SPECIFICATIONS		
Temperature Range	Operating	−55°C to +105°C
	Storage	−55°C to +125°C
Vibration		100 g, 10 to 3000 Hz
Constant Acceleration		5000 g
Shock		**50 g, 11 ms pulse**

SHORT CIRCUIT PROTECTION SPECIFICATIONS (HD20CF AND HD22CF) (At T_A = 25°C)	MIN	TYP	MAX	UNITS
Current Surge without Tripping, 100 ms pulse (See Fig 7 and Note 5)			4.25	Adc
Overload Trip Current, 5 ms pulse, V_{LOAD} = 60 Vdc (See Fig 7 and Note 5)			10	Adc
Time to Trip Turning relay ON into a short		400		μs
Time to Trip Shorting load while relay is ON		280		μs

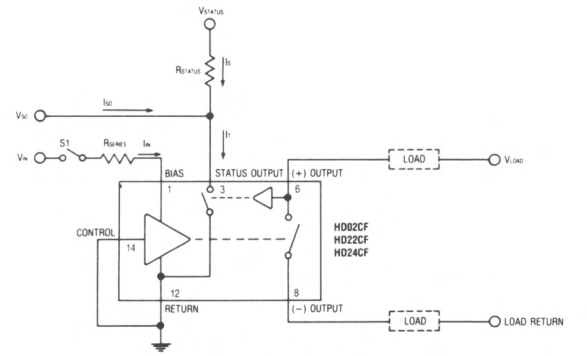
STATUS OUTPUT TRUTH TABLE (HD24CF)	
OUTPUT (SWITCH) STATE	STATUS OUTPUT LEVEL
TRIPPED (OFF)	Low (V_{SO} ≤ 0.4 Vdc)
NOT TRIPPED (ON OR OFF)	High (V_{SO} = V_{STATUS})



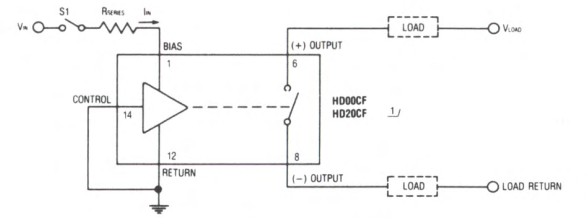
(A) 3 TERMINAL INPUT WITH STATUS (See Note 7)



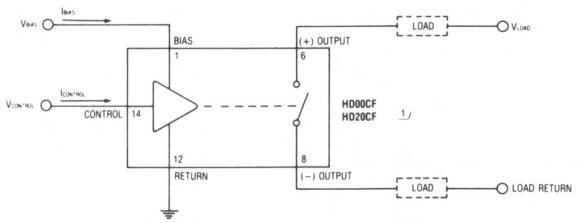
(B) 2 TERMINAL INPUT (OPEN COLLECTOR TTL DRIVE)



(C) 2 TERMINAL INPUT (DIRECT DRIVE) WITH STATUS



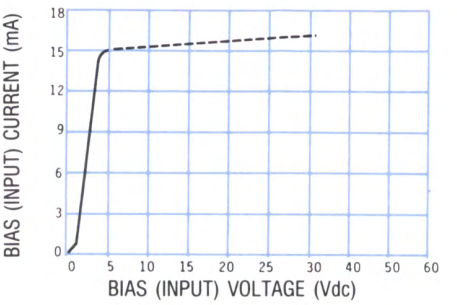
(D) 2 TERMINAL INPUT (DIRECT DRIVE)



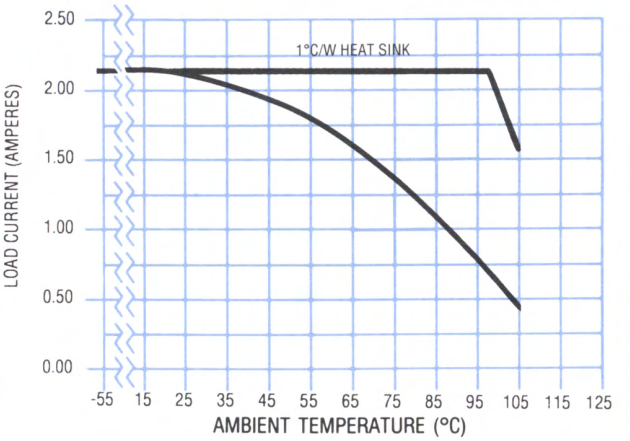
(E) 3 TERMINAL INPUT WITHOUT STATUS

1/ HD02CF and HD22CF may be wired without the status line as shown in (D) and (E) above.

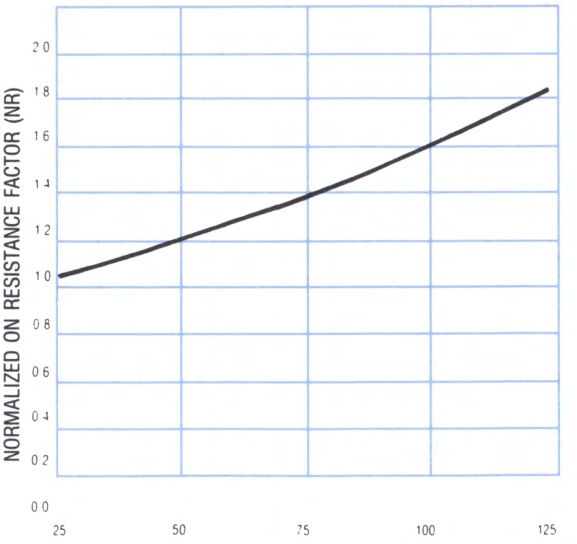
WIRING CONFIGURATIONS
FIGURE 1



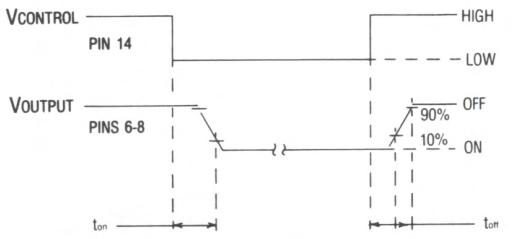
BIAS (INPUT) CURRENT VS BIAS (INPUT) VOLTAGE
FIGURE 2 (See Note 1)



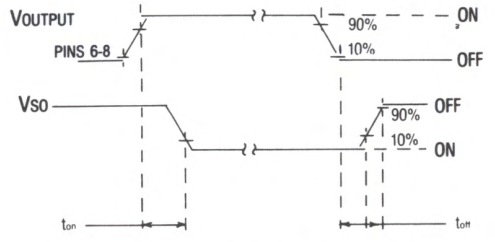
THERMAL DERATING CURVE
FIGURE 3



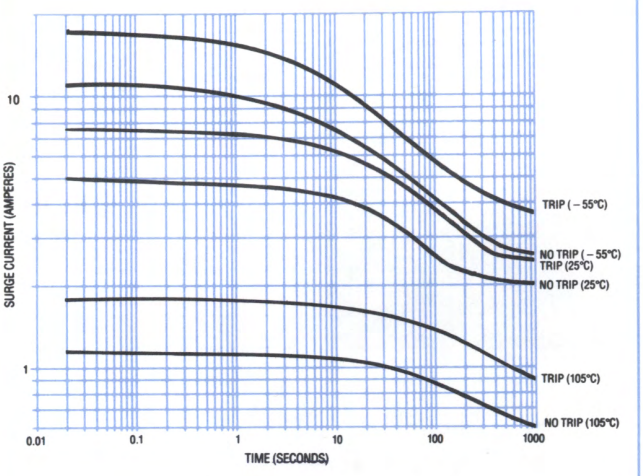
NORMALIZED ON RESISTANCE VS JUNCTION TEMPERATURE
FIGURE 4 (See Note 4)



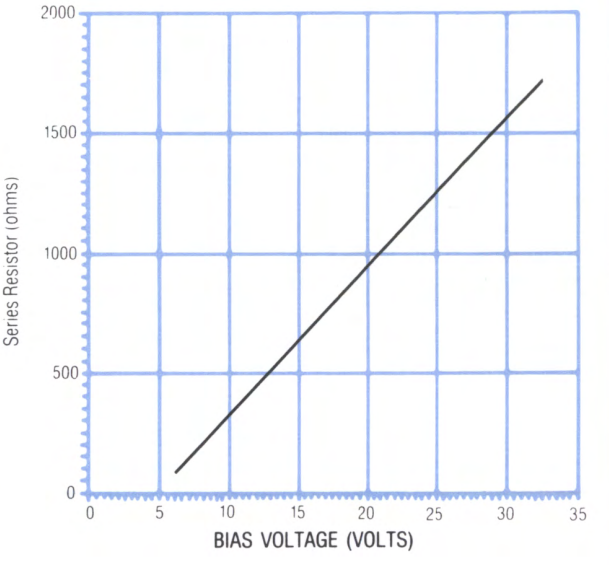
OUTPUT TURN-ON AND TURN-OFF TIMING
FIGURE 5



STATUS TURN-ON AND TURN-OFF TIMING
(HD02CF, HD22CF AND HD24CF)
FIGURE 6



TYPICAL TRIP CURRENT VS. TIME
FIGURE 7
See Note 5



SERIES LIMIT BIAS RESISTOR VS. BIAS VOLTAGE
FIGURE 8 (See Note 1)

NOTES:

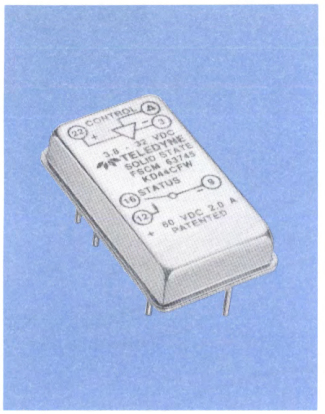
1. Control input is compatible with CMOS or open collector TTL (with pull up resistor). For bias voltages above 6V, a series resistor is required. Use the standard resistor value equal to or less than the value found in Figure 8.
2. The rated input voltage is 5V for all tests unless otherwise specified.
3. Transient blocking voltage and electrical system spike tests are performed per MIL-STD-704 (28 Vdc systems).
4. To calculate the maximum ON resistance for a given junction temperature, find the normalized ON resistance factor (NR) from Figure 4. Calculate the new ON resistance as follows:

$$R_{(ON)} = NR \bullet R_{ON} @ 25°C$$

5. Overload testing to the requirements of MIL-R-28750 is constrained to the limits imposed by the short circuit protection characteristics as defined in this specification. Series inductance for "load shorted" mode of operation should be $< 50\mu H$. Maximum repetition rate into a shorted load should not exceed 10 Hz.
6. A status pull up resistor is required for proper operation of the status output. Determine the current (Iso) required by the status interface. Calculate the current (Is) through the status resistor such that the sink current through the status output is 0.6 mA. Select the status resistor such that it does not allow more than 0.6 mA to flow through the status output.

$$R_{STATUS} = \frac{V_{STATUS} - 0.4V}{0.6\ mA - Iso}$$

7. Reversing the polarity of the output may cause permanent damage. Inductive loads must be diode suppressed. Input transitions should be ≤ 1 ms duration and the input drive should be a bounceless contact type.



TELEDYNE SOLID STATE

DC SOLID STATE RELAY

OPTICALLY ISOLATED
2.0 AMPS AT 60 Vdc

MODEL

KD44CF

SPST/NO

FEATURES/BENEFITS

- Short circuit and overload protected –
  Prevents damage to relay and system wiring.
- Flat trip curve (temperature compensated) –
  Stable predictable overload protection.
- Trip status –
  Discrete signal indicates an overload has occured, for failure analysis and diagnostics.
- High surge capability –
  Prevents safe transients from causing erroneous protection trips.
- TTL and CMOS compatible –
  Standard system interface.
- Low ON resistance power FET output –
  Virtually no offset and very low output voltage drop.
- Optical Isolation –
  Isolates output switching transients from system control signals.
- Tested utilizing comparable to MIL-R-28750 test methods –
- Meets surge and spike requirements of MIL-STD-704 –

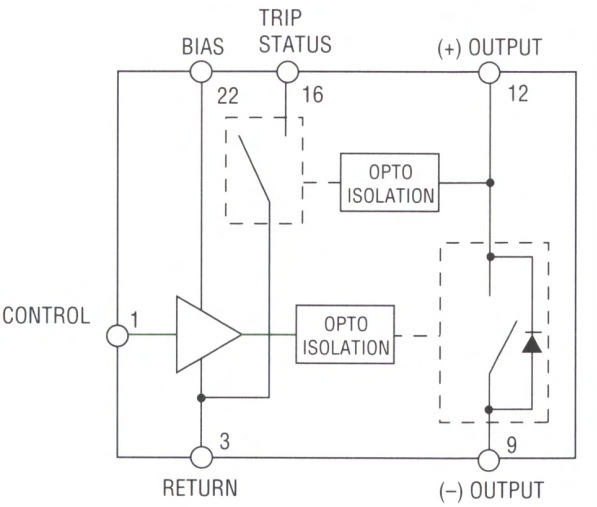
DESCRIPTION

The KD44CF solid state relay is screened utilizing the test methods of MIL-R-28750 and is packaged in a low profile hermetically sealed case. These relays are constructed using state-of-the-art hybrid technology. They feature fully floating power FET outputs that allows the load to be connected to either output terminal and provides a low ON resistance. The input (control) and the output are optically isolated to protect input logic circuits from output transients. The short circuit/overload protection is temperature compensated, and has a flat trip characteristic over the operating temperature range. These relays will not be damaged by a continuous short circuit on the load, or by being turned on into a short circuit. A trip status indicator turns on when an overcurrent condition has occured, and the short circuit protection has been activated. Cycling the control voltage resets the output switch and trip status indicator.

PART NUMBER*	RELAY TYPE
KD44CF	Solid State D.C. Relay, with Flat Trip Short Circuit Protection and Trip Status

* A suffix, W or Y, denotes screening test methods comparable to MIL-R-28750.

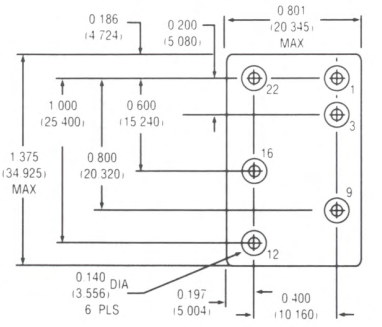
BLOCK DIAGRAM

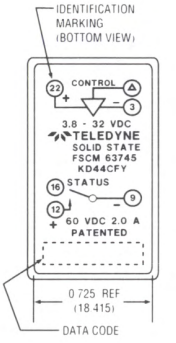


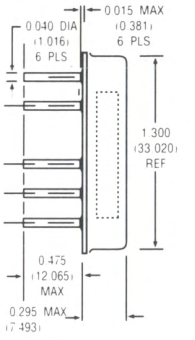
ELECTRICAL SPECIFICATIONS
(–55°C TO +125°C AMBIENT UNLESS OTHERWISE NOTED)

INPUT CHARACTERISTICS When used in 2 terminal configuration (TTL or direct control) (See Fig. 1)		MIN	TYP	MAX	UNITS
Input Current @ V_{BIAS} = 5 Vdc (See Fig. 2, 4)				15	mAdc
Turn-Off Voltage (Guaranteed Off)				1.5	Vdc
Turn-On Voltage (Guaranteed On)		3.8			Vdc
Reverse Voltage Protection				–32	Vdc
Input Supply Range (See Note 1)		3.8		32	Vdc
CONTROL CHARACTERISTICS When used in 3 terminal configuration (CMOS or open collector TTL) (See Fig. 1)		**MIN**	**TYP**	**MAX**	**UNITS**
Control Current	(V_{INPUT} = 5 Vdc)			250	µAdc
	(V_{INPUT} = 18 Vdc)			1	mAdc
Control Voltage Range		0		18	Vdc
Bias Supply Voltage Range (See Note 1)		3.8		32	Vdc
Bias Supply Current (See Fig. 1 & 2)				16	mAdc
Turn-Off Voltage (Guaranteed Off)		3.2			Vdc
Turn-On Voltage (Guaranteed On)	–55°C to 85°C			0.5	Vdc
	–55°C to 125°C			0.3	Vdc
OUTPUT (LOAD) SPECIFICATION (See Note 2, 3 & 6)		**MIN**	**TYP**	**MAX**	**UNITS**
Continuous Load Current (See Fig. 6)				2	Adc
Leakage Current V_{LOAD} = 60 Vdc				40	µA
Output Voltage Drop				0.60	Vdc
Continuous Operating Load Voltage				60	Vdc
Transient Blocking Voltage (See Note 3)				80	Vdc
ON Resistance I_{LOAD} = 100 mA T_J = 25°C (See Fig. 5 & Note 4)				0.30	Ohms
Turn-On Time (See Fig. 7)				3	ms
Turn-Off Time (See Fig. 7)				1	ms
dv/dt				100	V/µs
Electrical System Spike (See Note 3)				±600	V pk
Output Capacitance, 25V, 100 KHz				1000	pF
Isolation (Input to Output)				15	pF
Dielectric Strength		1000			Vac
Insulation Resistance @ 500 Vdc		10^9			Ohms
Output Junction Temperature @ I_{LOAD} = maximum rated current				130	°C
Maximum Junction Temperature				150	°C
Thermal Resistance Junction to Ambient, θ_{JA}				35	°C/W
Thermal Resistance Junction to Case, θ_{JC}				10	°C/W
STATUS OUTPUT SPECIFICATIONS		**MIN**	**TYP**	**MAX**	**UNITS**
Supply Voltage				32	Vdc
Leakage Current 15 Vdc				4	µA
On Voltage @ 15 ma				0.4	Vdc

MECHANICAL SPECIFICATIONS







ENCLOSURE: Hermetically Sealed DIP
LEAK RATE: 1 x 10^{-8} CC/Sec Maximum
MATERIAL: Header – Cold Rolled Steel Nickel Plated
Pins – Copper Core
Can – Cold Rolled Steel Nickel Plated
WEIGHT: 20 grams
TOLERANCE: .XXX = ±.005

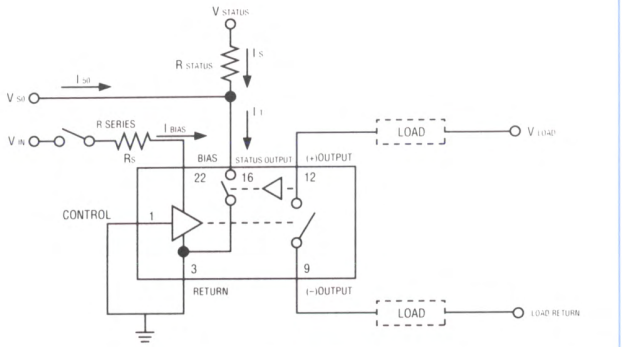
PIN-OUTS	
PIN NO.	FUNCTION
1	CONTROL
3	GND
9	–V (OUT)
12	+V (OUT)
16	TRIP
22	BIAS

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETER)

ENVIRONMENTAL SPECIFICATIONS		
Temperature Range	Operating	–55°C to +125°C
	Storage	–55°C to +125°C
Vibration		100 g, 10 to 3000 Hz
Constant Acceleration		5000 g
Shock		1500 g, 0.5 ms pulse

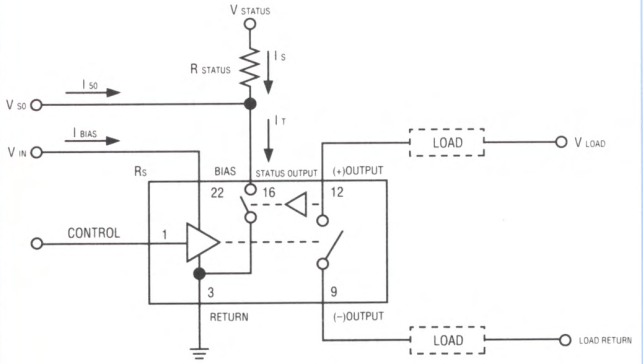
STATUS OUTPUT TRUTH TABLE		
Status Output	**Control Voltage**	**Output State**
Off (High)	Low	On
On (Low)	Low	Tripped
Off (High)	High	Off

WIRING CONFIGURATIONS

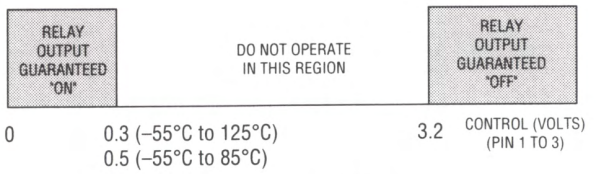


(A) 2 TERMINAL INPUT (DIRECT DRIVE) WITH STATUS (SEE NOTE 6)

(B) 2 TERMINAL CONTROL RANGE

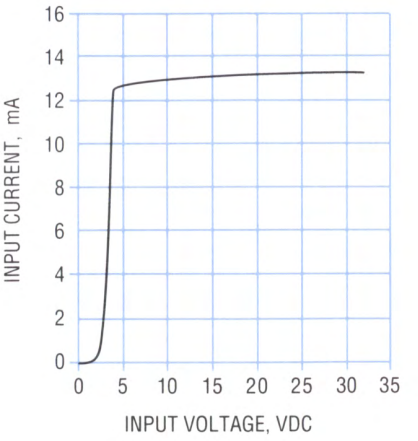


(C) 3 TERMINAL INPUT WITH STATUS (SEE NOTE 6)

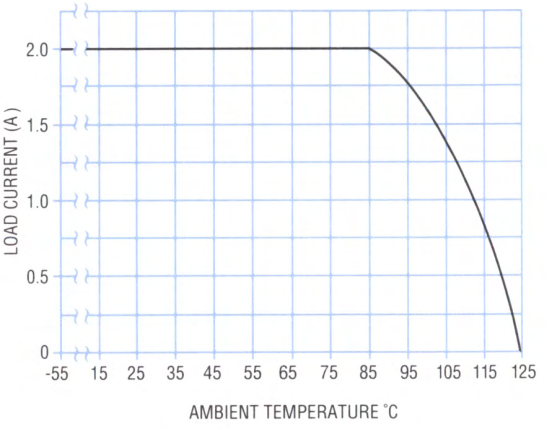


(D) 3 TERMINAL CONTROL RANGE

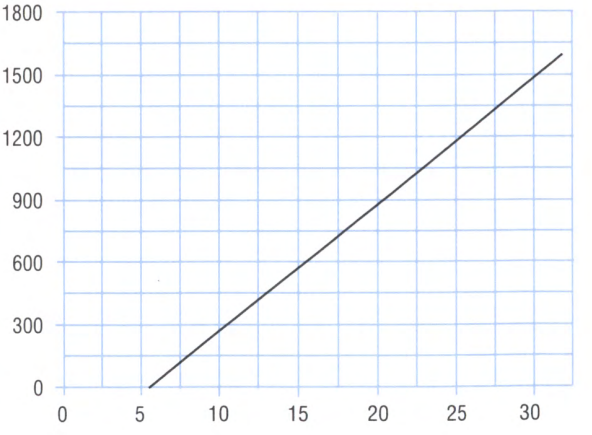
FIGURE 1 (SEE NOTE 7)



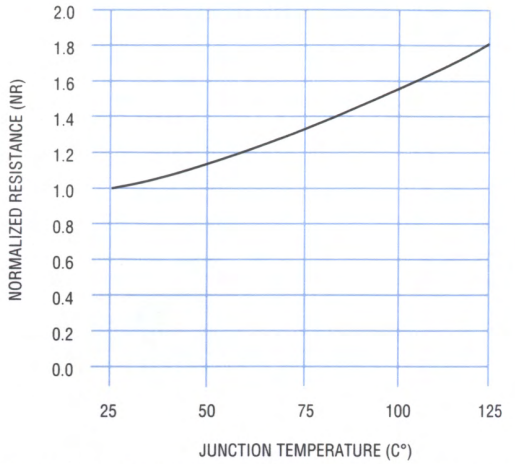
TYPICAL INPUT CURRENT VS. INPUT VOLTAGE
FIGURE 2 (SEE FIGURE 4)



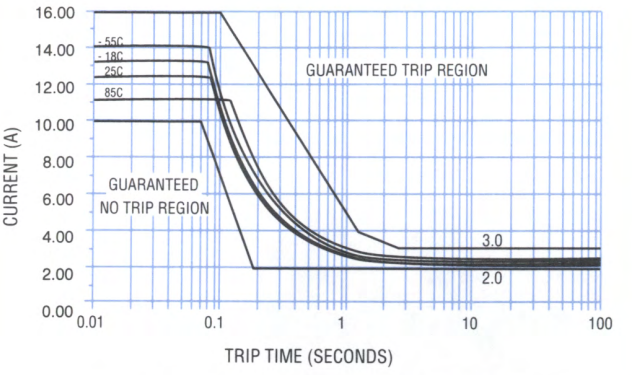
OUTPUT CURRENT DERATING CURVE
FIGURE 3



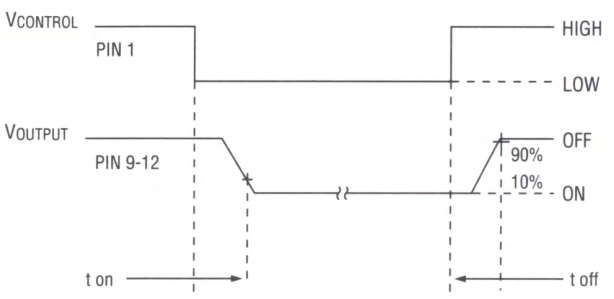
SERIES LIMIT BIAS RESISTOR VS. BIAS VOLTAGE
FIGURE 4 (SEE NOTE 1)



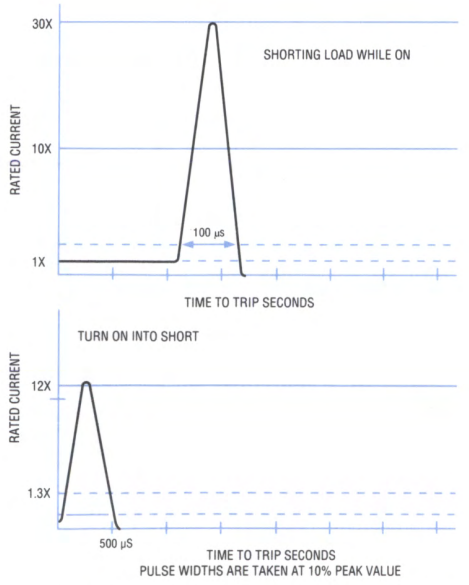
NORMALIZED ON RESISTANCE VS. JUNCTION TEMPERATURE
FIGURE 5 (SEE NOTE 4)



TYPICAL OVERLOAD CURRENT VS. TRIP TIME
FIGURE 6



OUTPUT TURN-ON AND OFF TIMING
FIGURE 7



TYPICAL TRIP CURRENT CHARACTERISTICS
FOR SHORT CIRCUIT CONDITIONS
FIGURE 8

NOTES:

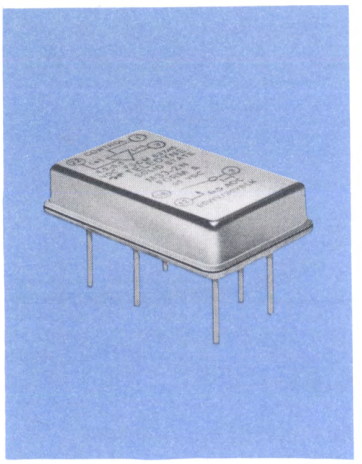
1. Control input is compatible with CMOS or open collector TTL (with pull up resistor.) For bias voltages above 6V, a series resistor is required. Use the standard resistor value equal to or less than the value found in Figure 4.
2. The rated input voltage is 5V for all tests unless otherwise specified.
3. Transient blocking voltage and electrical system spike tests are performed per MIL-R-28750.
4. To calculate the maximum ON resistance for a given junction temperature, find the normalized ON resistance factor (NR) from Figure 5. Calculate the new ON resistance as follows:

$$R_{(ON)} = NR \bullet R_{ON} @ 25°C + 0.15$$

5. Overload testing to requirements of MIL-R-28750 is constrained to the limits imposed by the short circuit protection characteristics as defined in this specification. Series inductance for "load shorted" mode of operation should be < 50 µH. Maximum repetition rate into a shorted load should not exceed 10 Hz.
6. A status pull up resistor is required for proper operation of the status output. Determine the current (Iso) required by the status interface. Calculate the current (Is) through the status resistor such that the sink current through the status output does not exceed 15 ma.

$$R_{STATUS} = \frac{V_{STATUS} - 0.4V}{Is}$$

7. Reversing the polarity of the output may cause permanent damage. Inductive loads must be diode suppressed. Input transitions should be ≤ 1 ms duration and the input drive should be a bounceless contact type.



TELEDYNE SOLID STATE

MILITARY SOLID STATE

DC OUTPUT SQUIB FIRE RELAY

MODEL

M33-2N

SPST/NO

FEATURES

- Up to 100 Amp pulse load capability
- Fast switching speed
- Low ON resistance
- Power FET output
- 1000 Vrms isolation
- Transformer Isolated
- TTL or CMOS logic compatible input control
- Low profile metal DIP — hermetically sealed
- Meets MIL-STD-704A 80V surge and ± 600V spike requirements
- Built and tested utilizing test method comparable to MIL-R-28750

DESCRIPTION

The M33-2N is a military style DC solid state relay designed specifically for high current pulse load applications such as squib firing. This device is constructed utilizing state-of-the-art solid state techniques and features the latest power FET output technology to eliminate bipolar offset and minimize ON resistance. This feature provides minimum output voltage drop and allows the M33-2N to switch high pulse currents up to 100 amps at higher temperatures than those allowable with bipolar devices. The input and output are magnetically isolated to protect delicate input logic circuits from output voltage transients.

The M33-2N is designed to switch loads on MIL-STD-704A 28 Vdc power systems, and meets 80V surge and ± 600V spike requirements.

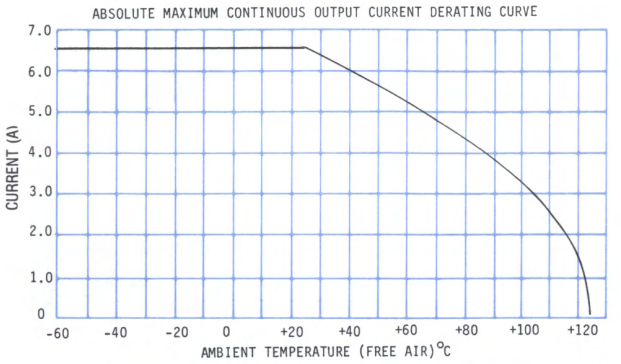
The M33-2N is packaged in a low profile hermetically sealed 22 pin DIP.

ELECTRICAL SPECIFICATIONS

(−55°C TO +125°C CASE UNLESS OTHERWISE SPECIFIED)

INPUT (CONTROL) CHARACTERISTICS		MIN.	TYP.	MAX.	UNITS
Control Current @5 Vdc (Note 5)			70	80	μA
Control Voltage Range			5.0	6.5	Vdc
Bias Supply Range V_{DD} (Note 7)		4.5	5.0	5.5	Vdc
Bias Current @ 105° C			13	16	mA
Turn-Off @ 105°C (Guaranteed off)				0.4	Vdc
Turn-On (Guaranteed on)		2.0			Vdc
Isolation @ 500 Vdc, Input to Case, Input to Output, Output to Case		10^9			Ohms
Capacitance (Input to Output at 1 KHz)				15	pF
Dielectric Strength, Input to Case, Input to Output, Output to Case				1000	V rms 60 Hz
OUTPUT (LOAD) SPECIFICATIONS		**MIN.**	**TYP.**	**MAX.**	**UNITS**
Maximum Continuous Output Current (See Figure 1)	25° C			7.0	A
	120° C			3.0	
Pulse/Surge Current (See Notes 1, 2, 3, Fig. 4)	100 μs			100	A
	100 ms			23.5	
Continuous Operating Output Voltage				60	Vdc
Continuous Blocking Voltage				80	Vdc
On-State Resistance R_{ds} (on) @ 25°C (Note 4)				0.071	Ohms
On-State Resistance R_{ds} (on) @ 85°C (Note 4)				0.090	Ohms
Turn-On Time, −55°C to 105°C (Figure 2)				60	μs
Turn-Off Time, −55°C to 105°C (Figure 2)				3.0	ms
Off-State Leakage at 60 Vdc	25°C			10	μA
	105°C			100	
Off-State Leakage at 80 Vdc	25°C–105°C			1.0	mA
Capacitance Across Output @ V_{DS} = 25 Vdc F = 1.0 MHz				1700	pF
Maximum Junction Temperature @ $I_L = I_{MAX\ RATED}$				125	°C
Thermal Resistance Junction To Ambient (θ_{JA})				35	°C/W
Thermal Resistance Junction To Case (θ_{JC})				7	°C/W

CHARACTERISTIC CURVES



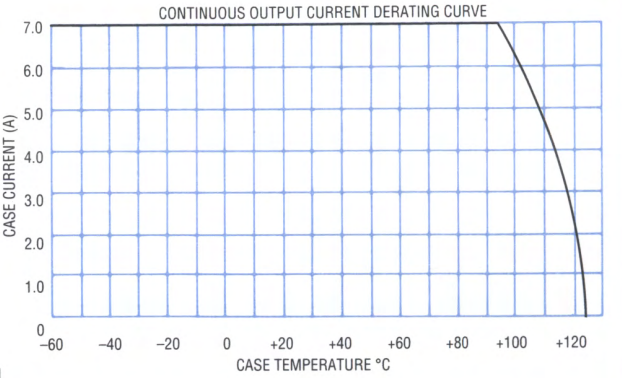
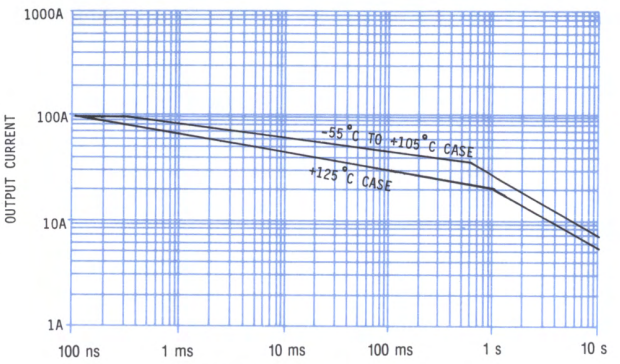


FIGURE 1



MAX OUTPUT CURRENT VS TIME

FIGURE 4

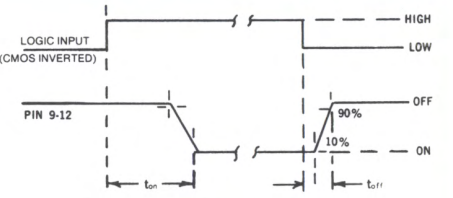
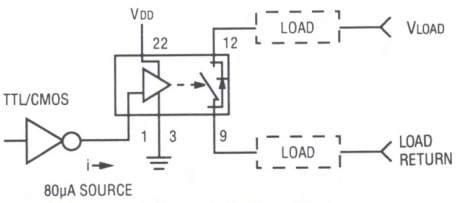


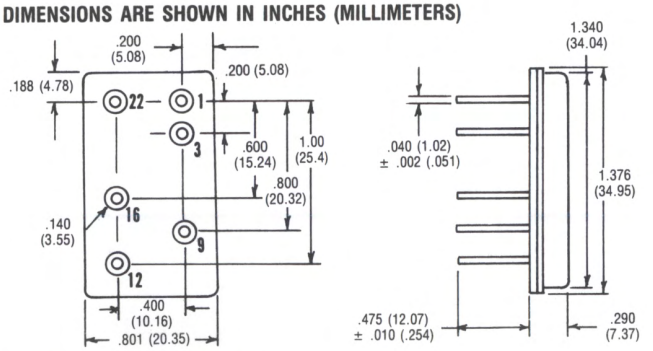
FIGURE 2 TIMING DIAGRAM



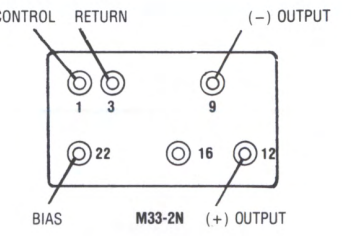
WIRING CONFIGURATION
FIGURE 3
NOTE: LOAD MAY BE CONNECTED TO EITHER TERMINAL

MECHANICAL SPECIFICATIONS

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)



- Enclosure: 22 Pin DIP, Hermetically Sealed
- Leak Rate: 1 X 10^{-8} CC/Sec Maximum
- Material: Header — Cold Rolled Steel Nickel Plated
  Pins — Copper Core, Alloy #52 Clad Gold Plated
  Can — Cold Rolled Steel Nickel Plated or Stainless
- Weight: 20 grams maximum

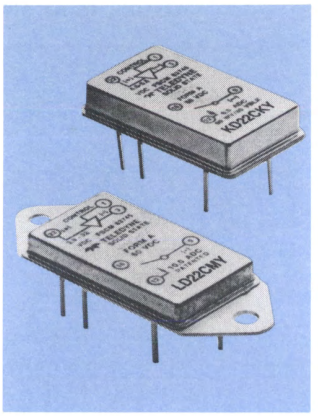


HEADER PINOUTS (BOTTOM VIEW)

NOTES

1. 100 Amp max for 100 μsec pulse, one second or more between pulses.
2. 23.5 Amps, 100 msec pulse, 47 VDC, 2Ω load, 30 times at 2% duty cycle, 5 seconds between pulses.
3. 17.5 Amp, 100 msec pulse, 35 VDC, 2Ω load, 120 times at 1 second intervals, 10% duty cycle.
4. On-state resistance measured at 22A, 300 μsec pulse, 10 Hz repetition rate; for test purposes only, not a continuous operating condition.
5. Input transitions are to be less than 1.0 msec duration.
6. Inductive loads must be diode suppressed.
7. For test purposes, input bias voltage shall be 5.0 VDC.
8. Specified temperatures are ambient unless noted as case temperature.

ENVIRONMENTAL SPECIFICATIONS		
Temperature Range	Operating	–55°C to +105°C
	Storage	–55°C to +125°C
Vibration		100 g, 10 to 3000 Hz
Constant Acceleration		5000 g
Shock		1500 g, 0.5 ms pulse



TELEDYNE SOLID STATE

DC SOLID STATE RELAY

SHORT CIRCUIT PROTECTED
OPTICALLY ISOLATED
10 A, 60 Vdc

SERIES

KD
LD

SPST/NO

FEATURES

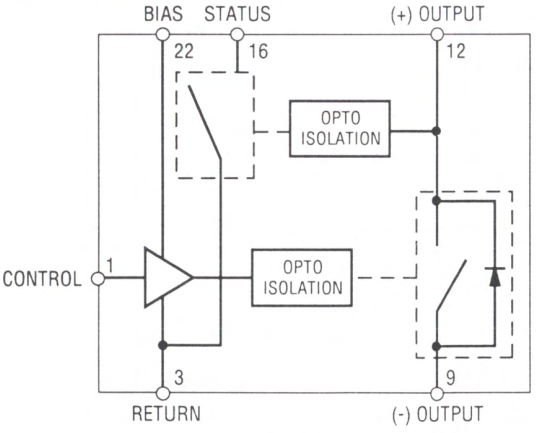
- Available with short circuit/current overload protection
- Available with switch status output
- TTL and CMOS compatible control
- Low ON resistance power FET output
- Fast switching speed
- Meets 28 Vdc system surge and spike requirements of MIL-STD-704
- Optical isolation
- Built and tested utilizing the test methods comparable to MIL-R-28750

PART NUMBER	RELAY TYPE
KD00CK	Basic 5 A Solid State Relay (SSR)
KD02CK	5 A SSR with Switch Status
KD20CK	5 A SSR with Short Circuit Protection
KD22CK	5 A SSR with Short Circuit Protection and Switch Status
LD00CM	Basic 10 A Solid State Relay
LD02CM	10 A SSR with Switch Status
LD20CM	10 A SSR with Short Circuit Protection
LD22CM	10 A SSR with Short Circuit Protection and Switch Status

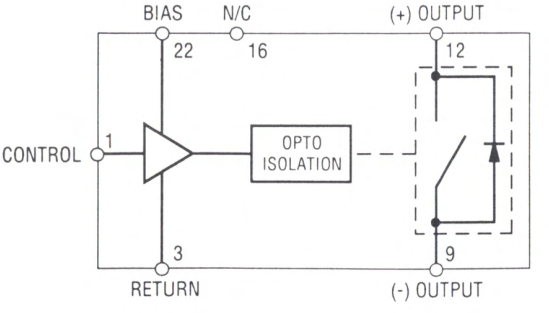
DESCRIPTION

The KD and LD series solid state relays are screened utilizing MIL-R-28750 test methods and are packaged in low profile hermetically sealed cases. These relays are constructed with state-of-the-art solid state techniques and feature fully floating power FET output technology. This allows the load to be connected to either output terminal and provides a low ON resistance. The input (control) and output are optically isolated to protect input logic circuits from output transients. Available options include short circuit and current overload protection, which provides complete protection for both the relay and system wiring. This feature not only provides protection should a short or overload occur while the relay is on, but will also provide protection should the relay be switched into a short. The second option is a status output line. Switch status returns the true status of the output switch and is optically isolated from the load. It provides status indication independent of the control circuitry of the relay. The status line provides a logic 0 (low) when the relay output is off with load voltage and continuity present, and a logic 1 (high) when the output is off. These options are available either together or separately as standard features.

BLOCK DIAGRAM



WITH STATUS

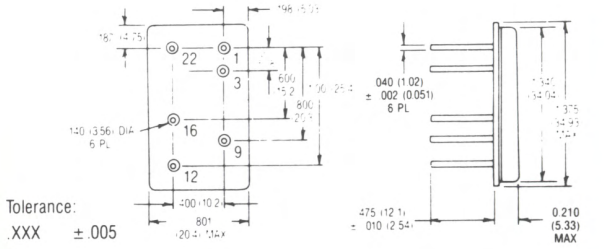


NO STATUS

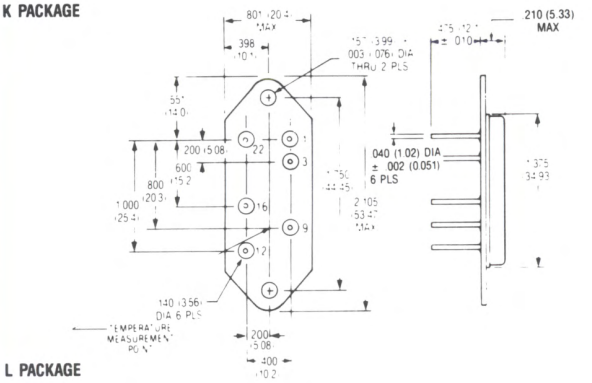
ELECTRICAL SPECIFICATIONS
(−55°C TO 105°C AMBIENT UNLESS OTHERWISE NOTED)

INPUT (CONTROL) CHARACTERISTICS When used in 2 terminal configuration (TTL or direct control) See Fig 1		MIN	TYP	MAX	UNITS
Input Current @ V_{BIAS} = 5 Vdc See Fig. 2			14	15	mAdc
Turn-Off Voltage (Guaranteed Off)				1.5	Vdc
Turn-On Voltage (Guaranteed On)		3.8			Vdc
Reverse Voltage Protection				−32	Vdc
Input Supply Range See Note 1		3.8		32	Vdc
INPUT (CONTROL) CHARACTERISTICS When used in 3 terminal configuration (CMOS or open collector TTL) See Fig 2		**MIN**	**TYP**	**MAX**	**UNITS**
Control Current	$V_{CONTROL}$ = 5 Vdc			250	μAdc
	$V_{CONTROL}$ = 18 Vdc			1	mAdc
Control Voltage Range		0		18	Vdc
Bias Supply Voltage Range See Note 1		3.8		32	Vdc
Bias Supply Current			14	16	mAdc
Turn Off Voltage (Guaranteed Off)		3.2			Vdc
Turn On Voltage (Guaranteed On)				0.3	Vdc
OUTPUT (LOAD) SPECIFICATION (See Note 2)		**MIN**	**TYP**	**MAX**	**UNITS**
Continuous Load Current (See Fig. 3)	KD and LD series without heat sink			5	Adc
	LD series with 2° C/W heat sink			10	
Leakage Current V_{LOAD} = 60 Vdc	KD00CK, KD20CK LD00CM, LD20CM			100	μA
	KD02CK, KD22CK LD02CM, LD22CM			2	mA
Output Voltage Drop	KD00CK, KD02CK			.60	Vdc
	KD20CK, KD22CK			.70	
	LD00CM, LD02CM			1.2	
	LD20CM, LD22CM			1.4	
Continuous Operating Load Voltage				60	Vdc
Transient Blocking Voltage (See Note 3)				80	Vdc
On Resistance I_{LOAD} = 100 mA T_J = 25°C (See Fig. 4)	KD00CK, KD02CK LD00CM, LD02CM			.075	Ohms
	KD20CK, KD22CK LD20CM, LD22CM			.100	
Turn-On Time (See Fig. 5)				5	ms
Turn-Off Time (See Fig. 5)				2	ms
Electrical System Spike (See Note 3)				±600	V pk
Output Capacitance, 25Vdc 100 KHz				1600	pF
Isolation (Input to Output)	KD00CK, KD20CK LD00CM, LD20CM			5	pF
	KD02CK, KD22CK LD02CM, LD22CM			15	
Dielectric Strength		1000			Vac
Insulation Resistance @ 500 Vdc		10^9			Ohms
Output Junction Temperature @ I_{LOAD} = maximum rated current				125	°C
Maximum Junction Temperature				150	°C
Thermal Resistance Junction to Ambient, Θ_{JA}				30	°C/W
Thermal Resistance Junction to Case, Θ_{JC}				7	°C/W

MECHANICAL SPECIFICATIONS
DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)



K PACKAGE



L PACKAGE

Enclosure: Hermetically Sealed DIP
Leak Rate: 1×10^{-8} CC/Sec Maximum
Material: Header — Cold Rolled Steel Nickel Plated
Pins — Copper Core
Can — Cold Rolled Steel Nickel Plated
Weight: 20 grams
Tolerance: .XXX ±.005

ENVIRONMENTAL SPECIFICATIONS

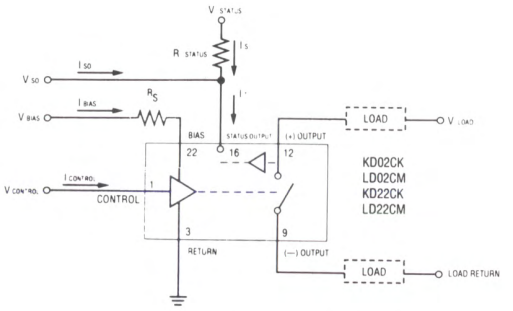
Temperature Range	Operating	−55°C to +105°C
	Storage	−55°C to +125°C
Vibration		100 g, 10 to 3000 Hz
Constant Acceleration		5000 g
Shock		1500 g, 0.5 ms pulse

STATUS OUTPUT TRUTH TABLE (KD02CK, LD02CM, KD22CK, LD22CM)

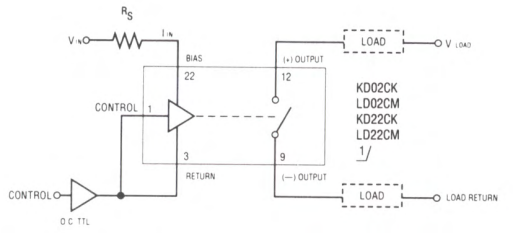
CONTROL VOLTAGE	RELAY OUTPUT STATE	STATUS OUTPUT LEVEL
High	Off	Low ($V_{SO} \leq 0.4$ Vdc)
Low	On	High (V_{SO} = V_{STATUS})

STATUS OUTPUT SPECIFICATIONS (KD02CK, LD02CM, KD22CK, LD22CM)	MIN	TYP	MAX	UNITS
Status Supply Voltage (See Fig 1)	1		18	Vdc
Status Leakage Current @ 15 Vdc			10	μAdc
Status (sink) Current ($V_{SO} \leq 0.4$ Vdc)			600	μAdc
Status Turn-On Time (See Fig 6)			3.5	ms
Status Turn-Off Time (See Fig 6)			9.0	ms

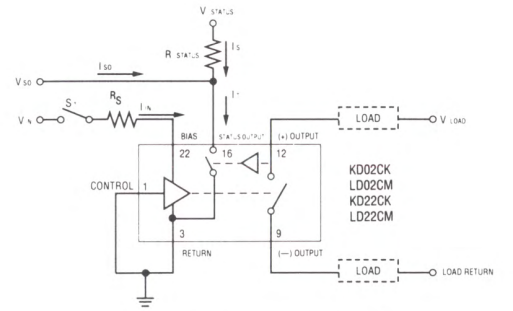
WIRING CONFIGURATIONS



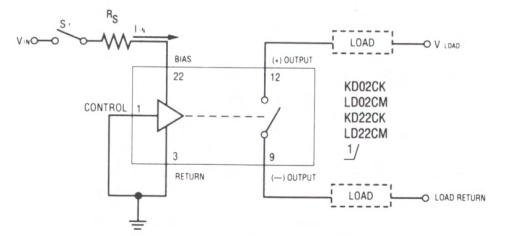
(A) 3 TERMINAL INPUT WITH STATUS (see note 7)



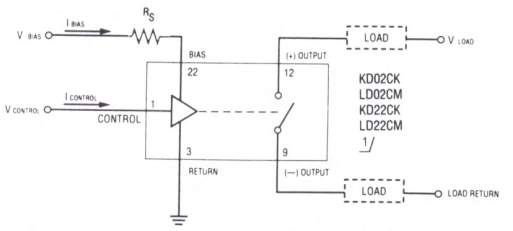
(B) 2 TERMINAL INPUT (OPEN COLLECTOR TTL DRIVE)



(C) 2 TERMINAL INPUT (DIRECT DRIVE) WITH STATUS



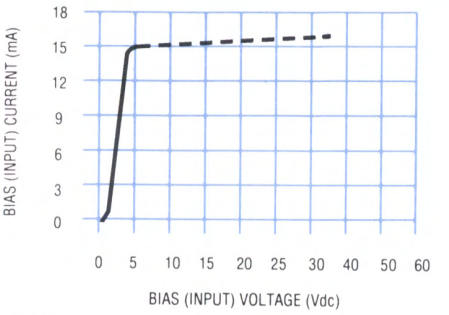
(D) 2 TERMINAL INPUT (DIRECT DRIVE)



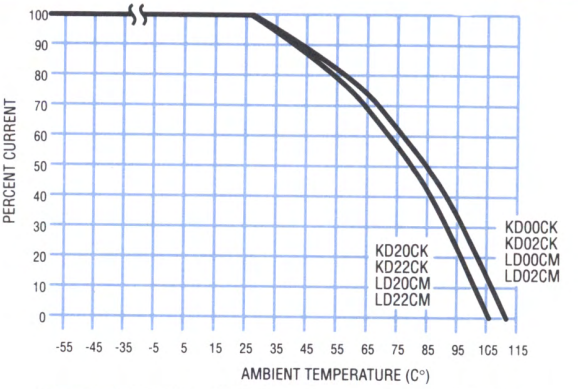
1/ KD22CK AND LD22CM MAY BE WIRED WITHOUT THE STATUS LINE AS SHOWN IN (D) AND (E) ABOVE.

(E) 3 TERMINAL INPUT WITHOUT STATUS

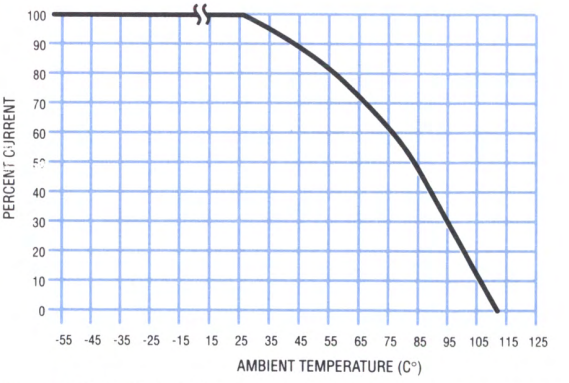
FIGURE 1 (SEE NOTE 1)



BIAS (INPUT) CURRENT VS. BIAS (INPUT) VOLTAGE
FIGURE 2 (See Note 1)

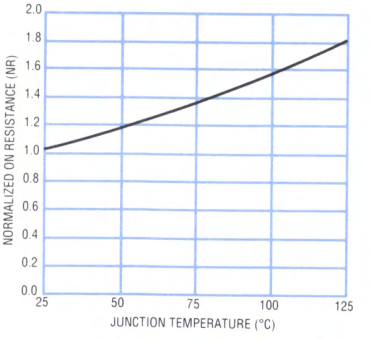


TEMPERATURE DERATING CURVE FOR KD AND LD SERIES WITHOUT A HEAT SINK



TEMPERATURE DERATING CURVE FOR LD SERIES ON A 2°C/W HEAT SINK

THERMAL DERATING CURVES
FIGURE 3



NORMALIZED ON RESISTANCE VS JUNCTION TEMPERATURE
FIGURE 4 (See Note 5)

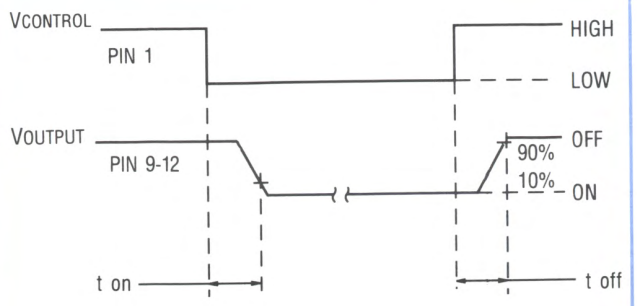


FIGURE 5 — OUTPUT TURN-ON AND TURN-OFF TIMING

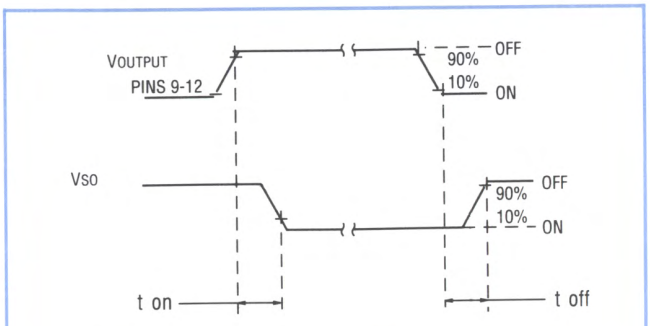


FIGURE 6 — STATUS TURN-ON AND TURN-OFF TIMING

NOTES:

1. Control input is compatible with CMOS or open collector TTL (with pull up resistor.) For bias voltages above 6V, a series resistor is required. Use the standard resistor value equal to or less than the value found in Figure 8.
2. The rated input voltage is 5V for all tests unless otherwise specified.
3. Transient blocking voltage and electrical system spike tests are performed per MIL-R-28750.
4. To calculate the maximum ON resistance for a given junction temperature, find the normalized ON resistance factor (NR) from Figure 4. Calculate the new ON resistance as follows:

$$R_{(ON)} = NR \bullet R_{ON} @ 25°C$$

5. Overload testing to the requirements of MIL-R-28750 is constrained to the limits imposed by the short circuit protection characteristics as defined in this specification. Series inductance for "load shorted" mode of operation should be $< 50\ \mu H$. Maximum repetition rate into a shorted load should not exceed 10 Hz.
6. A status pull up resistor is required for proper operation of the status output. Determine the current (Iso) required by the status interface. Calculate the current (Is) through the status resistor such that the sink current through the status output does not exceed 0.6 mA.

$$R_{STATUS} = \frac{V_{STATUS} - 0.4V}{0.6\ mA - I_{SO}}$$

7. Reversing the polarity of the output may cause permanent damage. Inductive loads must be diode suppressed. Input transitions should be ≤ 1 ms duration and the input drive should be a bounceless contact type.

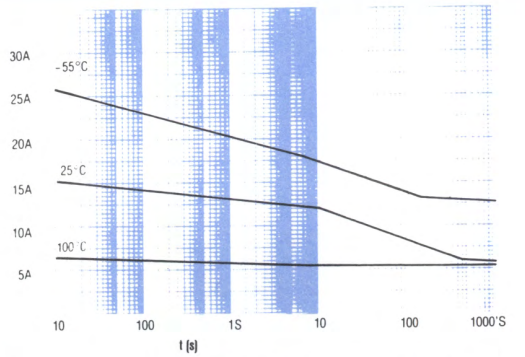


FIGURE 7 — OVERLOAD CURRENT VS TIME TO TRIP WITHOUT HEAT SINK (TYPICAL) KD20CK, KD22CK, LD20CM, LD22CM)

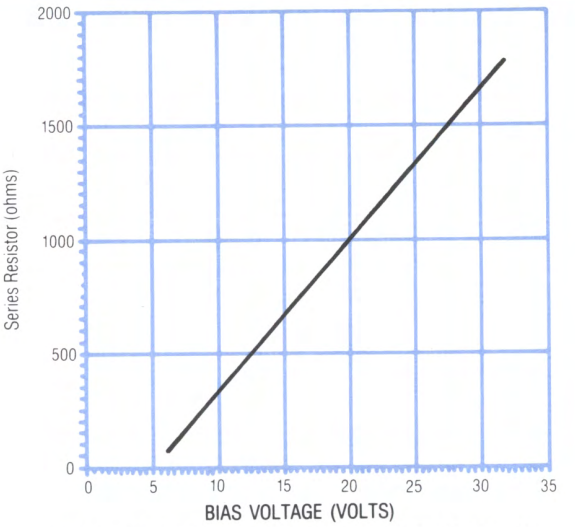


FIGURE 8 — SERIES LIMIT BIAS RESISTOR VS. BIAS VOLTAGE (SEE NOTE 1)

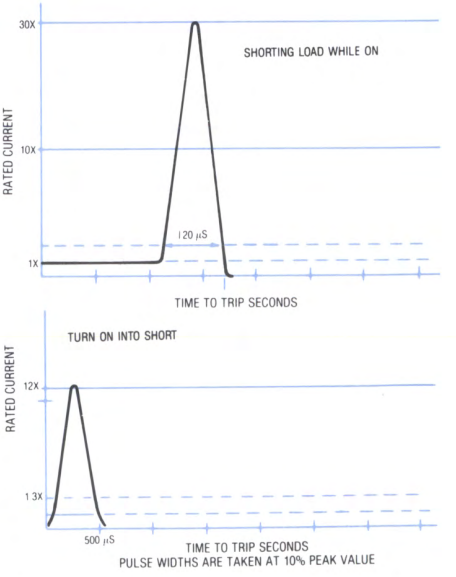
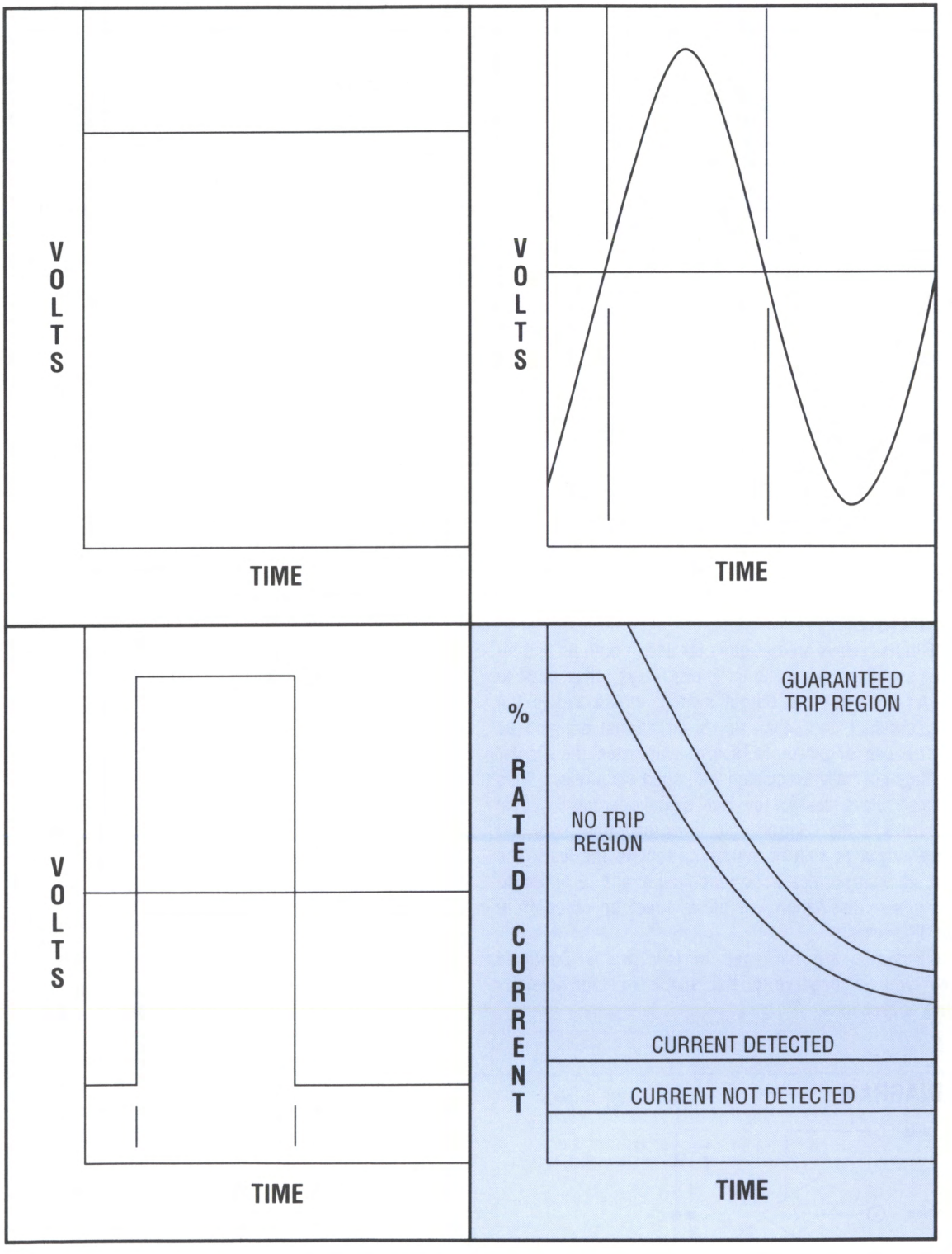
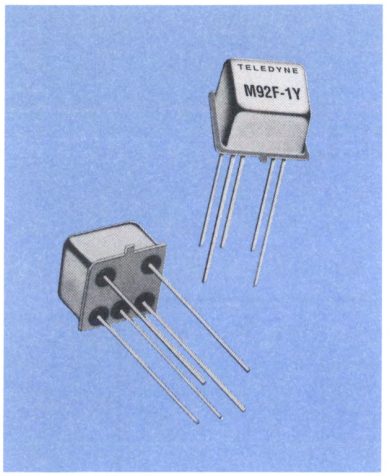


FIGURE 9 — TYPICAL TRIP CURRENT CHARACTERISTICS FOR SHORT CIRCUIT CONDITIONS

BI-DIRECTIONAL SOLID STATE RELAYS





TELEDYNE SOLID STATE

MILITARY SOLID STATE RELAY

OPTICALLY ISOLATED
BI-DIRECTIONAL OUTPUT
TO ± 240ma, ± 320Vdc

SERIES
M92F

SPST/NO

FEATURES

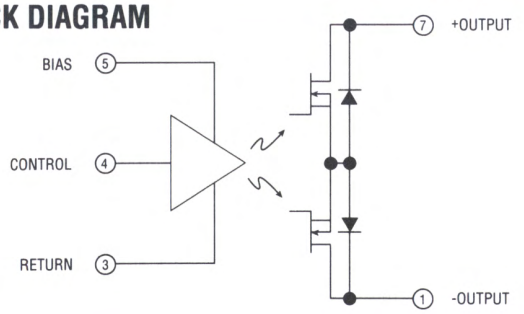
- Optical isolation-
  Isolates control elements from load transients
- Fully Floating Output-
  Eliminates ground loops and allows the output to sink or source current
- Power FET Output-
  low output voltage drop with virtually no offset
- Buffered Control-
  Relay can be controlled directly from TTL or CMOS logic circuits
- Controlled Rise and Fall Times-
  Minimizes EMI generated by switching transients

DESCRIPTION

The M92F series relays are designed for use in both dc and bi-directional switching applications. These relays utilize back to back power FETs for the output switch, which allows the output to conduct and block dc, bi-directional dc, and ac signals. The use of power FETs also eliminates the bipolar offset voltage normally associated with solid state relays, thus making these relays ideal for low level signal operation. Optical isolation protects the control logic from load transients and allows the output to sink or source current to the load. The input circuit incorporates a current limiter and a buffer to minimize power dissipation and allow direct operation from CMOS or TTL circuits.

The M92F series are packaged in low profile Centigrid packages which conserve board space in high density packaging applications.

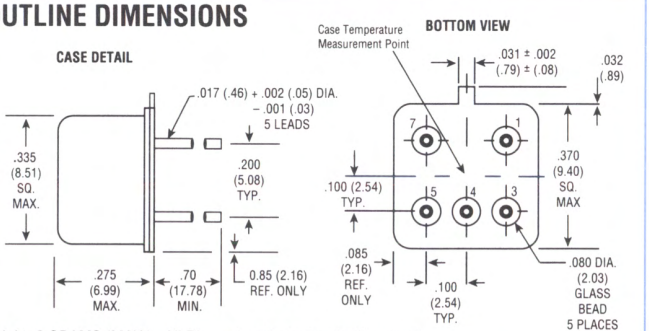
BLOCK DIAGRAM



PART NUMBER	DESC DRAWING NUMBER	RELAY TYPE
M92F-1W		SOLID STATE RELAY ± 320 Vdc
M92F-1Y		
M92F-2W		SOLID STATE RELAY ± 185 Vdc
M92F-2Y		
M92F-3W		SOLID STATE RELAY ± 85 Vdc
M92F-3Y	87034-001	

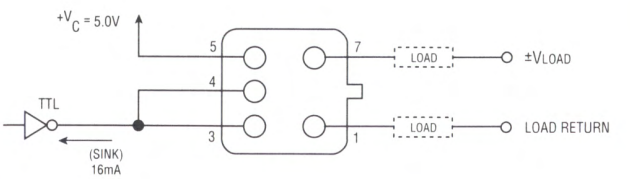
*The W or Y suffix denotes the screening level of MIL-R-28750

OUTLINE DIMENSIONS

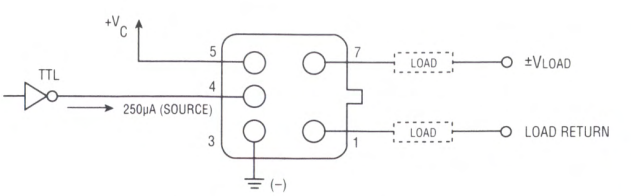


Weight: 2 GRAMS (MAX.) All Dimensions in inches (millimeters)

WIRING DIAGRAM



2 TERMINAL INPUT CONFIGURATION
(See Note 3)



3 TERMINAL (BUFFERED) INPUT CONFIGURATION
(See Note 3)

SCHEMATIC (BOTTOM VIEW)

ELECTRICAL SPECIFICATIONS
(–55°C TO +85°C AMBIENT UNLESS OTHERWISE NOTED)

INPUT (CONTROL) CHARACTERISTICS When used in 2 terminal configuration (TTL or direct control) (See Note 2)		MIN	TYP	MAX	UNITS
Input Current @ V_{BIAS} = 5 Vdc See Fig. 1			14	15	mAdc
Turn-Off Voltage (Guaranteed Off)				1.5	Vdc
Turn-On Voltage (Guaranteed On)		3.8			Vdc
Reverse Voltage Protection				-32	Vdc
Input Supply Range See Note 4		3.8		32	Vdc
INPUT (CONTROL) CHARACTERISTICS When used in 3 terminal configuration (CMOS or open collector TTL) (See Note 1)		**MIN**	**TYP**	**MAX**	**UNITS**
Control Current	$V_{CONTROL}$ = 5 Vdc			250	µAdc
	$V_{CONTROL}$ = 18 Vdc			1	mAdc
Control Voltage Range		0		18	Vdc
Bias Supply Voltage Range		3.8		32	Vdc
Bias Supply Current			14	16	mAdc
Turn Off Voltage (Guaranteed Off)		2.8			Vdc
Turn On Voltage (Guaranteed On)				0.3	Vdc
Schmitt Hysteresis		1.0			Vdc
OUTPUT (LOAD) SPECIFICATION (See Note 5)		**MIN**	**TYP**	**MAX**	**UNITS**
Continuous Load Current (See Fig. 2)	M92F-1			±90	mA
	M92F-2			±18	
	M92F-3			±240	
Leakage Current V_{LOAD} = 80% Max. Rated				±50	µA
Continuous Operating Load Voltage	M92F-1			±400	Vdc
	M92F-2			±200	
	M92F-3			±100	
On Resistance I_{LOAD} = 100 mA T_J = 25°C	M92F-1			50	Ohms
	M92F-2			20	
	M92F-3			8	
Turn-On Time				1	ms
Turn-Off Time				1	ms
Dielectric Strength		1000			Vac
Insulation Resistance @ 500 Vdc		10^9			Ohms
Output Junction Temperature @ I_{LOAD} = maximum rated current				125	°C
Maximum Junction Temperature				150	°C

ENVIRONMENTAL SPECIFICATIONS*

Temperature (Ambient Operating)	-55°C to Maximum Per Thermal Operating Curve
Temperature (Ambient Storage)	-55°C to 125°C
Vibration	100g, 10 to 3000 Hz
Acceleration	5000 g
Shock	1500g, 0.5 msec

*Contact factory for higher level environmental requirements.

CHARACTERSTIC CURVES

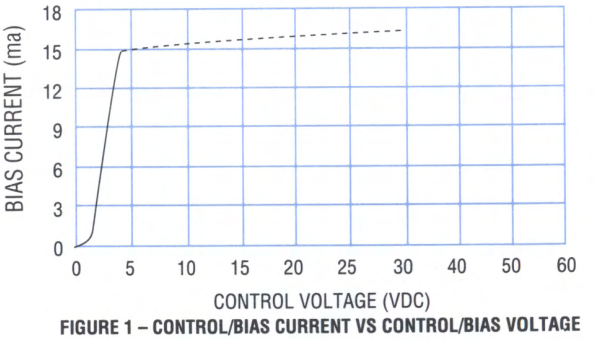


FIGURE 1 – CONTROL/BIAS CURRENT VS CONTROL/BIAS VOLTAGE

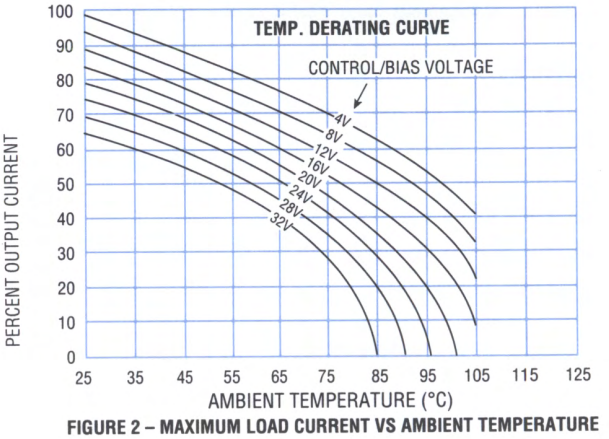


FIGURE 2 – MAXIMUM LOAD CURRENT VS AMBIENT TEMPERATURE

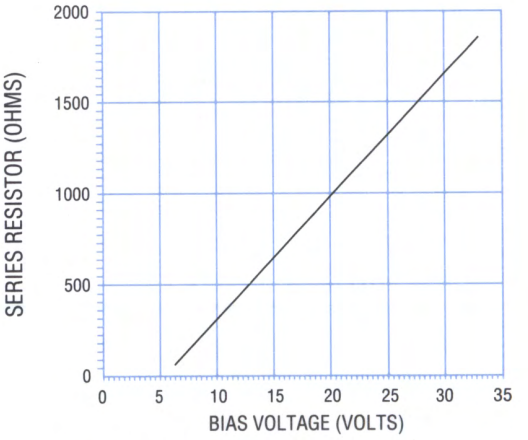
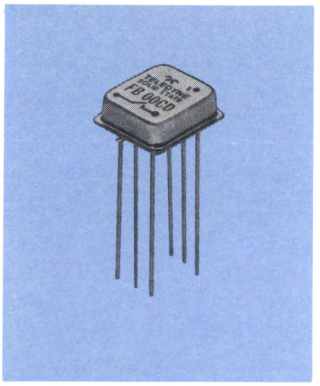


FIGURE 3 – SERIES LIMIT BIAS RESISTOR VS BIAS VOLTAGE

NOTES:

1. In the 3 terminal input configuration, relays provide inversion.
2. In the 2 terminal configuration the relays are non-inverting.
3. Relays may drive loads connected to either positive or negative referenced power.
4. If the Series Control/Bias Resistor of figure 3 is used to dissipate Input Power, the derating of Output Current vs. Bias/Control Voltage is not necessary. Curve at 4 volts applies.
5. The rated input voltage is 5V for all tests unless otherwise specified.
6. For on state resistance at temperature other than 25°C, use: $R = R_{25} \times e^{0.006 \times T}$ where R25 = resistance at 25°C from table, R = resistance at new temperature, T = new temperature -25°C, e = 2.7182818

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE



TELEDYNE SOLID STATE

SOLID STATE RELAY

LOW LEAKAGE
HIGH VOLTAGE
BI-DIRECTIONAL AND DC OUTPUT

SERIES

FB00CD

FB00FC

FB00KB

SPST/NO

FEATURES

- High voltage output
- Extremely low leakage current (200 nanoamperes)
- Bi-directional Power FET output
- Optical isolation
- Fast switching speed
- Adjustable turn-on times
- Low profile 6 pin mini-DIP
- Built and tested utilizing the test methods comparable to MIL-R-28750

APPLICATIONS

- Ideal for Automatic Test Equipment (ATE)
- Telecommunications applications
- High voltage instrumentation systems
- High speed switching with low EMI

PART NUMBER*	DESC DRAWING NUMBER	RELAY DESCRIPTION
FB00CDW		Basic Solid State Relay ±1.0 A @ ±80 Vdc Output
FB00CDY	89116-006	
FB00FCW		Basic Solid State Relay ±0.5 A @ ±180 Vdc Output
FB00FCY	89116-002	
FB00KBW		Basic Solid State Relay ±250 mA @ ±350 Vdc Output
FB00KBY	89116-004	

* The Y suffix denotes parameters tested to MIL-R-28750 test methods. The W suffix denotes parameters tested to Teledyne specifications.

DESCRIPTION

The FB series relay is an advanced solid state bi-directional relay designed specifically for high speed switching in A.T.E. systems. These devices utilize Teledyne state-of-the-art solid state circuit technology and manufacturing techniques to provide high reliability, low life cycle cost and exceptional switch performance. Each device is uniquely characterized by its switching function.

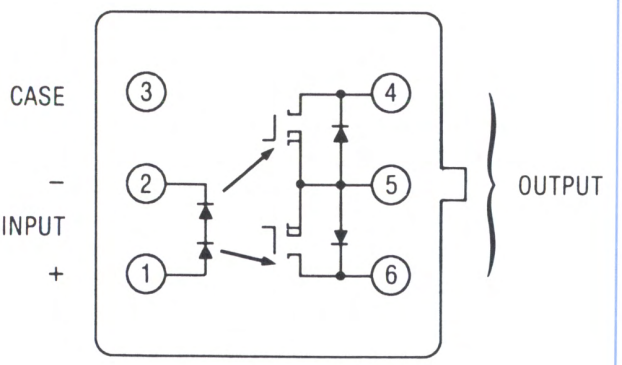
The FB00FC is a power instrumentation switch with low ON resistance and leakage current. The FB00KB is a high voltage instrumentation switch with a quarter ampere current rating. The FB00CD is a power switch with a current rating of 1 ampere and an ON resistance of 0.4 ohm.

The FB series solid state relay has very fast turn on times of under 1 msec and can also be controlled and adjusted with the input current for specific requirements.

Other features include optical coupling and full military temperature operating range for extreme applications. Optical coupling minimizes EMI generation and isolates and protects delicate input logic circuits from output voltage transients.

These devices are packaged and hermetically sealed in a low profile metal 6 pin mini-DIP with lead spacing on 0.300 centers for standard mounting configurations.

BLOCK DIAGRAM (BOTTOM VIEW)



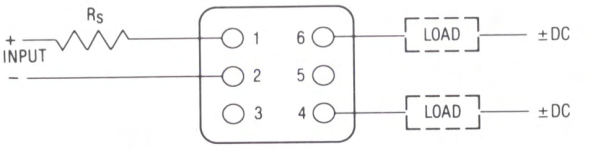
ELECTRICAL SPECIFICATIONS
(-55°C TO 120°C AMBIENT TEMPERATURE UNLESS OTHERWISE NOTED)

INPUT (CONTROL) CHARACTERISTICS (See Note 1)		MIN.	TYP.	MAX.	UNITS
Rated Input Current				25	mAdc
Input Voltage Drop at 25 mA				3.25	Vdc
Continuous Input Current	$-55°C < T_A < 105°C$	10		50	mAdc
	$105°C < T_A < 120°C$	10		25	
Reverse Voltage Protection				−5	Vdc
Input Current (Guaranteed Off)				10	μAdc
Input Current (Guaranteed On)		10			mA
Turn-Off Voltage				1.5	Vdc

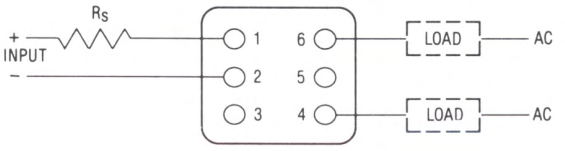
ENVIRONMENTAL SPECIFICATIONS

Temperature Range	Operating	−55°C to 120°C
	Storage	−55°C to 125°C
Vibration		100 g, 10 to 2000 Hz
Constant Acceleration		5000 g
Shock		1500 g, 0.5 ms pulse

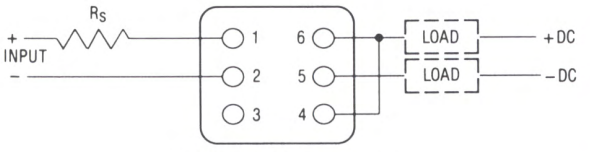
		FB00CD		FB00FC		FB00KB		
OUTPUT (LOAD) SPECIFICATIONS Bi-Directional and AC Configurations (Pin 4 to Pin 6) (See Note 2)		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	UNITS
Continuous Load Current (See Fig. 3 & Note 5)			±1.0		±0.5		±0.25	Adc
Leakage Current @ V_{load} = max. operating voltage	$-55°C < T_A < 25°C$		±200		±200		±200	nAdc
	$25°C < T_A < 120°C$		±20		±20		±20	μAdc
Output Voltage Drop			±0.75		±1.0		±2.4	Vdc
Continuous Operating Load Voltage			±80		±180		±350	Vdc
Transient Blocking Voltage (5 s max.)			±90		±180		±360	Vdc
ON Resistance R_{ds} (on) at T_J = 25°C I_{load} = 100 mAdc (See Fig. 4 & Note 6)			0.4		1.0		7.2	Ohms
Turn-On Time @ I_{IN} = 25 mA (See Fig. 2 and 5)			800		800		500	μs
Turn-Off Time (See Fig. 5)			500		500		500	μs
dv/dt		100		100		100		V/μs
Load Surge Current (See Note 3)			±3.5		±1.75		±0.875	Adc
DC Offset Voltage			100		100		100	μV
Output Capacitance at 25 Vdc, 1 MHz			325		250		100	pF
OUTPUT (LOAD) SPECIFICATIONS DC Configuration (Pins 4 and 6 connected together referenced to Pin 5) (See Notes 2 & 7)		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	UNITS
Continuous Load Current (See Fig. 3 & Note 5)			2.0		1.0		0.5	Adc
Leakage Current @ V_{load} = max. operating voltage	$-55°C < T_A < 25°C$		400		400		400	nAdc
	$25°C < T_A < 120°C$		40		40		40	μAdc
Output Voltage Drop			0.4		0.5		1.8	Vdc
Continuous Operating Load Voltage			80		180		350	Vdc
Transient Blocking Voltage (5 s max.)			90		180		360	Vdc
ON Resistance R_{ds} (on) at T_J = 25°C I_{load} = 100 mAdc (See Fig. 4 & Note 6)			0.1		0.25		1.8	Ohms
Turn-On Time @ I_{IN} = 25 mA (See Fig. 2 and 5)			800		800		500	μs
Turn-Off Time (See Fig. 5)			500		500		500	μs
dv/dt		100		100		100		V/μs
Load Surge Current (See Note 3)			7.0		3.5		1.75	Adc
Output Capacitance at 25 Vdc, 1 MHz			650		500		200	pF
OUTPUT (LOAD) SPECIFICATIONS All Configurations		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	UNITS
Input to Output Capacitance			5		5		5	pF
Dielectric Strength		500		500		500		Vac
Insulation Resistance @500 Vdc		10^9		10^9		10^9		Ohms
Output Junction Temperature @ I_{load} = max. rated current			125		125		125	°C
Maximum Junction Temperature T_J (max.)			150		150		150	°C
Thermal Resistance Junction to Ambient θ_{JA}			110		110		110	°C/W
Thermal Resistance Junction to Case θ_{JC}			20		20		20	°C/W



A) BI-DIRECTIONAL CONFIGURATION (SEE NOTE 4)

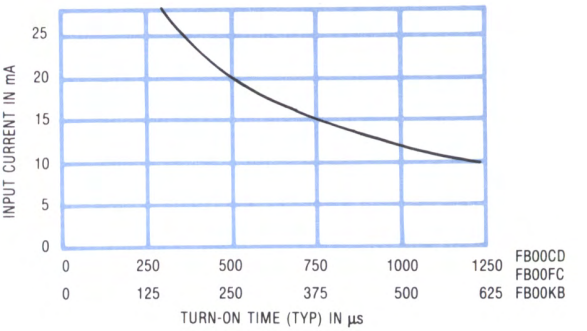


B) AC CONFIGURATION (SEE NOTE 4)

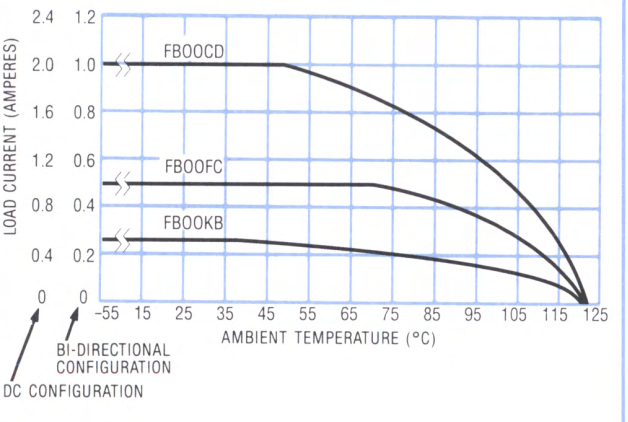


C) DC CONFIGURATION (SEE NOTE 4)

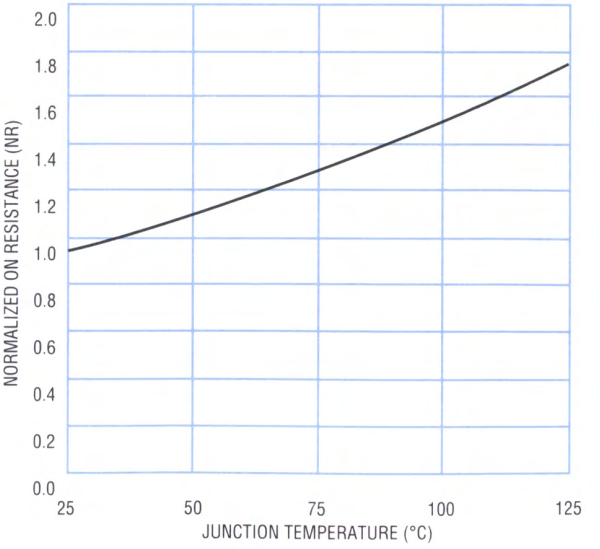
WIRING CONFIGURATIONS
FIGURE 1



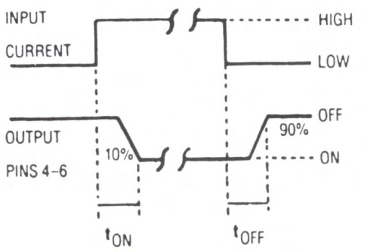
INPUT CURRENT VS TURN-ON TIME
FIGURE 2



THERMAL DERATING CURVE
FIGURE 3



NORMALIZED ON RESISTANCE VS JUNCTION TEMPERATURE
FIGURE 4 (See Note 7)



OUTPUT TURN-ON AND TURN-OFF TIMING
FIGURE 5

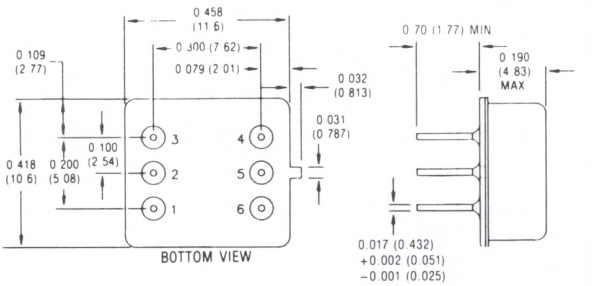
NOTES:

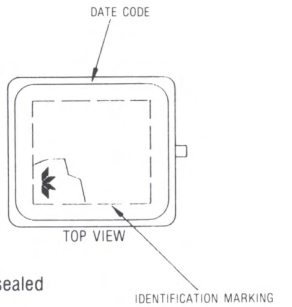
1. Series resistor required to limit input current to 50 mA max.
2. The rated input current is 25 mA for all tests unless otherwise specified.
3. Surge current is specified for 25°C, 10 cycles maximum at a 1 Hz repetition rate with 10% duty cycle and 0.1 s. duration.
4. Relays may drive loads connected to either positive or negative referenced power supply lines. Inductive loads must be diode suppressed.
5. Continuous load current is rated under the condition of still air.
6. To calculate the maximum ON resistance for a given junction temperature, find the normalized ON resistance factor (NR) from Figure 4. Calculate the new ON resistance as follows:

$$R_{(ON)} = NR \times R_{(ON)} @ 25°C$$

7. Relays are tested in the bi-directional configuration only. D.C. parameters are shown for reference only.

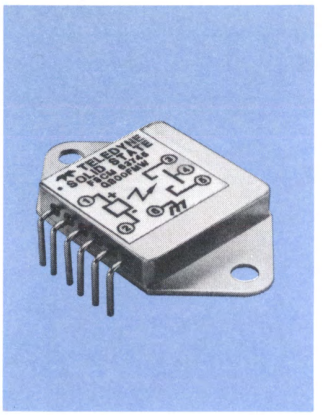
MECHANICAL SPECIFICATIONS





- **WEIGHT:** 2 gm max
- **CASE:** 6 pin DIP hermetically sealed
- **MATERIAL AND PLATING:**
  CAN: Grade A Nickel
  PINS AND HEADER: Kovar gold plated per MIL-G-45204. Type III, Grade A, Class 1.

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)



TELEDYNE SOLID STATE

SOLID STATE RELAY

BI-DIRECTIONAL/DC
OPTICALLY ISOLATED
±10 A, ±150 V

MODEL

QB00FM

SPST/NO

FEATURES

- High voltage output
- Low ON resistance (0.10 Ohms)
- Power FET output
- Optical isolation
- Fast switching speed
- High surge current capability
- Capable of AC, DC, and bi-directional switching
- Parameters tested utilizing comparable MIL-R-28750 test methods

APPLICATIONS

- Ideal for Automatic Test Equipment (ATE)
- High voltage systems
- High speed switching with low EMI
- Squib Fire

DESCRIPTION

The QB00FM relay is an advanced solid state bi-directional relay designed for high speed power switching applications. This relay utilizes state-of-the-art solid state circuit technology and manufacturing techniques to provide high reliability, low life cycle cost and exceptional switch performance.

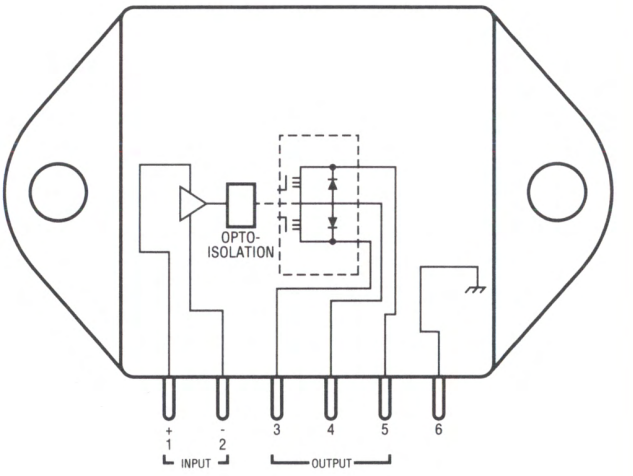
The QB00FM is capable of switching AC, DC, and bi-directional DC power. The three output terminals can be configured for DC switching with ON resistance reduced to 25 milliohms and a current rating of 15 A continuous.

Other features include optical coupling to minimize EMI generation and to protect logic circuits from output voltage transients.

The QB00FM is packaged in a hermetically sealed low profile package suitable for heat sink or circuit card mounting. Pin 6 is connected to the case for additional safety shielding.

PART NUMBER*	RELAY TYPE
QB00FM	BI-DIRECTIONAL OR DC SOLID STATE RELAY

*A suffix, W or Y, denoting parameters tested utilizing test methods comparable to MIL-R-28750.

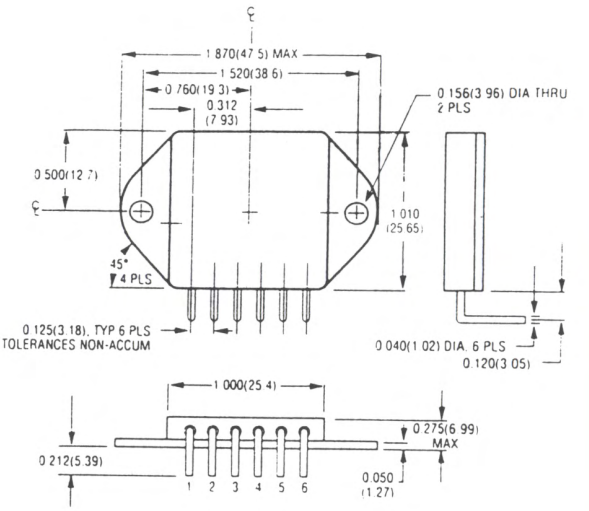


BLOCK DIAGRAM

ELECTRICAL SPECIFICATIONS
(–55°C TO +105°C AMBIENT TEMPERATURE UNLESS OTHERWISE SPECIFIED)

INPUT (CONTROL) CHARACTERISTICS (See Fig. 1 and Note 1)	MIN	MAX	UNITS
Input Current @ V_{IN} = 16 Vdc (See Fig. 2 and Note 1)		35.0	mAdc
Turn-Off Voltage (Guaranteed Off)		1.5	Vdc
Turn-On Voltage (Guaranteed On)	4.5		Vdc
Reverse Voltage Polarity		–16	Vdc
Input Supply Range	4.5	16.0	Vdc
OUTPUT (LOAD) SPECIFICATIONS (See Note 2) Bi-directional Configuration (See Fig. 1)	**MIN**	**MAX**	**UNITS**
Continuous Load Current (See Fig. 3)		±10	Adc
Leakage Current @ V_{LOAD} = ±150 Vdc (25°C)		±10	µA dc
Leakage Current @ V_{LOAD} = ±150 Vdc (105°C)		±100	µA dc
Output Voltage Drop at I_L = 4.3 A, 25°C		0.7	Vdc
Continuous Operating Output Voltage		±150	Vdc
Transient Blocking Voltage (See Note 3)		±180	Vdc
ON Resistance R_{ds} (on) at T_J = 25°C I_{LOAD} = 100 mA dc (See Fig. 4 and Note 4)		0.10	Ohms
Turn-On Time (See Fig. 5)		7.5	ms
Turn-Off Time (See Fig. 5)		2.0	ms
DC Offset Voltage @ V_{IN} = 10 Vdc		±250	µVdc
dv/dt	100		V/µs
Output Capacitance at 25 Vdc, 100 KHz		1600	pF
OUTPUT (LOAD) SPECIFICATIONS DC Configuration (See Fig. 1 and Notes 2 & 7)	**MIN**	**MAX**	**UNITS**
Continuous Load Current (See Fig. 3)		15	Adc
Leakage Current @ V_{LOAD} = 150 Vdc (25°C)		20	µA dc
Leakage Current @ V_{LOAD} = 150 Vdc (105°C)		200	µA dc
Output Voltage Drop at I_L = 15 A, 25°C		0.7	Vdc
Continuous Operating Load Voltage		150	Vdc
Transient Blocking Voltage (See Note 3)		180	Vdc
ON Resistance R_{ds} (on) at T_J = 25°C I_{LOAD} = 100 mA dc (See Fig. 4 & Note 4)		0.025	Ohms
Turn-On Time (See Fig. 5)		8.5	ms
Turn-Off Time (See Fig. 5)		2.0	ms
Output Capacitance at 25 Vdc, 100 KHz		3200	pF
OUTPUT (LOAD) SPECIFICATIONS All Configurations	**MIN**	**MAX**	**UNITS**
Isolation		15	pF
Dielectric Strength	500		Vac
Insulation Resistance @ 500 Vdc	10^9		Ohms
Output Junction Temperature @ I_{LOAD} = maximum rated current		125	°C
Maximum Junction Temperature, T_J (max)		150	°C
Thermal Resistance Junction to Ambient, θ_{JA}		30	°C/W
Thermal Resistance Junction to Case, θ_{JC}		2.0	°C/W

MECHANICAL SPECIFICATIONS



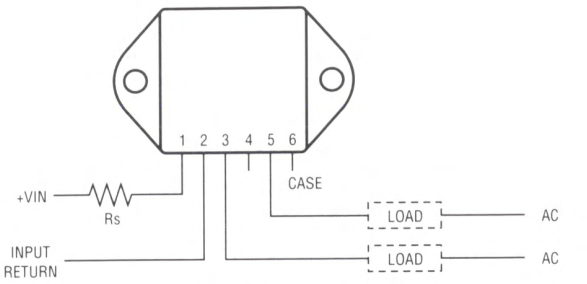
- Weight: 25 gm (max)
- Case: 6 pin, hermetically sealed
- Pins: Plated, gold

TOLERANCES:
.XX ± 0.015
.XXX ± 0.010
ANGLE ± 1/2°

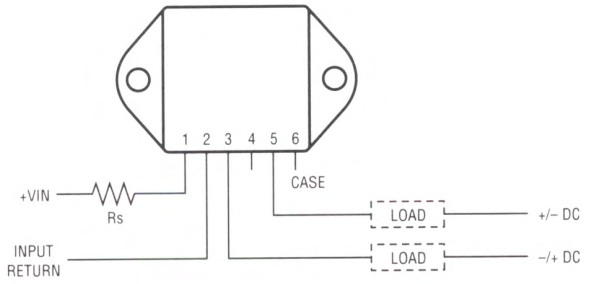
DIMENSIONS ARE SHOWN IN INCHES (MILLIMETER)

ENVIRONMENTAL SPECIFICATIONS		
Temperature Range	Operating	–55°C to +105°C
	Storage	–55°C to +125°C
Vibration		100 g, 10 to 2000 Hz
Constant Acceleration		5000 g
Shock		1500 g, 0.5 ms pulse

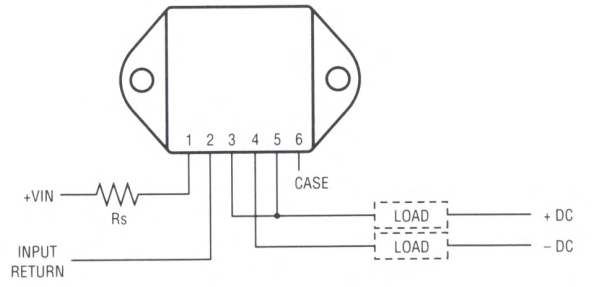
WIRING CONFIGURATION



A) AC CONFIGURATION (SEE NOTE 3)

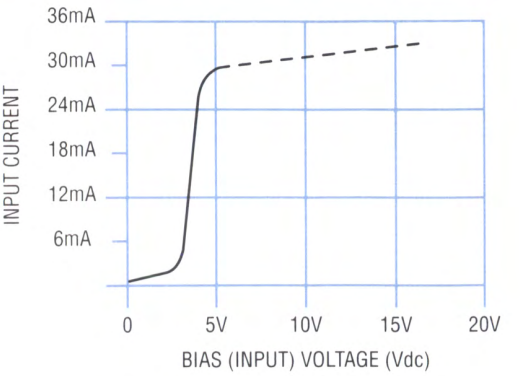


B) BI-DIRECTIONAL CONFIGURATION (SEE NOTE 3)

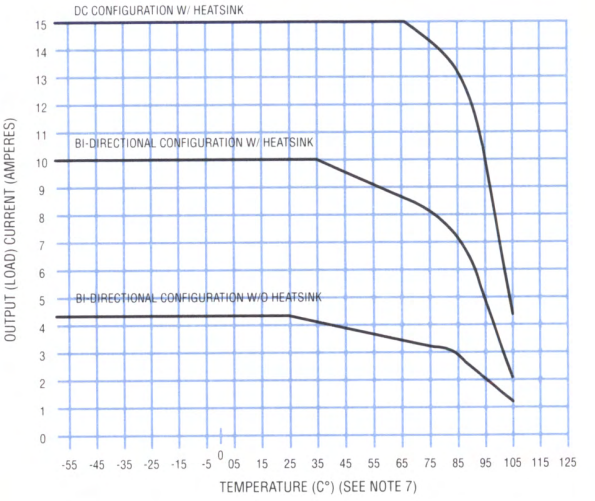


C) DC CONFIGURATION (SEE NOTE 3)

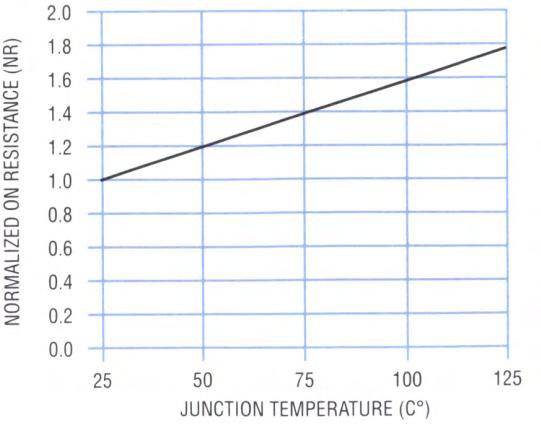
FIGURE 1



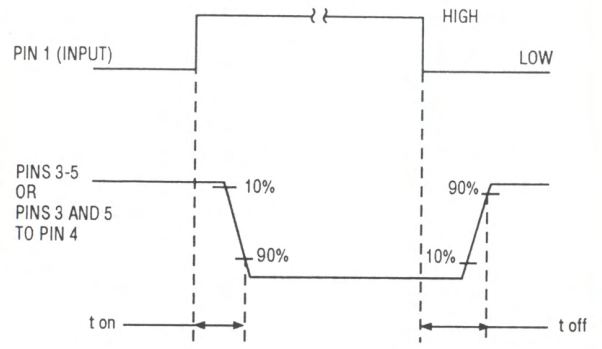
INPUT CURRENT VS. INPUT VOLTAGE
FIGURE 2



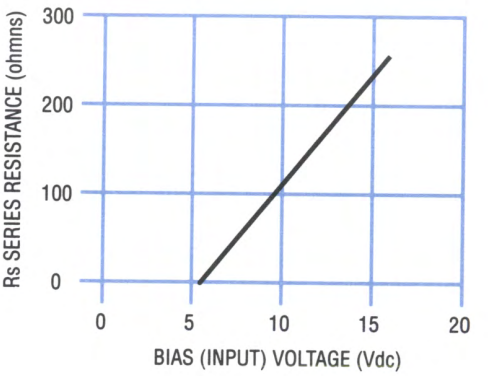
THERMAL DERATING CURVE
FIGURE 3



NORMALIZED ON RESISTANCE VS. JUNCTION TEMPERATURE
FIGURE 4 (See Note 4)



TURN ON AND TURN OFF
FIGURE 5

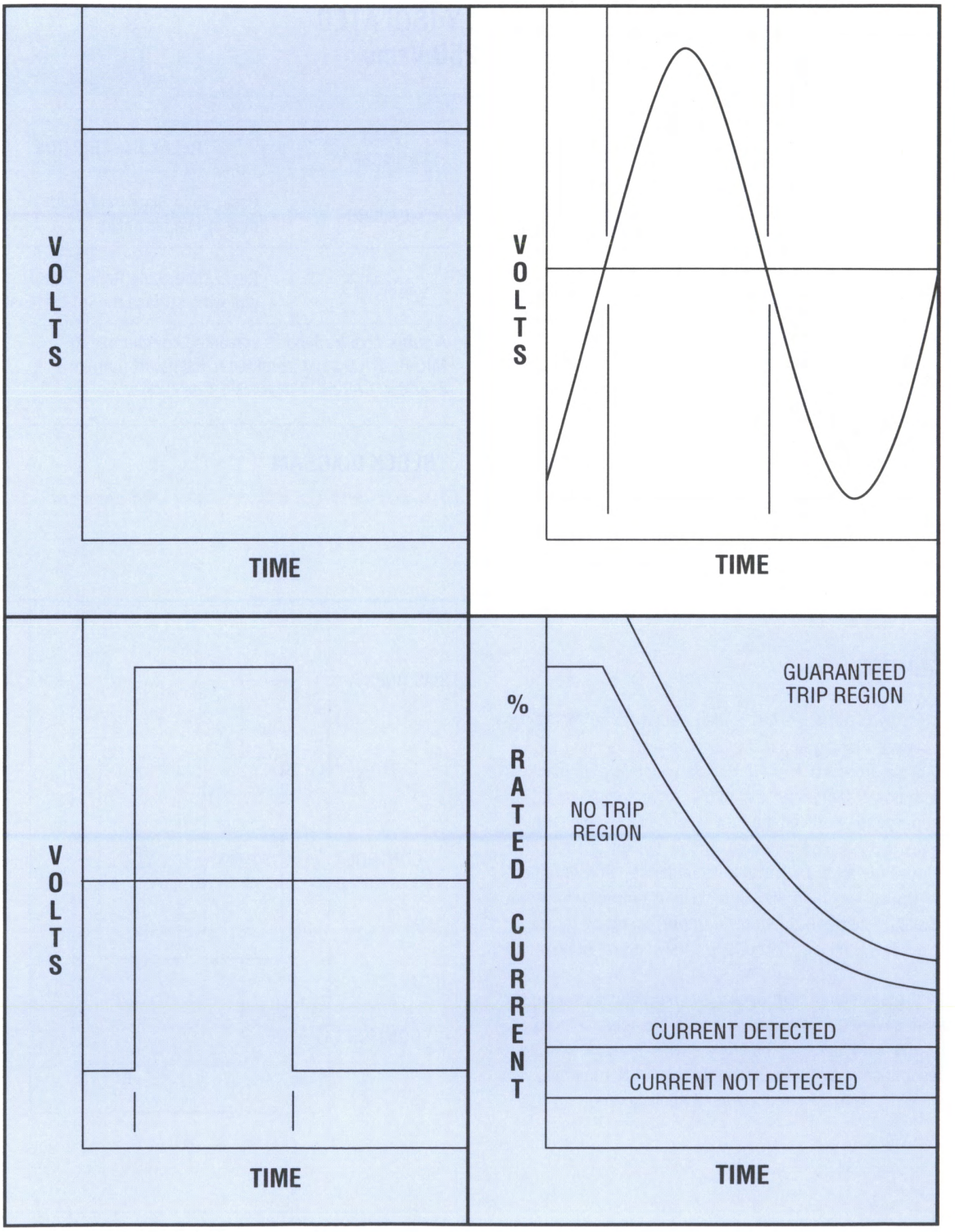


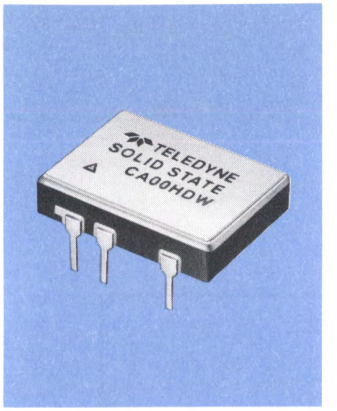
SERIES RESISTANCE VS. INPUT VOLTAGE
FIGURE 6 (See Note 1)

NOTES:

1. For input voltages above 6V, a series resistor is required. Use the standard resistor value equal to or less than the value found in Figure 6.
   $(V_{INPUT} - 6V) / 0.035\ A$
   The input voltage should never exceed 16 Vdc
2. The rated input voltage is 5V for all tests unless otherwise specified.
3. Relays may drive loads connected to either positive or negative reference power supply lines. Inductive loads must be diode suppressed.
4. To calculate the maximum ON resistance for a given junction temperature, find the normalized ON resistance factor (NR) from Figure 4. Calculate the new ON resistance as follows:
   $R_{(ON)} = NR \times R_{(ON)} @ 25°C$
5. Input transition should be $\leq$ 1 ms duration and input drive should be "bounceless contact" type.
6. Minimum heat sink requirement 2°C/Watt.
7. Relays are tested in bi-directional configuration only. DC parameters are shown for reference only.

AC SOLID STATE RELAYS





TELEDYNE SOLID STATE

MILITARY AND AEROSPACE SOLID STATE RELAY

OPTICALLY ISOLATED 1 A, 250 Vrms

SERIES

CA

SPST/NO

FEATURES/BENEFITS

- Optical Isolation –
  Isolates control elements from load transients.
- Low Zero Cross Window –
  Minimizes switching transients and lowers EMI.
- Fully Floating Output –
  Eliminates ground potential loops and allows the output to sink or source current.
- Meets MIL-STD-704 Requirements –
  Allows relay to be used in avionic systems without external transient protection.
- Buffered Control –
  Relay can be controlled directly from TTL or CMOS logic circuits.
- Low Profile Ceramic DIP Package –
  Allows high density packaging for through-hole and surface mount applications.

DESCRIPTION

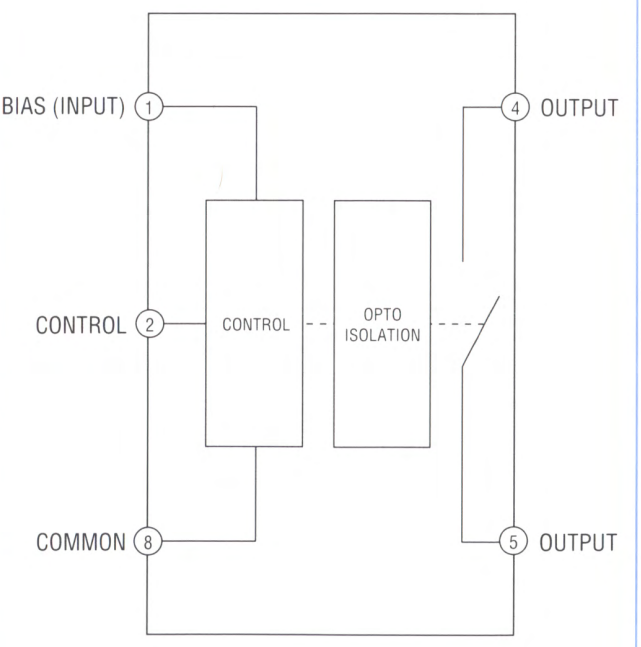
The CA series is designed for printed circuit board mounting in AC power switching applications. The relay is rated for 1A at 250 Vrms from 40 to 440 Hz for resistive and reactive loads with power factors as low as 0.2. Inverse parallel SCRs are configured for zero voltage turn on and can handle current surges up to 8A. The patented circuit design assures the lowest possible EMI by virtually eliminating commutation spikes. Optical isolation allows a floating output with 1200 Vrms isolation between the control (input) and load (output). This allows low level logic circuits to safely control AC loads.

The low profile ceramic DIP package is hermetically sealed to withstand severe environmental conditions encountered in military and aerospace applications. This relay is available with conventional leads for through-hole PCB mounting or with gull wing leads for surface mount applications.

PART NUMBER*	RELAY DESCRIPTION
CA00HD	Basic Solid State Relay with dual in-line terminals.
SCA00HD	Basic Solid State Relay with gull wing surface mount terminals.

* A suffix W or Y, denotes screening comparable to MIL-R-28750 must be added to each part number. Example: CA00HDY denotes a Y level relay.

BLOCK DIAGRAM

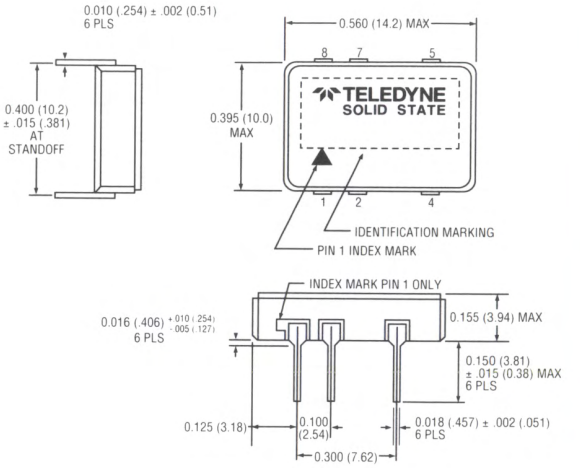


ELECTRICAL SPECIFICATIONS
(–55°C TO +120°C)

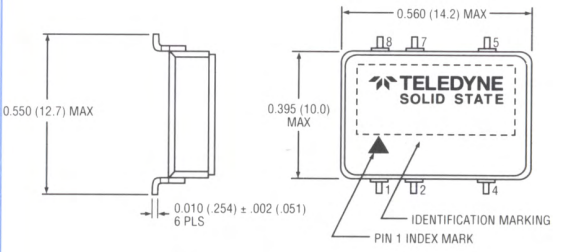
INPUT CHARACTERISTICS 2 Terminal Configuration (See Notes 2, 5 & 6)		MIN.	MAX.	UNITS
Input Voltage		3.8	32	Vdc
Input Current	(V_{INPUT} = 5 Vdc)		15	mA
	(V_{INPUT} = 32 Vdc)		16	
Turn-On Input Voltage		3.8		Vdc
Turn-Off Input Voltage			1.5	Vdc
Reverse Polarity			–32	Vdc
INPUT CHARACTERISTICS Buffered Control Configuration (See Notes 2, 5 & 6)		**MIN.**	**MAX.**	**UNITS**
Bias Voltage		3.8	32	Vdc
Bias Current (V_{INPUT} = 32 Vdc)			16	mA
Control Voltage Range		0	18	Vdc
Control Current at 5 Vdc			250	µAdc
Turn-On Control Voltage			0.4	Vdc
Turn-Off Control Voltage		2.0		Vdc
OUTPUT SPECIFICATIONS (See Note 7)		**MIN.**	**MAX.**	**UNITS**
Load Voltage		20	250	Vac
Frequency Range		40	440	Hz
Load Current (See Figure 3)		0.01	1	A
Output Voltage Drop			1.5	Vrms
Surge Current, 16 ms at 25°C			8	A peak
Fusing I^2T (10 ms)			1	A^2S
Leakage Current at 250 Vac, 400 Hz			1	mArms
Turn-On Time			1/2	cycle
Turn-Off Time			1	cycle
Zero Voltage Turn-On			±18	V peak
Waveform Distortion			4	V peak
Load Power Factor		0.2	1.0	
Exponential Rate of Voltage Rise (See Note 1)		100		V/µs
Transient Voltage, (t < 5s) (See Note 4)			±500	V peak
Dielectric Strength (60 Hz)		1500		Vrms
Insulation Resistance (@ 500 Vdc)		10^9		M Ohm
Input to Output Capacitance			15	pF
Power Dissipation Factor at 25°C			1.5	W/A
Junction Temperature at Rated Current			130	°C
Thermal Resistance Junction to Case			25	°C/W
Thermal Resistance Junction to Ambient			60	°C/W

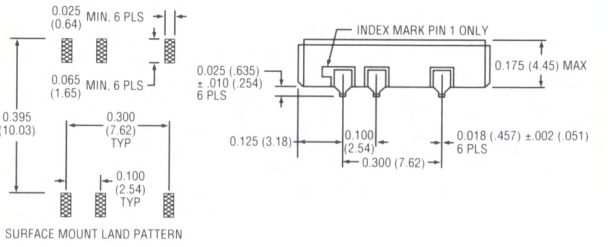
ENVIRONMENTAL SPECIFICATIONS		
Temperature Range	Operating	–55°C to +110°C
	Storage	–55°C to +130°C
Vibration		100 g, 10 to 3000 Hz
Constant Acceleration		5000 g
Shock		1500 g, 0.5 ms pulse

MECHANICAL SPECIFICATIONS



CA SERIES OUTLINE





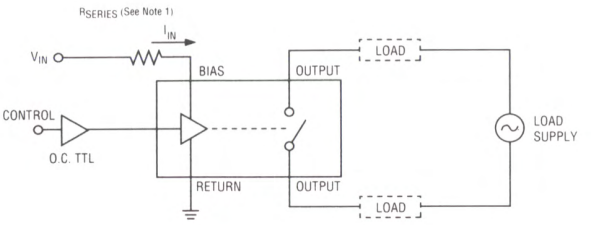
SCA SERIES OUTLINE

TOLERANCES
XX = ± .010 (.254)
XXX = ± .005 (.127)

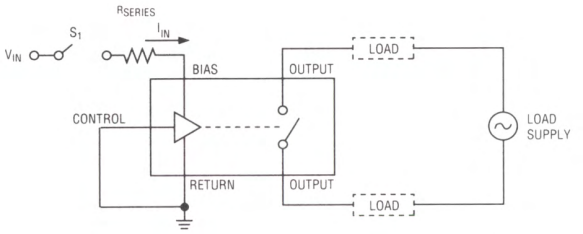
- **WEIGHT:** 2 gm max
- **CASE:** DIP, hermetically sealed, ceramic
- **PINS:** Gold plated.

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETER)

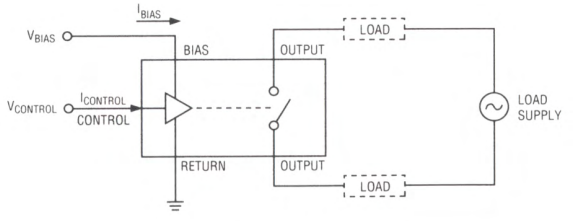
WIRING CONFIGURATIONS



(A) OPEN COLLECTOR TTL DRIVE INPUT CONFIGURATION

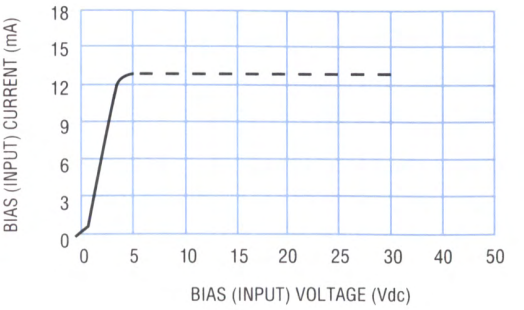


(B) DIRECT DRIVE INPUT CONFIGURATION

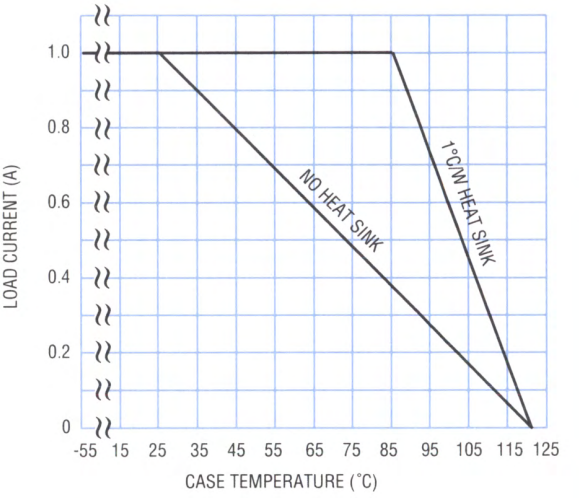


(C) BUFFERED INPUT CONFIGURATION

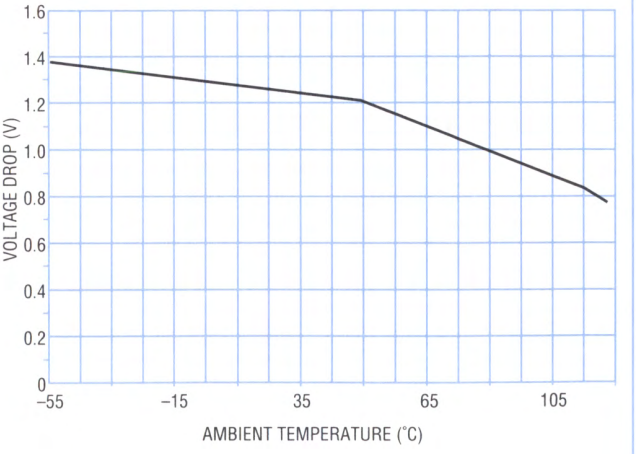
WIRING CONFIGURATIONS
FIGURE 1 (See Note 2)



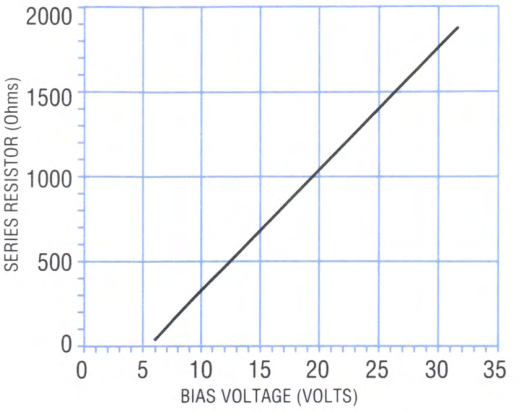
BIAS (INPUT) CURRENT VS BIAS (INPUT) VOLTAGE
FIGURE 2



LOAD CURRENT TEMPERATURE DERATING CURVE
FIGURE 3



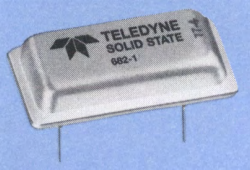
TYPICAL OUTPUT VOLTAGE DROP AT RATED CURRENTS
FIGURE 4



SERIES LIMIT BIAS RESISTOR VS BIAS VOLTAGE
FIGURE 5 (See Note 3)

NOTES:

1. To increase the dV/dt characteristic to 200V/µs, use an RC snubber across the output terminals with R = 100 and C = 0.01 µF.
2. Control input is compatible with CMOS or open collector TTL (with pull up resistor).
3. For bias voltages above 6V, a series resistor is recommended. Use a standard resistor value equal to or less than the value found from Figure 5.
4. Output may temporarily lose blocking capability during and after a surge, until T_J falls below maximum.
5. Input transition should be ≤ 1 msec duration and input drive should be "bounceless contact" type.
6. Unless otherwise noted, the input voltage for functional tests shall be 5 Vdc.
7. DC offset voltage and waveform distortion is as specified when the load current is between 10% and 100% of the rated load.



TELEDYNE SOLID STATE

AC SOLID STATE RELAY

OPTICALLY ISOLATED
1 A, 250 Vrms
(2 A with Heat Sink)

MODEL

682-1

(M28750/9)

SPST/NO

FEATURES

- Relay qualified to MIL-R-28750
- Zero voltage turn-on SCR output
- Optical isolation
- Logic compatible input
- Low minimum output current
- Extremely low EMI
- Low profile metal DIP package

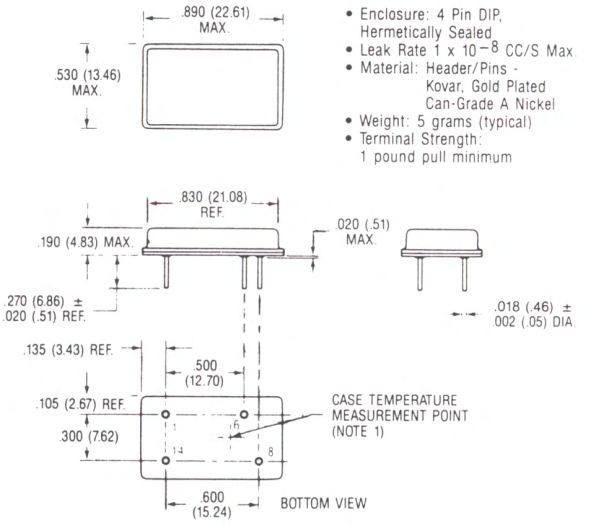
DESCRIPTION

This state-of-the-art solid state relay is designed for use in ac power switching applications. The output is rated for 1 A (2 A with heat sink) at 250 Vrms and can operate from 40 to 440 Hz for resistive and reactive loads with power factors as low as 0.2. Back-to-back SCRs are configured for zero voltage turn-on and can handle current surges up to 8 A. The patented circuit design assures the lowest possible EMI by virtually eliminating commutation spikes while maintaining excellent noise immunity. Optical isolation allows safe control of ac loads from low level logic circuits. The low profile metal DIP package is hermetically sealed to withstand severe environmental conditions encountered in military and aerospace applications. This relay is qualified to MIL-R-28750/9-001 and is available to Y screening levels.

PART NUMBER*	MILITARY NUMBER*	RELAY TYPE
682-1Y	M28250/9-001Y	AC Solid State Relay

* The Y suffix denotes parameters tested to MIL-R-28750 test methods. The suffix W denotes parameters tested to Teledyne specifications.

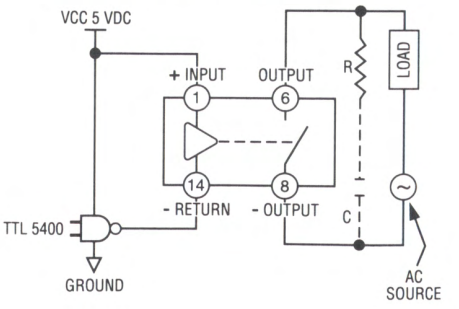
OUTLINE DIMENSIONS



DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

WIRING DIAGRAM

TYPICAL INTERFACE TO 5 VOLT LOGIC
(WITH SUGGESTED dv/dt SUPPRESSION – SEE NOTE 2)



RELAY BOTTOM VIEW

ELECTRICAL SPECIFICATIONS
(-55°C TO +110°C UNLESS OTHERWISE SPECIFIED)

INPUT (CONTROL) CHARACTERISTICS		MIN	TYP	MAX	MAX
Input Current (See Figure 1)	V_{IN} = 5 Vdc		13	15	mA dc
	V_{IN} = 32 Vdc		13	16	
Turn-Off Voltage (Guaranteed Off)				1.5	Vdc
Turn-On Voltage (Guaranteed On)		3.8			Vdc
Reverse Voltage Protection				-32	Vdc
Input Voltage Range		3.8		32	Vdc
OUTPUT (LOAD) SPECIFICATIONS		**MIN**	**TYP**	**MAX**	**UNITS**
Output Current Rating (See Fig. 4 & 5)		0.020		2.0	Arms
Output Voltage Rating		20		250	Vrms
Frequency Range		40		440	Hz
Output Voltage Drop @ 1 Ampere (See Figure 2)				1.5	Vrms
Off-State Leakage Current (250 Vac, 400 Hz)				1.0	mArms
Turn-On Time				1/2	Cycle
Turn-Off Time				1	Cycle
Transient Voltage (T < 5 s)				±500	Vpk
Surge Current @ 25°C (16 ms) (See Figure 3)				8	Apk
Overload (Repetitive, 10% Duty Cycle)				1.5	Arms
DC Offset Voltage				±100	mV
Waveform Distortion				4	Vrms
Zero Voltage Turn-On Point at 25°C				±15	Vpk
Off-State dv/dt (With Snubber — See Note 2)		200			V/μs
Commutating dv/dt		5			V/μs
Load Power Factor (With Snubber — See Note 3)		0.2			
Fusing I^2T (10 ms)				1	A^2s
Insulation Resistance @ 500 Vdc		10^9			Ohms
Isolation (Input to Output)				10	pF
Dielectric Withstanding Voltage		1500			Vrms 60 Hz SINE WAVE
Power Dissipation				2	Watts
Output Switch Junction Temperature (T_J Max.)				130	°C
Thermal Resistance Junction to Ambient (Θ_{JA})				65	°C/W
Thermal Resistance Junction to Case (Θ_{JC})				15	°C/W

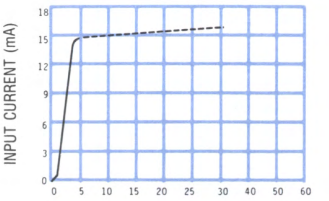
ENVIRONMENTAL SPECIFICATIONS*

Ambient Temperature	-55°C to 110°C Operating -55°C to 125°C Storage
Shock	1500 g, 0.5 ms
Vibration	30 g, 10-3000 Hz
Acceleration Y1 Axis Only	5000 g

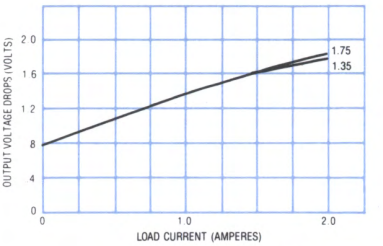
*Contact factory for higher level environmental requirements

NOTES:
1. Case temperature is measured at point specified.
2. Recommended snubber across output terminals R = 100Ω 1/2 W, C = 0.01 μF 600V. The dv/dt rating is based on a source impedance of 50 ohms.
3. Output may lose blocking capability during and after surge until TJ falls below maximum.
4. Contact factory for additional specifications.

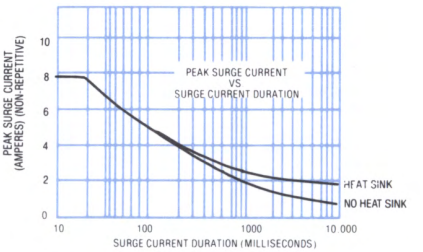
CHARACTERISTIC CURVES



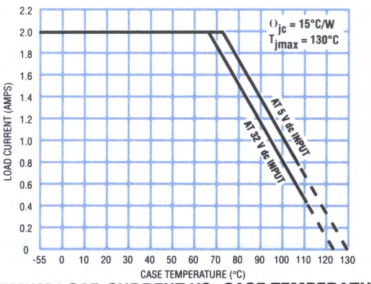
TYPICAL INPUT CURRENT VS. INPUT VOLTAGE
FIGURE 1



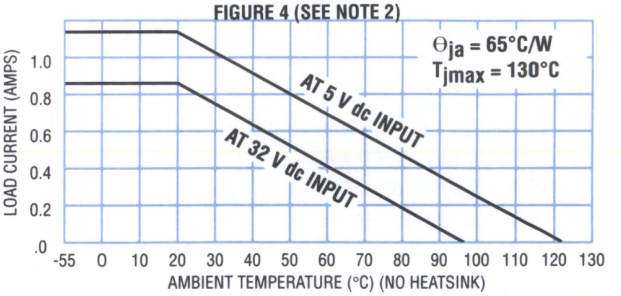
LOAD CURRENT VS. TYPICAL OUTPUT VOLTAGE DROP
FIGURE 2



PEAK SURGE CURRENT VS. SURGE CURRENT DURATION
FIGURE 3 (SEE NOTE 5)

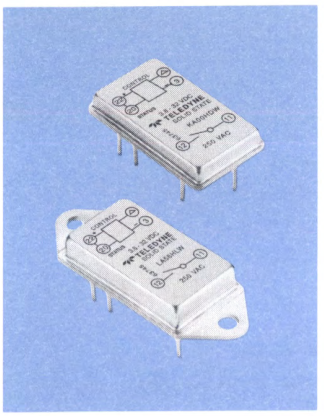


MAXIMUM LOAD CURRENT VS. CASE TEMPERATURE
FIGURE 4 (SEE NOTE 2)



MAXIMUM LOAD CURRENT VS. AMBIENT TEMPERATURE
FIGURE 5

PATENT #4,339,670



TELEDYNE SOLID STATE

MILITARY AND AEROSPACE SOLID STATE RELAY

OPTICALLY ISOLATED 2.0 TO 7.5 A, 250 Vrms

SERIES

KA
LA

SPST/NO

FEATURES/BENEFITS

- Available with thermal protection and thermal TRIP status – Provides self-protection from thermal runaway conditions and indicates protection state for system BIT.
- Optical Isolation – Isolates control elements from load transients with reduced EMI.
- Fully Floating Output – Eliminates ground potential loops and allows the output to sink or source current.
- Buffered Control – Relay can be controlled directly from TTL or CMOS logic circuits.
- Integral Snubber Circuit – Enhances dV/dt capability while minimizing EMI.

DESCRIPTION

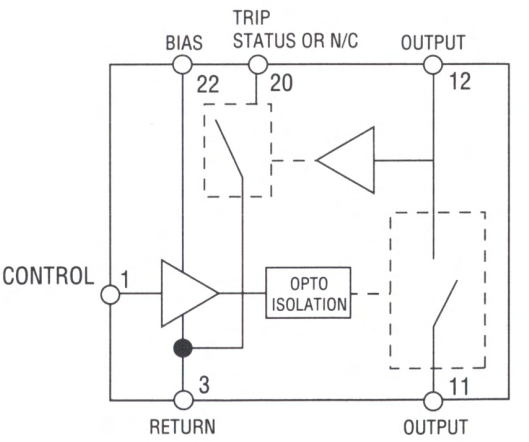
The KA/LA series of solid state relays (SSRs) is designed for use in AC power switching applications where safety and reliability are primary concerns. These SSRs are rated for load voltages up to 250 Vrms from 40 to 400 Hz and are ideal for resistive and reactive loads with power factors as low as 0.2. Inverse parallel SCRs are configured for zero voltage turn on and can handle current surges up to 75 A (LA). Optical isolation to 1250 Vrms between the control (input) and load (output) allows the load to be safely controlled by low level logic circuitry.

The KA/LA series is available with thermal protection and thermal TRIP status. In case of a thermal runaway condition, the SSR will shut down the output switch and latch off until the input is reset and the junction temperature returns to a safe level. When the output does latch off, the TRIP status line will yield a logic level output indicating the protection state of the SSR. This feature provides the user with failure mode indication while enhancing the system diagnostic capability. These SSRs are available to the W and Y screening levels of MIL-R-28750 and are packaged in low profile hermetically sealed cases.

PART NUMBER*	RELAY DESCRIPTION
KA00HF	Basic 2 A Solid State Relay (SSR)
KA58HF	2 A SSR with Thermal Protection and Thermal TRIP Status
LA00HL	Basic 7.5 A SSR
LA58HL	7.5 A SSR with Thermal Protection and Thermal TRIP Status

* A W or Y suffix denoting the screening level of MIL-R-28750, must be added to each part number.
Example: LA00HLY indicates a Y level SSR.

BLOCK DIAGRAM

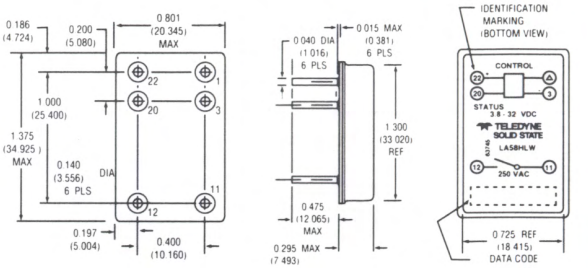


ELECTRICAL SPECIFICATIONS
(–55°C TO +125°C)

INPUT CHARACTERISTICS 2 Terminal Configuration (See Figure 1)		MIN.	MAX.	UNITS
Input Voltage (See Note 2)		3.8	32	Vdc
Input Current	(V_{INPUT} = 5 Vdc)		15	mA
	(V_{INPUT} = 32 Vdc)		16	
Turn-On Input Voltage		3.8		Vdc
Turn-Off Input Voltage			1.5	Vdc
Reverse Polarity			–32	Vdc
INPUT CHARACTERISTICS Buffered Control Configuration (See Figure 1)		**MIN.**	**MAX.**	**UNITS**
Bias Voltage (See Note 2)		3.8	32	Vdc
Bias Current (V_{INPUT} = 32 Vdc)			16	mA
Control Voltage Range		0	18	Vdc
Control Current at 5 Vdc			250	µAdc
Turn-On Control Voltage			0.3	Vdc
Turn-Off Control Voltage		3.2		Vdc
OUTPUT SPECIFICATIONS (See Note 4)		**MIN.**	**MAX.**	**UNITS**
Load Voltage		20	250	Vac
Frequency Range		40	440	Hz
Continuous Load Current (See Figure 3)	KA and LA Series without heat sink		2.0	A
	LA Series with heat sink		7.5	
Output Voltage Drop			1.2	Vrms
Surge Current, 16 ms at 25°C (See Note 5)	KA Series		60	Arms
	LA Series		75	
Leakage Current at 250 Vac, 400 Hz			10	mA
Turn-On Time			1/2	cycle
Turn-Off Time			1	cycle
Zero Voltage Turn-On			±15	V peak
Waveform Distortion (See Note 6)			4	Vrms
Load Power Factor		0.2		
dv/dt		100		V/µs
Transient Voltage, (t < 5s) (See Note 7)			±500	V peak
Dielectric Strength (60 Hz)		1250		Vrms
Insulation Resistance (@ 500 Vdc)		1000		M Ohm
Input to Output Capacitance			15	pF
Power Dissipation Factor at 25°C			1.0	W/A
Junction Temperature at Rated Current			125	°C
Maximum Junction Temperature			150	°C
Thermal Resistance Junction to Case			5	°C/W
Thermal Resistance Junction to Ambient			32	°C/W

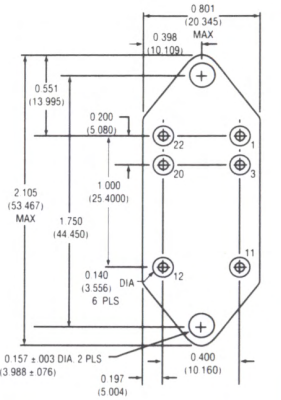
STATUS OUTPUT TRUTH TABLE		
STATUS OUTPUT STATE	CONTROL INPUT	OUTPUT (LOAD) STATE
Off (High)	Low	On
On (Low)	Low	Tripped
Off (High)	High	Off
On (Low)	High	Relay Malfunction

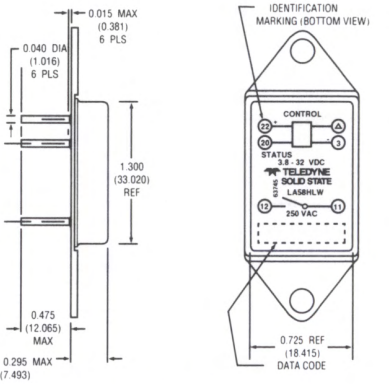
MECHANICAL SPECIFICATIONS



KA SERIES

ENCLOSURE: Hermetically Sealed DIP
LEAK RATE: 1 X 10^{-8} CC/Sec Maximum
MATERIAL: Header – Cold Rolled Steel Nickel Plated
Pins – Copper Core
Can – Cold Rolled Steel Nickel Plated
WEIGHT: 20 grams
TOLERANCE: .XX = ±.010 (±.25)
.XXX = ±.005 (±.13)





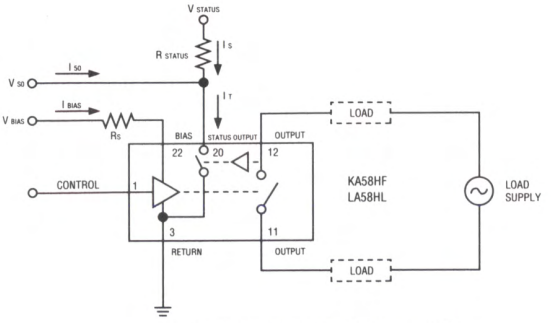
LA SERIES

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETER)

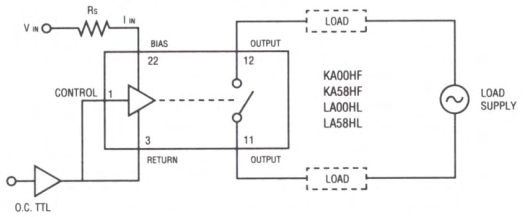
STATUS OUTPUT SPECIFICATIONS	MIN.	MAX.	UNITS
Status Supply Voltage	3.8	32	Vdc
Status Leakage Current @ 32 Vdc		10	µAdc
Status Sink Current (Vso ≤ 0.4 Vdc)		10	mAdc

ENVIRONMENTAL SPECIFICATIONS		
Temperature Range	Operating	–55°C to +110°C
	Storage	–55°C to +125°C
Vibration		100 g, 10 to 3000 Hz
Constant Acceleration		5000 g
Shock		1500 g, 0.5 ms pulse

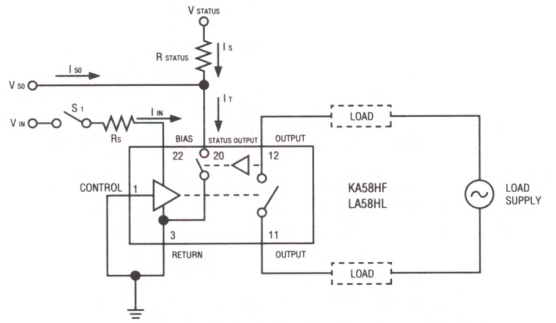
WIRING CONFIGURATIONS



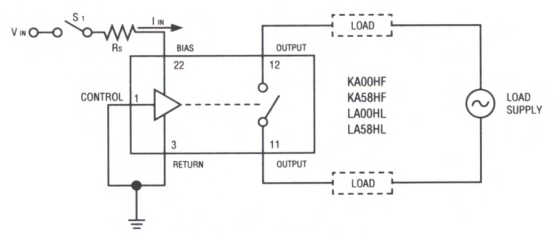
(A) 3 TERMINAL INPUT WITH STATUS (see note 7)



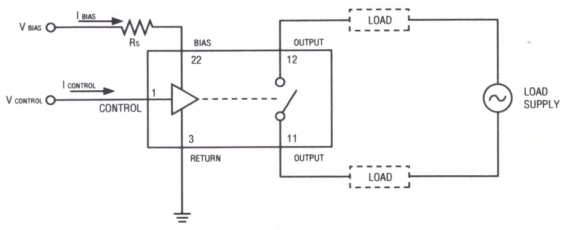
(B) 2 TERMINAL INPUT (OPEN COLLECTOR TTL DRIVE)



(C) 2 TERMINAL INPUT (DIRECT DRIVE) WITH STATUS

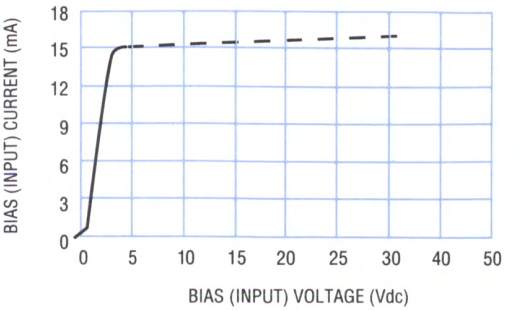


(D) 2 TERMINAL INPUT (DIRECT DRIVE)

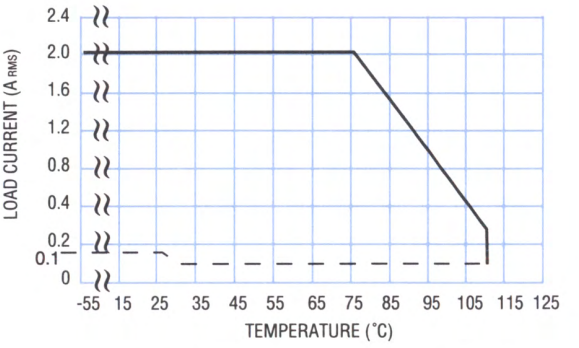


(E) 3 TERMINAL INPUT WITHOUT STATUS

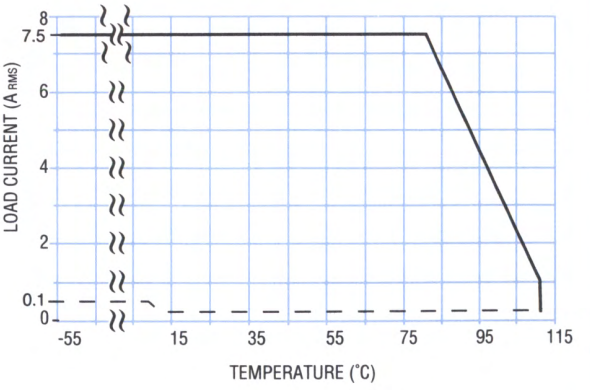
WIRING CONFIGURATIONS
FIGURE 1 (See Notes 1, 2 and 3)



BIAS (INPUT) CURRENT VS BIAS (INPUT) VOLTAGE
FIGURE 2 (See Note 2)

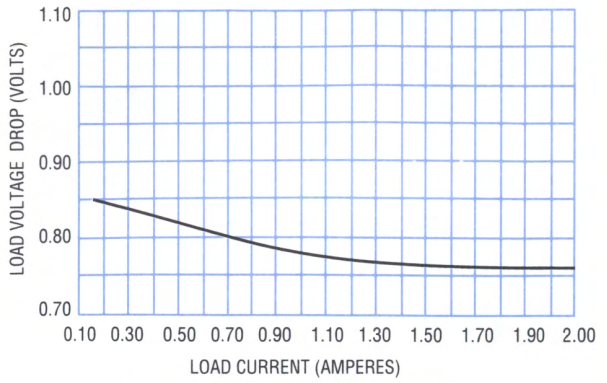


MAXIMUM LOAD CURRENT VS AMBIENT TEMPERATURE
LA SERIES WITHOUT HEATSINK OR KA SERIES



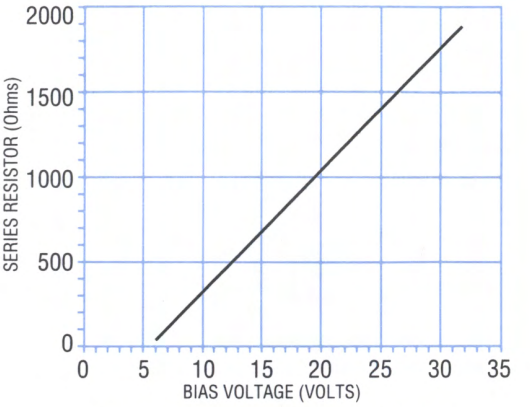
MAXIMUM LOAD CURRENT VS CASE TEMPERATURE
LA SERIES WITH HEATSINK

THERMAL DERATING CURVE
FIGURE 3



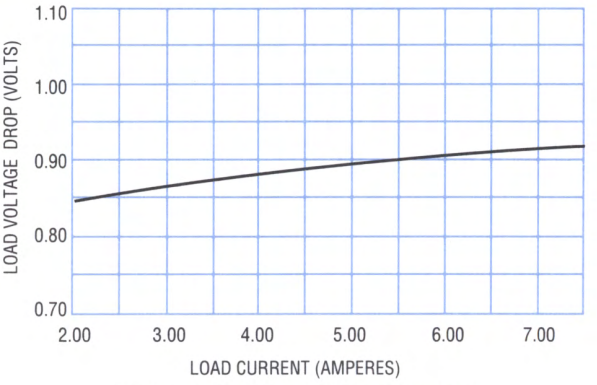
TYPICAL VOLTAGE DROP VS LOAD CURRENT OF KA/LA SERIES WITHOUT HEATSINK

FIGURE 4



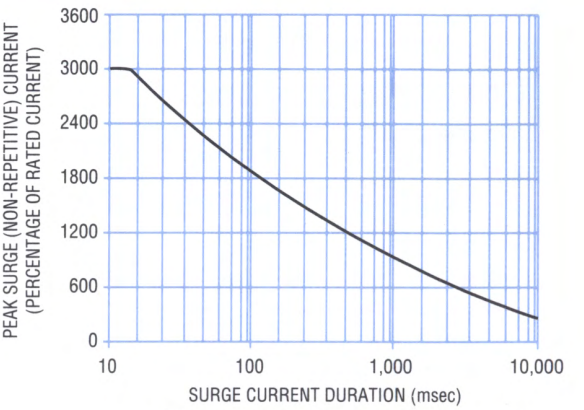
SERIES LIMIT BIAS RESISTOR VS BIAS VOLTAGE

FIGURE 6 (See Note 2)



TYPICAL VOLTAGE DROP VS LOAD CURRENT OF LA SERIES WITH 1°C/W HEATSINK

FIGURE 5

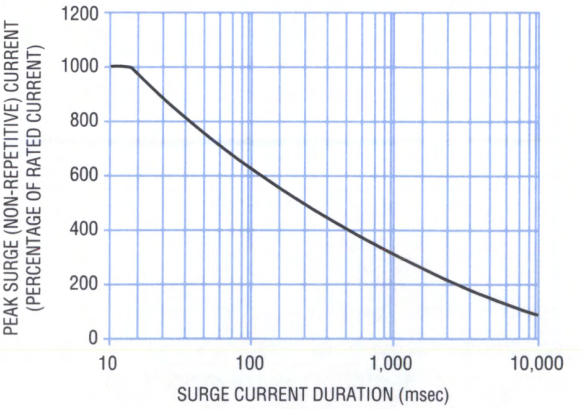


PEAK SURGE CURRENT VS SURGE CURRENT DURATION KA SERIES

FIGURE 7

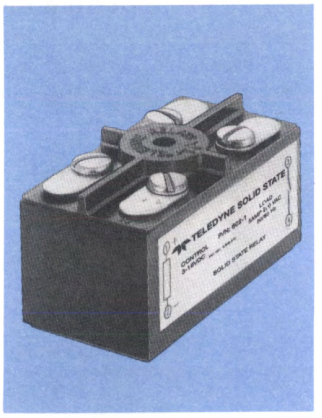
NOTES:

1. Control input is compatible with CMOS or open collector TTL (with pull up resistor).
2. For bias voltages above 6 Vdc, a series resistor is recommended. Use a standard resistor value equal to or less than the value found from Figure 6.
3. Input transition should be ≤ 1 msec duration and input drive should be "bounceless contact" type.
4. Unless otherwise noted, the input voltage for functional tests shall be 5 Vdc.
5. Output may temporarily lose blocking capability during and after a surge, until T_J falls below maximum.
6. DC offset voltage and waveform distortion is as specified when the load current is between 10% and 100% of the rated load.
7. Transient suppression must be used to limit the voltage to < 500 Vpeak when switching inductive loads. Load voltage must be applied before turning ON an inductive load.



PEAK SURGE CURRENT VS SURGE CURRENT DURATION LA SERIES

FIGURE 8



TELEDYNE SOLID STATE
AC SOLID STATE RELAY

OPTICALLY ISOLATED
10 A, 250 Vac

SERIES

602

SPST/NO

FEATURES

- Available to DESC drawing 86031-001
- Optical isolation
- Low minimum output current
- Extremely low EMI
- Zero voltage turn-on
- Zero current turn-off
- Logic compatible input
- Available to Y screening levels of MIL-R-28750

DESCRIPTION

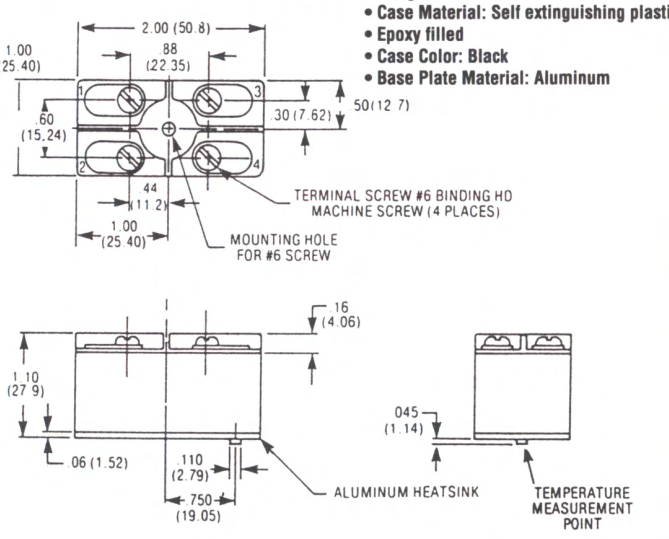
The 602-1 is an ac output solid state relay designed for power switching. The relay incorporates a hermetically sealed, optically coupled solid state relay as a driver. This driver provides zero voltage turn-on as well as a logic compatible control circuit. The relay output is rated for 10A at 250 Vac and switches the load with a hermetically sealed triac. A built in snubber circuit provides reliable seitching of both resistive and reactive loads with power factors as low as 0.2. The internal components are potted with a thermally conductive epoxy, which provides an environmental seal for severe environmental conditions encountered in military and aerospace applications. The 602-1 is available in W and Y screening levels comparable to MIL-R-28750. The 602-1Y is available to DESC drawing 86031-001.

PART NUMBER*	MILITARY NUMBER*	RELAY TYPE
602-1W		AC SOLID STATE RELAY
602-1Y	86031-001	

*The Y suffix denotes parameters tested to MIL-R-28750 test methods. A W suffix denotes Teledyne test specifications.

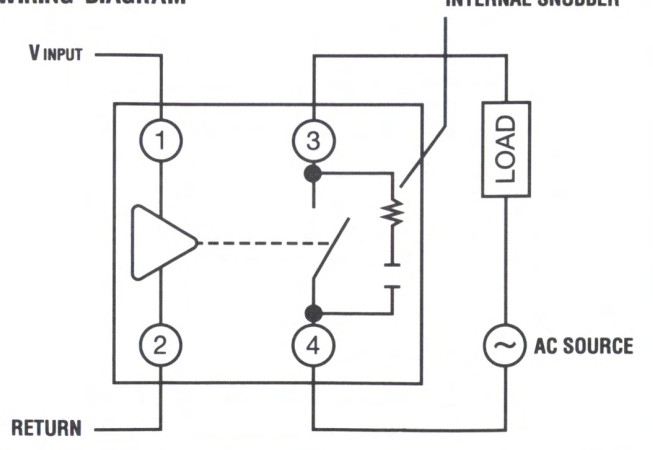
MECHANICAL SPECIFICATIONS

- Weight: 3 oz. max.
- Case Material: Self extinguishing plastic
- Epoxy filled
- Case Color: Black
- Base Plate Material: Aluminum



(DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

WIRING DIAGRAM



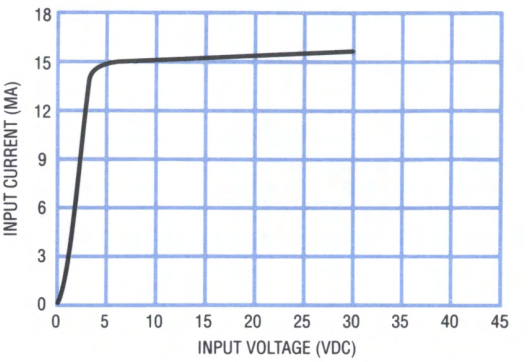
ELECTRICAL SPECIFICATIONS
(-55°C TO 95°C UNLESS OTHERWISE SPECIFIED)

INPUT (CONTROL) CHARACTERISTICS		MIN	TYP	MAX	MAX
Input Current (See Figure 1)	V_{IN} = 5 Vdc		13	15	mA dc
	V_{IN} = 32 Vdc		13	16	
Turn-Off Voltage (Guaranteed Off)				1.0	Vdc
Turn-On Voltage (Guaranteed On)		3.8			Vdc
Reverse Voltage Protection				−32	Vdc
Control Voltage Range		3.8		32	Vdc
OUTPUT (LOAD) SPECIFICATIONS		**MIN**	**TYP**	**MAX**	**UNITS**
Output Current Rating (See Figure 3)		.15		10	Amps (rms)
Output Voltage Rating		25		250	Vac (rms)
Frequency Range		45		440	Hz
Output Voltage Drop @ 10 Ampere (See Figure 2)				1.5	Vac (rms)
Off-State Leakage Current (250 Vac, 400 Hz)				8.0	mA (rms)
Turn-On Time				1/2	Cycle
Turn-Off Time				1	Cycle
Transient Voltage ($T \leq 5$ s)				±460	V peak
Overload Current (See Note 4)				35	Amps (rms)
Zero Voltage Turn-On Point at 25°C				±15	V peak
Off-State dv/dt (With Snubber. — See Note 3)		200			V/μs
Load Power Factor (See Note 3)		0.2			
Fusing I^2T (10 ms)				150	A^2sec
Insulation Resistance @ 500 Vdc		10^9			Ohms
Isolation (Input to Output)				10	pf
Dielectric Withstanding Voltage		1500			Vac (rms) 60 Hz SINE WAVE
Power Dissipation				1.5	Watts
Output Switch Junction Temperature (T_J Max.)				110	°C
Thermal Resistance Junction to Ambient (Θ_{JA})				11.5	°C/W
Thermal Resistance Junction to Case (Θ_{JC})				2	°C/W

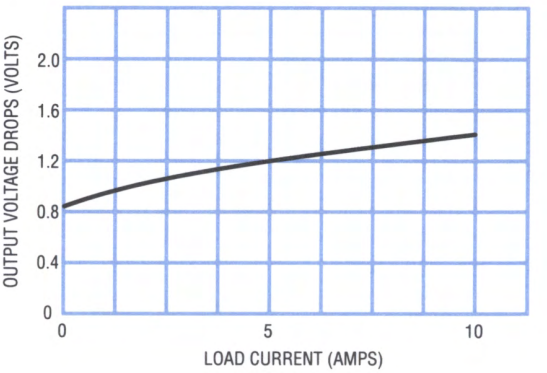
ENVIRONMENTAL SPECIFICATIONS

Ambient Temperature	−55°C to 95°C Operating −55°C to 110°C Storage
Shock	100 g for 6 ms
Vibration	30 g, 78-2000 Hz (0.1 Double Amplitude 10-78 Hz)
Acceleration	100 g

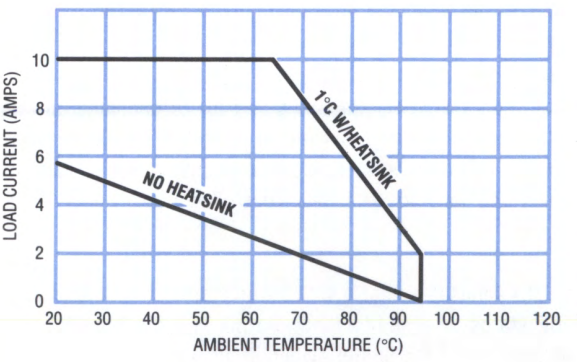
CHARACTERISTIC CURVES



TYPICAL INPUT CURRENT VS. INPUT VOLTAGE
FIGURE 1



LOAD CURRENT VS. TYPICAL OUTPUT VOLTAGE DROP
FIGURE 2

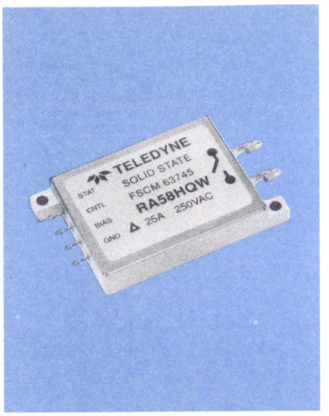


THERMAL DERATING CURVES
FIGURE 3

PATENT #3,648,075

NOTES:

1. Case temperature 75°C max. @ 10 A, measured at point specified.
2. Built-in snubber (R = 100Ω, C = 0.01 μF).
3. Output may lose blocking capability during and after surge until T_J falls below maximum.
4. 100 ms pulse @ 1 Hz repetitive rate at 25°C, maximum 10 cycles.



TELEDYNE SOLID STATE

MILITARY AND AEROSPACE AC SOLID STATE RELAY

OPTICALLY ISOLATED 25 A, 250 Vrms

SERIES

RA

SPST/NO

FEATURES/BENEFITS

- Available with thermal protection and thermal TRIP status – Provides self-protection from thermal runaway conditions and indicates protection state for system BIT.
- Optical Isolation – Isolates control elements from load transients with reduced EMI.
- Fully Floating Output – Eliminates ground potential loops and allows the output to sink or source current.
- Buffered Control – Relay can be controlled directly from TTL or CMOS logic circuits.
- Integral Snubber Circuit – Enhances dV/dt capability while minimizing EMI.

DESCRIPTION

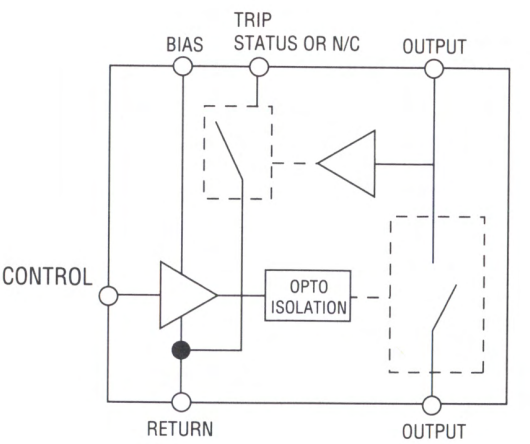
The RA series of solid state relays (SSRs) is designed for use in AC power switching applications where safety and reliability are primary concerns. These SSRs are rated for load voltages up to 250 Vrms from 40 to 440 Hz and are ideal for resistive and reactive loads with power factors as low as 0.2. Inverse parallel SCRs are configured for zero voltage turn on and can handle current surges up to 250 A. Optical isolation to 1500 Vrms between the control (input) and load (output) allows the load to be safely controlled by low level logic circuitry.

The RA series is available with thermal protection and thermal TRIP status. In case of a thermal runaway condition, the SSR will shut down the output switch and latch off until the input is reset and the junction temperature returns to a safe level. When the output does latch off, the TRIP status line will yield a logic level output indicating the protection state of the SSR. This feature provides the user with failure mode indication while enhancing the system diagnostic capability. These SSRs are packaged in low profile hermetically sealed cases.

PART NUMBER*	RELAY DESCRIPTION
RA00HQ	Basic 25 A Solid State Relay (SSR)
RA58HQ	25 A SSR with Thermal Protection and Thermal TRIP Status

* A W or Y suffix denotes the screening level comparable to MIL-R-28750.
Example: RA00HQY indicates a Y level SSR.

BLOCK DIAGRAM

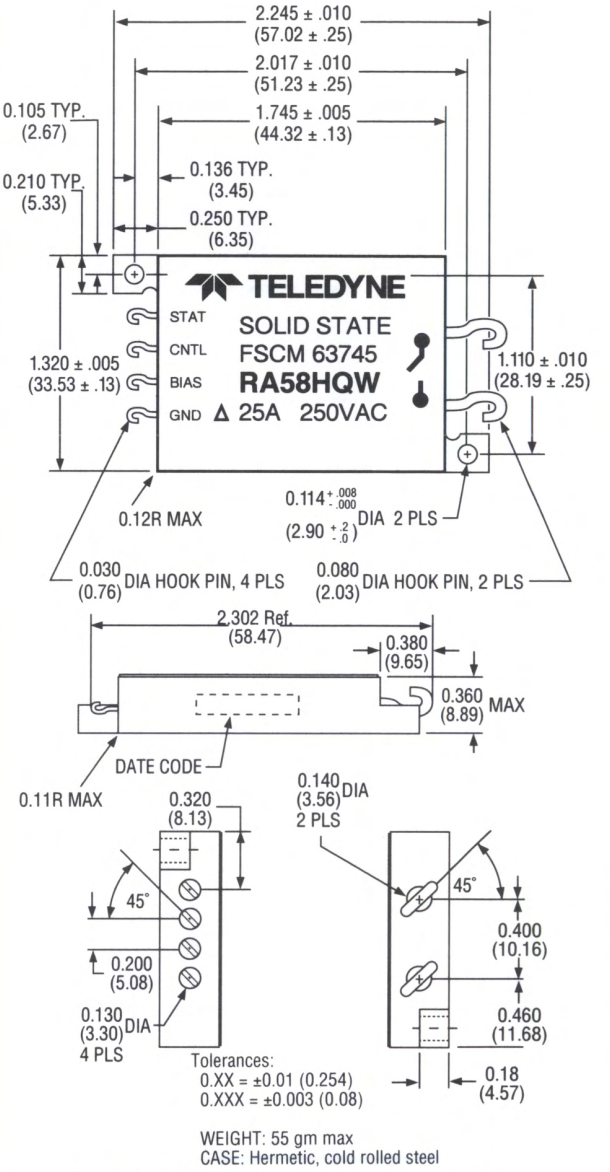


ELECTRICAL SPECIFICATIONS
(–55°C TO +110°C)

INPUT CHARACTERISTICS 2 Terminal Configuration (See Figure 1)		MIN.	MAX.	UNITS
Input Voltage (See Note 2)		3.8	32	Vdc
Input Current	(V_{INPUT} = 5 Vdc)		15	mA
	(V_{INPUT} = 32 Vdc)		16	
Turn-On Input Voltage		3.8		Vdc
Turn-Off Input Voltage			1.5	Vdc
Reverse Polarity			–32	Vdc
INPUT CHARACTERISTICS 3 Terminal Configuration (See Figure 1)		**MIN.**	**MAX.**	**UNITS**
Bias Voltage (See Note 2)		3.8	32	Vdc
Bias Current (V_{INPUT} = 32 Vdc)			16	mA
Control Voltage Range		0	18	Vdc
Control Current at 5 Vdc			250	µAdc
Turn-On Control Voltage			0.3	Vdc
Turn-Off Control Voltage		2.8		Vdc
OUTPUT SPECIFICATIONS (See Note 4)		**MIN.**	**MAX.**	**UNITS**
Load Voltage		20	250	Vac
Frequency Range		40	440	Hz
Continuous Load Current (See Figure 3)	RA Series without heat sink	0.2	7.5	A
	RA Series with heat sink	0.2	25	
Output Voltage Drop			1.3	Vrms
Surge Current, 16 ms at 25°C (See Note 5 and Figure 6)	RA Series		250	Arms
Leakage Current at 250 Vac, 400 Hz			5	mArms
Turn-On Time			1/2	cycle
Turn-Off Time			1	cycle
Zero Voltage Turn-On			±15	V peak
Waveform Distortion (See Note 6)			4	Vrms
Load Power Factor		0.2		
Exponential Rate of Voltage Rise (dv/dt)		100		V/µs
Transient Voltage, (t < 5s) (See Note 7)			±500	V peak
Dielectric Strength (60 Hz)		1500		Vrms
Insulation Resistance (@ 500 Vdc)		10^9		Ohm
Input to Output Capacitance			20	pF
Power Dissipation Factor at 25°C			1.5	W/A
Junction Temperature at Rated Current			125	°C
Maximum Junction Temperature			150	°C
Thermal Resistance Junction to Case			0.7	°C/W
Thermal Resistance Junction to Ambient			16	°C/W

STATUS OUTPUT TRUTH TABLE (See Note 8)		
STATUS OUTPUT STATE	CONTROL INPUT	OUTPUT (LOAD) STATE
Off (High)	Low	On
On (Low)	Low	Tripped
Off (High)	High	Off
On (Low)	High	Relay Malfunction

MECHANICAL SPECIFICATIONS



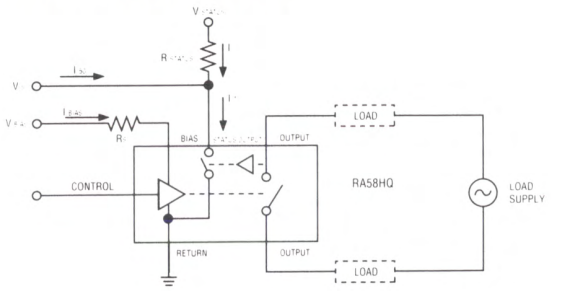
WEIGHT: 55 gm max
CASE: Hermetic, cold rolled steel

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETER)

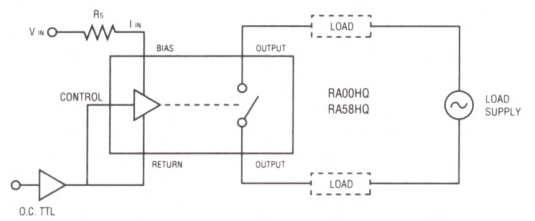
STATUS OUTPUT SPECIFICATIONS	MIN.	MAX.	UNITS
Status Supply Voltage	3.8	32	Vdc
Status Leakage Current @ 32 Vdc		10	µAdc
Status Sink Current (Vso ≤ 0.4 Vdc)		10	mAdc

ENVIRONMENTAL SPECIFICATIONS		
Temperature Range	Operating	–55°C to +110°C
	Storage	–55°C to +125°C
Vibration		30 g, 10 to 3000 Hz
Constant Acceleration		5000 g
Shock		100 g, 6 ms pulse

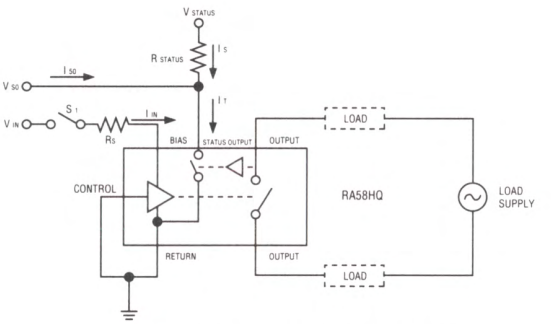
WIRING CONFIGURATIONS



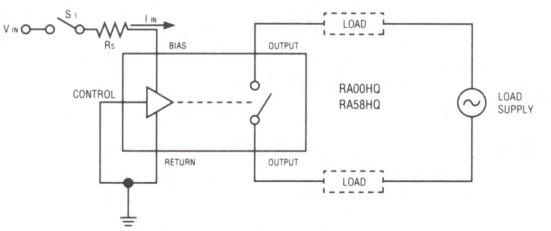
(A) 3 TERMINAL INPUT WITH STATUS (See Note 7)



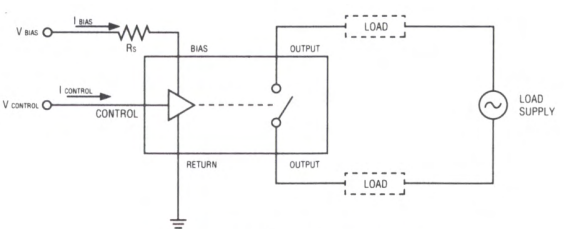
(B) 2 TERMINAL INPUT (OPEN COLLECTOR TTL DRIVE)



(C) 2 TERMINAL INPUT (DIRECT DRIVE) WITH STATUS

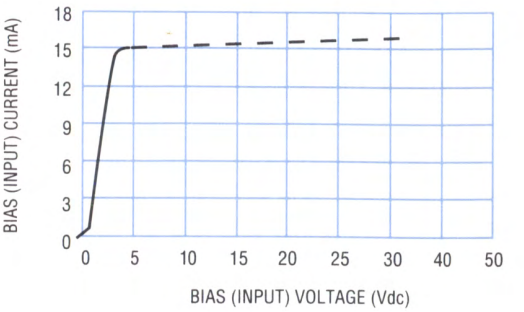


(D) 2 TERMINAL INPUT (DIRECT DRIVE)

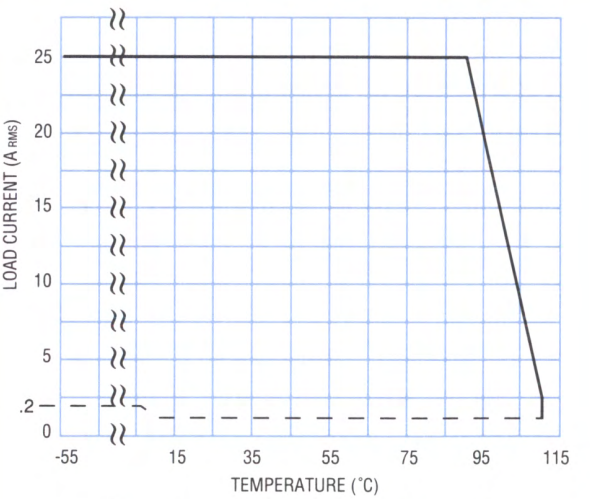


(E) 3 TERMINAL INPUT WITHOUT STATUS

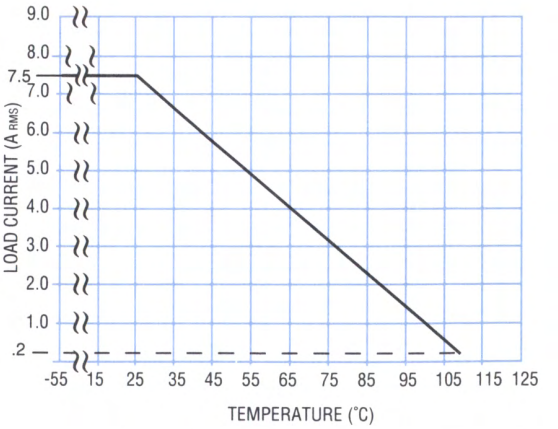
WIRING CONFIGURATIONS
FIGURE 1 (See Notes 1, 2 and 3)



BIAS (INPUT) CURRENT VS BIAS (INPUT) VOLTAGE
FIGURE 2 (See Note 2)

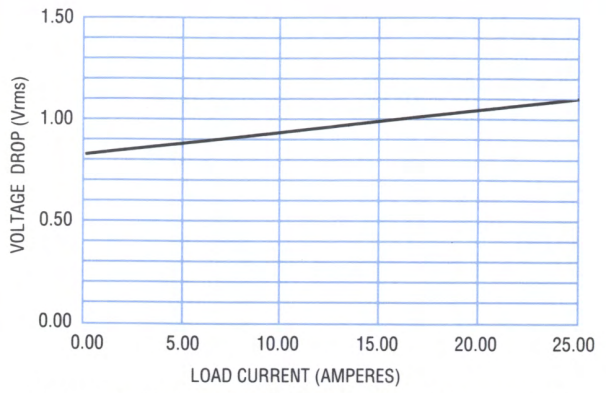


MAXIMUM LOAD CURRENT VS CASE TEMPERATURE



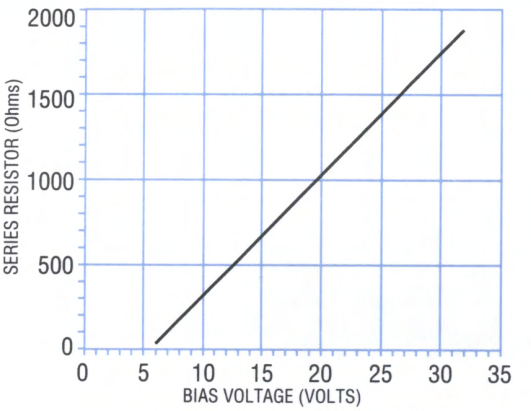
MAXIMUM LOAD CURRENT VS AMBIENT TEMPERATURE (WITHOUT HEATSINK)

FIGURE 3



TYPICAL OUTPUT VOLTAGE DROP VS LOAD CURRENT AT 25°C AMBIENT
(With 2° C/W Heatsink)

FIGURE 4

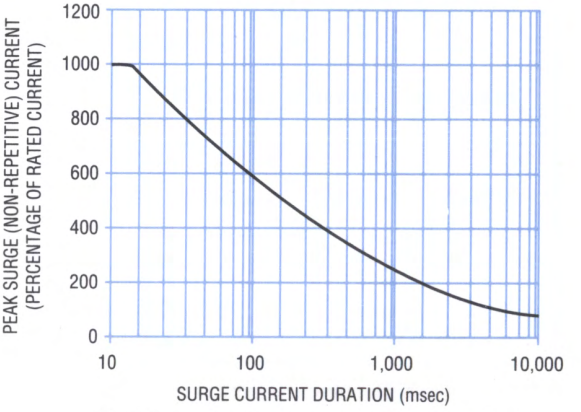


SERIES LIMIT BIAS RESISTOR VS BIAS VOLTAGE

FIGURE 5 (See Note 2)

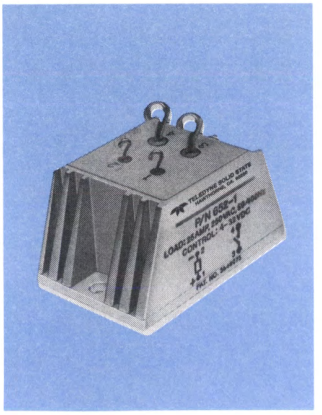
NOTES:

1. Control input is compatible with CMOS or open collector TTL (with pull up resistor).
2. For bias voltages above 6 Vdc, a series resistor is recommended. Use a standard resistor value equal to or less than the value found from Figure 5.
3. Input transition should be ≤ 1 msec duration and input drive should be "bounceless contact" type.
4. Unless otherwise noted, the input voltage for functional tests shall be 5 Vdc.
5. Output may temporarily lose blocking capability during and after a surge, until T_J falls below maximum.
6. DC offset voltage and waveform distortion is as specified when the load current is between 10% and 100% of the rated load.
7. Transient suppression must be used to limit the voltage to < 500 Vpeak when switching inductive loads. Load voltage must be applied before turning ON an inductive load.
8. Control input implies presence of bias voltage.



PEAK SURGE CURRENT VS SURGE CURRENT DURATION
RA SERIES

FIGURE 6



TELEDYNE SOLID STATE
MILITARY SOLID STATE RELAY

OPTICALLY ISOLATED
25 A, 250 Vrms

MODEL

652

(M28750/10-001)
(M28750/10-002)

SPST/NO

FEATURES

- JAN Relay, qualified to MIL-R-28750
- Optical isolation
- Extremely low EMI
- Zero voltage turn-on
- Zero current turn-off
- Logic compatible input
- Available to W or Y screening levels

DESCRIPTION

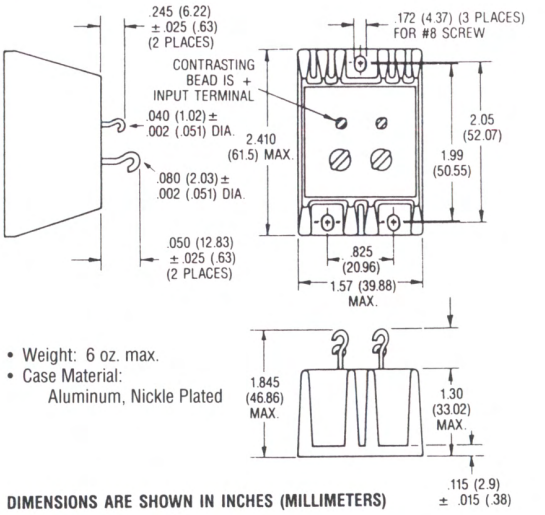
The 652 series is an ac output solid state relay designed for power switching. This relay incorporates a hermetically sealed, optically coupled solid state relay as a zero voltage turn-on driver. The input circuit is TTL logic compatible. Output switching is accomplished by back-to-back SCRs with a built-in snubber circuit, which provides reliable switching of both resistive and reactive loads with power factors as low as 0.2. The protected drive circuitry provides high transient immunity while reducing the commutation spike for low EMI.

The 652 series is housed in a hermetically sealed aluminum case to withstand severe environmental conditions encountered in military and aerospace applications. These relays are qualified to MIL-R-28750/10 and are available to a W or Y screening level.

PART NUMBER*	MILITARY NUMBER*	RELAY TYPE
652-1	M28750/10-001	AC SOLID STATE RELAY
652-2	M28250/10-002	

* The suffix Y denotes the screening level of MIL-R-28750. A suffix W defines parts screened to Teledyne specifications.

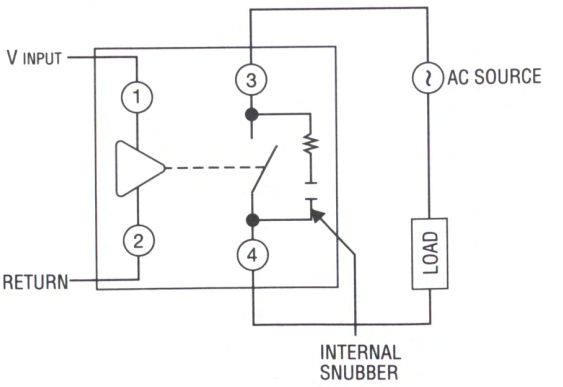
MECHANICAL SPECIFICATIONS



- Weight: 6 oz. max.
- Case Material: Aluminum, Nickle Plated

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

WIRING DIAGRAM



ELECTRICAL SPECIFICATIONS
(-55°C TO +110°C UNLESS OTHERWISE SPECIFIED)

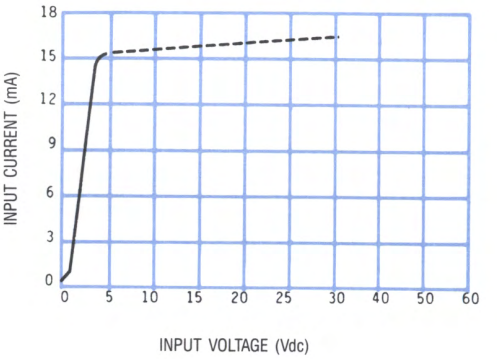
INPUT (CONTROL) CHARACTERISTICS		MIN	TYP	MAX	MAX
Input Current (See Figure 1)	V_{IN} = 5 Vdc		10	15	mA dc
	V_{IN} = 32 Vdc		11	16	
Turn-Off Voltage (Guaranteed Off)				1.0	Vdc
Turn-On Voltage (Guaranteed On)		4			Vdc
Reverse Voltage Protection				-32	Vdc
Input Voltage Range		4		32	Vdc
OUTPUT (LOAD) SPECIFICATIONS		**MIN**	**TYP**	**MAX**	**UNITS**
Output Current Rating (See Figures 2 & 4)		0.1		25	Arms
Output Voltage Rating		25		250	Vrms
Frequency Range		45		440	Hz
Output Voltage Drop @ 25 Ampere				1.5	Vrms
Off-State Leakage Current (220 Vac, 400 Hz)				10	mArms
Turn-On Time				1/2	Cycle
Turn-Off Time				1	Cycle
Transient Voltage ($T \leq 5$ s)				±500	Vpk
Overload Current (See Note 3)				80	Arms
DC Offset Voltage				±150	mV
Waveform Distortion				4	Vrms
Zero Voltage Turn-On Point	652-1			±15	Vpeak
	652-2			±40	
Off-State dv/dt (See Note 1)		200	400		V/μs
Fusing I^2T (10 ms)				300	A^2s
Insulation Resistance @ 500 Vdc		10^8			Ohms
Isolation (Input to Output)				20	pF
Dielectric Withstanding Voltage		1500			Vrms 60 Hz SINE WAVE
Power Dissipation				3	Watts
Output Switch Junction Temperature (T_J Max.)				125	°C
Thermal Resistance Junction to Ambient (Θ_{JA})				6.8	°C/W
Thermal Resistance Junction to Case (Θ_{JC})				1.2	°C/W

ENVIRONMENTAL SPECIFICATIONS*

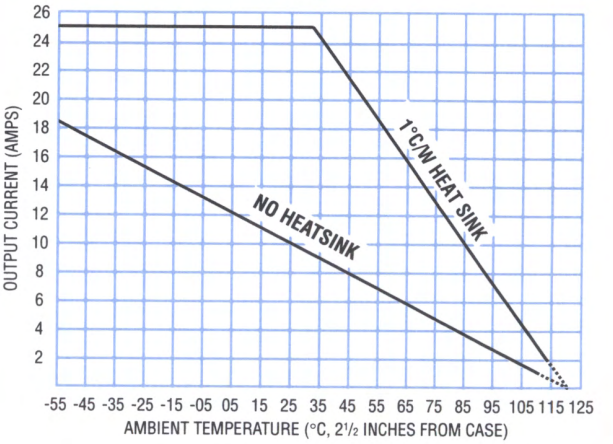
Ambient Temperature	−55°C to 110°C Operating −55°C to 125°C Storage
Shock	1500 g for 0.5 ms
Vibration	30 g, 10-3000 Hz

*Contact factory for higher level environmental requirements

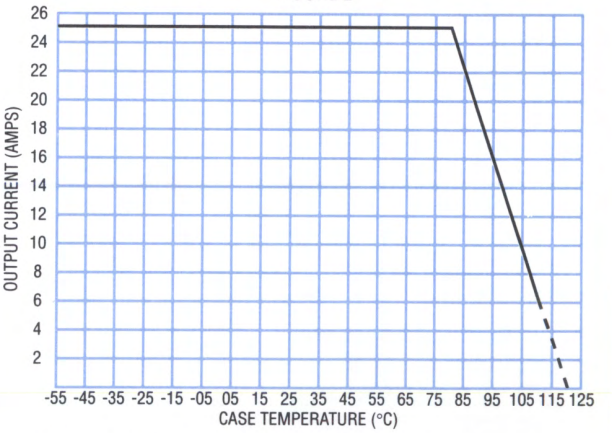
CHARACTERISTIC CURVES



TYPICAL INPUT CURRENT VS. INPUT VOLTAGE
FIGURE 1



MAXIMUM ALLOWABLE CURRENT VS. AMBIENT TEMPERATURE
FIGURE 2



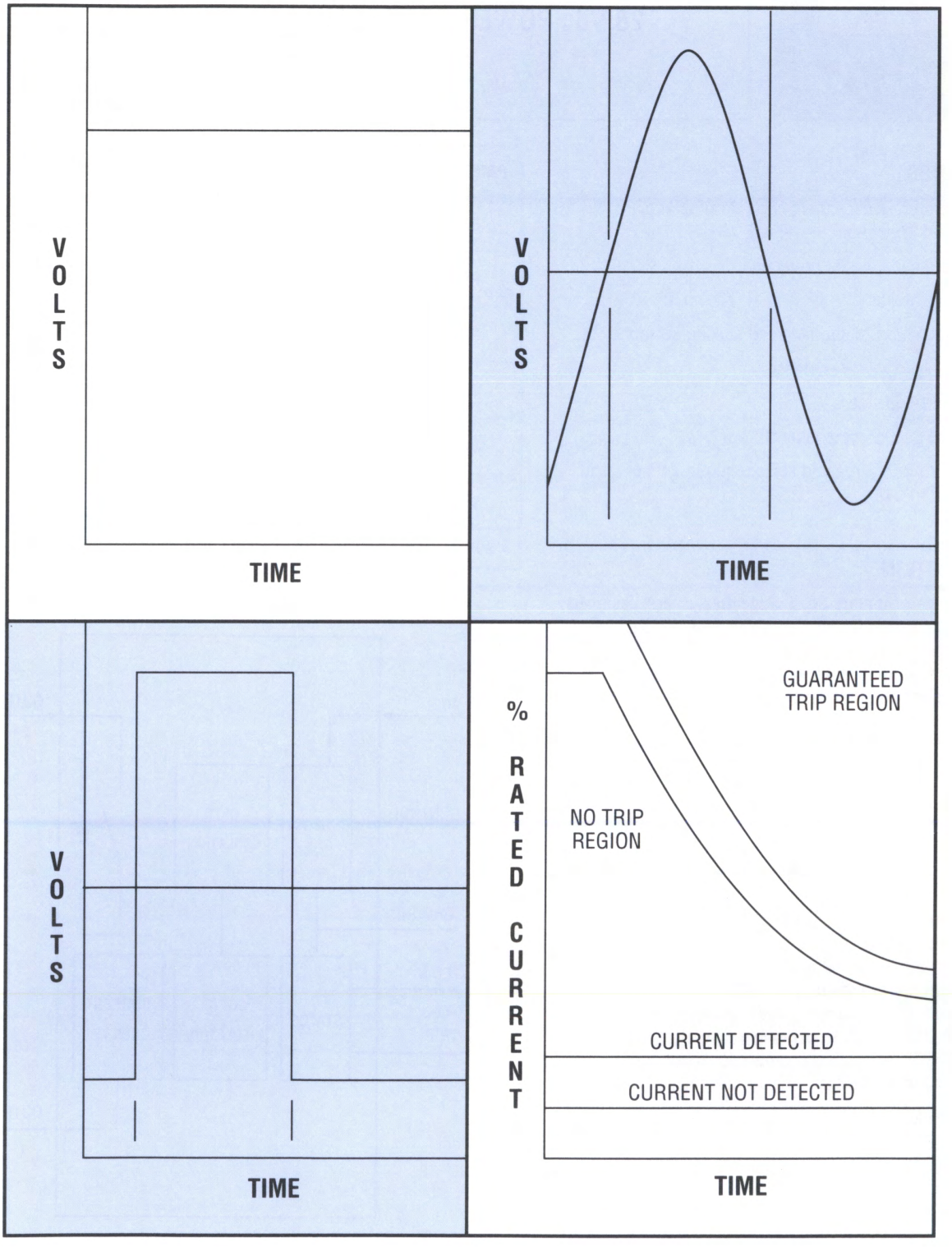
MAXIMUM ALLOWABLE CURRENT VS. CASE TEMPERATURE
FIGURE 3 (SEE NOTE 2)

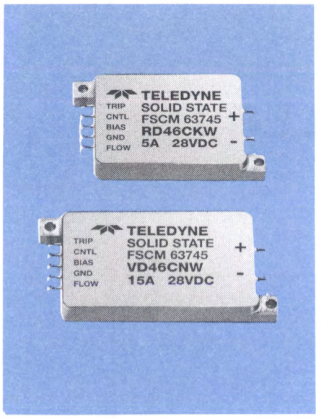
PATENT #3,648,075

NOTES:

1. Output transient (dv/dt) protection is provided in all models. The dv/dt rating is based on a source impedance of 50 ohms.
2. Case temperature measurement point is center of mounting surface.
3. Output may lose blocking capability during and after surge until TJ falls below maximum.
4. Designed to operate within all categories of MIL-STD-704B Aircraft Power Limits.
5. Designed to switch resistive or inductive load to 0.2 power factor.

DC SOLID STATE POWER CONTROLLERS





TELEDYNE SOLID STATE

MILITARY AND AEROSPACE SOLID STATE RELAY

28 Vdc POWER CONTROLLER

SERIES

RD
VD

SPST/NO

FEATURES

- Temperature-independent current rating and overload protection
- Trip-free short circuit protection
- Optical isolation
- Output capable of sourcing and sinking current
- Extremely low ON-resistance
- Flow and Trip status
- TTL and CMOS compatible control
- Meets 28 Vdc surge and spike requirements of MIL-STD-704A

DESCRIPTION

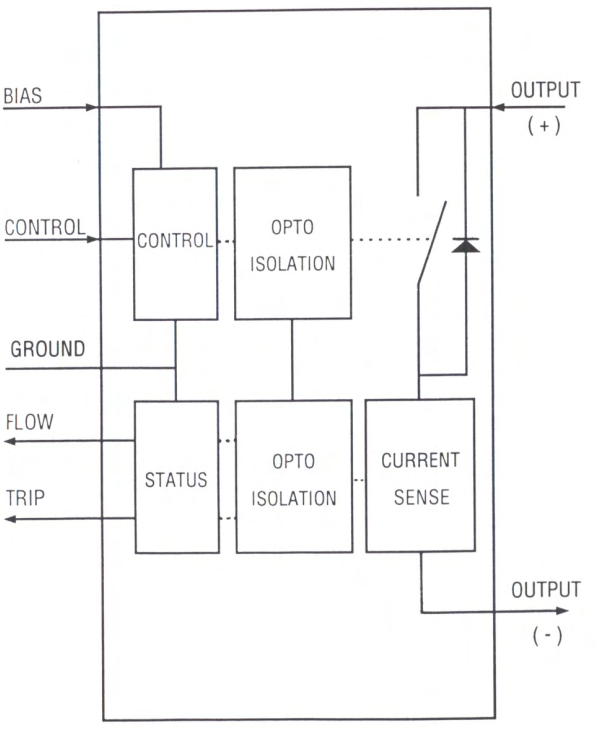
These state-of-the-art Solid State Relays are designed for use in Power Controller applications. The relays utilize the latest technology to provide a low ON-resistance output with complete short circuit and current overload protection. In addition, status output lines for trip and flow are provided to monitor the load and provide a built-in-test (BIT) feature. The control circuit is TTL and CMOS compatible and is optically isolated from the output (load) circuit. This optical isolation allows the output to source or sink current to the load (high or low side switching).

The integrated short circuit and overload protection provides complete protection for both the relay and the system wiring. This feature not only provides protection should a short or overload occur while the relay output is on, but also if the relay is switched into a short. The output can be reset by recycling the control. The relay's trip levels and output (load) current ratings are maintained over the full operating temperature range. The trip current is inversely proportional to time, thus preventing false tripping due to current surges.

The optically isolated status lines provide direct feedback of the output state. The trip status line changes state if the relay output has automatically turned off due to a current overload or short circuit condition. The flow status line turns on if the output (load) current is greater than 10% of the rated output current. A system test (or BIT) can be accomplished by monitoring the status lines and the state of the control line as shown in the truth table.

PART NUMBER*	RELAY DESCRIPTION
RD46CF	Solid State Relay 28 Vdc, 2A Power Controller
RD46CK	Solid State Relay 28 Vdc, 5A Power Controller
RD46CL	Solid State Relay 28 Vdc, 7.5A Power Controller
VD46CM	Solid State Relay 28 Vdc, 10A Power Controller
VD46CN	Solid State Relay 28 Vdc,15A Power Controller
VD46CQ	Solid State Relay 28 Vdc, 25A Power Controller

* A suffix, W or Y, denotes test methods comparable to MIL-R-28750.

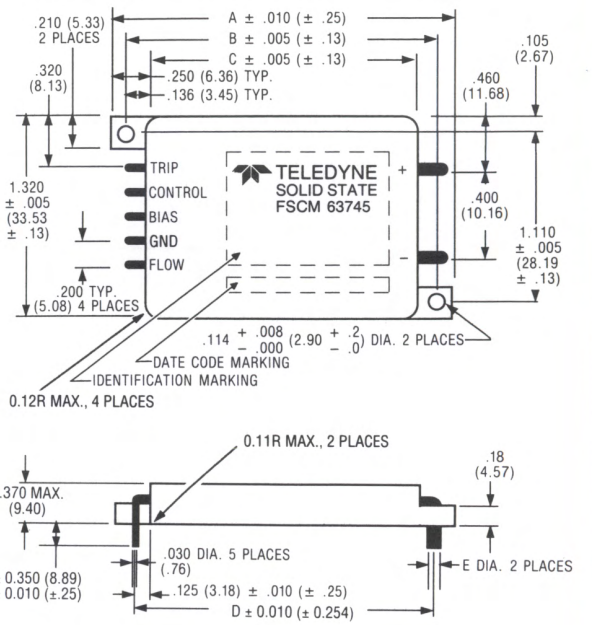


BLOCK DIAGRAM

ELECTRICAL SPECIFICATIONS
(-55°C TO +105°C CASE TEMPERATURE)

INPUT CHARACTERISTICS		MIN	MAX	UNITS
Bias Voltage Range		–0.5	5.5	Vdc
Bias Current at V_{BIAS} = 5 Vdc			45	mA
Turn-On Voltage			2.0	Vdc
Turn-Off Control Voltage		–0.5	0.8	Vdc
Control Current at $V_{CONTROL}$ = 5 Vdc			100	µA
OUTPUT CHARACTERISTICS (V_{BIAS} = 5 Vdc, V_{LOAD} (Rated) = 28 Vdc)		**MIN**	**MAX**	**UNITS**
Continuous Load Current	RD46CF		2	A
	RD46CK		5	
	RD46CL		7.5	
	VD46CM		10	
	VD46CN		15	
	VD46CQ		25	
Leakage Current V_{LOAD} = 28 Vdc	RD46CF		100	µA
	RD46CK		200	
	RD46CL		300	
	VD46CM		400	
	VD46CN		500	
	VD46CQ		700	
Load Voltage		10	60	Vdc
Surge Voltage – MIL-STD-704A			80	Vdc
Transient Voltage – MIL-STD-704A			±600	Vpk
ON Resistance	RD46CF		0.170	Ohms
	RD46CK		0.084	
	RD46CL		0.058	
	VD46CM		0.044	
	VD46CN		0.035	
	VD46CQ		0.030	
Turn-On Delay Time			0.7	mS
Rise Time			0.3	mS
Turn-Off Delay Time			0.7	mS
Fall Time			0.3	mS
Exponential Rate of Voltage Rise		100		V/µs
Rupture Current		unlimited		
Overload Current (See Figure 3)			1900	%
Trip Reset Time		50		mS
Output Capacitance	RD46CF		1500	pF
	RD46CK		3000	
	RD46CL		4500	
	VD46CM		6000	
	VD46CN		7500	
	VD46CQ		10,500	
Input to Output Capacitance			30	pF
Dielectric Strength		790		Vrms
Insulation Resistance (@ 500 Vdc)		10^9		Ohm
Junction Temperature at I max			115	°C
Maximum Junction Temperature			150	°C
Thermal Trip Temperature			145	°C
Thermal Resistance (Junction to Case)			0.5	°C/W
Thermal Resistance (Junction to Ambient)	R_{SERIES}		21	°C/W
	V_{SERIES}		19	

MECHANICAL SPECIFICATIONS



	'R' SERIES	'V' SERIES
DIM. 'A'	2.245 (57.02)	2.690 (68.33)
DIM. 'B'	2.017 (51.23)	2.462 (62.54)
DIM. 'C'	1.745 (44.32)	2.190 (55.63)
DIM. 'D'	1.995 (50.67)	2.480 (62.99)
DIM. 'E'	0.040 (1.02)	0.080 (2.03)
WEIGHT	60 gm. max.	70 gm. max.

XXX = INCHES
(xxx) = MILLIMETERS

.xx = ±.01 (±.25)
.xxx = ±.003 (±.08)

ENVIRONMENTAL SPECIFICATIONS		
Temperature Range	Operating	–55°C to +105°C
	Storage	–55°C to +125°C
Vibration		30 g, 10 to 2000 Hz
Constant Acceleration		5000 g
Shock		100 g, 6 ms pulse

STATUS CHARACTERISTICS	MIN.	MAX.	UNITS
V_{STATUS} (L) at I_{STATUS} = 4.0 mA		0.4	Vdc
V_{STATUS} (H) at I_{STATUS} = –4.0 mA	3.7		Vdc
Flow Status Response Time		3	mS
Trip Status Response Time		1	mS

STATUS TRUTH TABLE			
CONTROL VOLTAGE	FLOW STATUS	TRIP STATUS	SYSTEM STATUS
Low	Low	Low	Relay Malfunction or No Bias
Low	Low	High	Control Malfunction or Shorted Output
Low	High	Low	Relay Malfunction
Low	High	High	Normal Condition Relay Off
High	Low	Low	Trip Status Malfunction
High	Low	High	Normal Condition Relay On
High	High	Low	Output Tripped Off Overload or Short
High	High	High	Load Circuit Open or Current Less Than 10%

WIRING DIAGRAM

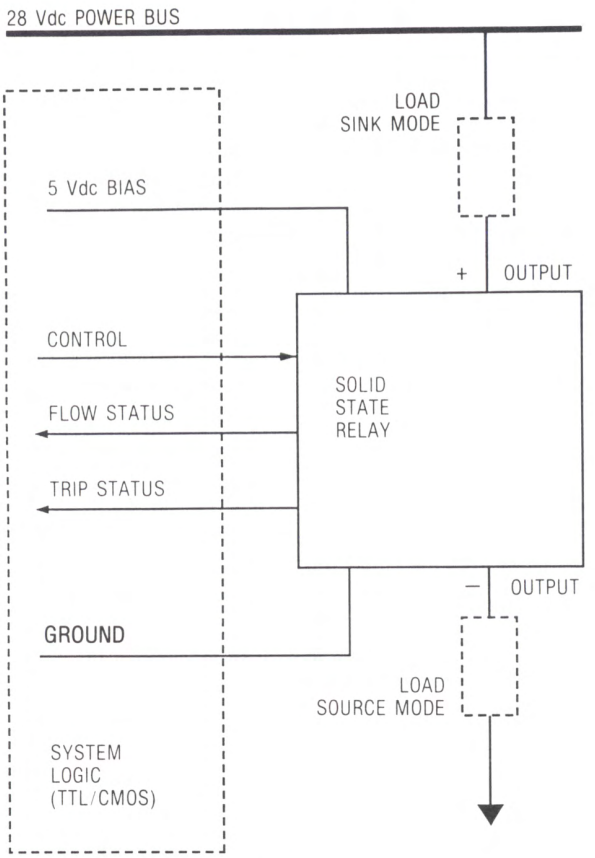
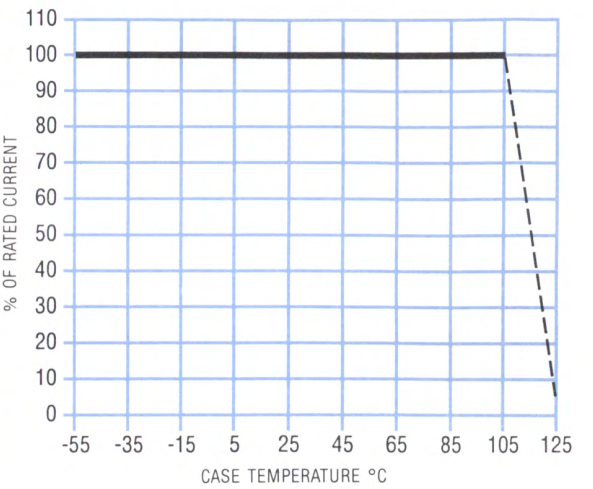
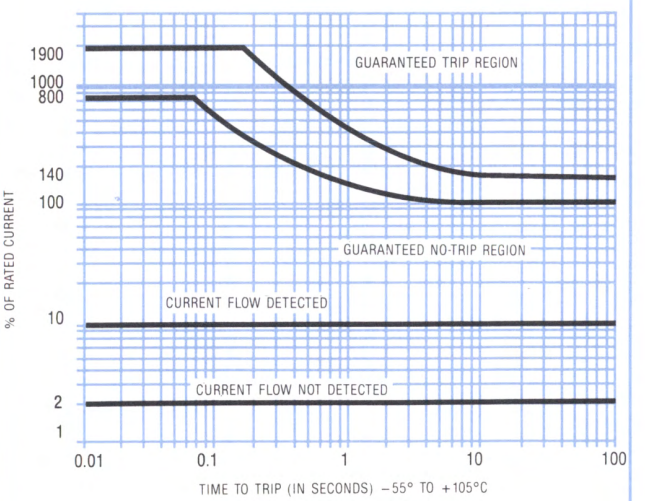


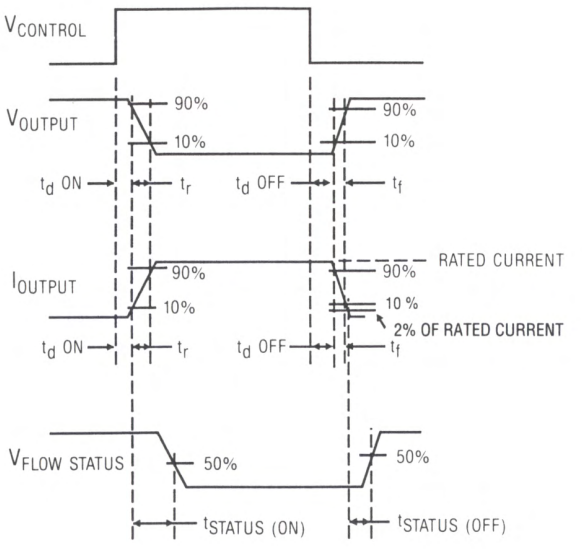
FIGURE 1



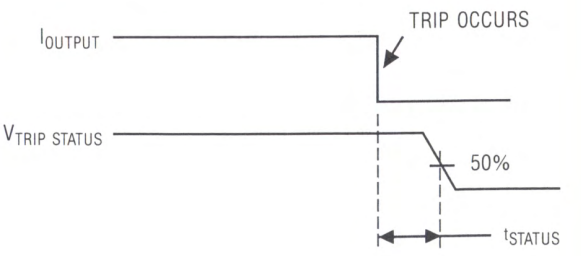
THERMAL DERATING CURVE
FIGURE 2



TRIP CURRENT VS. TIME
FIGURE 3



OUTPUT AND FLOW STATUS TIMING
FIGURE 4



TRIP STATUS TIMING
FIGURE 5

APPLICATION INFORMATION

The RD and VD series Solid State Relays are designed for power control applications. They are capable of switching power as well as providing complete circuit and self-protection. These Solid State Relays are ideally suited as a replacement for a mechanical contactor and circuit breaker combination.

Typical applications include:

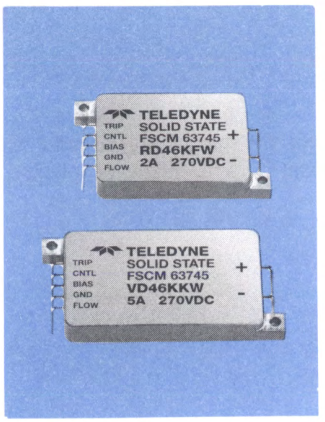
- Load management systems
- Circuit protection device
- Power Switching
- Load monitoring systems
- Replacement for mechanical/thermal circuit breakers
- Replacement for Remote Power Controllers
- Replacement for mechanical power relays/contactors
- Replacement for Remote Controlled Circuit Breakers

The wiring diagram in Figure 1 shows a typical connection of the relay in a solid state power controller application. Power can be switched to the load from either the 28 Vdc bus or ground, depending upon where the load is connected. Since the 28 Vdc power is normally applied to the output through a load, the circuit wiring, as well as the relay itself, is fully protected by the integrated short circuit/overload protection built into the relay. This feature is only present with a two terminal output, such as on these Solid State Relays.

To control the relay, a bias voltage is applied between the bias and ground pins. This is typically a standard 5 Vdc TTL supply. The control and status lines are referenced to the ground pin and are fully TTL and CMOS compatible. Typically, the relay would interface with system logic, such as a load management center or a remote terminal of a data bus system. A logic high on the control pin will turn the relay output on and a logic low will turn the relay output off. Toggling the control from high to low and back to high will reset the relay output in event that the short circuit or current overload trip has been activated. The flow status line will indicate a logic low when the output (load) current exceeds 10% of the rated current and a logic high when the output current is less than 2% of the rated current. The trip status line will indicate a logic low should the relay output automatically turn off due to a short circuit or current overload condition. It will remain low until the output is reset by pulling the control line low for a minimum of 50 mS. The trip status line is normally high when the trip circuit has not been activated. The timing relationships for the status lines are shown in Figures 4 and 5.

The trip curve in Figure 3 shows the relationship between current and time for an overload condition. For a short circuit or very high current overload conditions, the time to trip is extremely short. For a lower current overload, such as those encountered with inrush currents, this reponse time is longer. This allows the relay to handle inrush currents without tripping. Unlike current limiter type trip circuits, these relays use a current sense circuit which does not require the relay to dissipate excessive power and heat prior to tripping. Also, the trip circuit used in these relays does not exhibit oscillations that current limit type circuit often have prior to trip. The predetermined trip levels have been set to provide circuit wiring protection in event of overloads and shorts. This level is significantly less that the I^2t ratings for standard wire gauges.

The state-of-the-art technology incorporated into these relays allows a tight tolerance on the trip current. This feature allows for consistent trip levels over the entire operating temperature range. This 'flat trip' characteristic means that the output rating is not temperature dependent, as shown in Figure 2. In addition to the 'flat trip' characteristic, these relays incorporate true short circuit protection and are not damaged by a direct short, thus allowing for unlimited rupture current. Unlike other circuit protection/power control devices, these relays are not damaged by the true short circuits that can occur in real systems.



TELEDYNE SOLID STATE

MILITARY AND AEROSPACE SOLID STATE RELAY

270 Vdc POWER CONTROLLER

SERIES

RD
VD

SPST/NO

FEATURES

- Temperature-independent current rating and overload protection
- Trip-free short circuit protection
- Optical isolation
- Output capable of sourcing and sinking current
- Extremely low ON-resistance
- Flow and Trip status
- TTL and CMOS compatible control
- Meets 270 Vdc surge and spike requirements of MIL-STD-704D

PART NUMBER*	RELAY DESCRIPTION
RD46KD	Solid State Relay 270 Vdc, 1A Power Controller
RD46KF	Solid State Relay 270 Vdc, 2A Power Controller
VD46KK	Solid State Relay 270 Vdc, 5A Power Controller
VD46KL	Solid State Relay 270 Vdc, 7.5A Power Controller
VD46KM	Solid State Relay 270 Vdc,10A Power Controller

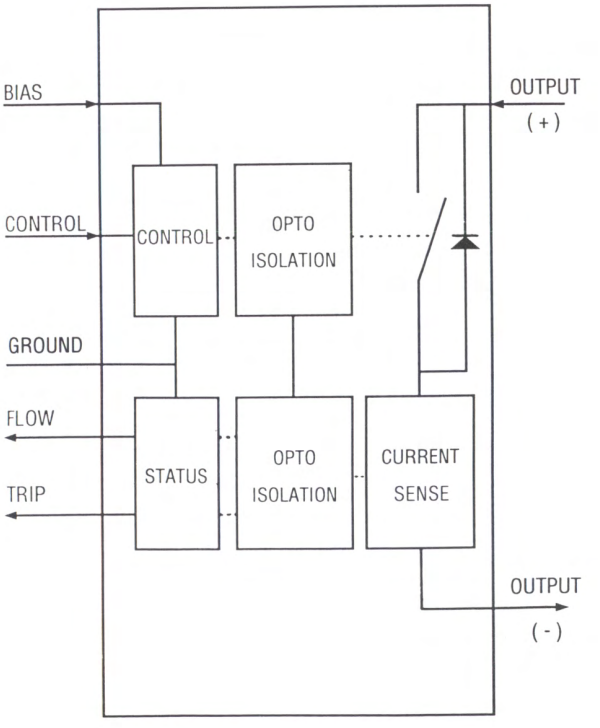
* A suffix, W or Y, denotes test methods comparable to MIL-R-28750.

DESCRIPTION

These state-of-the-art Solid State Relays are designed for use in Power Controller applications. The relays utilize the latest technology to provide a low ON-resistance output with complete short circuit and current overload protection. In addition, status output lines for trip and flow are provided to monitor the load and provide a built-in-test (BIT) feature. The control circuit is TTL and CMOS compatible and is optically isolated from the output (load) circuit. This optical isolation allows the output to source or sink current to the load (high or low side switching).

The integrated short circuit and overload protection provides complete protection for both the relay and the system wiring. This feature not only provides protection should a short or overload occur while the relay output is on, but also if the relay is switched into a short. The output can be reset by recycling the control. The relay's trip levels and output (load) current ratings are maintained over the full operating temperature range. The trip current is inversely proportional to time, thus preventing false tripping due to current surges.

The optically isolated status lines provide direct feedback of the output state. The trip status line changes state if the relay output has automatically turned off due to a current overload or short circuit condition. The flow status line turns on if the output (load) current is greater than 10% of the rated output current. A system test (or BIT) can be accomplished by monitoring the status lines and the state of the control line as shown in the truth table.

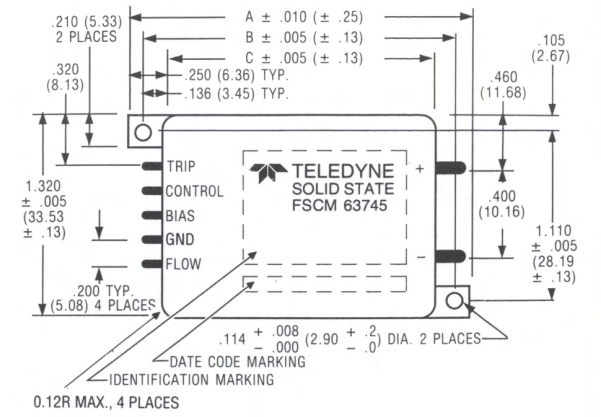


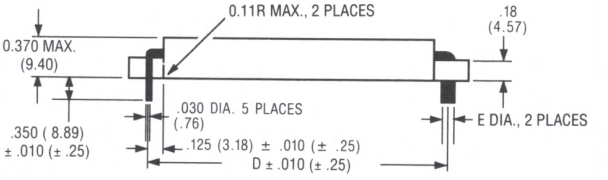
BLOCK DIAGRAM

ELECTRICAL SPECIFICATIONS
(-55°C TO +105°C CASE TEMPERATURE)

INPUT CHARACTERISTICS		MIN	MAX	UNITS
Bias Voltage Range		4.5	5.5	Vdc
Bias Current at V_{BIAS} = 5 Vdc			45	mA
Turn-On Voltage			2.0	Vdc
Turn-Off Control Voltage		–0.5	0.8	Vdc
Control Current at $V_{CONTROL}$ = 5 Vdc			100	µA
OUTPUT CHARACTERISTICS (V_{BIAS} = 5 Vdc, V_{LOAD} (Rated) = 270 Vdc)		**MIN**	**MAX**	**UNITS**
Continuous Load Current	RD46KD		1	A
	RD46KF		2	
	VD46KK		5	
	VD46KL		7.5	
	VD46KM		10	
Leakage Current V_{LOAD} = 270 Vdc	RD46KD		100	µA
	RD46KF		200	
	VD46KK		500	
	VD46KL		700	
	VD46KM		700	
Load Voltage		60	300	Vdc
Surge Voltage – MIL-STD-704A			470	Vdc
Transient Voltage – MIL-STD-704A			±600	Vpk
ON Resistance	RD46KD		0.780	Ohms
	RD46KF		0.390	
	VD46KK		0.160	
	VD46KL		0.140	
	VD46KM		0.100	
Turn-On Delay Time			0.7	mS
Rise Time			0.3	mS
Turn-Off Delay Time			0.7	mS
Fall Time			0.3	mS
Exponential Rate of Voltage Rise		100		V/µs
Rupture Current		unlimited		
Overload Current (See Figure 3)			1900	%
Trip Reset Time		50		mS
Output Capacitance	RD46KD		450	pF
	RD46KF		900	
	VD46KK		2250	
	VD46KL		3150	
	VD46KM		3150	
Input to Output Capacitance			30	pF
Dielectric Strength		1200		Vrms
Insulation Resistance (@ 500 Vdc)		10^9		Ohm
Junction Temperature at I max			115	°C
Maximum Junction Temperature			150	°C
Thermal Trip Temperature			145	°C
Thermal Resistance (Junction to Case)			0.5	°C/W
Thermal Resistance (Junction to Ambient)	R_{SERIES}		21	°C/W
	V_{SERIES}		19	

MECHANICAL SPECIFICATIONS





	'R' SERIES	'V' SERIES
DIM. 'A'	2.245 (57.02)	2.690 (68.33)
DIM. 'B'	2.017 (51.23)	2.462 (62.54)
DIM. 'C'	1.745 (44.32)	2.190 (55.63)
DIM. 'D'	1.995 (50.67)	2.480 (62.99)
DIM. 'E'	0.040 (1.02)	0.080 (2.03)
WEIGHT	60 gm. max.	70 gm. max.

XXX = INCHES
(xxx) = MILLIMETERS

.xx = ±.01 (±.25)
.xxx = ±.003 (±.08)

ENVIRONMENTAL SPECIFICATIONS		
Temperature Range	Operating	–55°C to +105°C
	Storage	–55°C to +125°C
Vibration		30 g, 10 to 2000 Hz
Constant Acceleration		5000 g
Shock		100 g, 6 ms pulse

STATUS CHARACTERISTICS	MIN.	MAX.	UNITS
V_{STATUS} (L) at I_{STATUS} = 4.0 mA		0.4	Vdc
V_{STATUS} (H) at I_{STATUS} = –4.0 mA	3.7		Vdc
Flow Status Response Time		3	mS
Trip Status Response Time		1	mS

STATUS TRUTH TABLE			
CONTROL VOLTAGE	FLOW STATUS	TRIP STATUS	SYSTEM STATUS
Low	Low	Low	Relay Malfunction or No Bias
Low	Low	High	Control Malfunction or Shorted Output
Low	High	Low	Relay Malfunction
Low	High	High	Normal Condition Relay Off
High	Low	Low	Trip Status Malfunction
High	Low	High	Normal Condition Relay On
High	High	Low	Output Tripped Off Overload or Short
High	High	High	Load Circuit Open or Current Less Than 10%

5

WIRING DIAGRAM

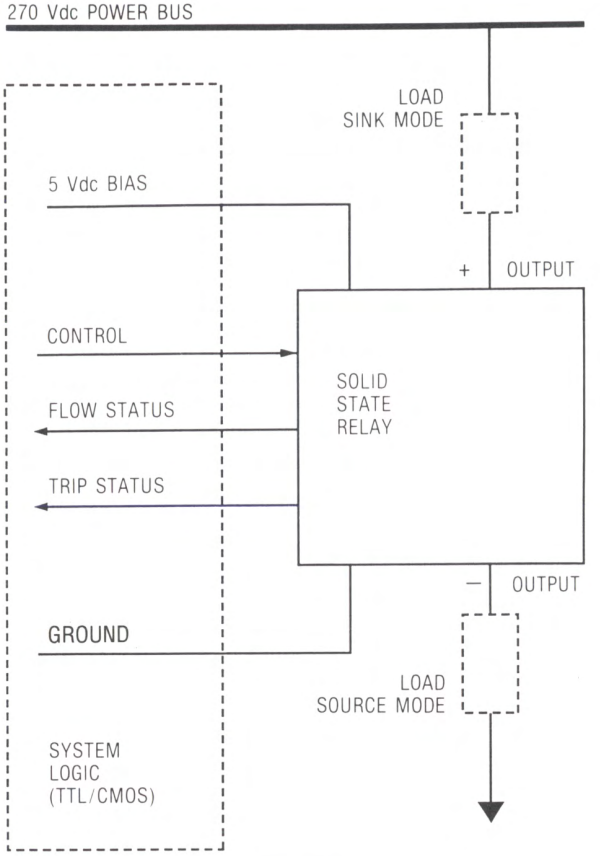
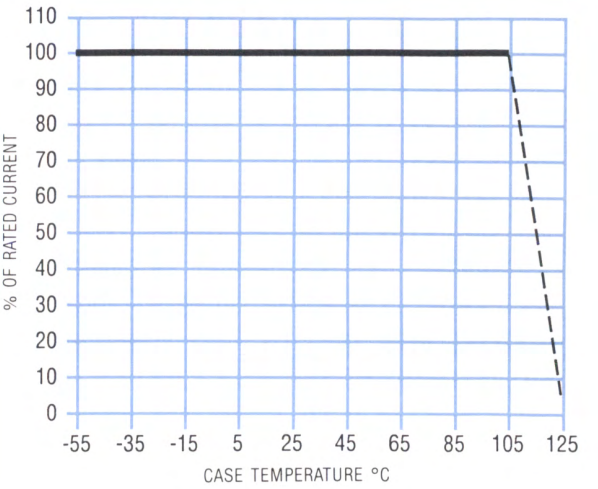
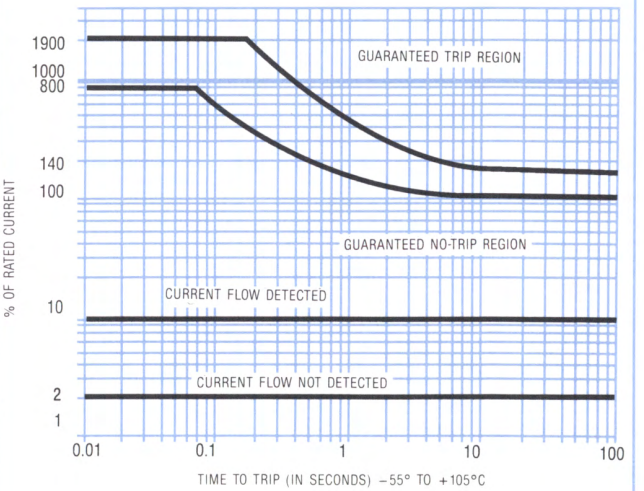


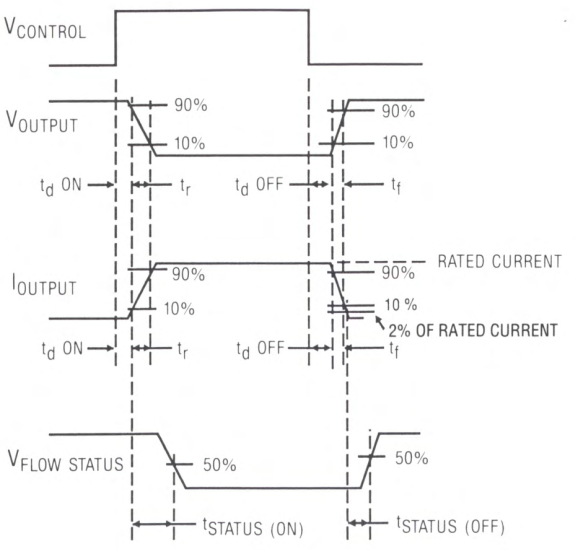
FIGURE 1



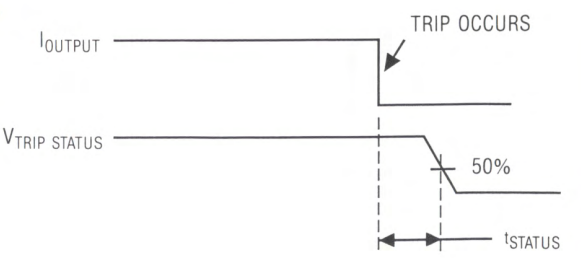
THERMAL DERATING CURVE
FIGURE 2



TRIP CURRENT VS. TIME
FIGURE 3



OUTPUT AND FLOW STATUS TIMING
FIGURE 4



TRIP STATUS TIMING
FIGURE 5

APPLICATION INFORMATION

The RD and VD series Solid State Relays are designed for power control applications. They are capable of switching power as well as providing complete circuit and self-protection. These Solid State Relays are ideally suited as a replacement for a mechanical contactor and circuit breaker combination.

Typical applications include:

- Load management systems
- Circuit protection device
- Power Switching
- Load monitoring systems
- Replacement for mechanical/thermal circuit breakers
- Replacement for Remote Power Controllers
- Replacement for mechanical power relays/contactors
- Replacement for Remote Controlled Circuit Breakers

The wiring diagram in Figure 1 shows a typical connection of the relay in a solid state power controller application. Power can be switched to the load from either the 270 Vdc bus or ground, depending upon where the load is connected. Since the 270 Vdc power is normally applied to the output through a load, the circuit wiring, as well as the relay itself, is fully protected by the integrated short circuit/overload protection built into the relay. This feature is only present with a two terminal output, such as on these Solid State Relays.

To control the relay, a bias voltage is applied between the bias and ground pins. This is typically a standard 5 Vdc TTL supply. The control and status lines are referenced to the ground pin and are fully TTL and CMOS compatible. Typically, the relay would interface with system logic, such as a load management center or a remote terminal of a data bus system. A logic high on the control pin will turn the relay output on and a logic low will turn the relay output off. Toggling the control from high to low and back to high will reset the relay output in event that the short circuit or current overload trip has been activated. The flow status line will indicate a logic low when the output (load) current exceeds 10% of the rated current and a logic high when the output current is less than 2% of the rated current. The trip status line will indicate a logic low should the relay output automatically turn off due to a short circuit or current overload condition. It will remain low until the output is reset by pulling the control line low for a minimum of 50 mS. The trip status line is normally high when the trip circuit has not been activated. The timing relationships for the status lines are shown in Figures 4 and 5.

The trip curve in Figure 3 shows the relationship between current and time for an overload condition. For a short circuit or very high current overload conditions, the time to trip is extremely short. For a lower current overload, such as those encountered with inrush currents, this reponse time is longer. This allows the relay to handle inrush currents without tripping. Unlike current limiter type trip circuits, these relays use a current sense circuit which does not require the relay to dissipate excessive power and heat prior to tripping. Also, the trip circuit used in these relays does not exhibit oscillations that current limit type circuit often have prior to trip. The predetermined trip levels have been set to provide circuit wiring protection in event of overloads and shorts. This level is significantly less that the I^2t ratings for standard wire gauges.

The state-of-the-art technology incorporated into these relays allows a tight tolerance on the trip current. This feature allows for consistent trip levels over the entire operating temperature range. This 'flat trip' characteristic means that the output rating is not temperature dependent, as shown in Figure 2. In addition to the 'flat trip' characteristic, these relays incorporate true short circuit protection and are not damaged by a direct short, thus allowing for unlimited rupture current. Unlike other circuit protection/power control devices, these relays are not damaged by the true short circuits that can occur in real systems.

TELEDYNE
ELECTRONIC TECHNOLOGIES
Solid State Relays

MILITARY PRODUCT CROSS REFERENCE CHART

DESC DRAWINGS

DESC DRAWING	TELEDYNE P/N
90091-002	CD21CDY
90091-004	CD20CDY
90091-006	CD01CFY
90091-008	CD00CFY
89116-002	FB00FCY
89116-004	FB00KBY
89116-006	FB00CDY

DESC DRAWING	TELEDYNE P/N
88062-002	HD22CFY
88062-004	HD20CFY
88062-006	HD02CFY
88062-008	HD00CFY
87034-001	M92F-3Y
86031-001	602-1Y
86001-001	602-2Y
85092-001	M93F-1Y
85092-002	M93F-2Y

DESC DRAWINGS NOT FOUND IN THIS DATA BOOK

DESC DRAWING	TELEDYNE P/N
88061-001	M85FS-2AY
88049-001	653-5Y
87042-001	686-2Y
86125-001	693-1Y
86114-001	M85F-2Y
85145-006	692-3Y

DESC DRAWING	TELEDYNE P/N
85007-001	690-1Y
85006-001	M90FS-2Y
84178-001	M03-2Y
84177-009	M21-15Y
84177-008	M21-13Y
84177-006	M21-6Y

QUALIFIED PRODUCTS

MILITARY QPL #	TELEDYNE P/N
M28750/5-001Y	M640-1Y
M28750/6-001Y	M643-1Y
M28750/7-001Y	M643-2Y

MILITARY QPL #	TELEDYNE P/N
M28750/8-001Y	683-1Y
M28750/9-001Y	682-1Y
M28750/10-001Y	652-1Y
M28750/10-002Y	652-2Y

QUALITY CONFORMANCE INSPECTION

All tests are 100% unless otherwise noted

LEVEL "W"

- Destructive Wirebond pull test (Sample test)
  MIL-STD-883 Method 2011
- Internal Visual
  MIL-STD-883 Method 2010, 2017, and 2032
- Temperature Cycling
  MIL-STD-883 Method 1010
  10 cycles, –55 to +125°C
- Load Conditioning
  3 hours at rated input and load 90% duty cycle
  1 to 30 operations per second
  (latching fault indication on failure)
- Dielectric Withstanding Voltage
  MIL-STD-202 Method 301
- Insulation Resistance
  MIL-STD-883 Method 1003
- Electrical Characteristics at 25°C
- Seal
  MIL-STD-883 Method 1014 (Gross)
  MIL-STD-202 Method 112 (Fine)
- Visual Mechanical Inspection

MIL-R-28750 LEVEL "Y"

- Destructive Wirebond pull test (Sample test)
  MIL-STD-883 Method 2011
- Internal Visual
  MIL-STD-883 Method 2010, 2017, and 2032
- Constant Acceleration
  MIL-STD-883 Method 2001
  5000 gs, Y1 axis
- High Temperature Storage
  MIL-STD-883 Method 1008
  24 hours at +125°C
- Temperature Cycling
  MIL-STD-883 Method 1010
  10 cycles, –55 to +125°C
- Load Conditioning
  3 hours at rated input and load 90% duty cycle
  1 to 30 operations per second
  (latching fault indication for drop out)
- Pre Burn-In (optional)
- Burn-in Test
  MIL-STD-883 Method 1015
  160 hours at specified temp. and rated load
  (latching fault indication on failure)
- Dielectric Withstanding Voltage
  MIL-STD-202 Method 301
- Insulation Resistance
  MIL-STD-883 Method 1003
- Electrical Characteristics at –55°C
- Electrical Characteristics at +25°C
- Electrical Characteristics at +125°C (or as specified)
- Seal
  MIL-STD-883 Method 1014 (Gross)
  MIL-STD-202 Method 112 (Fine)
- Visual Mechanical Inspection
- Solderability (2 samples)
  MIL-STD-202 Method 208

Glossary

Current, Bias - The current drawn by the input bias circuit of the SSR in both the quiescent and active state. It is usually specified at the rated voltage within the bias voltage range.

Current, Input (Or Control) - The current drawn by the control circuit of the SSR (related to the impedance of the input circuit). It is usually specified at the rated voltage within the input voltage range.

Current, Leakage (Maximum Off-State Current) - This is the current that flows through the load when the relay is in the off-state.

Current, Maximum Rate of Rise of (di/dt) - The maximum non-repetitive rate of current rise the output can withstand without being damaged.

Current, Repetitive Overload - The maximum allowable repetitive overload current that may be applied to the output for a specific duration and duty cycle while still maintaining output control.

Current, Output (Or Load) Rating - The maximum steady state load current rating at 25°C. For SSR package configurations designed expressly for PC Board mounting, this rating refers to free air mounting on a PC Board without external heat sinking. For package configurations designed for mounting to a panel, chassis, or other heat sinking surface this rating is qualified by specifying a required minimum heat sink surface area or heat sink thermal resistance.

Current Overload Protection - A feature incorporated into the output circuit of a solid state relay to protect the relay and circuitry against excessive current overloads. The relay output will turn-off should an overload occur. The output can be reset from the control. Short circuit protection is also provided.

Current, Surge Rating - The maximum non-repetitive surge (or overload) current for a specified duration that the SSR can safely withstand without causing permanent damage or degradation to the output switching device.

DESC - Defense Electronic Supply Center. Organization which provides information and recommendations to contractors on commonality and selection of parts, and to manufacturers for qualification of the parts.

DESC Drawing - This is a drawing created by DESC for parts manufactured to a Military Specification but are not yet qualified to that specification. These parts may be used in Military programs until a slash sheet is created and parts are qualified to the Military Specification.

Dielectric Strength - The breakdown voltage rating, expressed in VRMS, between input and output terminals. Sometimes referred to as "Isolation Voltage."

DIP - Dual inline package.

Dwell Time - The time interval between the interruption of one circuit before establishing another. (Applies to multiple throw devices).

EMI - Electro-magnetic interference.

FET - Field Effect Transistor.

Isolation - The resistance measured at 500 V dc between input and output terminals. Sometimes referred to as "Insulation Resistance."

MIL-R-28750 - General Specification for Solid State Relays. This Military Specification covers the design, construction, manufacture, performance, test, and screening of Military Solid State Relays. Relays qualified to this specification are JAN branded and are suitable for all military programs.

MIL-STD-704 - Characteristics and Utilization of Aircraft Electric Power. This is the Military Standard which defines the load voltage characteristics under which the relay output must be capable of operating or surviving. This standard includes 28V, 270V, and AC systems and their associated transient surges and spikes.

MIL-STD-883 - Test Method and Procedures for Microelectronics. This Military Standard describes the general test procedures and environmental parameters to be used for the test and screening of the relay. The screening tests within MIL-R-28750 reference the methods within MIL-STD-833 when applicable.

Off-State dv/dt - The rate of rise of voltage, expressed in volts per microsecond (V/μs), that the SRR output switching device can withstand without turning on.

Over-Voltage Rating - The guaranteed transient peak blocking (or breakdown) voltage rating of the SSR.

Power Controller - A solid State relay normally used for power switching and incorporates short circuit protection and status.

Power Dissipation, P_D - The maximum average power dissipated by the SSR for a given load current.

Relay, Solid State (SSR) - A relay with isolated input and output whose functions are achieved by means of electronic components without moving parts.

Glossary

Relay, Zero-Voltage Turn On - A relay with isolated input and output in which added control circuitry delays the output turn-on until a zero-voltage transition of the ac sine wave is detected.

Resistance, On-State, $R_{ds\ (ON)}$ - In a Power-FET relay this is the intrinsic resistance of the output circuit in the on state.

Short Circuit Protection - A feature incorporated into the output circuit of a solid state relay to protect the relay and circuitry against a shorted load. The relay output will turn-off should a short occur. The output can be reset from the control.

Status, Switch - Indicates the state of the output. It operates independent of the control/bias and will return a status as long as load voltage and load circuit continuity exists. It is generated from the load supply and creates an off-state leakage from 600 μA to 2 mA.

Status, Flow - Indicates whether there is load current flowing. It operates only when the output is conducting and has a threshold of 10 to 20% of the maximum rated output current. It does not create an off-state leakage, but only operates when the output circuit is conducting.

Status, Trip - This type of status is only applicable for short circuit protected relays. It provides an indication when the short circuit protection has been activated and the output has tripped off. It does not indicate the normal state of the output.

Status, Control - This type of status provides an indication of control circuit continuity. It is analogous to the second set of contacts of a double pole electromechanical relay. It does provide much higher output drive capability than the other types of status outputs.

Temperature Case, T_C - The temperature at a specified point on the relay which is used to evaluate the current capabilities of the relay.

Temperature, Maximum Allowable Case $T_{C\ (max)}$ - The maximum allowable case temperature for a given load current at rated line voltage.

Temperature, Maximum Junction, $T_{J\ (max)}$ - The maximum junction temperature of the output switching semiconductor(s) expressed in °C.

Temperature, Operating - That ambient temperature range over which operation is specified with relays unmounted or mounted to a heat sink as specified.

Temperature, Storage - That ambient temperature range to which a non-operating relay may be subjected without permanent electrical or mechanical damage.

Time, Delay, t_d - The time from the application of control voltage to the 10% point of the output change of state waveform.

Time, Fall, t_f - The time from the 90% and 10% points on the switching waveform.

Time, Rise, t_r - The time from the 10% and 90% points on the switching waveform.

Time, Storage, t_s - The time from the removal of control voltage to the 10% point of the output change of state waveform.

Time, Turn-Off - The sum of storage time and fall time.

Time, Turn-On - The sum of delay time and rise time.

Thermal Resistance, Junction to Ambient, θ_{JA} - The maximum thermal resistance between the output switch semiconductor junction and still air ambient (expressed in °C/W).

Thermal Resistance, Junction to Case, θ_{JC} - The maximum thermal resistance between the output switch semiconductor(s) junction to point of measurement on the relay case (expressed in °C/W).

Voltage, Blocking, V_{BLOCK} - The maximum allowable voltage that can be applied to the relay output in the "OFF" state without breaking down the output switching device.

Voltage Drop, V_{DROP} - Also referred to as V_{SAT} is the voltage at maximum load current developed across the output switching device when the relay is in the "ON" state.

Voltage, Input (Or Control) Range - The full range of input voltage over which the SSR is rated to operate.

Voltage, Maximum Output (Or Load) - The maximum steady state load voltage the SSR can withstand. It is related to the breakdown voltage rating of the output switching device.

Voltage, Reverse Polarity - The maximum allowable reverse voltage which may be applied to the input of a solid state relay without permanent damage.

Voltage, Turn-Off - The input voltage below which the SSR is guaranteed to turn-off. Analogous to the minimum drop-out voltage of an EMR.

Zero-Crossing Turn-On Voltage - The maximum voltage across the output terminals following initial turn-on.

TELEDYNE
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Solid State Relays
12964 Panama Street
Los Angeles, California 90066-6534
Telephone: (310) 822-8229
FAX: (310) 574-2015

DATE: _____

MIL-HDBK-217 MTBF REQUEST FORM

(PLEASE COMPLETE FORM AND RETURN TO TELEDYNE SOLID STATE FOR A PROMPT REPLY)

NAME: _____

COMPANY: _____

ADDRESS: _____

CITY: _____

STATE: _____

PHONE: _____

FAX NUMBER: _____

PART NUMBER: _____

SCREENING LEVEL: MIL-R-28750 _____ Y LEVEL _____ TELEDYNE W LEVEL

AMBIENT TEMPERATURE _____ °C

CONTROL VOLTAGE: _____

LOAD VOLTAGE: _____

LOAD CURRENT: _____

DUTY CYCLE: _____ %

HEATSINK (IF USED): _____ °C/W

ENVIRONMENT:

AIRBORNE:

_____ INHABITED CARGO, AIC
_____ INHABITED FIGHTER, AIF
_____ UNINHABITED CARGO, AUC
_____ UNINHABITED FIGHTER, AUF
_____ ROTARY WINGED, ARW

GROUND:

_____ BENIGN, GB
_____ FIXED, GF
_____ MOBILE, GM

MISSILE:

_____ LAUNCH, ML
_____ FLIGHT, MF

NAVAL:

_____ SHELTERED, NS
_____ UNSHELTERED, NU

OTHER:

_____ SPACE FLIGHT, SF
_____ CANNON, LAUNCH, CL

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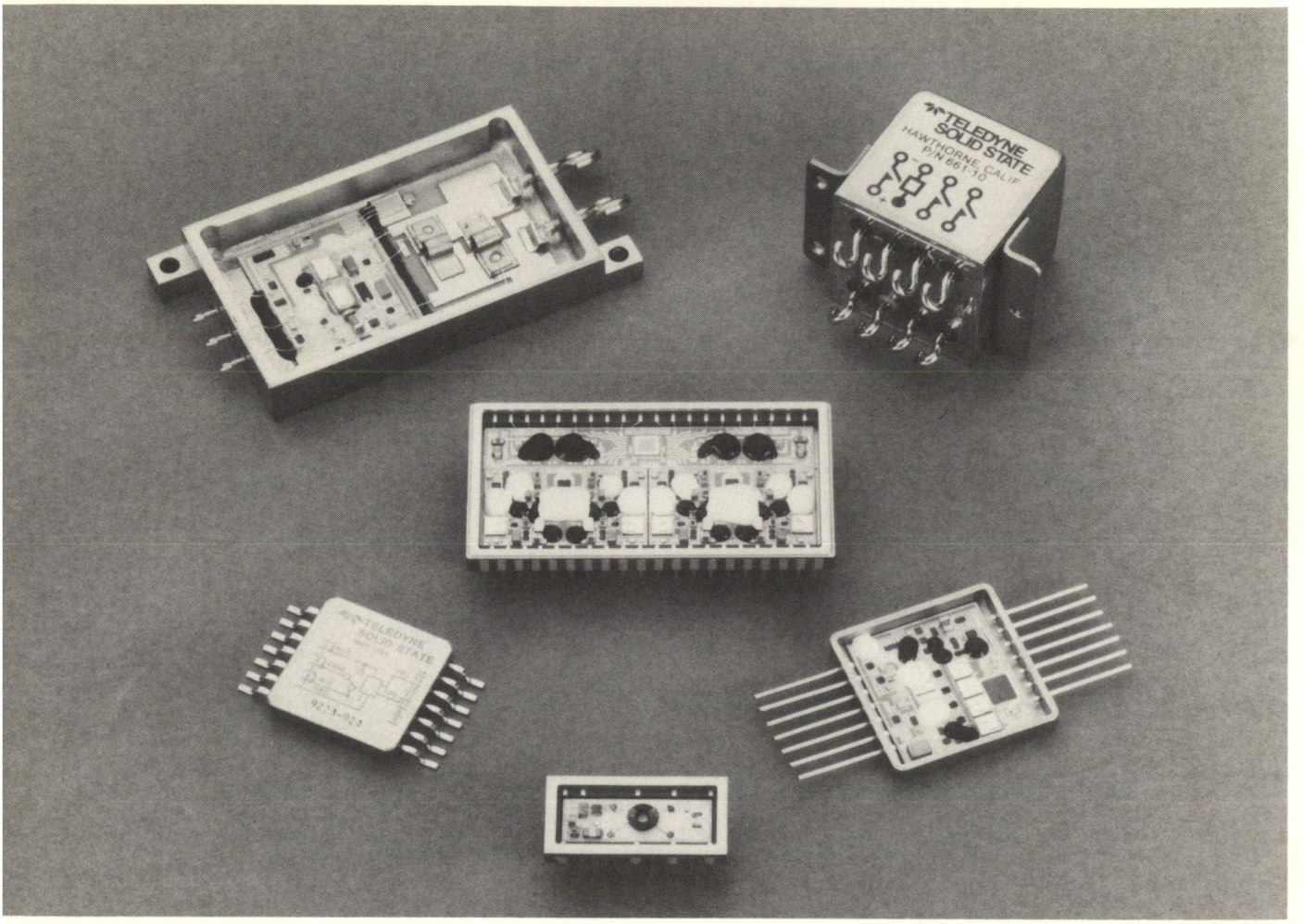

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