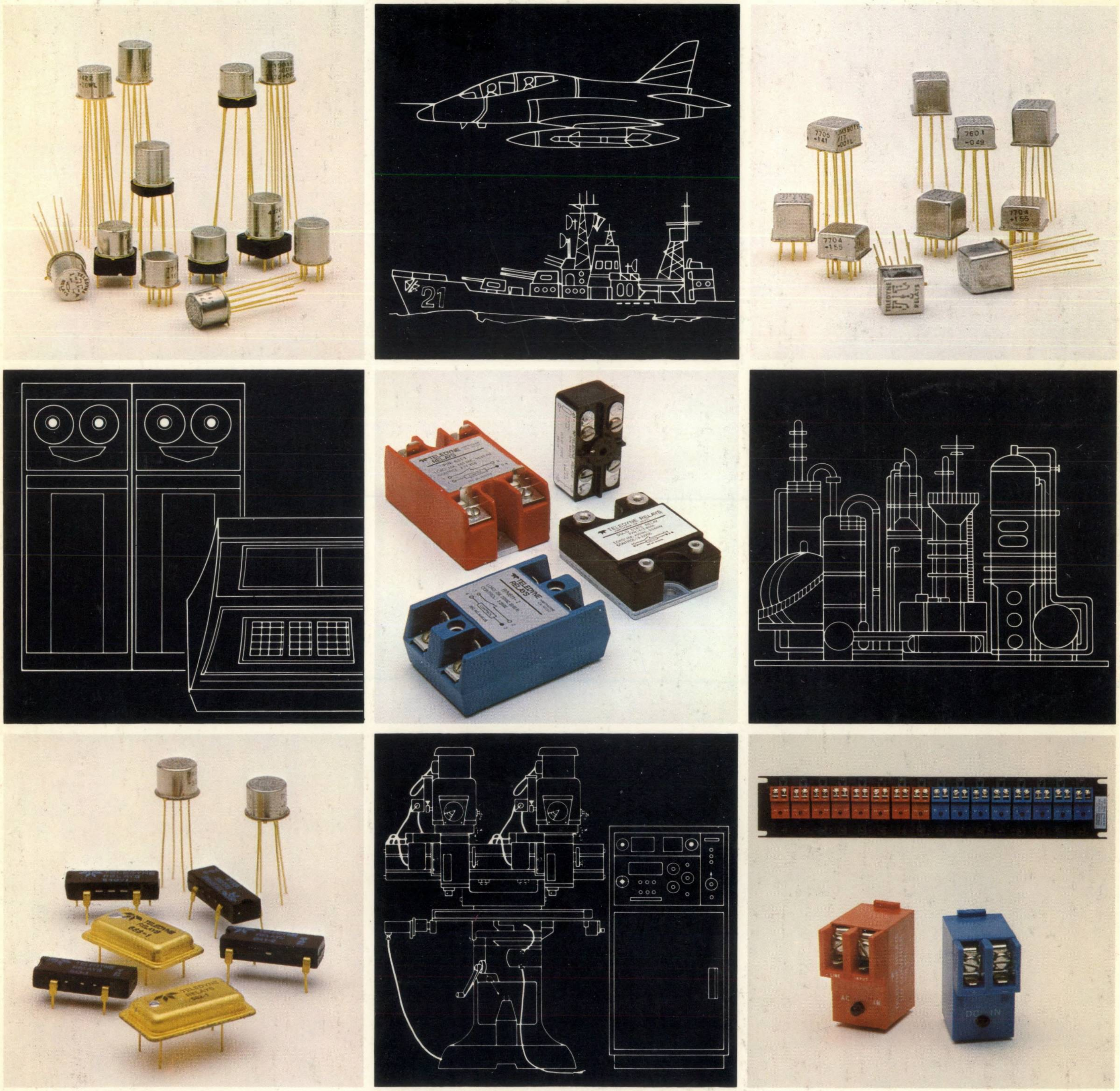
TELEDYNE RELAYS

1980 DATA BOOK



Innovations in Switching Technology

TELEDYNE RELAYS

1980 DATA BOOK

TELEDYNE RELAYS
HOME OFFICE
12525 Daphne Avenue
Hawthorne, California 90250
Telephone (213) 777-0077
TWX 910-321-4610

EUROPEAN HEADQUARTERS
Abraham Lincoln Strasse 38-42
62 Wiesbaden, W. Germany
6121-700811
TELEX 04-186851 (TREL-D)

UNITED KINGDOM SALES OFFICE
Heathrow House
Bath Road, Cranford
Hounslow, Middlesex, TW59QP U.K.
TELEX 935008

TABLE OF CONTENTS

Section I Military TO-5 Relays

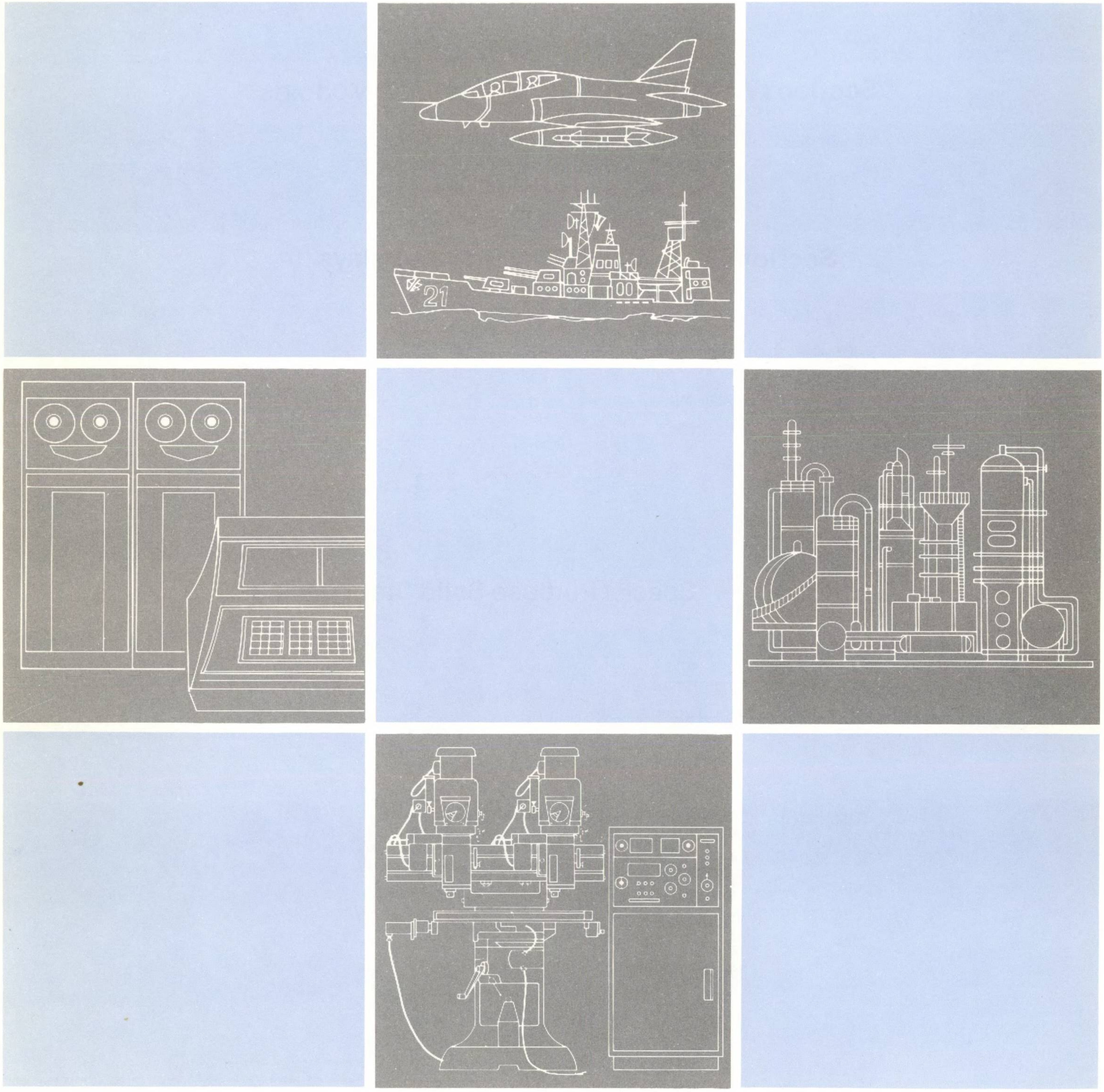
Section II Commercial/Industrial TO-5 Relays

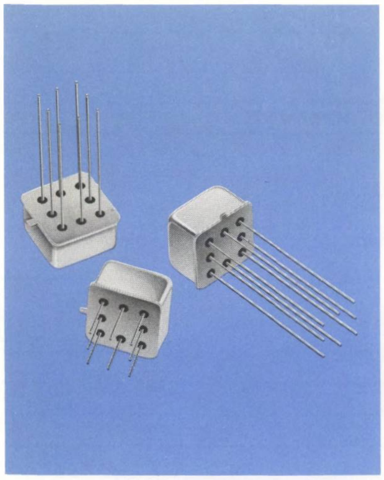
Section III Commercial/Industrial Solid State Relays

Specifications published herein are subject to change without notice.

SECTION I

Military TO-5 Relays





TELEDYNE RELAYS

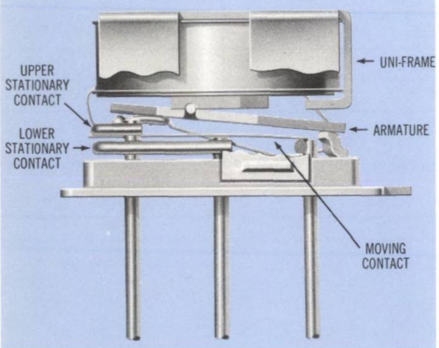
CENTIGRID® MILITARY RELAY

DPDT

SERIES
112

SERIES DESIGNATION	RELAY TYPE	QUALIFIED TO MILITARY SPECIFICATIONS
112	**DPDT basic relay**	MIL-R-39016/17 U.K. DEF. STD. 59/59 164/S/4093
112D	**DPDT relay with internal diode for coil transient suppression**	MIL-R-39016/18 U.K. DEF. STD. 59/59 171/S/4093
112DD	**DPDT relay with internal diodes for coil transient suppression and polarity reversal protection**	MIL-R-39016/19 U.K. DEF. STD. 59/59 162/S/4093

INTERNAL CONSTRUCTION



ENVIRONMENTAL AND PHYSICAL SPECIFICATIONS	
Temperature (Ambient)	-65°C to +125°C
Vibration	30 g's to 3000 Hz (Note 1)
Shock	75 g's for 6 msec. (Note 1)
Acceleration	75 g's (Note 1)
Enclosure	All welded, hermetically sealed
Weight	0.09 oz. (2.6gms.) max.

DESCRIPTION

The ultraminiature Centigrid® Relay is the smallest hermetically sealed armature relay available. Its extremely low profile height (.225'') and .100'' grid spaced terminals, which precludes the need for spreader pads, makes it ideal for applications where extreme packaging density and/or close PC board spacing are required.

The basic design and internal construction are similar to the Teledyne standard DPDT TO-5 relay (412 Series). The following unique construction features and manufacturing techniques provide overall high reliability and excellent resistance to environmental extremes:

- 100% all-welded construction.
- Patented uni-frame design providing high magnetic efficiency and mechanical rigidity.
- High force/mass ratios for resistance to shock and vibration.
- Advanced cleaning and sealing techniques provide maximum assurance of freedom from contact contamination.
- Precious metal contact material (gold, platinum, palladium alloy) with gold plating assures excellent high current and dry circuit switching capabilities.

The 112D and 112DD Series utilize internal discrete silicon diodes, with characteristics similar to 1N5315.

By virtue of its inherently low intercontact capacitance and contact circuit losses, the TO-5 relay has proven to be an excellent subminiature RF switch for frequency ranges up through UHF. A typical RF application for the TO-5 relay is in hand held radio transceivers, wherein the combined features of good RF performance, small size, low coil power dissipation and high reliability make it the preferred relay for T-R switching (see Figures 1 and 2).

GENERAL ELECTRICAL SPECIFICATIONS (-65°C to +125°C unless otherwise noted)

Contact Arrangement	2 Form C (DPDT)
Rated Duty	Continuous
Contact Resistance	0.1 ohm max. before life; 0.2 ohm max. after life (measured 1/8'' from header)
Contact Load Ratings (DC)	Resistive: 1 Amp/28VDC Inductive: 200 mA/28VDC (320 mH) Lamp: 100 mA/28VDC (See Fig. 3 for other DC resistive voltage/current ratings)
Contact Load Ratings (AC)	Resistive: 600 mA/115VAC, 400 Hz (Case ungrounded); 400 mA/115VAC, 60 Hz (Case ungrounded) 200 mA/115VAC, 60 and 400 Hz, (Case grounded)
Contact Life Ratings	10,000,000 operations (typical) at low level 1,000,000 operations min. at 0.5A/28VDC resistive 100,000 operations min. at all other loads specified above
Contact Overload Rating	2 Amps/28VDC (100 operations min.)
Contact Carry Rating	5 Amps (Continuous, unswitched)
Coil Operating Power	450 milliwatts nominal at nominal rated voltage at 25°C
Operate Time	2.0 msec. max. at nominal rated coil voltage
Release Time	112 Series: 1.5 msec. max. — 112D, 112DD, Series: 4.0 msec. max.
Contact Bounce	1.5 msec. max.
Intercontact Capacitance	0.4 pf. typical
Insulation Resistance	10,000 megohms min. between mutually isolated terminals
Dielectric Strength	Sea level: 500 VRMS/60 Hz. — 70,000 ft.: 125 VRMS/60 Hz.

DETAILED ELECTRICAL SPECIFICATIONS (-65°C to +125°C unless otherwise noted)

	GENERIC PART NUMBERS ➡	112-5 112D-5 112DD-5	112-6 112D-6 112DD-6	112-9 112D-9 112DD-9	112-12 112D-12 112DD-12	112-18 112D-18 112DD-18	112-26 112D-26 112DD-26
Coil Voltage (VDC)	Nom.	5.0	6.0	9.0	12.0	18.0	26.5
	Max.	5.8	8.0	12.0	16.0	24.0	32.0
Coil Resistance (Ohms ±10% @ 25°C)	112, 112D	50	98	220	390	880	1560
	112DD (Note 2)	39	78	220	390	880	1560
Coil Current (mADC @ 25°C) (112DD Series only)	(Note 3) Min.	93.2	46.3	33.0	25.6	17.5	14.8
	(Note 3) Max.	128.2	62.3	42.9	32.8	22.1	18.5
Pick-up Voltage (VDC)	112, 112D	3.5	4.5	6.8	9.0	13.5	18.0
	112DD	3.9	5.2	7.8	10.0	14.5	19.0
Drop-out Voltage (VDC)	Min.	0.14	0.18	0.35	0.41	0.59	0.89
	Max.	2.5	3.2	4.9	6.5	10.0	13.0
Diode P.I.V. (VDC, Min.) 112D, 112DD		100					
Negative Coil Transient (VDC, Max.) 112D, 112DD		1.0					

PERFORMANCE CURVES

RF PERFORMANCE

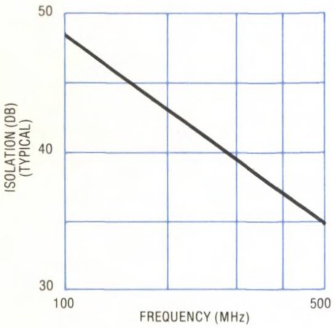


FIGURE 1

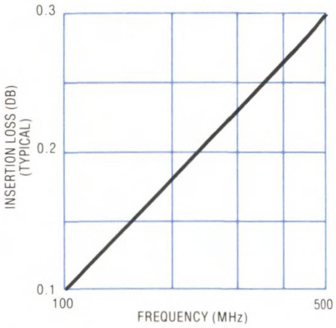


FIGURE 2

DC CONTACT RATINGS (RESISTIVE)

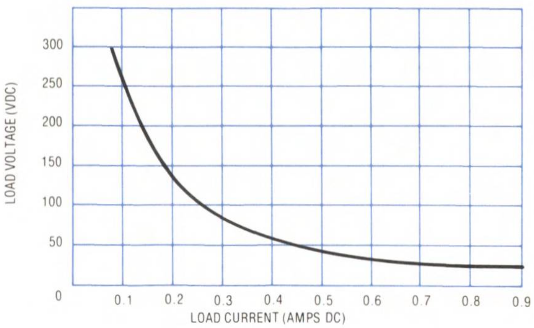
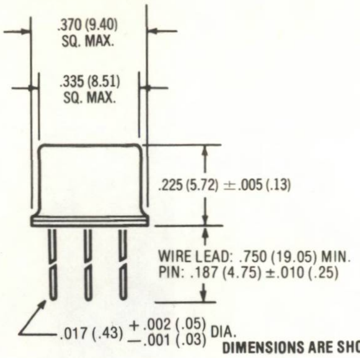


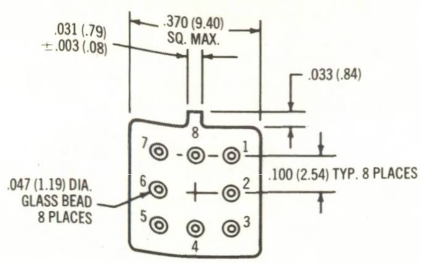
FIGURE 3

OUTLINE DIMENSIONS

CASE DETAIL

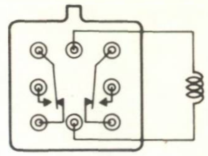


TERMINAL LOCATIONS
(Viewed from Terminals, Numbers for Reference only)

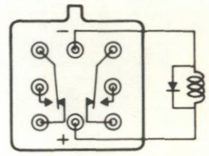


DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

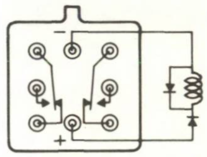
SCHEMATIC DIAGRAMS



112



112D

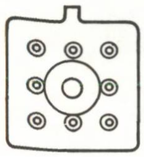


112DD

SCHEMATICS ARE VIEWED FROM TERMINALS

MOUNTING PAD

Relays can be supplied with a .015 in. thick mounting pad epoxied to the relay header. The pad (P/N 194-3) permits the relay to be spaced away from the mounting surface facilitating solder joint inspection. To order add M4 to Part Number. Example: 112**M4**-26.



NOTE – Max. height above mounting surface increased to .250 in.

MILITARY RELAY P/N CROSS REFERENCE

MILITARY DESIGNATION	TELEDYNE PART NO.
M39016/17 -001L	J112 -5WL
-002L	-6WL
-003L	-9WL
-004L	-12WL
-005L	-18WL
-006L	-26WL
-007L	-5PL
-008L	-6PL
-009L	-9PL
-010L	-12PL
-011L	-18PL
-012L	-26PL

MILITARY DESIGNATION	TELEDYNE PART NO.
M39016/18 -001	J112D -5WL
-002	-6WL
-003	-9WL
-004	-12WL
-005	-18WL
-006	-26WL
-007	-5PL
-008	-6PL
-009	-9PL
-010	-12PL
-011	-18PL
-012	-26PL

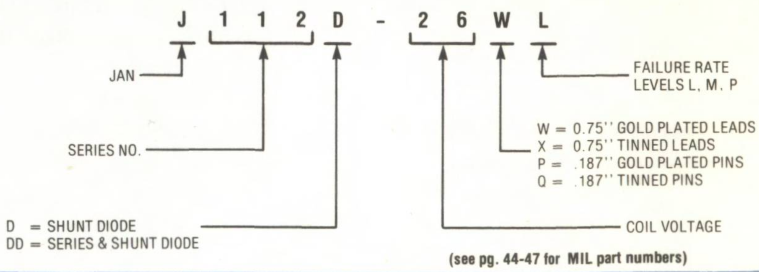
MILITARY DESIGNATION	TELEDYNE PART NO.
M39016/19 -001	J112DD-5WL
-002	-6WL
-003	-9WL
-004	-12WL
-005	-18WL
-006	-26WL
-007	-5PL
-008	-6PL
-009	-9PL
-010	-12PL
-011	-18PL
-012	-26PL

''L'' suffix denotes L level failure rate. Teledyne M39016/17, /18, & /19 relays also carry M level qualification.

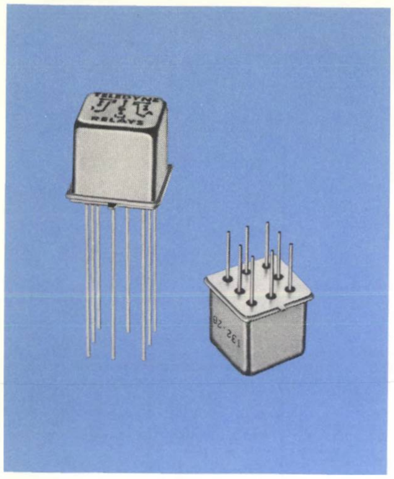
NOTES:

1. Relays will exhibit no contact chatter or transfer within specified ratings.
2. For reference only. Coil resistance not directly measurable at relay terminals due to internal series diode.
3. Measured at nominal voltage for 5 sec. maximum.
4. Screened hi-rel versions available on special order.

TELEDYNE PART NUMBERING SYSTEM FOR MIL-QUALIFIED RELAYS



(see pg. 44-47 for MIL part numbers)



TELEDYNE RELAYS

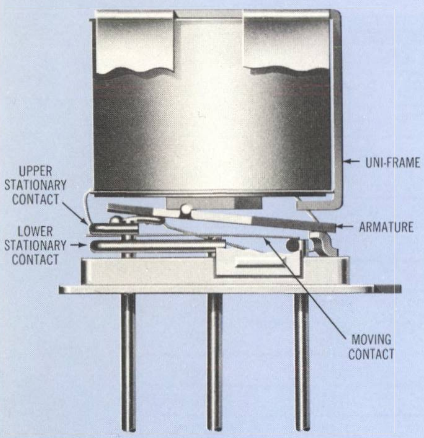
CENTIGRID® MILITARY RELAY

SENSITIVE DPDT

SERIES 132

SERIES DESIGNATION	RELAY TYPE	QUALIFIED TO MILITARY SPECIFICATIONS
132	DPDT basic relay	MIL-R-39016/41
132D	DPDT relay with internal diode for coil transient suppression	MIL-R-39016/42
132DD	DPDT relay with internal diodes for coil transient suppression and polarity reversal protection	MIL-R-39016/43

INTERNAL CONSTRUCTION



ENVIRONMENTAL AND PHYSICAL SPECIFICATIONS	
Temperature (Ambient)	-65°C to +125°C
Vibration	30 g's to 3000 Hz (Note 1)
Shock	75 g's for 6 msec. (Note 1)
Acceleration	75 g's (Note 1)
Enclosure	All welded, hermetically sealed
Weight	0.15 oz. (4.2gms.) max.

DESCRIPTION

The sensitive Centigrid relay retains the same features as the standard Centigrid with only a minimal increase in profile height (.350 in.). It provides a .100 in. grid spaced terminal pattern which precludes the need for spreader pads and, together with the low profile, is ideal for applications where high packaging density is important.

Unique construction features and manufacturing techniques provide excellent resistance to environmental extremes and overall high reliability.

- 100% all-welded construction.
- Patented uni-frame design providing high magnetic efficiency and mechanical rigidity.
- High force/mass ratios for resistance to shock and vibration.
- Advanced cleaning and sealing techniques provide maximum assurance of freedom from contact contamination.
- Precious metal contact material (gold, platinum, palladium alloy) with gold plating assures excellent high current and dry circuit switching capabilities.

The 132D and 132DD Series utilize internal discrete silicon diodes, with characteristics similar to 1N5315.

The sensitive Centigrid relay features exceptionally high coil resistance thus providing for extremely low operating power (200 mw typical). The advantages of reduced heat dissipation and power supply demands are obvious.

By virtue of its inherently low intercontact capacitance and contact circuit losses, the 132 relay has proven to be an excellent subminiature RF switch for frequency ranges up through UHF. A typical RF application is in hand held radio transceivers, wherein the combined features of good RF performance, small size, low coil power dissipation and high reliability make it the preferred relay for T-R switching (see Figures 1 and 2).

GENERAL ELECTRICAL SPECIFICATIONS (-65°C to +125°C unless otherwise noted)

Contact Arrangement	2 Form C (DPDT)
Rated Duty	Continuous
Contact Resistance	0.1 ohm max. before life; 0.2 ohm max. after life at 1A/28VDC. (measured 1/8'' from header)
Contact Load Ratings (DC)	Resistive: 1 Amp/28VDC Inductive: 200 mA/28VDC (320 mH) Lamp: 100 mA/28VDC (See Fig. 3 for other DC resistive voltage/current ratings)
Contact Load Ratings (AC)	Resistive: 600 mA/115VAC, 400 Hz (Case ungrounded); 400 mA/115VAC, 60 Hz (Case ungrounded). 200 mA/115VAC, 60 and 400 Hz, (Case grounded)
Contact Life Ratings	10,000,000 operations (typical) at low level 1,000,000 operations min. at 0.5A/28VDC resistive 100,000 operations min. at all other loads specified above
Contact Overload Rating	2 Amps/28VDC (100 operations min.)
Contact Carry Rating	5 Amps (Continuous, unswitched)
Coil Operating Power	200 milliwatts nominal at nominal rated voltage at 25°C
Operate Time	4.0 msec. max. at nominal rated coil voltage
Release Time	132 Series: 2.0 msec. max. / 132D, 132DD Series: 7.5 msec. max.
Contact Bounce	1.5 msec. max.
Intercontact Capacitance	0.4 pf. typical
Insulation Resistance	10,000 megohms min. between mutually isolated terminals
Dielectric Strength	Sea level: 500 VRMS/60 Hz. / 70,000 ft.: 125 VRMS/60 Hz.

DETAILED ELECTRICAL SPECIFICATIONS (-65°C to +125°C unless otherwise noted)

		GENERIC PART NUMBERS ➡	132-5 132D-5 132DD-5	132-6 132D-6 132DD-6	132-9 132D-9 132DD-9	132-12 132D-12 132DD-12	132-18 132D-18 132DD-18	132-26 132D-26 132DD-26	132-36 132D-36 132DD-36	132-48 132D-48 132DD-48
Coil Voltage (VDC)	Nom.		5.0	6.0	9.0	12.0	18.0	26.5	36.0	48.0
	Max.		7.5	10.0	15.0	20.0	30.0	40.0	57.0	75.0
Coil Resistance	132, 132D		100	200	400	800	1600	3200	6500	11000
(Ohms ±10% @25°C)	132DD (Note 2)		64	125	400	800	1600	3200	6500	11000
Coil Current (mADC @ 25°C)	(Note 3)	Min.	56.8	36.3	18.1	12.5	9.6	7.2	4.9	3.9
(132DD Series only)		Max.	78.1	48.9	23.6	16.0	12.2	9.0	6.4	4.8
Pick-up Voltage (VDC)	132, 132D		3.5	4.5	6.8	9.0	13.5	18.0	27.0	36.0
	132DD		3.6	4.8	8.0	11.0	14.5	19.0	27.0	36.0
Drop-Out Voltage (VDC)	Min.		0.12	0.18	0.35	0.41	0.59	0.89	1.25	1.60
	Max.		2.5	3.2	4.9	6.5	10.0	13.0	19.0	26.0
Diode P.I.V. (VDC, Min.) 132D, 132DD			100							
Negative Coil Transient (VDC, Max.) 132D, 132DD			1.0							

PERFORMANCE CURVES

RF PERFORMANCE

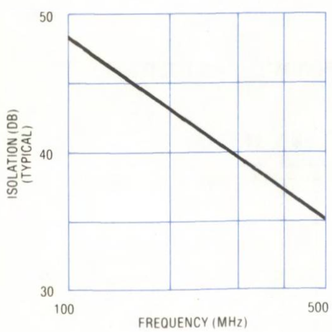


FIGURE 1

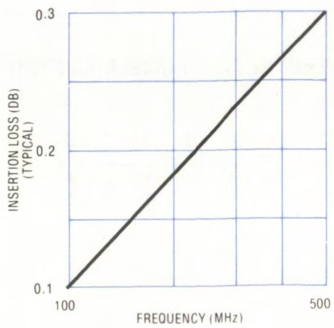


FIGURE 2

DC CONTACT RATINGS (RESISTIVE)

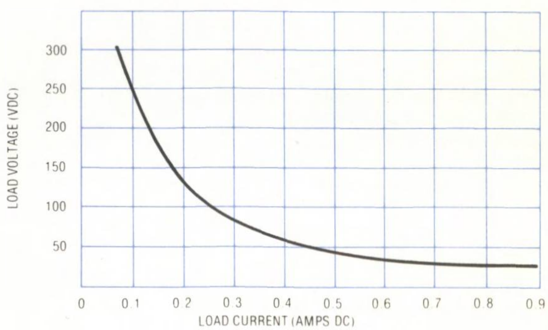
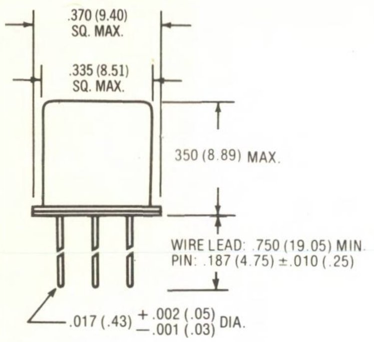


FIGURE 3

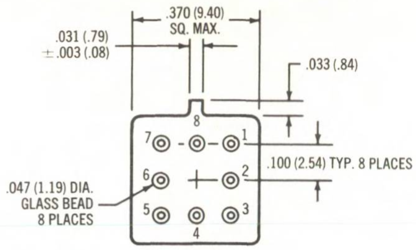
OUTLINE DIMENSIONS

CASE DETAIL



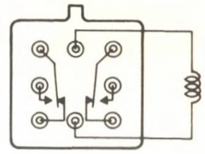
TERMINAL LOCATIONS

(Viewed from Terminals, Numbers for Reference only)

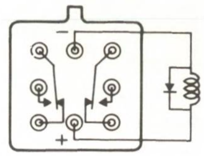


DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

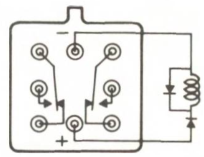
SCHEMATIC DIAGRAMS



132



132D

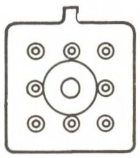


132DD

SCHEMATICS ARE VIEWED FROM TERMINALS

MOUNTING PAD

Relays can be supplied with a .015 in. thick mounting pad epoxied to the relay header. The pad (P/N 194-3) permits the relay to be spaced away from the mounting surface facilitating solder joint inspection. To order add M4 to Part Number. Example: 132**M4**-26.



NOTE – Max. height above mounting surface increased to .375 in.

MILITARY RELAY P/N CROSS REFERENCE

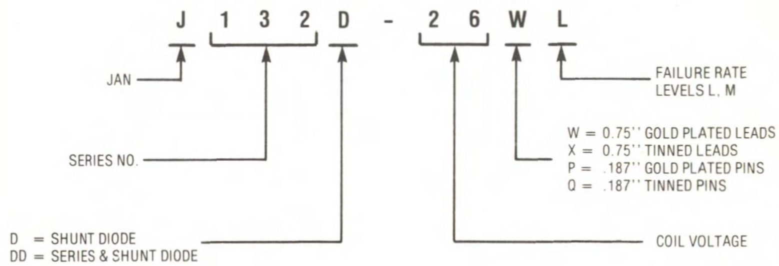
MILITARY DESIGNATION	TELEDYNE PART NO.	MILITARY DESIGNATION	TELEDYNE PART NO.	MILITARY DESIGNATION	TELEDYNE PART NO.	MILITARY DESIGNATION	TELEDYNE PART NO.	MILITARY DESIGNATION	TELEDYNE PART NO.	MILITARY DESIGNATION	TELEDYNE PART NO.
M39016/41-001L	J132 -5WL	M39016/41-017L	J132 -5XL	M39016/42-001L	J132D -4WL	M39016/42-017L	J132D -5XL	M39016/43-001L	J132DD -5WL	M39016/43-017L	J132DD -5XL
-002L	-6WL	-018L	-6XL	-002L	-6WL	-018L	-6XL	-002L	-6WL	-018L	-6XL
-003L	-12WL	-019L	-12XL	-003L	-12WL	-019L	-12XL	-003L	-9WL	-019L	-9XL
-004L	-26WL	-020L	-26XL	-004L	-26WL	-020L	-26XL	-004L	-12WL	-020L	-12XL
-005L	-36WL	-021L	-36XL	-005L	-36WL	-021L	-36XL	-005L	-18WL	-021L	-18XL
-006L	-48WL	-022L	-48XL	-006L	-48WL	-022L	-48XL	-006L	-26WL	-022L	-26XL
-007L	-9WL	-023L	-9XL	-007L	-9WL	-023L	-9XL	-007L	-36WL	-023L	-36XL
-008L	-18WL	-024L	-18XL	-008L	-18WL	-024L	-18XL	-008L	-48WL	-024L	-48XL
-009L	-5PL	-025L	-5QL	-009L	-5PL	-025L	-5QL	-009L	-5PL	-025L	-5QL
-010L	-6PL	-026L	-6QL	-010L	-6PL	-026L	-6QL	-010L	-6PL	-026L	-6QL
-011L	-12PL	-027L	-12QL	-011L	-12PL	-027L	-12QL	-011L	-9PL	-027L	-9QL
-012L	-26PL	-028L	-26QL	-012L	-26PL	-028L	-260QL	-012L	-12PL	-028L	-12QL
-013L	-36PL	-029L	-36QL	-013L	-36PL	-029L	-36QL	-031L	-18PL	-029L	-18QL
-014L	-48PL	-030L	-48QL	-014L	-48PL	-030L	-48QL	-014L	-26PL	-030L	-26QL
-015L	-9PL	-031L	-9QL	-015L	-9PL	-031L	-9QL	-015L	-36PL	-031L	-36QL
-016L	-18PL	-032L	-18QL	-016L	-18PL	-032L	-18QL	-016L	-48PL	-032L	-48QL

"L" suffix denotes L level failure rate.

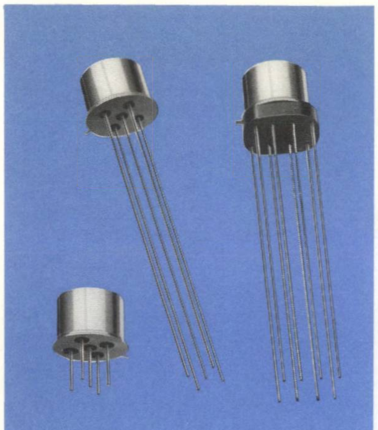
NOTES:

1. Relays will exhibit no contact chatter or transfer within specified ratings.
2. For reference only. Coil resistance not directly measurable at relay terminals due to internal series diode.
3. Measured at nominal voltage for 5 sec. max.

TELEDYNE PART NUMBERING SYSTEM FOR MIL-QUALIFIED RELAYS



(see pg. 44-47 for MIL part numbers)



Actual Size

TELEDYNE RELAYS

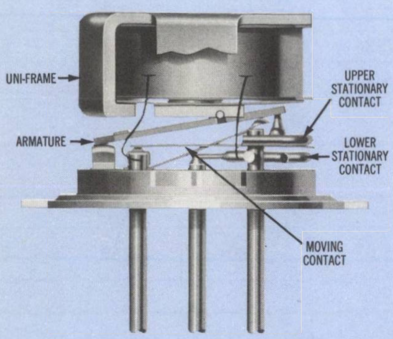
MILITARY TO-5 RELAYS

SPDT

SERIES **411**

SERIES DESIGNATION	RELAY TYPE	QUALIFIED TO MILITARY SPECIFICATIONS
411	SPDT basic relay	MIL-R-39016/7 U.K. DEF. STD. 59/59 167/S/4093
411D	SPDT relay with internal diode for coil transient suppression	MIL-R-39016/23 U.K. DEF. STD. 59/59 172/S/4093
411DD	SPDT relay with internal diodes for coil transient suppression and polarity reversal protection	MIL-R-39016/24 U.K. DEF. STD. 59/59 173/S/4093
411T	SPDT relay with internal transistor driver and coil suppression diode	MIL-R-28776/5 U.K. DEF. STD. 59/59 174/S/4093

INTERNAL CONSTRUCTION



ENVIRONMENTAL AND PHYSICAL SPECIFICATIONS	
Temperature (Ambient)	-65°C to +125°C
Vibration	30 g's to 3000 Hz (Note 1)
Shock	75 g's for 6 msec. (Note 1)
Acceleration	75 g's (Note 1)
Enclosure	All welded, hermetically sealed
Weight	0.09 oz. (2.6gms.) max.

DESCRIPTION

The TO-5 relay, originally conceived and developed by Teledyne, has become the industry standard for low level switching from dry circuit to 1 ampere. Designed expressly for high density PC Board mounting, its small size and low coil dissipation make the TO-5 relay the most versatile subminiature relay available.

Unique construction features and manufacturing techniques provide excellent resistance to environmental extremes and overall high reliability

- 100% all-welded construction.
- Patented uni-frame design providing high magnetic efficiency and mechanical rigidity.
- High force/mass ratios for resistance to shock and vibration.
- Advanced cleaning and sealing techniques provide maximum assurance of freedom from contact contamination.
- Precious metal contact material (gold, platinum, palladium alloy) with gold plating assures excellent high current and dry circuit switching capabilities.

The 411D and 411DD Series utilize internal discrete silicon diodes, with characteristics similar to 1N5315. The hybrid 411T Series features passivated silicon planar diode and transistor chips (similar to 2N2222A). The integrated packaging of the relay with its associated semi-conductor devices greatly reduces PC Board floor space requirements as well as component installation costs.

By virtue of its inherently low intercontact capacitance and contact circuit losses, the TO-5 relay has proven to be an excellent subminiature RF switch for frequency ranges up through UHF. A typical RF application for the TO-5 relay is in hand held radio transceivers, wherein the combined features of good RF performance, small size, low coil power dissipation and high reliability make it the preferred relay for T-R switching (see Figures 1 and 2).

SERIES 411

GENERAL ELECTRICAL SPECIFICATIONS (-65° to +125°C unless otherwise noted)

Contact Arrangement	1 Form C (SPDT)	
Rated Duty	Continuous	
Contact Resistance	0.1 ohm max. before life; 0.2 ohm max. after life at 1A/28VDC, (measured 1/8'' from header)	
Contact Load Ratings (DC)	Resistive: 1 Amp/28VDC Inductive: 200 mA/28VDC (320 mH) Lamp: 100 mA/28VDC (See Fig. 3 for other DC resistive voltage/current ratings)	
Contact Load Ratings (AC)	Resistive: 600 mA/115VAC, 400 Hz (Case ungrounded); 400 mA/115VAC, 60 Hz (Case ungrounded). 200 mA/115 VAC, 60 and 400 Hz, (Case grounded)	
Contact Life Ratings	10,000,000 operations (typical) at low level 1,000,000 operations min. at 0.5A/28VDC resistive 100,000 operations min. at all other loads specified above	
Contact Overload Rating	2 Amps/28VDC (100 operations min.)	
Contact Carry Rating	5 Amps (Continuous, unswitched)	
Coil Operating Power	300 milliwatts nominal at nominal rated voltage at 25°C	
Operate Time	2.0 msec. max. at nominal rated coil voltage	
Release Time	411 Series: 1.5 msec. max.	411D, 411DD, 411T Series: 4.0 msec. max.
Contact Bounce	1.5 msec. max.	
Intercontact Capacitance	0.4 pf. typical	
Insulation Resistance	10,000 megohms min. between mutually isolated terminals	
Dielectric Strength	Sea level: 500 VRMS/60 Hz.	411T: 350 VRMS/60 Hz
	70,000 ft.: 300 VRMS/60 Hz	411T: 125 VRMS/60 Hz

DETAILED ELECTRICAL SPECIFICATIONS (-65° to +125°C unless otherwise noted)

	GENERIC PART NUMBERS ➡	411-5 411D-5 411DD-5 411T-5	411-6 411D-6 411DD-6 411T-6	411-9 411D-9 411DD-9 411T-9	411-12 411D-12 411DD-12 411T-12	411-18 411D-18 411DD-18 411T-18	411-26 411D-26 411DD-26 411T-26
Coil Voltage (VDC)	Nom.	5.0	6.0	9.0	12.0	18.0	26.5
	Max.	5.8	8.0	12.0	16.0	24.0	32.0
Coil Resistance (Ohms ±10% @ 25°C)	411, 411D, 411T	63	125	280	500	1130	2000
	411DD (Note 2)	50	98	280	500	1130	2000
Coil Current (mADC @ 25°C) (411DD Series only)	(Note 3) Min.	72.7	46.3	25.9	20.0	13.6	11.5
	(Note 3) Max.	100	62.4	33.7	25.6	17.2	14.4
Pick-up Voltage (VDC)	411, 411D	3.5	4.5	6.8	9.0	13.5	18.0
	411DD, 411T	3.9	5.2	7.8	10.0	14.5	19.0
Drop-out Voltage (VDC)	Min.	0.15	0.18	0.35	0.40	0.58	0.89
	Max.	2.4	2.8	4.2	5.6	8.4	10.4
Diode P.I.V. (VDC, Min.) 411D, 411DD, 411T		100					
Negative Coil Transient (VDC, Max.) 411D, 411DD, 411T		1.0					
411T SERIES TRANSISTOR CHARACTERISTICS	**Base Voltage to Turn Off (VDC, Max.)**	0.3					
	Base Current to Turn On (mADC, Min.) (Note: Limit base-emitter current to 15 mA max.)	2.38	1.60	1.07	0.80	0.53	0.40
	Emitter-base Voltage (BV_{EBO}) (@ 25°C) (VDC, MAX.)	6.0					
	Collector-base Voltage (BV_{CBO}) (@ 25°C & I_C = 100 μa) (VDC, Min.)	80					

PERFORMANCE CURVES

RF PERFORMANCE

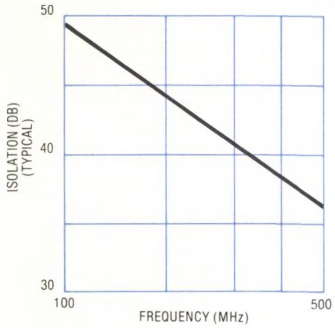


FIGURE 1

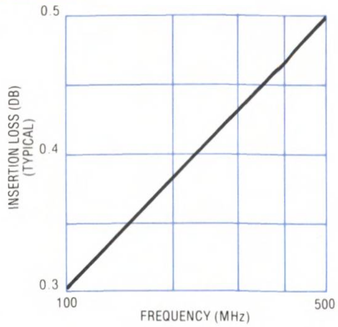


FIGURE 2

DC CONTACT RATINGS (RESISTIVE)

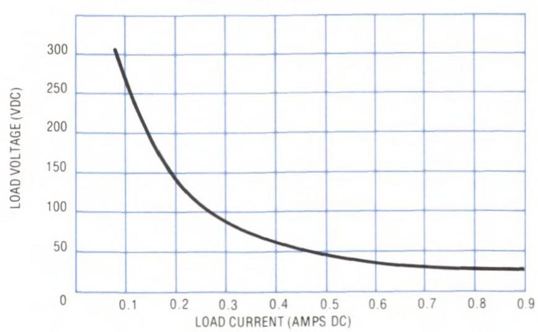
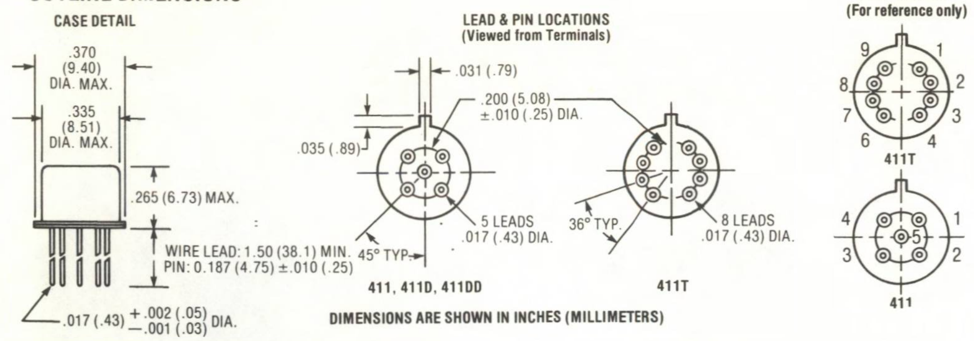


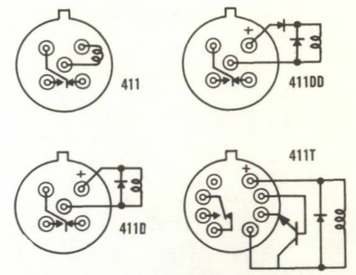
FIGURE 3

OUTLINE DIMENSIONS



DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

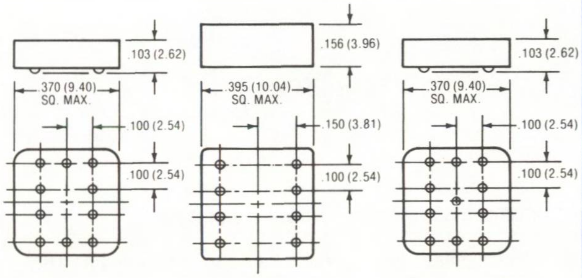
SCHEMATIC DIAGRAMS



SCHEMATICS ARE VIEWED FROM TERMINALS

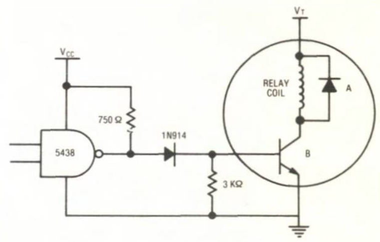
SPREADER PADS

Relays can be supplied with spreader pads installed and cemented in place. P/N 192-10 or 192-59 can be used with the 411T relay. P/N 192-67 can be used with the 411, 411D and 411DD relays. Relays supplied with the 192-59 pad installed have leads trimmed to .130 in. (3.3mm) below the pad. To order, add M for the 192-10 Pad, M2 for the 192-59 Pad, and M3 for the 192-67 Pad to the part number (e.g., 411T**M2**-26).



P/N192-10 (Qualified to M38527/5) | **P/N192-59** | **P/N192-67**

TYPICAL TTL INTERFACE CIRCUIT
(See Note 5)



(A) INTERNAL SUPPRESSION DIODE (B) INTERNAL DRIVER TRANSISTOR

MILITARY RELAY P/N CROSS REFERENCE

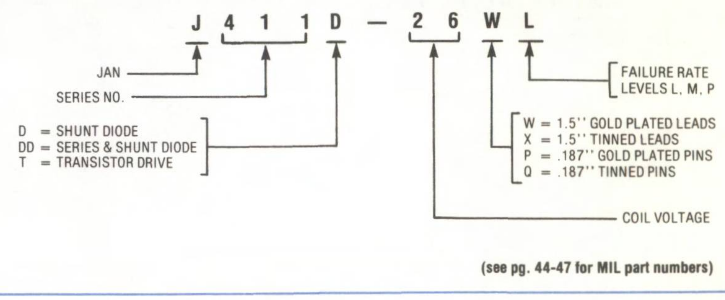
MILITARY DESIGNATION	TELEDYNE PART NO.	MILITARY DESIGNATION	TELEDYNE PART NO.	MILITARY DESIGNATION	TELEDYNE PART NO.	MILITARY DESIGNATION	TELEDYNE PART NO.
M39016/7 -001L	J411 -5WL	M39016/23 -001L	J411D -5WL	M39016/24 -001L	J411DD -5WL	M28776/5 -001L	J411T -5WL
-002L	-5PL	-002L	-6WL	-002L	-6WL	-007	-5PL
-003L	-6WL	-003L	-9WL	-003L	-9WL	-002	-6WL
-004L	-6PL	-004L	-12WL	-004L	-12WL	-008	-6PL
-005L	-9WL	-005L	-18WL	-005L	-18WL	-003	-9WL
-006L	-9PL	-006L	-26WL	-006L	-26WL	-009	-9PL
-007L	-12WL	-007L	-5PL	-007L	-5PL	-004	-12WL
-008L	-12PL	-008L	-6PL	-008L	-6PL	-010	-12PL
-009L	-18WL	-009L	-9PL	-009L	-9PL	-005	-18WL
-010L	-18PL	-010L	-12PL	-010L	-12PL	-011	-18PL
-011L	-26WL	-011L	-18PL	-011L	-18PL	-006	-26WL
-012L	-26PL	-012L	-26PL	-012L	-26PL	-012	-26PL

"L" suffix denotes L level failure rate. Teledyne M39016/9, /15, & /20 relays also carry M and P level qualification; M28776/1 relays also carry M level qualification.

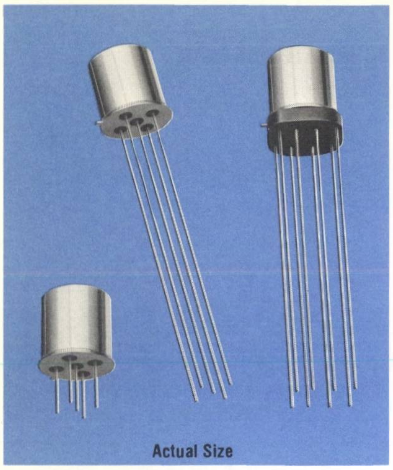
NOTES:

1. Relays will exhibit no contact chatter or transfer within specified ratings.
2. For reference only. Coil resistance not directly measurable at relay terminals due to internal series diode.
3. Measured at nominal voltage for 5 sec. maximum.
4. Screened hi-rel versions available on special order. Some relay models are qualified to one or more of the following NASA specifications:
   NASA/MSFC Spec. 40M37496
   NASA/GSFC Spec. S-311-P2(06)
5. Circuit is typical for all 411T Series. Values shown are for 411T-5 relay, and apply over full operating temperature range.

TELEDYNE PART NUMBERING SYSTEM FOR MIL-QUALIFIED RELAYS



(see pg. 44-47 for MIL part numbers)



TELEDYNE RELAYS

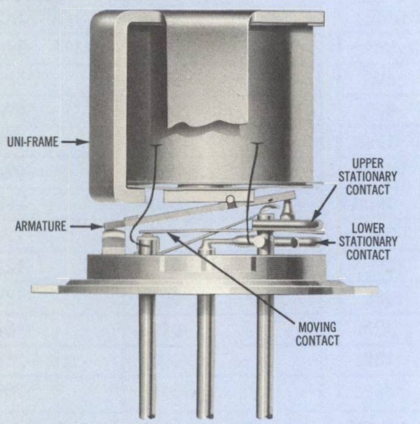
MILITARY TO-5 RELAYS

SENSITIVE SPDT

SERIES
431

SERIES DESIGNATION	RELAY TYPE	QUALIFIED TO MILITARY SPECIFICATIONS
431	**SPDT basic relay**	MIL-R-39016/10 U.K. DEF. STD. 59/59 170/S/4093
431D	**SPDT relay with internal diode for coil transient suppression**	MIL-R-39016/25 U.K. DEF. STD. 59/59 179/S/4093
431DD	**SPDT relay with internal diodes for coil transient suppression and polarity reversal protection**	MIL-R-39016/26 U.K. DEF. STD. 59/59 180/S/4093
431T	**SPDT relay with internal transistor driver and coil suppression diode**	MIL-R-28776/4

INTERNAL CONSTRUCTION



ENVIRONMENTAL AND PHYSICAL SPECIFICATIONS	
Temperature (Ambient)	-65°C to +125°C
Vibration	30 g's to 3000 Hz (Note 1)
Shock	75 g's for 6 msec. (Note 1)
Acceleration	75 g's (Note 1)
Enclosure	All welded, hermetically sealed
Weight	0.15 oz. (4.3gms.) max.

DESCRIPTION

The TO-5 relay, originally conceived and developed by Teledyne, has become the industry standard for low level switching from dry circuit to 1 ampere. Designed expressly for high density PC Board mounting, its small size and low coil dissipation make the TO-5 relay the most versatile subminiature relay available.

Unique construction features and manufacturing techniques provide excellent resistance to environmental extremes and overall high reliability.

- 100% all-welded construction.
- Patented uni-frame design providing high magnetic efficiency and mechanical rigidity.
- High force/mass ratios for resistance to shock and vibration.
- Advanced cleaning and sealing techniques provide maximum assurance of freedom from contact contamination.
- Precious metal contact material (gold, platinum, palladium alloy) with gold plating assures excellent high current and dry circuit switching capabilities.

The 431D and 431DD Series utilize internal discrete silicon diodes, with characteristics similar to 1N5315. The hybrid 431T Series features passivated silicon planar diode and transistor chips (similar to 2N2222A). The integrated packaging of the relay with its associated semi-conductor devices greatly reduces PC Board floor space requirements as well as component installation costs.

By virtue of its inherently low intercontact capacitance and contact circuit losses, the TO-5 relay has proven its worth as an RF switch for frequencies up through UHF. In addition, the sensitive 431 Series relay features exceptionally high coil resistance thus providing for extremely low operating power (150 milliwatts typical at room temperature). The advantages of reduced heat dissipation and power supply demands are obvious.

GENERAL ELECTRICAL SPECIFICATIONS (-65°C to +125°C unless otherwise noted)

Contact Arrangement	1 Form C (DPDT)
Rated Duty	Continuous
Contact Resistance	0.1 ohm max. before life; 0.2 ohm max. after life at 1A/28VDC (measured 1/8'' from header)
Contact Load Ratings (DC)	Resistive: 1 Amp/28VDC Inductive: 200 mA/28VDC (320 mH) Lamp: 100 mA/28VDC (See Fig. 3 for other DC resistive voltage/current ratings)
Contact Load Ratings (AC)	Resistive: 600 mA/115VAC, 400 Hz (Case ungrounded); 400 mA/115VAC, 60 Hz (Case ungrounded). 200 mA/115VAC, 60 and 400 Hz, (Case grounded)
Contact Life Ratings	10,000,000 operations (typical) at low level 1,000,000 operations min. at 0.5A/28VDC resistive 100,000 operations min. at all other loads specified above
Contact Overload Rating	2 Amps/28VDC (100 operations min.)
Contact Carry Rating	5 Amps (Continuous, unswitched)
Coil Operating Power	150 milliwatts typical at nominal rated voltage at 25°C
Operate Time	3.5 msec. max. at nominal rated coil voltage
Release Time	431 Series: 2.0 msec. max. — 431D, 431DD, 431T Series: 7.5 msec. max.
Contact Bounce	1.5 msec. max.
Intercontact Capacitance	0.4 pf. typical
Insulation Resistance	10,000 megohms min. between mutually isolated terminals
Dielectric Strength	Sea level: 500 VRMS/60 Hz. (350 VRMS for 431TSeries) — 70,000 ft.: 125 VRMS/60 Hz.

DETAILED ELECTRICAL SPECIFICATIONS (-65° to +125°C unless otherwise noted)

	GENERIC PART NUMBERS ➡	431-5 431D-5 431DD-5 431T-5	431-6 431D-6 431DD-6 431T-6	431-9 431D-9 431DD-9 431T-9	431-12 431DD-12 431DD-12 431T-12	431-18 431D-18 431DD-18 431T-18	431-26 431D-26 431DD-26 431T-26	431-32 431D-32 431DD-32 431T-32	431-40 431D-40 431DD-40 431T-40
Coil Voltage (VDC)	Nom.	5.0	6.0	9.0	12.0	18.0	26.5	32.0	40.0
	Max.	8.0	11.0	16.0	22.0	33.0	45.0	57.0	75.0
Coil Resistance (Ohms ±10% @ 25°C)	431, 431D, 431T	125	255	630	1025	2300	4000	6500	11,000
	431DD (Note 2)	100	200	630	1025	2300	4000	6500	11,000
Coil Current (mADC @ 25°C) 431DD only	(Note 3) Min.	36.3	22.7	11.5	9.7	6.7	5.7	4.3	3.2
	(Note 3) Max.	50.0	30.6	15.0	12.5	8.5	7.2	5.4	4.0
Pick-up Voltage (VDC)	431, 431D	3.5	4.5	6.8	9.0	13.5	18.0	24.0	30.0
	431DD, 431T	3.6	4.8	7.8	10.0	14.5	19.0	24.0	30.0
Drop-out Voltage (VDC)	Min.	0.15	0.18	0.35	0.41	0.58	0.89	1.0	1.3
	Max.	2.0	2.8	4.2	5.6	8.4	10.4	15.0	18.7
Diode P.I.V. (VDC, Min.) 431D, 431DD, 431T		100							
Negative Coil Transient (VDC, Max.) 431D, 431DD, 431T		1.0							
431 SERIES TRANSISTOR CHARACTERISTICS	Base Voltage to Turn Off (VDC, Max.)	0.3							
	Base Current to Turn On (mADC, Min.) (Note: Limit base-emitter current to 15 mA max.)	1.20	0.78	0.48	0.39	0.26	0.20		
	Emitter-base Voltage (BV_{EBO}) (@ 25°C) (VDC, Max.)	6.0							
	Collector-base Voltage (BV_{CBO}) (@25°C & I_C = 100 μa) (VDC, Min.)	8.0							

PERFORMANCE CURVES

RF PERFORMANCE

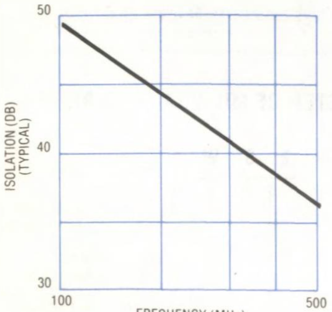


FIGURE 1

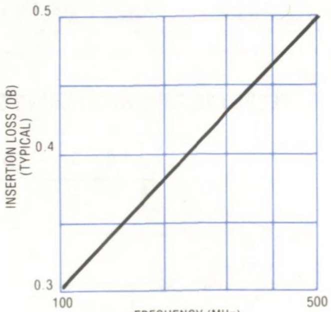


FIGURE 2

DC CONTACT RATINGS (RESISTIVE)

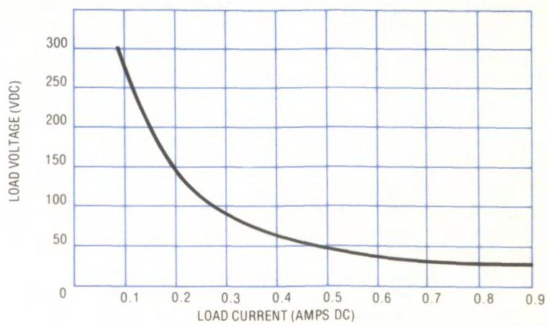
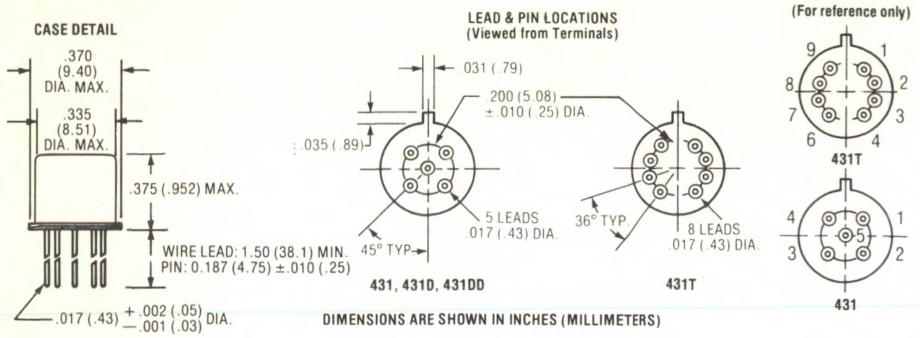


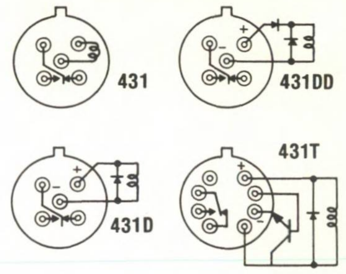
FIGURE 3

OUTLINE DIMENSIONS



DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

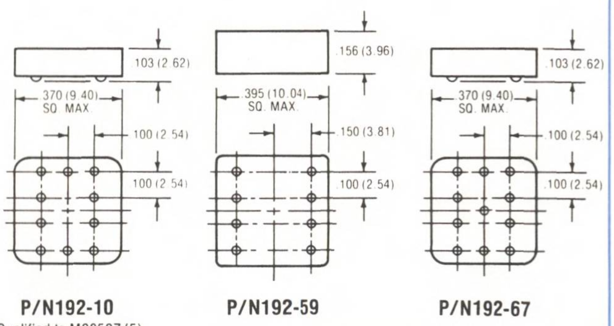
SCHEMATIC DIAGRAMS



SCHEMATICS ARE VIEWED FROM TERMINALS

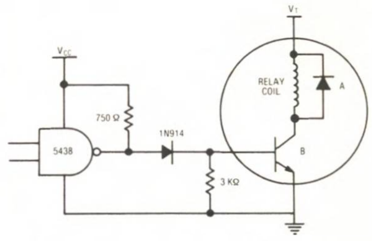
SPREADER PADS

Relays can be supplied with spreader pads installed and cemented in place. P/N 192-10 or 192-59 can be used with the 431T relay. P/N 192-67 can be used with the 431, 431D and 431DD relays. Relays supplied with the 192-59 pad installed have leads trimmed to .130 in. (3.3mm) below the pad. To order, add M for the 192-10 Pad, M2 for the 192-59 Pad, and M3 for the 192-67 Pad to the part number (e.g., 431T**M2**-26).



(Qualified to M38527/5)

TYPICAL TTL INTERFACE CIRCUIT (See Note 5)



(A) INTERNAL SUPPRESSION DIODE
(B) INTERNAL DRIVER TRANSISTOR

MILITARY RELAY P/N CROSS REFERENCE

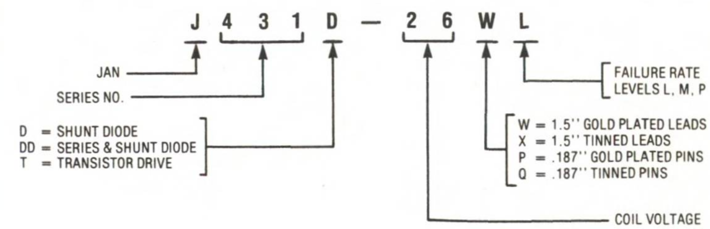
MILITARY DESIGNATION	TELEDYNE PART NO.	MILITARY DESIGNATION	TELEDYNE PART NO.	MILITARY DESIGNATION	TELEDYNE PART NO.	MILITARY DESIGNATION	TELEDYNE PART NO.
M39016/10 -001L	J431 -5WL	M39016/25 -001L	J431D -5WL	M39016/26 -001L	J431DD -5WL	M28776/4 -001	J431T -5WL
-002L	-5Pl	-002L	-6WL	-002L	-6WL	-009	-5PL
-003L	-6WL	-003L	-12WL	-003L	-12WL	-002	-6WL
-004L	-6PL	-004L	-26WL	-004L	-26WL	-010	-6PL
-005L	-12WL	-005L	-32WL	-005L	-32WL	-003	-9WL
-006L	-12PL	-006L	-40WL	-006L	-40WL	-011	-9PL
-007L	-26WL	-007L	-5PL	-007L	-5PL	-004	-12WL
-008L	-26PL	-008L	-6PL	-008L	-6PL	-012	-12PL
-009L	-32WL	-009L	-12PL	-009L	-12PL	-005	-18WL
-010L	-32PL	-010L	-26PL	-010L	-26PL	-013	-18PL
-011L	-40WL	-011L	-32PL	-011L	-32PL	-006	-26WL
-012L	-40PL	-012L	-40PL	-012L	-40PL	-014	-26PL
-031L	-9WL	-013L	-9WL	-013L	-9WL	-007	-32WL
-014L	-9PL	-014L	-18WL	-014L	-18WL	-015	-32PL
-015L	-18WL	-015L	-9PL	-015L	-9PL	-008	-40WL
-016L	-18PL	-016L	-18PL	-016L	-18PL	-016	-40PL

"L" suffix denotes L level failure rate. Teledyne M39016/9, /15, & /20 relays also carry M and P level qualification; M28776/1 relays also carry M level qualification.

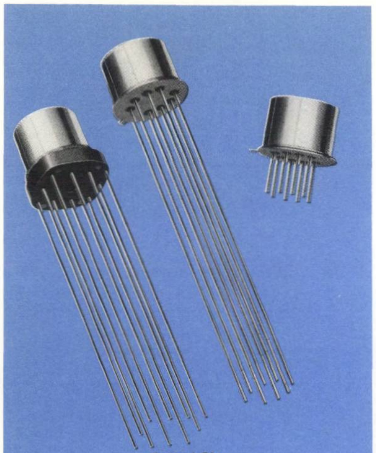
NOTES:

1. Relays will exhibit no contact chatter or transfer within specified ratings.
2. For reference only. Coil resistance not directly measurable at relay terminals due to internal series diode.
3. Measured at nominal voltage for 5 sec. maximum.
4. Screened hi-rel versions available on special order. Some relay models are qualified to one or more of the following NASA specifications:
   NASA/MSFC Spec. 40M37496
   NASA/GSFC Spec. S-311-P2(06)
5. Circuit is typical for all 431T Series. Values shown are for 431T-5 relay, and apply over full operating temperature range.

TELEDYNE PART NUMBERING SYSTEM OF MIL-QUALIFIED RELAYS



(see pg. 44-47 for MIL part numbers)


Actual Size

TELEDYNE RELAYS

MILITARY TO-5 RELAYS

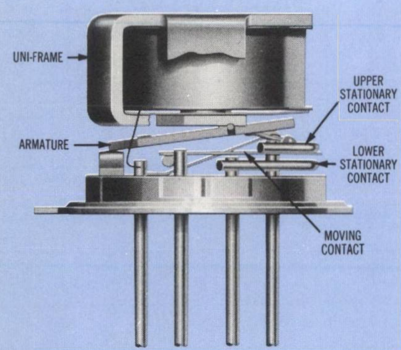
DPDT

SERIES

412

SERIES DESIGNATION	RELAY TYPE	QUALIFIED TO MILITARY SPECIFICATIONS
412	**DPDT basic relay**	MIL-R-39016/9 U.K. DEF. STD. 59/59 169/S/4093
412D	**DPDT relay with internal diode for coil transient suppression**	MIL-R-39016/15 U.K. DEF. STD. 59/59 175/S/4093
412DD	**DPDT relay with internal diodes for coil transient suppression and polarity reversal protection**	MIL-R-39016/20 U.K. DEF. STD. 59/59 163/S/4093
412T	**DPDT relay with internal transistor driver and coil suppression diode**	MIL-R-28776/1 U.K. DEF. STD. 59/59 160/S/4093

INTERNAL CONSTRUCTION



ENVIRONMENTAL AND PHYSICAL SPECIFICATIONS	
Temperature (Ambient)	-65°C to +125°C
Vibration	30 g's to 3000 Hz (Note 1)
Shock	75 g's for 6 msec. (Note 1)
Acceleration	75 g's (Note 1)
Enclosure	All welded, hermetically sealed
Weight	0.09 oz. (2.6gms.) max.

DESCRIPTION

The TO-5 relay, originally conceived and developed by Teledyne, has become the industry standard for low level switching from dry circuit to 1 ampere. Designed expressly for high density PC Board mounting, its small size and low coil dissipation make the TO-5 relay the most versatile subminiature relay available.

Unique construction features and manufacturing techniques provide excellent resistance to environmental extremes and overall high reliability:

- 100% all-welded construction.
- Patented uni-frame design providing high magnetic efficiency and mechanical rigidity.
- High force/mass ratios for resistance to shock and vibration.
- Advanced cleaning and sealing techniques provide maximum assurance of freedom from contact contamination.
- Precious metal contact material (gold, platinum, palladium alloy) with gold plating assures excellent high current and dry circuit switching capabilities.

The 412D and 412DD Series utilize internal discrete silicon diodes, with characteristics similar to 1N5315. The hybrid 412T Series features passivated silicon planar diode and transistor chips (similar to 2N2222A). The integrated packaging of the relay with its associated semi-conductor devices greatly reduces PC Board floor space requirements as well as component installation costs.

By virtue of its inherently low intercontact capacitance and contact circuit losses, the TO-5 relay has proven to be an excellent subminiature RF switch for frequency ranges up through UHF. A typical RF application for the TO-5 relay is in hand held radio transceivers, wherein the combined features of good RF performance, small size, low coil power dissipation and high reliability make it the preferred relay for T-R switching (see Figures 1 and 2).

SERIES 412

GENERAL ELECTRICAL SPECIFICATIONS (-65° to +125°C unless otherwise noted)

Contact Arrangement	2 Form C (DPDT)	
Rated Duty	Continuous	
Contact Resistance	0.1 ohm max. before life; 0.2 ohm max. after life at 1A/28VDC, (measured 1/8'' from header)	
Contact Load Ratings (DC)	Resistive: 1 Amp/28VDC Inductive: 200 mA/28VDC (320 mH) Lamp: 100 mA/28VDC (See Fig. 3 for other DC resistive voltage/current ratings)	
Contact Load Ratings (AC)	Resistive: 600 mA/115VAC, 400 Hz (Case ungrounded); 400 mA/115VAC, 60 Hz (Case ungrounded). 200 mA/115 VAC, 60 and 400 Hz, (Case grounded)	
Contact Life Ratings	10,000,000 operations (typical) at low level 1,000,000 operations min. at 0.5A/28VDC resistive 100,000 operations min. at all other loads specified above	
Contact Overload Rating	2 Amps/28VDC (100 operations min.)	
Contact Carry Rating	5 Amps (Continuous, unswitched)	
Coil Operating Power	450 milliwatts nominal at nominal rated voltage at 25°C	
Operate Time	2.0 msec. max. at nominal rated coil voltage	
Release Time	412 Series: 1.5 msec. max.	412D, 412DD, 412T Series: 4.0 msec. max.
Contact Bounce	1.5 msec. max.	
Intercontact Capacitance	0.4 pf. typical	
Insulation Resistance	10,000 megohms min. between mutually isolated terminals	
Dielectric Strength	Sea level: 500 VRMS/60 Hz. (350 VRMS for 412T Series)	70,000 ft.: 125 VRMS/60 Hz.

DETAILED ELECTRICAL SPECIFICATIONS (-65° to +125°C unless otherwise noted)

	GENERIC PART NUMBERS ➡	412-5 412D-5 412DD-5 412T-5	412-6 412D-6 412DD-6 412T-6	412-9 412D-9 412DD-9 412T-9	412-12 412D-12 412DD-12 412T-12	412-18 412D-18 412DD-18 412T-18	412-26 412D-26 412DD-26 412T-26
Coil Voltage (VDC)	Nom.	5.0	6.0	9.0	12.0	18.0	26.5
	Max.	5.8	8.0	12.0	16.0	24.0	32.0
Coil Resistance (Ohms ±10% @ 25°C)	412, 412D, 412T	50	98	220	390	880	1560
	412DD (Note 2)	39	78	220	390	880	1560
Coil Current (mADC @ 25°C) (412DD Series only)	(Note 3) Min.	93.2	58.3	33.0	25.6	17.5	14.8
	(Note 3) Max.	128.2	78.3	42.9	32.8	22.1	18.5
Pick-up Voltage (VDC)	412, 412D	3.5	4.5	6.8	9.0	13.5	18.0
	412DD, 412T	3.9	5.2	7.8	10.0	14.5	19.0
Drop-out Voltage (VDC)	Min.	0.14	0.18	0.35	0.41	0.59	0.89
	Max.	2.3	3.2	4.9	6.5	10.0	13.0
Diode P.I.V. (VDC, Min.) 412D, 412DD, 412T		100					
Negative Coil Transient (VDC, Max.) 412D, 412DD, 412T		1.0					
412T SERIES TRANSISTOR CHARACTERISTICS: Base Voltage to Turn Off (VDC, Max.)		0.3					
412T SERIES TRANSISTOR CHARACTERISTICS: Base Current to Turn On (mADC, Min.) (Note: Limit base-emitter current to 15 mA max.)		3.00	2.04	1.36	1.03	0.68	0.50
412T SERIES TRANSISTOR CHARACTERISTICS: Emitter-base Voltage (BV_{EBO}) (@ 25°C) (VDC, Max.)		6.0					
412T SERIES TRANSISTOR CHARACTERISTICS: Collector-base Voltage (BV_{CBO}) (@ 25°C & Ic = 100 μa) (VDC, Min.)		80					

PERFORMANCE CURVES

RF PERFORMANCE

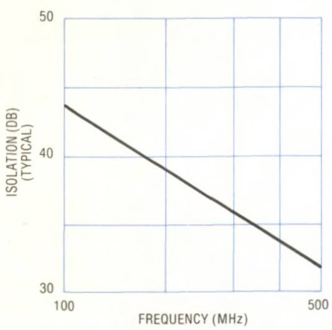


FIGURE 1

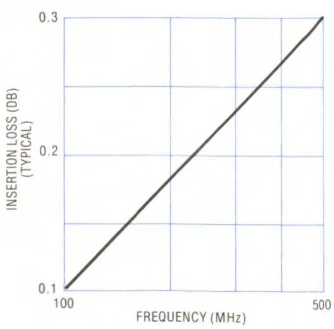


FIGURE 2

DC CONTACT RATINGS (RESISTIVE)

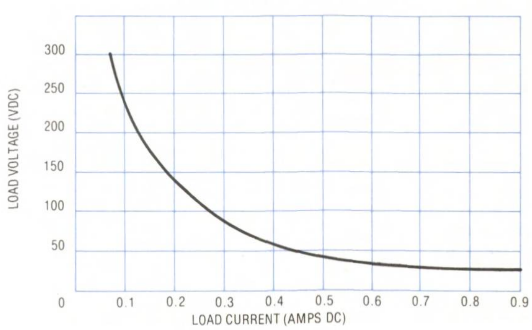
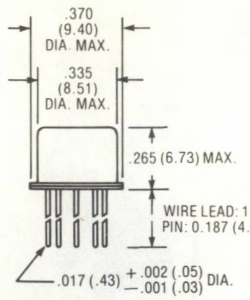
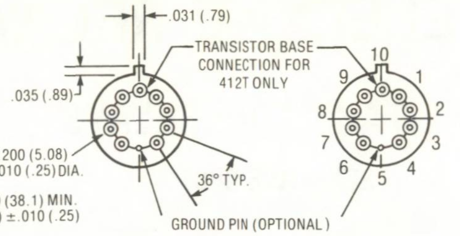


FIGURE 3

OUTLINE DIMENSIONS

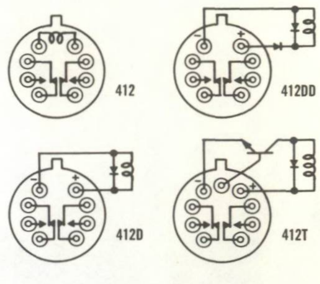


TERMINAL LOCATIONS AND PIN NUMBERING (REF. ONLY)
(Viewed from Terminals)



DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

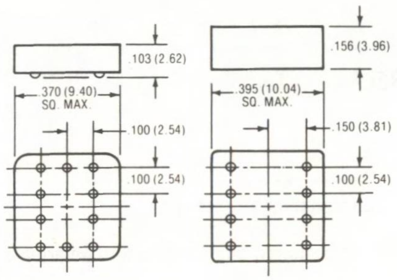
SCHEMATIC DIAGRAMS



SCHEMATICS ARE VIEWED FROM TERMINALS

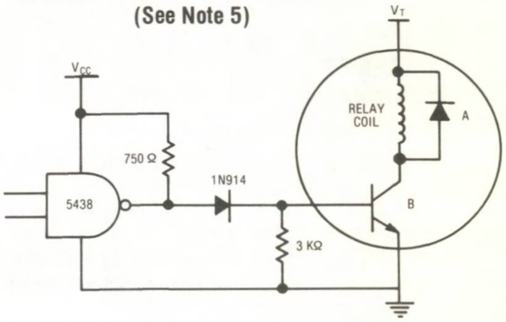
SPREADER PADS

Relays can be supplied with spreader pads installed and cemented in place. P/N 192-10 can be used with all 412, 412D, 412DD and 412T Series Relays; P/N 192-59 is limited to 8 pins and therefore will not accommodate the 412T Series Relay. Relays supplied with 192-59 pad installed have leads trimmed to .130'' (3.3 mm) below pad. Spreader specification MIL-M-38527 (MIL P/N M38527/5-03). To order, add M for the 192-10 pad or M2 for the 192-59 pad to the part number (e.g., 412D**M2**-26).



P/N192-10 (Qualified to M38527/5) **P/N192-59**

TYPICAL TTL INTERFACE CIRCUIT
(See Note 5)



(A) INTERNAL SUPPRESSION DIODE (B) INTERNAL DRIVER TRANSISTOR

MILITARY RELAY P/N CROSS REFERENCE

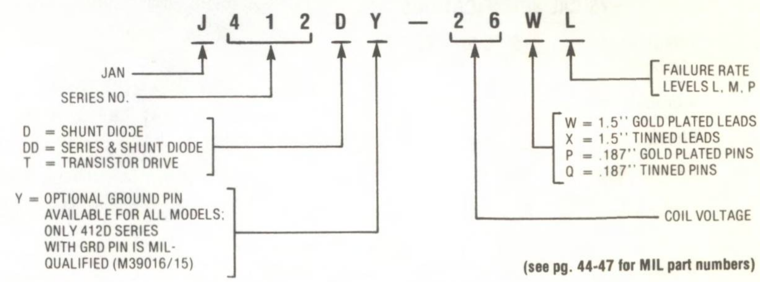
MILITARY DESIGNATION	TELEDYNE PART NO.	MILITARY DESIGNATION	TELEDYNE PART NO.	MILITARY DESIGNATION	TELEDYNE PART NO.	MILITARY DESIGNATION	TELEDYNE PART NO.
M39016/9 -001L	J412 -5WL	M39016/15 -001L	J412D -6WL	M39016/20 -001L	J412DD -5WL	M28776/1 -001L	J412T -5WL
-002L	-6WL	-002L	-9WL	-002L	-6WL	-002L	-6WL
-003L	-9WL	-003L	-12WL	-003L	-9WL	-003L	-9WL
-004L	-12WL	-004L	-18WL	-004L	-12WL	-004L	-12WL
-005L	-18WL	-005L	-26WL	-005L	-18WL	-005L	-18WL
-006L	-26WL	-006L	-5WL	-006L	-26WL	-006L	-26WL
-007L	-5PL	-017L	-6PL	-025L	-5PL	-007L	-5PL
-008L	-6PL	-018L	-9PL	-026L	-6PL	-008L	-6PL
-009L	-9PL	-019L	-12PL	-027L	-9PL	-009L	-9PL
-010L	-12PL	-020L	-18PL	-028L	-12PL	-010L	-12PL
-011L	-18PL	-021L	-26PL	-029L	-18PL	-011L	-18PL
-012L	-26PL	-022L	-5PL	-030L	-26PL	-012L	-26PL

''L'' suffix denotes L level failure rate. Teledyne M39016/9, /15, & /20 relays also carry M and P Level qualification; M28776/1 relays also carry M level qualification.

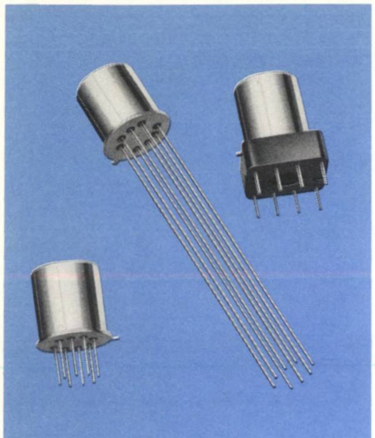
NOTES:

1. Relays will exhibit no contact chatter or transfer within specified ratings.
2. For reference only. Coil resistance not directly measurable at relay terminals due to internal series diode.
3. Measured at nominal voltage for 5 sec. maximum.
4. Screened hi-rel versions available on special order. Some relay models are qualified to one or more of the following NASA specifications:
   NASA/MSFC Spec. 40M37496
   NASA/GSFC Spec. S-311-P2(06)
5. Circuit is typical for all 412T Series. Values shown are for 412T-5 relay, and apply over full operating temperature range.

TELEDYNE PART NUMBERING SYSTEM FOR MIL-QUALIFIED RELAYS



(see pg. 44-47 for MIL part numbers)



Actual Size

TELEDYNE RELAYS

MILITARY TO-5 RELAYS

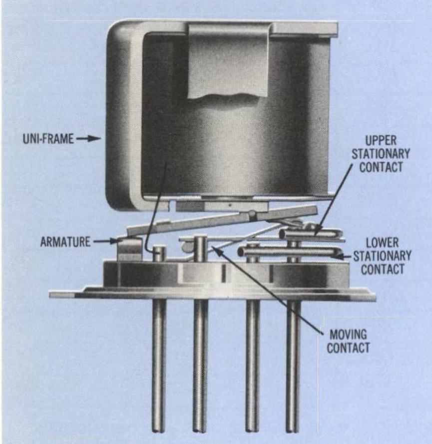
SENSITIVE DPDT

SERIES 432

SPDT/NO

SERIES DESIGNATION	RELAY TYPE	QUALIFIED TO MILITARY SPECIFICATIONS
432	**DPDT basic relay**	MIL-R-39016/11 U.K. DEF. STD. 59/59 165/S/4093
432D	**DPDT relay with internal diode for coil transient suppression**	MIL-R-39016/16 U.K. DEF. STD. 59/59 176/S/4093
432DD	**DPDT relay with internal diodes for coil transient suppression and polarity reversal protection**	MIL-R-39016/21 U.K. DEF. STD. 59/59 161/S/4093
432T	**DPDT relay with internal transistor driver and coil suppression diode**	MIL-R-28776/3

INTERNAL CONSTRUCTION



ENVIRONMENTAL AND PHYSICAL SPECIFICATIONS	
Temperature (Ambient)	-65°C to +125°C
Vibration	30 g's to 3000 Hz (Note 1)
Shock	75 g's for 6 msec. (Note 1)
Acceleration	75 g's (Note 1)
Enclosure	All welded, hermetically sealed
Weight	0.15 oz. (4.3gms.) max.

DESCRIPTION

The TO-5 relay, originally conceived and developed by Teledyne, has become the industry standard for low level switching from dry circuit to 1 ampere. Designed expressly for high density PC Board mounting, its small size and low coil dissipation make the TO-5 relay the most versatile subminiature relay available.

Unique construction features and manufacturing techniques provide excellent resistance to environmental extremes and overall high reliability

- 100% all-welded construction.
- Patented uni-frame design providing high magnetic efficiency and mechanical rigidity.
- High force/mass ratios for resistance to shock and vibration.
- Advanced cleaning and sealing techniques provide maximum assurance of freedom from contact contamination.
- Precious metal contact material (gold, platinum, palladium alloy) with gold plating assures excellent high current and dry circuit switching capabilities.

The 432D and 432DD Series utilize internal discrete silicon diodes, with characteristics similar to 1N5315. The hybrid 432T Series features passivated silicon planar diode and transistor chips (similar to 2N2222A). The integrated packaging of the relay with its associated semi-conductor devices greatly reduces PC Board floor space requirements as well as component installation costs.

By virtue of its inherently low intercontact capacitance and contact circuit losses, the TO-5 relay has proven its worth as an RF switch for frequencies up through UHF. In addition, the sensitive 432 Series relay features exceptionally high coil resistance thus providing for extremely low operating power (150 milliwatts typical at room temperature). The advantages of reduced heat dissipation and power supply demands are obvious.

GENERAL ELECTRICAL SPECIFICATIONS (-65°C to +125°C unless otherwise noted)

Contact Arrangement	2 Form C (DPDT)
Rated Duty	Continuous
Contact Resistance	0.1 ohm max. before life; 0.2 ohm max. after life at 0.5A/28VDC (measured 1/8'' from header)
Contact Load Ratings (DC)	Resistive: 1 Amp/28VDC Inductive: 200 mA/28VDC (320 mH) Lamp: 100 mA/28VDC (See Fig. 3 for other DC resistive voltage/current ratings)
Contact Load Ratings (AC)	Resistive: 600 mA/115VAC, 400 Hz (Case ungrounded); 400 mA/115VAC, 60 Hz (Case ungrounded). 200 mA/115VAC, 60 and 400 Hz, (Case grounded)
Contact Life Ratings	10,000,000 operations (typical) at low level 1,000,000 operations min. at 0.5A/28VDC resistive 100,000 operations min. at all other loads specified above
Contact Overload Rating	2 Amps/28VDC (100 operations min.)
Contact Carry Rating	5 Amps (Continuous, unswitched)
Coil Operating Power	200 milliwatts typical at nominal rated voltage at 25°C
Operate Time	4.0 msec. max. at nominal rated coil voltage
Release Time	432 Series: 2.0 msec. max. / 432D, 432DD, 432T Series: 7.5 msec. max.
Contact Bounce	1.5 msec. max.
Intercontact Capacitance	0.4 pf. typical
Insulation Resistance	10,000 megohms min. between mutually isolated terminals
Dielectric Strength	Sea level: 500 VRMS/60 Hz. (350 VRMS for 432TSeries) / 70,000 ft.: 125 VRMS/60 Hz.

DETAILED ELECTRICAL SPECIFICATIONS (-65° to +125°C unless otherwise noted)

	GENERIC PART NUMBERS ➡	432-5 432D-5 432DD-5 432T-5	432-6 432D-6 432DD-6 432T-6	432-9 432D-9 432DD-9 432T-9	432-12 432D-12 432DD-12 432T-12	432-18 432D-18 432DD-18 432T-18	432-26 432D-26 432DD-26 432T-26	432-36 432D-36 432DD-36 432T-36	432-48 432D-48 432DD-48 432T-48
Coil Voltage (VDC)	Nom.	5.0	6.0	9.0	12.0	18.0	26.5	36.0	48.0
	Max.	7.5	10.0	15.0	20.0	30.0	40.0	57.0	75.0
Coil Resistance (Ohms ±10% @ 25°C)	432, 432D, 432T	100	200	400	850	1600	3300	6500	11,000
	432DD (Note 2)	64	125	400	850	1600	3300	6500	11,000
Coil Current (mADC @ 25°C) 432DD only	(Note 3) Min.	56	36.3	18.1	11.7	9.6	7.0	4.9	3.9
	(Note 3) Max.	78.1	48.9	23.6	15.0	12.2	8.8	6.1	4.8
Pick-up Voltage (VDC)	432, 432D	3.5	4.5	6.8	9.0	13.5	18.0	27.0	36.0
	432DD, 432T	3.6	4.8	8.0	11.0	14.5	19.0	27.0	36.0
Drop-out Voltage (VDC)	Min.	0.12	0.18	0.35	0.41	0.59	0.89	1.25	1.6
	Max.	2.5	3.2	4.9	6.5	10.0	13.0	19.0	26.0
Diode P.I.V. (VDC, Min.) 432D, 432DD, 432T		100							
Negative Coil Transient (VDC, Max.) 432D, 432DD, 432T		1.0							
432 SERIES TRANSISTOR CHARACTERISTICS	Base Voltage to Turn Off (VDC, Max.)	0.3							
	Base Current to Turn On (mADC, Min.) (Note: Limit base-emitter current to 15 mA max.)	1.50	1.0	0.75	0.47	0.38	0.24		
	Emitter-base Voltage (BV_{EBO}) (@ 25°C) (VDC, Max.)	6.0							
	Collector-base Voltage (BV_{CBO}) (@25°C & Ic = 100μa) (VDC, Min.)	80							

PERFORMANCE CURVES

RF PERFORMANCE

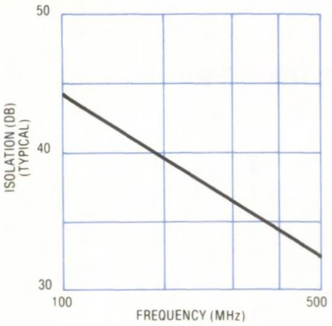


FIGURE 1

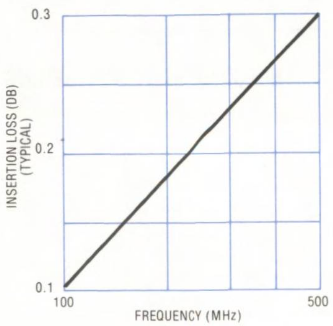


FIGURE 2

DC CONTACT RATINGS (RESISTIVE)

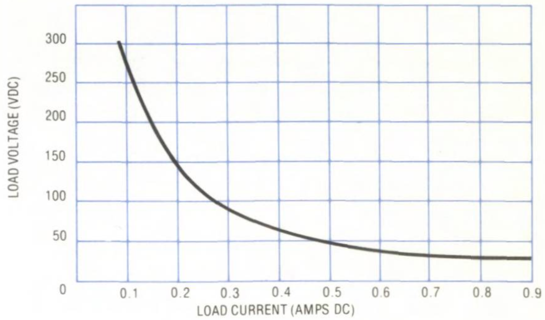
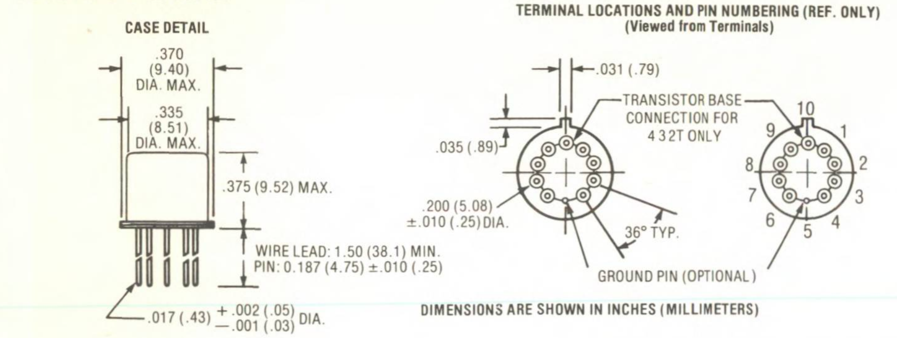


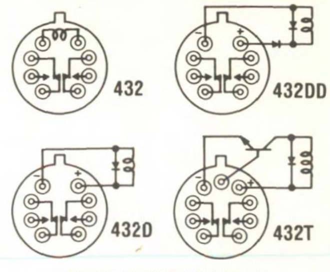
FIGURE 3

OUTLINE DIMENSIONS



DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

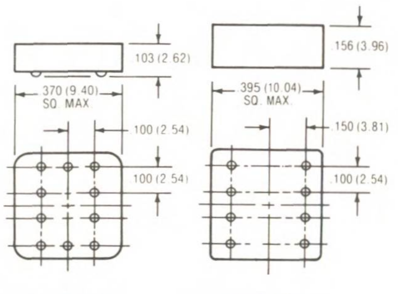
SCHEMATIC DIAGRAMS



SCHEMATICS ARE VIEWED FROM TERMINALS

SPREADER PADS

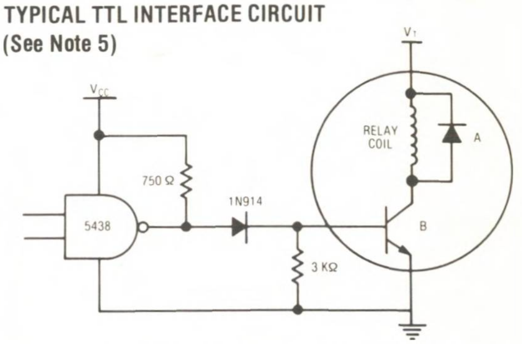
Relays can be supplied with spreader pads installed and cemented in place. P/N 192-10 can be used with all 432, 432D, 432DD and 432T Series Relays; P/N 192-59 is limited to 8 pins and therefore will not accommodate the 432T Series Relay. Relays supplied with 192-59 pad installed have leads trimmed to .130" (3.3 mm) below pad. Spreader specification MIL-M-38527 (MIL P/N M38527/5-03). To order, add M for the 192-10 pad or M2 for the 192-59 pad to the part number (e.g., 432D**M2**-26).



P/N192-10
(Qualified to M38527/5)

P/N192-59

TYPICAL TTL INTERFACE CIRCUIT
(See Note 5)



(A) INTERNAL SUPPRESSION DIODE (B) INTERNAL DRIVER TRANSISTOR

MILITARY RELAY P/N CROSS REFERENCE

MILITARY DESIGNATION	TELEDYNE PART NO.
M39016/11 -001L	J432 -5WL
-002L	-5PL
-003L	-6WL
-004L	-6PL
-005L	-12WL
-006L	-12PL
-007L	-26WL
-008L	-26PL
-009L	-36WL
-010L	-36PL
-011L	-48WL
-012L	-48PL
-013L	-9WL
-041L	-9PL
-015L	-18WL
-016L	-18PL

MILITARY DESIGNATION	TELEDYNE PART NO.
M39016/16 -001L	J432D -5WL
-002L	-6WL
-003L	-12WL
-004L	-26WL
-005L	-36WL
-006L	-48WL
-007L	-9WL
-008L	-18WL
-009L	-5PL
-010L	-6PL
-011L	-12PL
-012L	-26PL
-013L	-36PL
-014L	-48PL
-015L	-9PL
-016L	-18PL

MILITARY DESIGNATION	TELEDYNE PART NO.
M39016/21 -001L	J432DD -5WL
-002L	-6WL
-003L	-9WL
-004L	-12WL
-005L	-18WL
-006L	-26WL
-013L	-5PL
-014L	-6PL
-015L	-9PL
-016L	-12PL
-017L	-18PL
-018L	-26PL
-025L	-36WL
-026L	-48WL
-027L	-36PL
-028L	-48PL

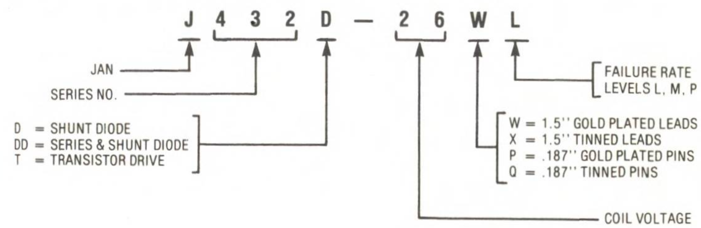
MILITARY DESIGNATION	TELEDYNE PART NO.
M28776/3 -001	J432T -5WL
-009	-5PL
-002	-6WL
-010	-6PL
-003	-9WL
-011	-9PL
-004	-12WL
-012	-12PL
-005	-18WL
-013	-18PL
-006	-26WL
-014	-26PL
-007	-36WL
-015	-36PL
-008	-48WL
-016	-48PL

"L" suffix denotes L level failure rate. Teledyne M39016/9, /15, & /20 relays also carry M and P level qualification; M28776/1 relays also carry M level qualification.

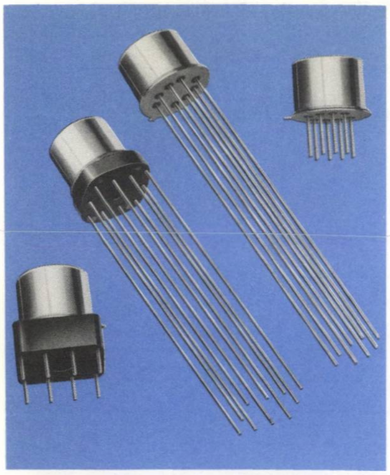
NOTES:

1. Relays will exhibit no contact chatter or transfer within specified ratings.
2. For reference only. Coil resistance not directly measurable at relay terminals due to internal series diode.
3. Measured at nominal voltage for 5 sec. maximum.
4. Screened hi-rel versions available on special order. Some relay models are qualified to one or more of the following NASA specifications:
   NASA/MSFC Spec. 40M37496
   NASA/GSFC Spec. S-311-P2(06)
5. Circuit is typical for all 432T Series. Values shown are for 432T-5 relay, and apply over full operating temperature range.

TELEDYNE PART NUMBERING SYSTEM FOR MIL-QUALIFIED RELAYS



(see pg. 44-47 for MIL part numbers)



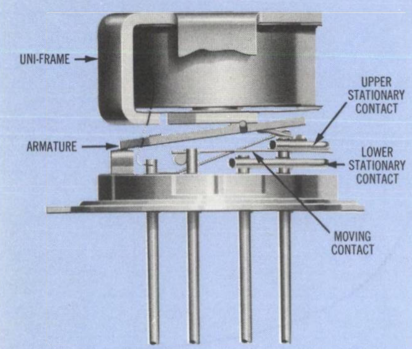
TELEDYNE RELAYS

HIGH TEMPERATURE (200°C) MILITARY STYLE TO-5 RELAY

DPDT

SERIES 412H

INTERNAL CONSTRUCTION



ENVIRONMENTAL AND PHYSICAL SPECIFICATIONS	
Temperature (Ambient)	-65°C to +200°C
Vibration	30 g's to 3000 Hz (Note 1)
Shock	75 g's for 6 msec. (Note 1)
Acceleration	75 g's (Note 1)
Enclosure	All welded, hermetically sealed
Weight	0.09 oz. (2.6gms.) max.

DESCRIPTION

The TO-5 Relay, originally conceived and developed by Teledyne, has become the industry standard for low level switching from dry circuit to 1 ampere. Designed expressly for high density PC Board mounting, its small size and low coil power dissipation make the TO-5 Relay the most versatile subminiature relay available.

The 412H Series of TO-5 Relays are designed for reliable operation in elevated ambient temperatures up to 200°C. Special material selection and processing provide assurance of freedom from contact contamination and mechanical malfunctioning that might otherwise be caused by ambient temperature conditions in excess of maximum military temperature limits.

Typical applications are:

- Aircraft avionics and control systems.
- Missile control systems.
- Spaceflight systems.
- Oil exploration (''down-hole'') instrumentation.
- High temperature industrial and process control instrumentation.

High temperature magnetic latching and sensitive relays are also available.

By virtue of its inherently low intercontact capacitance and contact circuit losses, the TO-5 relays has proven to be an excellent subminiature RF switch for frequency ranges up through UHF. A typical RF application for the TO-5 relay is in hand held radio transceivers, wherein the combined features of good RF performance, small size, low coil power dissipation and high reliability make it the preferred relay for T-R switching (see Figures 1 and 2).

DETAILED ELECTRICAL SPECIFICATIONS (-65°C to 200°C unless otherwise noted)

	GENERIC PART NUMBERS (SEE NOTE 2) ➡	412H-5 412HS-5	412H-6 412HS-6	412H-9 412HS-9	412H-12 412HS-12	412H-18 412HS-18	412H-26 412HS-26
Coil Voltage (VDC)	Nom.	5.0	6.0	9.0	12.0	18.0	26.5
	Max.	5.8	8.0	12.0	16.0	24.0	32.0
Coil Resistance (Ohms ±10% @ 25°C)		50	98	220	390	880	1560
Pick-up Voltage (VDC)	412	4.6	5.6	8.5	11.2	17.0	23.0
Drop-out Voltage (VDC)	Min.	0.14	0.18	0.35	0.41	0.59	0.89
	Max.	2.5	3.2	4.9	6.5	10.0	13.0

SERIES 412H

GENERAL ELECTRICAL SPECIFICATIONS (-65°C to +200°C unless otherwise noted) (Meets Requirements of MIL-R-39016 unless otherwise specified)

Contact Arrangement	2 Form C (DPDT)
Rated Duty	Continuous
Contact Resistance	0.1 ohm max. before life; 0.2 ohm max. after life at 1A/28VDC (measured 1/8'' from header)
Contact Load Ratings (DC)	Resistive: 1 Amp/28VDC Inductive: 200 mA/28VDC (320 mH) Lamp: 100 mA/28VDC (See Fig. 3 for other DC resistive voltage/current ratings)
Contact Load Ratings (AC)	Resistive: 600 mA/115VAC, 400 Hz (Case ungrounded); 400 mA/115VAC, 60 Hz (Case ungrounded). 200 mA/115VAC, 60 and 400 Hz, (Case grounded)
Contact Life Ratings	10,000,000 operations (typical) at low level 1,000,000 operations min. at 0.5A/28VDC resistive 100,000 operations min. at all other loads specified above
Contact Overloand Rating	2 Amps/28VDC (100 operations min.)
Contact Carry Rating	5 Amps (Continuous, unswitched)
Coil Operating Power	450 milliwatts nominal at nominal rated voltage at 25°C
Operate Time	2.0 msec. max. at nominal rated coil voltage
Release Time	1.5 msec. max.
Contact Bounce	1.5 msec. max.
Intercontact Capacitance	0.4 pf. typical
Insulation Resistance	10,000 megohms min. between mutually isolated terminals
Dielectric Strength	Sea level: 500 VRMS/60 Hz. 70,000 ft.: 125 VRMS/60 Hz.

PERFORMANCE CURVES

RF PERFORMANCE

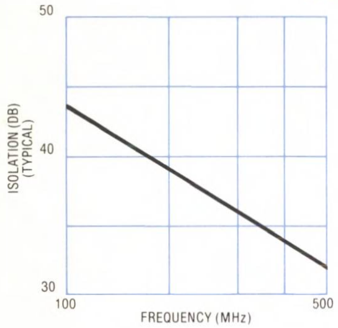


FIGURE 1

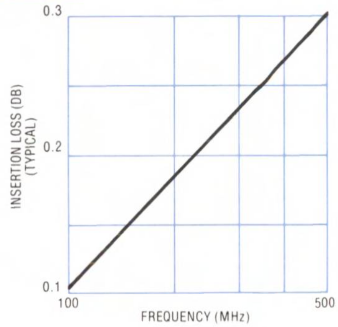


FIGURE 2

DC CONTACT RATINGS (RESISTIVE)

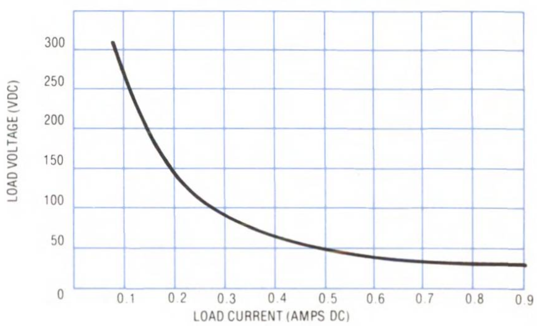
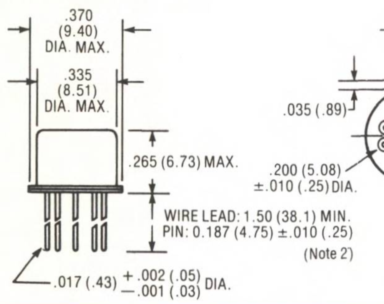
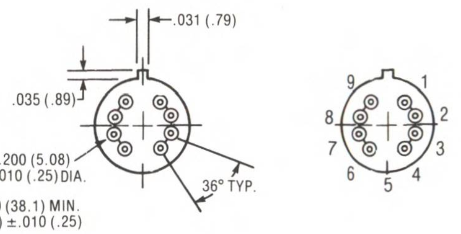


FIGURE 3

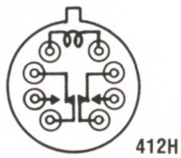
OUTLINE DIMENSIONS



TERMINAL LOCATIONS AND PIN NUMBERING (REF. ONLY) (Viewed from Terminals)



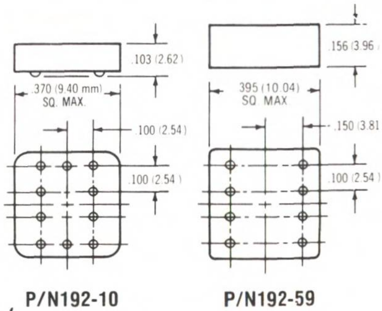
SCHEMATIC DIAGRAMS



SCHEMATICS ARE VIEWED FROM TERMINALS

SPREADER PADS

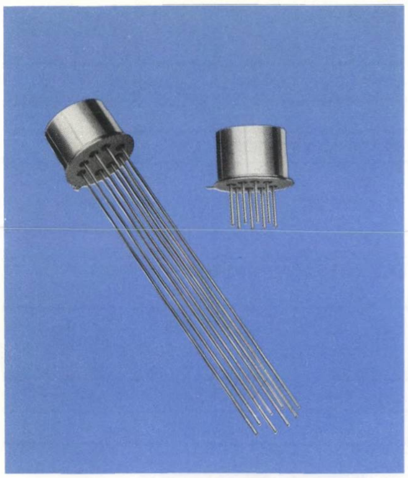
Relays can be supplied with spreader pads installed and cemented in place. Relays supplied with 192-59 pad installed have leads trimmed to .130'' (3.3mm) below pad. To order, add M for the 192-10 pad or M2 for the 192-59 pad to the part number (e.g., 412H-**M2**-26).



P/N192-10 (Qualified to M38527/5) **P/N192-59**

NOTES:

1. Relays will exhibit no contact chatter or transfer within specified ratings.
2. Unless otherwise specified relays are supplied with 1.500'' (38.10mm) leads. For .187'' (4.74mm) pin versions, add ''S'' to part number (i.e., 412H-26 becomes 412SH-26).
3. Screened hi-rel versions are available on special order and can be supplied to meet the requirements of NASA MSEC Spec. 40M 37496 or NASA GSEC Spec. S-311-P-2(06).

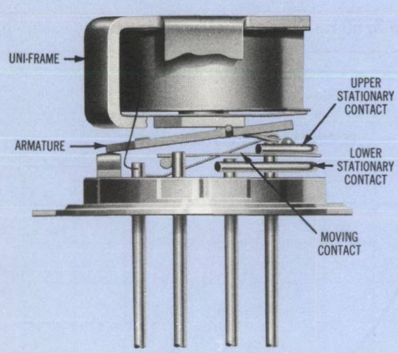


TELEDYNE RELAYS

HIGH SHOCK
MILITARY STYLE TO-5 RELAY
DPDT

SERIES 412K

INTERNAL CONSTRUCTION



ENVIRONMENTAL AND PHYSICAL SPECIFICATIONS	
Temperature (Ambient)	-65°C to +125°C
Vibration	30 g's to 3000 Hz
Shock	75 g's 6 msec. (Note 1)
	4000 g's 0.5 msec. axiel plane 2000 g's 0.5 msec. side planes (Note 2)
Acceleration	75 g's (Note 1)
Enclosure	All welded, hermetically sealed
Weight	0.09 oz. (2.6gms.) max.

DESCRIPTION

The TO-5 Relay, originally conceived and developed by Teledyne, has become the industry standard for low level switching from dry circuit to 1 ampere. Designed expressly for high density PC Board mounting, its small size and low coil power dissipation make the TO-5 Relay the most versatile subminiature relay available.

The 412K Series of TO-5 Relays are designed to withstand shock levels up to 4000 g's/.5 millisecond duration. Special material selection and construction details provide assurance that critical elements of the relay structure and mechanism will not be permanently displaced or damaged as a result of extremely high g level shocks.

Typical applications are:

- Missile control systems.
- Aircraft avionics and control systems.
- Spaceflight systems.

High shock magnetic latching and sensitive relays are also availalble.

By virtue of its inherently low intercontact capacitance and contact circuit losses, the TO-5 relay has proven to be an excellent subminiature RF switch for frequency ranges up through UHF. A typical RF application for the TO-5 relay is in hand held radio transceivers, wherein the combined features of good RF performance, small size, low coil power dissipation and high reliability make it the preferred relay for T-R switching (see Figures 1 and 2).

DETAILED ELECTRICAL SPECIFICATIONS (-65°C to +125°C unless otherwise noted)

	GENERIC PART NUMBERS (NOTE 3) ➡	412K-5 412KS-5	412K-6 412KS-6	412K-9 412KS-9	412K-12 412KS-12	412K-18 412KS-18	412K-26 412KS-26
Coil Voltage	Nom.	5.0	6.0	9.0	12.0	18.0	26.5
	Max.	5.8	8.0	12.0	16.0	14.0	32.0
Coil Resistance (Ohms ±10% @ 25°C)		50	80	160	300	600	1350
Pick-up Voltage (VDC)		4.3	5.2	7.6	10.0	14.3	21.0
Drop-out Voltage (VDC)	Min.	0.14	0.18	0.35	0.41	0.59	0.89
	Max.	2.5	3.2	4.9	6.5	10.0	13.0

412K SERIES

GENERAL ELECTRICAL SPECIFICATIONS (-65°C to +125°C unless otherwise noted)

(Meets Requirements of MIL-R-39016 unless otherwise specified)

Contact Arrangement	2 Form C (DPDT)	
Rated Duty	Continuous	
Contact Resistance	0.1 ohm max. before life; 0.2 ohm max. after life at 1A/28VDC (measured 1/8'' from header)	
Contact Load Ratings (DC)	Resistive: 1 Amp/28VDC Inductive: 200 mA/28VDC (320 mH) Lamp: 100 mA/28VDC (See Fig. 3 for other DC resistive voltage/current ratings)	
Contact Load Ratings (AC)	Resistive: 600 mA/115VAC, 400 Hz (Case ungrounded); 400 mA/115VAC, 60 Hz (Case ungrounded). 200 mA/115VAC, 60 and 400 Hz, (Case grounded)	
Contact Life Ratings	10,000,000 operations (typical) at low level 1,000,000 operations min. at 0.5A/28VDC resistive 100,000 operations min. at all other loads specified above	
Contact Overload Rating	2 Amps/28VDC (100 operations min.)	
Contact Carry Rating	5 Amps (Continuous, unswitched)	
Coil Operating Power	500 milliwatts nominal at nominal rated voltage at 25°C	
Operate Time	2.0 msec. max. at nominal rated coil voltage	
Release Time	1.5 msec. max.	
Contact Bounce	1.5 msec. max.	
Intercontact Capacitance	0.4 pf. typical	
Insulation Resistance	10,000 megohms min. between mutually isolated terminals	
Dielectric Strength	Sea level: 500 VRMS/60 Hz.	70,000 ft.: 125 VRMS/60 Hz.

PERFORMANCE CURVES

RF PERFORMANCE

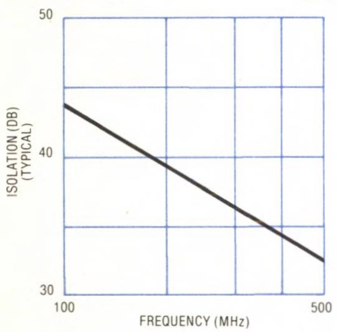


FIGURE 1

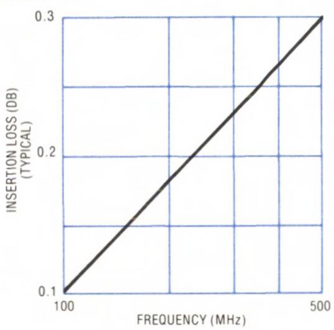


FIGURE 2

DC CONTACT RATINGS (RESISTIVE)

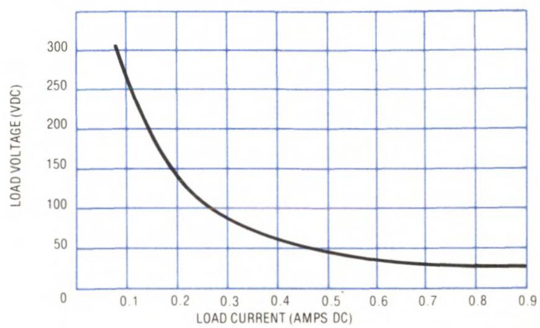
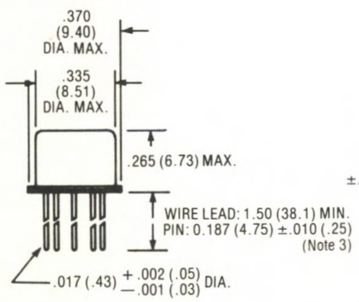
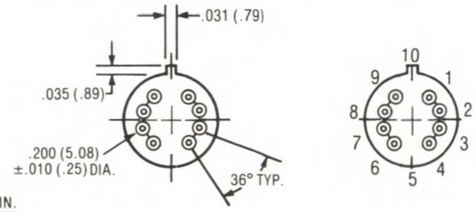


FIGURE 3

OUTLINE DIMENSIONS

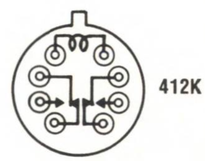


TERMINAL LOCATIONS AND PIN NUMBERING (REF. ONLY)
(Viewed from Terminals)



DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

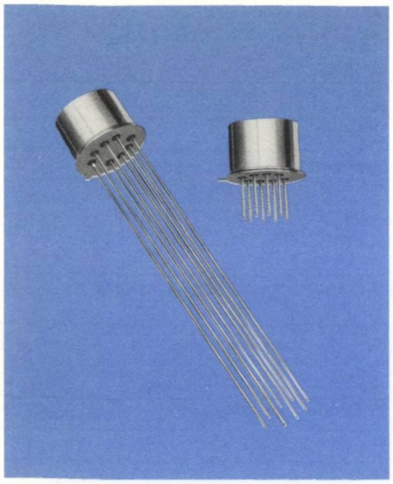
SCHEMATIC DIAGRAMS



SCHEMATICS ARE VIEWED FROM TERMINALS

NOTES:

1. Relays will exhibit no contact chatter or transfer within specified ratings.
2. Survival only - contact chatter may occur.
3. Unless otherwise specified relays are supplied with 1.500'' (38.10mm) leads. For .187'' (4.75mm) pin versions, add ''S'' to part number (i.e., 412K-26 becomes 412SK-26).
4. Screened hi-rel versions are available on special order and can be supplied to meet the requirements of NASA MSFC Spec. 40M 37496 or NASA GSFC Spec. S-311-P-2(06).



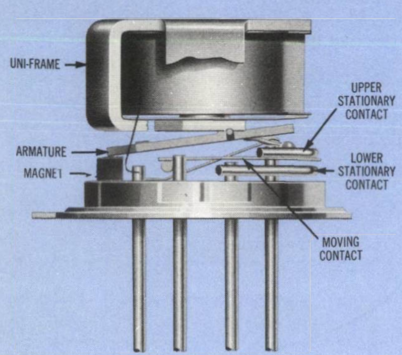
TELEDYNE RELAYS

HIGH VIBRATION MILITARY STYLE TO-5 RELAY

DPDT

SERIES 412V

INTERNAL CONSTRUCTION



ENVIRONMENTAL AND PHYSICAL SPECIFICATIONS	
Temperature (Ambient)	−65°C to + 125°C
Vibration	250 g's 140 to 2000Hz(Note 1)
Shock	150 g's for 11 msec. (Note 1)
Acceleration	75 g's (Note 1)
Enclosure	All welded, hermetically sealed
Weight	0.10 oz. (3.1gms.) max.

DESCRIPTION

The TO-5 Relay, originally conceived and developed by Teledyne, has become the industry standard for low level switching from dry circuit to 1 ampere. Designed expressly for high density PC Board mounting, its small size and low coil power dissipation make the TO-5 Relay the most versatile subminiature relay available.

The 412V Series of TO-5 Relays are designed to withstand vibration levels up to 250 g's sinusoidal up to 2000 Hz. A unique magnetic circuit prevents contact opening (chatter) in excess of 10 microseconds under vibration or shock conditions.

Typical applications are:

- Aircraft Avionics and control systems
- Missile control systems
- Spaceflight systems

High vibration versions of sensitive coil TO-5 Relays are also available.

By virtue of its inherently low intercontact capacitance and contact circuit losses, the TO-5 relay has proven to be an excellent subminiature RF switch for frequency ranges up through UHF. A typical RF application for the TO-5 relay is in hand held radio transceivers, wherein the combined features of good RF performance, small size, low coil power dissipation and high reliability make it the preferred relay for T-R switching (see Figures 1 and 2).

DETAILED ELECTRICAL SPECIFICATIONS (-65°C to +125°C unless otherwise noted)

	GENERIC PART Numbers (Note 2)	412V-5 412VS-5	412V-6 412VS-6	412V-9 412VS-9	412V-12 412VS-12	412V-18 412VS-18	412V-26 412VS-26
Coil Voltage (VDC)	Nom.	5.0	6.0	9.0	12.0	18.0	26.5
	Max.	5.8	8.0	12.0	16.0	24.0	32.0
Coil Resistance (Ohms ±10% @ 25°C)		50	70	155	235	610	1130
Pick-up Voltage (VDC)		4.6	5.5	8.2	11.0	16.5	22.0
Drop-out Voltage (VDC)	Min.	0.14	0.18	0.35	0.41	0.59	0.89
	Max.	2.5	3.2	4.9	6.5	10.0	13.0

SERIES 412V

GENERAL ELECTRICAL SPECIFICATIONS (-65°C to +125°C unless otherwise noted)
(Meets Requirements of MIL-R-39016 unless otherwise specified)

Contact Arrangement	2 Form C (DPDT)
Rated Duty	Continuous
Contact Resistance	0.1 ohm max. before life; 0.2 ohm max. after life at 1A/28VDC (measured 1/8'' from header)
Contact Load Ratings (DC)	Resistive: 1 Amp/28VDC Inductive: 200 mA/28VDC (320 mH) Lamp: 100 mA/28VDC (See Fig. 3 for other DC resistive voltage/current ratings)
Contact Load Ratings (AC)	Resistive: 600 mA/115VAC, 400 Hz (Case ungrounded); 400 mA/115VAC, 60 Hz (Case ungrounded). 200 mA/115VAC, 60 and 400 Hz, (Case grounded)
Contact Life Ratings	10,000,000 operations (typical) at low level 1,000,000 operations min. at 0.5A/28VDC resistive 100,000 operations min. at all other loads specified above
Contact Overload Rating	2 Amps/28VDC (100 operations min.)
Contact Carry Rating	5 Amps (Continuous, unswitched)
Coil Operating Power	525 milliwatts nominal at nominal rated voltage at 25°C
Operate Time	6.0 msec. max. at nominal rated coil voltage
Release Time	3.5 msec. max.
Contact Bounce	1.5 msec. max.
Intercontact Bounce	0.4 pf. typical
Insulation Resistance	10,000 megohms min. between mutually isolated terminals
Dielectric Strength	Sea level: 500 VRMS/60 Hz. 70,000 ft.: 125 VRMS/60 Hz.

PERFORMANCE CURVES

RF PERFORMANCE

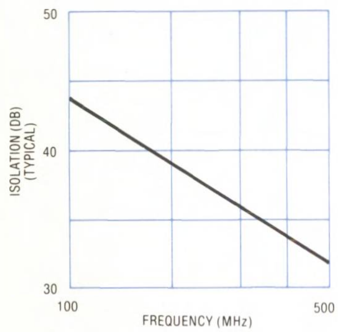


FIGURE 1

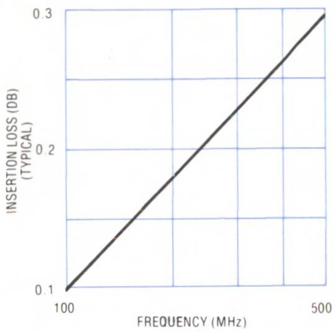


FIGURE 2

DC CONTACT RATINGS (RESISTIVE)

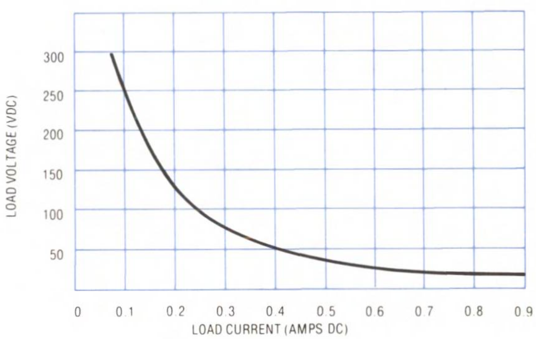
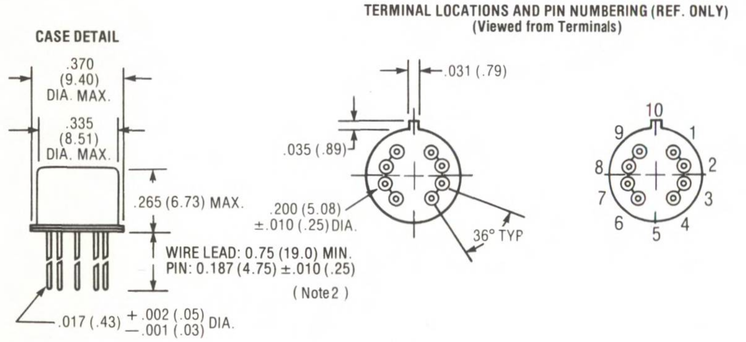
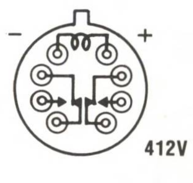


FIGURE 3

OUTLINE DRAWINGS

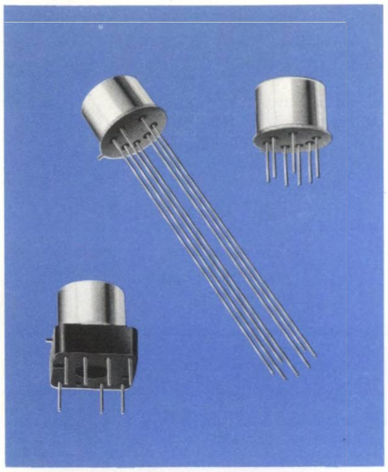


SCHEMATIC DIAGRAM



NOTES:

1. Relays will exhibit no contact chatter or transfer within specified ratings.
2. Unless otherwise specified relays are supplied with 1.500'' (38.10mm) leads. For .187'' (4.75mm) pin versions, add ''S'' to part number (i.e., 412V-26 becomes 412SV-26).
3. Screened hi-rel versions are available on special order and can be supplied to meet the requirements of NASA MSFC Spec. 40M 37496 or NASA GSFC Spec. S-311-P-2(06).



TELEDYNE RELAYS

MILITARY TO-5 RELAY

SPDT MAGNETIC LATCHING

SERIES 421

SERIES DESIGNATION	RELAY TYPE	QUALIFIED TO MILITARY SPECIFICATIONS
421	**SPDT basic relay**	MIL-R-39016/8 U.K. DEF. STD. 59/59 168/S/4093
421D	**SPDT relay with internal diode for coil transient suppression**	MIL-R-39016/27 U.K. DEF. STD. 59/59 177/S/4093
421DD	**SPDT relay with internal diodes for coil transient suppression and polarity reversal protection**	MIL-R-39016/28 U.K. DEF. STD. 59/59 178/S/4093

DESCRIPTION

The TO-5 relay, originally conceived and developed by Teledyne, has become the industry standard for low level switching from dry circuit to 0.5 ampere. Designed expressly for high density PC Board mounting, its small size and low coil dissipation make the TO-5 relay the most versatile subminiature relay available.

Unique construction features and manufacturing techniques provide excellent resistance to environmental extremes and overall high reliability.

- 100% all-welded construction.
- Patented uni-frame design providing high magnetic efficiency and mechanical rigidity.
- High force/mass ratios for resistance to shock and vibration.
- Advanced cleaning and sealing techniques provide maximum assurance of freedom from contact contamination.
- Precious metal contact material (gold, platinum, palladium alloy) with gold plating assures excellent high current and dry circuit switching capabilities.

The 421D and 421DD Series utilize internal discrete silicon diodes, with characteristics similar to 1N5315.

By virtue of its inherently low intercontact capacitance and contact circuit losses, the TO-5 relay has proven to be an excellent subminiature RF switch for frequency ranges up through UHF. A typical RF application for the TO-5 relay is in hand held radio transceivers, wherein the combined features of good RF performance, small size, low coil power dissipation and high reliability make it the preferred relay for T-R switching (see Figures 1 and 2).

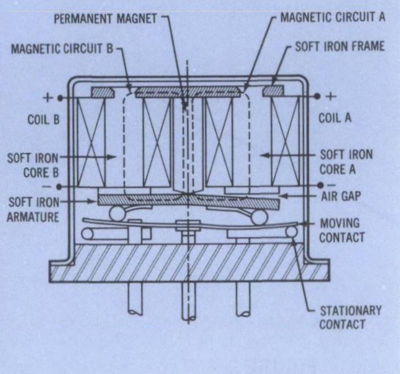
The 421 Series magnetic latching relays are ideally suited for applications where power dissipation must be minimized. The relays can be operated with a short duration pulse. After contacts have transferred, no holding power is required.

The magnetic latching feature of the 421 Series provides a "memory" capability, since the relays will not reset upon removal of power.

PRINCIPLE OF OPERATION

Energizing Coil B produces a magnetic field opposing the holding flux of the permanent magnet in Circuit B. As this net holding force decreases, the attractive force in the air gap of Circuit A, which also results from the flux of the permanent magnet, becomes great enough to break the armature free of Core B, and snap it into a closed position against Core A. The armature then remains in this position upon removal of energy from Coil B, but will snap back into position B upon energizing Coil A. Since operation depends upon cancellation of a magnetic field, it is necessary to apply the correct polarity to the relay coils as indicated on the relay schematic.

Coils should not be energized simultaneously with either DC or AC voltages. Particular attention should be given to transients, as an extremely short pulse above rated voltage applied to both coils, or to one coil with the other energized may cause permanent damage.



ENVIRONMENTAL AND PHYSICAL SPECIFICATIONS

Temperature (Ambient)	-65°C to +125°C
Vibration	30 g's to 3000 Hz (Note 1)
Shock	100 g's for 6 msec (Note 1)
Acceleration	75 g's (Note 1)
Enclosure	All welded, hermetically sealed
Weight	0.08 oz. (2.3gms.) max.

SERIES 421

GENERAL ELECTRICAL SPECIFICATIONS (-65°C to +125°C unless otherwise noted)

Contact Arrangement	1 Form C (DPDT)
Rated Duty	Continuous
Contact Resistance	0.1 ohm max. before life; 0.2 ohm max. after life at 0.5A/28VDC (measured 1/8'' from header)
Contact Load Ratings (DC)	Resistive: 0.5 Amp/28VDC Inductive: 100 mA/28VDC (320 mH) Lamp: 50 mA/28VDC (See Fig. 3 for other DC resistive voltage/current ratings)
Contact Load Ratings (AC)	Resistive: 400 mA/115VAC, 60 Hz & 400 Hz (Case ungrounded) 200 mA/115VAC, 60 and 400 Hz, (Case grounded)
Contact Life Ratings	10,000,000 operations (typical) at low level 100,000 operations min. at all other loads specified above
Contact Overload Rating	1 Amp/28VDC (100 operations min.)
Contact Carry Rating	4 Amps (Continuous, unswitched)
Coil Operating Power	290 milliwatts nominal at nominal rated voltage at 25°C
Operate Time	1.5 msec. max. at nominal rated coil voltage
Contact Bounce	0.5 msec. max.
Minimum Operate Pulse	1.5 msec. @ nominal voltage
Intercontact Capacitance	0.4 pf. typical
Insulation Resistance	10,000 megohms min. between mutually isolated terminals
Dielectric Strength	Sea level: 500 VRMS/60 Hz. 70,000 ft.: 125 VRMS/60 Hz.

DETAILED ELECTRICAL SPECIFICATIONS (-65°C to +125°C unless otherwise noted)

	GENERIC PART NUMBERS ➡	421-5 421D-5 421DD-5	421-6 421D-6 421DD-6	421-9 421D-9 421DD-9	421-12 421D-12 421DD-12	421-18 421D-18 421DD-18	421-26 421D-26 421DD-26
Coil Voltage (VDC)	Nom.	5.0	6.0	9.0	12.0	18.0	26.5
	Max.	5.8	8.0	12.0	16.0	24.0	32.0
Coil Resistance (Ohms ±10% @ 25°C)	421, 421D	61	120	280	500	1130	2000
	421DD (Note 2)	48	97	280	500	1130	2000
Coil Current (mADC @ 25°C) 421DD Series only	(Note 3) Min.	75.8	46.9	26.0	20.0	13.7	11.6
	(Note 3) Max.	104.2	62.0	33.7	25.5	17.2	14.4
Set & Reset Voltage (VDC) (See Note 4)	421/421D	3.5	4.5	6.8	9.0	13.5	18.0
	421DD	3.9	5.2	7.8	10.0	14.5	19.0
Diode P.I.V. (VDC, Min.) 421D, 421DD		100					
Negative Coil Transient (VDC, Max.) 421D, 421DD		1.0					

PERFORMANCE CURVES

RF PERFORMANCE

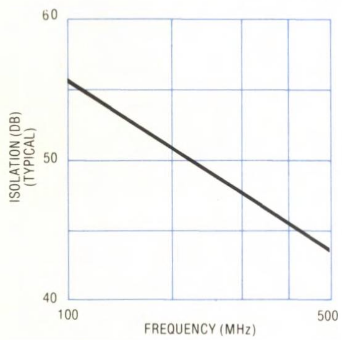


FIGURE 1

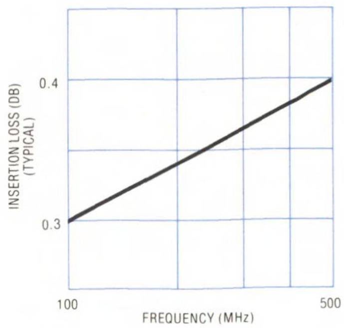


FIGURE 2

DC CONTACT RATINGS (RESISTIVE)

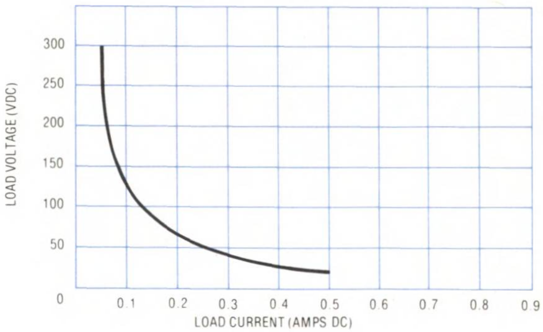
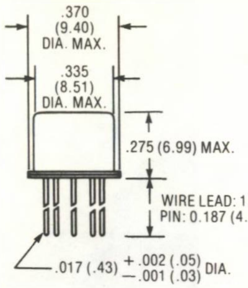


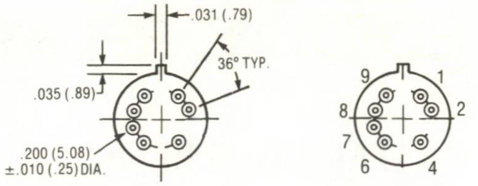
FIGURE 3

OUTLINE DRAWINGS

CASE DETAIL

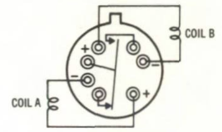


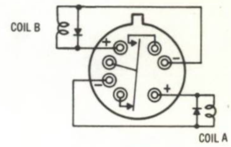
TERMINAL LOCATIONS AND PIN NUMBERING (REF. ONLY)
(Viewed from Terminals)



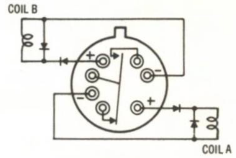
DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

SCHEMATIC DIAGRAMS





421D

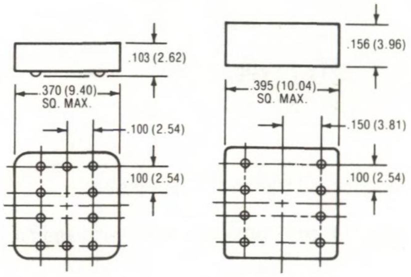


421DD

SCHEMATICS ARE VIEWED FROM TERMINALS
COIL A LAST ENERGIZED

SPREADER PADS

Relays can be supplied with spreader pads installed and cemented in place. Relays supplied with 192-59 pad installed have leads trimmed to .130'' (3.3mm) below pad. To order, add M for the 192-10 pad or M2 for the 192-59 pad to the part number (e.g., 421D**M2**-26).



P/N192-10
(Qualified to M38527/5)

P/N192-59

MILITARY RELAY P/N CROSS REFERENCE

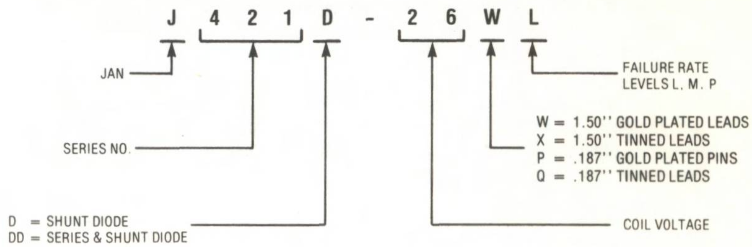
MILITARY DESIGNATION	TELEDYNE PART NO.	MILITARY DESIGNATION	TELEDYNE PART NO.	MILITARY DESIGNATION	TELEDYNE PART NO.
M39016/8 -001L	J421 -5WL	M39016/27 -001L	J421D -5WL	M39016/28 -001L	J421DD -5WL
-002L	-5PL	-002L	-6WL	-002L	-6WL
-003L	-6WL	-003L	-9WL	-003L	-9WL
-004L	-6PL	-004L	-12WL	-004L	-12WL
-005L	-9WL	-005L	-18WL	-005L	-18WL
-006L	-9PL	-006L	-26WL	-006L	-26WL
-007L	-12WL	-007L	-5PL	-007L	-5PL
-008L	-12PL	-008L	-6PL	-008L	-6PL
-009L	-18WL	-009L	-9PL	-009L	-9PL
-010L	-18PL	-010L	-12PL	-010L	-12PL
-011L	-26WL	-011L	-18PL	-011L	-18PL
-012L	-26PL	-012L	-26PL	-012L	-26PL

''L'' suffix denotes L level failure rate. Teledyne M39016/8, /27, /28 also carry M&P level qualification (See note 4).

NOTES:

1. Relays will exhibit no contact chatter or transfer within specified ratings.
2. For reference only. Coil resistance not directly measurable at relay terminals due to internal series diode.
3. Measured at nominal voltage for 5 sec. maximum.
4. Screened hi-rel versions available on special order. Some relay models are qualified to one or more of the following NASA specifications:
   NASA/MSFC Spec. 40M37496
   NASA/GSFC Spec. S-311-P2(06)

TELEDYNE PART NUMBERING SYSTEM FOR MIL-QUALIFIED RELAYS



(see pg. 44-47 for MIL part numbers)

TELEDYNE RELAYS

MILITARY TO-5 RELAY

DPDT MAGNETIC LATCHING

SERIES
420/422

SERIES DESIGNATION	RELAY TYPE	QUALIFIED TO MILITARY SPECIFICATIONS
422	**DPDT basic relay**	MIL-R-39016/12 U.K. DEF. STD. 59/59 166/S/4093
422D	**DPDT relay with internal diode for coil transient suppression**	MIL-R-39016/29 U.K. DEF. STD. 59/59 181/S/4093
422DD	**DPDT relay with internal diodes for coil transient suppression and polarity reversal protection**	MIL-R-39016/30 U.K. DEF. STD. 59/59 181/S/4093

DESCRIPTION

The TO-5 relay, originally conceived and developed by Teledyne, has become the industry standard for low level switching from dry circuit to 1 ampere. Designed expressly for high density PC Board mounting, its small size and low coil dissipation make the TO-5 relay the most versatile subminiature relay available.

Unique construction features and manufacturing techniques provide excellent resistance to environmental extremes and overall high reliablity.

- 100% all-welded construction.
- Patented uni-frame design providing high magnetic efficiency and mechanical rigidity.
- High force/mass ratios for resistance to shock and vibration.
- Advanced cleaning and sealing techniques provide maximum assurance of freedom from contact contamination.
- Precious metal contact material (gold, platinum, palladium alloy) with gold plating assures excellent high current and dry circuit switching capabilities.

The 420D/422DD and 420DD/422DD Series utilize discrete silicon diodes, with characteristics similar to 1N5315.

By virtue of its inherently low intercontact capacitance and contact circuit losses, the TO-5 relay has proven to be an excellent subminiature RF switch for frequency ranges up through UHF. A typical RF application for the TO-5 relay is in hand held radio transceivers, wherein the combined features of good RF performance, small size, low coil power dissipation and high reliability make it the preferred relay for T-R switching (see Figures 1 and 2).

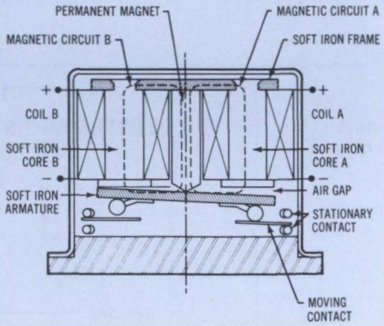
The 420/422 Series magnetic latching relays are ideally suited for applications where power dissipation must be minimized. The relays can be operated with a short duration pulse. After contacts have transferred, no holding power is required.

The magnetic latching feature of the 420/422 Series provides a "memory" capability, since the relays will not reset upon removal of power.

PRINCIPLE OF OPERATION

Energizing Coil B produces a magnetic field opposing the holding flux of the permanent magnet in Circuit B. As this net holding force decreases, the attractive force in the air gap of Circuit A, which also results from the flux of the permanent magnet, becomes great enough to break the armature free of Core B, and snap it into a closed position against Core A. The armature then remains in this position upon removal of energy from Coil B, but will snap back to position B upon energizing Coil A. Since operation depends upon cancellation of a magnetic field, it is necessary to apply the correct polarity to the relay coils as indicated on the relay schematic.

Coils should not be energized simultaneously with either DC or AC voltages. Particular attention should be given to transients, as an extremely short pulse above rated voltage applied to both coils, or to one coil with the other energized may cause permanent damage.



ENVIRONMENTAL AND PHYSICAL SPECIFICATIONS

Temperature (Ambient)	-65°C to +125°C
Vibration	30 g's to 3000 Hz (Note 1)
Shock	100 g's for 6 msec (Note 1)
Acceleration	75 g's (Note 1)
Enclosure	All welded, hermetically sealed
Weight	0.1 oz. (2.9gms.) max.

GENERAL ELECTRICAL SPECIFICATIONS (-65°C to +125°C unless otherwise noted)

Contact Arrangement	2 Form C (DPDT)
Rated Duty	Continuous
Contact Resistance	0.1 ohm max. before life; 0.2 ohm max. after life at 1A/28VDC (measured 1/8'' from header)
Contact Load Ratings (DC)	Resistive: 1 Amp/28VDC Inductive: 200 mA/28VDC (320 mH) Lamp: 100 mA/28VDC (See Fig. 3 for other DC resistive voltage/current ratings)
Contact Load Ratings (AC)	Resistive: 600 mA/115VAC, 400 Hz (Case ungrounded); 400 mA/115VAC, 60 Hz (Case ungrounded). 200 mA/115VAC, 60 and 400 Hz, (Case grounded)
Contact Life Ratings	10,000,000 operations (typical) at low level 1,000,000 operations min. at 0.5A/28VDC resistive 100,000 operations min. at all other loads specified above
Contact Overload Rating	2 Amps/28VDC (100 operations min.)
Contact Carry Rating	5 Amps (Continuous, unswitched)
Coil Operating Power	290 milliwatts nominal at rated voltage at 25°C
Operate Time	1.5 msec. max. at nominal rated coil voltage
Contact Bounce	2.0 msec. max.
Minimum Operate Pulse	1.5 msec. at nominal voltage
Intercontact Capacitance	0.4 pf. typical
Insulation Resistance	10,000 megohms min. between mutually isolated terminals
Dielectric Strength	Sea level: 500 VRMS/60 Hz; 70,000 ft.: 125 VRMS/60 Hz.

DETAILED ELECTRICAL SPECIFICATIONS (-65°C to +125°C unless otherwise noted)

	GENERIC PART NUMBERS ➡	420/422-5 420D/422D-5 420DD/422DD-5	420/422-6 420D/422D-6 420DD/422DD-6	420/422-9 420D/422D-9 420DD/422DD-9	420/422-12 420D/422D-12 420DD/422DD-12	420/422-18 420D/422D-18 420DD/422DD-18	420/422-26 420D/422D-26 420DD/422DD-26
Coil Voltage (VDC)	Nom.	5.0	6.0	9.0	12.0	18.0	26.5
	Max.	5.8	8.0	12.0	16.0	24.0	32.0
Coil Resistance (Ohms ±10% @ 25°C)	420/422, 420D/422D	61	120	280	500	1130	2000
	420DD/422DD (See Note 2)	48	97	280	500	1130	2000
Coil Current (mADC @ 25°C) 420DD/422DD only	(Note 3) Min.	75.8	46.2	21.0	20.0	13.7	11.6
	(Note 3) Max.	104.2	62.0	33.7	25.5	17.2	14.4
Set & Reset Voltage (VDC) (See Note 4)	420/422 420D/422D	3.5	4.5	6.8	9.0	13.5	18.0
	420DD/422DD	3.9	5.2	7.8	10.0	14.5	19.0
Diode P.I.V. (VDC, Min.) 420D/422D, 420DD/422DD		100					
Negative Coil Transient (VDC, Max.) 420D/422D, 420DD/422DD		1.0					

PERFORMANCE CURVES

RF PERFORMANCE

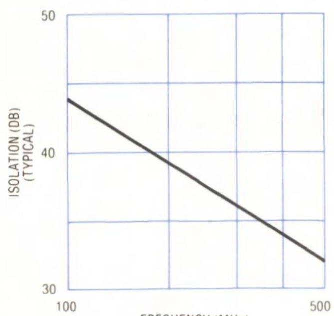


FIGURE 1

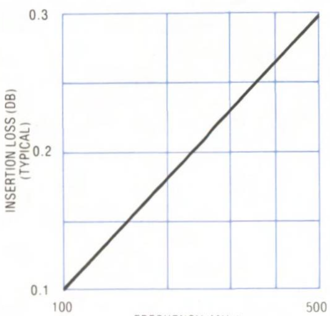


FIGURE 2

DC CONTACT RATINGS (RESISTIVE)

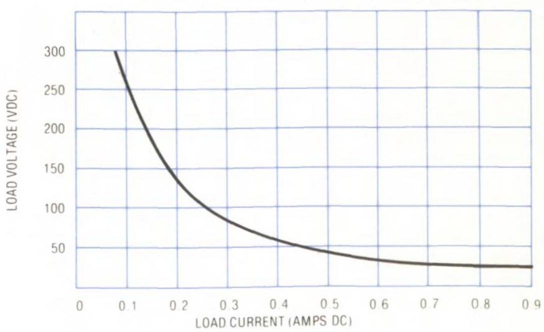
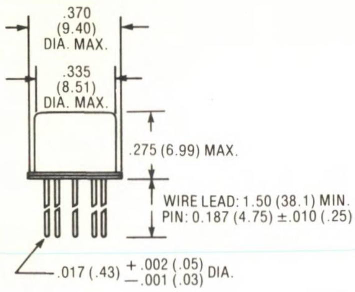


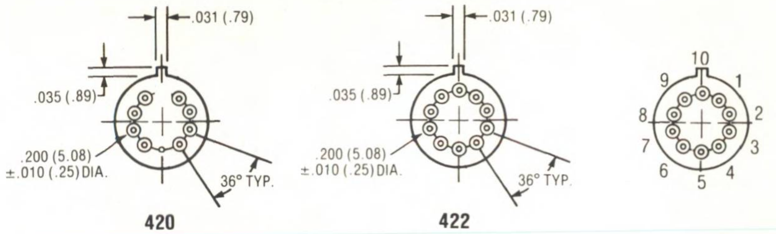
FIGURE 3

OUTLINE DIMENSIONS

CASE DETAIL



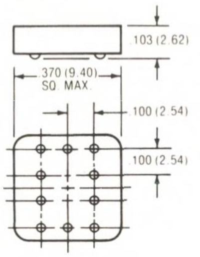
TERMINAL LOCATIONS AND PIN NUMBERING (REF. ONLY)
(Viewed from Terminals)



DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

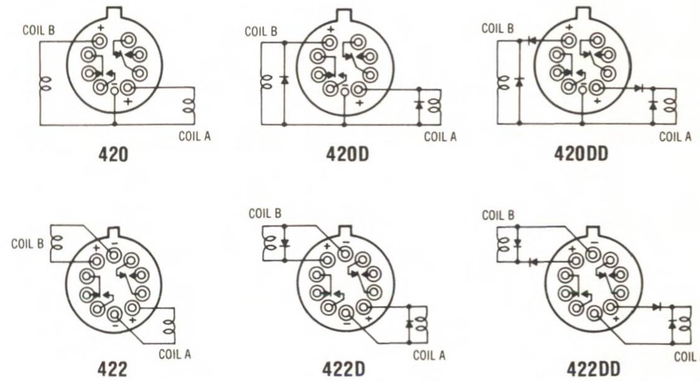
SPREADER PADS

Relays can be supplied with the P/N 192-10 spreader pad installed and cemented in place. To order, add M to the part number (e.g., 422D**M**-26).



P/N192-10
(Qualified to M38527/5)

SCHEMATIC DIAGRAMS



SCHEMATICS ARE VIEWED FROM TERMINALS.
CONTACTS SHOWN IN POSITION RESULTING WHEN COIL A LAST ENERGIZED.

MILITARY RELAY P/N CROSS REFERENCE

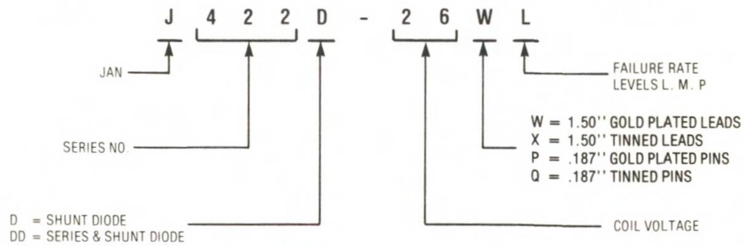
MILITARY DESIGNATION	TELEDYNE PART NO.	MILITARY DESIGNATION	TELEDYNE PART NO.	MILITARY DESIGNATION	TELEDYNE PART NO.	MILITARY DESIGNATION	TELEDYNE PART NO.	MILITARY DESIGNATION	TELEDYNE PART NO.	MILITARY DESIGNATION	TELEDYNE PART NO.
M39016/12 -001L	J420 -5WL	M39016/12 -013L	J422 -5WL	M39016/29 -001L	J420D -6WL	M39016/29 -013L	J422D -5WL	M39016/30 -001L	J420DD -6WL	M39016/30 -013L	J422DD -5WL
-002L	-6WL	-014L	-6WL	-002L	-9WL	-014L	-6WL	-002L	-9WL	-014L	-6WL
-003L	-9WL	-015L	-9WL	-003L	-12WL	-015L	-9WL	-003L	-12WL	-015L	-9WL
-004L	-12WL	-016L	-12WL	-004L	-18WL	-016L	-12WL	-004L	-18WL	-016L	-12WL
-005L	-18WL	-017L	-18WL	-005L	-26WL	-017L	-18WL	-005L	-26WL	-017L	-18WL
-006L	-26WL	-018L	-26WL	-006L	-6PL	-018L	-26WL	-006L	-6PL	-018L	-26WL
-007L	-5PL	-019L	-5PL	-007L	-9PL	-019L	-5PL	-007L	-9PL	-019L	-5PL
-008L	-6PL	-020L	-6PL	-008L	-12PL	-020L	-6PL	-008L	-12PL	-020L	-6PL
-009L	-9PL	-021L	-9PL	-009L	-18PL	-021L	-9PL	-009L	-18PL	-021L	-9PL
-010L	-12PL	-022L	-12PL	-010L	-26PL	-022L	-12PL	-010L	-26PL	-022L	-12PL
-011L	-18PL	-023L	-18PL	-011L	-5WL	-023L	-18PL	-011L	-5WL	-023L	-18PL
-012L	-26PL	-024L	-26PL	-012L	-5PL	-024L	-26PL	-012L	-5PL	-024L	-26PL

''L'' suffix denotes L level failure rate. M39016/12, /29, /30 also carry M & P level qualification (See Note 4)

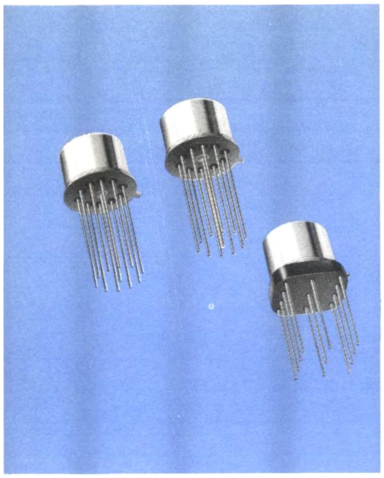
NOTES:

1. Relays will exhibit no contact chatter or transfer within specified ratings.
2. For reference only. Coil resistance not directly measurable at relay terminals due to internal series diode.
3. Measured at nominal voltage for 5 sec. maximum.
4. Screened hi-rel versions available on special order. Some relay models are qualified to one or more of the following NASA specifications:
   NASA/MSFC Spec. 40M37496
   NASA/GSFC Spec. S-311-P2(06)

TELEDYNE PART NUMBERING SYSTEM FOR MIL-QUALIFIED RELAYS



(see pg. 44-47 for MIL part numbers)



TELEDYNE RELAYS

MAGNETIC LATCHING MILITARY STYLE TO-5 RELAY

4 PST

SERIES 424A

SERIES DESIGNATION	RELAY TYPE
424A	**DPDT basic relay**
424AD	**DPDT relay with internal diode for coil transient suppression**

DESCRIPTION

The TO-5 relay, originally conceived and developed by Teledyne, has become the industry standard for low level switching from dry circuit to 0.5 ampere. Designed expressly for high density PC Board mounting, its small size and low coil dissipation make the TO-5 relay the most versatile subminiature relay available.

Unique construction features and manufacturing techniques provide excellent resistance to environmental extremes and overall high reliablity.

- 100% all-welded construction.
- Patented uni-frame design providing high magnetic efficiency and mechanical rigidity.
- High force/mass ratios for resistance to shock and vibration.
- Advanced cleaning and sealing techniques provide maximum assurance of freedom from contact contamination.
- Precious metal contact (gold, platinum, palladium alloy) with gold plating assures excellent high current and dry circuit switching capabilities.

The 424AD utilizes an internal discrete silicon diode, with characteristics similar to 1N5315.

By virtue of its inherently low intercontact capacitance and contact circuit losses, the TO-5 relay has proven to be an excellent subminiature RF switch for frequency ranges up through UHF. A typical RF application for the TO-5 relay is in hand held radio transceivers, wherein the combined features of good RF performance, small size, low coil power dissipation and high reliability make it the preferred relay for T-R switching (see Figures 1 and 2).

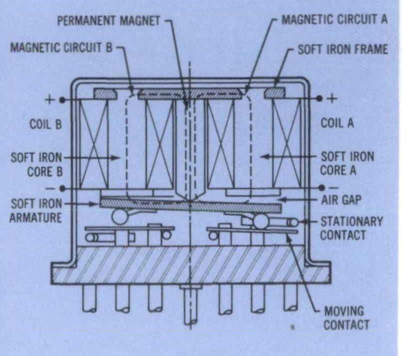
The 424A Series magnetic latching relays are ideally suited for applications where power dissipation must be minimized. The relays can be operated with a short duration pulse and after contacts have transferred, no holding power is required.

The magnetic latching feature of the 424A Series provides a ''memory'' capability, since the relays will not reset upon removal of power.

PRINCIPLE OF OPERATION

Energizing Coil B produces a magnetic field opposing the holding flux of the permanent magnet in Circuit B. As this net holding force decreases, the attractive force in the air gap of Circuit A, which also results from the flux of the permanent magnet, becomes great enough to break the armature free of Core B, and snap it into a closed position against Core A. The armature then remains in this position upon removal of energy from Coil B, but will snap back to position B upon energizing Coil A. Since operation depends upon cancellation of a magnetic field, it is necessary to apply the correct polarity to the relay coils as indicated on the relay schematic.

Coils should not be energized simultaenously with either DC or AC voltages. Particular attention should be given to transients, as an extremely short pulse above rated voltage applied to both coils, or to one coil with the other energized may cause permanent damage.



ENVIRONMENTAL AND PHYSICAL SPECIFICATIONS	
Temperature (Ambient)	-65°C to +125°C
Vibration	30 g's to 3000 Hz (Note 1)
Shock	100 g's for 6 msec. (Note 1)
Acceleration	75 g's (Note 1)
Enclosure	All welded, hermetically sealed
Weight	0.09 oz. (2.6gms.) max.

SERIES 424A

GENERAL ELECTRICAL SPECIFICATIONS (-65°C to +125°C unless otherwise noted)

Meets requirements of MIL-R-39016 unless otherwise specified. (See Note 2)

Contact Arrangement	4 Form A (4 PST)
Rated Duty	Continuous
Contact Resistance	0.1 ohm max. before life; 0.2 ohm max. after life at 0.5A/28VDC (measured 1/8'' from header)
Contact Load Ratings (DC)	Resistive: 0.5 Amp/28VDC Inductive: 100 mA/28VDC (320 mH) Lamp: 50 mA/28VDC (See Fig. 3 for other DC resistive voltage/current ratings)
Contact Load Ratings (AC)	Resistive: 400 mA/115VAC, 60 Hz & 400 Hz (Case ungrounded) 200 mA/115VAC, 60 and 400 Hz, (Case grounded)
Contact Life Ratings	10,000,000 operations (typical) at low level 100,000 operations min. at all other loads specified above
Contact Overload Rating	1 Amp/28VDC (100 operations min.)
Contact Carry Rating	4 Amps (Continuous, unswitched)
Coil Operating Power	290 milliwatts nominal at rated voltage at 25°C
Operate Time	1.5 msec. max. at nominal rated coil voltage
Minimum Operate Pulse	1.5 msec. @ nominal voltage
Contact Bounce	3.0 msec. max.
Intercontact Capacitance	0.4 pf. typical
Insulation Resistance	10,000 megohms min. between mutually isolated terminals
Dielectric Strength	Sea level: 350 VRMS/60 Hz — 70,000 ft.: 125 VRMS/60 Hz.

DETAILED ELECTRICAL SPECIFICATIONS (-65°C to +125°C unless otherwise noted)

	GENERIC PART NUMBERS ➡	424A-5 424AD-5	424A-6 424AD-6	424A-9 424AD-9	424A-12 424AD-12	424A-18 424AD-18	424A-26 424AD-26
Coil Voltage (VDC)	Nom.	5.0	6.0	9.0	12.0	18.0	26.5
	Max.	5.8	8.0	12.0	16.0	24.0	32.0
Coil Resistance (Ohms ±10% @ 25°C)		61	120	280	500	1130	2000
Set & Reset Voltage (VDC)		4.0	4.8	7.2	9.6	14.5	19.0
Diode P.I.V. (VDC, Min.) 424AD		100					
Negative Coil Transient (VDC, Max.) 424AD		1.0					

PERFORMANCE CURVES

RF PERFORMANCE

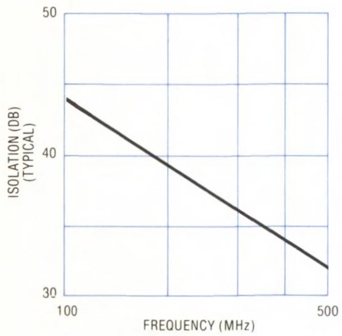


FIGURE 1

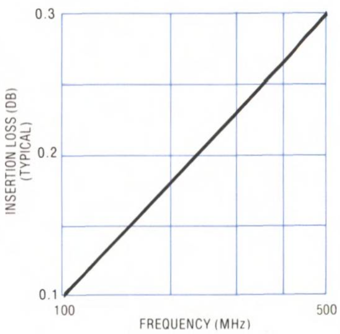


FIGURE 2

DC CONTACT RATINGS (RESISTIVE)

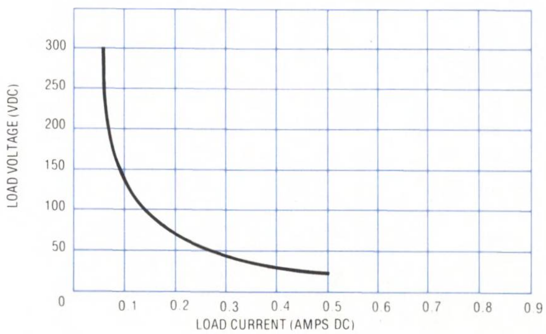
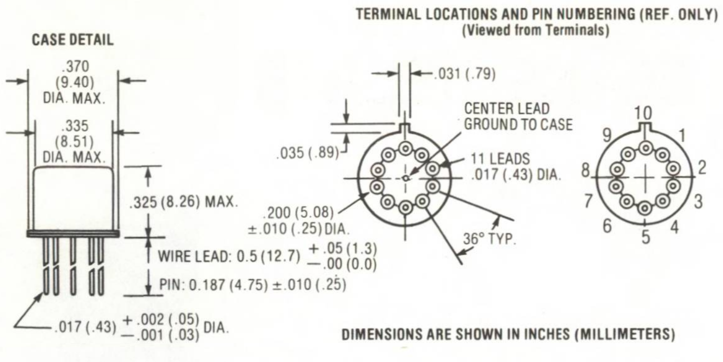


FIGURE 3

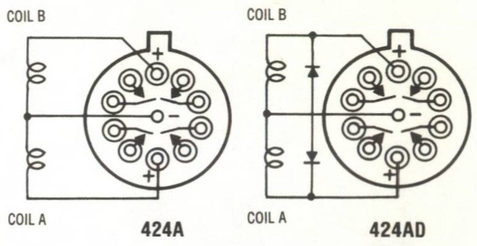
OUTLINE DIMENSIONS



DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

SCHEMATIC DIAGRAMS

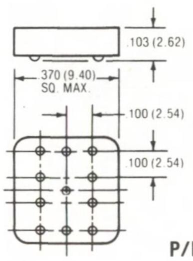
VIEWED FROM TERMINALS



Negative coil leads are internally common and grounded to case. Contacts shown in position resulting when Coil A last energized.

SPREADER PADS

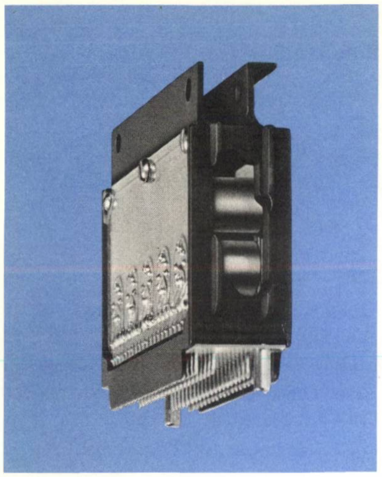
Relays can be supplied with spreader pads installed and cemented in place. To order, add M3 to the part number (e.g., 424AD**M3**-26).



P/N192-67

NOTES:

1. Relays will exhibit no contact chatter or transfer within specified ratings.
2. Screened hi-rel versions available on special order.



TELEDYNE RELAYS

SEM MODULE

SERIES 900

PART NUMBER	KEY CODE	RELAY DESCRIPTION	APPLICABLE MILITARY SPECIFICATION
900J432D26WM10	RRF	Relay module containing 10 DPDT TO-5 Relays.	MIL-M-28787/279
900J432D26WM5	RSP	Relay module containing 5 DPDT TO-5 Relays.	MIL-M-28787

ENVIRONMENTAL AND PHYSICAL SPECIFICATIONS

Temperature	-55°C to 100°C
Vibration	30g to 2,000 Hz (Note 1)
Shock	100g (Note 1)
Module Size	1B
Weight	RRF – 59 grms. max. RSP – 42 grms. max.
Durability	500 cycles.

GENERAL DESCRIPTION

The TO-5 relay, originally conceived and developed by Teledyne, has become the industry standard for low level switching from dry circuit to 1 ampere. Its small size, low coil dissipation and unique processing make the Teledyne TO-5 relay a versatile and reliable performer. This relay has now been incorporated into a Standard Electronic Module (SEM) for the Standard Electronic Module Program, thus making available all of the TO-5 relay advantages for military programs specifying SEM. The module conforms to MIL-M-28787 Class II and is a 1B size. Relays supplied in the module are type M39016/16-004M (Teledyne P/N J432D-26WM).

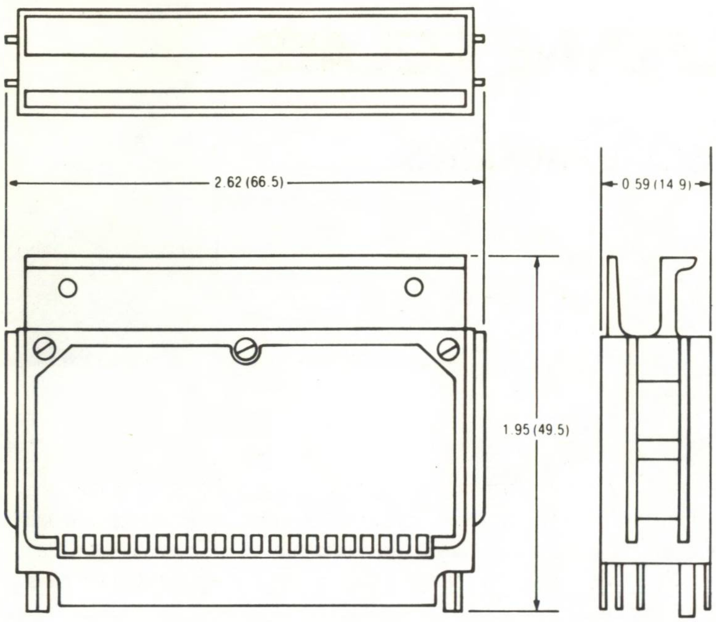
ELECTRICAL SPECIFICATIONS (Module)

Power Dissipation	5 watts at 32 VDC @ -55°C. 2.28 watts at 26 VDC @ 25°C.
Failure Rate	$.258/10^6$hrs. max. (RRF)

ELECTRICAL SPECIFICATIONS (each relay).

Pickup Voltage	6.0-20.0 VDC	
Drop Out Voltage	0.89-13.0 VDC	
Operate Time	4 ms max.	
Release Time	7.5 ms max.	
Contact Bounce	1.5 ms max.	
Contact Load Ratings (DC)	Resistive: 1 Amp/28VDC Inductive: 200 mA/28VDC (320 mH) Lamp: 100 mA/28VDC	(See Fig. 1 for other DC resistive voltage/current ratings)
Contact Load Ratings (AC)	Resistive: 600 mA/115VAC, 400 Hz (Case ungrounded); 400 mA/115VAC, 60 Hz (Case ungrounded) 200 mA/115VAC, 60 and 400 Hz, (Case grounded)	
Contact Life Ratings	10,000,000 operations (typical) at low level 1,000,000 operations min. at 0.5A/28VDC resistive 100,000 operations min. at all other loads specified above	
Contact Overload Rating	2 Amps/28VDC (100 operations min.)	
Contact Carry Rating	5 Amps (Continuous, unswitched)	

RRF & RSP OUTLINE DIMENSIONS



DIMENSIONS ARE SHOWN IN INCHES (MM)

DC CONTACT RATING CURVE

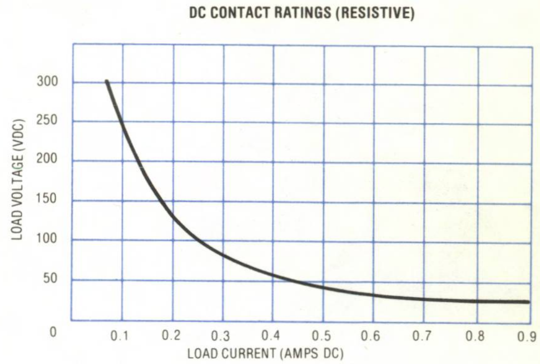
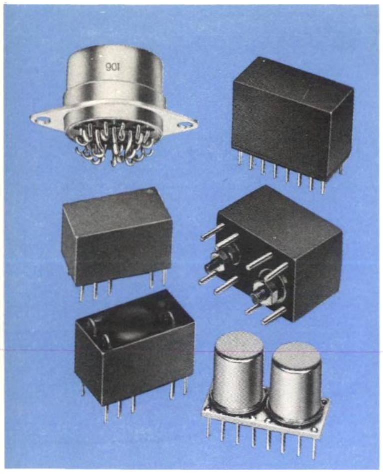


FIGURE 1

NOTES:

1. Relays will exhibit no contact chatter or transfer within specified ratings.



TELEDYNE RELAYS

SPECIAL PACKAGES

SERIES
901
902
910

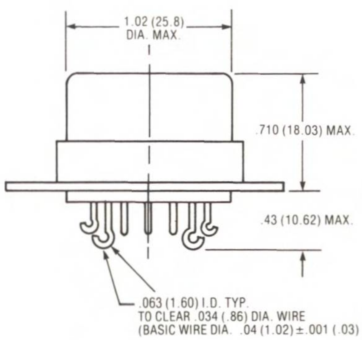
GENERAL DESCRIPTION

The TO-5 relay, originally conceived and developed by Teledyne, has become the industry standard for low level switching from dry circuit to 1 ampere. Its small size, low coil dissipation and unique processing make the Teledyne TO-5 relay a versatile and reliable performer. Because of its small size and high reliability, the TO-5 has often been called upon to replace other relays or to be incorporated into custom designs. To achieve this, the TO-5 has been repackaged in some of the more familiar package configurations. Below are examples of frequently requested packages. Other special designs can be made at the customer's request.

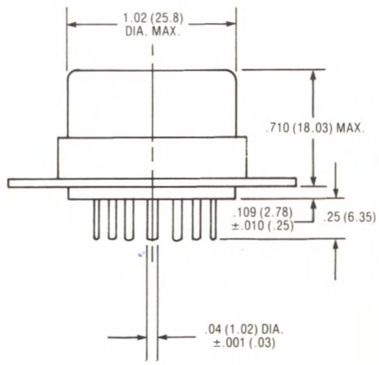
SERIES 901

The six PDT round relay, qualified to Mil-R-5757 and often found in old military hardware designs, has been reproduced using three 412 relays. It has a lower height (.710 in.) and a reduced contact rating (1 amp) compared to the original.

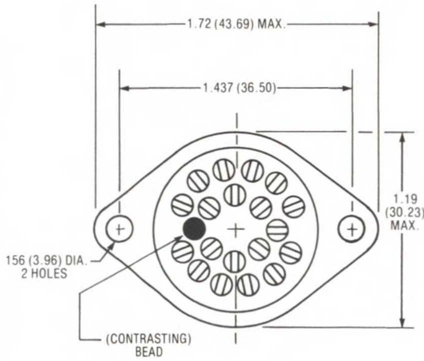
OUTLINE DIMENSIONS

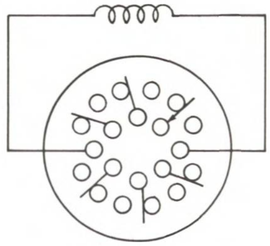


P/N 901-26H6



P/N 901-26P7

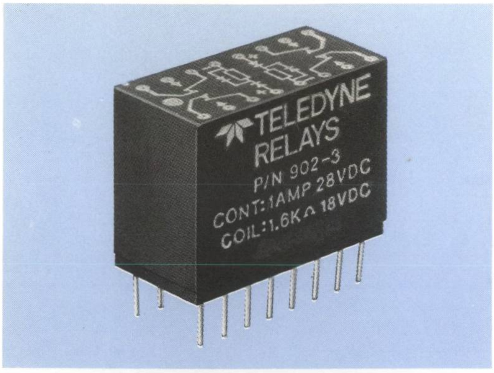




SCHEMATIC DIAGRAM
UNENERGIZED POSITION
BOTTOM VIEW

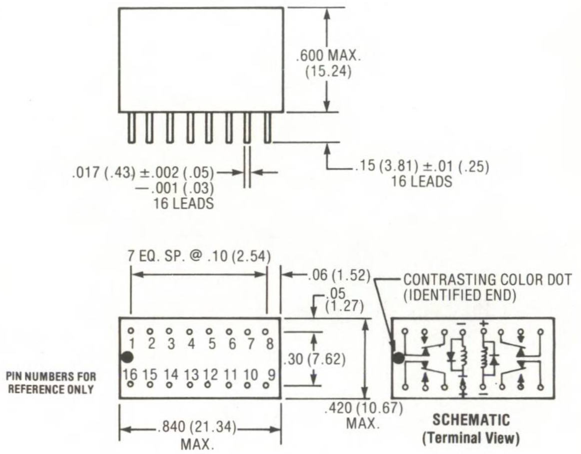
DIMENSIONS ARE SHOWN IN INCHES (MM)

SERIES 902-3



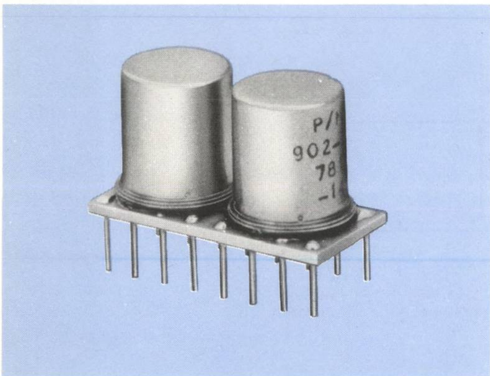
One of the most frequently asked for configurations is the DIP. In this design, two sensitive 432 relays are packaged together in a diallyl phthalate cup and then potted. The device retains all of the specifications of the TO-5 relay itself over a temperature range of −55°C to 125°C. Many variations of this relay; i.e., relays with different coil voltage, series diodes, and transistor drivers are also available.

OUTLINE DIMENSIONS



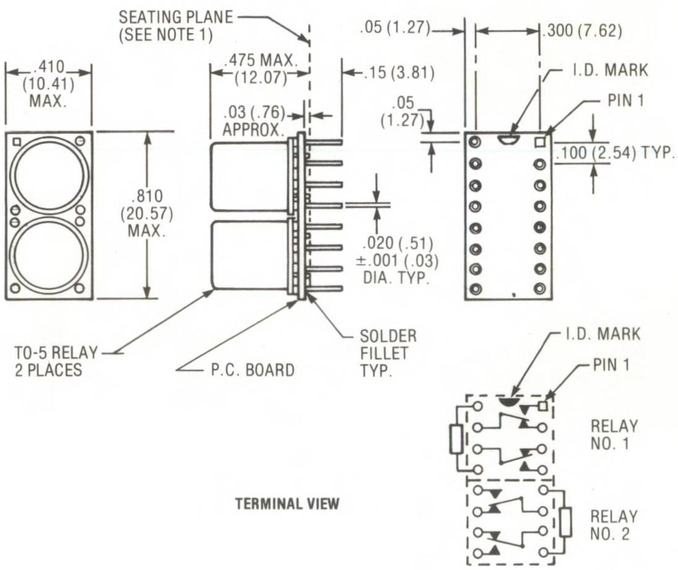
DIMENSIONS ARE SHOWN IN INCHES (MM)

SERIES 902-18



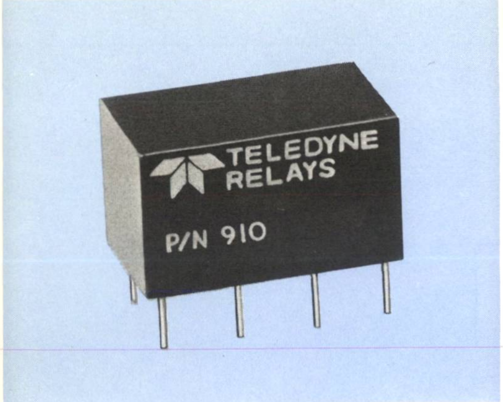
This relay is designed to be a direct plug-in replacement for the AMP 53451-1. Two 732 relays are mounted side by side on a PCB providing either 4 PDT or dual 2 PDT operation depending on how the relay coils are connected.

OUTLINE DIMENSIONS



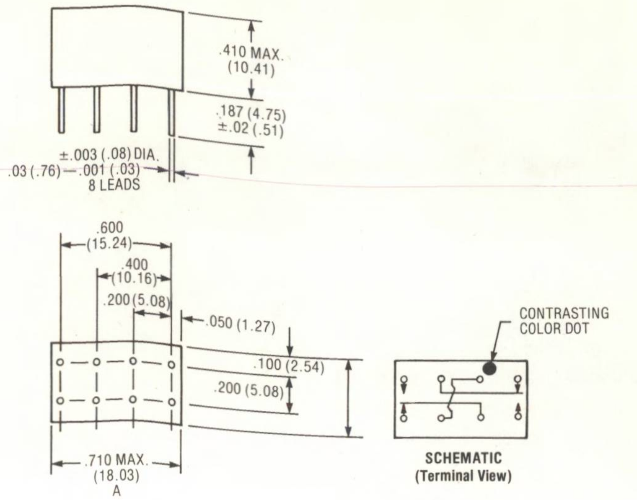
DIMENSIONS ARE SHOWN IN INCHES (MM)

SERIES 910



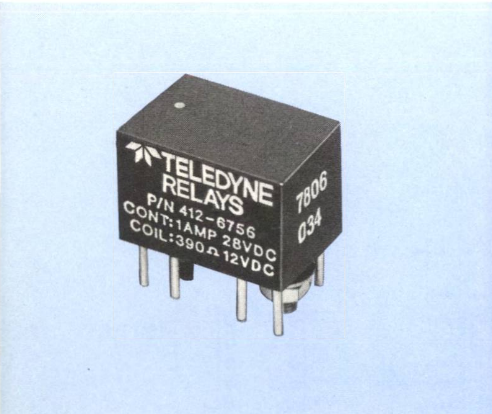
A single 412 TO-5 relay is mounted in a diallyl phthalate cup and potted to provide a replacement for the popular 1/2 crystal can relay. The length of the package has been reduced to .710 in. (0.1 in. shorter than the 1/2 crystal can). The 910 relay has been used where high reliability is essential at contact currents of 1 amp or less.

OUTLINE DIMENSIONS



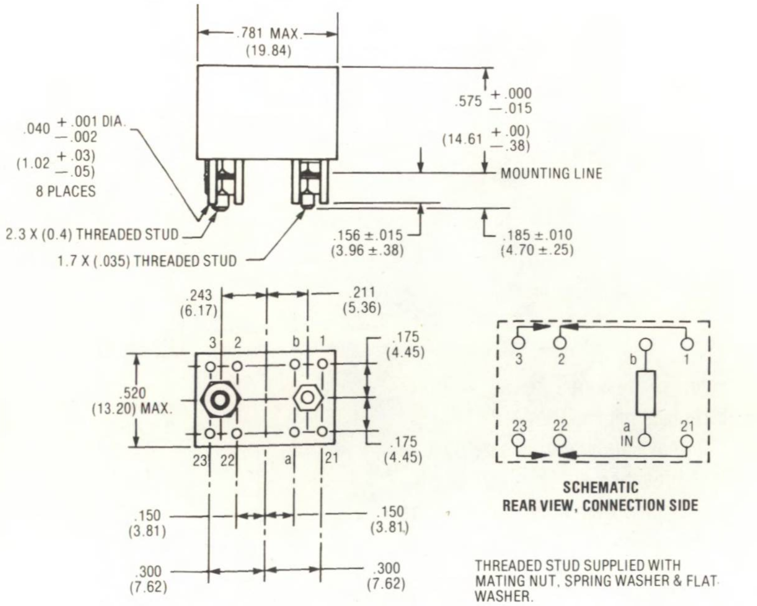
DIMENSIONS ARE SHOWN IN INCHES

412-6756



Another example of a special package employs the 412 relay potted in a diallyl phthalate cup with heavy duty terminals and mounting studs.

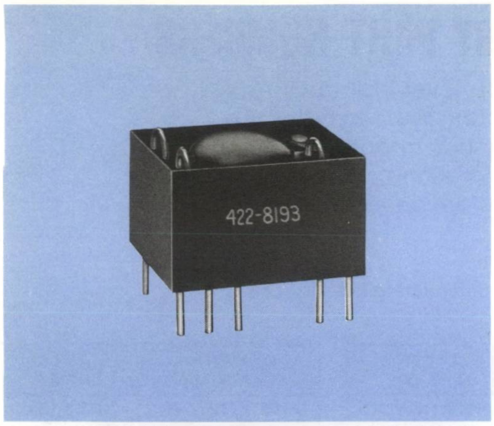
OUTLINE DIMENSIONS



THREADED STUD SUPPLIED WITH MATING NUT, SPRING WASHER & FLAT WASHER.

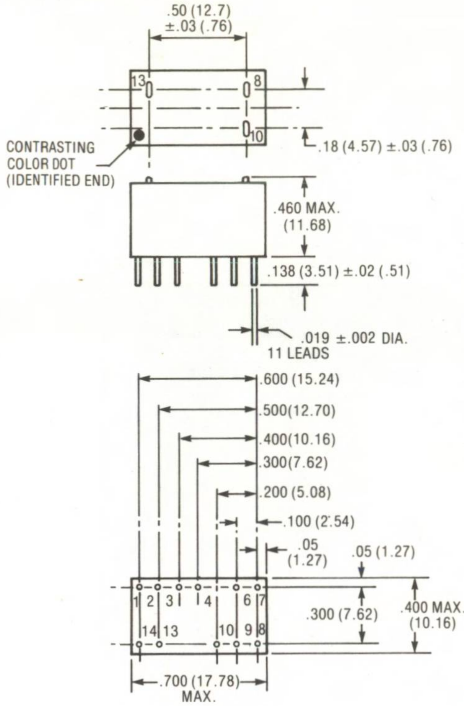
DIMENSIONS SHOWN IN INCHES (MILLIMETERS)

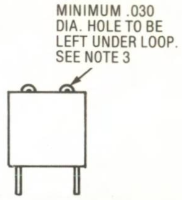
422-8193



This relay represents a more specialized package, using a 422D latch relay potted into a diallyl phthalate cup. Terminals are brought out on a DIP pattern and test point terminals are brought out on the top of the package.

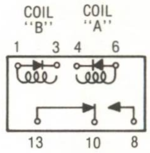
OUTLINE DIMENSIONS





NOTES:

1. Pins 2, 7, 9 and 14 are for mechanical stability only. No electrical connection required.
2. Positive coil voltage must be applied to pin 3 or 4.
3. Terminals are test probe points common to terminals 13, 10 and 8 as indicated.



SCHEMATIC
(TERMINAL VIEW)
CONTACTS IN POSITION RESULTING WHEN COIL "B" LAST ENERGIZED

DIMENSIONS ARE SHOWN IN INCHES

CROSS REFERENCE: TELEDYNE VS MILITARY PART NUMBERS

The military designation suffix letter listed refers to MIL level "L" qualification. Relays qualified to levels L, M, and P are indicated by ◇ symbol. To order the appropriate failure rate level, change suffix letter in both the military and Teledyne part numbers. Example: "M" level version of M28776/1-001L becomes M28776/1-001M; the corresponding Teledyne part number J412T-5WL becomes J412T-5WM.

◇ Indicates qualification to levels L, M, and P.   ● Indicates qualification to levels L and M.

MILITARY DESIGNATION	TELEDYNE PART NO.	
M39016/7 -001L	**J411**-5WL	
-002L	-5PL	
-003L	-6WL	
-004L	-6PL	
-005L	-9WL	
-006L	-9PL	
-007L	-12WL	
-008L	-12PL	
-009L	-18WL	
-010L	-18PL	
-011L	-26WL	
-012L	-26PL	
-013L	-5XL	
-014L	-5QL	
-015L	-6XL	◇
-016L	-6QL	
-017L	-9XL	
-018L	-9QL	
-019L	-12XL	
-020L	-12QL	
-021L	-18XL	
-022L	-18QL	
-023L	-26XL	
-024L	-26QL	

MILITARY DESIGNATION	TELEDYNE PART NO.	
M39016/8 -001L	**J421**-5WL	
-002L	-5PL	
-003L	-6WL	
-004L	-6PL	
-005L	-9WL	
-006L	-9PL	
-007L	-12WL	
-008L	-12PL	
-009L	-18WL	
-010L	-18PL	
-011L	-26WL	
-012L	-26PL	◇
-013L	-5XL	
-014L	-5QL	
-015L	-6XL	
-016L	-6QL	
-017L	-9XL	
-018L	-9QL	
-019L	-12XL	
-020L	-12QL	
-021L	-18XL	
-022L	-18QL	
-023L	-26XL	
-024L	-26QL	

MILITARY DESIGNATION	TELEDYNE PART NO.	
M39016/9 -001L	**J412**-5WL	
-002L	-6WL	
-003L	-9WL	
-004L	-12WL	
-005L	-18WL	◇
-006L	-26WL	
-007L	-5PL	
-008L	-6PL	
M39016/9 -009L	**J412**-9PL	
-010L	-12PL	
-011L	-18PL	
-012L	-26PL	
-013L	-5XL	
-014L	-6XL	◇
-015L	-9XL	
-016L	-12XL	
-017L	-18XL	
-018L	-26XL	
-019L	-5QL	
-020L	-6QL	
-021L	-9QL	
-022L	-12QL	
-023L	-18QL	
-024L	-26QL	
-049L	-30WL	
-050L	-30PL	
-051L	-30XL	
-052L	-30QL	

MILITARY DESIGNATION	TELEDYNE PART NO.	
M39016/10-001L	**J431**-5WL	
-002L	-5PL	
-003L	-6WL	
-004L	-6PL	
-005L	-12WL	
-006L	-12PL	
-007L	-26WL	
-008L	-26PL	
-009L	-32WL	
-010L	-32PL	
-011L	-40WL	
-012L	-40PL	
-013L	-9WL	◇
-014L	-9PL	
-015L	-18WL	
-016L	-18PL	
-017L	-5XL	
-018L	-5QL	
-019L	-6XL	
-020L	-6QL	
-021L	-12XL	
-022L	-12QL	
-023L	-26XL	
-024L	-26QL	
-025L	-32XL	
-026L	-32QL	
-027L	-40XL	
-028L	-40QL	
-029L	-9XL	
-030L	-9QL	
-031L	-18XL	
-032L	-18QL	

MILITARY DESIGNATION	TELEDYNE PART NO.	
M39016/11-001L	**J432**-5WL	
-002L	-5PL	
-003L	-6WL	◇
-004L	-6PL	
M39016/11-005L	**J432** -12WL	
-006L	-12PL	
-007L	-26WL	
-008L	-26PL	
-009L	-36WL	
-010L	-36PL	
-011L	-48WL	
-012L	-48PL	
-013L	-9WL	
-014L	-9PL	
-015L	-18WL	
-016L	-18PL	
-017L	-5XL	◇
-018L	-5QL	
-019L	-6XL	
-020L	-6QL	
-021L	-12XL	
-022L	-12QL	
-023L	-26XL	
-024L	-26QL	
-025L	-36XL	
-026L	-36QL	
-027L	-48XL	
-028L	-48QL	
-029L	-9XL	
-030L	-9QL	
-031L	-18XL	
-032L	-18QL	

MILITARY DESIGNATION	TELEDYNE PART NO.	
M39016/12-001L	**J420**-5WL	
-002L	-6WL	
-003L	-9WL	
-004L	-12WL	
-005L	-18WL	
-006L	-26WL	
-007L	-5PL	
-008L	-6PL	
-009L	-9PL	
-010L	-12PL	
-011L	-18PL	
-012L	-26PL	
-013L	**J422**-5WL	◇
-014L	-6WL	
-015L	-9WL	
-016L	-12WL	
-017L	-18WL	
-018L	-26WL	
-019L	-5PL	
-020L	-6PL	
-021L	-9PL	
-022L	-12PL	
-023L	-18PL	
-024L	-26PL	
M39016/12-025L	**J420**-5XL	
-026L	-6XL	
-027L	-9XL	◇
-028L	-12XL	
M39016/12-029L	**J420**-18XL	
-030L	-26XL	
-031L	**J422**-5XL	
-032L	-6XL	
-033L	-9XL	
-034L	-12XL	
-035L	-18XL	
-036L	-26XL	
-037L	**J420**-5QL	◇
-038L	-6QL	
-039L	-9QL	
-040L	-12QL	
-041L	-18QL	
-042L	-26QL	
-043L	**J422**-5QL	
-044L	-6QL	
-045L	-9QL	
-046L	-12QL	
-047L	-18QL	
-048L	-26QL	

MILITARY DESIGNATION	TELEDYNE PART NO.	
M39016/15-001L	**J412D**-6WL	
-002L	-9WL	
-003L	-12WL	
-004L	-18WL	
-005L	-26WL	
-006L	-5WL	
-017L	-6PL	
-018L	-9PL	
-019L	-12PL	
-020L	-18PL	
-021L	-26PL	
-022L	-5PL	
-029L	-6XL	
-030L	-9XL	
-031L	-12XL	
-032L	-18XL	
-033L	-26XL	
-034L	-5XL	◇
-035L	-6QL	
-036L	-9QL	
-037L	-12QL	
-038L	-18QL	
-039L	-26QL	
-040L	-5QL	
-053L	**J412DY**-6WL	
-054L	-9WL	
-055L	-12WL	
-056L	-18WL	
-057L	-26WL	
-058L	-5WL	
-065L	-6XL	
-066L	-9XL	
-067L	-12XL	
-068L	-18XL	
-069L	-26XL	
-070L	-5XL	

◇ Indicates qualification to levels L, M, and P.

● Indicates qualification to levels L and M.

MILITARY DESIGNATION	TELEDYNE PART NO.	
M39016/16-001L	**J432D**-5WL	
-002L	-6WL	
-003L	-12WL	
-004L	-26WL	
-005L	-36WL	
-006L	-48WL	
-007L	-9WL	
-008L	-18WL	
-009L	-5PL	
-010L	-6PL	
-011L	-12PL	
-012L	-26PL	
-013L	-36PL	
-014L	-48PL	
-015L	-9PL	
-016L	-18PL	
-017L	-5XL	◇
-018L	-6XL	
-019L	-12XL	
-020L	-26XL	
-021L	-36XL	
-022L	-48XL	
-023L	-9XL	
-024L	-18XL	
-025L	-5QL	
-026L	-6QL	
-027L	-12QL	
-028L	-26QL	
-029L	-36QL	
-030L	-48QL	
-031L	-9QL	
-032L	-18QL	

MILITARY DESIGNATION	TELEDYNE PART NO.	
M39016/17-001L	**J112**-5WL	
-002L	-6WL	
-003L	-9WL	
-004L	-12WL	
-005L	-18WL	
-006L	-26WL	
-007L	-5PL	
-008L	-6PL	
-009L	-9PL	
-010L	-12PL	
-011L	-18PL	
-012L	-26PL	◇
-013L	-5XL	
-014L	-6XL	
-015L	-9XL	
-016L	-12XL	
-017L	-18XL	
-018L	-26XL	
-019L	-5QL	
-020L	-6QL	
-021L	-9QL	
-022L	-12QL	
-023L	-18QL	
-024L	-26QL	

MILITARY DESIGNATION	TELEDYNE PART NO.	
M39016/18-001L	**J112D**-5WL	
-002L	-6WL	
-003L	-9WL	
-004L	-12WL	
-005L	-18WL	
-006L	-26WL	
-007L	-5PL	
-008L	-6PL	
-009L	-9PL	
-010L	-12PL	
-011L	-18PL	
-012L	-26PL	◇
-013L	-5XL	
-014L	-6XL	
-015L	-9XL	
-016L	-12XL	
-017L	-18XL	
-018L	-26XL	
-019L	-5QL	
-020L	-6QL	
-021L	-9QL	
-022L	-12QL	
-023L	-18QL	
-024L	-26QL	

MILITARY DESIGNATION	TELEDYNE PART NO.	
M39016/19-001L	**J112DD**-5WL	
-002L	-6WL	
-003L	-9WL	
-004L	-12WL	
-005L	-18WL	
-006L	-26WL	
-007L	-5PL	
-008L	-6PL	
-009L	-9PL	
-010L	-12PL	
-011L	-18PL	
-012L	-26PL	◇
-013L	-5XL	
-014L	-6XL	
-015L	-9XL	
-016L	-12XL	
-017L	-18XL	
-018L	-26XL	
-019L	-5QL	
-020L	-6QL	
-021L	-9QL	
-022L	-12QL	
-023L	-18QL	
-024L	-26QL	

MILITARY DESIGNATION	TELEDYNE PART NO.	
M39016/20-001L	**J412DD**-5WL	
-002L	-6WL	
-003L	-9WL	
-004L	-12WL	◇
-005L	-18WL	
-006L	-26WL	
-007L	-5XL	
-008L	-6XL	

MILITARY DESIGNATION	TELEDYNE PART NO.	
M39016/20-009L	**J412DD**-9XL	
-010L	-12XL	
-011L	-18XL	
-012L	-26XL	◇
-025L	-5PL	
-026L	-6PL	
-027L	-9PL	
-028L	-12PL	
-029L	-18PL	
-030L	-26PL	
-037L	-5QL	
-038L	-6QL	
-039L	-9QL	
-040L	-12QL	
-041L	-18QL	
-042L	-26QL	

MILITARY DESIGNATION	TELEDYNE PART NO.	
M39016/21-001L	**J432DD**-5WL	
-002L	-6WL	
-003L	-9WL	
-004L	-12WL	
-005L	-18WL	
-006L	-26WL	
-007L	-5XL	
-008L	-6XL	
-009L	-9XL	
-010L	-12XL	
-011L	-18XL	
-012L	-26XL	
-013L	-5PL	
-014L	-6PL	
-015L	-9PL	◇
-016L	-12PL	
-017L	-18PL	
-018L	-26PL	
-019L	-5QL	
-020L	-6QL	
-021L	-9QL	
-022L	-12QL	
-023L	-18QL	
-024L	-26QL	
-025L	-36WL	
-026L	-48WL	
-027L	-36PL	
-028L	-48PL	
-029L	-36XL	
-030L	-48XL	
-031L	-36QL	
-032L	-48QL	

MILITARY DESIGNATION	TELEDYNE PART NO.	
M39016/23-001L	**J411D**-5WL	
-002L	-6WL	
-003L	-9WL	
-004L	-12WL	
-005L	-18WL	◇
-006L	-26WL	
-007L	-5PL	
-008L	-6PL	

MILITARY DESIGNATION	TELEDYNE PART NO.	
M39016/23-009L	**J411D**-9PL	
-010L	-12PL	
-011L	-18PL	
-012L	-26PL	
-013L	-5XL	
-014L	-6XL	
-015L	-9XL	
-016L	-12XL	◇
-017L	-18XL	
-018L	-26XL	
-019L	-5QL	
-020L	-6QL	
-021L	-9QL	
-022L	-12QL	
-023L	-18QL	
-024L	-26QL	

MILITARY DESIGNATION	TELEDYNE PART NO.	
M39016/24-001L	**J411DD**-5WL	
-002L	-6WL	
-003L	-9WL	
-004L	-12WL	
-005L	-18WL	
-006L	-26WL	
-007L	-5PL	
-008L	-6PL	
-009L	-9PL	
-010L	-12PL	
-011L	-18PL	
-012L	-26PL	
-013L	-5XL	◇
-014L	-6XL	
-015L	-9XL	
-016L	-12XL	
-017L	-18XL	
-018L	-26XL	
-019L	-5QL	
-020L	-6QL	
-021L	-9QL	
-022L	-12QL	
-023L	-18QL	
-024L	-26QL	

MILITARY DESIGNATION	TELEDYNE PART NO.	
M39016/25-001L	**J431D**-5WL	
-002L	-6WL	
-003L	-12WL	
-004L	-26WL	
-005L	-32WL	
-006L	-40WL	
-007L	-5PL	
-008L	-6PL	◇
-009L	-12PL	
-010L	-26PL	
-011L	-32PL	
-012L	-40PL	
-013L	-9WL	
-014L	-18WL	
-015L	-9PL	
-016L	-18PL	

◇ Indicates qualification to levels L, M, and P.
● Indicates qualification to levels L and M.

MILITARY DESIGNATION	TELEDYNE PART NO.	
M39016/25-017L	**J431D**-5XL	
-018L	-6XL	
-019L	-12XL	
-020L	-26XL	
-021L	-32XL	
-022L	-40XL	
-023L	-9XL	
-024L	-18XL	◇
-025L	-5QL	
-026L	-6QL	
-027L	-12QL	
-028L	-26QL	
-029L	-32QL	
-030L	-40QL	
-031L	-9QL	
-032L	-18QL	
M39016/26-001L	**J431DD**-5WL	
-002L	-6WL	
-003L	-12WL	
-004L	-26WL	
-005L	-32WL	
-006L	-40WL	
-007L	-5PL	
-008L	-6PL	
-009L	-12PL	
-010L	-26PL	
-011L	-32PL	
-012L	-40PL	◇
-013L	-9WL	
-014L	-18WL	
-015L	-9PL	
-016L	-18PL	
-017L	-5XL	
-018L	-6XL	
-019L	-12XL	
-020L	-26XL	
-021L	-32XL	
-022L	-40XL	
-023L	-9XL	
-024L	-18XL	
M39016/26-025L	**J431DD**-5QL	
-026L	-6QL	
-027L	-12QL	
-028L	-26QL	◇
-029L	-32QL	
-030L	-40QL	
-031L	-9QL	
-032L	-18QL	
M39016/27-001L	**J421D**-5WL	
-002L	-6WL	
-003L	-9WL	
-004L	-12WL	◇
-005L	-18WL	
-006L	-26WL	
-007L	-5PL	

MILITARY DESIGNATION	TELEDYNE PART NO.	
M39016/27-008L	**J421D**-6PL	
-009L	-9PL	
-010L	-12PL	
-011L	-18PL	
-012L	-26PL	◇
-013L	-5XL	
-014L	-6XL	
-015L	-9XL	
-016L	-12XL	
-017L	-18XL	
-018L	-26XL	
-019L	-5QL	
-020L	-6QL	
-021L	-9QL	
-022L	-12QL	
-023L	-18QL	
-024L	-26QL	
M39016/28-001L	**J421DD**-5WL	
-002L	-6WL	
-003L	-9WL	
-004L	-12WL	
-005L	-18WL	
-006L	-26WL	
-007L	-5PL	
-008L	-6PL	
-009L	-9PL	
-010L	-12PL	
-011L	-18PL	◇
-012L	-26PL	
-013L	-5XL	
-014L	-6XL	
-015L	-9XL	
-016L	-12XL	
-017L	-18XL	
-018L	-26XL	
-019L	-5QL	
-020L	-6QL	
-021L	-9QL	
-022L	-12QL	
-023L	-18QL	
-024L	-26QL	
M39016/29-001L	**J420D**-6WL	
-002L	-9WL	
-003L	-12WL	
-004L	-18WL	
-005L	-26WL	
-006L	-6PL	
-007L	-9PL	
-008L	-12PL	
-009L	-18PL	
-010L	-26PL	
M39016/29-011L	**J422D**-5WL	
-012L	-5PL	◇
-013L	-5WL	
-014L	-6WL	
-015L	-9WL	

MILITARY DESIGNATION	TELEDYNE PART NO.	
M39016/29-016L	**J422D**-12WL	
-017L	-18WL	
-018L	-26WL	
-019L	-5PL	
-020L	-6PL	◇
-021L	-9PL	
-022L	-12PL	
-023L	-18PL	
-024L	-26PL	
M39016/29-025L	**J420D**-6XL	
-026L	-9XL	
-027L	-12XL	
-028L	-18XL	
-029L	-26XL	
-030L	-5XL	
-031L	**J422D**-5XL	
-032L	-6XL	
-033L	-9XL	
-034L	-12XL	
-035L	-18XL	
-036L	-26XL	◇
-037L	**J420D**-6QL	
-038L	-9QL	
-039L	-12QL	
-040L	-18QL	
-041L	-26QL	
-042L	-5QL	
-043L	**J422D**-5QL	
-044L	-6QL	
-045L	-9QL	
-046L	-12QL	
-047L	-18QL	
-048L	-26QL	
M39016/30-001L	**J420DD**-6WL	
-002L	-9WL	
-003L	-12WL	
-004L	-18WL	
-005L	-26WL	
-006L	-6PL	
-007L	-9PL	
-008L	-12PL	
-009L	-18PL	
-010L	-26PL	
-011L	-5WL	◇
-012L	-5PL	
-013L	**J422DD**-5WL	
-014L	-6WL	
-015L	-9WL	
-016L	-12WL	
-017L	-18WL	
-018L	-26WL	
-019L	-5PL	
-020L	-6PL	
-021L	-9PL	
-022L	-12PL	
-023L	-18PL	

MILITARY DESIGNATION	TELEDYNE PART NO.	
M39016/30-024L	**J422DD**-26PL	
-025L	**J420DD**-6XL	
-026L	-9XL	
-027L	-12XL	
-028L	-18XL	
-029L	-26XL	
-030L	-5XL	
-031L	**J422DD**-5XL	
-032L	-6XL	
-033L	-9XL	◇
-034L	-12XL	
-035L	-18XL	
-036L	-26XL	
-037L	**J420DD**-6QL	
-038L	-9QL	
-039L	-12QL	
-040L	-18QL	
-041L	-26QL	
-042L	-5QL	
-043L	**J422DD**-5QL	
-044L	-6QL	
-045L	-9QL	
-046L	-12QL	
-047L	-18QL	
-048L	-26QL	
M28776/1 -001L	**J412T**-5WL	
-002L	-6WL	
-003L	-9WL	
-004L	-12WL	
-005L	-18WL	
-006L	-26WL	
-007L	-5PL	
-008L	-6PL	
-009L	-9PL	
-010L	-12PL	
-011L	-18PL	
-012L	-26PL	●
-013L	-5XL	
-014L	-6XL	
-015L	-9XL	
-016L	-12XL	
-017L	-18XL	
-018L	-26XL	
-019L	-5QL	
-020L	-6QL	
-021L	-9QL	
-022L	-12QL	
-023L	-18QL	
-024L	-26QL	
M28776/3-001L	**J432T**-5WL	
-002L	-6WL	
-003L	-9WL	
-004L	-12WL	●
-005L	-18WL	
-006L	-26WL	

◇ Indicates qualification to levels L, M, and P.

● Indicates qualification to levels L and M.

MILITARY DESIGNATION	TELEDYNE PART NO.	
M28776/3 -007L	**J432T** -36WL	
-008L	-48WL	
-009L	-5PL	
-010L	-6PL	
-011L	-9PL	
-012L	-12PL	
-013L	-18PL	
-014L	-26PL	
-015L	-36PL	
-016L	-48PL	●
-017L	-5XL	
-018L	-6XL	
-019L	-9XL	
-020L	-12XL	
-021L	-18XL	
-022L	-26XL	
-023L	-36XL	
-024L	-48XL	
-025L	-5QL	
-026L	-6QL	
-027L	-9QL	
-028L	-12QL	
-029L	-18QL	
-030L	-26QL	
-031L	-36QL	
-032L	-48QL	

M28776/4 -001L	**J431T**-5WL	
-002L	-6WL	
-003L	-9WL	
-004L	-12WL	
-005L	-18WL	
-006L	-26WL	
-007L	-32WL	
-008L	-40WL	
-009L	-5PL	
-010L	-6PL	
-011L	-9PL	
-012L	-12PL	
-013L	-18PL	
-014L	-26PL	
-015L	-32PL	
-016L	-40PL	
-017L	-5XL	
-018L	-6XL	
-019L	-9XL	●
-020L	-12XL	
-021L	-18XL	
-022L	-26XL	
-023L	-36XL	
-024L	-48XL	
-025L	-5QL	
-026L	-6QL	
-027L	-9QL	
-028L	-12QL	
-029L	-18QL	
-030L	-26QL	
-031L	-36QL	
-032L	-48QL	

MILITARY DESIGNATION	TELEDYNE PART NO.	
M28776/5 -001L	**J411T**-5WL	
-002L	-6WL	
-003L	-9WL	
-004L	-12WL	
-005L	-18WL	
-006L	-26WL	
-007L	-5PL	
-008L	-6PL	
-009L	-9PL	
-010L	-12PL	
-011L	-18PL	
-012L	-26PL	●
-013L	-5XL	
-014L	-6XL	
-015L	-9XL	
-016L	-12XL	
-017L	-18XL	
-018L	-26XL	
-019L	-5QL	
-020L	-6QL	
-021L	-9QL	
-022L	-12QL	
-023L	-18QL	
-024L	-26QL	

M39016/41 -001L	**J132** -5WL
-002L	-6WL
-003L	-12WL
-004L	-26WL
-005L	-36WL
-006L	-48WL
-007L	-9WL
-008L	-18WL
-009L	-5PL
-010L	-6PL
-011L	-12PL
-012L	-26PL
-013L	-36PL
-014L	-48PL
-015L	-9PL
-016L	-18PL
-017L	-5XL
-018L	-6XL
-019L	-12XL
-020L	-26XL
-021L	-36XL
-022L	-48XL
-023L	-9XL
-024L	-18XL
-025L	-5QL
-026L	-6QL
-027L	-12QL
-028L	-26QL
-029L	-36QL
-030L	-48QL
-031L	-9QL
-032L	-18QL

M39016/42 -001L	**J132D** -4WL
-002L	-6WL
-003L	-12WL

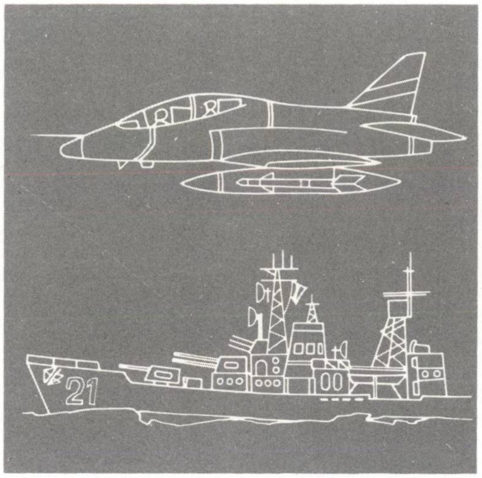
MILITARY DESIGNATION	TELEDYNE PART NO.
-004L	-26WL
-005L	-36WL
-006L	-48WL
-007L	-9WL
-008L	-18WL
-009L	-5PL
-010L	-6PL
-011L	-12PL
-012L	-26PL
-013L	-36PL
-014L	-48PL
-015L	-9PL
-016L	-18PL
-017L	-5XL
-018L	-6XL
-019L	-12XL
-020L	-26XL
-021L	-36XL
-022L	-48XL
-023L	-9XL
-024L	-18XL
-025L	-5QL
-026L	-6QL
-027L	-12QL
-028L	-26 QL
-029L	-36QL
-030L	-48QL
-031L	-9QL
-032L	-18QL

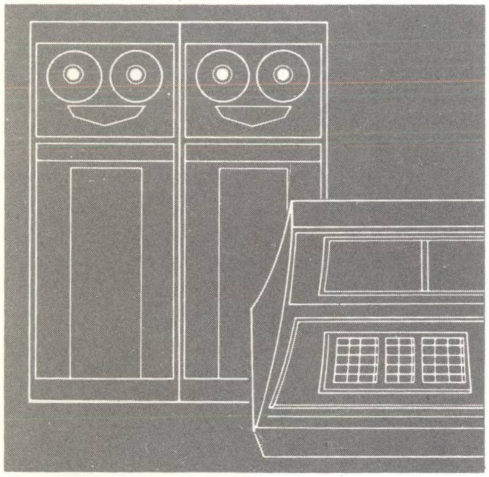
M39016/43 -001L	**J132DD**-5WL
-002L	-6WL
-003L	-9WL
-004L	-12WL
-005L	-18WL
-006L	-26WL
-007L	-36WL
-008L	-48WL
-009L	-5PL
-010L	-6PL
-011L	-9PL
-012L	-12PL
-031L	-18PL
-014L	-26PL
-015L	-36PL
-016L	-48PL
-017L	-5XL
-018L	-6XL
-019L	-9XL
-020L	-12XL
-021L	-18XL
-022L	-26XL
-023L	-36XL
-024L	-48XL
-025L	-5QL
-026L	-6QL
-027L	-9QL
-028L	-12QL
-029L	-18QL
-030L	-26QL
-031L	-36QL
-032L	-48QL

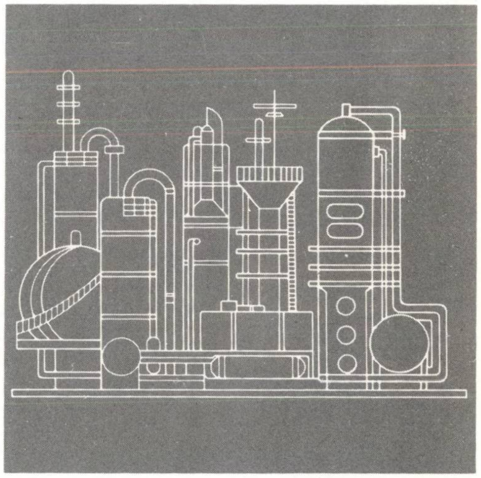
MILITARY DESIGNATION	TELEDYNE PART NO.
MIL-R-28750	
M28750/5 -001	**M640**-1W
M28750/6 -001	**M643**-1W
M28750/7 -001	-2W

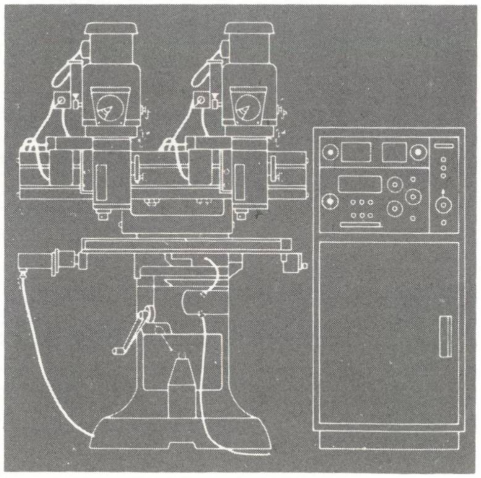
SECTION II

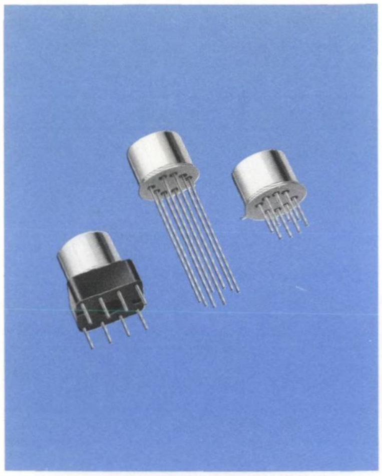
Commercial/Industrial TO-5 Relays











TELEDYNE RELAYS

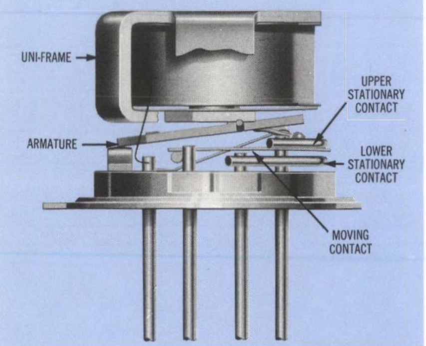
COMMERCIAL/INDUSTRIAL TO-5 RELAYS

DPDT

SERIES 712

SERIES DESIGNATION	RELAY TYPE
712	**DPDT basic relay**
712D	**DPDT relay with internal diode for coil transient suppression**
712TN	**DPDT relay with internal transistor driver and coil suppression diode**

INTERNAL CONSTRUCTION



ENVIRONMENTAL AND PHYSICAL SPECIFICATIONS	
Temperature Ambient	-55°C to +71°C
Vibration	10 g's to 500 Hz (Note 1)
Shock	30 g's for 6 msec. (Note 1)
Enclosure	All welded, hermetically sealed
Weight	0.09 oz. (2.6 gms.) max.

DESCRIPTION

The TO-5 relay, originally conceived and developed by Teledyne, has become the industry standard for low level switching from dry circuit to 1 ampere. Designed expressly for high density PC Board mounting, its small size and low coil dissipation make the TO-5 relay the most versatile subminiature relay available.

Unique construction features and manufacturing techniques provide excellent resistance to environmental extremes and overall high reliability.

- 100% all-welded construction.
- Patented uni-frame design providing high magnetic efficiency and mechanical rigidity.
- High force/mass ratios for resistance to shock and vibration.
- Advanced cleaning and sealing techniques provide maximum assurance of freedom from contact contamination.
- Precious metal contact material (gold, platinum, palladium alloy) with gold plating assures excellent high current and dry circuit switching capabilities.

The 712D Series utilizes internal discrete silicon diodes, with characteristics similar to 1N5315. The hybrid 712TN Series features passivated silicon planar diode and transistor chips (similar to 2N2222A). The integrated packaging of the relay with its associated semi-conductor devices greatly reduces PC Board floor space requirements as well as component installation costs.

By virtue of its inherently low intercontact capacitance and contact circuit losses, the TO-5 relay has proven to be an excellent subminiature RF switch for frequency ranges up through UHF. A typical RF application for the TO-5 relay is in hand held radio transceivers, wherein the combined features of good RF performance, small size, low coil power dissipation and high reliability make it the preferred relay for T-R switching (see Figures 1 and 2).

GENERAL ELECTRICAL SPECIFICATIONS (@25°C)

Contact Arrangement	2 Form C (DPDT)
Rated Duty	Continuous
Contact Resistance	0.1 ohm max. before life; 0.2 ohm max. after life at 1A/28VDC, (measured 1/8'' from header)
Contact Load Ratings (DC)	Resistive: 1 Amp/28VDC Inductive: 200 mA/28VDC (320 mH) Lamp: 100 mA/28VDC (See Fig. 3 for other DC resistive voltage/current ratings)
Contact Load Ratings (AC)	Resistive: 600 mA/115VAC, 400 Hz (Case ungrounded); 400 mA/115VAC, 60 Hz (Case ungrounded). 200 mA/115VAC, 60 and 400 Hz, (Case grounded)
Contact Life Ratings	10,000,000 operations (typical) at low level 1,000,000 operations min. at 0.5A/28VDC resistive 100,000 operations min. at all other loads specified above
Contact Overload Rating	2 Amps/28VDC (100 operations min.)
Contact Carry Rating	5 Amps (Continuous, unswitched)
Coil Operating Power	450 milliwatts nominal at nominal rated voltage
Operate Time	4.0 msec. max. at nominal rated coil voltage
Release Time	712 Series: 3.0 msec. max. — 712D, 712T Series: 6.0 msec. max.
Intercontact Capacitance	0.4 pf. typical
Insulation Resistance	1,000 megohms min. between mutually isolated terminals
Dielectric Strength	Sea level: 350 VRMS/60 Hz.

DETAILED ELECTRICAL SPECIFICATIONS (@ 25°C)

	GENERIC PART NUMBERS ➡	712-5 712D-5 712TN-5	712-6 712D-6 712TN-6	712-9 712D-9 712TN-9	712-12 712D-12 712TN-12	712-18 712D-18 712TN-18	712-26 712D-26 712TN-26
Coil Voltage (VDC)	Nom.	5.0	6.0	9.0	12.0	18.0	26.5
	Max.	5.8	8.0	12.0	16.0	24.0	32.0
Coil Resistance (Ohms ±10% @ 25°C) (Note 3)		50	98	220	390	880	1560
Pick-up Voltage (VDC)		3.6	4.2	6.5	8.4	13.0	17.0
Diode P.I.V. (VDC, Min.) 712D, 712TN		60					
Negative Coil Transient (VDC, Max.) 712D, 712TN		2.0					
712TN SERIES TRANSISTOR CHARACTERISTICS	**Base Voltage to Turn Off (VDC, Max.)**	0.3					
	Base Current to Turn On (mADC, Min.) (Note: Limit base-emitter current to 15 mA max.)	3.00	2.04	1.36	1.03	0.68	0.50
	Emitter-base Voltage (BV_{EBO}) (@25°C) (VDC, Max.)	6.0					
	Collector-base Voltage (BV_{CBO}) (@25°C & I_C = 100 μa) (VDC, Min.)	60					

PERFORMANCE CURVES

RF PERFORMANCE

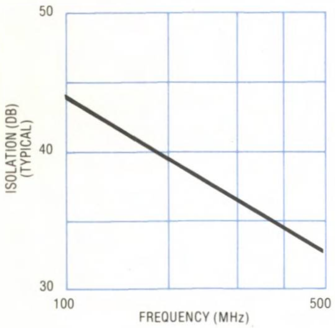


FIGURE 1

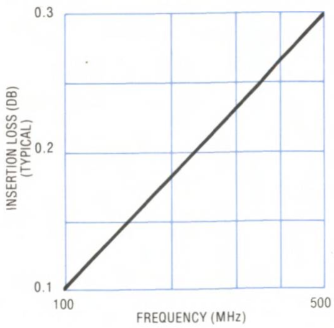


FIGURE 2

DC CONTACT RATINGS (RESISTIVE)

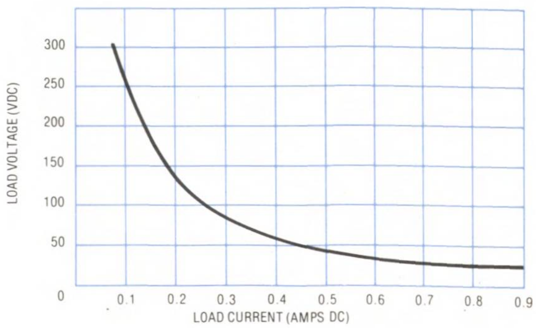
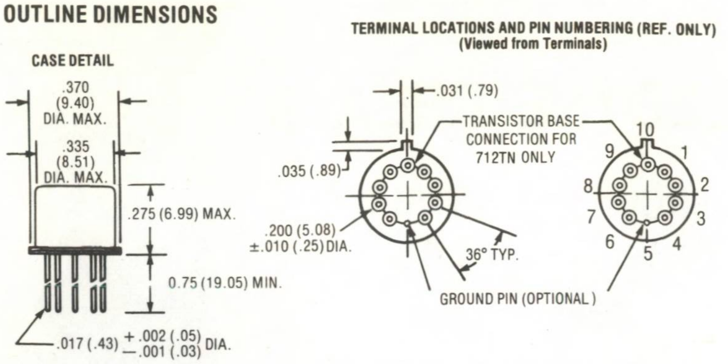


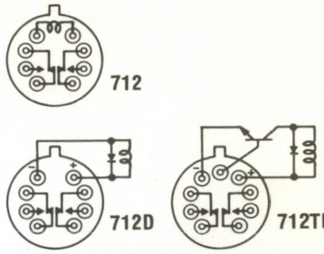
FIGURE 3

OUTLINE DIMENSIONS



DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

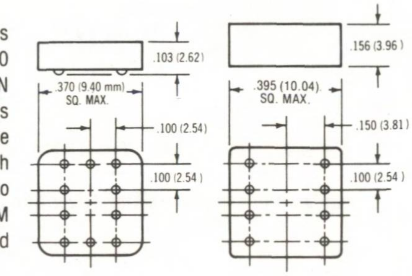
SCHEMATIC DIAGRAMS



SCHEMATICS ARE VIEWED FROM TERMINALS

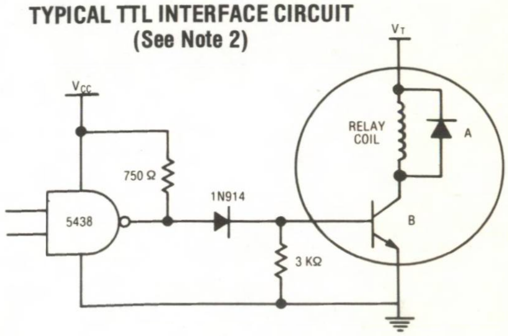
SPREADER PADS

Relays can be supplied with spreader pads installed and cemented in place. P/N 192-10 can be used with all 712, 712D, and 712TN Series Relays; P/N 192-59 is limited to 8 pins and therefore will not accommodate the 712TN Series Relay. Relays supplied with 192-59 pad installed have leads trimmed to .130'' (3.3mm) below pad. To order, add M for the 192-10 pad or M2 for the 192-59 pad to the part number (e.g., 712D**M2**-26).



P/N192-10 P/N192-59

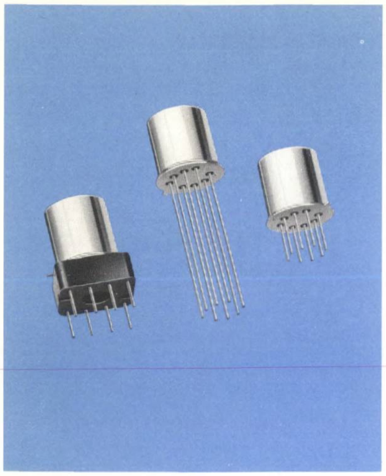
TYPICAL TTL INTERFACE CIRCUIT
(See Note 2)



(A) INTERNAL SUPPRESSION DIODE (B) INTERNAL DRIVER TRANSISTOR

NOTES:

1. Relays will exhibit no contact chatter or transfer within specified ratings.
2. Circuit is typical for all 712TN Series. Values shown are for 712TN-5 relay, and apply over full operating temperature range.
3. Coil Resistance not directly measurable on 712TN Relay



TELEDYNE RELAYS

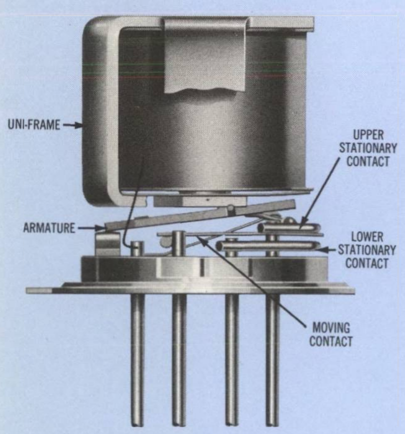
COMMERCIAL/INDUSTRIAL SENSITIVE TO-5 RELAYS

DPDT

SERIES 732

SERIES DESIGNATION	RELAY TYPE
732	**DPDT basic relay**
732D	**DPDT relay with internal diode for coil transient suppression**
732TN	**DPDT relay with internal transistor driver and coil suppression diode**

INTERNAL CONSTRUCTION



ENVIRONMENTAL AND PHYSICAL SPECIFICATIONS	
Temperature (Ambient)	−55°C to +71°C
Vibration	10 g's to 500 Hz (Note 1)
Shock	30 g's for 6 msec. (Note 1)
Enclosure	All welded, hermetically sealed
Weight	0.09 oz. (2.6gms.) max.

DESCRIPTION

The TO-5 relay, originally conceived and developed by Teledyne, has become the industry standard for low level switching from dry circuit to 1 ampere. Designed expressly for high density PC Board mounting, its small size and low coil dissipation make the TO-5 relay the most versatile subminiature relay available.

Unique construction features and manufacturing techniques provide excellent resistance to environmental extremes and overall high reliability

- 100% all-welded construction.
- Patented uni-frame design providing high magnetic efficiency and mechanical rigidity.
- High force/mass ratios for resistance to shock and vibration.
- Advanced cleaning and sealing techniques provide maximum assurance of freedom from contact contamination.
- Precious metal contact material (gold, platinum, palladium alloy) with gold plating assures excellent high current and dry circuit switching capabilities.

The 732D relay utilizes internal discrete silicon diodes, with characteristics similar to 1N5315. The hybrid 732TN Series features passivated silicon planar diode and transistor chips (similar to 2N2222A). The integrated packaging of the relay with its associated semi-conductor devices greatly reduces PC Board floor space requirements as well as component installation costs.

By virtue of its inherently low intercontact capacitance and contact circuit losses, the TO-5 relay has proven to be an excellent subminiature RF switch for frequency ranges up through UHF. A typical RF application for the TO-5 relay is in hand held radio transceivers, wherein the combined features of good RF performance, small size, low coil power dissipation and high reliability make it the preferred relay for T-R switching (see Figures 1 and 2).

GENERAL ELECTRICAL SPECIFICATIONS (@25°C)

Contact Arrangement	2 Form C (DPDT)
Rated Duty	Continuous
Contact Resistance	0.1 ohm max. before life; 0.2 ohm max. after life at 1A/28VDC (measured 1/8'' from header)
Contact Load Ratings (DC)	Resistive: 1 Amp/28VDC Inductive: 200 mA/28VDC (320 mH) Lamp: 100 mA/28VDC (See Fig. 3 for other DC resistive voltage/current ratings)
Contact Load Ratings (AC)	Resistive: 600 mA/115VAC, 400 Hz (Case ungrounded); 400 mA/115VAC, 60 Hz (Case ungrounded). 200 mA/115VAC, 60 and 400 Hz, (Case grounded)
Contact Life Ratings	10,000,000 operations (typical) at low level 1,000,000 operations min. at 0.5A/28VDC resistive 100,000 operations min. at all other loads specified above
Contact Overload Rating	2 Amps/28VDC (100 operations min.)
Contact Carry Rating	5 Amps (Continuous, unswitched)
Coil Operating Power	200 milliwatts nominal at nominal rated voltage
Operate Time	6.0 msec. max. at nominal rated coil voltage
Release Time	732 Series: 3.0 msec. max. / 732D, 732TN Series: 7.5 msec. max.
Intercontact Capacitance	0.4 pf. typical
Insulation Resistance	1000 megohms min. between mutually isolated terminals
Dielectric Strength	Sea level: 350 VRMS/60 Hz

DETAILED ELECTRICAL SPECIFICATIONS (@25°C)

		GENERIC PART NUMBERS ➡	732-5 732D-5 732TN-5	732-6 732D-6 732TN-6	732-9 732D-9 732TN-9	732-12 732D-12 732TN-12	732-18 732D-18 732TN-18	732-26 732D-26 732TN-26	732-1000 732D-1000 732TN-1000
Coil Voltage (VDC)		Nom.	5.0	6.0	9.0	12.0	18.0	26.5	12.0
		Max.	5.8	8.0	12.0	16.0	24.0	32.0	17.0
Coil Resistance (Ohms ±10% @ 25°C) (Note 3)			100	200	400	850	1600	3300	940
Pick-up Voltage (VDC)		732, 732D, 732TN	3.5	4.5	6.8	9.0	13.5	18.0	7.2
Diode P.I.V. (VDC, Min.)			60						
Negative Coil Transient (VDC, Max.) 732D, 732TN			2.0						
732TN SERIES TRANSISTOR CHARACTERISTICS	**Base Voltage to Turn Off (VDC, Max.)**		0.3						
	Base Current to Turn On (mADC, Min.) (Note: Limit base-emitter current to 15 mA Max.)		1.50	1.00	0.75	0.47	0.38	0.24	
	Emitter-base Voltage (BV_{EBO}) (@ 25°C) (VDC, Max.)		6.0						
	Collector-base Voltage (BV_{CBO}) (@25°C & I_C = 100μa) (VDC, Min.)		60						

PERFORMANCE CURVES

RF PERFORMANCE

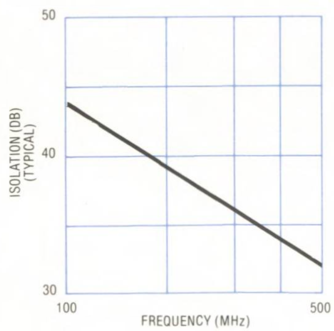


FIGURE 1

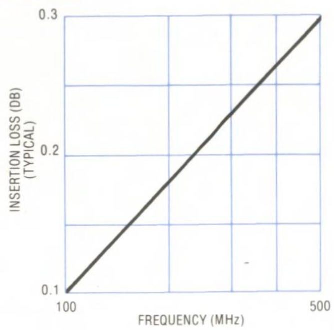


FIGURE 2

DC CONTACT RATINGS (RESISTIVE)

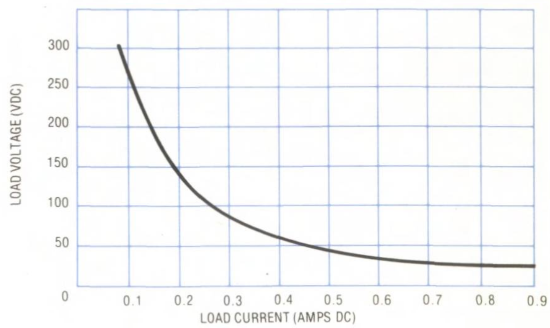
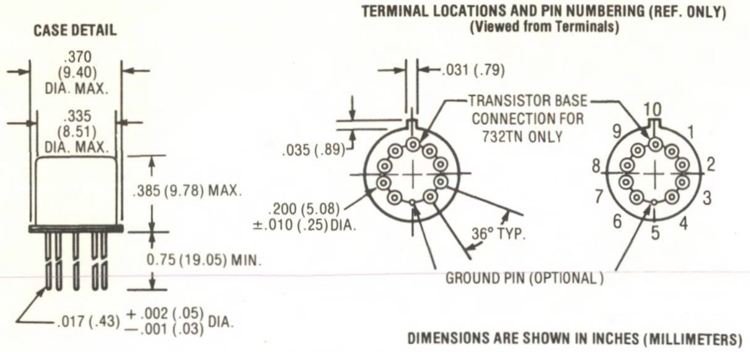
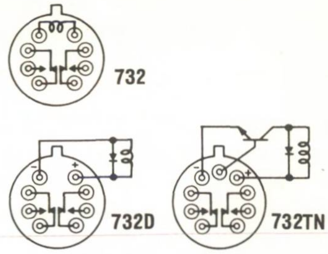


FIGURE 3

OUTLINE DIMENSIONS



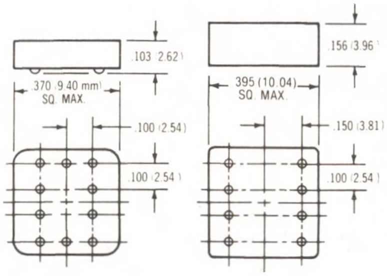
SCHEMATIC DIAGRAMS



SCHEMATICS ARE VIEWED FROM TERMINALS

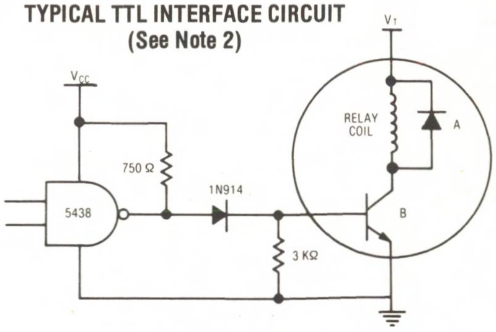
SPREADER PADS

Relays can be supplied with spreader pads installed and cemented in place. P/N 192-10 can be used with all 732, 732D, and 732TN Series Relays; P/N 192-59 is limited to 8 pins and therefore will not accommodate the 732TN Series Relay. Relays supplied with 192-59 pad installed have leads trimmed to .130'' (3.3mm) below pad. To order, add M for the 192-10 pad or M2 for the 192-59 pad to the part number (e.g., 732D**M2**-26).



P/N192-10 P/N192-59

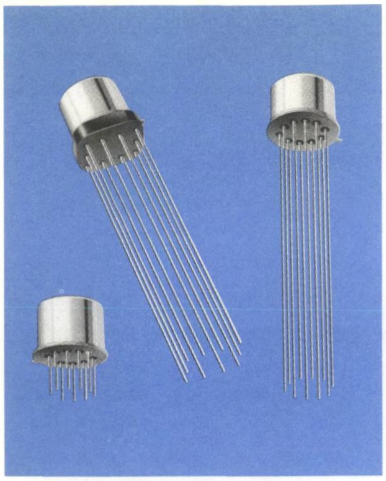
TYPICAL TTL INTERFACE CIRCUIT (See Note 2)



(A) INTERNAL SUPPRESSION DIODE (B) INTERNAL DRIVER TRANSISTOR

NOTES:

1. Relays will exhibit no contact chatter or transfer within specified ratings.
2. Circuit is typical for all 732 Series. Values shown are for 732T-5 relay, and apply over full operating temperature range.
3. Coil resistance not directly measurable on 732TN relay



TELEDYNE RELAYS

SERIES

720/722

COMMERCIAL/INDUSTRIAL TO-5 RELAY

DPDT MAGNETIC LATCHING

SERIES DESIGNATION	RELAY TYPE
720	**DPDT relay, with negative coil leads internally common and grounded to case.**
720R	**DPDT relay, with positive coil leads internally common and grounded to case.**
722	**DPDT relay, with mutually isolated coils with external connections to all four coil leads.**

DESCRIPTION

The TO-5 relay, originally conceived and developed by Teledyne, has become the industry standard for low level switching from dry circuit to 1 ampere. Designed expressly for high density PC Board mounting, its small size and low coil dissipation make the TO-5 relay the most versatile subminiature relay available.

Unique construction features and manufacturing techniques provide excellent resistance to environmental extremes and overall high reliability.

- 100% all-welded construction.
- Patented uni-frame design providing high magnetic efficiency and mechanical rigidity.
- High force/mass ratios for resistance to shock and vibration.
- Advanced cleaning and sealing techniques provide maximum assurance of freedom from contact contamination.
- Precious metal contact material (gold, platinum, palladium alloy) with gold plating assures excellent high current and dry circuit switching capabilities.

The 720/722 Series magnetic latching relays are ideally suited for applications where power dissipation must be minimized. The relays can be operated with a short duration pulse and after contacts have transferred, no holding power is required.

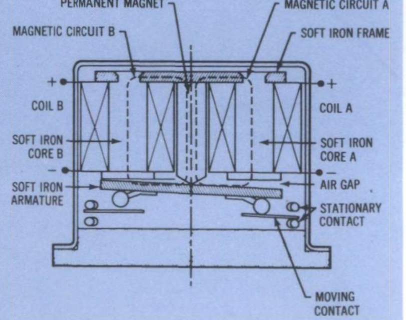
The magnetic latching feature of the 720/722 Series provides a "memory" capability, since the relays will not reset upon removal of power.

By virtue of its inherently low intercontact capacitance and contact circuit losses, the TO-5 relay has proven to be an excellent subminiature RF switch for frequency ranges up through UHF. A typical RF application for the TO-5 relay is in hand held radio transceivers, wherein the combined features of good RF performance, small size, low coil power dissipation and high reliability make it the preferred relay for T-R switching (see Figures 1 and 2).

PRINCIPLE OF OPERATION

Energizing Coil B produces a magnetic field opposing the holding flux of the permanent magnet in Circuit B. As this net holding force decreases, the attractive force in the air gap of Circuit A, which also results from the flux of the permanent magnet, becomes great enough to break the armature free of Core B, and snap it into a closed position against Core A. The armature then remains in this position upon removal of energy from Coil B, but will snap back to position B upon energizing Coil A. Since operation depends upon cancellation of a magnetic field, it is necessary to apply the correct polarity to the relay coils as indicated on the relay schematic.

Coils should not be energized simultaneously with either DC or AC voltages. Particular attention should be given to transients, as an extremely short pulse above rated voltage applied to both coils, or to one coil with the other energized may cause permanent damage.



ENVIRONMENTAL AND PHYSICAL SPECIFICATIONS

Temperature (Ambient)	−55°C to +71°C
Vibration	10 g's to 1000 Hz (Note 1)
Shock	30 g's for 6 msec (Note 1)
Enclosure	All welded, hermetically sealed
Weight	0.1 oz. (2.9gms.) max.

GENERAL ELECTRICAL SPECIFICATIONS @ 25°C

Contact Arrangement	2 Form C (DPDT)	
Rated Duty	Continuous	
Contact Resistance	0.1 ohm max. before life; 0.2 ohm max. after life at 1A/28VDC (measured 1/8'' from header)	
Contact Load Ratings (DC)	Resistive: 1 Amp/28VDC Inductive: 200 mA/28VDC (320 mH) Lamp: 100 mA/28VDC (See Fig. 3 for other DC resistive voltage/current ratings)	
Contact Load Ratings (AC)	Resistive: 600 mA/115VAC, 400 Hz (Case ungrounded); 400 mA/115VAC, 60 Hz (Case ungrounded) 200 mA/115VAC, 60 and 400 Hz, (Case grounded)	
Contact Life Ratings	10,000,000 operations (typical) at low level 1,000,000 operations min. at 0.5A/28VDC resistive 100,000 operations min. at all other loads specified above	
Contact Overload Rating	2 Amps/28VDC (100 operations min.)	
Contact Carry Rating	5 Amps (Continuous, unswitched)	
Coil Operating Power	290 milliwatts nominal at nominal rated voltage	
Operate Time	1.5 msec. max. at nominal rated coil voltage	
Minimum Operate Pulse	2.0 msec. @ nominal voltage	
Intercontact Capacitance	0.4 pf. typical	
Insulation Resistance	10,000 megohms min. between mutually isolated terminals	
Dielectric Strength	Sea level: 350 VRMS/60 Hz.	70,000 ft.: 125 VRMS/60 Hz.

DETAILED ELECTRICAL SPECIFICATIONS @ 25°C

	GENERIC PART NUMBERS ➡	720-5 720R-5 722-5	720-6 720R-6 722-6	720-9 720R-9 722-9	720-12 720R-12 722-12	720-18 720R-18 722-18	720-26 720R-26 722-26
Coil Voltage (VDC)	Nom.	5.0	6.0	9.0	12.0	18.0	26.5
	Max.	5.8	8.0	12.0	16.0	24.0	32.0
Coil Resistance (Ohms ±10% @ 25°C)		61	120	280	500	1130	2000
Set & Reset Voltage (VDC)		3.5	4.5	6.8	9.0	13.5	18.0

PERFORMANCE CURVES

RF PERFORMANCE

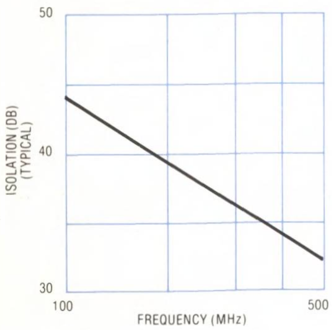


FIGURE 1

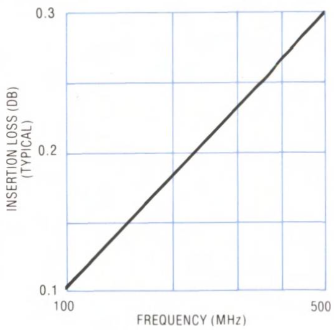


FIGURE 2

DC CONTACT RATINGS (RESISTIVE)

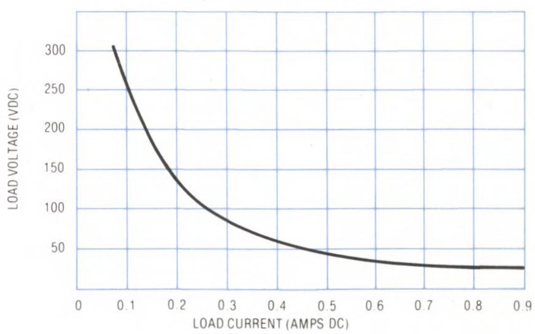
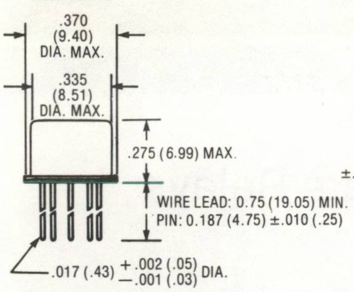


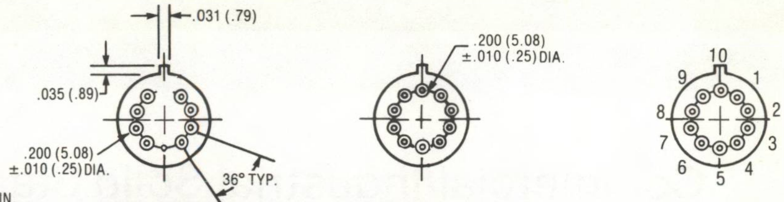
FIGURE 3

OUTLINE DRAWINGS

CASE DETAIL



TERMINAL LOCATIONS AND PIN NUMBERING (REF. ONLY)
(Viewed from Terminals)



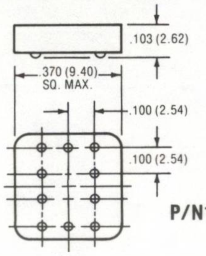
720 / 720R

722

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

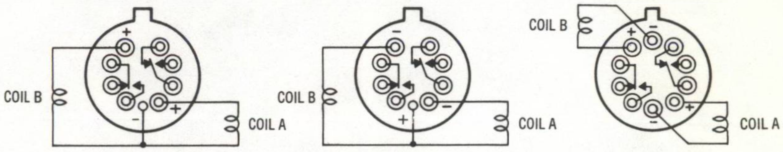
SPREADER PADS

Relays can be supplied with the 192-10 spreader pad installed and cemented in place. To order, add M to the part number (e.g., 722**M**-26).



P/N192-10

SCHEMATIC DIAGRAMS



720 720R 722

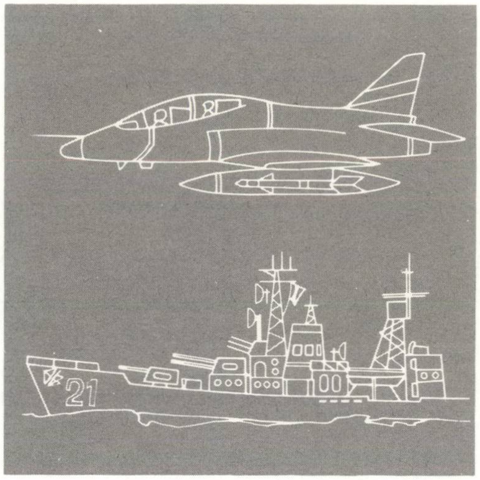
SCHEMATICS ARE VIEWED FROM TERMINALS. CONTACTS SHOWN IN POSITION RESULTING WHEN COIL A LAST ENERGIZED.

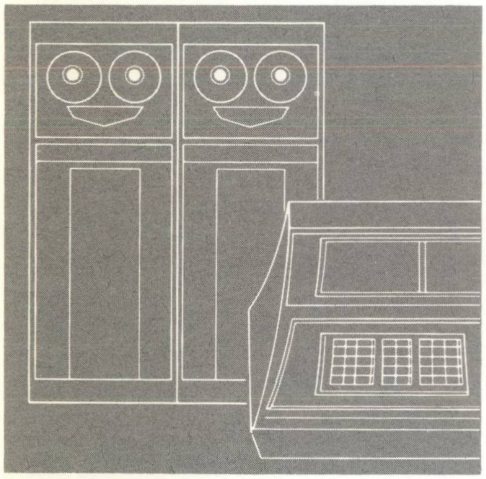
NOTES:

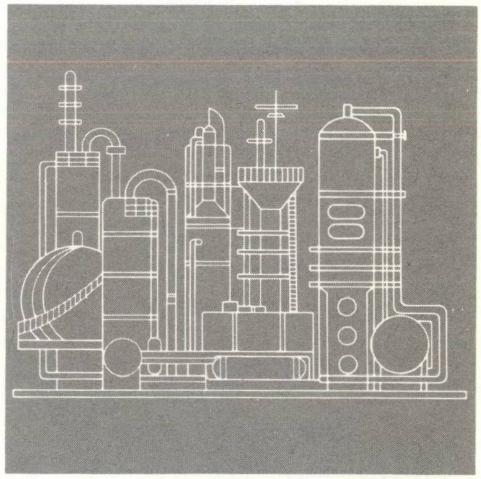
1. Relays will exhibit no contact chatter or transfer within specified ratings.

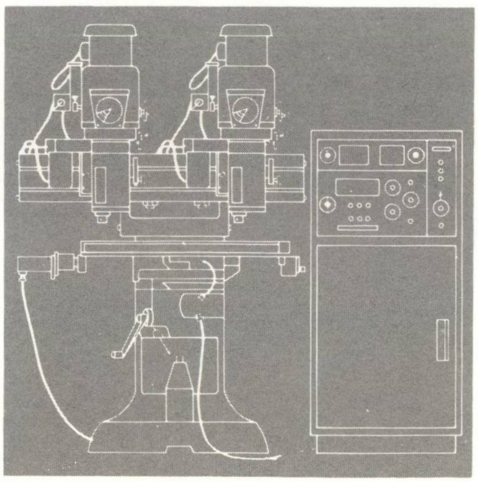
SECTION III

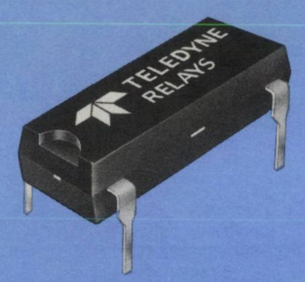
Commercial/Industrial Solid State Relays











TELEDYNE RELAYS

SERENDIP®
SOLID STATE AC/DC RELAY
TRANSFORMER ISOLATED
±80 mA

MODEL
640-1

SPST/NO

FEATURES

- Solid State pin compatible replacement for DIP reed relays
- Switches AC or DC up to 50V
- Low on-resistance (2 ohms typical)
- High switching speed
- Standard TO-116 DIP

DESCRIPTION

The 640-1 features AC/DC switching capability up to 50V and low on-resistance which is stable with time and temperature. Thus it serves as an ideal solid state replacement for SPST DIP reed relays. Transformer coupling provides 1500V (P-P) isolation and low off-state leakage. Internal construction employs hybrid microcircuit techniques with a unique patented lead frame design for low cost, molded in a standard TO-116 DIP. The 640-1 is most frequently used as a data coupler, isolated line driver, current loop switch, and for general purpose analog and transducer signal switching.

ELECTRICAL SPECIFICATIONS
(25°C UNLESS OTHERWISE SPECIFIED)

INPUT (CONTROL) SPECIFICATIONS	MIN.	TYP.	MAX.	UNITS	NOTES
Control Voltage Range	3.8		10	VDC	
Input Current at 5VDC Control Voltage		18	22	mA	See Fig. 1
Turn Off Voltage			0.4	VDC	
Dielectric Strength (Input to Output)	1500			VAC(PP) 60 Hz	
Isolation (Input to Output)	10^9			Ohms	
Capacitance (Input to Output)			5	pf	
Reverse Voltage Protection			0.5	VDC	
OUTPUT (LOAD) SPECIFICATIONS	**MIN.**	**TYP.**	**MAX.**	**UNITS**	**NOTES**
Maximum Allowable Output Current (10 Volt Input)	0		±80	mA Peak	See Fig. 2 & Note 1
Maximum Allowable Output Current (5 Volt Input)	0		±40	mA Peak	See Fig. 2 & Note 1
Output Voltage (At Any Current)	0		±50	V Peak	
Offset Voltage		±1.0	±5.0	MV	See Fig. 3, 6
Output "On" Resistance		2	5	Ohms	
Off State Leakage Current V = ±25V			0.006	µA	See Fig. 4
Off State Leakage Current V = ±50V			60	µA	See Fig. 4
Turn On Time ($T_{DELAY} + T_{RISE}$) (See Fig. 9)			1.0	µSEC	$V_L = 20V$, $R_L = 1K\Omega$, $V_{IN} = 5V$, $f_{IN} = 5$ KHz
Turn Off Time ($T_{DELAY} + T_{FALL}$) (See Fig. 7)		8	10	µSEC	$V_L = 20V$, $R_L = 1K\Omega$, $V_{IN} = 5V$, $f_{IN} = 5$ KHz
Capacitance Across Output		7	10	pf	
Maximum Surge Thru Output			150	% of Current Rating	See Fig. 5

PATENT #3,791,025

CHARACTERISTIC CURVES

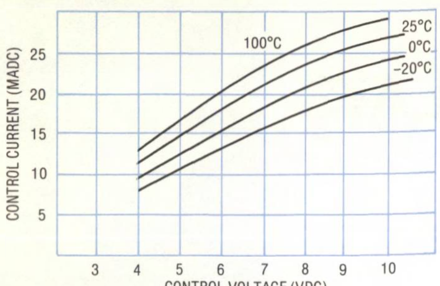


FIGURE 1 - INPUT CURRENT VS. INPUT CONTROL VOLTAGE (TYPICAL)

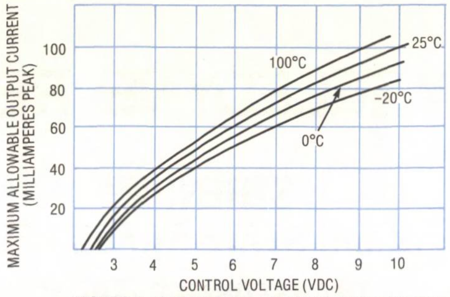


FIGURE 2 - MAXIMUM ALLOWABLE OUTPUT CURRENT VS. INPUT CONTROL VOLTAGE

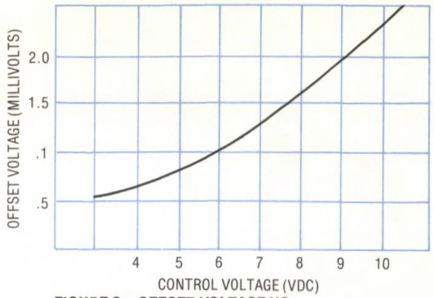


FIGURE 3 - OFFSET VOLTAGE VS. INPUT CONTROL VOLTAGE (TYPICAL)

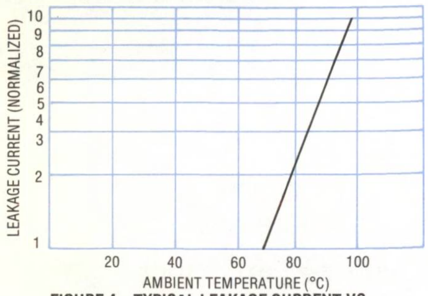


FIGURE 4 - TYPICAL LEAKAGE CURRENT VS. AMBIENT TEMPERATURE (NORMALIZED TO 25°C)

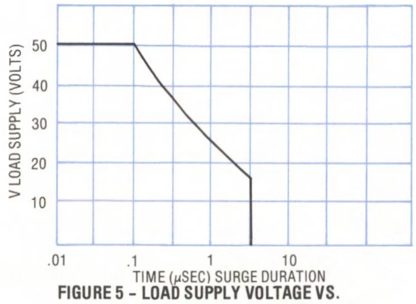


FIGURE 5 - LOAD SUPPLY VOLTAGE VS. ALLOWABLE SURGE CURRENT DURATION (CURRENT MUST NOT EXCEED 150% OF RATING)

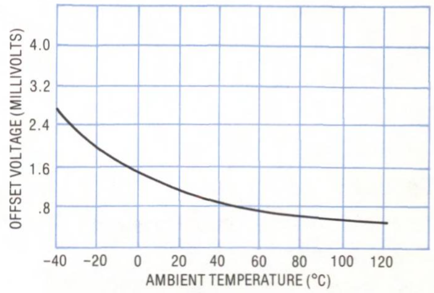


FIGURE 6 - OFFSET VOLTAGE VS. AMBIENT TEMPERATURE (TYPICAL)

FIGURE 7 - TURN OFF TIME VS. LOAD RESISTANCE (TYPICAL)

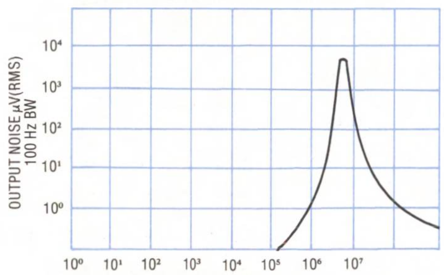


FIGURE 8 - CONTACT NOISE VS. FREQUENCY .100 HZ BANDWIDTH (TYPICAL)

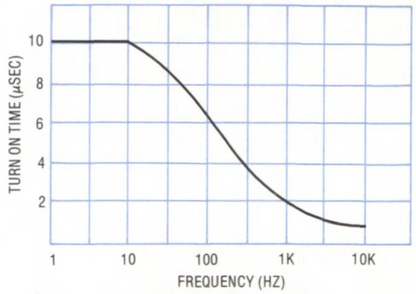
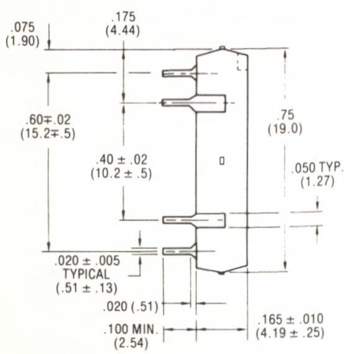
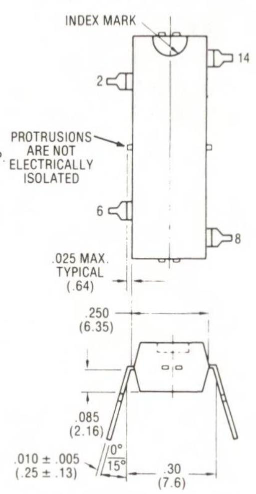


FIGURE 9 - TURN ON TIME VS. DRIVE FREQUENCY (TYPICAL)

MECHANICAL SPECIFICATIONS



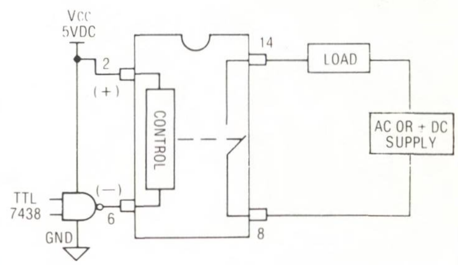


- Ambient Temperature Range: -20°C to 100°C Operating & Storage
- Vibration: 30G Level, 10 to 2,000 Hz
- Shock: Meets or exceeds MIL-STD-202
- Weight: 2.0 grams max.
- Case: 14 pin dual in line (TO-116)
- Case Material: Filled epoxy, self extinguishing

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

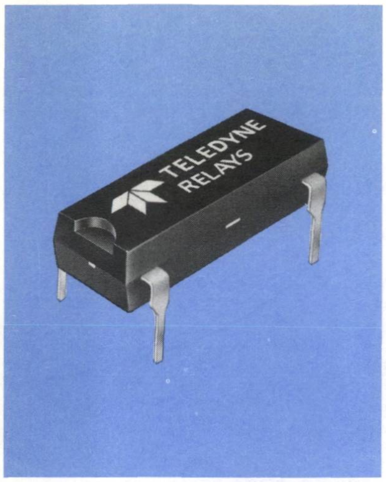
Tolerances unless otherwise specified ±.015 (.38)

TYPICAL INTERFACE TO 5V LOGIC



NOTES:

1. For any control voltage, the maximum steady state load current value shown in Figure 2 must not be exceeded. (Attempting to draw steady state currents in excess of these curves can cause permanent damage.)



TELEDYNE RELAYS

SERENDIP®
SOLID STATE AC RELAY
TRANSFORMER ISOLATED
1 AMP

SERIES
641

SPST/NO

FEATURES

- TTL Compatible Input
- High input/output isolation (2500 VRMS)
- ½ Amp output rating (to 50°C) without sinking
- 10 Amp surge capability
- Low minimum output current (5MA)
- Standard TO-116 DIP
- UL Recognized, File #E55197
- CSA Certified, File #LR31043

DESCRIPTION

The 641 Series features the industry's smallest AC solid state relay package, with triac output rated at 0.5 amp up to 50°C ambient without a heat sink. Addition of a heat sink raises the output rating to 1 amp. A high frequency input oscillator with isolation transformer coupled directly to the triac gate provides the added capability of driving very low current AC loads down to 5 mA. Internal design employs hybrid microcircuit techniques with a unique patented lead frame construction molded in a standard TO-116 plastic DIP.

PART NUMBERING

P/N	OUTPUT VOLTAGE RATING	
	CONTINUOUS (RMS)	TRANSIENT (PEAK)
641-1	140	200
641-2	250	400

ELECTRICAL SPECIFICATIONS
(25°C UNLESS OTHERWISE SPECIFIED)

INPUT (CONTROL) SPECIFICATIONS		MIN.	MAX.	UNITS	NOTES
Control Voltage Range		4	10	VDC	See Fig. 1.
Input Current at 5V Control Voltage			16	mA DC	V_L = 120VAC R_L = 1KΩ See Fig. 1
Turn-Off Voltage 0 ≤ Ta ≤ 100°C			0.5	VDC	
Dielectric Strength (Input to Output)		2500		VAC(RMS)	
Isolation (Input to Output)		10^9		Ohms	@ 500VDC
Capacitance (Input to Output)			5	pf	
Reverse Voltage Protection			0.5	VDC	
OUTPUT (LOAD) SPECIFICATIONS		**MIN.**	**MAX.**	**UNITS**	**NOTES**
Output Current	No Heat Sink	.005	0.5	AMP	See Notes 3, 4 & Fig. 2
	with heat sink	.005	1.0	AMP	
Load Voltage Rating	641-1	6	140	V RMS	
	641-2	6	250	V RMS	
Frequency Range		0.1	70	Hz	See Note 2
Output Voltage Drop at Rated Current			1.5	V RMS	
Surge Current Rating			10	AMPS	Non-re-petitive 20 mSEC max. See Fig. 3
Off State Leakage at Rated Voltage at 100°C			1.0	mA RMS	
Turn On Time (60 Hz)			20	μSEC	
Turn Off Time (60 Hz)			8.3	mSEC	
Over Voltage Rating	641-1		200	V(PEAK)	
	641-2		400		
Off State dv/dt	With RC	200		V/μSEC	See Fig. 4
	Without RC	50			
Fusing I^2T (1 mS)			3	A^2SEC	
Triac Power Dissipation Factor (D)			1.5	Watts/Amps	
Triac Junction Temp. (T_J Max.)			100	°C	
Thermal Resistance	Θ_{JA}		67	°C/W	
	Θ_{JC}		10		

PATENT #3,791,025

CHARACTERISTIC CURVES

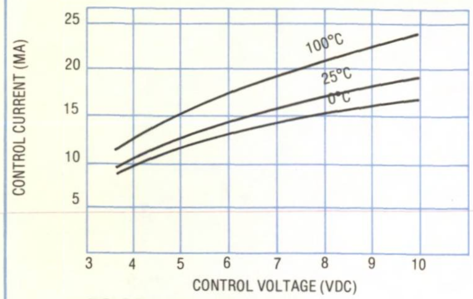


FIGURE 1 - CONTROL CURRENT VS. CONTROL VOLTAGE TYPICAL

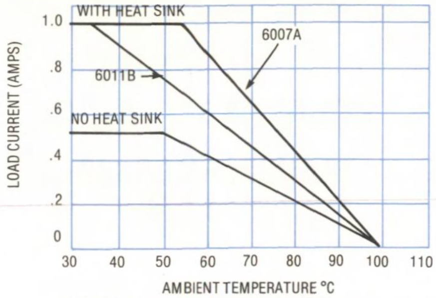


FIGURE 2 - MAXIMUM LOAD CURRENT VS. AMBIENT TEMPERATURE (SEE NOTE 4)

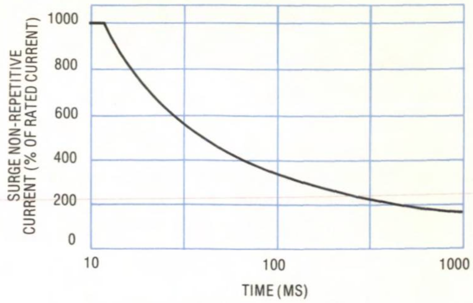
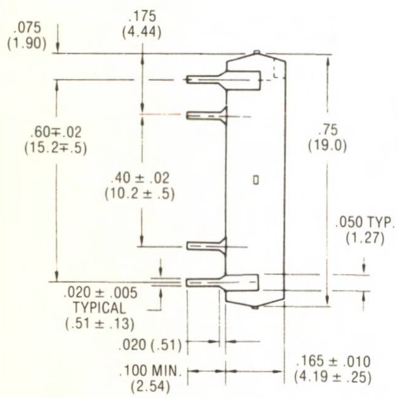
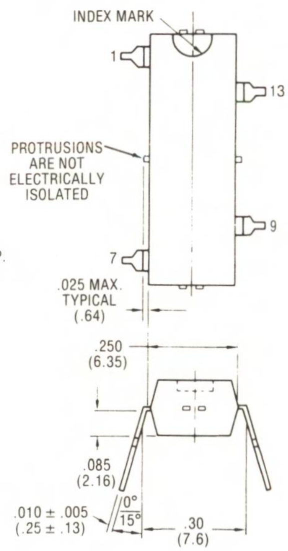


FIGURE 3 - PEAK SURGE CURRENT VS. SURGE CURRENT DURATION (NOTE 1)

MECHANICAL SPECIFICATIONS





- Ambient Temperature Range:
  0°C to 100°C Operating
  −20°C to 100°C Storage
- Vibration: 30 G Level, 10 to 2,000 Hz
- Shock: Meets or exceeds MIL-STD-202
- Weight: 2.0 grams max.
- Case: 14 pin dual in line (TO-116)
- Case Material: Filled epoxy – self extinguishing

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

Tolerances (unless otherwise specified) ±.015 (.38)

TYPICAL INTERFACE TO 5V LOGIC:
(with suggested transient voltage and dv/dt suppression, if required)

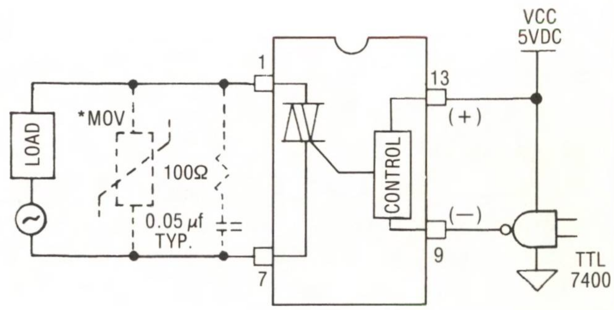
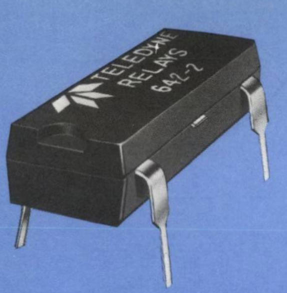


FIGURE 4

*Use Teledyne Metal Oxide Varistor PT. NO. 970-1, with 641-2 Relay for 140 VRMS line operation. See 970 Series Data for further information on MOV's.

NOTES:

1. Triac may lose blocking capability during and after surge until TJ falls below 100°C maximum.
2. For 400 Hz applications consult the factory.
3. UL rated @ 0.5 Amp for motor starting and incandescent lamp control.
4. 1 Amp capability shown when using typical DIP heatsinks such as Thermalloy P/N6007A and glue-on type P/N6011B.



16 PIN DIP

TELEDYNE RELAYS

SERENDIP®
SOLID STATE AC RELAY

OPTICALLY ISOLATED
1.5 AMP

SERIES
642

SPST/NO

FEATURES

- Logic compatible constant current input
- Zero voltage turn-on; zero current turn-off
- High output transient immunity (200V/μsec.)
- High peak voltage rating (up to 600 V)
- Standard 16 pin TO-116 DIP
- UL Recognized File #E55197

DESCRIPTION

This newest addition to the Serendip line of DIP SSRs is optically coupled to provide 2500 VRMS input/output isolation. Internal design employs hybrid microcircuit techniques and custom integrated circuits on Teledyne's unique patented lead frame construction for high performance, reliability and low cost. Constant current input circuit provides low and high level logic compatibility and low input power dissipation over an input voltage range of 3-32 VDC. Output current rating is 1.0 amp without heat sink, 1.5 amp with PC board heat sink.

PART NUMBERING

P/N	Output Voltage Rating	
	Continuous (RMS)	Transient (Peak)
642-1	140	200
642-2	250	400
642-2H	250	600

ELECTRICAL SPECIFICATIONS
(25°C UNLESS OTHERWISE SPECIFIED)

INPUT (CONTROL) SPECIFICATIONS		MIN.	MAX.	UNITS	NOTES
Control Voltage Range		3	32	VDC	See Fig. 1
Input Current at 5V Control Voltage			15	mA DC	See Fig. 1
Turn-Off Voltage 0≤Ta≤100°C			1.0	VDC	
Dielectric Strength (Input to Output)		2500		VAC(RMS)	
Isolation (Input to Output)		10^9		Ohms	@500 VDC
Capacitance (Input to Output)			10	pf	
Reverse Voltage Protection			35	VDC	
OUTPUT (LOAD) SPECIFICATIONS		**MIN.**	**MAX.**	**UNITS**	**NOTES**
Output Current	No Heatsink	.02	1.0	AMP	See Fig. 2
	With Heatsink	.02	1.5	AMP	
Load Voltage Rating	642-1	12	140	VRMS	
	642-2,-2H	12	250	VRMS	
Frequency Range		47	70	Hz	
Output Voltage Drop at Rated Current			1.5	VRMS	
Voltage Across Load at Turn-On			30	V PEAK	
Surge Current Rating			10	AMPS	Non-repetitive 20 mSEC max. See Fig. 3
Off State Leakage at Rated Voltage at 100°C			3.0	mA RMS	
Turn-On Time (60 Hz)			8.3	mSEC	
Turn-Off Time (60 Hz)			14	mSEC	
Over Voltage Rating (Transient Peak)	642-1		200	V PEAK	
	642-2		400		
	642-2H		600		
Off State dv/dt	With RC	200		V/μSEC.	See Fig. 4
	Without RC	50			
Fusing I^2T (1 mS)			5	A^2SEC	
Triac Power Dissipation Factor (D)			1	WATTS/AMP	
Triac Junction Temp. (T_J Max.)			100	°C	
Thermal Resistance	Θ_{JA}		65	°C/W	
	Θ_{JC}		10		

PATENT #3,791,025

CHARACTERISTIC CURVES

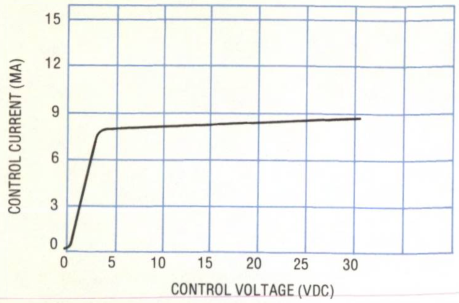


FIGURE 1 - CONTROL CURRENT VS. CONTROL VOLTAGE (TYPICAL)

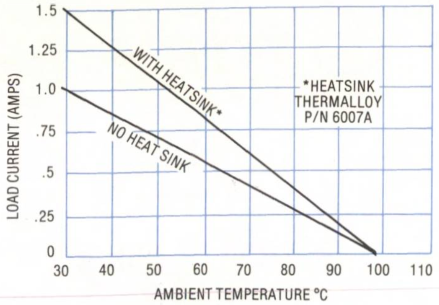


FIGURE 2 - MAXIMUM LOAD CURRENT VS. AMBIENT TEMPERATURE

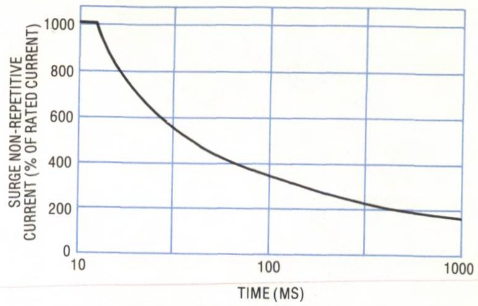
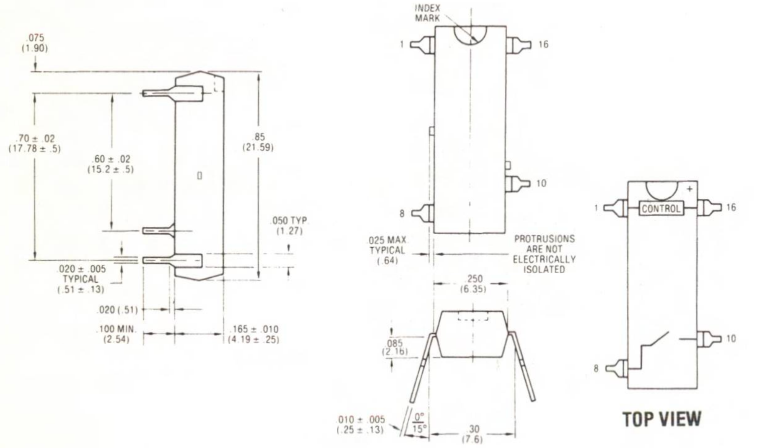


FIGURE 3 - PEAK SURGE CURRENT VS. SURGE CURRENT DURATION (NOTE 1)

MECHANICAL SPECIFICATIONS



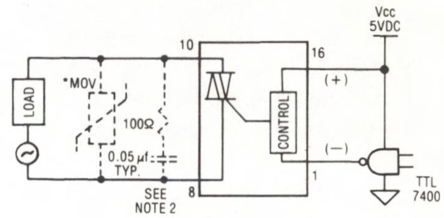
TOP VIEW

- Ambient Temperature Range: −20°C to 100°C Operating and Storage
- Life: 10^{10} operations full rated load, 25°C
- Vibration: 20g Level, 10 to 2,000 Hz
- Shock: Meets or exceeds MIL-STD-202
- Weight: 2.0 grams max.
- Case: 16 pin dual in line (TO-116)
- Case Material: Filled epoxy – self extinguishing

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

- Tolerances (unless otherwise specified) ±.015 (.38)

TYPICAL INTERFACE TO 5V LOGIC (with suggested transient voltage and dv/dt suppression, if required)



*USE THE TABLE BELOW FOR SELECTION OF PROPER METAL OXIDE VARISTOR (MOV)

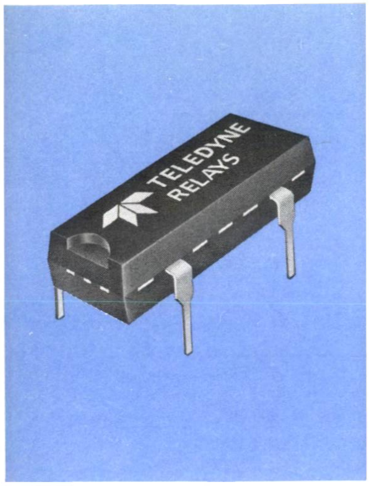
MAXIMUM CONTINUOUS LINE VOLTAGE RATING	TRANSIENT (PEAK) RATING OF RELAY	TELEDYNE MOV P/N
140 VAC	400	970-1
250 VAC	600	970-2

(SEE 970 SERIES DATA SHEET FOR FURTHER INFORMATION ON MOV'S).

FIGURE 4

NOTES:

1. Triac may lose blocking capability during and after surge until TJ falls below 100°C maximum.
2. Recommended snubber for inductive loads; 100 Ω, 0.05 MFD.



TELEDYNE RELAYS

SERENDIP®
SOLID STATE DC RELAY
TRANSFORMER ISOLATED
100mA to 600mA

SERIES 643

SPST/NO

FEATURES

- Solid State pin compatible replacement for DIP reed relays
- TTL compatible input
- Exceed current and voltage ratings of opto-isolators
- High switching speed
- Standard TO-116 DIP

DESCRIPTION

The 643 Series DC SSRs employ transformer coupling for high input/output isolation and extremely low off-state leakage. The output current and voltage ratings greatly exceed the capabilities of opto-isolators, with an equivalent current transfer ratio as high as 2500%. Thus, they serve as ideal solid state alternatives for opto-isolators and reed relays in applications such as isolated line drivers, lamp drivers, current loop switches, and general purpose DC switching where "relay" isolation is required. Internal construction employs hybrid microcircuit techniques with a unique patented lead frame design for low cost, molded in a standard TO-116 DIP.

PART NUMBERING

PART NUMBER	OUTPUT CURRENT RATING (MA DC)	OUTPUT VOLTAGE RATING (VDC)
643-1	400	60
643-2	100	250
643-3	600	130

ELECTRICAL SPECIFICATIONS

(25°C UNLESS OTHERWISE SPECIFIED)

INPUT (CONTROL) SPECIFICATIONS	MIN.	TYP.	MAX.	UNITS	NOTES
Control Voltage Range	3.8		10	VDC	
Input Current at 5VDC Control Voltage		9	15	mA	See Fig. 1
Turn Off Voltage			0.4	VDC	
Dielectric Strength (Input to Output)	1500			VAC(PP) 60 Hz	
Isolation (Input to Output)	10^9			Ohms	
Capacitance (Input to Output)			5	pf	
Reverse Voltage Protection			0.5	VDC	

OUTPUT (LOAD) SPECIFICATIONS			MIN.	TYP.	MAX.	UNITS	NOTES
Max. Allowable Output Current (10 Volt Input)	643-1		0		400	mA	See Fig. 2 And Note 1
	643-2		0		100		
	643-3		0		600		
Max. Allowable Output Current (5 Volt Input)	643-1		0		200	mA	See Fig. 2 And Note 1
	643-2		0		50		
	643-3		0		250		
Output Voltage	643-1		0		60	VDC	
	643-2		0		250		
	643-3		0		130		
Output Voltage Drop				0.8	1.5	VDC	See Fig. 4
Offstate Leakage Current	643-1	V=30VDC			0.006	µA	See Fig. 4
		V=60VDC			60		
	643-2	V=125VDC			0.06		
		V=250VDC			60		
	643-3	V=65VDC			.07		
		V=130VDC			75		
Turn On Time (TDELAY + TRISE) (See Fig. 6)	643-1			0.5	1.0	µSEC	VL = 20V, VIN = 5V, fIN = 5KHz, RL(-1), (-3) = 100Ω, RL(-2) = 1 KΩ
	643-2			1.0	5.0		
	643-3				10		
Turn Off Time (TDELAY + TFALL)	643-1			3	5		
	643-2			30	75		
	643-3				75		
Capacitance Across Output	643-1			10	15	pf	
	643-2			30	40		
	643-3				150		
Maximum Surge					200	% Of Rating	See Fig. 6

PATENT #3,791,025

CHARACTERISTIC CURVES

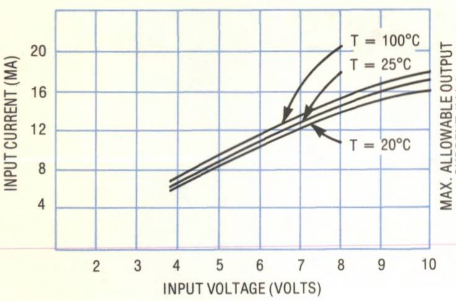


FIGURE 1 - INPUT CURRENT VS. INPUT VOLTAGE (TYPICAL)

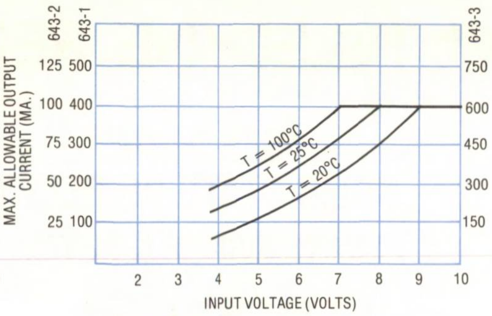


FIGURE 2 - MAXIMUM ALLOWABLE OUTPUT CURRENT VS. INPUT CONTROL VOLTAGE

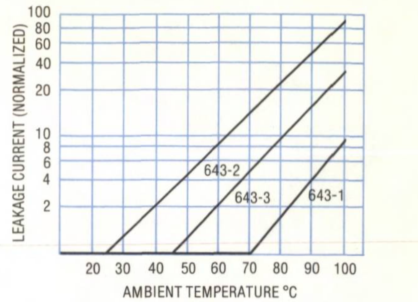


FIGURE 3 - TYPICAL LEAKAGE CURRENT VS. AMBIENT TEMPERATURE (NORMALIZED TO 25°C)

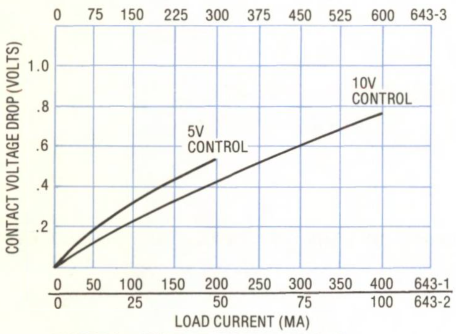


FIGURE 4 - CONTACT VOLTAGE DROP VS. LOAD CURRENT (TYPICAL)

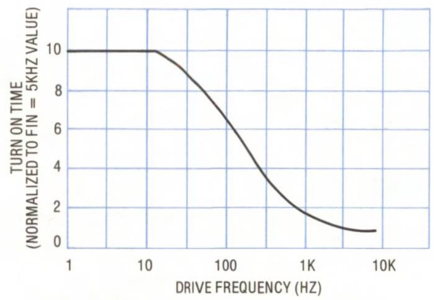


FIGURE 5 - NORMALIZED TURN-ON TIME VS. DRIVE FREQUENCY (TYPICAL)

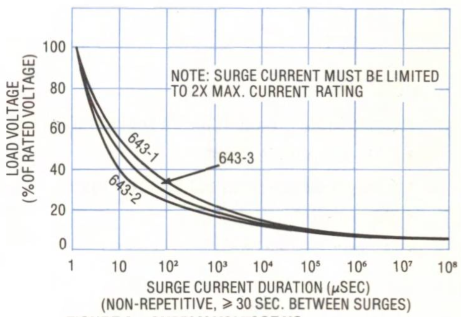
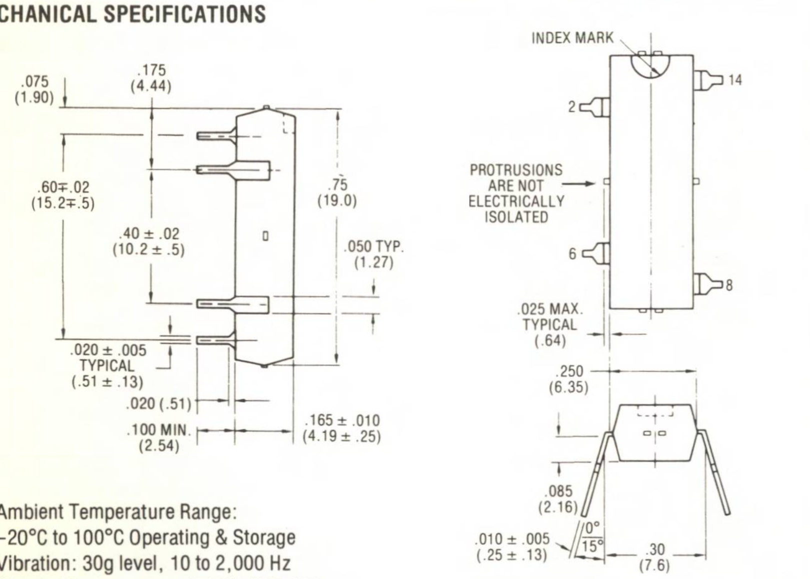


FIGURE 6 - SUPPLY VOLTAGE VS. SURGE CURRENT DURATION

MECHANICAL SPECIFICATIONS

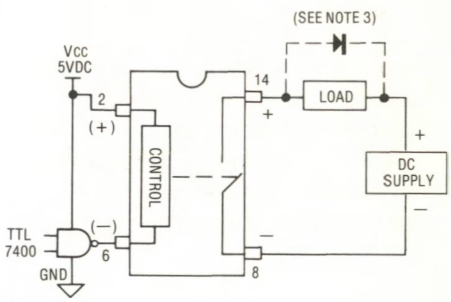


DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

- Tolerances (unless otherwise specified) ±.015 (.38)

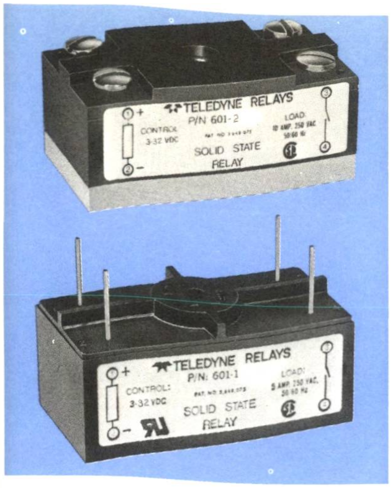
- Ambient Temperature Range: −20°C to 100°C Operating & Storage
- Vibration: 30g level, 10 to 2,000 Hz
- Shock: Meets or exceeds MIL-STD-202
- Weight: 2.0 grams max.
- Enclosure: 14 pin dual in line TO-116
- Case Material: Filled epoxy, self extinguishing

WIRING DIAGRAM



NOTES:

1. For any control voltage, the maximum load current value shown in figure 2 must not be exceeded. Attempting to draw currents in excess of these curves can cause permanent damage.
2. Pin 14 must be positive with respect to pin 8 or damage may result.
3. Inductive loads must be diode suppresed.



TELEDYNE RELAYS

SOLID STATE AC RELAY

OPTICALLY ISOLATED 5 AMP and 10 AMP (DC INPUT CONTROL)

SERIES

601

SPST/NO

FEATURES

- Logic compatible constant current input
- Zero voltage turn-on; zero current turn-off
- High transient immunity
- Variety of terminal and mounting options

DESCRIPTION

This popular series of AC SSRs has been redesigned to incorporate custom integrated circuits to replace conventional discrete circuitry. The resultant reduction of over 40% in component count provides higher performance and reliability along with lower cost. Optical coupling between control and load circuits provides a minimum of 1500 VRMS input/output isolation. Improved circuit design and built-in snubber protection guarantee high immunity from false triggering and reliable switching of low power factor loads. Available in two basic mounting and terminal styles – pin terminals for direct mounting on PC boards and screw terminals (with optional quick disconnect adaptors) for chassis or heat sink mounting.

Note: 601-1400 Series with DC input are still available under original part number, however, the relays on this page are recommended for new design.

PART NUMBERING (SEE NOTE 3)

INPUT CONTROL VOLTAGE RATING	OUTPUT VOLTAGE RATING		OUTPUT (LOAD) CURRENT RATING & PART NUMBERS	
	Continuous (RMS)	Transient (PEAK)	5 AMP	10 AMP
3-32 VDC	250 VAC	500	601-1	601-2
		650	601-1H	601-2H

ELECTRICAL SPECIFICATIONS

(25°C unless otherwise noted)

INPUT (CONTROL) SPECIFICATIONS	MIN.	TYP.	MAX.	UNITS
Control Voltage Range	3		32	VDC
Input Current @ 5 VDC Control Voltage Over Temp. Range (See Figure 1)		7	10	mA(DC)
Input Current @ Max. Control Voltage Over Temp. Range (See Figure 1)			18	mA(DC)
Turn-On Voltage Over Temp. Range (See Figure 2)	3.0			VDC
Turn-Off Voltage Over Temp. Range (See Figure 2)			1.0	VDC
Reverse Voltage Protection			-32	VDC
Isolation (Input to Output, Input & Output to Case)	10^{10}			OHMS
Dielectric (Input to Output, Input & Output to Case)	2500			VAC(RMS) 60 Hz
Capacitance (Input to Output)		8	15	pF
OUTPUT (LOAD) SPECIFICATIONS	**MIN.**	**TYP.**	**MAX.**	**UNITS**
Output Current Rating (See Figure 3 or 4 for Temperature Derating)	.05		5 or 10	Amps (RMS)
Load Voltage Rating	12		250	VAC(RMS)
Frequency Range	47		70	Hz
Surge Current Rating (16mS) (See Figure 5)			1000	% of steady state
Over Voltage Range — 601-1, -2	500			V(PEAK)
Over Voltage Range — 601-1H, -2H	650			V(PEAK)
Voltage Drop Across Output At Rated Current		0.8	1.5	VAC (RMS)
Turn-On Time (60 Hz)		3.0	8.3	mS
Turn-Off Time (60 Hz)		5.0	16.6	mS
Off-State Leakage @ Rated Load Voltage			9	mA(RMS)
Zero Voltage Turn-On Point		±12		V(PEAK)
Off-State dv/dt (See Note 1)	200	400		V/μs
Fusing I^2T (1ms) — 5 Amp			18	A^2sec
Fusing I^2T (1ms) — 10 Amp			20	A^2sec
Triac Power Dissipation Factor (D) — 5 Amp			0.92	WATTS/AMP
Triac Power Dissipation Factor (D) — 10 Amp			1.21	WATTS/AMP
Triac Junction Temperature (T_J Max.)			110	°C
Thermal Resistance — Junct. to Amb. (Θ_{JA}) — 5 Amp			19	°C/W
Thermal Resistance — Junct. to HS (Θ_{JS}) — 10 Amp			4.8	°C/W

PATENT #3,648,075

CHARACTERISTIC CURVES

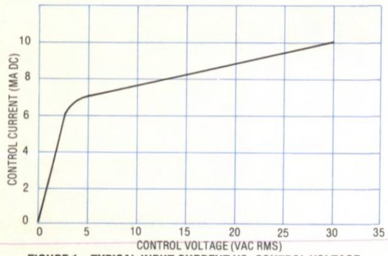


FIGURE 1 - TYPICAL INPUT CURRENT VS. CONTROL VOLTAGE

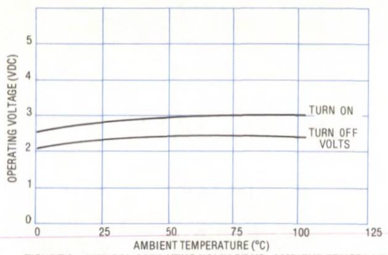


FIGURE 2 - TYPICAL OPERATING VOLTAGE VS. AMBIENT TEMPERATURE

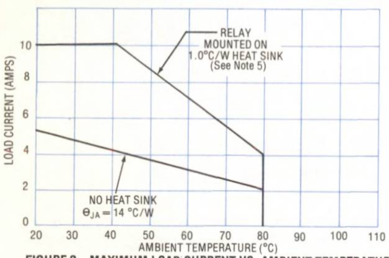


FIGURE 3 - MAXIMUM LOAD CURRENT VS. AMBIENT TEMPERATURE
601-2, -2H (SEE NOTE 2)

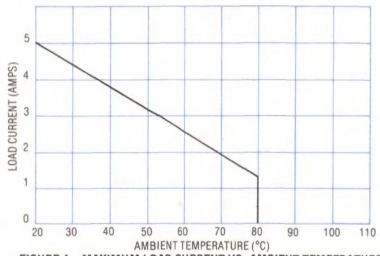


FIGURE 4 - MAXIMUM LOAD CURRENT VS. AMBIENT TEMPERATURE
601-1, -1H (SEE NOTE 2)

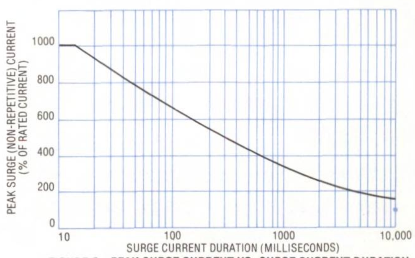
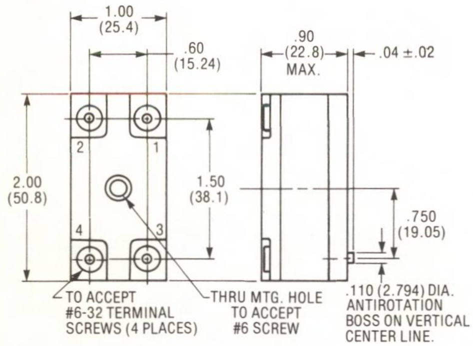


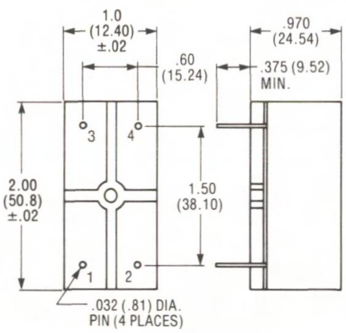
FIGURE 5 - PEAK SURGE CURRENT VS. SURGE CURRENT DURATION
ALL MODELS (SEE NOTE 4)

MECHANICAL SPECIFICATIONS



SCREW TERMINAL VERSION (10 AMP)
601-2, -2H

FIGURE 6



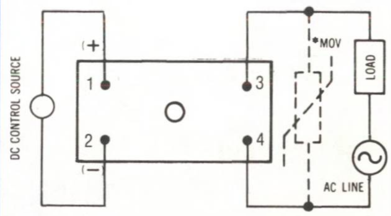
PC BOARD VERSION (5 AMP)
601-1, -1H

FIGURE 7

- Ambient Temperature Range
  -40°C to + 80°C Operating
  -40°C to + 80°C Storage
- Weight: 3 oz. max.
- Case Material: Plastic, Black
  Standard and "Q" Versions:
  Aluminum Base plate
- Header Material: Phenolic, black
- Terminals: Brass, Pins tin plated
  Screws nickel plated
- Epoxy Encapsulated

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)
TOLERANCES UNLESS OTHERWISE SPECIFIED
.XX ±.01 (.25); .XXX ±.005 (.13)

WIRING DIAGRAM



*OPTIONAL TRANSIENT VOLTAGE PROTECTION.

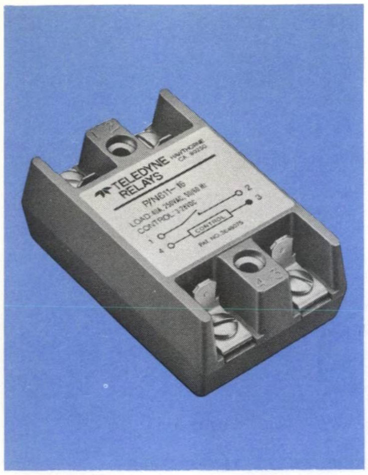
USE THE TABLE BELOW FOR SELECTION OF PROPER METAL OXIDE VARISTOR (MOV)

MAXIMUM CONTINUOUS LINE VOLTAGE RATING	TRANSIENT (PEAK) RATING OF RELAY	TELEDYNE MOV P/N
140 VAC	500	970-1
250 VAC	650	970-2

(See 970 Series Data for further information on MOVs).

NOTES:

1. Output transient (dv/dt) protection is provided in all models and they are designed to switch resistive or inductive loads to 0.2 power factor. The dv/dt rating is based on a source impedance of 50 ohms.
2. For any mounting conditions: 5 Amp relays, Θ_{JA} = 19°C/W. For 10 Amp relays, Θ_{JS} = 4.8°C/W.
3. Basic part number provides screw terminals (Fig. 6) or PC board pins (Fig. 7).
   For single ¼" quick disconnect terminals add suffix "Q" to 10 Amp Part Nos., or "QQ" suffix for double ¼" quick disconnects.
   (Examples: 601-2Q, 601-2QQ)
4. Triac may lose blocking capability during and after surge until T_J falls below maximum.
5. Relays mounted with silicone grease on heat sink such as Astrodyne, Inc., type 2518-0500-A00B (for 1.0°C/W).
6. Available in normally closed configuration to special order (factory).
7. For higher dielectric voltage consult factory.



TELEDYNE RELAYS

SOLID STATE AC RELAY

OPTICALLY ISOLATED
10 THRU 40 AMP
(DC INPUT CONTROL)

SERIES
611

SPST/NO

FEATURES

- 10, 25, and 40 Amp ratings
- High impedance logic compatible DC input
- High dv/dt rating (200V/μsec typical)
- Recessed dual-purpose terminals (screws and quick disconnects)
- Functional package design
- Form A & B versions available
- Zero voltage turn-on; zero current turn-off
- UL Recognized, File #E55197
- CSA Certified, File #LR31034

DESCRIPTION

This popular AC SSR Series features a functional as well as attractive package design, with dual-purpose screw and quick disconnect terminals recessed to provide high barriers and resulting long creepage paths for safety. Available in three output current ratings – 10, 25, and 40 Amps – and output voltage ratings up to 250 VRMS continuous and 600V peak transient. These DC input versions have high input circuit impedance and resultant low input current drain which provides compatibility with low and high level logic systems. Form A (SPST, normally open) and Form B (SPST, normally closed) versions are available.

PART NUMBERING

INPUT CONTROL VOLTAGE RANGE	OUTPUT VOLTAGE RATING (VAC) Continuous (RMS)	Transient (PEAK)	OUTPUT (LOAD) CURRENT RATING & PART NUMBERS 10 AMP	15 AMP	25 AMP	40 AMP
3-28 VDC	140	250	611-7*	611-3	611-1	611-5
	250	500	611-8*	611-4	611-2	611-6
	250	650	611-8H*	611-4H	611-2H	611-6H

*Available in N/C (Form B) configuration, with "B" suffix (e.g., 611B-7)

ELECTRICAL SPECIFICATIONS
(25°C UNLESS OTHERWISE SPECIFIED)

INPUT (CONTROL) SPECIFICATIONS	MIN.	TYP.	MAX.	UNITS
Control Voltage Range	3		28	VDC
Input Current at 5 V Control Voltage (-40°C ≤ Ta ≤ 80°C)			6	mA
Turn-On Voltage	3.0			VDC
Turn-On Voltage (-40°C ≤ Ta ≤ 80°C)	3.8			VDC
Turn-Off Voltage (-40°C ≤ Ta ≤ 80°C)			0.8	VDC
Isolation (Input to Output, Input to Case, Output to Case)	10^9			OHMS
Capacitance (Input to Output)		8	10	pf
Dielectric Strength (Input to Output, Input to Case, Output to Case)	1500			VAC (RMS) 60 Hz
Reverse Voltage Protection	30			VDC
OUTPUT (LOAD) SPECIFICATIONS	**MIN.**	**TYP.**	**MAX.**	**UNITS**
Output Current Rating (See Figure 2 or 5 for Temperature Derating)	0.05		10.15 25, 40	AMPS (RMS)
Load Voltage Rating (See Part Numbering)	12		250	VAC (RMS)
Frequency Range	47		70	Hz
Surge Current Rating (16MS) (See Figure 3)			1000	% OF RATING
Over Voltage Rating 611-1,-3,-5,-7	250			V PEAK
Over Voltage Rating 611-2,-4,-6,-8	500			V PEAK
Over Voltage Rating 611-2H,-4H,-6H,-8H	650			V PEAK
Contact Voltage Drop at Rated Current		0.8	1.5	VAC (RMS)
Turn-On Time (60 Hz)			8.3	mS
Turn-Off Time (60 Hz)			16.6	mS
Off-State Leakage (40°C ≤ Ta ≤ 80°C) @ 140 V			8	mA (RMS)
Off-State Leakage (40°C ≤ Ta ≤ 80°C) @ 250 V			13	mA (RMS)
Zero Voltage Turn-On Point		±12		V (PEAK)
Off-State dv/dt (See Note 1)	100	200		V/μsec
Triac Power Dissipation Factor (D) 10, 15, 25A			1.21	WATTS/AMP
Triac Power Dissipation Factor (D) 40A			1.25	WATTS/AMP
Triac Junction Temperature (T_J Max) 10, 15, 25A			100	Degrees Centigrade
Triac Junction Temperature (T_J Max) 40A			110	Degrees Centigrade
Thermal Resistance Junction to HS (Θ_{JS}) (Includes Θ_{CS}) 10A			3.1	°C/WATT
Thermal Resistance Junction to HS (Θ_{JS}) (Includes Θ_{CS}) 15A			1.8	°C/WATT
Thermal Resistance Junction to HS (Θ_{JS}) (Includes Θ_{CS}) 25A, 40A			1.3	°C/WATT

PATENT #3,648,075

CHARACTERISTIC CURVES

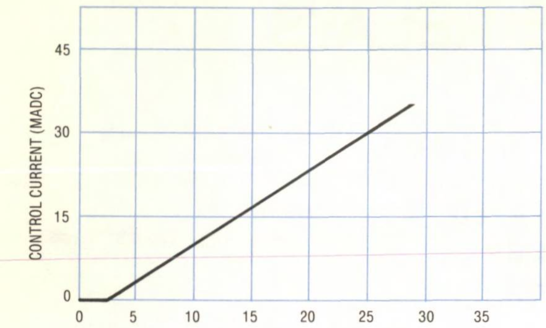


FIGURE 1 - TYPICAL INPUT CURRENT VS. CONTROL VOLTAGE

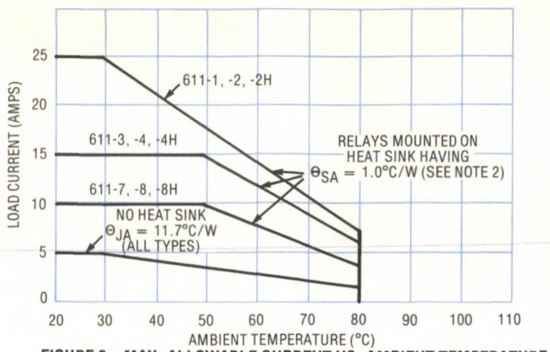


FIGURE 2 - MAX. ALLOWABLE CURRENT VS. AMBIENT TEMPERATURE

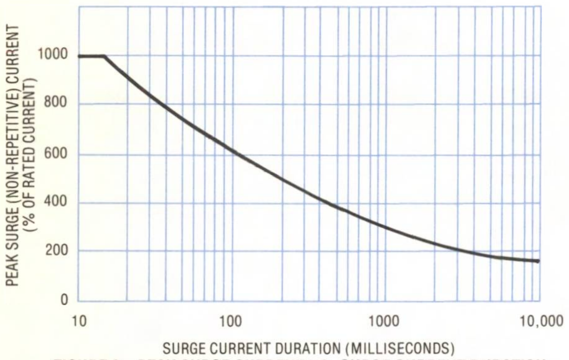


FIGURE 3 - PEAK SURGE CURRENT VS. SURGE CURRENT DURATION (SEE NOTE 3)

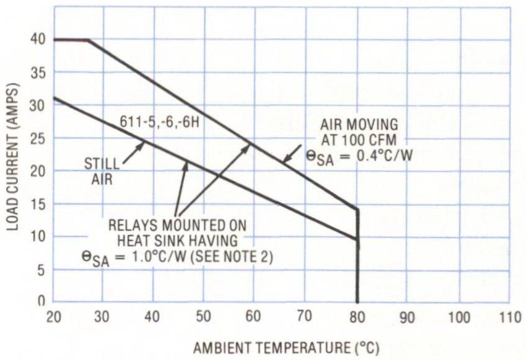
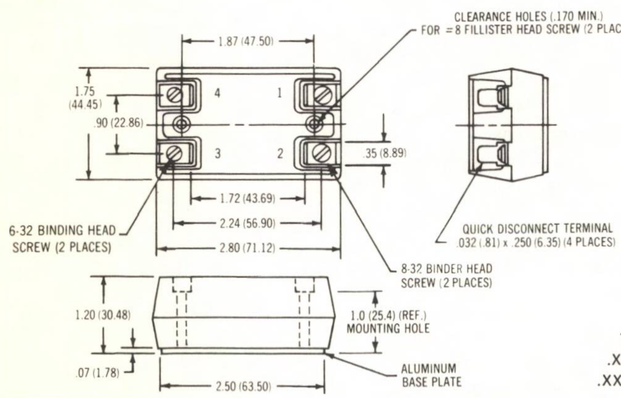
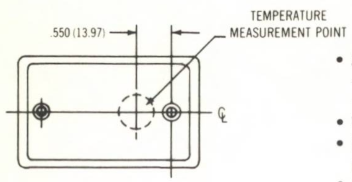


FIGURE 4 - MAX. ALLOWABLE CURRENT VS. AMBIENT TEMPERATURE

MECHANICAL SPECIFICATIONS



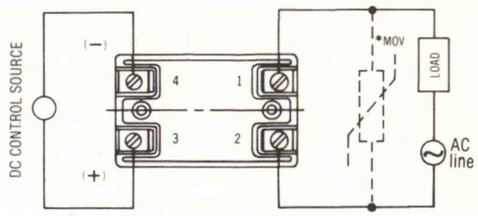
TOLERANCES
.XX ± .01 (.25mm);
.XXX ± .005 (.13mm)



- Ambient Temperature Range:
  −40°C to +80°C Operating
  −40°C to +100°C Storage
- Weight: 4 oz. max.
- Case Material: Glass filled polycarbonate rated self-extinguishing
- Base Plate Material: Aluminum
- Color: Aqua

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

WIRING DIAGRAM



*OPTIONAL TRANSIENT VOLTAGE PROTECTION.
(See Note 4)

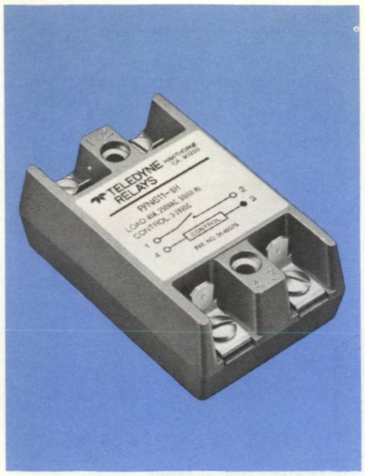
USE THE TABLE BELOW FOR SELECTION OF PROPER METAL OXIDE VARISTOR (MOV)

MAXIMUM CONTINUOUS LINE VOLTAGE RATING	TRANSIENT (PEAK) RATING OF RELAY	TELEDYNE MOV P/N
140 VAC	500	970-1
250 VAC	650	970-2

(See 970 Series Data for further information on MOVs).

NOTES:

1. Output (dv/dt) protection is provided in all models, and they are designed to switch resistive or inductive loads to 0.2 power factor. The dv/dt rating is based on a source impedance of 50 ohms.
2. Relays mounted with silicone grease on heat sink such as Astrodyne, Inc., Type 2518-0500-A00B (for 1.0°C/W).
3. Triac may lose blocking capability during and after surge until T_J falls below maximum.
4. With proper MOV installed, relay is protected against voltage transients such as those defined in IEEE STD 472-1974.



TELEDYNE RELAYS

SERIES **611**

SOLID STATE AC RELAY

OPTICALLY ISOLATED
10 THRU 40 AMP
(AC INPUT CONTROL)

SPST/NO

FEATURES

- 10, 25, and 40 Amp ratings
- 90-250 VRMS voltage range
- High dv/dt rating (200V/μsec typical)
- Recessed dual-purpose terminals (screws and quick disconnects)
- Functional package design
- Zero Voltage Turn-On; Zero Current Turn-Off
- UL Recognized File #E55197
- CSA Certified, File #LR31043

DESCRIPTION

This popular AC SSR Series features a functional as well as attractive package design, with dual-purpose screw and quick disconnect terminals recessed to provide high barriers and resulting long creepage paths for safety. Available in three output current ratings - 10, 25, and 40 Amps - and output voltage ratings up to 250 VRMS continuous and 600V transient. These versions of the 611 Series are driven by AC, with an input voltage range of 90-250 VRMS.

PART NUMBERING

INPUT CONTROL VOLTAGE RANGE	OUTPUT VOLTAGE RATING (VAC)		OUTPUT (LOAD) CURRENT RATING & PART NUMBERS			
	Continuous (RMS)	Transient (PEAK)	10 AMP	15 AMP	25 AMP	40 AMP
90-250 VAC	140	250	611-17	611-13	611-11	611-15
	250	500	611-18	611-14	611-12	611-16
	250	650	611-18H	611-14H	611-12H	611-16H

ELECTRICAL SPECIFICATIONS

(25°C UNLESS OTHERWISE SPECIFIED)

INPUT (CONTROL) SPECIFICATIONS	MIN.	TYP.	MAX.	UNITS
Control Voltage (-40°C to +80°C)	90		250	VAC
Frequency Range	47		70	Hz
Input Current at Max. Control Voltage (-40°C ≤ Ta ≤ 80°C)			18	mA (RMS)
Turn-On Voltage (-40°C ≤ Ta ≤ 80°C)	90			VAC
Turn-Off Voltage (-40°C ≤ Ta ≤ 80°C)			4	VAC
Isolation (Input to Output, Input to Case, Output to Case)	10^9			OHMS
Capacitance (Input to Output)		8	10	pf
Dielectric Strength (Input to Output, Input to Case, Output to Case)	1500			VAC (RMS)
OUTPUT (LOAD) SPECIFICATIONS	**MIN.**	**TYP.**	**MAX.**	**UNITS**
Output Current Rating (See Figure 2 or 4 for Temperature Derating)	0.05		10, 15, 25, 40	AMPS (RMS)
Load Voltage Rating (See Part Numbering)	12		140, 250	VAC (RMS)
Frequency Range	47		70	Hz
Surge Current Rating (16MS) (See Figure 3)			1000	% OF RATING
Over-Voltage Rating: 611-11, -13, -15, -17	250			V PEAK
Over-Voltage Rating: 611-12, -14, -16, -18	500			V PEAK
Over-Voltage Rating: 611-12H, -14H, -16H, -18H	650			V PEAK
Contact Voltage Drop at Rated Current		0.8	1.5	VAC (RMS)
Turn-On Time (60 Hz)			10	mS
Turn-Off Time (60 Hz)		16	40	mS
Off-State Leakage (40°C ≤ Ta ≤ 80°C) @ 140 V			8	mA (RMS)
Off-State Leakage (40°C ≤ Ta ≤ 80°C) @ 250 V			13	mA (RMS)
Zero Voltage Turn-On Point		±12		V (PEAK)
Off-State dv/dt (See Note 1)	100	200		V/μsec
Triac Power Dissipation Factor (D) 10A, 15A, 25A			1.21	WATTS/AMP
Triac Power Dissipation Factor (D) 40A			1.25	WATTS/AMP
Triac Junction Temp. (T_J Max.) 10, 15, 25A			100	Degrees Centigrade
Triac Junction Temp. (T_J Max.) 40A			110	Degrees Centigrade
Thermal Resistance Junction to HS (Θ_{JS}) (Includes Θ_{CS}) 10A			3.1	°C/WATT
Thermal Resistance Junction to HS (Θ_{JS}) (Includes Θ_{CS}) 15A			1.8	°C/WATT
Thermal Resistance Junction to HS (Θ_{JS}) (Includes Θ_{CS}) 25A, 40A			1.3	°C/WATT

PATENT #3,648,075

CHARACTERISTIC CURVES

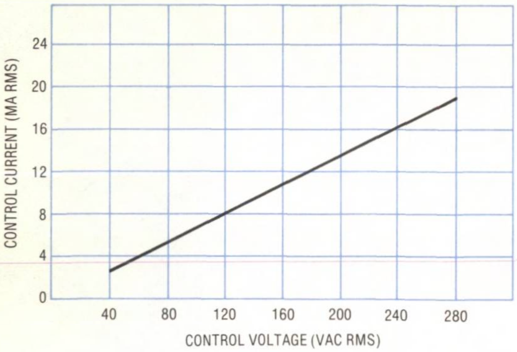


FIGURE 1 - TYPICAL INPUT CURRENT VS. CONTROL VOLTAGE

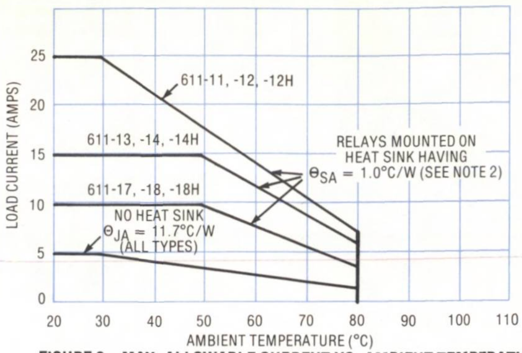


FIGURE 2 - MAX. ALLOWABLE CURRENT VS. AMBIENT TEMPERATURE

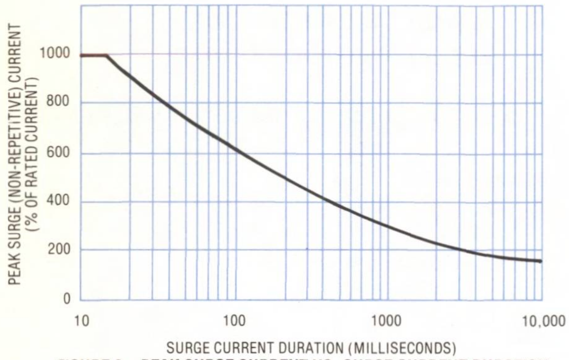


FIGURE 3 - PEAK SURGE CURRENT VS. SURGE CURRENT DURATION (SEE NOTE 3)

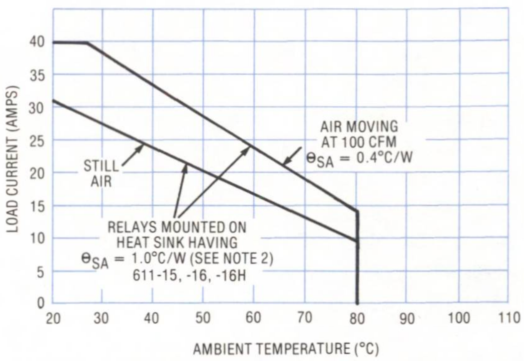
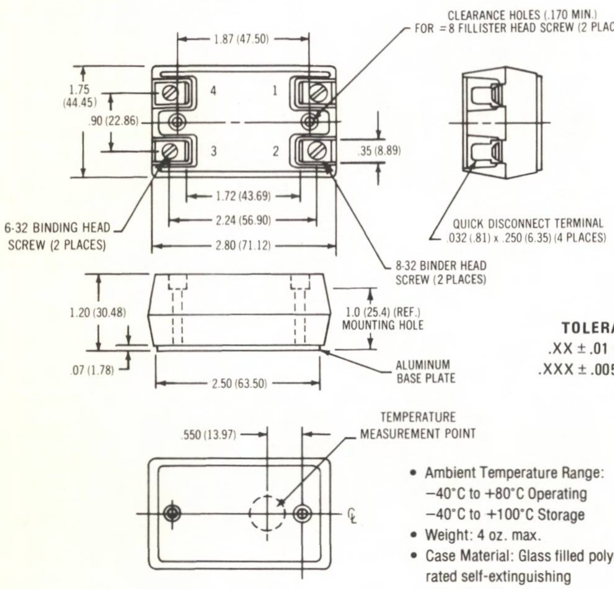


FIGURE 4 - MAX. ALLOWABLE CURRENT VS. AMBIENT TEMPERATURE

MECHANICAL SPECIFICATIONS

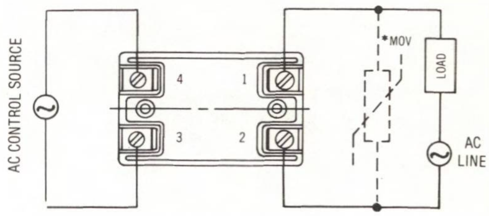


TOLERANCES
.XX ± .01 (.25mm);
.XXX ± .005 (.13mm)

- Ambient Temperature Range:
  −40°C to +80°C Operating
  −40°C to +100°C Storage
- Weight: 4 oz. max.
- Case Material: Glass filled polycarbonate rated self-extinguishing
- Base Plate Material: Aluminum
- Color: Aqua

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

WIRING DIAGRAM



*OPTIONAL TRANSIENT VOLTAGE PROTECTION.
(See Note 4)

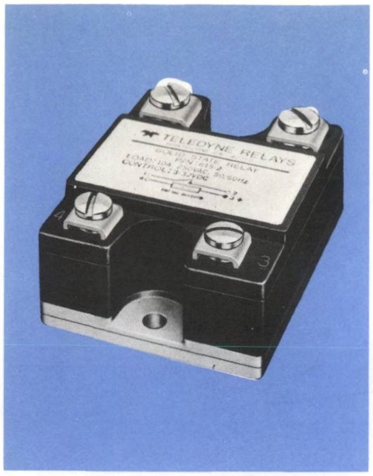
USE THE TABLE BELOW FOR SELECTION OF PROPER METAL OXIDE VARISTOR (MOV)

MAXIMUM CONTINUOUS LINE VOLTAGE RATING	TRANSIENT (PEAK) RATING OF RELAY	TELEDYNE MOV P/N
140 VAC	500	970-1
250 VAC	650	970-2

(See 970 Series Data for further information on MOVs).

NOTES:

1. Output (dv/dt) protection is provided in all models, and they are designed to switch resistive or inductive loads to 0.2 power factor. The dv/dt rating is based on a source impedance of 50 ohms.
2. Relays mounted with silicone grease on heat sink such as Astrodyne, Inc., Type 2518-0500-A00B (for 1.0°C/W).
3. Triac may lose blocking capability during and after surge until T_J falls below maximum.
4. With proper MOV installed, relay is protected against voltage transients such as those defined in IEEE STD 472-1974.



TELEDYNE RELAYS

SOLID STATE AC RELAY

OPTICALLY ISOLATED
10 THRU 40 AMP

SERIES
615

SPST/NO

FEATURES

- Optical isolation between control and load circuits
- Logic compatible input current levels
- Constant current input control circuit
- Zero voltage turn-on; zero current turn-off
- High transient immunity
- UL Recognized, File #E55197
- CSA Certified File #LR31043*

DESCRIPTION

These state-of-the-art AC SSRs utilize custom integrated circuits to replace conventional discrete circuitry. The resultant 40% reduction in component count provides numerous advantages, none the least of which are lower cost and higher reliability.

Optical coupling between control and load circuits provides a minimum of 2500 VRMS input/output isolation. Synchronous ''zero-voltage'' turn-on and zero current turn-off minimize switching transients and EMI. Improved circuit design and built-in snubber protection guarantee high immunity from false triggering and reliable switching of low power factor loads. Constant current input circuitry reduces excessive power dissipation at higher input voltage levels.

PART NUMBERING

INPUT CONTROL VOLTAGE RANGE	OUTPUT VOLTAGE RATING (VAC)		OUTPUT (LOAD) CURRENT RATING & PART NUMBERS		
	Continuous (RMS)	Transient (PEAK)	10 AMP	25 AMP	40 AMP
3-32 VDC	140	250	615-1*	615-3	615-5
	250	500	615-2*	615-4	615-6
	250	650	615-2H*	615-4H	615-6H

ELECTRICAL SPECIFICATIONS
(25°C UNLESS OTHERWISE NOTED)

INPUT (CONTROL) SPECIFICATIONS		MIN.	MAX.	UNITS
Control Voltage Range		3	32	VDC
Input Current (Current Limited, See Figure 1) (-40°C ≤ ta ≤ 80°C)	5V		10	mA
	32V		14	
Turn-On Voltage (-40°C ≤ Ta ≤ 80°C)		3.0		VDC
Turn-Off Voltage (-40°C ≤ Ta ≤ 80°C)			1.0	VDC
Isolation (input to Output, Input to Case, Output to Case)		10^{10}		OHMS
Capacitance (Input to Output)			15	pf
Dielectric Strength (Input to Output)		2500		VAC(RMS) 60 Hz
Dielectric Strength (Input & Output to Case) (See Note 5)	615-1,-2,-2H	1500		
	615-3,-4,-4H -5,-6,-6H	2500		
Reverse Voltage Protection		32		VDC

OUTPUT (LOAD) SPECIFICATIONS		MIN.	MAX.	UNITS
Output Current Rating (See Figures 2 and 4 for Temperature Derating)		0.05	10 25,40	AMPS (RMS)
Load Voltage Rating	615-1,-3,-5	12	140	VAC(RMS)
	615-2,-2H,-4, -4H,-6,-6H	12	250	
Frequency Range		47	70	Hz
Surge Current Rating (16ms) (See Figure 3)			1000	% OF RATING
Over Voltage Rating (Transient Peak)	615-1,-3,-5	250		V PEAK
	615-2,-4,-6	500		
	615-2H,-4H,-6H	650		
Contact Voltage Drop at Rated Current			1.5	VAC(RMS)
Turn-On Time (60 Hz)			8.3	mS
Turn-Off Time (60 Hz)			14	mS
Off-State Leakage	@ 140 V		6	mA(RMS)
	@ 250 V		9	
Off-State dv/dt (See Note 1)		200		V/μsec
Triac Power Dissipation Factor (D)	615-1,-2,-2H		1.21	WATTS/ AMP
	615-3,-4,-4H		1.2	
	615-5,-6,-6H		1.125	
Fusing I^2T (1ms)	615-1,-2,-2H		20	A^2SEC
	615-3,-4,-4H		150	
	615-5,-6,-6H		300	
Triac Junction Temperature (T_J Max.)			110	°C
Thermal Resistance, Junction to HS (Θ_{JS}) (Includes Θ_{CS})	615-1,-2,-2H		3.1	°C/WATT
	615-3,-4,-4H		0.8	
	615-5,-6,-6H		0.7	

CHARACTERISTIC CURVES

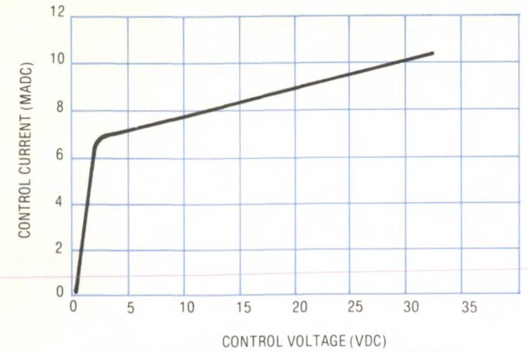


FIGURE 1 - INPUT CURRENT VS. VOLTAGE (TYPICAL)

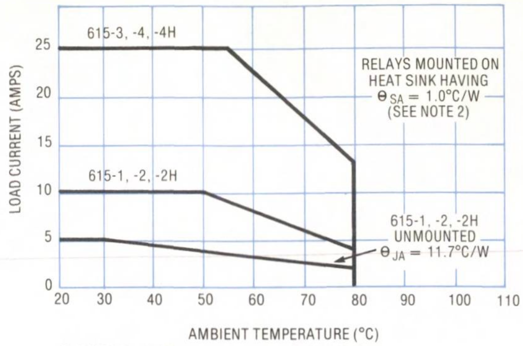


FIGURE 2 - THERMAL DERATING CURVES

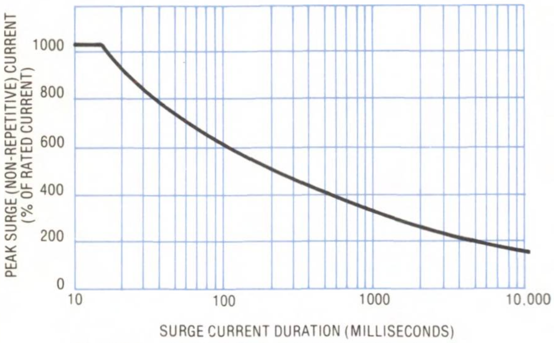


FIGURE 3 - SURGE CURRENT DURATION (See Note 3)

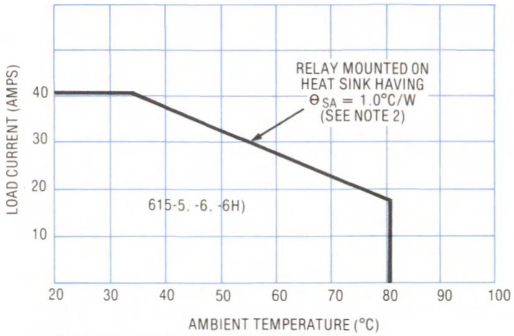
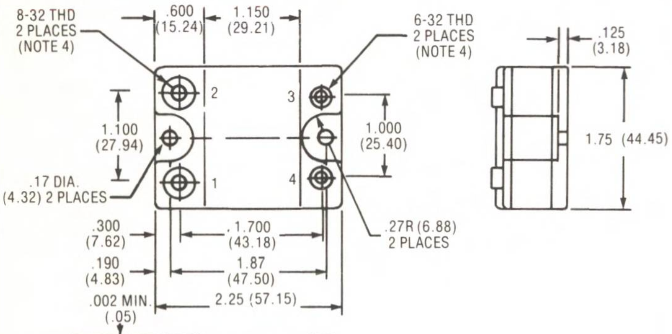
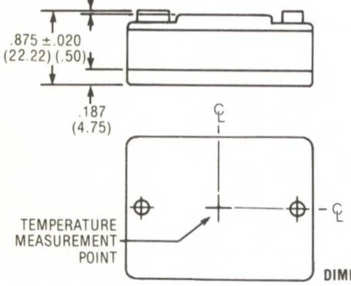


FIGURE 4 - THERMAL DERATING CURVES

MECHANICAL SPECIFICATIONS





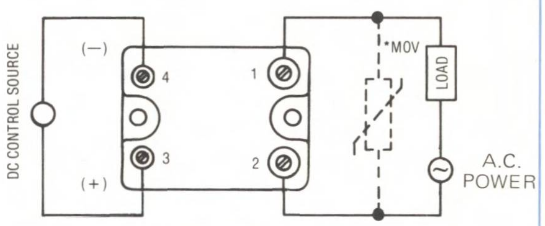
- Ambient Temperature Range: −40°C to +80°C Operating and Storage
- Weight: 4 oz. max.
- Case Material: Plastic, self-extinguishing
- Base Plate Material: Aluminum
- Case Color: Black

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

TOLERANCES:

.XX±.02 (.50); .XXX±.01 (.25)

WIRING DIAGRAM



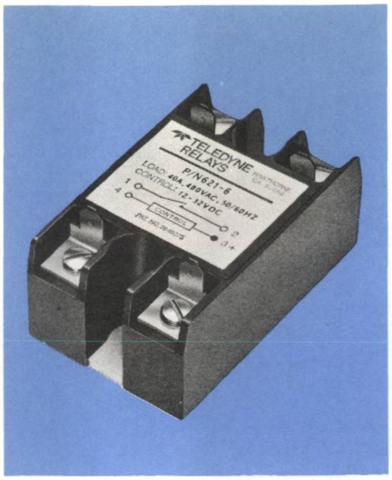
*OPTIONAL EXTERNAL TRANSIENT VOLTAGE PROTECTION.

USE THE TABLE BELOW FOR SELECTION OF PROPER METAL OXIDE VARISTOR (MOV)

MAXIMUM CONTINUOUS LINE VOLTAGE RATING	TRANSIENT (PEAK) RATING OF RELAY	TELEDYNE MOV P/N
140 VAC	500	970-1
250 VAC	650	970-2

(SEE 970 SERIES DATA SHEET FOR FURTHER INFORMATION ON MOV'S).

1. Output (dv/dt) protection is provided in all models, and they are designed to switch resistive or inductive loads to 0.2 power factor. The dv/dt rating is based on a source impedance of 50 ohms.
2. Relays mounted with silicone grease on heat sink such as Astrodyne, Inc., Type 2518-0500-A00B (for 1.0°C/W).
3. Triac may lose blocking capability during and after surge until TJ falls below maximum.
4. Hardware packaged separately: 6-32 and 8-32 Screws and Saddle Clamps.
5. 615 series are available with 3750 Dielectric Input and Output to Case. Use "A" suffix when ordering (Example: 615-2HA).
6. Relays may be shipped with ¼" Quick Disconnects instead of Saddle Clamps by adding a "Q" (for single) or "QQ" (for double) to Basic Part Number (Example: 615-2HAQ).



TELEDYNE RELAYS

HIGH VOLTAGE SOLID STATE AC RELAY

OPTICALLY ISOLATED 15 THRU 40 AMP

SERIES 621

SPST/NO

FEATURES

- High input/output isolation (3750 VRMS)
- High output voltage ratings
- High dv/dt rating (200V/μsec minimum)
- Logic compatible DC input voltage ranges
- Multipurpose screw/quick disconnect terminals
- Designed to meet safety requirements of UL, CSA, and VDE
- Zero voltage turn-on; zero current turn-off
- UL Recognized File #E55197

DESCRIPTION

The 621 Series high voltage AC SSRs were designed for applications involving high line voltages (up to 480 VRMS) and/or high peak transient voltages (up to 800V peak). In addition, the high input/output isolation rating of 3750 VRMS meets VDE specifications for equipment to be used in the European market. The 480 VRMS continuous load voltage rating also provides sufficient guard band for 220 VRMS 3-phase ungrounded wye or delta systems where high line to line voltages are experienced. A choice of two DC input control ranges offers compatibility with both high and low level logic. Recessed barriered multi-purpose screw/quick disconnect terminals with resulting long creepage paths provide additional safety from arc-over.

PART NUMBERING

INPUT CONTROL VOLTAGE RANGE	OUTPUT VOLTAGE RATING (VAC)		OUTPUT (LOAD) CURRENT RATING & PART NUMBERS		
	Continuous (RMS)	Transient (PEAK)	15 AMP	25 AMP	40 AMP
3-14 VDC	480	800	621-1	621-3	621-5
12-32 VDC	480	800	621-2	621-4	621-6
90-250 VAC	480	800	621-11	621-13	621-15

ELECTRICAL SPECIFICATIONS

(25°C UNLESS OTHERWISE SPECIFIED)

INPUT (CONTROL) SPECIFICATIONS		MIN.	TYP.	MAX.	UNITS
Control Voltage Range	621-1,-3,-5	3		14	VDC
	621-2,-4,-6	12		32	
	621-11,-13,-15	90		250	VAC
Input Current at: (-40°C≤Ta ≤80°C)	5V 621-1,-3,-5			16	mA
	28V 621-2,-4,-6			20	
	250 VAC 621-11,-13,-15			18	
Turn-On Voltage (-40°C≤Ta≤80°C)	621-1,-3,-5	3.8			VDC
	621-2,-4,-6	12			
	621-11,-13,-15	90			VAC
Turn-Off Voltage (-40°C≤Ta≤80°C)	621-2,-4,-6			1.0	VDC
	621-1,-2,-5				
	621-11,-13,-15	3.5			VAC
Isolation (Input to Output, Input to Case, Output to Case)		10^9			OHMS
Capacitance (Input to Output)			8	10	pf
Dielectric Strength (Input to Output, Input to Case, Output to Case)		3750			VAC(RMS) 60 Hz
Reverse Voltage Protection		30			VDC
OUTPUT (LOAD) SPECIFICATIONS		**MIN.**	**TYP.**	**MAX.**	**UNITS**
Output Current Rating (See Figures 2 & 3)		.100		15, 25, 40	AMPS (RMS)
Load Voltage Rating		25		480	VAC (RMS)
Frequency Range		45		70	Hz
Surge Current Rating (60 Hz, 1 Cycle) (See Figure 4)				1000	% OF RATING
Overvoltage Rating Transient (T≤20Ms)				800	V (PEAK)
Contact Voltage Drop at Rated Current			0.8	1.5	VAC
Turn-On Time (60 Hz)				1/2	CYCLE
Turn-Off Time (60 Hz)				1	CYCLE
Off State Leakage at 440 VAC (-40°C≤Ta≤80°C)				10	mA(RMS)
Zero Voltage Turn-On Point			±20		V (PEAK)
Off State dv/dt (See Note 1)		200			V/μsec
Fusing I^2T (1ms)	621-1,-2			150	A^2SEC
	621-3,-4			250	
	621-5,-6			300	
Triac Power Dissipation Factor (D)	15A, 25A			1.21	WATTS/AMP
	40A			1.25	
Triac Junction Temperature (T_J Max.)				110	_C
Thermal Resistance Junction to Heatsink (Θ_{JS}) (Includes Θ_{CS})	621-1,-2			1.4	°C/WATT
	621-3,-4			1.1	
	621-5,-6			1.1	

PATENT #3,648,075

CHARACTERISTIC CURVES

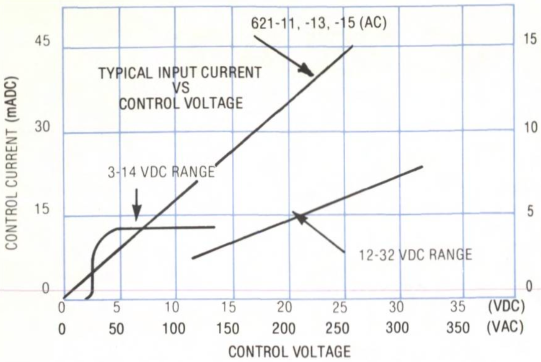


FIGURE 1 - TYPICAL INPUT CURRENT VS. CONTROL VOLTAGE

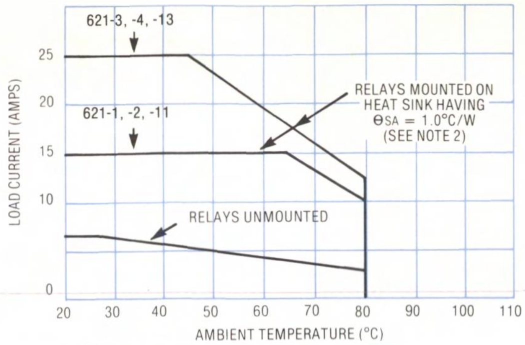


FIGURE 2 - MAXIMUM ALLOWABLE CURRENT VS. AMBIENT TEMPERATURE

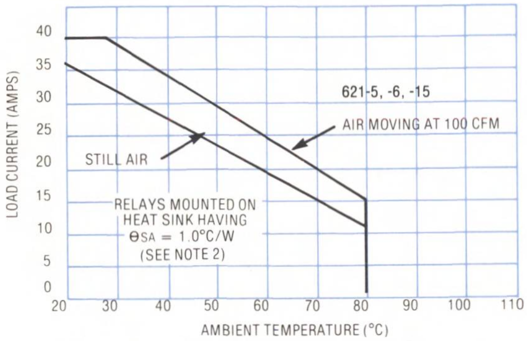


FIGURE 3 - MAXIMUM ALLOWABLE CURRENT VS. AMBIENT TEMPERATURE

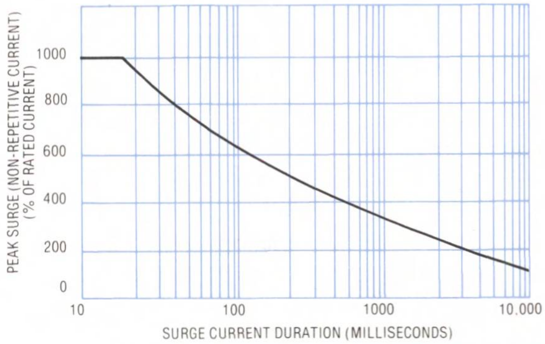
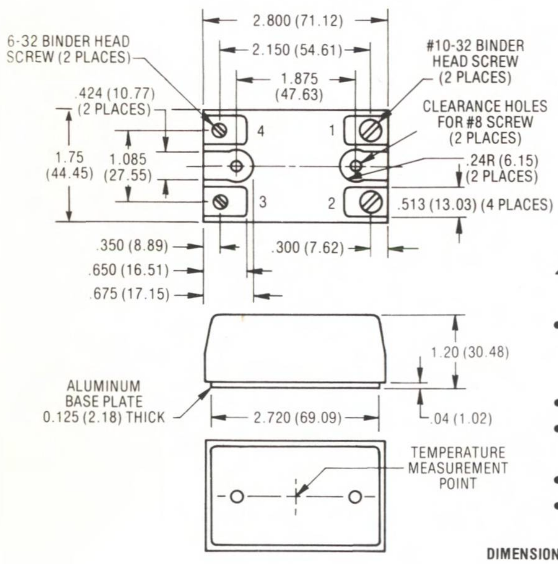
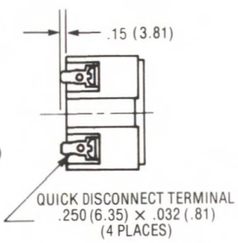


FIGURE 4 - PEAK SURGE CURRENT VS. SURGE CURRENT DURATION (SEE NOTE 3)

MECHANICAL SPECIFICATIONS



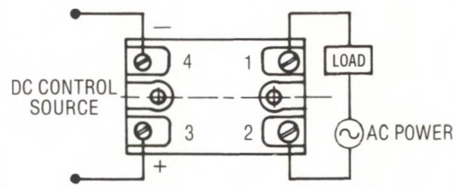


- Ambient Temperature Range:
  -40°C to 80°C Operating
  -40°C to 80°C Storage
- Weight: 6 Oz. Max.
- Case Material: Plastic, Rated Self-Extinguishing
- Base Plate Material: Aluminum
- Case Color: Red

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

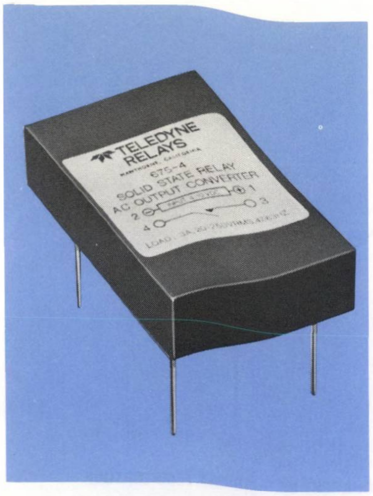
TOLERANCES:
.XX ±.01 (.25); .XXX ±.005 (.13)

WIRING DIAGRAM



NOTES:

1. Output transient (dv/dt) protection is provided in all models, and they are designed to operate resistive or inductive loads to 0.2 power factor. The dv/dt rating is based on a source impedance of 50 ohms.
2. A typical 1.0°C/W heat sink is Astrodyne P/N 2518-0500-A00B.
3. Triac may lose blocking capability during and after surge until T_J falls below maximum.



TELEDYNE RELAYS

SOLID STATE AC RELAY

OPTICALLY ISOLATED
3 AMP

SERIES
675

SPST/NO

FEATURES

- Low profile package for PC Board mounting
- Logic compatible DC input ranges
- UL Recognized File #E47991
- CSA Certified File #LR31043

DESCRIPTION

This AC SSR is designed expressly for PC Board applications where low profile height is required due to close board spacing. Optical coupling provides 1500 VRMS input/output isolation, and a choice of two DC input ranges offers compatibility with low and high level logic systems. Output rating is 3A/250 VRMS up to 40°C ambient temperature, derating to 1.5A/250 VRMS at 70°C. Internal snubber network is included – across output.

PART NUMBERING

INPUT CONTROL VOLTAGE RATING	PART NUMBER	OUTPUT VOLTAGE RATING CONTINUOUS (RMS)	OUTPUT VOLTAGE RATING TRANSIENT PEAK
4-32 VDC	675-6	250 VAC	400 VAC
4-32 VDC	675-6H		600 VAC

ELECTRICAL CHARACTERISTICS
(25°C UNLESS OTHERWISE SPECIFIED)

INPUT SPECIFICATIONS		MIN.	TYP.	MAX.	UNITS	NOTES
Input Voltage Range	675-6,-6H	4		32	VDC	See Note 4
Input Current	@ 5VDC			10	mADC	See Fig. 1
	@32VDC			18		
Dielectric Strength (Input to Output)		2500			VAC(RMS) 60 Hz	
Capacitance (Input to Output)				15	pf	
Turn-On Voltage	675-6,-6H	4			VDC	
Turn-Off Voltage (Both Types)				1	VDC	
OUTPUT SPECIFICATIONS		**MIN.**	**TYP.**	**MAX.**	**UNITS**	**NOTES**
Load Current Rating		.010		4	AMPS (RMS)	See Fig. 2
Load Voltage Rating	675-6	20		132	VAC(RMS)	
	675-6H	20		250		
Frequency Range		47		70	Hz	
Surge Current Rating (16mS)				80	AMPS	See Fig. 3
Off State dv/dt		100	200		V/μSEC	
Peak Transient Voltage	675-6	±400			V(PEAK)	See Note 8
	675-6H	±600				
Voltage across Load at Turn-On			±12		V(PEAK)	
Output Voltage Drop				2	VAC(RMS)	
Off State Leakage Current (60 Hz)	@115VAC			8	mA(RMS)	
	@230VAC			13		
Turn-On Time at 60 Hz				8.3	mSEC	
Turn-Off Time				16	mSEC	
Power Dissipation @ 1 Max.				1.5	watts/amp	

PATENT #3,648,075

CHARACTERISTIC CURVES

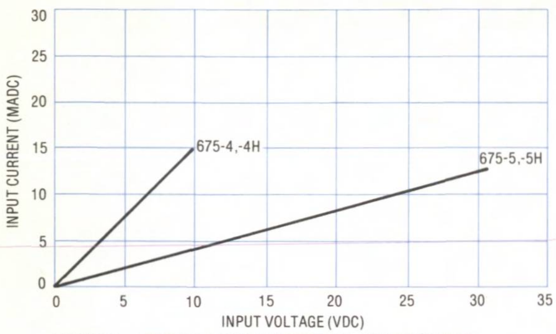


FIGURE 1 – TYPICAL INPUT CURRENT VS. INPUT VOLTAGE

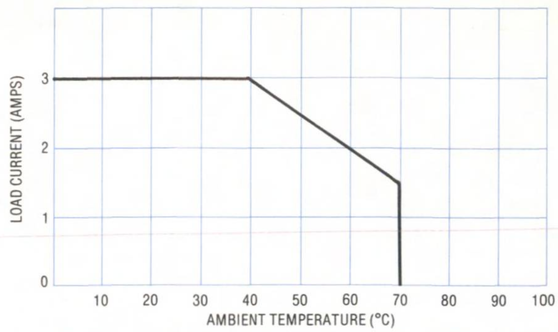


FIGURE 2 – MAXIMUM LOAD CURRENT VS. AMBIENT TEMPERATURE

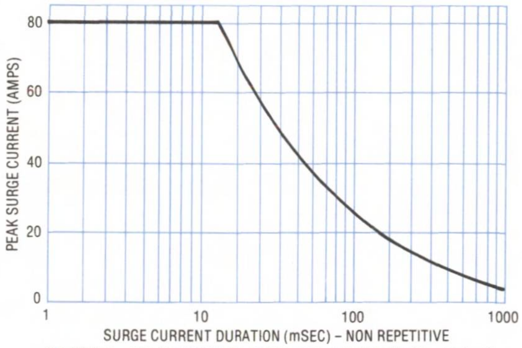
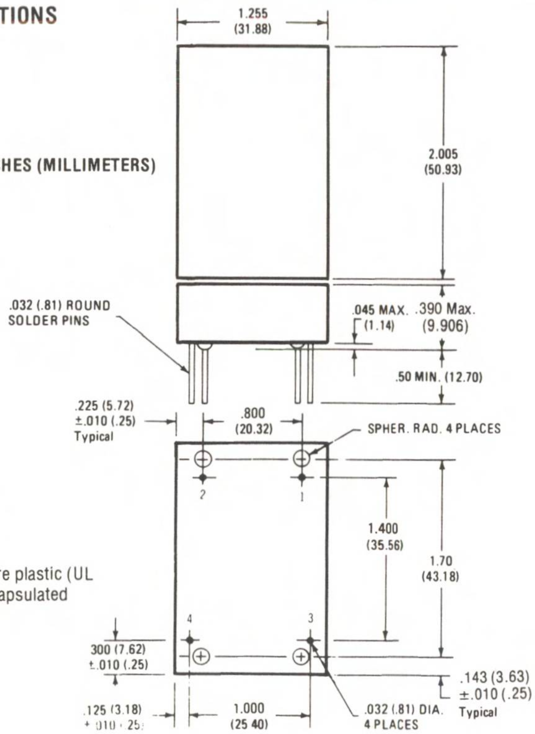


FIGURE 3 – PEAK SURGE CURRENT VS. DURATION (See Note 3)

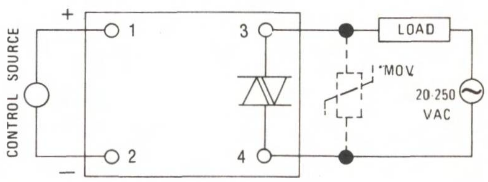
MECHANICAL SPECIFICATIONS

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)



- Ambient Temperature Range:
  0°C to 70°C Operating
  –30°C to 80°C Storage
- Weight: 50 Grms.
- Case Material: High temperature plastic (UL Recognized, 94V0), epoxy encapsulated

WIRING DIAGRAM



USE THE TABLE BELOW FOR SELECTION OF PROPER METAL OXIDE VARISTOR (MOV)
*OPTIONAL TRANSIENT VOLTAGE PROTECTION.
(SEE NOTE 4)

TABLE 1

MAXIMUM CONTINUOUS LINE VOLTAGE (OPERATING	TRANSIENT (PEAK) RATING OF RELAY	TELEDYNE MOV P/N
140VAC	400	970-1
250VAC	600	970-2

(SEE 970 SERIES DATA FOR FURTHER INFORMATION ON MOVs)

NOTES:

1. Reverse polarity input protection is provided up to 10VDC maximum.
2. Output transient (dv/dt) protection is provided in all models, and they are designed to switch resistive or inductive loads to 0.2 power factor. The dv/dt rating is based on a source impedance of 50 ohms.
3. Triac may lose blocking capability during surge conditions.
4. With proper MOV installed, relay is protected against voltage transients such as those defined in IEEE STD 472-1974.

TELEDYNE RELAYS

SOLID STATE DC RELAY

OPTICALLY ISOLATED
2 & 5 AMP/50 VDC
(AC OR DC INPUT CONTROL)

SERIES
603

SPST/NO

FEATURES

- TTL compatible inputs
- Optional controlled rise & fall times
- Terminal options: Screws, quick disconnects, or PC Board solder pins

DESCRIPTION

These optically coupled DC SSRs are rated at 2 and 5 amps, respectively, at 50 VDC, and are available with either TTL compatible DC inputs or AC line voltage inputs. Optional controlled output rise and fall times provide the following added advantages:

a) limit in-rush currents for capacitive and lamp loads
b) limit turn-off transients with inductive loads
c) minimize EMI and switching transients

The adaptive package design offers a choice of screw or quick disconnect terminals for chassis, panel, or heat sink mounting, or solder pins for direct mounting on PC boards.

PART NUMBERING (See Note 1)

INPUT CONTROL VOLTAGE RANGE	OUTPUT VOLTAGE RATING	OUTPUT LOAD RATING & PART NUMBERING			
				CONTROLLED RISE AND FALL TIME	
		2 AMP	5 AMP	2 AMP	5 AMP
3-32 VDC	50 VDC	603-1	603-2	603-21	603-22
90-250 VAC		603-11	603-12		

ELECTRICAL SPECIFICATIONS
(25°C UNLESS OTHERWISE SPECIFIED)

INPUT (CONTROL) SPECIFICATIONS			MIN.	TYP.	MAX.	UNITS	REF.
DC INPUT MODELS	Control Voltage Range (-30°C to +80°C)		3		32	VDC	
	Input Current at 5V (-30°C to +80°C)				5.5	mA DC	Fig. 3
	Input Current at 32V (-30°C to +80°C)			35	42	mA DC	Fig. 3
	Turn-On Voltage		3			VDC	
	Turn-Off Voltage (-30°C to +80°C)				0.8	VDC	
AC INPUT MODELS	Control Voltage Range (-30°C to +80°C)		90		250	VAC	
	Input Current at Max. Control Voltage				25	mA RMS	Fig. 3
	Turn-On Voltage (-30°C to +80°C)		90			VAC	
	Turn-Off Voltage (-30°C to +80°C)				20	VAC	Note 4
	Control Voltage Frequency		47		70	Hz	
Isolation (Input to Output, Input to Case, Output to Case)			10^9			OHMS	
Capacitance (Input to Output)				10	20	PF	
Dielectric Strength (Input to Output, Input to Case, Output to Case)			1500			VRMS	
Reverse Voltage Protection (DC Control)					32	VDC	
OUTPUT (LOAD) SPECIFICATIONS			**MIN.**	**TYP.**	**MAX.**	**UNITS**	**REF.**
Output Current Rating (Resistive)		603-1,-11,-21			2	AMPS	Fig. 1 & 2
		603-2,-12,-22			5	AMPS	
Load Voltage Rating			3		50	VDC	
Voltage Drop at Max. Current				1	1.5	VDC	
Surge Current (% of Rating)							Fig. 4
DC INPUT MODELS	Turn On Time Delay ($T_{d(on)}$)	603-1,-2		15	25	μsec.	
	$5V_{in}$ / $50V_{load}$	603-21,-22		25	100	μsec.	
	Rise Time (T_r)	603-1,-2		50	75	μsec.	Fig. 5 6, 7
	$5V_{in}$ / $50V_{load}$	603-21,-22	0.5	1	2	Msec.	
	Turn Off Time Delay ($T_{d(off)}$)	603-1,-2			100	μsec.	
	$5V_{in}$ / $50V_{load}$	603-21,-22		1	2	Msec.	
	Fall Time (T_f)	603-1,-2		100	200	μsec.	
	$5V_{in}$ / $50V_{load}$	603-21,-22	65	100	145	μsec./VOLT	
AC INPUT MODELS.	Turn-On Time (time delay (T_d) + rise time (T_r)) $120V_{in}$ / $50V_{load}$			15	25	Msec.	
	Turn-Off Time (time delay (T_d) + fall time (T_f)) $120V_{in}$ / $50V_{load}$			15	25	Msec.	
Output Leakage Current (at 50V, 80°C)		603-1,-11,-21		4	10	mA DC	
		603-2,-12,-22		6	15	mA DC	
Power Dissipation Factor (D)					1.5	W/AMP	
Power Switch Junction Temperature (T_J Max.)					150	°C	

CHARACTERISTIC CURVES

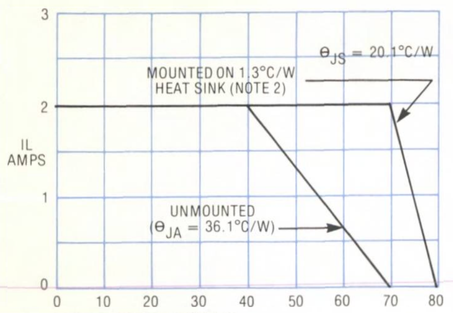


FIGURE 1 - 603-1/603-21 DC RELAY DERATING CURVE

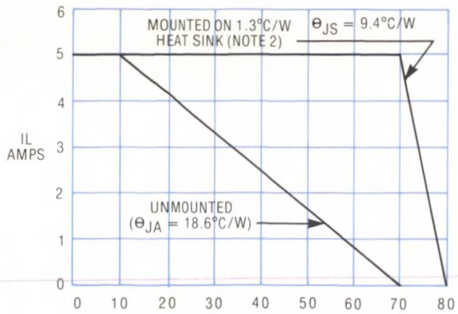


FIGURE 2 - 603-2/603-22 DC RELAY DERATING CURVE

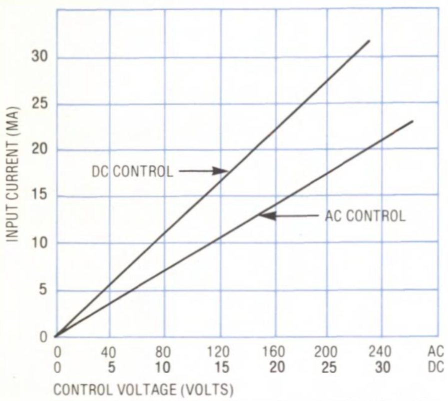


FIGURE 3 - INPUT CURRENT VS. CONTROL VOLTAGE (TYPICAL) ALL UNITS

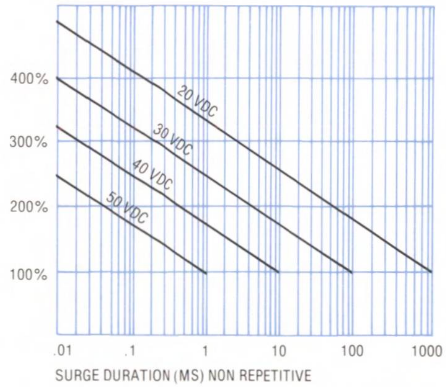


FIGURE 4 - MAXIMUM ALLOWABLE OVERLOADING AS A FUNCTION OF SUPPLY VOLTAGE

RESPONSE CURVES

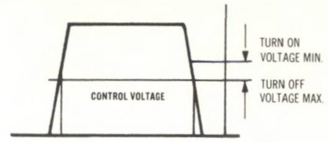


FIGURE 5

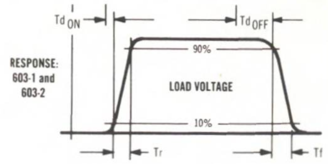


FIGURE 6

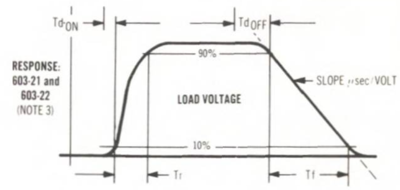


FIGURE 7

MECHANICAL SPECIFICATIONS

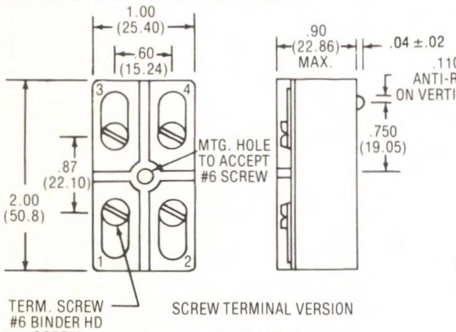


FIGURE 8

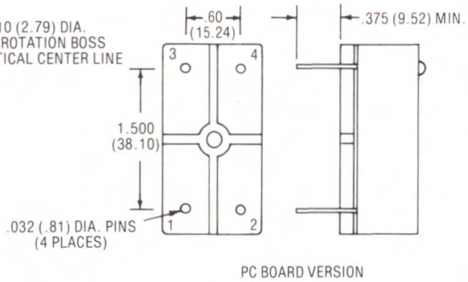


FIGURE 9

- Ambient Temperature Range:
  - -30°C to +80°C Operating
  - -30°C to +80°C Storage
- Weight: 3 oz. max.
- Case Material: Aluminum, black anodized
- Header Material: Phenolic, black
- Epoxy Encapsulated
- Shock: 300g.
- Vibration: 30g, 50-500 Hz.

TOLERANCES

.XX ± .01 (.25); .XXX ± .005 (.13)

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

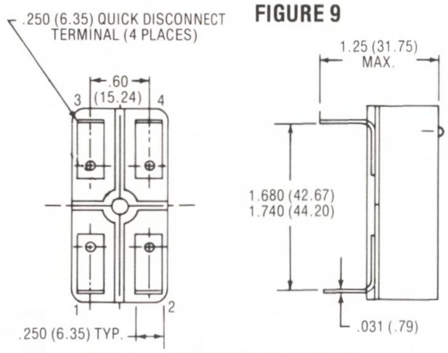
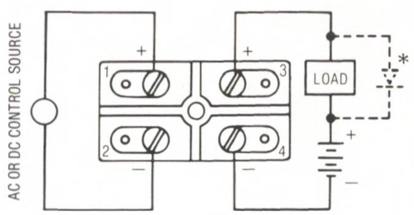


FIGURE 10

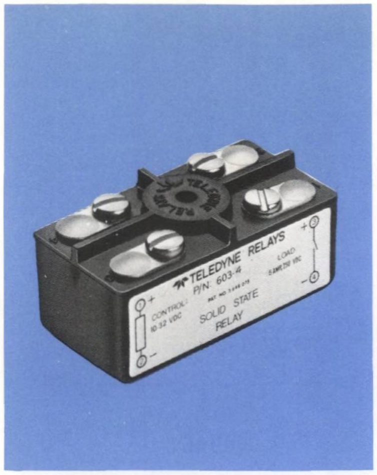
WIRING DIAGRAM



Input and output polarity must be observed.
*Inductive loads must be diode suppressed.

NOTES:

1. Basic part number provides for screw terminals only (Fig. 8). For PC Board pins add suffix "P" to part number (Fig. 9) for quick disconnect terminals, add suffix "Q" (Fig. 10). Example: 603-2P.
2. Relays mounted with silicone grease on heat sink such as Astrodyne, Inc., type 2158-0400-A-00B-(for 1.3°C/W).
3. Maximum continuous duty repetition rate for both 603-21 & 603-22 at full load current is one cycle/second.



TELEDYNE RELAYS

HIGH VOLTAGE SOLID STATE DC RELAY

TRANSFORMER ISOLATED
5 AMP

SERIES
603

SPST/NO

FEATURES

- High output voltage rating (250 VDC)
- Logic compatible DC input range
- Low off-state leakage
- Terminal options: Screws, quick disconnects, or PC Board solder pins

DESCRIPTION

These DC SSRs were designed specifically for high voltage loads up to 5A/250 VDC. They utilize the Teledyne transformer coupled 643-2 as a driver/isolator to provide high input/output isolation and low off-state leakage. The adaptive package design offers a choice of screw or quick disconnect terminals for chassis, panel, or heat sink mounting, or solder pins for direct mounting on PC boards.

PART NUMBERING

PART NUMBERS	INPUT CONTROL VOLTAGE RANGE	OUTPUT VOLTAGE RATING	OUTPUT (LOAD) CURRENT RATING
603-3	4-10 VDC	250 VDC	5 AMPS
603-4	10-32 VDC		

ELECTRICAL SPECIFICATIONS

(25°C UNLESS OTHERWISE SPECIFIED)

INPUT (CONTROL) SPECIFICATIONS		MIN.	TYP.	MAX.	UNITS	REF.
Control Voltage Range (-20°C to +100°C)	603-3	4		10	VDC	Note 3
	603-4	10		32		
Input Current at 5V (-20°C to +100°C)	603-3		10	15	mADC	Fig. 2
Input Current at 28V (-20°C to +100°C)	603-4		22	35	mADC	Fig. 2
Turn-On Voltage	603-3	4			VDC	
	603-4	10				
Turn-Off Voltage (-20°C to +100°C)				0.4	VDC	
Isolation (Input to Output, Input to Case, Output to Case)		10^9			OHMS	
Capacitance (Input to Output)				15	pf	
Dielectric Strength (Input to Output, Input to Case, Output to Case)		1500			VRMS	
OUTPUT (LOAD) SPECIFICATIONS		**MIN.**	**TYP.**	**MAX.**	**UNITS**	**REF.**
Output Current at Rating (Resistive)				5	AMPS	Fig. 1
Load Voltage Rating		3		250	VDC	
Voltage Drop at Max. Current			1.8	2	VDC	
Turn-On Time Delay ($T_{d(on)}$) @ 10V input, 1 amp/250V load			10	30	μsec	Fig. 3 and 4
Rise Time (T_r) @ 10V input, 1 amp/250V load			5	10	μsec	
Turn-Off Time Delay ($T_{d(off)}$) @ 10V input, 1 amp/250V load			100	200	μsec	
Fall Time (T_f) @ 10V input, 1 amp/250V load			25	50	μsec	
Output Leakage Current (@ 250V)	25°C			20	μADC	
	100°C		0.2	1	mADC	
Power Dissipation Factor (D)				2	W/AMP	
Power Switch Junction Temperature (T_J Max.)				175	°C	
Thermal Resistance, Junction to Sink (Θ_{JS})				9.7	°C/WATT	Fig. 1
Thermal Resistance, Junction to Ambient (Θ_{JA})				26.9		

CHARACTERISTIC CURVES

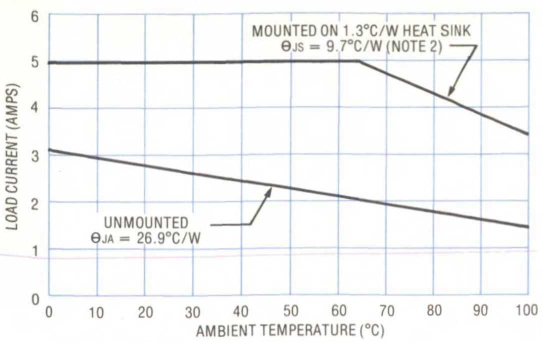


FIGURE 1 — AMP VS. AMBIENT TEMPERATURE

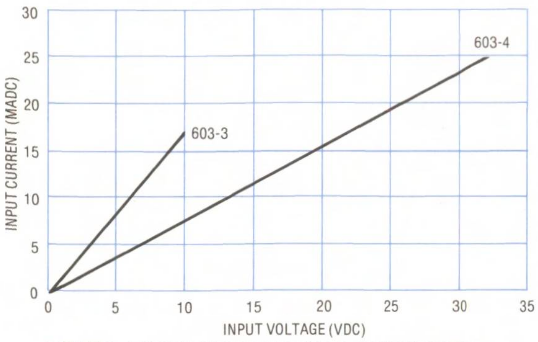


FIGURE 2 — TYPICAL INPUT CURRENT VS. INPUT VOLTAGE

RESPONSE CURVES

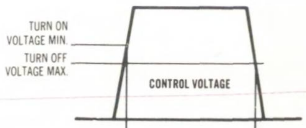


FIGURE 3

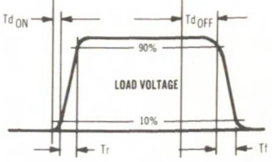


FIGURE 4

MECHANICAL SPECIFICATIONS

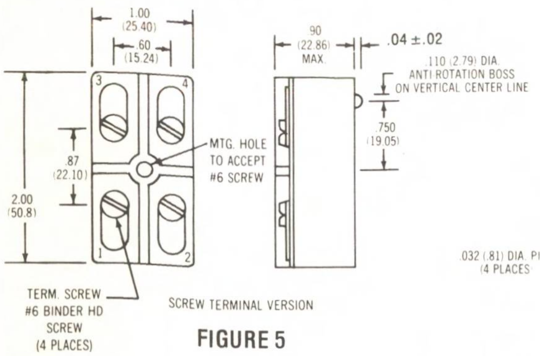


FIGURE 5

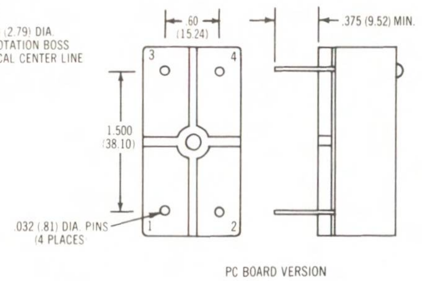


FIGURE 6

- Ambient Temperature Range:
  -20°C to +100°C Operating
  -30°C to +100°C Storage
- Weight: 3 oz. max.
- Case Material: Aluminum, black anodized
- Header Material: Phenolic, black
- Epoxy Encapsulated

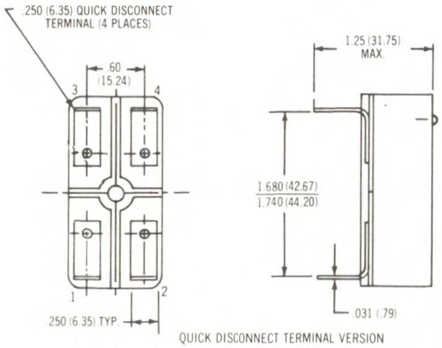


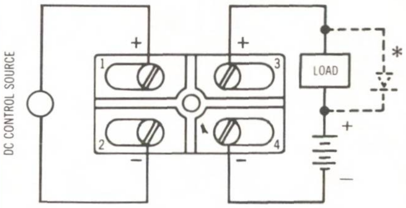
FIGURE 7

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

TOLERANCES

.XX ± .01 (.25); .XXX ± .005 (.13)

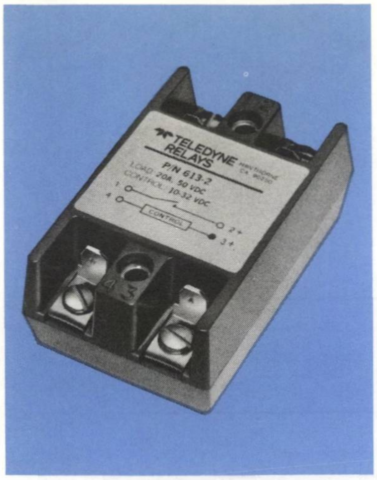
WIRING DIAGRAM



Input and output polarity must be observed.* Inductive loads must be diode suppressed.

NOTES:

1. Basic part number provides for screw terminals only (Figure 5). For PC board pins add suffix "P" to part number (Figure 6). For quick disconnect terminals, add suffix "Q" (Figure 7).
2. Relays mounted with silicon grease on heat sink such as Astrodyne, Inc. Type 2518-0400-A00B-(for 1.3°C/W).
3. Rise and fall times of input signal must be ⩽ 10μS, or damage may result.



TELEDYNE RELAYS

HIGH CURRENT SOLID STATE DC RELAY

TRANSFORMER ISOLATED 20 AMP

SERIES 613

SPST/NO

FEATURES

- High and low level logic compatible input
- Transformer isolated for low off-state leakage
- Snap action prevents damage from slowly ramped inputs
- Multi-purpose terminals - screw and quick disconnects

DESCRIPTION

The 613 Series high current DC solid state relays are designed for switching DC loads up to 20 amps at 50°C and below, derating to 10 amps at 100°C (when mounted on a 1°C/Watt heat sink or equivalent heat sinking panel or chassis). The internal circuit consists of a transformer isolated 643 Series Serendip® driving an output power transistor, thus providing 1500 VRMS of input/output isolation and low offstate leakage.

PART NUMBERING

INPUT CONTROL VOLTAGE RANGE	OUTPUT VOLTAGE RATING	OUTPUT LOAD RATING & PART NUMBERING
		20 AMP
4-10 VDC	50 VDC	613-1
10-32 VDC	50 VDC	613-2

ELECTRICAL SPECIFICATIONS

(25°C UNLESS OTHERWISE SPECIFIED)

INPUT (CONTROL) SPECIFICATIONS		MIN.	TYP.	MAX.	UNITS	REF.
Control Voltage Range (-20°C to +80°C)	-1	4		10	VDC	
	-2	10		32		
Input Current at: (-20°C to +80°C)	5 VDC -1		10	15	mADC	Fig. 1
	32 VDC -2		22	35	mADC	Fig. 1
Turn-On Voltage	613-1	4			VDC	
	613-2	10				
Turn-Off Voltage (-20°C to +80°C)				.4	VDC	
Isolation (Input to Output, Input to Case, Output to Case)		10^9			OHMS	
Dielectric Strength (Input to Output, Input to Case, Output to Case)		1500			VAC(RMS) 60 Hz	
Capacitance (Input to Output)				15	pf	
OUTPUT (LOAD) SPECIFICATIONS		**MIN.**	**TYP.**	**MAX.**	**UNITS**	**REF.**
Load Voltage Range		3		50	VDC	
Output Current Rating (Resistive)				20	AMPS	See Fig. 2
Voltage Drop at Max. Current			1.7	2	VDC	
Turn-On Time Delay (Td(on)) 10V in /50V load, R_L = 12 Ω			40	200	µsec	
Rise Time (Tr) 10V in /50V load, R_L = 12 Ω			1	15	µsec	Fig. 3
Turn-Off Time Delay (Td(off)) 10V in /50V load, R_L = 12 Ω			10	50	µsec	
Fall Time (Tf) 10V in /50V load, R_L = 12 Ω			25	100	µsec	
Output Leakage Current (at 50V, 25°C)				5	mADC	
Power Switch Junction Temperature (T_J Max.)				150	°C	
Thermal Resistance Junction to Heat Sink (Θ_{JS}) (Includes Θ_{CS})				1.5	°C/WATT	
Thermal Resistance Junction to Ambient (Θ_{JA})				6.5	°C/WATT	

PATENT #3,691,426

CHARACTERISTIC CURVES

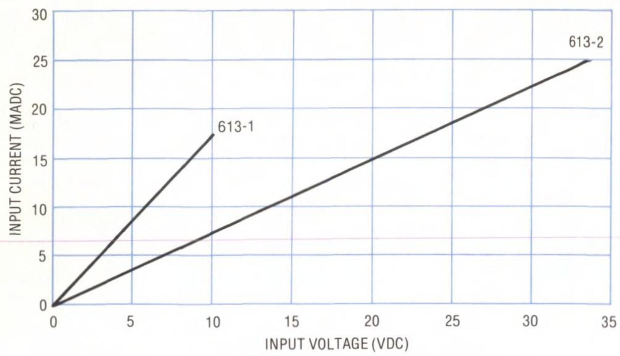


FIGURE 1 — TYPICAL INPUT CURRENT VS. INPUT VOLTAGE

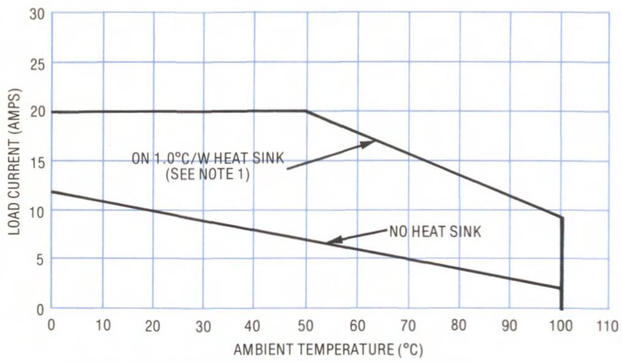


FIGURE 2 — LOAD CURRENT VS. AMBIENT TEMPERATURE

RESPONSE CURVES

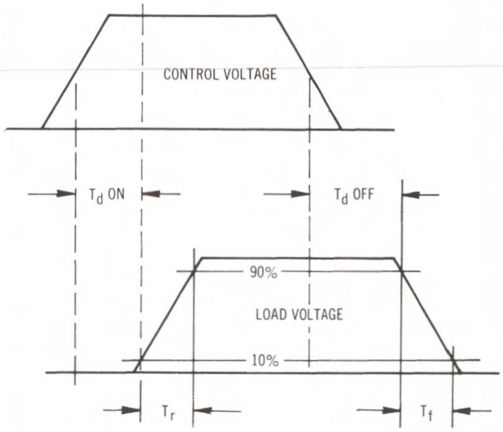
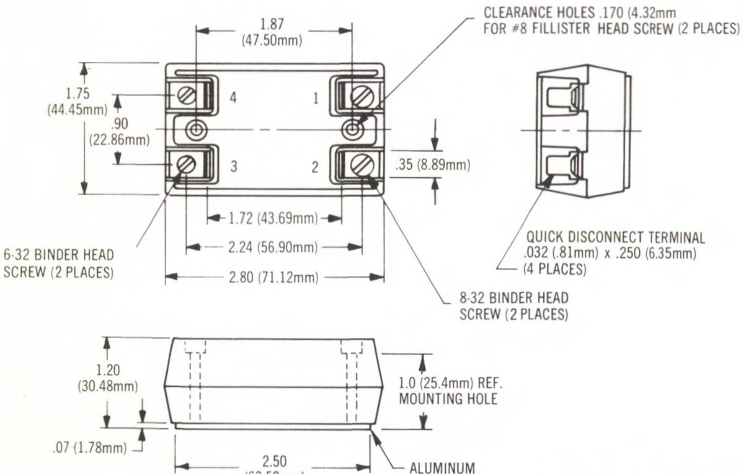
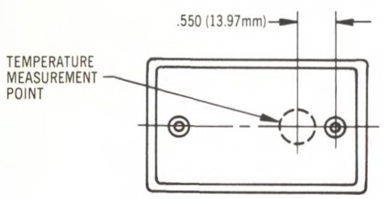


FIGURE 3

MECHANICAL SPECIFICATIONS

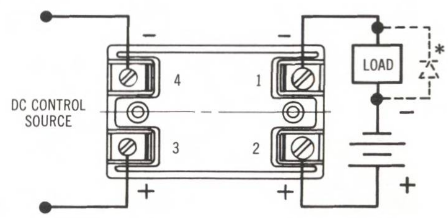




- Ambient Temperature Range:
  −20°C to +100°C Operating
  −40°C to +100°C Storage
- Weight: 4 Oz. Max.
- Case Material: Plastic, Rated Self-Extinguishing
- Base Plate Material: Aluminum
- Case Color: Aqua

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

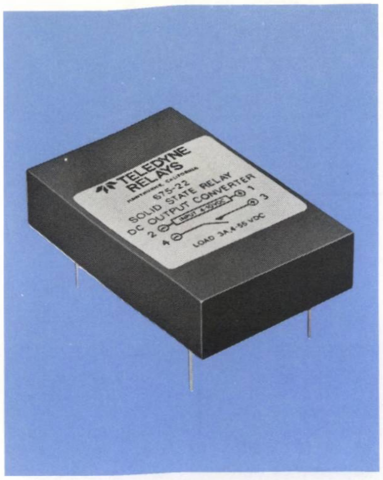
WIRING DIAGRAM



Input and output polarity must be observed.
*Inductive loads must be diode suppressed.

NOTES:

1. Relays mounted on heat sink such as Astrodyne, Inc. Type 2518-0500-A00B.



TELEDYNE RELAYS

SOLID STATE DC RELAY

OPTICALLY ISOLATED
3 AMP

SERIES
675

SPST/NO

FEATURES

- Low profile package for PC Board mounting
- Logic compatible DC input ranges

DESCRIPTION

This DC SSR is designed expressly for PC board applications where low profile height is required due to close board spacing. Optical coupling provides 1500 VRMS input/output isolation, and a choice of two DC input ranges offers compatibility with low and high level logic systems. Output rating is 3A/50 VDC up to 50°C ambient temperature, derating to 2A/50 VDC at 70°C

PART NUMBERING

INPUT CONTROL VOLTAGE RANGE	PART NUMBER	OUTPUT VOLTAGE RATING
4-10VDC	675-22	55VDC
10-32VDC	675-23	

ELECTRICAL SPECIFICATIONS
(25°C UNLESS OTHERWISE SPECIFIED)

INPUT SPECIFICATIONS		MIN.	TYP.	MAX.	UNITS	NOTES
Input Voltage Range	675-22	4		10	VDC	See Note 2
	675-23	10		32		
Input Current	@ 5VIN		4	7	mADC	
	@ 28VIN		10	12		
Dielectric Strength (Input to Output)		1500			VAC(RMS) 60 Hz	
Capacitance (Input to Output)				15	pf	
Turn-On Voltage	675-22	4			VDC	
	675-23	10				
Turn-Off Voltage (Both Types)				0.8	VDC	

OUTPUT SPECIFICATIONS	MIN.	TYP.	MAX.	UNITS	NOTES
Output Current Rating			3	AMPS DC	See Fig. 2 And Note 1
Load Voltage Rating	4		55	VDC	
Voltage Drop (at 2 Amps)			2	VDC	
Off-State Leakage Current at 55VDC			10	mADC	
Turn-On Time			500	μSEC	See Note 3
Turn-Off Time			2.5	mSEC	See Note 3
Power Dissipation			1.5	watts/amp	

PATENT #3,691,426

SERIES 675-DC

CHARACTERISTIC CURVES

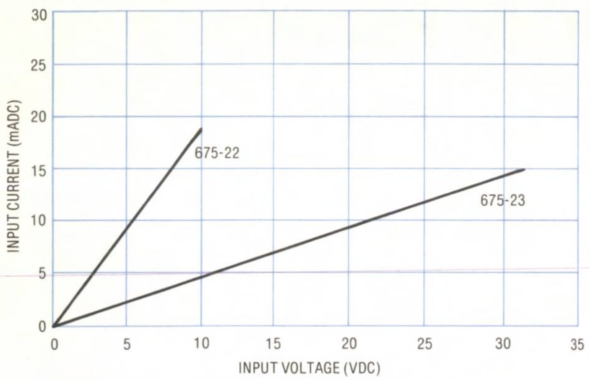


FIGURE 1 – TYPICAL INPUT CURRENT VS. INPUT VOLTAGE

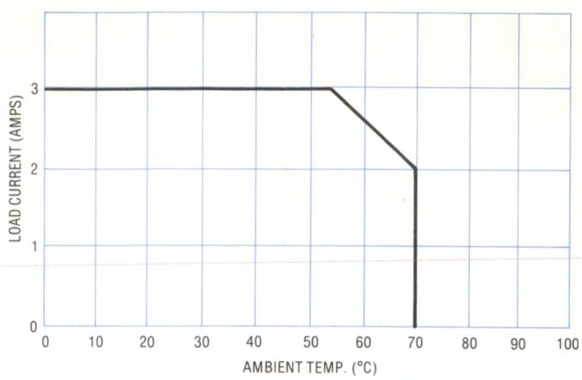
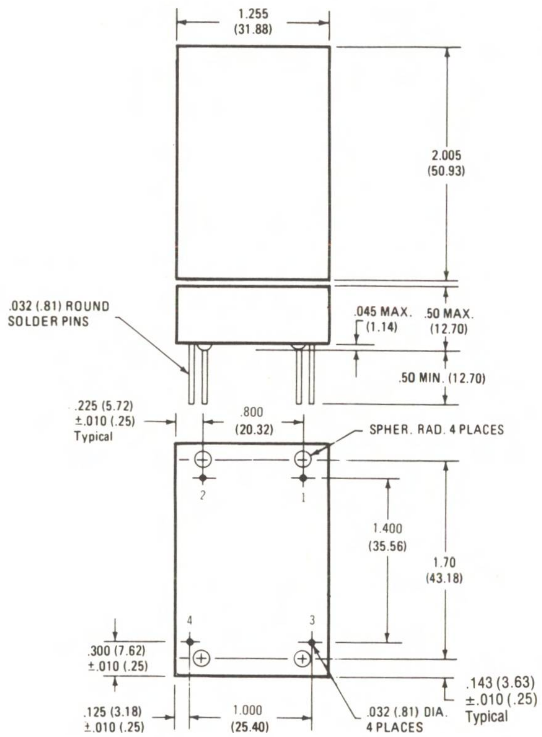


FIGURE 2 – MAXIMUM LOAD CURRENT VS. AMBIENT TEMPERATURE

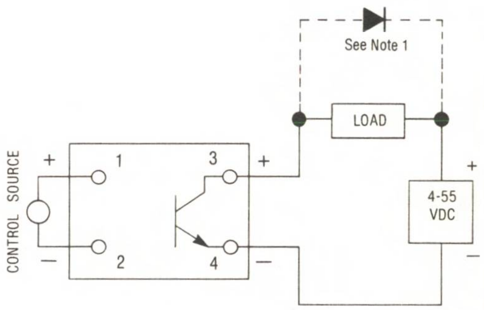
MECHANICAL SPECIFICATIONS



- Ambient Temperature Range:
  0°C to 70°C Operating
  −30°C to 70°C Storage
- Weight: 50 Grms.
- Case Material: High temperature plastic (UL recognized, 94VO), epoxy encapsulated.

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

WIRING DIAGRAM

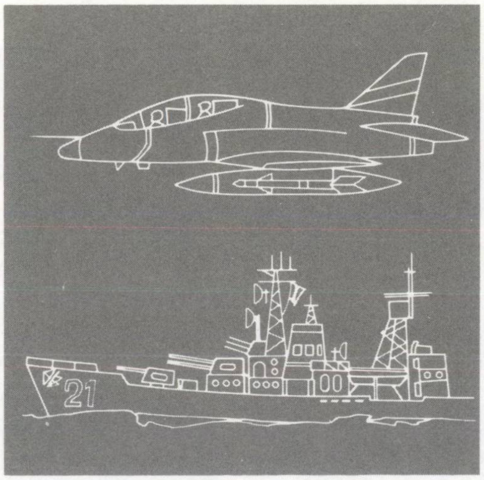


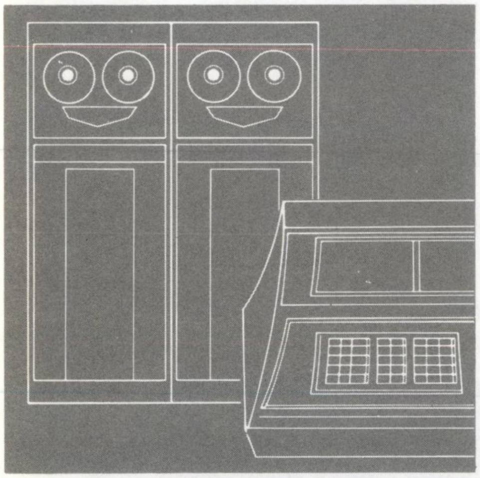
NOTES:

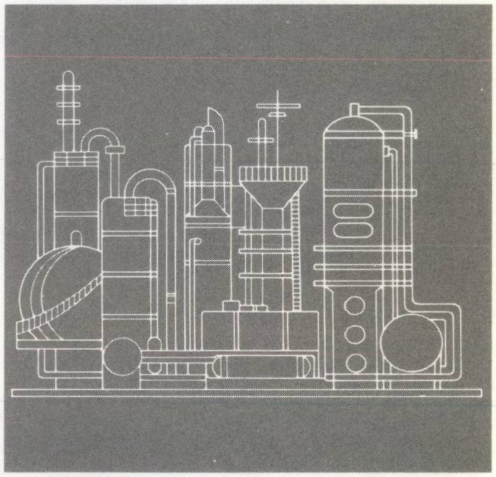
1. Inductive loads must be diode suppressed.
2. Reverse polarity input protection is provided up to 10VDC max.
3. Includes delay time.

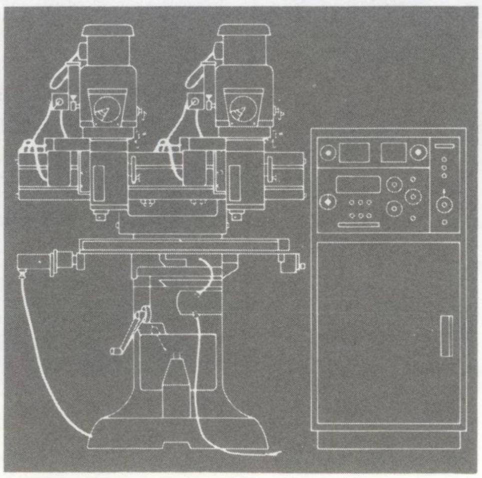
SECTION IV

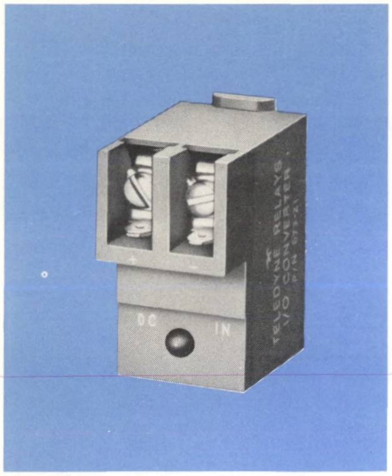
Solid State I/O Interface Modules











TELEDYNE RELAYS

SOLID STATE AC & DC I/O CONVERTER MODULES

OPTICALLY ISOLATED

SERIES 673

SPST/NO

FEATURES

- All solid state - optically isolated.
- AC output modules feature synchronous zero voltage switching, and built-in snubber network.
- Output modules have built-in transient voltage suppression.
- Logic terminals physically and electrically isolated from AC line terminals.
- LED status indicators for monitoring and troubleshooting.
- High noise immunity - can withstand severe industrial environments without misfiring.

PART NUMBERING

P/N	MODULE TYPE	INPUT VOLTAGE RANGE	OUTPUT MAX VOLTAGE RATINGS
673-1	AC INPUT	95-132VAC	18VDC
673-11		187-250VAC	
673-6	AC OUTPUT	4-32VDC	132VAC
673-6H			250VAC
673-21	DC INPUT	10-55VDC	18VDC
673-31		95-132VDC	
673-41		187-250VDC	
673-22	DC OUTPUT	4-10VDC	55VDC
673-23		10-32VDC	

AC Modules are Color Coded Red
DC Modules are Color Coded Blue

DESCRIPTION

The Teledyne 673 Series Solid State I/O Converter modules are designed expressly for application in programmable controllers, machine tool controls, computerized process controllers, etc. Solid state technology is combined with a unique packaging concept to provide reliable, noise-free I/O interface switching circuits between the computer and the loads and sensing switches of the process being controlled.

Each module contains a LED indicator to facilitate fault location and quick surveillance of individual circuit status. Electrical isolation between logic and the power lines is accomplished by means of optical isolators. Noise suppression and signal conditioning circuits provide a high level of noise immunity against the harsh industrial environments in which devices must operate.

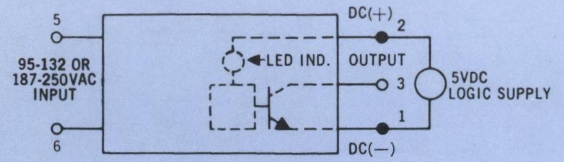
Output modules are functionally equivalent to conventional four-terminal SSRs, with AC and DC load current ratings of 3-4 amps maximum (at room temperature), sufficient for most standard solenoids, motor starters, etc. AC output modules incorporate MOVs and DC modules include zeners across their output terminals for transient voltage protection.

Input modules provide the reverse switching function of output modules. They convert the high voltage AC and DC control signals coming from pressure, flow, limit switches, etc., to "clean" low level logic signals for computer input.

673 Series modules feature barriered power terminals (combination screw/quick disconnect) for service wiring hook-up, eliminating the need for external power line terminal strips. When panel mounted in rows, the barriered power terminals in effect become an internal terminal strip for service wiring and provide for maximum physical isolation of power lines from logic circuits. Custom 19" mounting panels which accept up to 16 I/O modules are available.

Typical applications include: microprocessor control systems, programmable controllers, machine tool controls and process control systems.

673-1 AND 673-11 AC INPUT MODULE



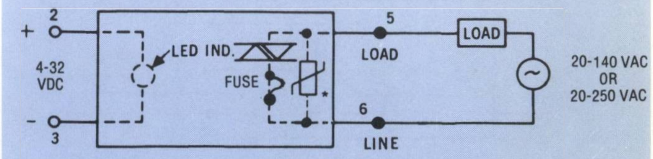
ELECTRICAL CHARACTERISTICS

(25°C UNLESS OTHERWISE SPECIFIED)

INPUT SPECIFICATIONS		MIN.	TYP.	MAX.	UNITS	NOTES
Input Line Voltage at 47-70 Hz	673-1	95	120	132	VAC(RMS)	
	673-11	187	230	264		
Input Current	@120V IN		6	7.5	mA(RMS)	
	@230V IN		3	4		
Dielectric Strength (Input to Output)		1500			VAC(RMS) 60 Hz	
Capacitance (Input to Output)				10	pf	
Input Current which will not cause relay to turn on				1.0	mA(RMS)	See Note 2
Turn-Off Voltage	673-1			10	VAC(RMS)	
	673-11			25		
Input Transient Voltage Immunity (Duration ≤1 mS)				±600	V(PEAK)	
OUTPUT SPECIFICATIONS		**MIN.**	**TYP.**	**MAX.**	**UNITS**	**NOTES**
Turn-On Time (60 Hz)	673-1	5		21	mSEC	See Note 3
	673-11	3		30		
Turn-Off Time (60 Hz)	673-1	5		21	mSEC	See Note 3
	673-11	3		30		
Output Transistor Breakdown Voltage				18	VDC	See Note 6
Output Current (1V(sat))				16	mA	
Output Leakage at 12VDC (Input Off)				100	μA	See Note 6
Output Voltage Drop (at 8 mA Load)				0.4	VDC	
Logic Supply Voltage		4.5		6	VDC	See Note 9
Logic Supply Current (at 6VDC)				17	mA	

673-6 AND -6H AC OUTPUT MODULE

(Zero Voltage Turn-On)



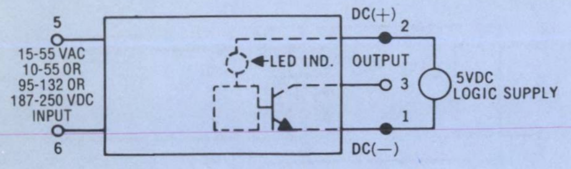
*See Note 8

ELECTRICAL CHARACTERISTICS

(25°C UNLESS OTHERWISE SPECIFIED)

INPUT SPECIFICATIONS		MIN.	TYP.	MAX.	UNITS	NOTES
Input Voltage Range	673-6,-6H	4		32	VDC	See Note 4
Input Current	@ 5VDC			10	mADC	See Fig. 1
	@32VDC			18		
Dielectric Strength (Input to Output)		2500			VAC(RMS) 60 Hz	
Capacitance (Input to Output)				15	pf	
Turn-On Voltage	673-6,-6H	4			VDC	
Turn-Off Voltage (Both Types)				1	VDC	
OUTPUT SPECIFICATIONS		**MIN.**	**TYP.**	**MAX.**	**UNITS**	**NOTES**
Load Current Rating		.010		4	AMPS (RMS)	See Fig. 2
Load Voltage Rating	673-6	20		132	VAC(RMS)	
	673-6H	20		250		
Frequency Range		47		70	Hz	
Surge Current Rating (16mS)				80	AMPS	See Fig. 3
Off State dv/dt		100	200		V/μSEC	
Peak Transient Voltage	673-6	±500			V(PEAK)	See Note 8
	673-6H	±650				
Voltage across Load at Turn-On			±12		V(PEAK)	
Output Voltage Drop				2	VAC(RMS)	
Off State Leakage Current (60 Hz)	@115VAC			8	mA(RMS)	
	@230VAC			13		
Turn-On Time at 60 Hz				8.3	mSEC	
Turn-Off Time				16	mSEC	
Power Dissipation @ 1 Max.				1.5	watts/amp	

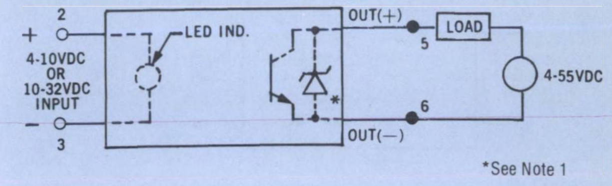
673-21, -31, -41, and -51 DC INPUT MODULE



ELECTRICAL CHARACTERISTICS
(25°C UNLESS OTHERWISE SPECIFIED)

INPUT SPECIFICATIONS		MIN.	TYP.	MAX.	UNITS	NOTES
Input Voltage Range	673-21	10		55	VDC	
	673-31	95	120	132	VDC	
	673-41	187	230	250	VDC	
	673-51	15		55	VAC	
Input Current @ 55VDC	673-21		20	25	mADC	
Input Current @120VDC	673-31		6	7.5	mADC	
Input Current @230VDC	673-41		3	4	mADC	
Input Current @ 55 VAC	673-51			25	mA	
Dielectric Strength (Input to Output)		1500			VAC(RMS) 60 Hz	
Capacitance (Input to Output)				10	pf	
Input Current which will not cause relay to turn on	673-21			1.4	mA	See Note 2
	673-31			1.0	mA	See Note 2
	673-41			1.0	mA	See Note 2
	673-51			1.4	mA	See Note 2
Turn-Off Voltage	673-21			3.5	VDC	
	673-31			10	VDC	
	673-41			25	VDC	
	673-51			3.5	VDC	
Input Transient Voltage Immunity (Duration ≤1 mS)	673-21, 51			±55	VDC	
	673-31			±600	VDC	
	673-41			±600	VDC	
OUTPUT SPECIFICATIONS		**MIN.**	**TYP.**	**MAX.**	**UNITS**	**NOTES**
Turn-On Time	673-21	0.5		5.0	mSEC	See Note 3
	673-31	2.5		25	mSEC	See Note 3
	673-41	2.5		25	mSEC	See Note 3
	673-51			6	mSEC	See Note 3
Turn-Off Time	673-21	0.5		5.0	mSEC	See Note 3
	673-31	2.5		25	mSEC	See Note 3
	673-41	2.5		25	mSEC	See Note 3
	673-51			5	mSEC	See Note 3
Output Transistor Breakdown Voltage				18	VDC	See Note 6
Output Current (1V(sat))				16	mA	
Output Leakage at 12VDC (Input Off)				100	µA	See Note 6
Output Voltage Drop (at 8 mA Load)				0.4	VDC	
Logic Supply Voltage		4.5		6	VDC	See Note 9
Logic Supply Current @ 6VDC				17	mA	

673-22, -23, and -42 DC OUTPUT MODULE

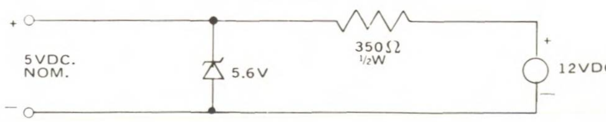


ELECTRICAL CHARACTERISTICS
(25°C UNLESS OTHERWISE SPECIFIED)

INPUT SPECIFICATIONS		MIN.	TYP.	MAX.	UNITS	NOTES
Input Line Voltage	673-22, -42	4		10	VDC	See Note 4
	673-23	10		32	VDC	See Note 4
Input Current @ 5VDC	673-22		15	16	mADC	See Fig. 1
Input Current @ 5VDC	673-42		18	22	mADC	See Fig. 1
Input Current @28VDC	673-23		21	22.5		
Dielectric Strength (Input to Output)		1500			VAC(RMS) 60 Hz	
Capacitance (Input to Output)				10	pf	
Turn-On Voltage	673-22, -42	4			VDC	
	673-23	10			VDC	
Turn-Off Voltage	673-22, -23			1	VDC	
	673-42			0.5	VDC	
OUTPUT SPECIFICATIONS		**MIN.**	**TYP.**	**MAX.**	**UNITS**	**NOTES**
Load Current Rating	673-22,-23			4	AMPS DC	See Fig. 2 and Note 1
	673-42			2	AMPS DC	See Fig. 2 and Note 1
Load Voltage Rating	673-22,-23	4		55	VDC	
	673-42	4		250	VDC	
Voltage Drop (at Max. Load Current)				1.5	VDC	
Off State Leakage Current at 55VDC	673-22, -23			10	mADC	
Off State Leakage Current at 250 VDC	673-42			1.0		
Turn-On Time	673-22, -23			500	µSEC	See Note 5
	673-42			10	µSEC	
Turn-Off Time	673-22, -23			2.5	mSEC	See Note 5
	673-42			400	µSEC	
Power Dissipation				1.5	watts/amp	

NOTES:

1. Zener diode is built-in to clip transient voltages in excess of maximum ratings.
2. Relates to allowable open circuit leakage current in limit switches, drivers, etc.
3. The logic output transistor will not bounce during input turn-on or turn-off and during steady state conditions (on or off) will maintain a constant logic state.
4. Reverse polarity input protection is provided up to 10VDC max.
5. Includes delay time.
6. Open collector output.
7. No minimum power factor for inductive loads as long as surge rating is not exceeded. The dv/dt rating is based on a source impedance of 50 ohms.
8. Internal MOV. clips transient voltages at 400 volts for 673-4, -6 and 600 volts for 673-6H.
9. For 673-1, -11, -21, -31 and -41 with VCC supplied from 12VDC source, use circuit below:
10. Inner scale applies to resistive current 673-22, -23, -42. Outer scale applies to constant current 673-6 & 674.



CHARACTERISTIC CURVES

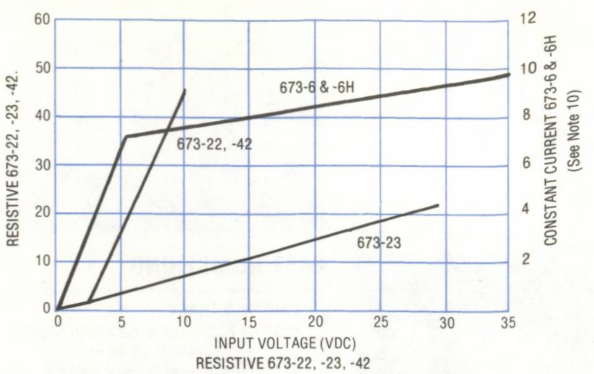


FIGURE 1 - TYPICAL INPUT CURRENT VS. INPUT VOLTAGE

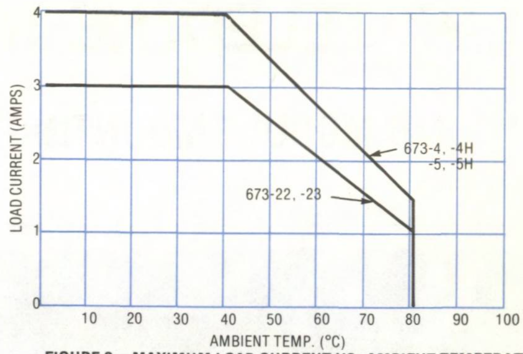


FIGURE 2 - MAXIMUM LOAD CURRENT VS. AMBIENT TEMPERATURE

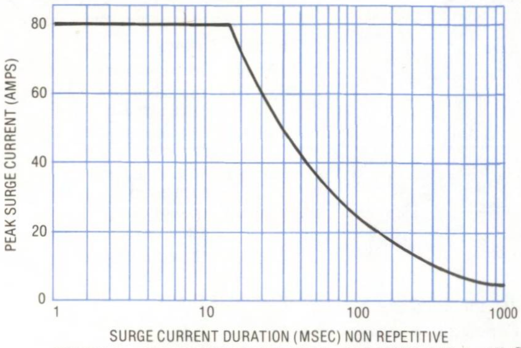


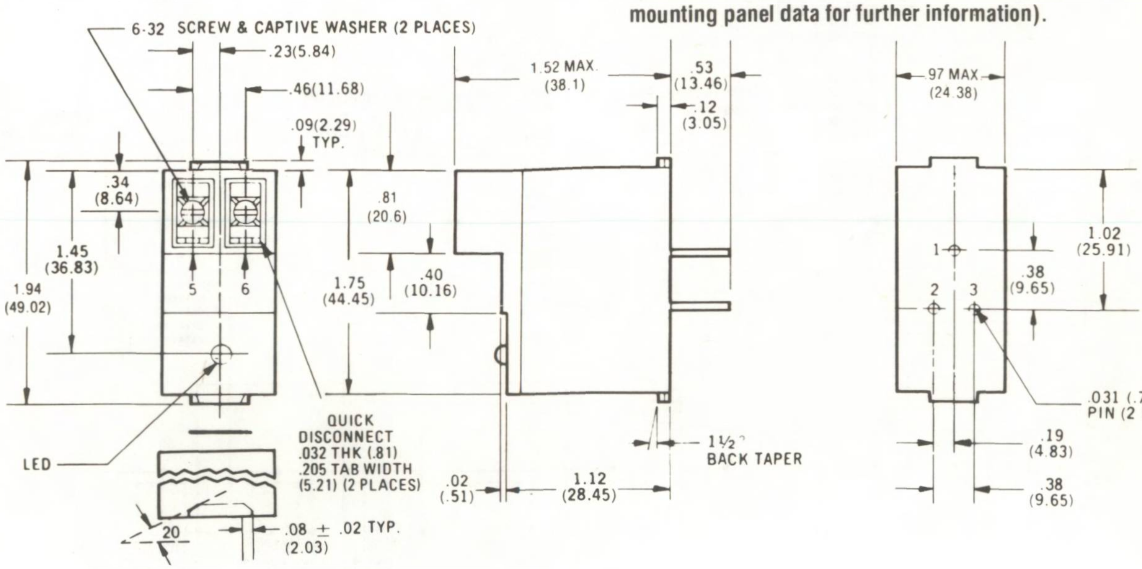
FIGURE 3 - PEAK SURGE CURRENT VS. DURATION (673-4, -4H, 673-5, -5H)

- Ambient Temperature Range:
  0°C to +80°C Operating
  -30°C to +80°C Storage

Note: Temperature derating curves (Fig. 2) are based on 16 modules mounted on a panel at full load. Ambient temperature is measured 1'' in front of screw terminals in still air.

OUTLINE SPECIFICATIONS

16 Modules may be mounted on Teledyne 671P-2 or 671P-4 Series panels by means of adapter kit P/N 9-369 (see Series 671P mounting panel data for further information).



MECHANICAL SPECIFICATIONS:
WEIGHT: 6 oz. max.
CASE MATERIAL: Glass-filled polycarbonate (rated self-extinguishing)
POWER LINE TERMINALS: #6 screws with non-rotating captive washers capable of accepting two #14 AWG wires. Quick disconnects .205 × .032
LOGIC TERMINALS: .031'' Dia. pins

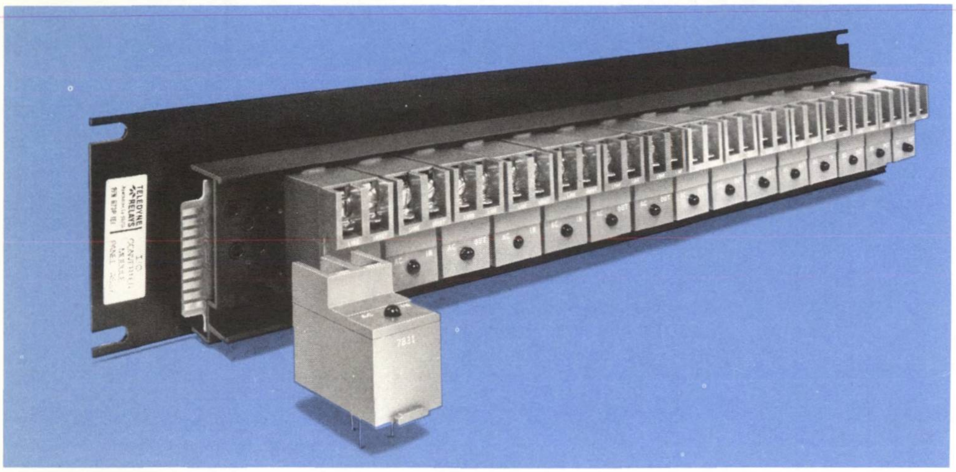
DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

TOLERANCES
.XX ±.01 (.25); .XXX ±.005 (.13)

TELEDYNE RELAYS

I/O MODULE MOUNTING TRACK

SERIES
673P



Custom designed mounting tracks for Teledyne 673 Series Solid State I/O Converter modules are available to accept 8 or 16 modules. Tracks provide snap-in feature for modules, eliminating need for mounting screws. Tracks contain integral interconnect wiring to a variety of connectors for interface with logic circuitry. Tracks are also available affixed to panels for mounting in standard 19'' racks in single or double row versions, accommodating up to 32 modules.

PART NUMBERING

8 MODULE TRACK

673P-1E7	8 module track with edge board contacts (Note 4)
673P-1M7	8 module track with flat ribbon cable connector (Note 4)
673P-1E8	8 module track on 3.5 in. panel with edge board contacts (Note 4)
673P-1M8	8 module track on 3.5 in. panel with flat ribbon cable connector (Note 4)

16 MODULE TRACK

673P-1E0	16 module track with edge board contacts
673P-1M0	16 module track with flat ribbon cable connector
673P-1D0	16 module track with ''D'' style connector
673P-1E1	16 module track on 3.5 in. panel with edge board contacts
673P-1M1	16 module track on 3.5 in. panel with flat ribbon cable connector
673P-1D1	16 module track on 3.5 in. panel with ''D'' style connector

32 MODULE TRACK

673P-1E2	Dual 16 module tracks on 5.25 in. panel with edge board contacts
673P-1M2	Dual 16 module tracks on 5.25 in. panel with two edge board connectors
673P-1D2	Dual 16 module tracks on 5.25 in. panel with two ''D'' style connectors

WIRING DIAGRAM

EDGE BOARD STYLE CONNECTOR

	P1
DATA LINE 15	H
DATA LINE 14	D
DATA LINE 13	E
DATA LINE 12	F
DATA LINE 11	5
DATA LINE 10	6
DATA LINE 9	4
DATA LINE 8	7
DATA LINE 7	K
DATA LINE 6	B
DATA LINE 5	C
DATA LINE 4	J
DATA LINE 3	3
DATA LINE 2	8
DATA LINE 1	2
DATA LINE 0	9
SIGNAL RETURN	A
INPUT VOLTAGE	1

MATING CONNECTOR EXAMPLE:
TI Part #H411131-IO or equivalent

FLAT RIBBON CABLE STYLE CONNECTOR

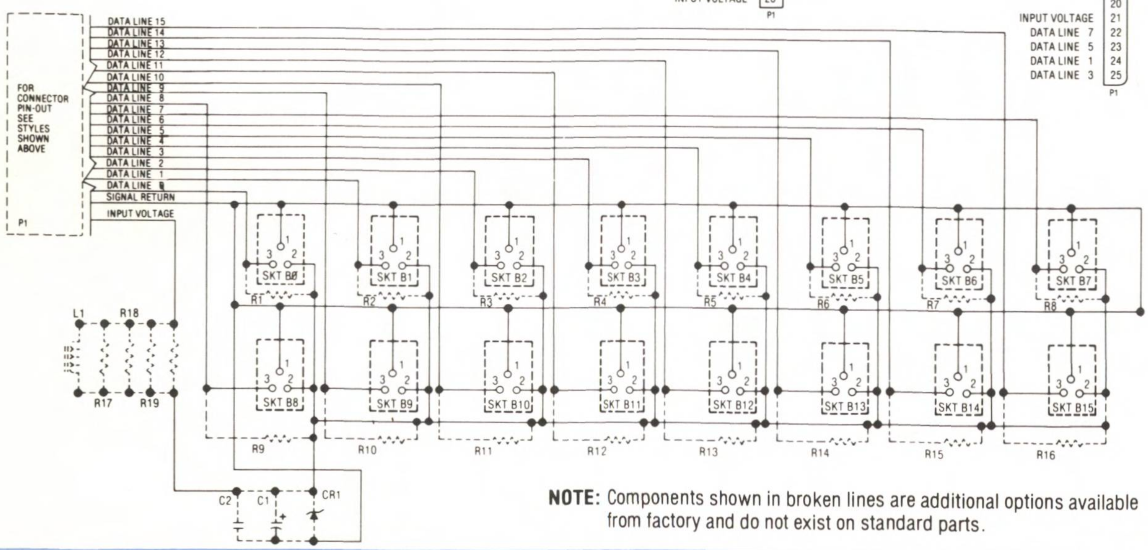
	P1
N/C	2
N/C	1
DATA LINE 15	7
DATA LINE 14	13
DATA LINE 13	11
DATA LINE 12	9
DATA LINE 11	12
DATA LINE 10	10
DATA LINE 9	14
DATA LINE 8	8
DATA LINE 7	3
DATA LINE 6	17
DATA LINE 5	15
DATA LINE 4	5
DATA LINE 3	16
DATA LINE 2	6
DATA LINE 1	18
DATA LINE 0	4
SIGNAL RETURN	19
INPUT VOLTAGE	20

MATING CONNECTOR EXAMPLE:
3M Part #3428-2302 or equivalent

''D'' STYLE CONNECTOR

	P1
DATA LINE 11	1
DATA LINE 13	2
DATA LINE 15	3
DATA LINE 9	4
	5
N/C	6
	7
	8
SIGNAL RETURN	9
DATA LINE 6	10
DATA LINE 0	11
DATA LINE 2	12
DATA LINE 4	13
DATA LINE 12	14
DATA LINE 14	15
DATA LINE 10	16
DATA LINE 8	17
	18
N/C	19
	20
INPUT VOLTAGE	21
DATA LINE 7	22
DATA LINE 5	23
DATA LINE 1	24
DATA LINE 3	25

MATING CONNECTOR EXAMPLE:
AMP Part #HDP-20 205737-2 or equivalent



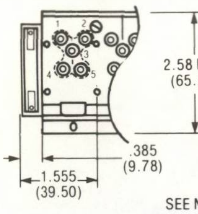
NOTE: Components shown in broken lines are additional options available from factory and do not exist on standard parts.

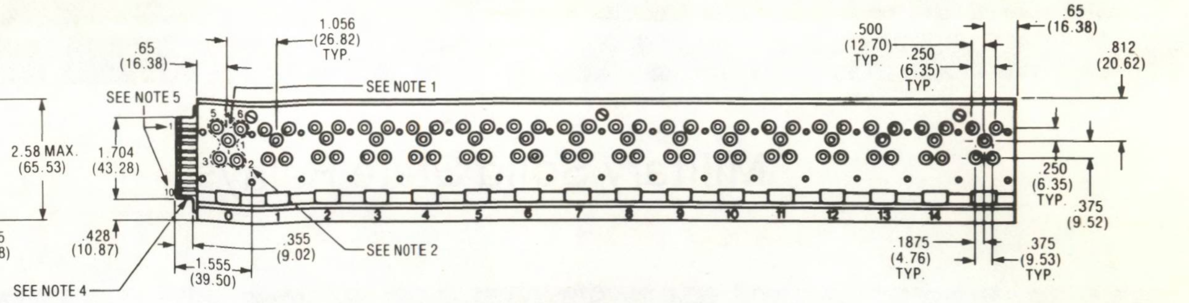
MECHANICAL SPECIFICATIONS

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

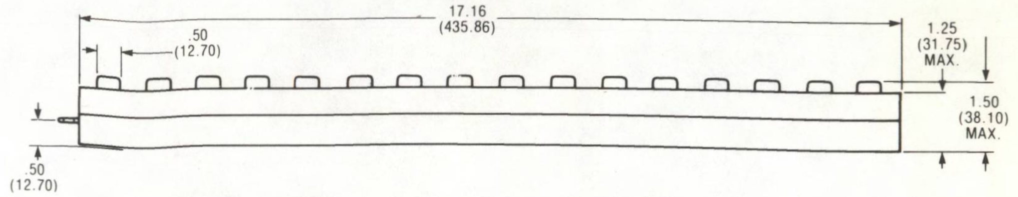
673P-1E0

673P-1M0



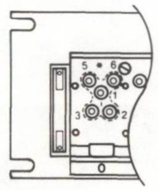


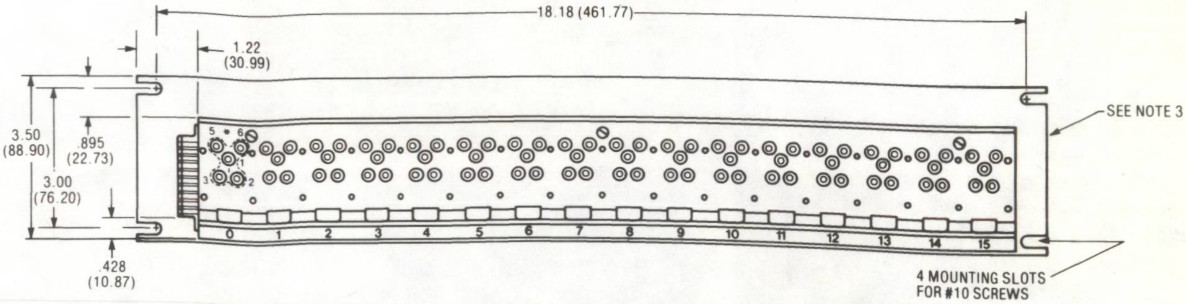
673P-1D0
(See Note 6)



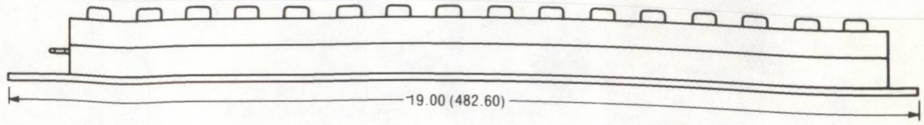
673P-1E1

673P-1M1



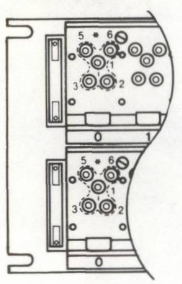


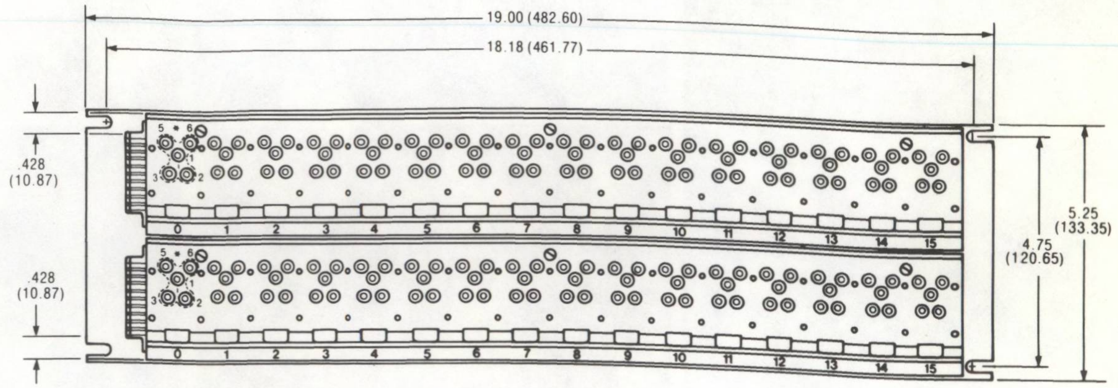
673P-1D1
(See Note 6)



673P-1E2

673P-1M2





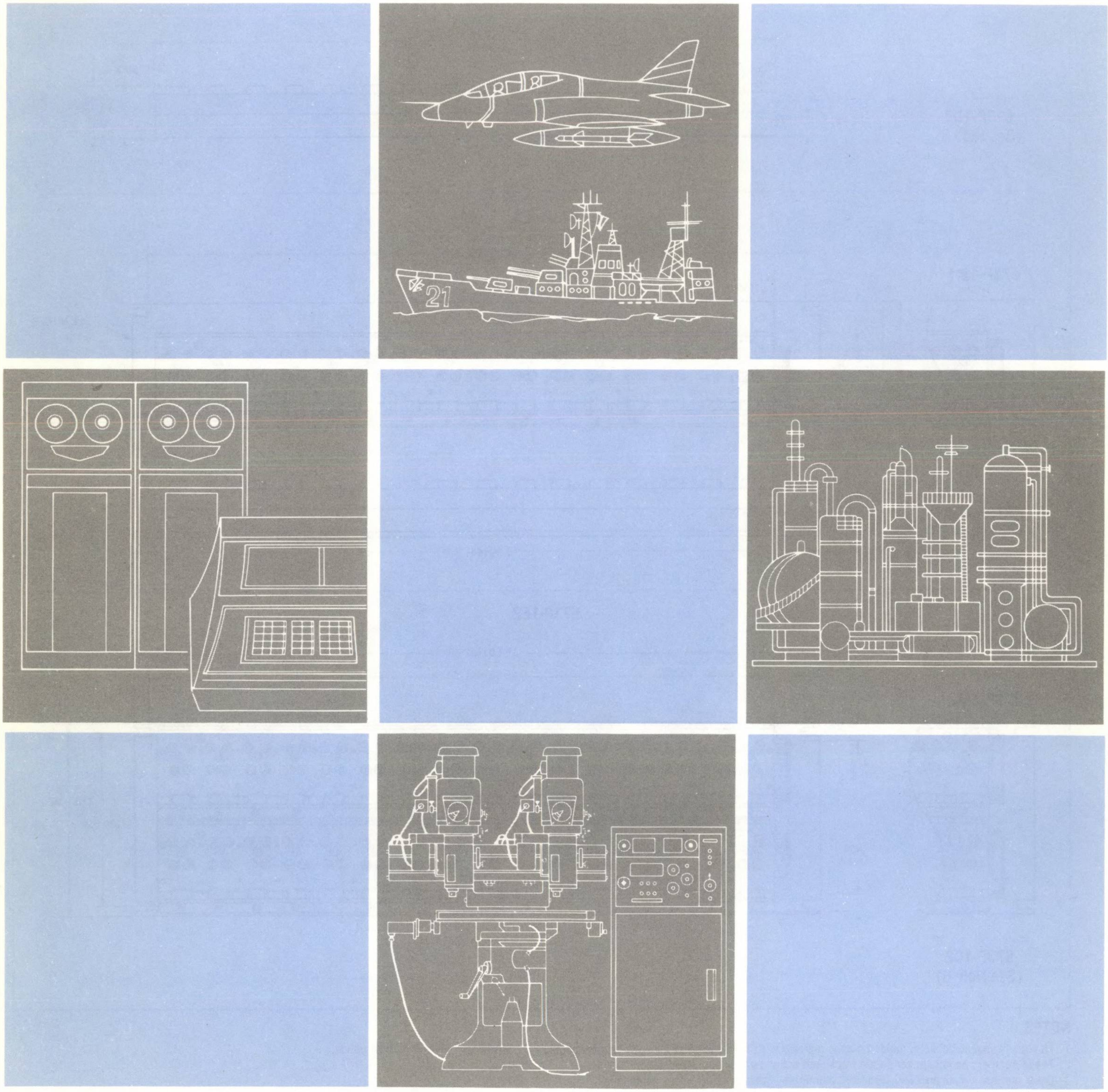
673P-1D2
(See Note 6)

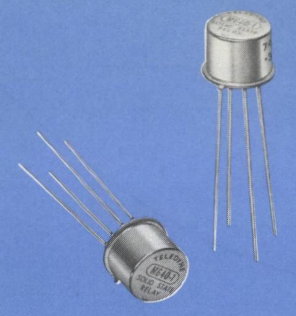
NOTES:

1. 16 equally spaced sockets, molded plastic material with AMP #380598-2 circuit board receptacles or equivalent (Pins 5 & 6 not used).
2. These numbers do not appear on the track, but are shown for pin identification.
3. Cover and back plate are black anodized aluminum. Springs, steel, black oxide finish.
4. Contact factory for mechanical specifications and wiring diagram.
5. Pins 1 & 10 on side shown.
6. "D" connector mounted on rear of track or panel – contact factory for mechanical specifications.

SECTION V

Military Solid State Relays





TELEDYNE RELAYS

MILITARY SOLID STATE AC/DC RELAY

±50 mA

MODEL

M640-1W

SPST/NO

FEATURES

- Low on-resistance (2 ohms typical)
- Switches AC or DC up to 40V
- High switching speed
- TO-5 Package - hermetically sealed
- Qualified to MIL-R-28750/5

DESCRIPTION

This all solid state TO-5 relay features AC/DC switching capability up to 40V and low on resistance (2 ohms typical) which is stable with time and temperature. Thus, it serves as an ideal solid state alternative to electromechanical relays in low level switching applications. Transformer coupling provides 1,000 VAC (P-P) isolation and low off-state leakage. Internal construction employs hybrid microcircuit techniques. The M640-1 is most frequently used as a data coupler, isolated line driver, current loop switch, and for general purpose analog and transducer signal switching in military/aerospace applications.

PART NUMBERING

Teledyne P/N	Military P/N	Output Voltage Rating (VDC)	Output Current Rating @ 7V DC Input (mA)
M640-1W	M28750/5-001	±40	±50

ENVIRONMENTAL SPECIFICATIONS

Temperature (Ambient, Operating & Storage)	-55°C to 125°C
Vibration	20 g, 10 to 2000 Hz
Shock	50 g, 11 mSec.
Acceleration	100 g

ELECTRICAL SPECIFICATIONS

(-55°C TO 125°C UNLESS OTHERWISE SPECIFIED)

INPUT (CONTROL) SPECIFICATIONS	MIN.	TYP.	MAX.	UNITS	NOTES
Control Voltage Range	4		7	VDC	Note 2
Input Current at 5V Control Voltage		13	22	mA DC	See Fig. 1
Rated Turn On Voltage	5			VDC	
Rated Turn Off Voltage			1.0	VDC	
Dielectric Strength (Input to Output)	1000			VAC(PP) 60 Hz	
Insulation Resistance (Input to Output)	10^9			Ohms	@500VDC
Capacitance (Input to Output)			10	pf	
OUTPUT (LOAD) SPECIFICATIONS	**MIN.**	**TYP.**	**MAX.**	**UNITS**	**NOTES**
Output Current (7 Volt Input) (-20°C to 125°C)	0		±50	mA Peak	See Fig. 2 And Note 1
Output Current (5 Volt Input) (-20°C to 125°C)	0		±25	mA Peak	See Fig. 2 And Note 1
Output Voltage	0		±40	V Peak	AC or DC
Output Voltage Drop			0.5	VDC	
Offset Voltage			10	mV	See Fig. 3, 5
"On" Resistance (@25°C)		2.0	5.0	Ohms	See Fig. 4
Off State Leakage Current @40V			100	μA	
Turn On Time (T_{DELAY} + T_{RISE})			10	μSEC	
Turn Off Time (T_{DELAY} + T_{FALL})			15	μSEC	See Fig. 6
Capacitance Across Output		7	10	pf	
Insulation Resistance (Input to Output, Output to Case)	10^9			Ohms	@500VDC
Dielectric Strength (Case to Output)	1000			VAC(PP) 60 Hz	
Overload (1% Duty Cycle)			.01	JOULES	See Fig. 8
Power Dissipation			140	mW	

SPECIFICATIONS SHOWN HEREIN SUBJECT TO CHANGE WITHOUT NOTICE.

MODEL M 640-1W

CHARACTERISTIC CURVES

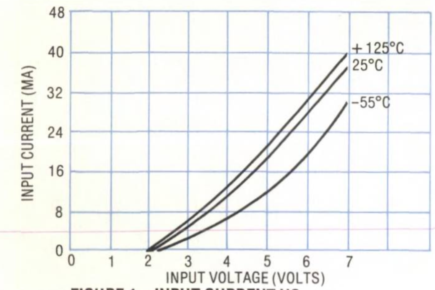


FIGURE 1 - INPUT CURRENT VS. INPUT VOLTAGE (TYPICAL)

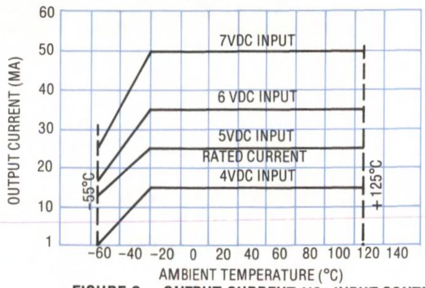


FIGURE 2 - OUTPUT CURRENT VS. INPUT CONTROL VOLTAGE AND AMBIENT TEMPERATURE

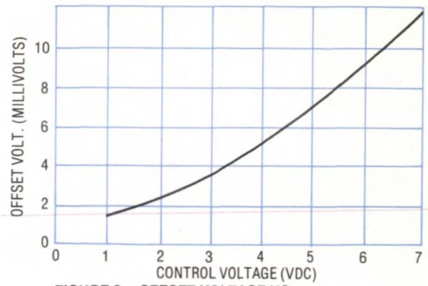


FIGURE 3 - OFFSET VOLTAGE VS. INPUT CONTROL VOLTAGE (TYPICAL)

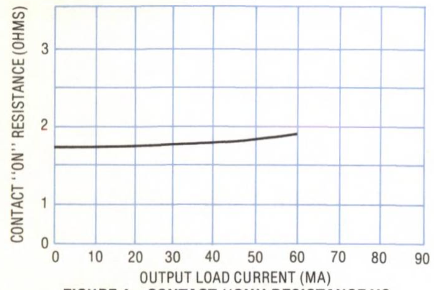


FIGURE 4 - CONTACT "ON" RESISTANCE VS. OUTPUT LOAD CURRENT (TYPICAL)

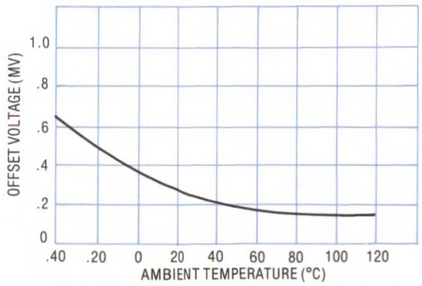


FIGURE 5 - OFFSET VOLTAGE VS. AMBIENT TEMPERATURE (TYPICAL)

FIGURE 6 - TURN OFF TIME VS. LOAD RESISTANCE (TYPICAL)

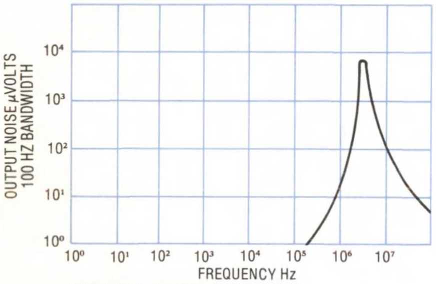


FIGURE 7 - CONTACT NOISE VS. FREQUENCY 100 Hz BANDWIDTH (TYPICAL)

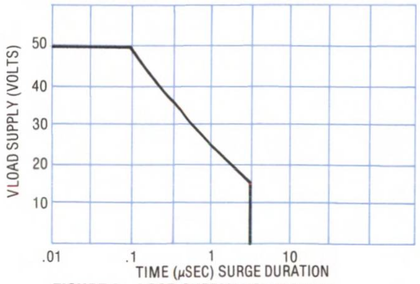
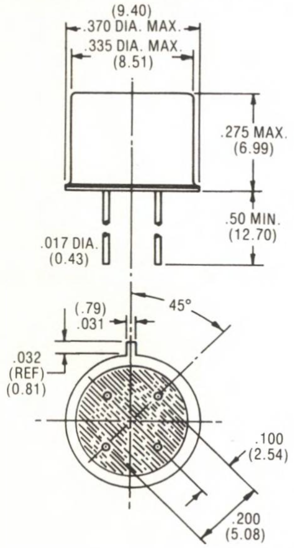


FIGURE 8 - LOAD SUPPLY VOLTAGE VS. ALLOWABLE SURGE DURATION (CURRENT MUST NOT EXCEED 150% OF RATING)

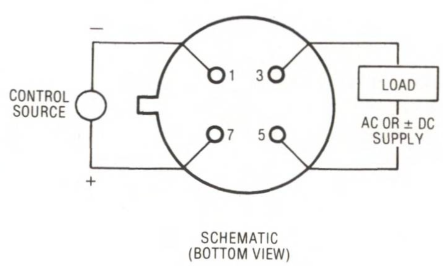
MECHANICAL SPECIFICATIONS



DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

- Weight: 5 grams (typical)
- Enclosure: TO-5 (4 pin)
- Seal: Hermetic

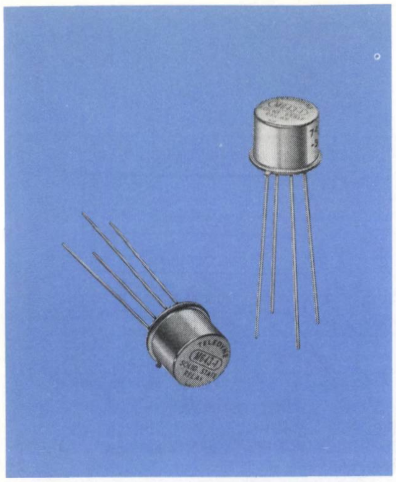
WIRING DIAGRAM



SCHEMATIC
(BOTTOM VIEW)

NOTES:

1. For any control voltage, the maximum steady state load current value shown in Figure 2 must not be exceeded. Attempting to draw steady state currents in excess of these curves can cause permanent damage. (See Fig. 8).
2. Reversing polarity of input may cause permanent damage.



TELEDYNE RELAYS

SERIES

M643

MILITARY SOLID STATE DC RELAYS

100 mA and 250 mA

SPST/NO

FEATURES

- High switching speed
- Exceeds current and voltage ratings of opto-isolators
- TO-5 package - hermetically sealed
- Qualified to MIL-R-28750/6 and 7

DESCRIPTION

These all solid state DC relays employ transformer coupling for high isolation and low off-state leakage. The output current and voltage ratings greatly exceed the capabilities of opto-isolators, with an equivalent current transfer ratio as high as 2000%. Thus, they serve as ideal solid state alternatives for opto-isolators and electromechanical relays in applications such as isolated line drivers, lamp drivers, current loop switches, and general purpose DC switching where "relay" isolation is required. Internal construction employs hybrid microcircuit techniques.

PART NUMBERING

Teledyne P/N	Military P/N	Output Voltage Rating (VDC)	Output Current Rating @ 7VDC Input (mA)
M643-1W	M28750/6-001	40	250
M643-2W	M28750/7-001	250	100

ENVIRONMENTAL SPECIFICATIONS

Temperature (Ambient, Operating & Storage)	-55°C to 125°C
Vibration	20 g, 10 to 2000 Hz
Shock	50G, 11mSec.
Acceleration	100 g

ELECTRICAL SPECIFICATIONS

(-55°C TO 125°C UNLESS OTHERWISE SPECIFIED)

INPUT (CONTROL) SPECIFICATIONS		MIN.	TYP.	MAX.	UNITS	NOTES
Control Voltage Range		4		7	VDC	See Fig. 2 and 3
Input Current at 5V Control Voltage			13	22	mA DC	See Fig. 1
Rated Turn On Voltage		5			VDC	
Rated Turn Off Voltage				1.0	VDC	
Dielectric Strength (Input to Output, Input to Case)		1000			VAC(PP) 60 Hz	
Insulation Resistance (Input to Output, Input to Case)		10^9			Ohms	@500VDC
Capacitance (Input to Output, Input to Case)				10	pf	
OUTPUT (LOAD) SPECIFICATIONS		**MIN.**	**TYP.**	**MAX.**	**UNITS**	**NOTES**
Output Current 7 Volts Input						
-35°C to 100°C	M643-1W	0		250	mA	See Fig. 2,3 And Note 2
-20°C to 125°C	M643-2W	0		100	mA	
Output Current (5 Volt Input) (-20°C to 125°C)	M643-1W	0		125	mA	See Fig. 2,3 And Note 2
	M643-2W	0		50	mA	
Output Voltage	M643-1W	0		50	VDC	
	M643-2W	0		250	VDC	
Output Voltage Drop				0.5	VDC	
Off State Leakage at Max Load Voltage	M643-1W V = 40 VDC			100	μA	
	M643-2W V = 250VDC			200	μA	
Turn On Time ($T_D + T_R$)	-1			10	μSEC	
	-2			10	μSEC	
Turn Off Time ($T_D + T_F$)	-1			15		See Fig. 6
	-2			75	μSEC	See Fig. 7
Capacitance Across Output	M643-1W		10	15	pf	
	M643-2W		30	40		
Insulation Resistance (Input to Output, Output to Case)		10^9			Ohms	@500VDC
Dielectric Strength (Input to Output, Output to Case)		1000			VAC(PP) 60 Hz	
Maximum Surge Through Output 5 mS, 1% Duty Cycle				150	% of Current Rating	See Fig. 5
Power Dissipation	M643-1W			260	mW	
	M643-2W			160	mW	

CHARACTERISTIC CURVES

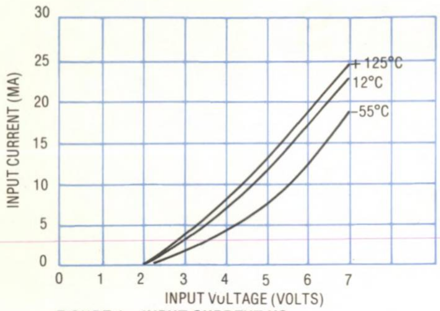


FIGURE 1 - INPUT CURRENT VS. INPUT VOLTAGE (TYPICAL)

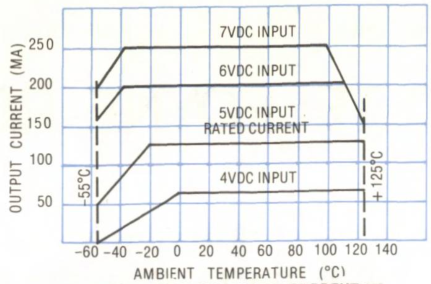


FIGURE 2 - M643-1W OUTPUT CURRENT VS. INPUT CONTROL VOLTAGE AND AMBIENT TEMPERATURE

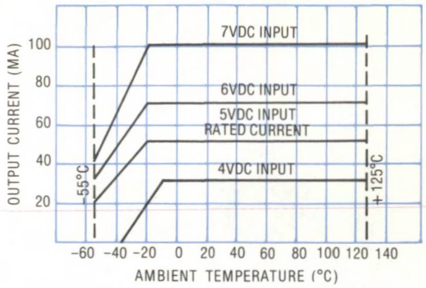


FIGURE 3 - M643-2W OUTPUT CURRENT VS. INPUT CONTROL VOLTAGE AND AMBIENT TEMPERATURE

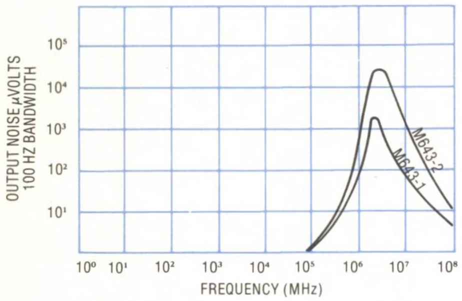


FIGURE 4 - CONTACT NOISE VS. FREQUENCY 100 HZ BANDWIDTH (TYPICAL)

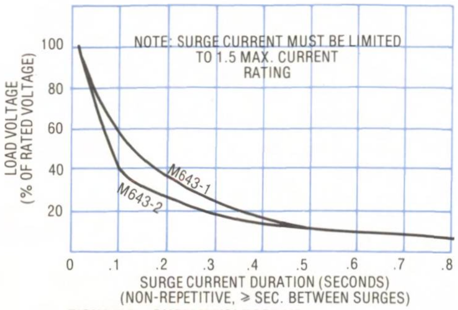


FIGURE 5 - SUPPLY VOLTAGE VS. SURGE CURRENT DURATION

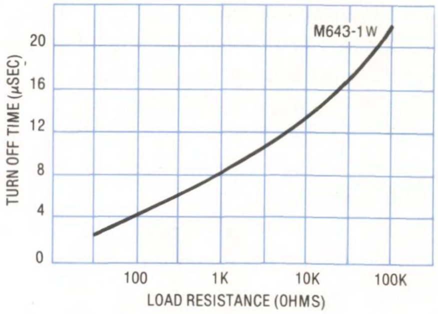


FIGURE 6 - TURN-OFF TIME VS. LOAD RESISTANCE (TYPICAL)

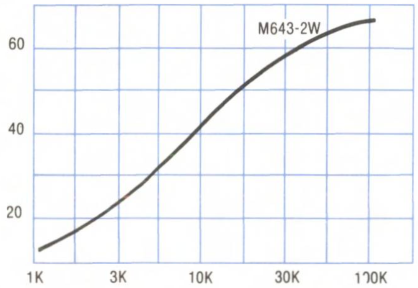
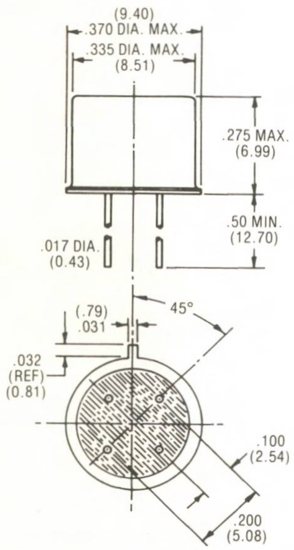


FIGURE 7 - TURN-OFF TIME VS. LOAD RESISTANCE (TYPICAL)

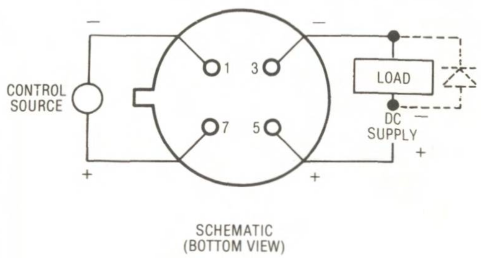
MECHANICAL SPECIFICATIONS



DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

- Weight: 5 grams (typical).
- Enclosure: TO-5 (4 pin).
- Seal: Hermetic.

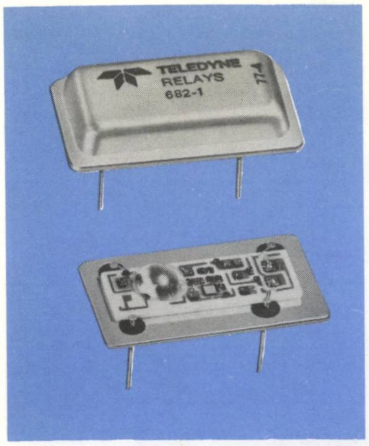
WIRING DIAGRAM



SCHEMATIC
(BOTTOM VIEW)

NOTES:

1. Reversing polarity of input or output may cause permanent damage.
2. For any control voltage, the maximum load current value shown in Figure 2 and 3 must not be exceeded. Attempting to draw currents in excess of these curves can cause permanent damage.
3. Inductive loads must be diode suppressed.



TELEDYNE RELAYS

MILITARY SOLID STATE AC RELAY

OPTICALLY ISOLATED
1 AMP
(2 AMPS with Heat Sink)

MODEL
682-1

SPST/NO

FEATURES

- Low profile metal DIP package
- Zero voltage turn-on
- Low minimum output current
- Logic compatible input
- Meets MIL-R-28750/9 & MIL-STD-704B

DESCRIPTION

Optically isolated, with 1500 VRMS input/output isolation, this state of the art military solid state relay features a load rating of 1 amp at 250 VRMS over a frequency range of 45 to 440 Hz. Synchronous "zero voltage" turn-on assures low EMI, which is critical for most military applications. The output circuit utilizes inverse parallel SCRs, which provide reliable switching of both resistive and reactive loads with power factors as low as .2, and also 10 amp surge capability for high inrush loads.

The 682-1 meets the requirements of MIL-R-28750/9, and is designed to withstand severe environmental conditions encountered in military/aerospace applications. Advanced circuit design together with conservative component derating assure reliable operation over a wide operating temperature range.

ENVIRONMENTAL SPECIFICATIONS

Temperature (Ambient, Operating & Storage)	-55 to +110°C
Vibration	50g, 10-2000 Hz
Shock	50g, 11mSec
Acceleration	100g

ELECTRICAL SPECIFICATIONS

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

INPUT (CONTROL) SPECIFICATIONS	MIN.	TYP.	MAX.	MAX.
Control Voltage Range (Note 1)	3		16	VDC
Input Current at: 5 VDC (See Figure 1)		10	15	mA DC
16 VDC		12	18	
Turn-On Voltage	3			VDC
Turn-Off Voltage			1.0	VDC
Isolation @ 500 VDC (Input to Case, Input to Output, Output to Case)	10^9			OHMS
Capacitance (Input to Output)			10	pf
Dielectric Strength — Input to Output	1500			VAC(RMS) 60 Hz
Dielectric Strength — Input/Output to Case	1250			
OUTPUT (LOAD) SPECIFICATIONS	**MIN.**	**TYP.**	**MAX.**	**UNITS**
Output Current Rating (See Note 6 & Figure 4 for Temperature Derating)	.020		1.0	AMPS (RMS)
Load Voltage Rating	20		250	VAC(RMS)
Frequency Range	45		440	Hz
Surge Current @ 25°C (16 ms) (See Figure 3)			10	AMPS PEAK
Over Voltage Rating, Transient (T ≤ 20ms) (See Note 3)			±460	V PEAK
Output Voltage Drop @ 1 Amp (See Figure 2)			1.4	VAC(RMS)
Turn-On Time			½	CYCLE
Turn-Off Time			1.0	CYCLE
Off-State Leakage Current (250 VAC, 400 Hz)			3	mA
Zero Voltage Turn-On Point V_{in} = 3 VDC, V_L = 220 VAC, R_L = 500Ω			±10	V PEAK
Off-State dv/dt (With Snubber - See Note 4)	200			V/μS
Commutating dv/dt	5			V/μS
Load Power Factor (With Snubber - See Note 4)	0.2			
Fusing I^2T (10mS)			1	A^2SEC
Power Dissipation Factor @ 25°C			1.4	WATTS/AMP
Output Switch Junction Temperature (T_J Max.)			130	°C
Thermal Resistance Junction to Ambient (Θ_{JA})			75	°C/W
Thermal Resistance Junction to Case (Θ_{JC})			10	°C/W

CHARACTERISTIC CURVES

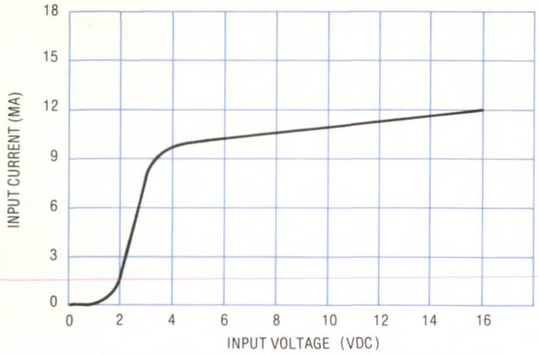


FIGURE 1 — TYPICAL INPUT CURRENT VS. INPUT VOLTAGE

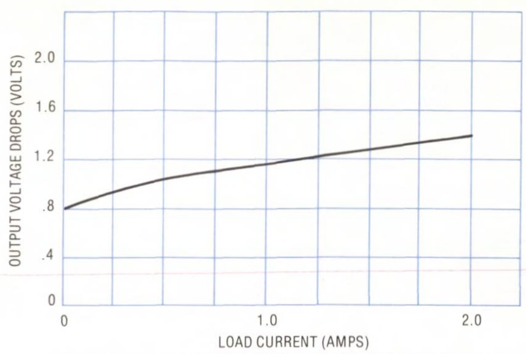


FIGURE 2 — LOAD CURRENT VS. TYPICAL OUTPUT VOLTAGE DROP

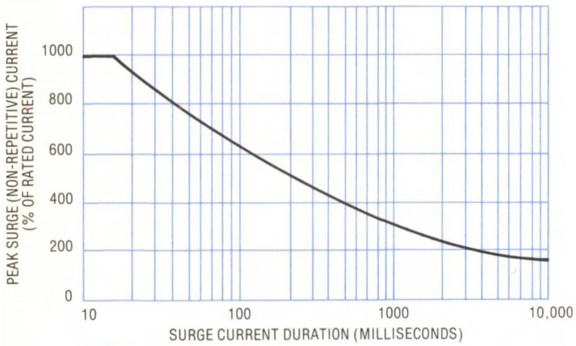


FIGURE 3 — PEAK SURGE CURRENT VS.
SURGE CURRENT DURATION (SEE NOTE 5)

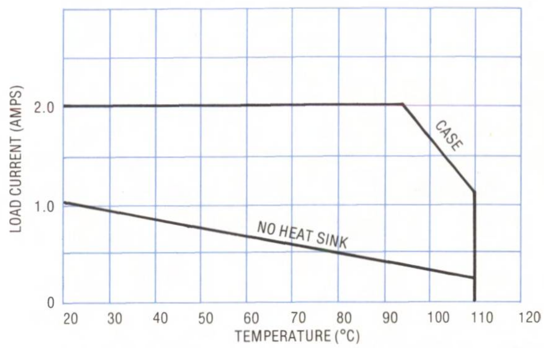
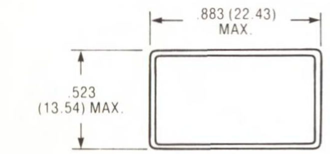
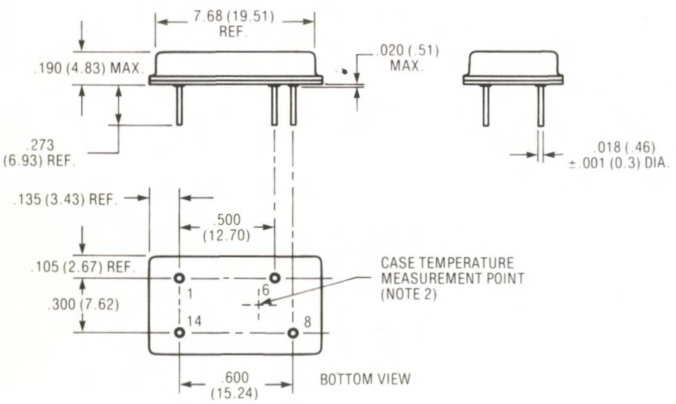


FIGURE 4 — MAX. LOAD CURRENT VS. TEMPERATURE (SEE NOTE 2)

OUTLINE DIMENSIONS



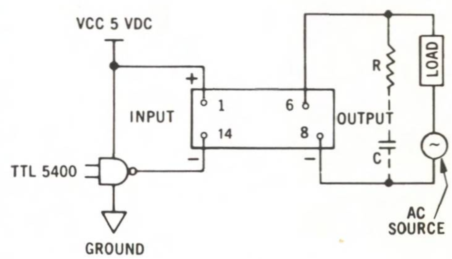
- Enclosure: 4 Pin DIP, Hermetically Sealed
- Leak Rate 1 × 10⁻⁸ CC/SEC. Max.
- Material: Header/Pins – Kovar, Gold Plated
  Can-Grade A Nickel



DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

WIRING DIAGRAM

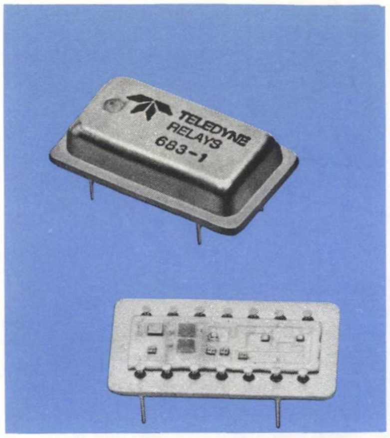
TYPICAL INTERFACE TO 5 VOLT LOGIC (WITH SUGGESTED dv/dt SUPPRESSION — SEE NOTE 4)



RELAY BOTTOM VIEW

NOTES:

1. Reversing polarity of input may cause permanent damage.
2. Case temperature is measured at point specified.
3. Designed to operate within limits of MIL-STD-704B-400 HZ aircraft power.
4. Recommended snubber across output terminals R = 100Ω, C = 0.01 MFD. The dv/dt rating is based on a source impedance of 50 ohms.
5. Output may lose blocking capability during and after surge unit T_J falls below maximum.
6. Absolute maximum current rating is 2 AMPS. (Power dissipation factor at 2 AMPS is 1.7 Watts/AMP)



TELEDYNE RELAYS

MILITARY SOLID STATE DC RELAY

OPTICALLY ISOLATED 600 MA

MODEL

683-1

SPST/NO

FEATURES

- 1500 VRMS optical isolation
- Logic compatible input
- High speed switching response
- Low profile metal DIP - hermetically sealed
- Meets MIL-R-28750/8

DESCRIPTION

The 683-1 is designed to replace electromechanical relays in military applications where all solid state circuitry is required. Utilizing hybrid thick film microcircuitry, this relay features a constant current input IC to limit input power dissipation over a control voltage range of 3 to 16 VDC. Dual photo-voltaic opto-couplers provide 500 VRMS isolation, high output current rating, and low off state leakage. Snap action switching precludes damage from slowly ramped inputs. Typical applications are isolated line drivers, data couplers, lamp drivers, and power transistor drivers.

ENVIRONMENTAL SPECIFICATIONS

Temperature (Ambient, Operating & Storage)	-55°C to 115°C
Vibration	50g, 10-2000 Hz
Shock	50g, 11mSEC
Acceleration	100g

ELECTRICAL SPECIFICATIONS

(—55°C to +115°C unless otherwise specified)

INPUT (CONTROL) SPECIFICATIONS		MIN.	TYP.	MAX.	UNITS
Control Voltage Range		3		16	VDC
Input Current at: (Current Limited, See Fig. 1)	5 VDC		10	15	mA DC
	16 VDC		15	20	
Turn-On Voltage		3			VDC
Turn-Off Voltage				1.0	VDC
Isolation @ 500 VDC, Input To Case Input To Output, Output To Case		10^9			OHMS
Capacitance, (Input To Output)				5	pf
Dielectric Strength, Input To Case Input To Output, Output To Case		500			VAC RMS 60 Hz
OUTPUT (LOAD) SPECIFICATIONS		**MIN.**	**TYP.**	**MAX.**	**UNITS**
Maximum Allowable Output Current (See Fig. 3 & 4)		0		600	mA
Output Voltage		2		50	VDC
Output Voltage Drop (See Fig. 2)			1.25	1.4	VDC
Turn-On Time ($V_L = 25V$, $R_L = 250\Omega$, $V_{IN} = 5V$)			15	50	µSEC
Turn-Off Time ($V_L = 25V$, $R_L = 25\Omega$, $V_{IN} = 5V$)			20	150	µSEC
Off-State Leakage At:	25 VDC			10	µA
	50 VDC			60	
Capacitance Across Contacts			50	75	pf
Output Switch Junction Temperature (T_J Max.)				150	°C
Thermal Resistance Junction To Ambient (Θ_{JA})				115	°C/W
Thermal Reistance Junction To Case (Θ_{JC})				35	°C/W

CHARACTERISTIC CURVES

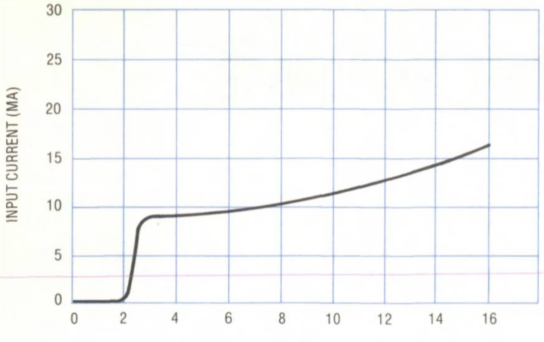


FIGURE 1 — TYPICAL INPUT CURRENT VS. INPUT VOLTAGE

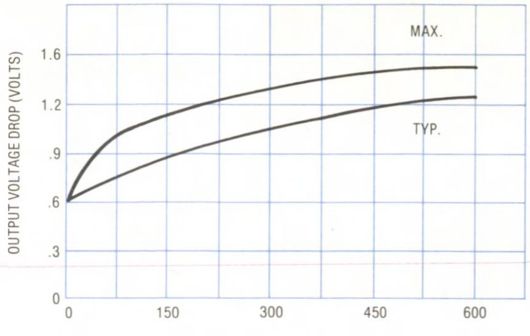


FIGURE 2 — LOAD CURRENT VS. OUTPUT VOLTAGE DROP

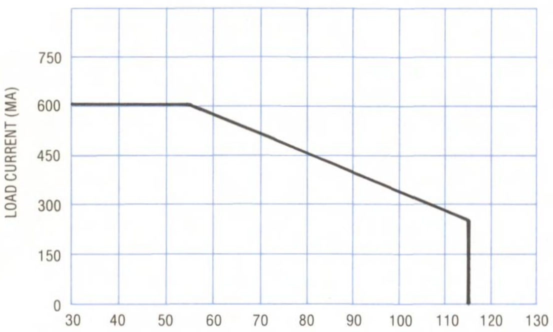


FIGURE 3 — MAX. LOAD CURRENT VS. AMBIENT TEMPERATURE

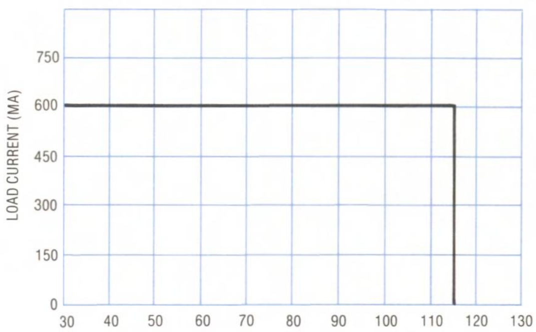
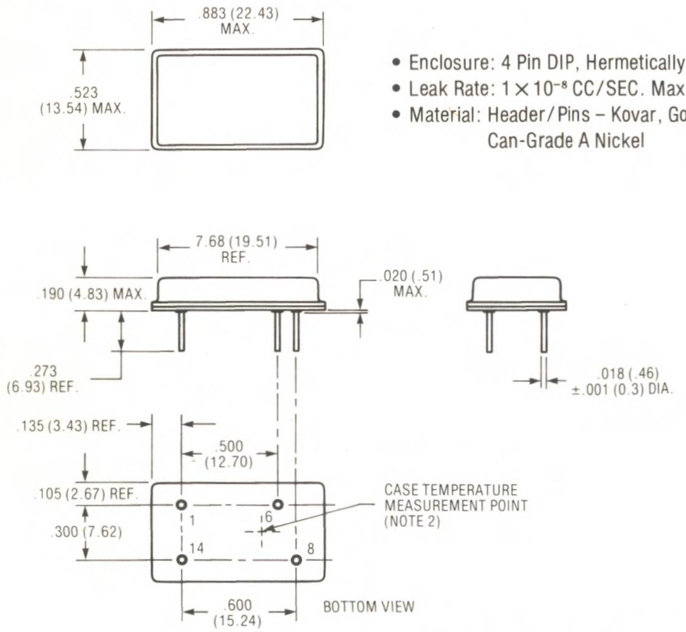


FIGURE 4 — MAX. LOAD CURRENT VS. CASE TEMPERATURE (SEE NOTE 3)

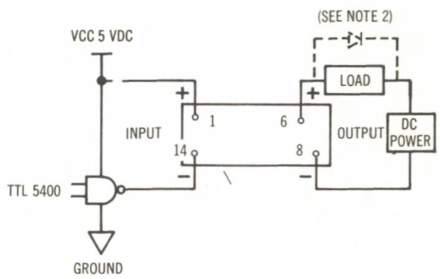
MECHANICAL SPECIFICATIONS



- Enclosure: 4 Pin DIP, Hermetically Sealed
- Leak Rate: 1×10^{-8} CC/SEC. Max.
- Material: Header/Pins – Kovar, Gold Plated
  Can-Grade A Nickel

DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

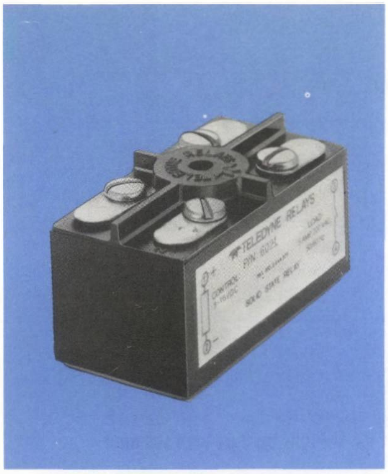
TYPICAL INTERFACE TO 5 VOLT LOGIC



RELAY BOTTOM VIEW

NOTES:

1. Reversing polarity of input or output may cause permanent damage.
2. Inductive loads must be diode suppressed.
3. Case temperature is measured at point specified.



TELEDYNE RELAYS

MILITARY SOLID STATE AC RELAY

OPTICALLY ISOLATED 10 AMP

MODEL
602-1

SPST/NO

FEATURES

- Optical Isolation between control and load circuits
- Logic compatible input
- Zero voltage turn-on for reduced EMI
- High transient immunity
- Designed to meet MIL-R-28750

DESCRIPTION

The 602-1 contains a hermetically sealed isolator which utilizes thick film hybrid microcircuit construction. Optically isolated, with synchronous ''Zero Voltage'' turn-on, this state of the art isolator provides the drive current for a hermetically sealed 10 amp output triac. Both components are potted in thermally conductive epoxy. A snubber circuit is included to provide reliable switching of both resistive and reactive loads with power factors as low as .2.

The 602-1 is designed to meet the requirements of MIL-R-28750, and can withstand severe environmental conditions encountered in military/aerospace applications.

ENVIRONMENTAL SPECIFICATIONS

Ambient Temperature	-55°C to 95°C Operating -55°C to 110°C Storage
Shock	100 g for 11 mS.
Vibration	30 g, 78-2000 Hz (0.1 Double Amplitude 10-78 Hz)
Acceleration	100g
Altitude	Sea Level to 100,000 ft.

ELECTRICAL SPECIFICATIONS

(25°C UNLESS OTHERWISE SPECIFIED)

INPUT (CONTROL) SPECIFICATIONS		MIN.	TYP.	MAX.	UNITS
Control Voltage Range (Note 1) (-55°C to 85°C)		3		16	VDC
Input Current at:	5 VDC		10	15	mA DC
(See Fig. 1)	16 VDC		12	18	
Turn-On Voltage (-55°C to 85°C)		3			VDC
Turn-Off Voltage (-55°C to 85°C)				1.0	VDC
Isolation @ 500 VDC (Input to Case, Input to Output, Output to Case)		10^9			OHMS
Capacitance (Input to Output)				10	pf
Dielectric Strength (Input to Case, Input to Output, Output to Case)		1500			VAC RMS 60 Hz
OUTPUT (LOAD) SPECIFICATIONS		**MIN.**	**TYP.**	**MAX.**	**UNITS**
Output Current Rating (See Note 4 for Temperature Derating)		.15		10	A
Load Voltage Rating		30		220	VAC
Frequency Range		45		440	Hz
Surge Current @ 25°C (16ms) (See Fig. 3)				100	A PEAK
Over Voltage Rating, Transient (T≤20ms) (See Note 3)				±460	V PEAK
Output Voltage Drop @ 10 Amp (See Fig. 2)				1.5	VDC
Turn-On Time				½	CYCLE
Turn-Off Time				1	CYCLE
Off State Leakage Current (220 VAC, 400 Hz) @ 85°C				8	mA
Zero Voltage Turn-On Point (-55°C to 85°C)				±10	V PEAK
Off State dv/dt (See Note 4)		200			V/μS
Commutating dv/dt @ 85°C		3			V/μS
Load Power Factor (See Note 4)		0.2			
Fusing I^2T (1ms)				150	A^2SEC
Power Dissipation Factor @ 25°C				1.25	WATTS/AMP
Output Switch Junction Temperature (T_J Max.)				100	°C
Thermal Resistance Junction to Ambient (Θ_{JA})				11.5	°C/W
Thermal Resistance Junction to H.S. (Θ_{JS}) (Includes Θ_{CS})				2	°C/W

CHARACTERISTIC CURVES

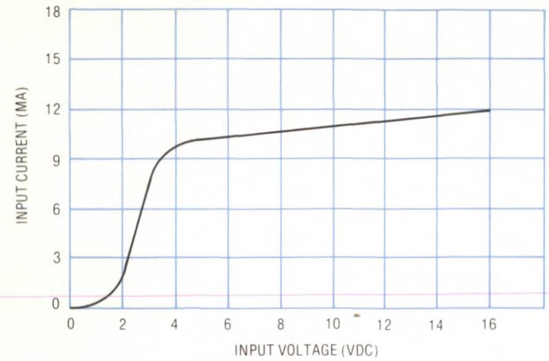


FIGURE 1 - TYPICAL INPUT CURRENT VS. INPUT VOLTAGE

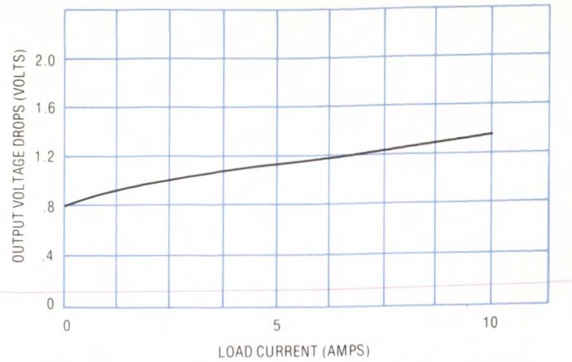


FIGURE 2 - LOAD CURRENT VS. TYPICAL OUTPUT VOLTAGE DROP

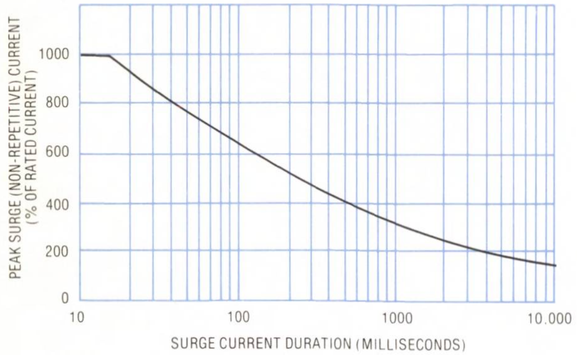


FIGURE 3 - PEAK SURGE CURRENT VS.
SURGE CURRENT DURATION (SEE NOTE 5)

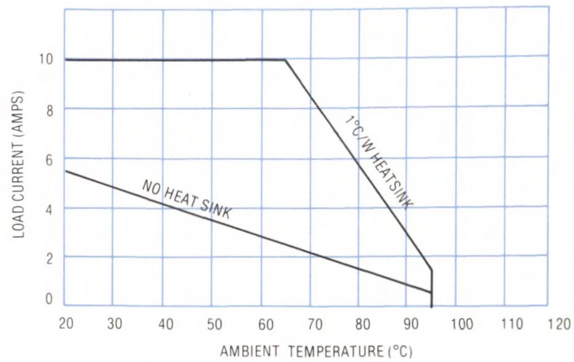
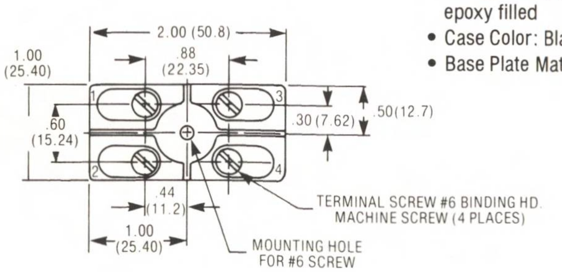
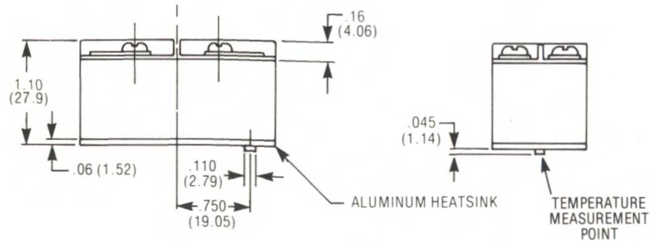


FIGURE 4 - THERMAL DERATING CURVES

MECHANICAL SPECIFICATIONS

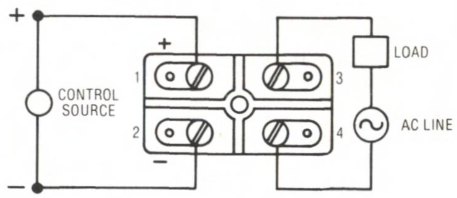
- Weight: 3 oz. max.
- Case Material: Self extinguishing plastic, epoxy filled
- Case Color: Black
- Base Plate Material: Aluminum





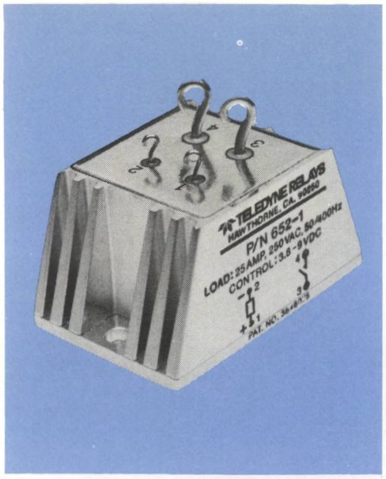
(DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS))

WIRING DIAGRAM



NOTES:

1. Reversing polarity of input may cause permanent damage.
2. Case temperature 75°C max. @ 10A, measured at point specified.
3. Designed to operate within limits of MIL-STD-704B 400 Hz aircraft power.
4. Built-in snubber (R = 100Ω, C = 0.01 MFD).
5. Output may lose blocking capability during and after surge until T_J falls below maximum.



TELEDYNE RELAYS

MILITARY SOLID STATE AC RELAY

OPTICALLY ISOLATED 25 AMP

SERIES **652**

SPST/NO

FEATURES

- **Optical Isolation between control and load circuits**
- **Logic compatible input current levels**
- **Zero voltage turn on for reduced EMI**
- **High transient immunity**
- **Meets MIL-R-28750/10 and MIL-STD-704B**

DESCRIPTION

The 652 Series is a military style AC power SSR packaged in a thermally efficient hermetically sealed aluminum case. Circuit components are exclusively military grade (hermetically sealed) with the circuit board assemblies encapsulated to assure resistance to military shock and vibration levels.

Output switching is accmplished by means of back-to-back SCRs which, together with advanced drive circuit techniques, provide reliable operation over a line frequency range of 45-440 Hz. Input drive circuitry is logic compatible, thereby precluding the need for additional relay driver stages. Synchronous "zero voltage" turn on and zero current turn off result in significantly lower EMI levels compared with mechanical relays and contactors, thus making the 652 an ideal alternative for AC power switching in aerospace applications.

PART NUMBERING

INPUT CONTROL VOLTAGE RANGE	OUTPUT VOLTAGE RATING (VAC)		OUTPUT CURRENT RATING & PART NUMBERING
	Continuous (RMS)	Transient (PEAK)	25 AMP
3.8-9 VDC	250	460	652-1
9-32 VDC			652-2

ENVIRONMENTAL SPECIFICATIONS

Ambient Temperature	-55°C to 110°C Operating & Storage
Shock	100 g for 11 mS
Vibration	30 g, 78-2000 Hz (0.1 IN. DA 10-78 Hz)
Acceleration	100 g
Altitude	Sea Level to 100,000 ft.

ELECTRICAL SPECIFICATIONS

(25°C UNLESS OTHERWISE SPECIFIED)

INPUT (CONTROL) SPECIFICATIONS		MIN.	TYP.	MAX.	UNITS
Control Voltage Range (-55°C to +110°C)	—1	3.8		9	VDC
	—2	9		32	
Input Current at: 5V (-55°C to +110°C)	—1			16	mA
28V	—2			20	mA
Turn-On Voltage (-55°C to +110°C)	—1	3.8			VDC
	—2	9			
Turn-Off Voltage (-55°C to +110°C)				0.8	VDC
Isolation (Input to Output, Input & Output to Case)		10^9			OHMS
Capacitance (Input to Output)			15	20	pf
Dielectric Strength (Input to Output, Input & Output to Case)		1500			VAC (RMS) 60 Hz
Transient Input Voltage which will not damage Relay (T ≤ 10 μsec) (Note 4)				±600	V PEAK

OUTPUT (LOAD) SPECIFICATIONS	MIN.	TYP.	MAX.	UNITS
Output Current Rating (See Figure 2, 4)	.100		25	AMPS (RMS)
Load Voltage Rating (-55°C to +110°C)	25		250	VAC (RMS)
Frequency Range (Note 4) (-55°C to +110°C)	45		440	Hz
Surge Current Rating (16ms) (See Figure 3)			1000	% OF RATING
Over Voltage Rating Transient (T ≤ 20M$_S$) (Note 4)			±460	V (PEAK)
Output Voltage Drop @ 25A			1.8	VAC
Turn-On Time (-55°C to +110°C)			1/2	CYCLE
Turn-Off Time (-55°C to +110°C)			10	mS
Off-State Leakage at 208 VAC, 400 Hz (-55°C to +110°C)			15	mA (RMS)
Zero Voltage Turn-On Point		±15	±30	V (PEAK)
Off-State dv/dt (See Note 1)	200	400		V/μSEC
Fusing I^2T (1 M$_S$)			300	A^2 SEC
Power Dissipation Factor (D)			1.25	WATTS/AMP
Power Switch Junction Temperature (T_J Max.)			125	°C
Thermal Resistance Junction to HS(Θ_{JS}) (Includes Θ_{CS}) (See Note 2)			1.2	°C/WATT
Thermal Resistance Junction to Ambient (Θ_{JA}) (No Heat Sink)			6.8	°C/WATT

PATENT #3,648,075

CHARACTERISTIC CURVES

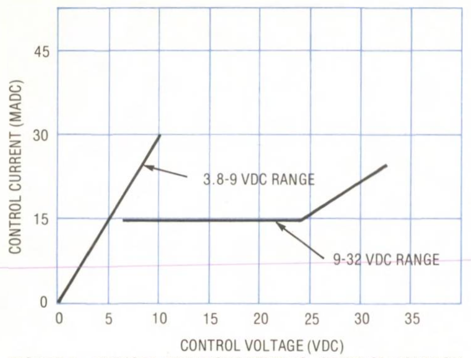


FIGURE 1 — TYPICAL INPUT CURRENT VS. CONTROL VOLTAGE

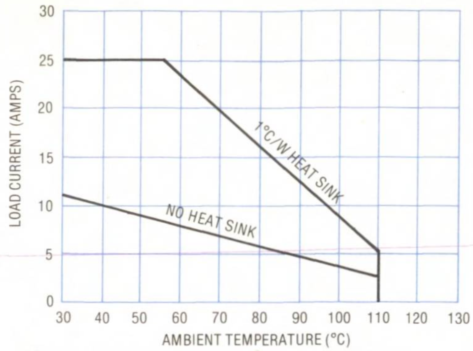


FIGURE 2 — MAX. ALLOWABLE CURRENT VS. AMBIENT TEMPERATURE

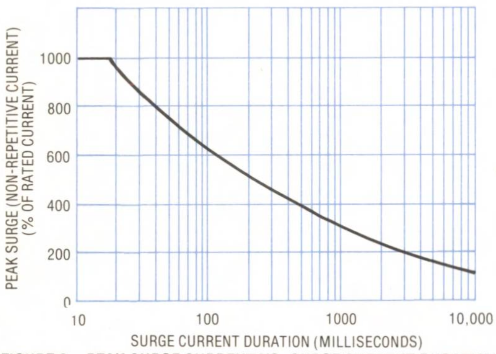


FIGURE 3 — PEAK SURGE CURRENT VS. SURGE CURRENT DURATION (SEE NOTE 3)

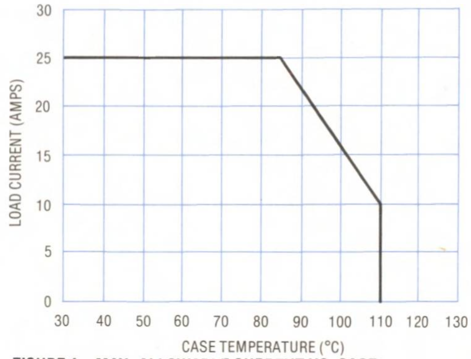
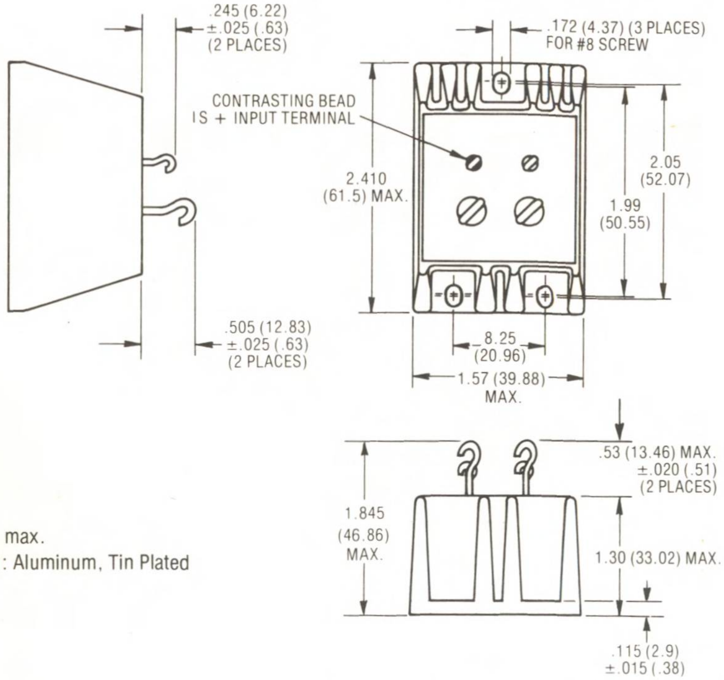


FIGURE 4 - MAX. ALLOWABLE CURRENT VS. CASE TEMPERATURE (SEE NOTE 2)

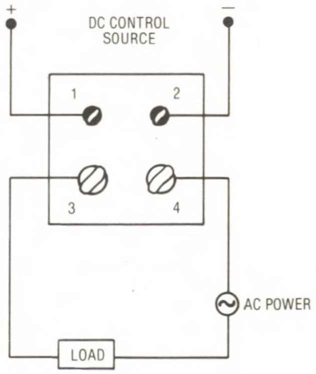
MECHANICAL SPECIFICATIONS



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

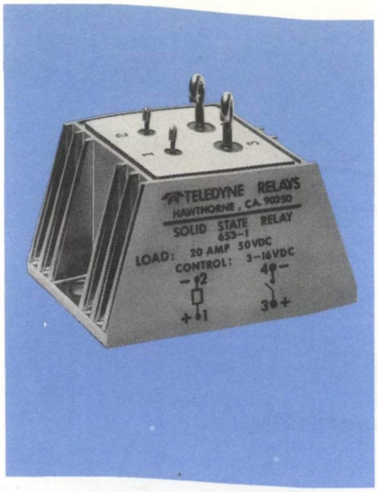
DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

WIRING DIAGRAM



NOTES:

1. Output transient (dv/dt) protection is provided in all models, and they are designed to switch resistive or inductive loads to 0.2 power factor. 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.



TELEDYNE RELAYS

MILITARY SOLID STATE DC RELAY

20 AMP

SERIES 653

SPST/NO

FEATURES

- Optical Isolation between control and load circuits
- Logic compatible input current level
- Snap action switching
- Meets MIL-R-28750

DESCRIPTION

The 653 is a military style DC power SSR packaged in a thermally efficient hermetically sealed aluminum case. Circuit components are exclusively military grade (hermetically sealed) with the circuit board assembly encapsulated to assure resistance to military shock and vibration levels.

Output switching is accomplished by means of a Darlington Power Transistor which, together with advanced drive circuit techniques, provide reliable operation over the full output range. Input drive circuitry is logic compatible, thereby eliminating the need for additional relay driver stages. Snap action switching precludes damage from slowly ramped inputs.

PART NUMBERING

INPUT CONTROL VOLTAGE RANGE	OUTPUT VOLTAGE RATING (VDC)	OUTPUT CURRENT RATING & PART NUMBERING
		20 AMP
3-16 VDC	50	653-1

ENVIRONMENTAL SPECIFICATIONS

Ambient Temperature	-55°C to 115°C Operating and Storage
Shock	50g for 11mSEC.
Vibration	50g Level 10 to 2000 Hz
Accelration	100g
Altitude	Sea Level to 100,000 ft.

ELECTRICAL SPECIFICATIONS

(25°C UNLESS OTHERWISE SPECIFIED)

INPUT (CONTROL) SPECIFICATIONS		MIN.	TYP.	MAX.	UNITS	NOTES
Control Voltage Range (-55°C to +115°C)		3		16	VDC	
Input Current at: (-55°C to +115°C)	5 VDC		10	15	mA	See Fig. 1
	16 VDC		15	20	mA	
Turn-On Voltage (-55°C to +115°C)		3			VDC	
Turn-Off Voltage (-55°C to +115°C)				1.0	VDC	
Isolation (Input to Output, Input & Output to Case)		10^9			Ohms	
Capacitance (Input to Output)				10	pf	
Dielectric Strength (Input to Output, Input & Output to Case)		500			VAC (RMS) 60 Hz	
OUTPUT (LOAD) SPECIFICATIONS		**MIN.**	**TYP.**	**MAX.**	**UNITS**	**NOTES**
Output Current Rating Resistive (See Figures 3 and 4)		.100		20	Amps	
Load Voltage Rating (-55°C to +115°C)		5		50	VDC	
Surge Current Rating @ 25°C for .1 sec. (See Figure 5)				40	Amps	
Output Voltage Drop @ 20 Amps (See Figure 2)				2.5	VDC	
Turn-On Time (-55°C to +115°C)				60	µSEC	See Note 3
Turn-Off Time (-55°C to +115°C)				175	µSEC	
Off-State Leakage @ 50 VDC		25°C		.3	mA	
		115°C		15	mA	
Power Switch Junction Temperature (T_J Max.)				150	°C	
Thermal Resistance Junction to HS (Θ_{JS}) (Includes Θ_{CS}) (See Note 2)				1.2	°C/Watt	
Thermal Resistance Junction to Ambient (Θ_{JA}) (No Heat Sink)				6.1	°C/Watt	

CHARACTERISTIC CURVES

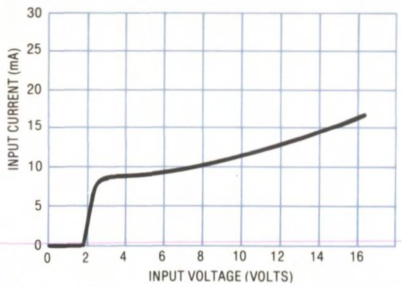


FIGURE 1 - INPUT CURRENT VS. INPUT VOLTAGE (TYPICAL)
LOAD CURRENT (A)

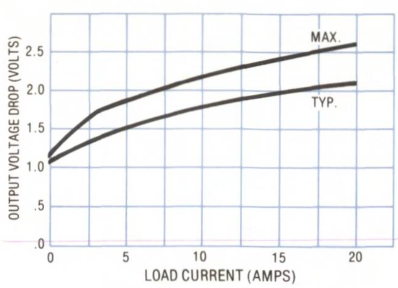


FIGURE 2 - LOAD CURRENT VS. OUTPUT VOLTAGE DROP

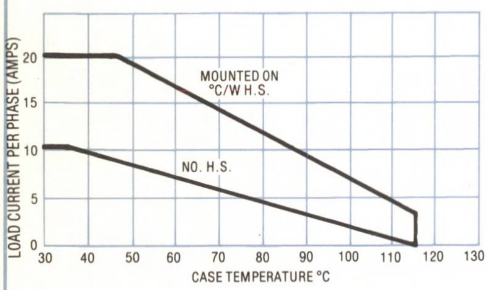


FIGURE 3 - MAX. LOAD CURRENT VS. AMBIENT TEMPERATURE

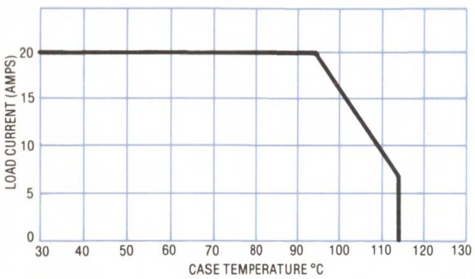


FIGURE 4 - MAX. LOAD CURRENT VS. CASE TEMPERATURE

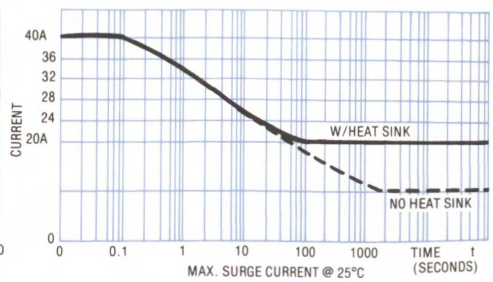
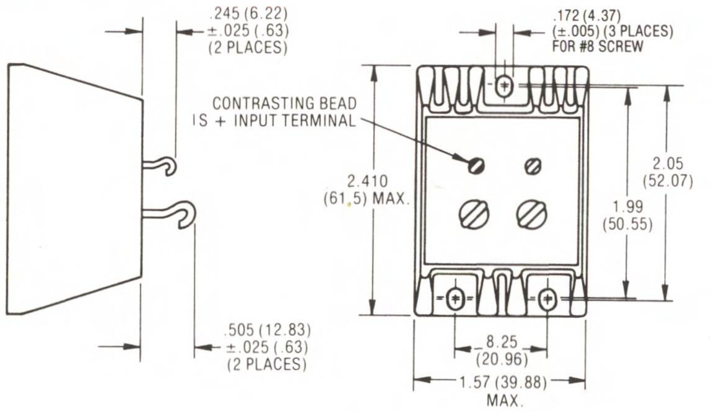
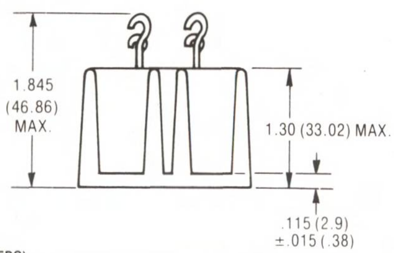


FIGURE 5 - MAX. SURGE CURRENT @ 25°C

MECHANICAL SPECIFICATIONS

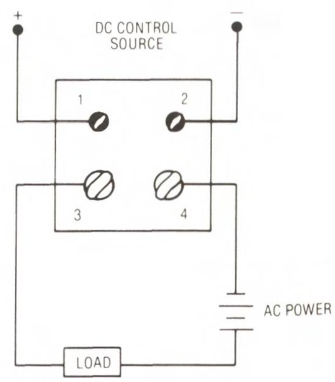




- Weight: 6 oz. max.
- Case Material: Aluminum, Tin Plated

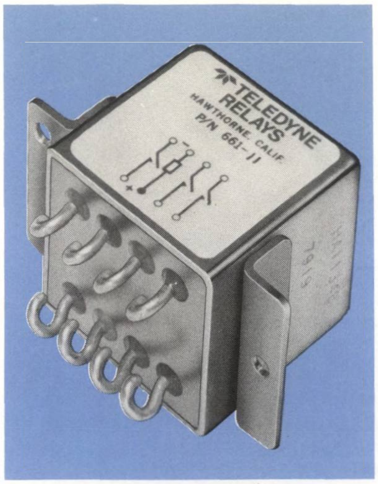
DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

WIRING DIAGRAM



NOTES:

1. Reversing polarity of input or output may cause permanent damage.
2. Case temperature measurement is center of mounting surface.
3. Measured at VL = 500 V RL = 10 Ω.
5. All units incorporate drop action.



TELEDYNE RELAYS

AC HERMETIC 3-PHASE MILITARY SOLID STATE RELAYS

OPTICALLY ISOLATED

SERIES 661

2 AMP/250 VAC (3 SPST/N.O.)

FEATURES

- Optical isolation between control and load circuits
- Zero voltage turn-on for reduced EMI
- Low minimum output current
- High transient immunity
- Meets MIL-R-28750 & MIL-STD-704B

DESCRIPTION

Utilizing three thick film hybrid microcircuits, the Series 661 is packaged in a hermetically sealed military style enclosure. Optically isolated, with 1500 VRMS input/output isolation, this state-of-the-art military solid state relay features a load rating of 2 amp at 250 VRMS over a frequency range of 45 to 440 Hz. Synchronous "zero voltage" turn-on assures low EMI, which is critical for most military applications. The output circuits utilize inverse parallel SRCs, which provide reliable switching of both resistive and reactive loads with power factors as low as .2, and also 10 amp surge capability for high inrush loads.

The 661 meets the requirements of MIL-R-18750, and is designed to withstand severe environmental conditions encountered in military/aerospace applications.

Advanced circuit design together with conservative component derating and state-of-the-art packaging, processing, and sealing techniques allow reliable operation over a wide operating temperature range.

ENVIRONMENTAL SPECIFICATIONS

Temperature (Ambient, Operating and Storage)	-55°C to +110°C
Vibration	50g, 10-2000 Hz
Shock	50g, 11 mSEC
Acceleration	100g
Leak Rate	1×10^{-8} CC/SEC MAX.

ELECTRICAL SPECIFICATIONS

(-55°C TO +100°C UNLESS OTHERWISE SPECIFIED)

INPUT (CONTROL) SPECIFICATIONS		MIN.	TYP.	MAX.	UNITS
Control Voltage Range (Note 1)	-10	3		16	VDC
	-11	14		32	VDC
Input Current at: (See Figure 1)	-10 5 VDC		30	45	mA DC
	-10 16 VDC		36	54	mA DC
	-11 32 VDC		29	35	mA DC
Turn-On Voltage	-10	3			VDC
	-11	14			
Turn-Off Voltage	Both			1.0	VDC
Isolation @ 500 VDC (Input to Case, Input to Output, Output to Case)		10^9			Ohms
Capacitance (Input to Output)				30	pf
Dielectric Strength (Input to Case, Input to Output, Output to Case)		1500			VAC(RMS) 60 Hz

OUTPUT (LOAD) SPECIFICATIONS PER PHASE	MIN.	TYP.	MAX.	UNITS
Output Current Rating (See Figure 3 and 4 for Temperature Derating)	.020		2.0	Amp
Load Voltage Rating (47-440 Hz)	20		250	VAC
Frequency Range	45		440	Hz
Surge Current @ 25°C (16 mS) (See Figure 3) Note 5			10	AMPS PEAK
Overvoltate Rating, Transient (T≤20 mS) (See Note 3)			±460	V PEAK
Output Voltage Drop @ 1 Amp (See Figure 2)			1.4	VDC
Turn-On Time			0.5	CYCLE
Turn-Off Time			1.0	CYCLE
Off-State Leakage Current (250 VAC, 400 Hz)			6	mA
Zero Voltage Turn-On Point V_{in} = VDC, V_L = 220 VAC, R_L = 500 Ω			±10	V PEAK
Off-State dv/dt	200			V/μS
Commutating dv/dt	5			V/μS
Load Power Factor	0.2			
Fusing I^2T (10 mS)			1	A^2SEC
Power Dissipation Factor @ 25°C 3 Phases Connected			4.2	WATTS/AMP
Output Switch Junction Temperature (T_J Max.)			130	°C
Thermal Resistance Junction to Ambient (Θ_{JA}) No Heat Sink			23	°C/W
Thermal Resistance Junction to Case (Θ_{JC})			11.3	°C/W

CHARACTERISTIC CURVES

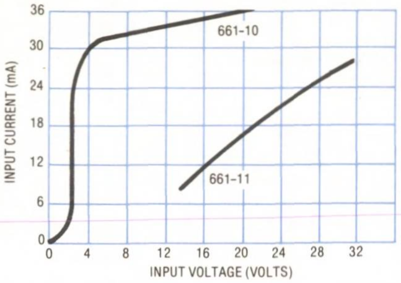


FIGURE 1 - INPUT CURRENT VS. INPUT VOLTAGE (TYPICAL)

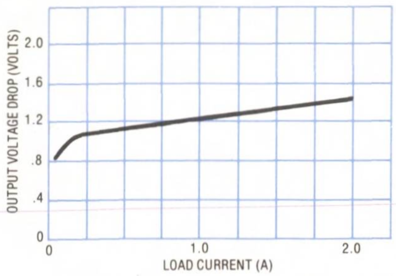


FIGURE 2 - TYPICAL OUTPUT VOLTAGE DROP VS. LOAD CURRENT

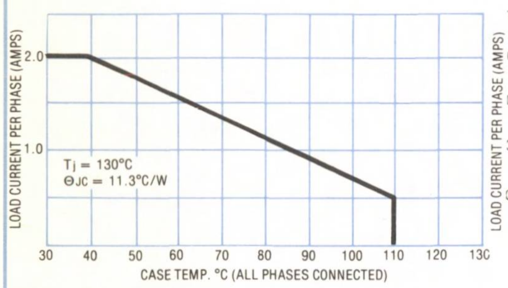


FIGURE 3 - MAX. LOAD CURRENT VS. CASE TEMPERATURE

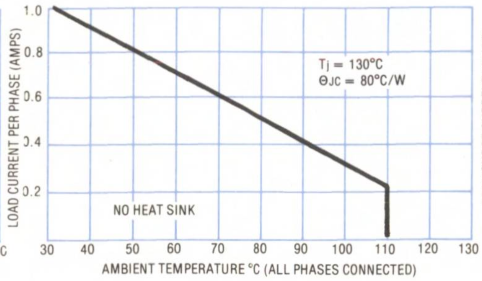


FIGURE 4 - MAX. LOAD CURRENT VS. AMBIENT TEMPERATURE

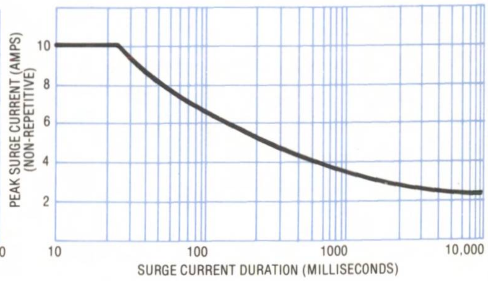
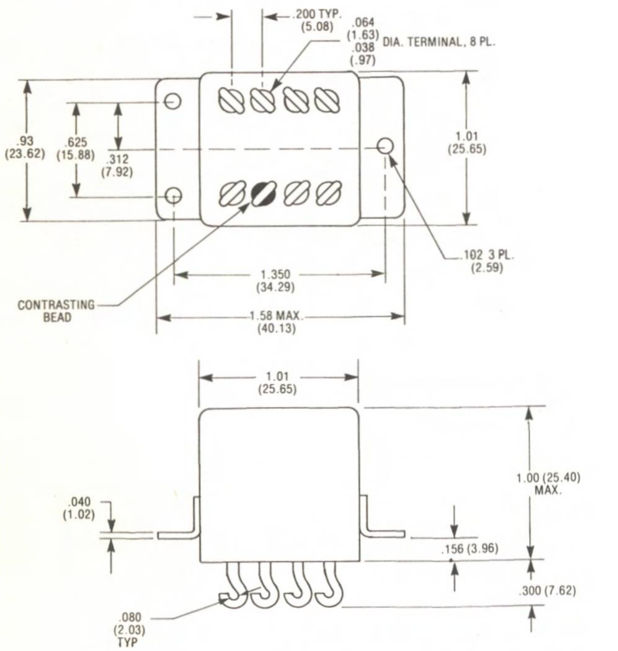


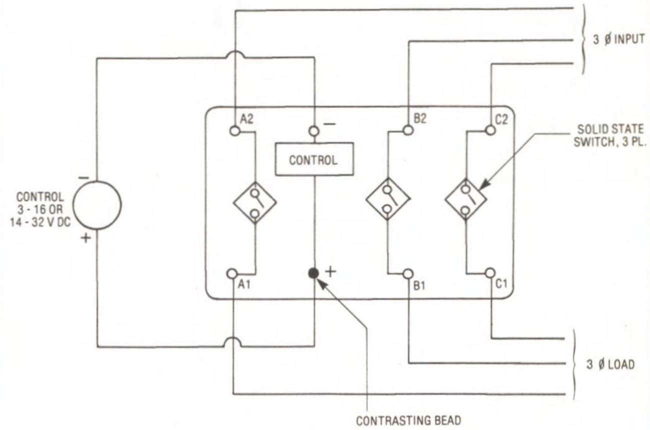
FIGURE 5 - PEAK SURGE CURRENT VS. SURGE CURRENT DURATION

MECHANICAL SPECIFICATIONS



DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

WIRING DIAGRAM

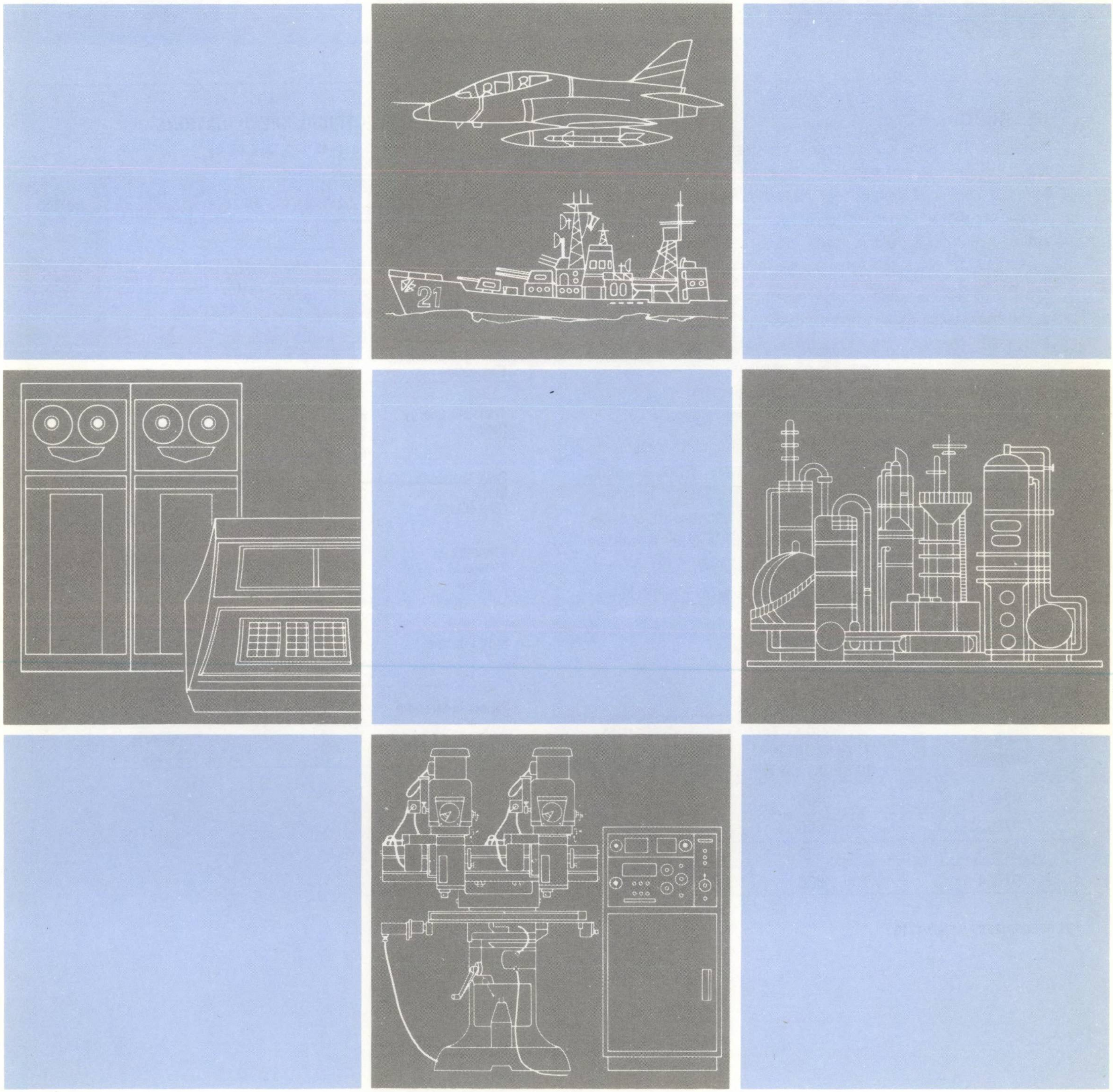


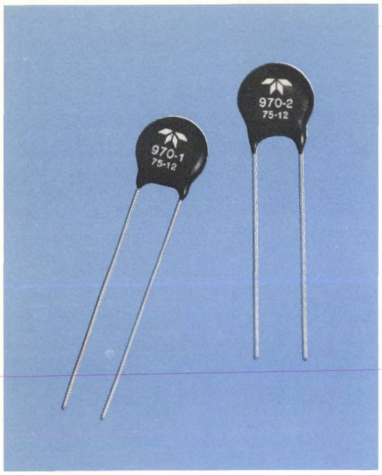
NOTES:

1. Reversing polarity of input may cause permanent damage.
2. Case temperature is measured at point specified.
3. Designed to operate within limits of MIL-STD-704B Hz aircraft power.
4. -11 input will withstand DC voltage transients per MIL-STD-704B.
5. Output may lose blocking capability during and after surge until TJ falls below maximum.
6. Specifications shown herein are subject to change without notice.

SECTION VI

Special Purpose Solid State Devices





TELEDYNE RELAYS

SERIES 970

METAL OXIDE VARISTOR (MOV)

FOR TRANSIENT VOLTAGE PROTECTION

DESCRIPTION

Teledyne 970 Series Metal Oxide Varistors (MOV's) are characterized specifically for use with Teledyne solid state AC relays and I/O converter modules for protection against high voltage transients that are prevalent on AC lines or otherwise generated when switching inductive loads. They can also be used for general circuit protective service other than solid state relays.

MOV's are bidirectional voltage sensitive devices that assume a low impedance state when their design voltage threshold is exceeded. As such, they perform a transient voltage clipping or suppression function on the AC line similar to back-to-back zener diodes and are ideal for circuit protection use from the standpoint of performance, economy and ease of installation.

The 970-1 and -2 have a specified 20 amp minimum clamping capability at 400V and 600V peak respectively. When shunting SSR's the transient energy dissipated by the MOV's is limited by the SSR load impedance as well as the line source impedance. The MOV's thus characterized, protect SSR's against voltage transients such as those defined in IEEE STD 472-1974.

(Consult factory for information regarding MOV's with higher ratings.)

PART NUMBERING

PART NUMBER	TRANSIENT (PEAK) RATING OF RELAY (MIN.)	MAXIMUM CONTINUOUS LINE VOLTAGE
970-1*	400	140 VAC
970-2*	600	250 VAC
970-3	600	264 VAC
970-4	800	410 VAC

*UL RECOGNIZED FILE #E64310

ELECTRICAL SPECIFICATIONS

(-40°C ≤ Ta ≤ 85°C)

CHARACTERISTICS		MIN.	MAX.	UNITS *	TEST CONDITIONS	NOTES
Allowable Continuous AC RMS Voltage	-1		140	VAC (RMS)	I = 1 mA	Note 2
	-2		250			
	-3		264			
	-4		410			
Average Power Dissipation			0.4	Watts		
Transient Energy Rating	-1		5	Joules	10 Amp, 2 mSEC Pulse	Note 1, 4 Fig. 2
	-2 -3		10			
	-4		40			
Peak Allowable Surge Current (End of Life)			500	Amps	20 μSEC Pulse Applied Twice	Note 1, 4 Fig. 2
Clamping Voltage at 20 Amps	-1		400	Volts (Peak)	I = 20 Amps Peak	Note 2-4 Fig. 1
	-2 -3		600			
	-4		800			
MOV Lifetime			10^4	Number of Transients	I = 100 Amps 20 μSEC Pulse 10 SEC Between Pulses	Note 1, 4 Fig. 2
Dielectric Strength		1500		VAC (RMS)	Leads to Case	
Insulation Resistance		10^9		Ω	Leads to Case	

CHARACTERISTIC CURVES

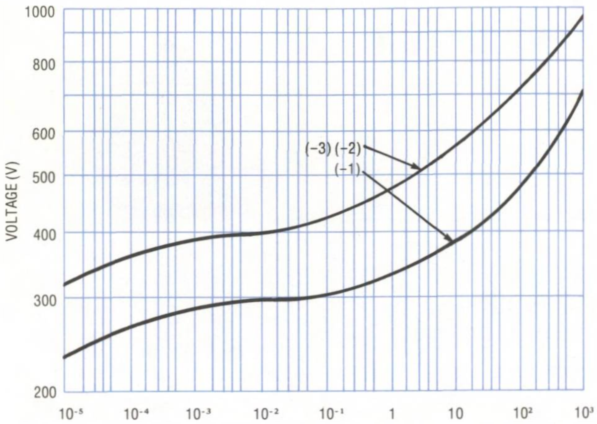


FIGURE 1 – MAXIMUM VOLT-AMPERE CHARACTERISTICS

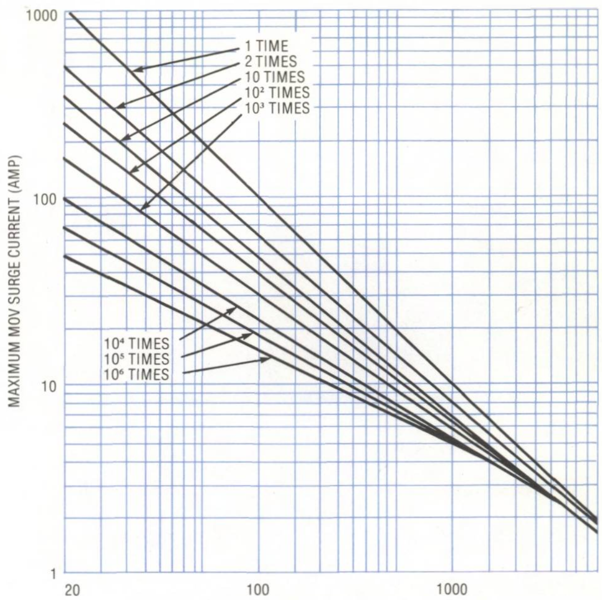
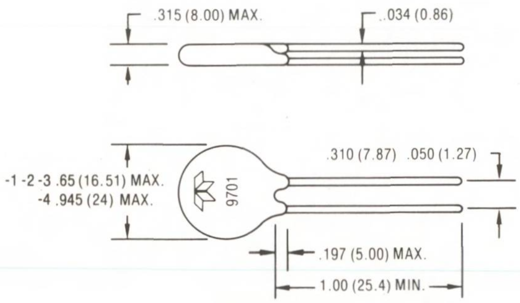


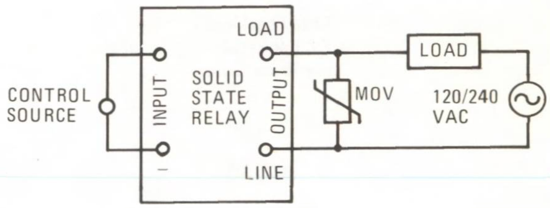
FIGURE 2 – MOV LIFETIME

MECHANICAL SPECIFICATIONS (NOTE 5)



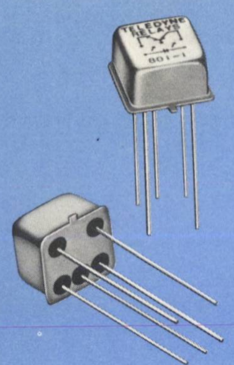
- Ambient Temperature Range:
  -40°C to +85°C Operating
  -40°C to +125°C Storage
- Solderability per MIL-STD-202D, Method 208B

TYPICAL APPLICATION:



NOTES:

1. End of life for these tests is when the post-test value of MOV voltage corresponding to 1 mA of leakage varies by more than 10% from the initial value.
2. The (-1) MOV is designed to be used on 140 VAC maximum line voltage, to protect solid state relays with 400V peak blocking capability.
   The (-2) MOV is designed to be used on 250 VAC maximum line voltage, to protect solid state relays with 600V peak blocking capability.
3. The maximum line transient (V_p) which can be clipped by the MOV without triac voltage breakdown is given by: (Where R_L is the load + source impedance.)
   $V_p = 20 R_L + 400$ (For -1 MOV) $V_p = 20 R_L + 600$ (For - 2 MOV)
4. Tested using a pulse having an 8 microsecond rise time.
5. Consult factory for ring, spade and quick-disconnect terminal options.



TELEDYNE RELAYS

ISO-CUBE®
MILITARY OPTO-ISOLATOR

MODEL
4N50

FEATURES

- HIGH ISOLATION . . . . 1,500 VRMS (2,100 VDC)
- HIGH TRANSFER RATIO 140%
- HIGH VOLTAGE OUTPUT . . . . 40 V MIN.
- LOW DISSIPATION
- ISOLATED CASE
- DESIGNED TO MEET MIL-S-19500

DESCRIPTION

The 4N50* Iso-Cube optically coupled isolator consists of a gallium arsenide LED photon-coupled to a silicon photodiode detector and a high gain NPN transistor with base access.

The low profile, hermetically sealed package measures .370'' square by .225'' high with pinout on .100'' centers for ease of PC board layout.

Employing unique construction techniques developed for Teledyne hybrid SSRs, the miniature Iso-Cube provides the highest isolation available in a military style coupler.

ELECTRICAL CHARACTERISTICS (25°C UNLESS OTHERWISE NOTED)

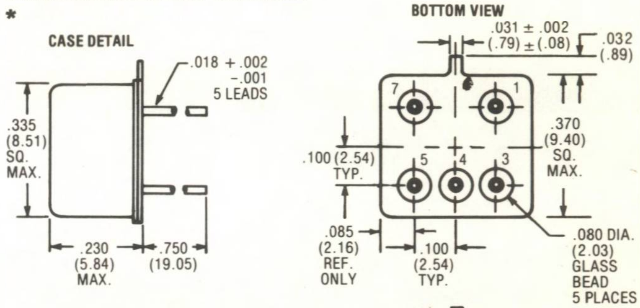
SYMBOL	PARAMETER		TEST CONDITIONS	LIMIT MIN.	LIMIT MAX.	UNITS
* $V_{(BR)CBO}$	Collector-Base Breakdown Voltage		$I_C = 100\ \mu A$, $I_E = 0$, $I_F = 0$	40		V
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage		$I_C = 1$ mA, $I_B = 0$, $I_F = 0$	40		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage		$I_E = 100\ \mu A$, $I_C = 0$, $I_F = 0$	4		V
* I_R	Input Diode Static Reverse Current		$V_R = 3V$		100	μA
$I_{C(on)}$	On-State Collector Current		$V_{CE} = 1$ V, $I_B = 0$, $I_F = 2$ mA	1		mA
			$V_{CE} = 1$ V, $I_B = 0$, $I_F = 10$ mA	13		mA
			$V_{CE} = 5$ V, $I_B = 0$, $I_F = 10$ mA	14		mA
		$T_A = -55°C$	$V_{CE} = 1$ V, $I_B = 0$, $I_F = 10$ mA	8.5		
			$V_{CE} = 5$ V, $I_B = 0$, $I_F = 10$ mA	9		
		$T_A = 100°C$	$V_{CE} = 1$ V, $I_B = 0$, $I_F = 10$ mA	8.5		
			$V_{CE} = 5$ V, $I_B = 0$, $I_F = 10$ mA	9		
* $I_{C(off)}$	Off-State Collector Current		$V_{CE} = 20$ V, $I_B = 0$, $I_F = 0$		100	nA
		$T_A = 100°C$	$V_{CE} = 20$ V, $I_B = 0$, $I_F = 0$		150	μA
		$T_A = 115°C$	$V_{CE} = 30$ V, $I_B = 0$, $I_F = 0$		350	μA
* V_F	Input Diode Static Forward Voltage		$I_F = 10$ mA	.8	1.3	V
		$T_A = -55°C$	$I_F = 10$ mA	1	1.5	V
		$T_A = 100°C$	$I_F = 10$ mA	.7	1.2	V
* $V_{CE(sat)}$	Collector-Emitter Saturation Voltage		$I_C = 10$ mA, $I_B = 0$, $I_F = 10$ mA		.3	V
		$T_A = -55°C$	$I_C = 10$ mA, $I_B = 0$, $I_F = 10$ mA		.3	V
* R_{io}	Input-to-Output Isolation Res.		Input Shorted / Output Shorted @ 500 VDC	10^9		Ω
* C_{io}	Input-to-Output Capacitance		Input Shorted / Output Shorted @ 1 KHz		5	pf
* $V_{(diel)}$	Dielectric Strength, Input-to-Output, Both to Case		Pins 1 & 7 and 3, 4, & 5 Shorted $I_{LEAK} \leqslant 1$ mA		1,500	VRMS/60 Hz
* t_r	Rise Time (See Figure 6)		$V_{CC} = 10$ V, $I_{F(on)} = 10$ mA, $R_L = 100\ \Omega$		20	μs
* t_f	Fall Time (See Figure 6)		$V_{CC} = 10$ V, $I_{F(on)} = 10$ mA, $R_L = 100\ \Omega$		20	μs

MODEL 4N50

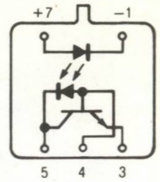
MAXIMUM RATINGS
(at 25°C unless otherwise noted)

*Isolation Voltage (Input-output-case)	1,500 VRMS
*Collector-Emitter Voltage (Base open)	40 V
*Collector-Base Voltage	40V
*Emitter-Base Voltage	4 V
*Input diode reverse voltage	3 V
*Input diode continuous forward Current @ 65°C ambient (See Note 4)	40 mA
*Continuous collector current	50 mA
*Continuous transistor power Dissipation @ 25°C (See Note 5)	300 mW
*Temperature Range, Operating & Storage	−55° to 125°C
*Lead soldering temperature, 10 SEC	260°C
*Peak input diode current (See Note 6)	1 A

MECHANICAL SPECIFICATIONS
*



ALL DIMENSIONS IN INCHES (MILLIMETERS)
TERMINAL NOS. FOR REFERENCE ONLY



SCHEMATIC
BOTTOM VIEW

TYPICAL CHARACTERISTICS

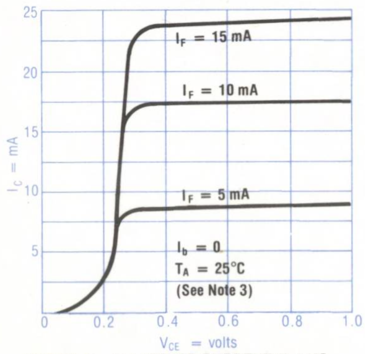


FIGURE 1 – COLLECTOR CURRENT (I_C) VS. COLLECTOR EMITTER VOLTAGE (V_{CE})

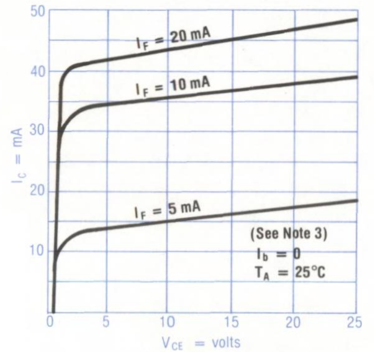


FIGURE 2 – COLLECTOR CURRENT (I_C) VS. COLLECTOR-EMITTER VOLTAGE (V_{CE})

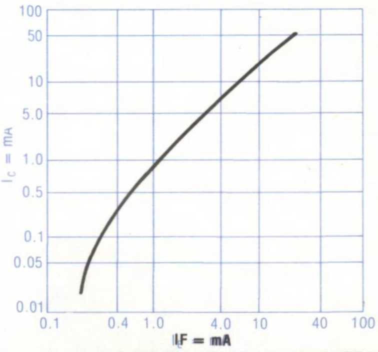


FIGURE 3 - PHOTOTRANSISTOR COLLECTOR CURRENT (IC) VS. INPUT DIODE FORWARD CURRENT (IF)

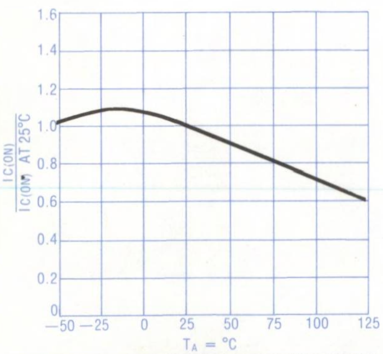


FIGURE 4 – NORMALIZED ON-STATE COLLECTOR CURRENT ($I_{C(on)}$) VS. FREE AIR TEMPERATURE (T_A)

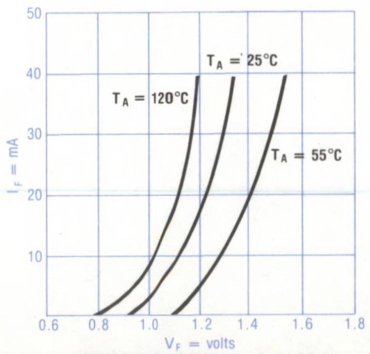


FIGURE 5 – INPUT DIODE FORWARD VOLTAGE (V_F) VS. FORWARD CURRENT (I_F)

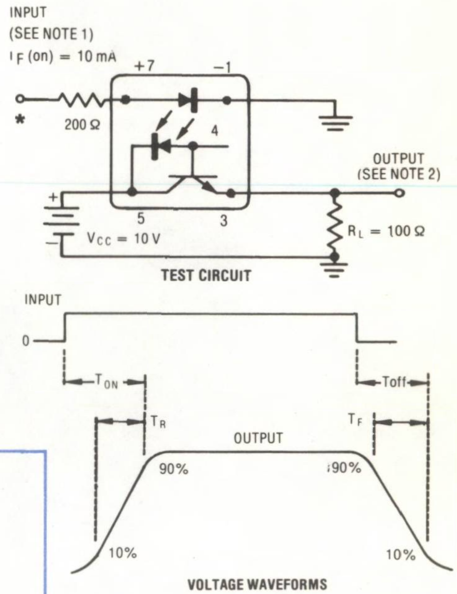


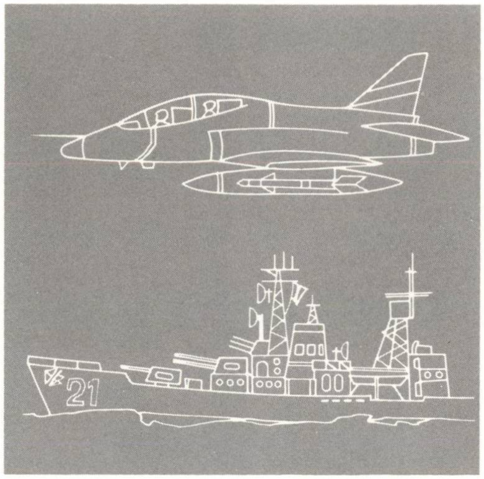
FIGURE 6 RESPONSE CURVES *

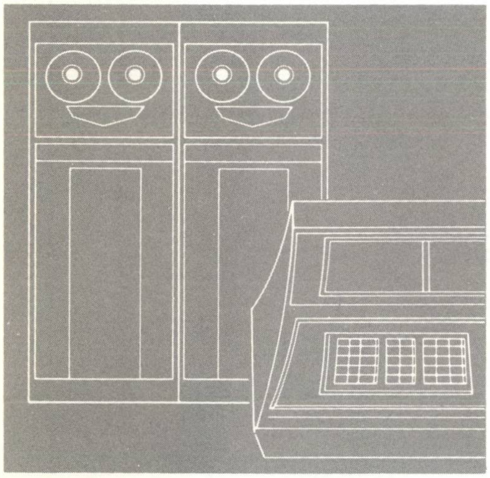
NOTES:

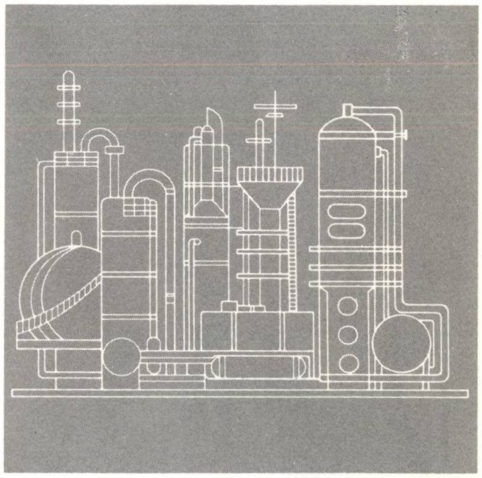
1. The input waveform is applied by a generator with the following characteristics: Z_{out} = 5 Ω
   $t_r \leq$ 15 ns, pulse width ≈ 100 μs
   duty cycle ≈ 1%
2. Waveforms are monitored on an oscilloscope with the following characteristics: t_r < 12 ns, R_{in} > 1 MΩ, C_{in} < 20 pf.
3. Parameters measured on 576 curve tracer.
4. Derate linearly to 125°C ambient at the rate of 0.67 mA/°C.
5. Derate linearly to 125°C ambient at the rate of 3 mW/°C.
6. This value applies for $T_W \leq$ 1 μs, PRR ≤ 300 PPS.
7. *Denotes JEDEC registered data.

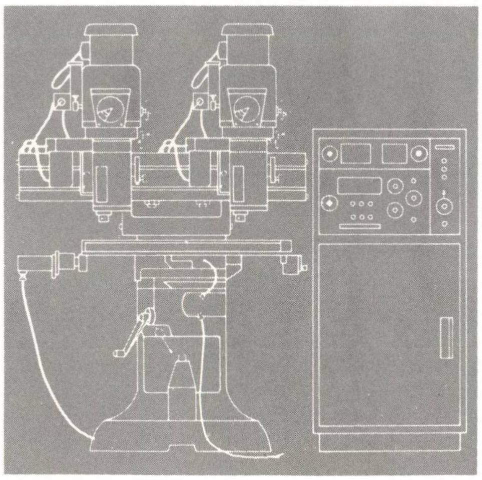
SECTION VII

Appendix

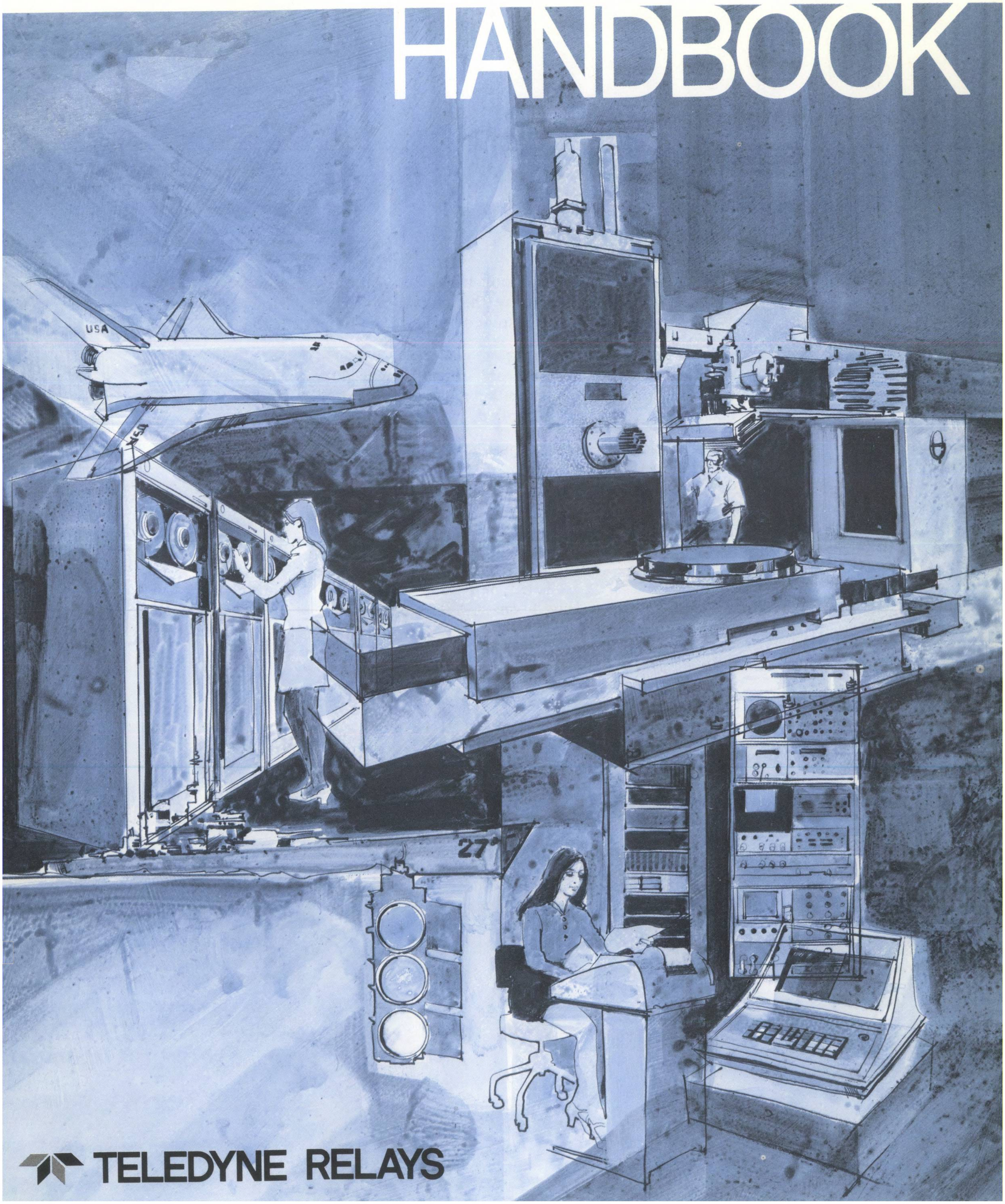








Solid State Relay Applications HANDBOOK



TELEDYNE RELAYS

The contents of this handbook have been carefully prepared by Teledyne Relays to assure their technical accuracy. However, no responsibility is assumed by Teledyne Relays for the consequences of their use.

All diagrams shown herein are intended as a guide to illustrate typical solid state relay applications and no patent licenses are conveyed or implied.

Teledyne Relays reserves the right to update and change the information contained herein at any time without prior notice. No portion of the SSR Handbook may be reproduced without the express written consent of Teledyne Relays.

Copyright © 1976
by
Teledyne Relays
Hawthorne, CA 90250

SOLID STATE RELAY APPLICATIONS HANDBOOK

An engineering guide to the selection and application of solid state relays

TELEDYNE RELAYS

12525 Daphne Avenue, Hawthorne, California 90250
Telephone (213) 777-0077
TWX 910-321-4610

EUROPEAN HEADQUARTERS
Abraham Lincoln Strasse 38-42
62 Wiesbaden, W. Germany
6121-700811
TELEX 04-186851 (TREL-D)

UNITED KINGDOM SALES OFFICE
Heathrow House
Bath Road, Cranford
Hounslow, Middlesex, TW59QP U.K.
TELEX 935008

FOREWORD

Prior to the development of semiconductor switching technology, electromechanical relays had been the mainstay for remote switching of electrical and electronic circuits. With the advent of the semiconductor switch, circuit designers were provided with a whole new spectrum of performance parameters not possible with electromechanical relays (e.g., high switching speed, greater reliability, longer life, smaller size). The one feature essential for many applications that was still missing, however, was electrical isolation between the control circuit and the circuit to be switched. The solid state relay fulfilled this requirement by combining the inherent advantages of semiconductor switching with the "coil-to-contact" isolation capability of the electromechanical relay.

It has become increasingly apparent to manufacturers as well as users that solid state relays, like any electronic components, have limitations that must be dealt with to assure reliable operation. These limitations do not necessarily preclude their use in most applications, but rather point to the fact that selection of the best relay for an application must take into consideration all of the critical parameters related to load conditions, transients, environment, method of mounting, etc.

This handbook has been prepared to provide those involved in selecting, specifying, testing, and procurement of solid state relays sufficient information to avoid the pitfalls of misapplication and to take full advantage of their many capabilities.

TELEDYNE RELAYS

TABLE OF CONTENTS

SECTION

1

1.0 INTRODUCTION TO SOLID STATE RELAYS

1.1 Definition of a Solid State Relay

A solid state relay (SSR) is an electronic switching device, utilizing either discrete circuitry or microelectronic techniques, that provides electrical isolation between the control circuit (input) and the load circuit (output) and that otherwise performs essentially the same remote switching function as an electromechanical relay (EMR).

1.2 Why Use Solid State Relays?

SSRs offer many advantages over electromechanical relays, depending upon the nature of the application. These advantages include:

a) Long life and high reliability
b) Logic compatability
c) Fast switching speed
d) Freedom from contact bounce
e) Reduction of electro-magnetic interference (EMI)
f) High surge current capability
g) High resistance to shock and vibration

Long Life and High Reliability

The very nature of an SSR, with its absence of moving parts and freedom from contact degradation due to arcing, provides the capability for inherently high reliability and long operational life. Compared to the usually well defined finite life of an EMR, typically 100,000 to 1,000,000 operations, SSRs have extremely long life expectancies closely related to the long life characteristics of semiconductor devices. This is, of course, dependent upon design techniques, selection of components for the SSR circuit, the quality surveillance program imposed by the SSR manufacturer, and the proper application of the SSR within its prescribed ratings.

Logic Compatability

SSRs are available with either AC or DC input ratings. DC input versions are by far the most common, and generally have low enough input power requirements to be compatible with most IC logic families, thus precluding the need for intermediate buffer or "relay driver" stages. For example, a typical Teledyne AC SSR (611 Series) with load current ratings at high as 40Amps requires a maximum of 6mA of control current at 5VDC.

Switching Speed

SSRs are available with switching speeds ranging from 8.3 milliseconds (typical specification limit for an AC SSR with zero voltage turn-on) down to the low microsecond region for lower current AC, DC, or bi-directional DIP SSRs (Teledyne Serendip® Series).

Freedom From Contact Bounce

The absence of moving contacts in an SSR provides the capability of bounce-free switching, which is an advantage when interfacing with logic circuits and other fast-acting loads.

Reduction of EMI

In addition to inherently low EMI generation due to the absence of contact arcing and bounce, AC SSRs offer two other features that contribute to substantially reduced EMI as compared to electromechanical relays. First, all AC SSRs turn off at zero current, which is an inherent characteristic of the thyristor output switching devices (triacs or SCRs). This is especially advantageous when switching inductive loads with respect to the reduction of back EMF transients. Secondly, most AC SSRs feature zero voltage turn-on (also known as zero crossover or synchronous switching). This feature provides that the line voltage is switched to the load only when it is close to zero (typically within ±12 volts), thus resulting in a very small step change in power with proportionately low EMI levels being generated.

High Surge Current Capability

AC SSRs offer the capability of withstanding high surge currents for relatively short durations, which makes them ideal for switching loads such as motors, transformers and lamps. Most AC SSRs have a one cycle peak non-repetitive surge current rating of ten times the steady state RMS rating.

DC SSRs can be designed to provide overcurrent surge capability, but only by using an "oversized" (or "over-rated") output transistor. This is due to the fact that power transistors are non-regenerative devices, which can be destroyed by overdissipation if the surge is prolonged. Surge ratings of over 400% for short durations (10 microseconds) have been achieved in some DC SSRs (Teledyne 603 Series).

High Resistance to Shock and Vibration

With no contacts to chatter or other moving parts to bind under extreme G levels, SSRs that are properly designed and packaged can typically withstand higher levels of shock and vibration than EMRs.

1.3 Types of Solid State Relays

SSRs can arbitrarily be classified in several ways:

a) Output switching capability (i.e., AC, DC, or Bi-directional)
b) Output current rating (high current or power vs. small signal)
c) Method of isolation (optical or transformer coupling)
d) Method of mounting (screw mounting to panel, chassis, or heat sink vs. direct pc board mounting)

1.4 The Anatomy of a Solid State Relay

An SSR consists basically of an input control/isolation circuit (analogous to the coil of an EMR) and a solid state output switching device (analogous to the EMR contacts). Input/output isolation is typically achieved by means of an opto-coupler or an oscillator-transformer combination. Both isolation techniques provide about the same degree of electrical isolation, which is now available up to 5000 volts. The input control voltage can either be DC or AC, in which latter case a rectifier/filter circuit is added ahead of the isolation circuit.

Most SSRs are specifically limited to switching either AC or DC, depending upon the type of output switching device employed. Thyristors, either triacs or back-to-back SCRs, are generally used for AC switching, while power transistors are best suited for DC switching. Teledyne model 640-1 Serendip® SSR, utilizing back-to-back transistors, features a bipolar output switching capability (either AC or DC) up to 50 volts and 80mA.

Many AC SSRs incorporate a zero voltage turn-on circuit that prevents the output thyristor from gating on until the voltage across the load is at or near zero (typically within ±12 volts). This results in a very small step change in power; hence, proportionately lower EMI levels are generated at the instant of switching. In addition, high in-rush currents associated with incandescent lamp loads are reduced considerably, which can extend lamp life.

The majority of SSRs available are single-pole-single-throw (SPST) normally open (analogous to a 1 form A electromechanical contact form). This stems mainly from the fact that multi-pole SSRs require duplication of most of the circuitry for each pole and, therefore, do not prove to be cost effective. In addition, thermal considerations relating to power dissipation in the output switching device dictate heat sinking areas, and hence package volume per pole, that would preclude there being any significant packaging advantage to multi-pole configurations.

Figures 1-1 and 1-2, respectively, show typical circuits for an optically coupled AC SSR and a transformer coupled DC SSR.

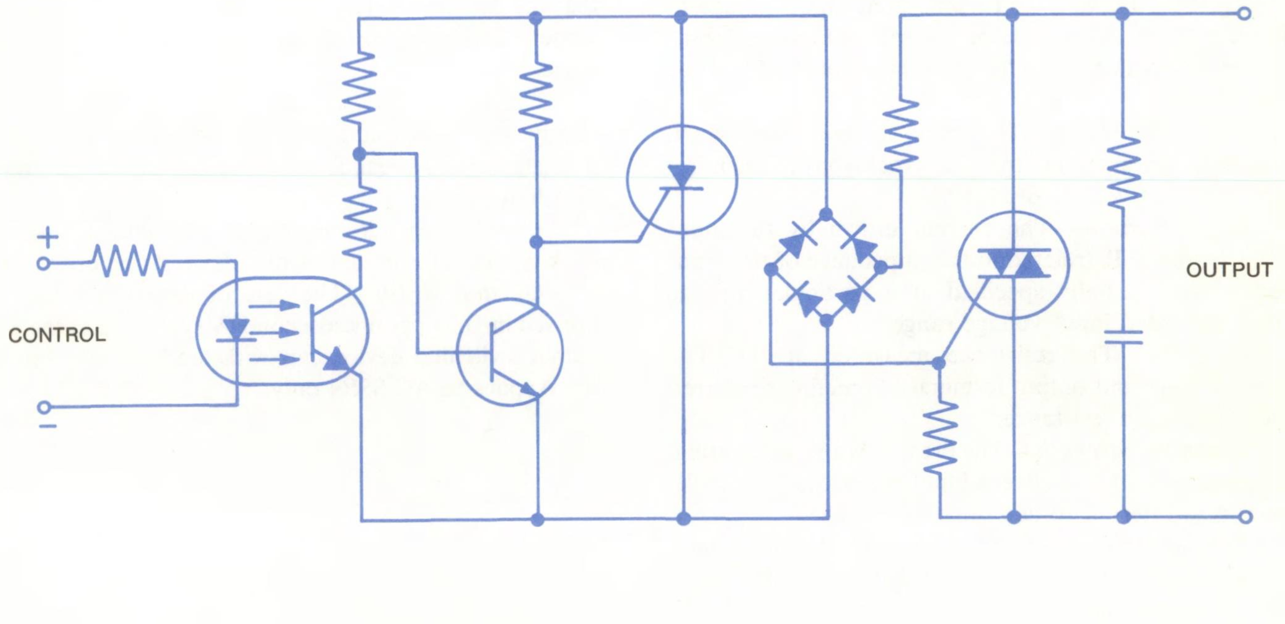


Fig. 1-1 Simplified schematic of optically-isolated AC SSR.

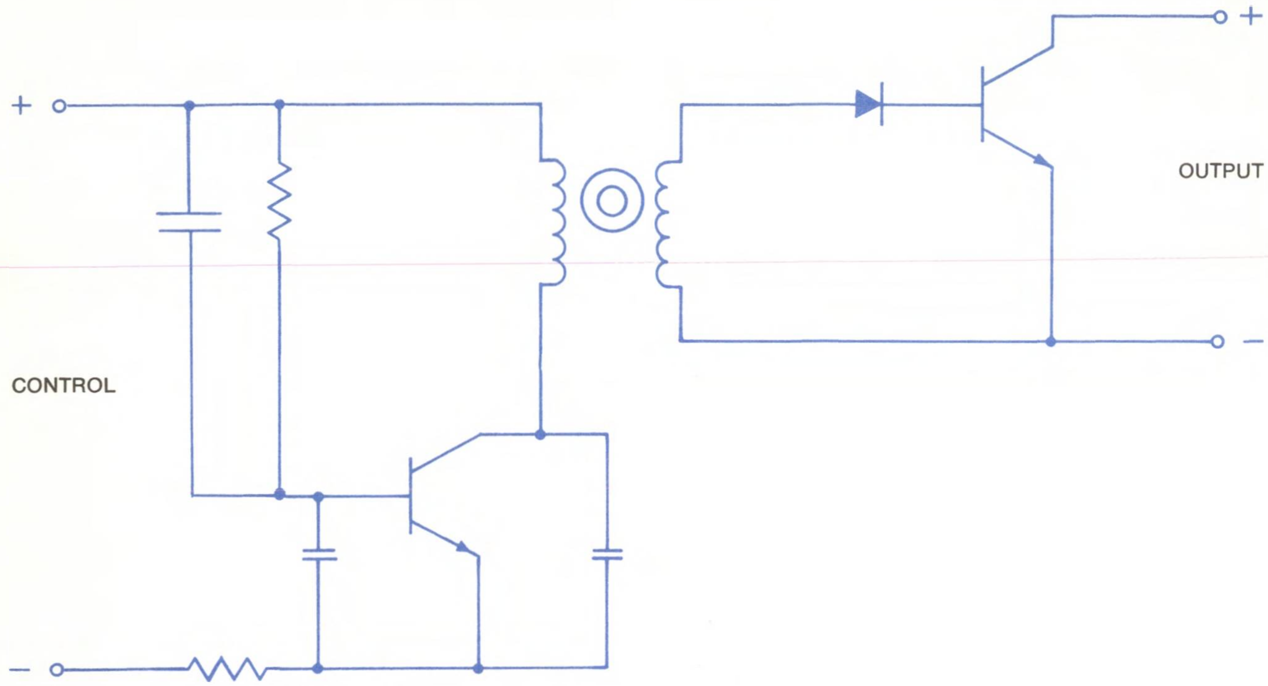


Fig. 1-2 Simplified schematic of transformer-isolated DC SSR.

1.5 Definition of Terms and Specification Parameters

Input (or Control) Voltage Range — The full range of input voltage over which the SSR will operate at 25°C unless otherwise specified.

Turn-on Voltage — The minimum input voltage to guarantee turn-on over the prescribed ambient temperature range. Analogous to the guaranteed pick-up voltage of an EMR.

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

Input Current — The current drawn by the input circuit of the SSR (related to the impedance of the input circuit). It is usually specified at a particular voltage within the rated input voltage range.

Isolation — The resistance measured at 500VDC between input and output terminals. Sometimes referred to as "insulation resistance."

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

Output (or Load) Current 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.

Surge Current 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.

Output (or Load) Voltage Rating — The maximum steady state load voltage that the SSR can withstand. It is related to the breakdown voltage rating of the output switching device.

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

Off-state dv/dt — The rate of rise of voltage, expressed in volts per microsecond (V/μsec.), that the SSR output switching device can withstand without turning on. Applies to AC SSRs only.

SECTION

2

2.0 APPLICATION OF SOLID STATE RELAYS

2.1 General

SSRs as alternatives to EMRs, combine the three-fold advantages of low control power requirements (i.e., logic compatibility), input/output isolation, and solid state switching reliability. Typical applications where solid state relays are used to advantage are:

a) Business Machines
b) Computers and Computer Peripherals
c) Industrial Control Systems
d) Machine Tool controls
e) Digital Process Control Systems
f) Film Processing Equipment
g) Batch Weighing and Processing Systems
h) Medical Electronic Equipment
i) Test Equipment and Instrumentation
j) Communications Equipment

2.2 Specifying the Solid State Relay

2.2.1 Input Specifications

When driving SSRs directly from 5-volt digital logic circuits, which is perhaps the most common mode of operation, the recommended method is to "sink" the SSR input to ground through the interfacing logic gate as shown in Fig. 2-1. The obvious considerations in selecting and specifying the SSR input characteristics are voltage and current requirements:

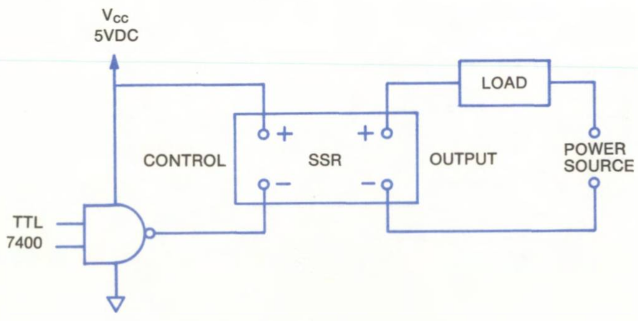


Fig. 2-1 Driving SSR from digital logic.

a) The current sinking capabilities of the gate must be sufficient to handle the maximum input current of the SSR. This is normally specified at a particular input voltage level (usually 5VDC) and also at the maximum rated input voltage of the SSR.

b) The SSR input voltage range must be broad enough to assure that the relay will operate under the worst case conditions of Vcc variation over the ambient temperature range.

Other logic families, such as CMOS and HiNIL, or discrete drivers can be used to drive SSRs as long as the SSR input voltage and current conditions are met.

AC input SSRs normally present no difficulties in terms of input requirements, since AC power sources usually have more than adequate drive current capacity and most AC input SSRs have broad enough input voltage ranges to assure operation at minimum low line voltage conditions.

2.2.2 Output Specifications

a) Steady State Current

All SSRs, AC and DC types alike, have well defined maximum steady state load current ratings relating directly to the maximum junction temperature rating of the output switching device (thyristor or transistor). Typical thyristor maximum junction temperatures are 100° to 110°C, while transistor maximum junction temperatures are typically 150°C. Since it is impractical for the user to readily measure semiconductor junction temperatures under operating conditions, thermal data is on the SSR data sheet. This data is provided to assure that the maximum operating conditions of current and ambient temperature are within the capability of the SSR, or to assure that an SSR with a high enough current rating is selected.

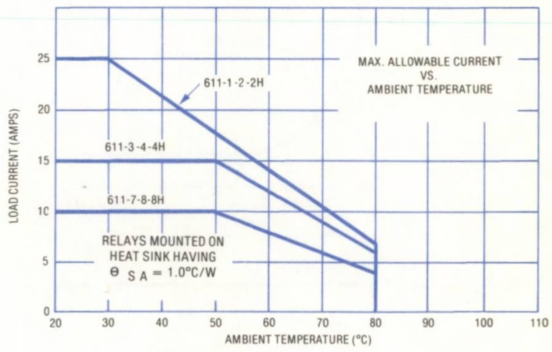


Fig. 2-2 Typical thermal derating curve for AC SSR (Teledyne 611 Series).

Thermal derating curves define allowable load current vs. ambient temperature. Figure 2-2 shows a typical thermal curve for a heat sink mounted AC SSR. For SSRs designed expressly for pc board mounting where no external heat sinking is required, the thermal curves provided on the SSR data sheet are usually sufficient to establish thermal derating conditions. For SSRs designed to be mounted on a heat sinking surface (panel, chassis or actual heat sink), thermal derating curves are somewhat limited in their usefulness since they are based on specifically defined typical heat sinks. As such, they are frequently used only as guidelines, since the actual heat sinking available in a given application may not be equivalent to the typical heat sinks specified on the curves. Thermal derating calculations are discussed in detail in Section 2.3.

b) Surge Current

The high surge current capability of AC SSRs makes them ideal for controlling loads such as motors, transformers, and lamps. Most AC SSRs have a one cycle peak non-repetitive surge current rating of ten times the steady state RMS rating. A typical surge current rating curve is shown in Fig. 2-3. It should be noted that the

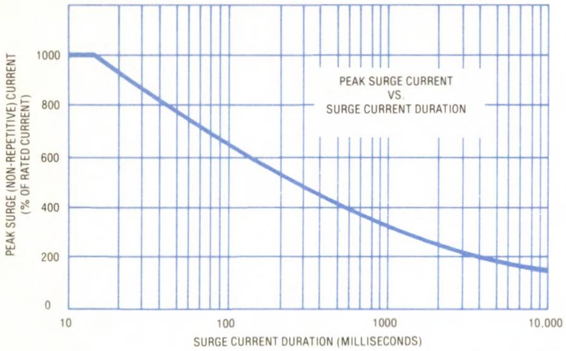


Fig. 2-3 Typical AC SSR surge current rating curve.

curve represent the loci limits of a peak current step function and does not define the shape of the allowable current surge. It should also be pointed out that during the surge current interval, gate control of the output thyristor may be lost for a few cycles until the junction cools down. It may not be possible, therefore, to turn off the SSR by removal of the control signal during and immediately after the surge. Underwriters Laboratories, Inc. takes this into consideration in its conservative motor and lamp load ratings, which are typically 25% and 40%, respectively, of the steady state rating.

Some DC SSRs have a specified overcurrent surge capability made possible by the use of an over-sized output transistor. Fig. 2-4 shows a typical DC SSR surge current duration curve (Teledyne 603 series).

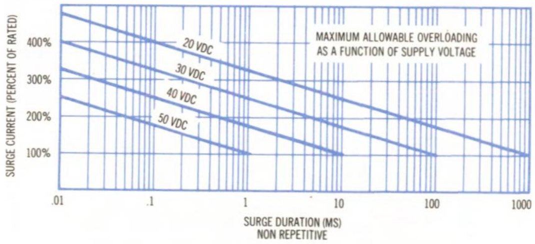


Fig. 2-4 Typical DC SSR surge current rating curve (Teledyne 603 Series).

Another way to cope with the surge current condition in DC switching circuits is by use of DC SSRs having controlled response times (Teledyne models 603-21 and -22). In these devices, the rise and fall times of the voltage across the load are extended by a factor of approximately 20. The longer rise time causes a substantial reduction in the in-rush current associated with the lamp loads. Figure 2-5 illustrates the reduction in in-rush current that can be achieved when switching a typical 40 watt lamp load with a controlled response time SSR.

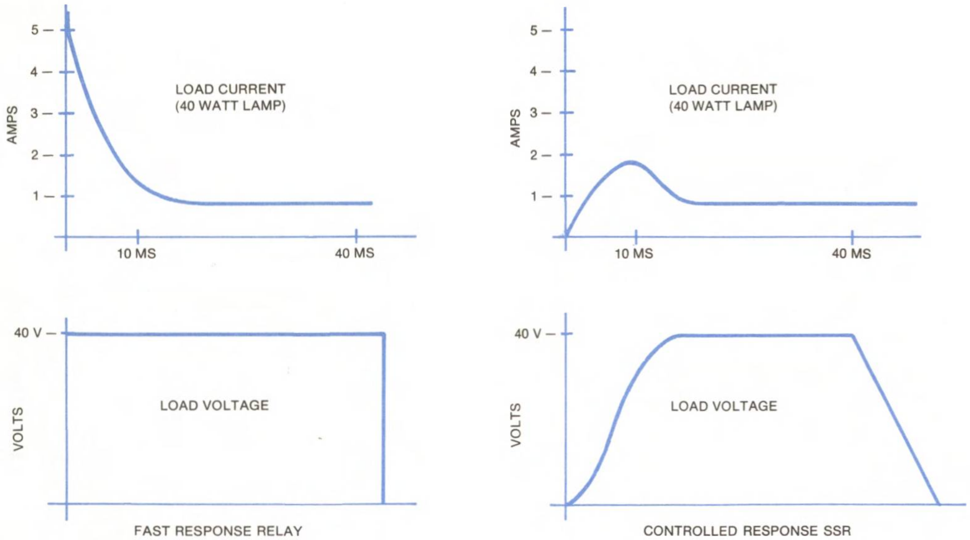


Fig. 2-5 Effect of controlled-response-time DC SSR driving lamp loads.

c) Leakage

Since the SSR output switching device is a semiconductor, there is always some leakage current in the "off" or non-conducting state. The drive circuitry of opto-isolated, zero crossing AC SSRs also contributes to this leakage. A third contributor, usually built into AC SSRs, is the RC "snubber" network, used to improve dv/dt and commutating characteristics. If external snubbers are added, the value of the capacitor should not be too large since it provides AC coupling into the load.

Off-state leakage current is usually specified as a maximum value for a particular load voltage over the full temperature range. For opto-coupled AC SSRs the off-state leakage is in the order of 8mA maximum (at 140VRMS). With transformer coupling, this figure is typically less than 5mA (or 2mA without a snubber).

Optically coupled DC SSRs exhibit leakage currents of approximately the same magnitude as their AC counterparts, while transformer coupled versions can have leakage currents in the low microampere region (less than 60 microamps in the Teledyne 643 Series). Off-state leakage current is inherently lower in the transformer coupled versions since bias currents for the output switching device are provided by the control signal rather than through the load.

d) Output Voltage

Steady State – AC SSRs designed for use in 120VRMS applications are normally rated at 140VRMS maximum and utilize output thyristors rated at 200V peak breakdown. SSRs designed for 220VRMS applications are normally rated at 250VRMS maximum and utilize output thyristors rated at 400V peak breakdown. AC SSRs with 600-volt ratings are also available (Teledyne "H" versions) for added safety from excessive "high line" conditions or where transient spikes are present. Some designers prefer to specify the higher voltage ratings even for 120VRMS applications for the added safety factor they provide.

Transients – If the breakdown (or peak blocking) voltage rating of an AC SSR is exceeded, the output thyristor will "anode fire" and the relay will turn on or "false trigger." This is attributable to self-induced bias by means of leakage into the gate, as opposed to "punch-through" which is permanent. In many applications this is undesirable and can even be dangerous in the case of industrial control equipment. If transient conditions are present and false triggering is to be prevented, the SSR must have a high enough peak blocking voltage rating (such that the maximum peak line voltage plus the superimposed transient voltage is still within the blocking voltage rating). Otherwise external transient suppression must be employed, which will be discussed in detail in Sec. 2.4.

2.2.3 Isolation Specifications

There are three parameters that relate to input/output isolation: resistance, voltage, and capacitance.

a) Resistance – Normally referred to as "isolation" or "insulation resistance," it is the leakage resistance typically measured at 500VDC between input and output terminals. It can also be specified between input and case and output and case, for a metal cased or metal based package. A typical specification limit which is sufficient for most applications is 10^9 ohms minimum.

b) Voltage – Normally referred to as "dielectric strength" or "isolation voltage," it is the breakdown voltage rating between input and output terminals. It can also be specified between input and case, and output and case for a metal cased or metal based package. A typical isolation voltage rating for an AC SSR is 1500VRMS, although higher ratings up to 3750VRMS are being specified where compliance with European specifications (i.e., VDE and IEC) is required.

c) Capacitance – Less frequently specified than resistance and voltage. Input/output capacitance of 10-20pf maximum is normally sufficient to assure that no appreciable noise is coupled from the load back to the input where it can have undesirable effects on interfacing logic.

2.2.4 Packaging Specifications

There are basically two styles of SSR packages: those designed for mounting directly on printed circuit boards, and those designed for mounting to a heat sinking surface such as a chassis, panel, or actual heat sink.

a) Printed Circuit Board Packages – Figure 2-6 shows a variety of standard SSR configurations designed expressly for pc board mounting. Since this involves essentially free air mounting without benefit of external heat sinking, pc board mounted SSRs are limited in their load current handling capacity to around 5Amps at room temperature.

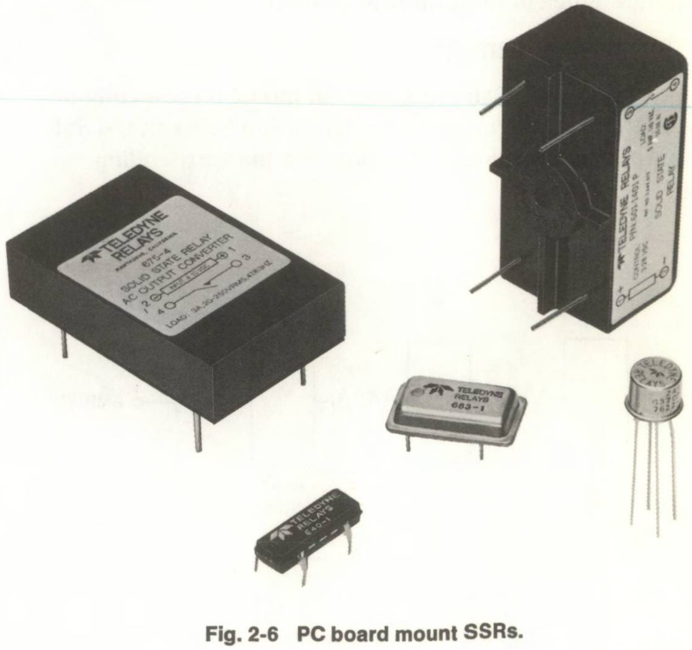


Fig. 2-6 PC board mount SSRs.

Fig. 2-7 Chassis mount SSRs.

b) Heat Sink Mounted Packages – Figure 2-7 shows a variety of standard SSR configurations designed for mounting to a heat sinking surface. These package styles require one or two mounting screws and feature screw terminals, quick disconnects, or dual purpose screw/quick disconnect terminals (Teledyne 611 Series). Thermally conductive grease should be used between the SSR mounting surface and the heat sinking surface to assure efficient uniform heat transfer.

2.3 Thermal Derating

Figure 2-8 shows a thermal model representing the heat flow and temperature relationship between the SSR output semiconductor junction and the surrounding ambient. Using the following equation, it is possible to calculate maximum safe load current, maximum allowable ambient temperature, junction temperature, or required heat sink size (expressed as thermal resistance) for any application:

$$T_J - T_A = P\theta_{JA} = P\,(\theta_{JC} + \theta_{CS} + \theta_{SA})$$

Where:

P = Power Dissipation = DI_L

and

T_J = Junction Temperature (°C)
T_A = Ambient Temperature (°C)
θ_{JC} = Thermal Resistance, junction to case (°C/watt)
θ_{CS} = Thermal Resistance, case to heat sink (°C/watt)
θ_{SA} = Thermal Resistance, heat sink to ambient (°C/watt)
D = Dissipation Factor for output semiconductor (watts/amp)
I_L = Load Current

T_J (max.), θ_{JC}, and D are specified on the SSR data sheet.

θ_{CS} is dependent upon how well the SSR is mounted to the heat sink surface. If the mounting surface is flat such that the SSR and the mating heat sink surface are in intimate contact and thermal conducting grease is used, θ_{CS} can be assumed to be approximately 0.2°C/watt.

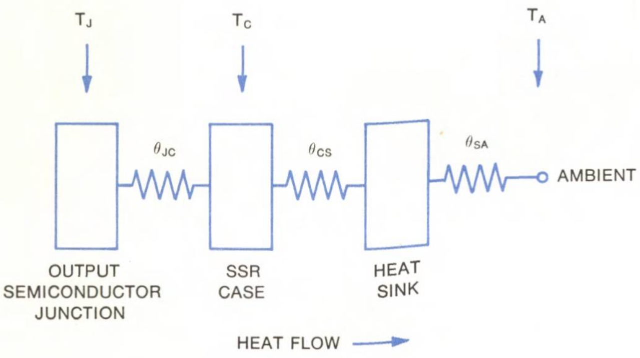


Fig. 2-8 Thermal model of SSR.

The following are thermal calculation examples:

Example A: To determine the maximum allowable load current, when the maximum ambient temperature and heat sink size are known.

SSR thermal characteristics from data sheet:

T_J (max.) = 100°C

D = 1.2 watts/amp

θ_{JC} = 1.1°C/watt

Known conditions:

T_A (max.) = 70°C

θ_{SA} = 1.0°C/watt

Calculations:

$$P = \frac{T_J - T_A}{\theta_{JC} + \theta_{CS} + \theta_{SA}}$$

$$= \frac{100 - 70}{1.1 + 0.2 + 1} = 13.04 \text{ watts}$$

$$I_L = \frac{P}{D} = \frac{13.04}{1.2} = 10.86 \text{ Amps}$$

Example B: To determine the maximum allowable ambient temperature, when maximum steady state load current and heat sink size are known. (Assume same SSR thermal characteristics as in Example A.)

Known conditions:

I_L = 5.0 amps

θ_{SA} = 1.0°C/watt

Calculations:

$P = DI_L = 1.2 \times 5.0 = 6.0$ watts

$T_J - T_A = P\,(\theta_{JC} + \theta_{CS} + \theta_{SA})$

$= 6\,(1.1 + 0.2 + 1) = 13.8$

$T_A = T_J - 13.8 = 100 - 13.8$

$= 86.2°C$

Example C: To determine the required heat sink size (expressed as thermal resistance), when the maximum ambient temperature and steady state load current are known. (Assume same SSR thermal characteristics as in Examples A & B)

Known conditions:

I_L = 8.0 Amps

T_A (max.) = 50°C

Calculations:

$P = DI_L = 1.2 \times 8.0 = 9.6$ Watts

$$\theta_{SA} = \frac{T_J - T_A}{P} - (\theta_{JC} + \theta_{CS})$$

$$\theta_{SA} = \frac{100 - 50}{9.6} - (1.1 + 0.2)$$

$= 3.9°C/watt$

For a given load current, one can also compute the maximum allowable case temperature for any ambient temperature conditions, and then provide sufficient cooling and/or heat sinking to assure that this case temperature is not exceeded.

By substituting T_C (case temperature measured at a specified point on the relay mounting surface) for T_A and deleting θ_{CS} and θ_{SA}, the thermal equation can be rewritten as follows:

$$T_J - T_C = P\theta_{JC}$$

Example:

For the same AC SSR used in the previous examples, at a load current of 5.0 Amps:

$P = DI_L = 1.2 \times 5.0 = 6$ Watts

$T_J - T_C = P\theta_{JC}$

$100 - T_C = 6 \times 1.1$

$T_C = 100 - 6.6 = 93.4°C$

Figure 2-9 shows a typical 1.3°C/watt aluminum heat sink with a Teledyne 611 Series AC SSR mounted. Where the SSR is mounted to an aluminum panel or

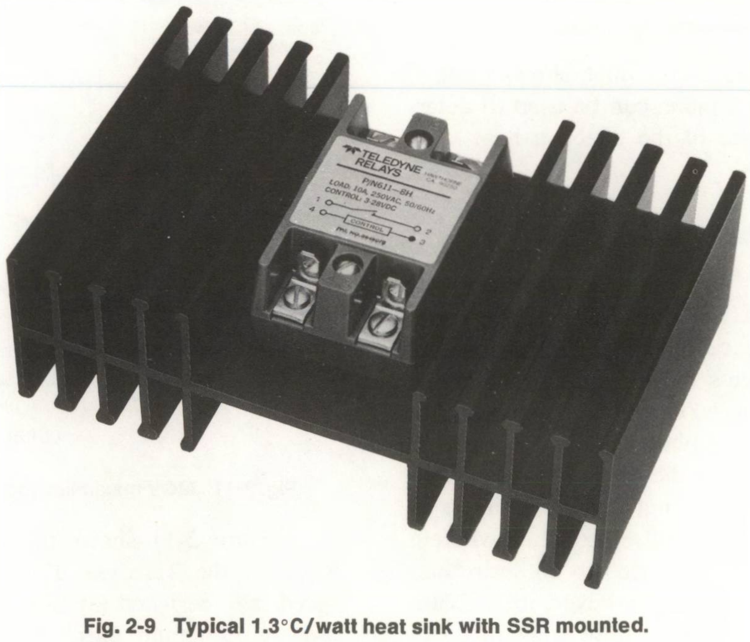


Fig. 2-9 Typical 1.3°C/watt heat sink with SSR mounted.

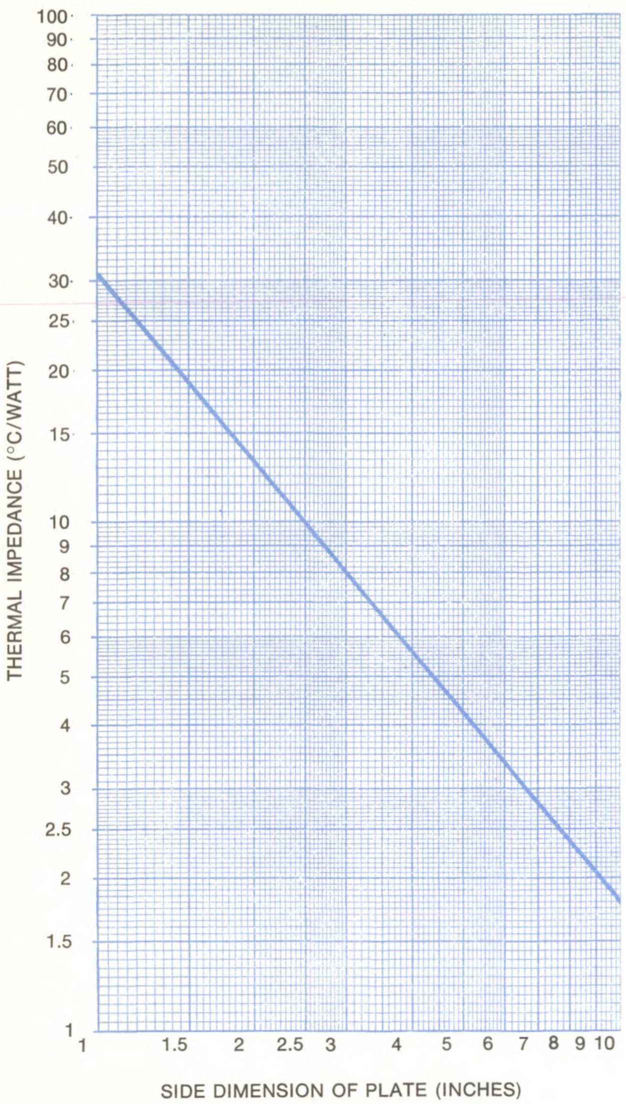


Fig. 2-10 Thermal impedance of square aluminum plate, ⅛″ thick.

chassis, the graph in Figure 2-10, which shows thermal resistance of ⅛″ aluminum plate, can be used to determine the thermal resistance of the effective heat sinking area.

2.4 Transient Suppression

2.4.1 AC Applications

False triggering of AC SSRs can be caused by over voltage transients which exceed the peak voltage rating of the relay, or by transients having a high rate-of-rise which exceeds the off-state dv/dt rating of the relay. In either case the false triggering phenomenon is not necessarily destructive to the SSR in the case of lower current loads. The reason is that the output thyristor, due to its regenerative nature, acts as a pulse stretcher wherein the briefest transient can be expanded to an entire half cycle of line voltage. Conversely, however, in the case of higher current loads, repetitive false triggering can cause degradation and eventual failure of the SSR. From an application standpoint false triggering can usually be tolerated when switching lamp or heater loads, and in fact may never be detected since the false triggering results in the SSR turning on for a maximum of a half cycle. In the cases of fast acting inductive loads such as solenoid actuators, however, false triggering could become a problem.

a) Suppression of Overvoltage Transients

With AC SSRs, brief over-voltage transients are somewhat reduced by the internal RC snubber network, depending upon its time constant. A more complete solution, however, involves employment of a transient clipper such as a metal oxide varistor (MOV) across the output terminals of the SSR. The MOV is a bi-directional voltage sensitive device that assumes a low impedance state when its design voltage threshold is exceeded. It offers the additional advantages of small size, low cost, and ease of installation.

Care must be taken in the selection of the proper SSR/MOV combination to ensure that there is sufficient safety margin between the maximum line voltage and the breakdown voltage rating of the SSR, otherwise the MOV could be totally ineffective. The MOV should be in its fully conductive state at a voltage less than the specified peak voltage rating of the SSR and in the high impedance state below the maximum peak line voltage. Thus, when using an MOV rated for nominal line voltage, a relay with an output rated for the next highest voltage should be selected. For example, on a nominal 115VAC line, an SSR with a 400V peak rating should be used instead of the usual 200V unit. Likewise, at 220VAC an SSR with a 600V peak rating instead of 400V should be used.

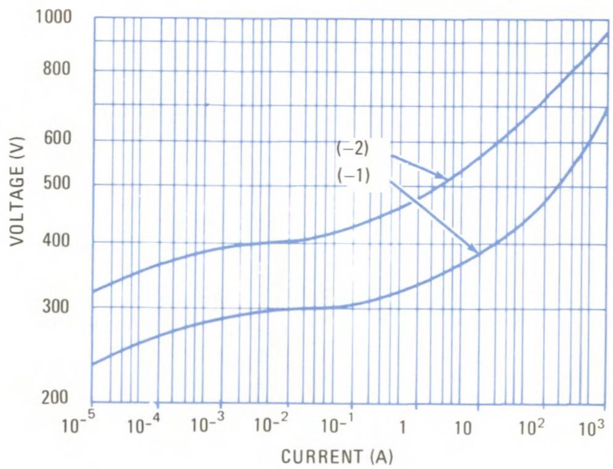


Fig. 2-11 MOV maximum volt-ampere characteristics.

Figure 2-11 shows the voltage-current characteristics for the Teledyne 970 Series of MOVs that are specifically designed for use with AC SSRs. The curves show a minimum current clamping capability of 20 amperes at the SSR peak voltage ratings of 400 and 600 volts. For these MOVs, the maximum line transient, V_P, which can be clipped without thyristor voltage breakdown is given by:

$$V_P = 20\,R_L + 400 \text{ (for the model 970-1)}$$
$$V_P = 20R_L + 600 \text{ (for the model 970-2)}$$

where R_L = load + source impedance

b) Off-state dv/dt

The rate effect phenomenon in thyristors is caused by capacitive coupling within the device between the high terminal and the gate, which can cause self-induced turn-on bias if the rate-of-rise of forward voltage (dv/dt) limits are exceeded. An internal RC snubber network across the output thyristor is employed to improve the transient immunity of the SSR. An off-state dv/dt rating of 100 volts/microsecond minimum is considered to be acceptable for most applications.

In order for the specified dv/dt rating of an SSR to be meaningful, it is necessary to define realistic test conditions, principally with regard to load and source impedance. Teledyne Relays uses a 50 ohm resistance in series with the SSR under test to represent an assumed load and source impedance. These test conditions have been proposed as an industry standard for inclusion in a joint EIA/NARM SSR relay specification. Incidentally, this resistance value could be set arbitrarily higher to give an implied higher, but unrealistic, dv/dt rating.

There exists a phenomenon that can occur when main AC power is applied to a system through closure of a mechanical contact whereby steep switching transients are generated. The rate-of rise of such transients can greatly exceed the dv/dt rating of a standard AC SSR, which would result in false triggering of the SSR for a half cycle. If this occurs and is deemed to be objectionable, external suppression circuitry must be employed. Figure 2-12 shows a suppression circuit designed specifically to eliminate this problem.

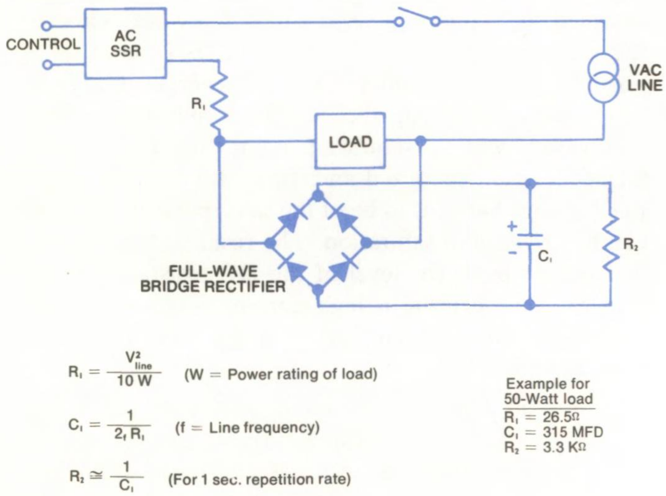


Fig. 2-12 dv/dt suppression circuit.

2.4.2 DC Applications

DC SSRs are equally as susceptible to over-voltage transients as their AC counterparts, while dv/dt is not a factor. Since the output switching semiconductors used in DC SSRs are non-regenerative devices, however, they will not latch on when false triggered, as a thyristor does for a half cycle. Figure 2-13 illustrates the two basic approaches to transient suppression in DC circuits — applying the suppression at the source of the transient, as in the case of back EMF transients generated on turn-off of an inductive load, and applying the suppression directly across the SSR output terminals.

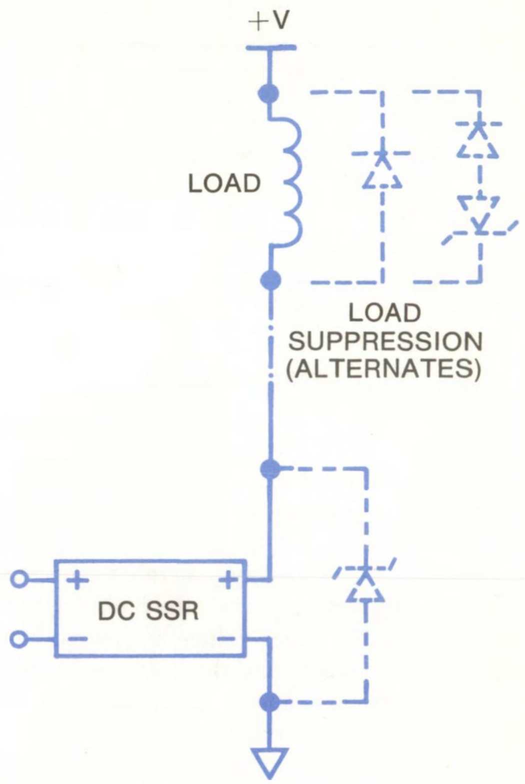


Fig. 2-13 Transient suppression for DC SSRs.

The classic "arc suppression" diode shunting the load is the simplest and most effective technique for suppressing transients generated in inductive loads. The disadvantage in this method lies in the fact that the diode slows down the response time of the load, which may be undesirable in some cases. This disadvantage can be overcome by using a zener in series with the diode, which provides clamping at the zener voltage level without prolonging the response time of the load. The zener voltage plus the operating load voltage should be less than the SSR breakdown voltage rating.

Another method of transient suppression in DC switching circuits involves the use of the controlled response time DC SSR. In this case, the extended fall time of the load current can result in a significant reduction in the back EMF transient generated when an inductive

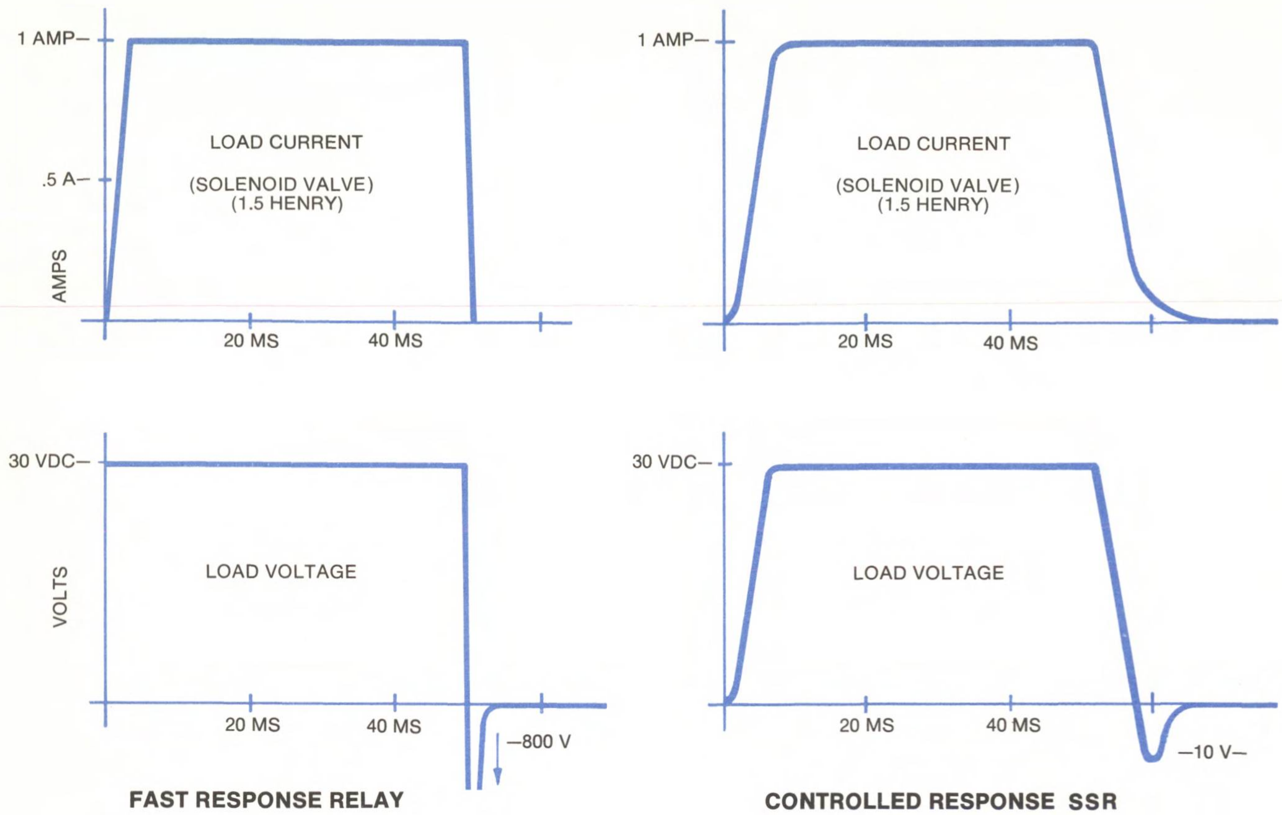


Fig. 2-14 Effect of controlled response time DC SSR driving inductive load.

load is switched off. Figure 2-14 illustrates this effect on the switching transient generated in a 1.5 henry solenoid valve.

If there are externally generated transients on the DC line, a zener clamp across the SSR output terminals must be used. The zener voltage should be between the operating load voltage and the SSR breakdown voltage. Under some circumstances, it may be desirable to use transient suppression across both the SSR and the load.

2.5 Inductive Load Switching

Switching inductive loads with AC SSRs can present certain conditions which must be dealt with to assure reliable performance.

These conditions and their respective solutions are discussed below.

2.5.1 Light Loads

Erratic turn-on can sometimes occur when AC SSRs are required to switch very low current inductive loads at low line voltages (under 50 VRMS). This is due to the load current failing to reach the holding current level of the output thyristor. This can be overcome by shunting the SSR output terminals with an additional RC snubber circuit. The capacitor discharge current will provide latching current early in the AC cycle holding the relay on until the load current can take over. Typical values for the RC snubber are 47 ohms and 0.5 microfarads.

Another possible problem area associated with low current inductive loads involves off-state leakage current. The inherent off-state leakage current of an AC SSR may be sufficient to prevent light solenoids and relays from dropping out. An acceptable solution is to shunt the load with an RC network to by-pass enough of the leakage current to provide normal drop-out of the load.

2.5.2 Transformer Loads

Transformers typically have a relatively high AC impedance and very low DC resistance and are usually designed for economy reasons, to operate very close to the saturation point on the magnetic BH curve. It is possible for a transformer, when last energized, to have been polarized leaving the core in a magnetized state somewhere near its saturation point. When the transformer is again energized and the first half cycle of applied voltage happens to be of the same polarity, the core can be driven into saturation. The result is that the impedance drops to the level of the DC resistance in the primary, thus causing a high current surge which can exceed the surge current rating of the SSR. Two solutions are possible:

a) Use an over-rated SSR that can safely handle the surge current.
b) Include some series resistance in the primary circuit to limit the in-rush current to within the surge rating of the SSR.

2.5.3 *Motor Loads*

Motor starting current and time, as well as surge currents resulting from locked rotor conditions, must be within the surge rating of the SSR. As with transformer loads, it may be necessary to employ a current limiting resistor or an over-rated SSR to assure that the surge current rating is not exceeded during start-up or under locked rotor conditions.

Motor reversing and braking are discussed separately in Section 2.6.

2.6 Special Solid State Relay Applications

In addition to simple on/off switching applications, SSRs can be used in a variety of other modes to perform special switching functions. The following circuits are presented as design guides and to stimulate further useful SSR applications.

2.6.1 *Reversing Control for Split Phase Motors (Fig. 2-15)*

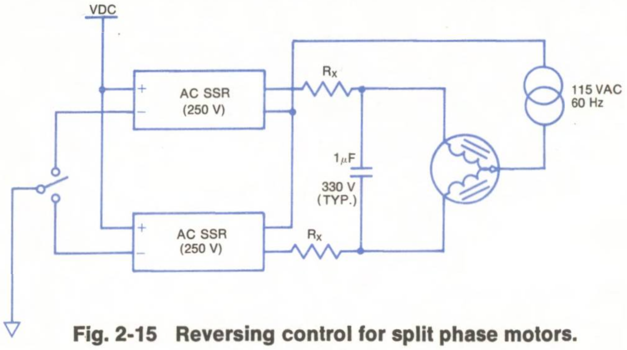


Fig. 2-15 Reversing control for split phase motors.

The LC phase shift causes twice line voltage to appear across the "off" relay, so the SSRs must be rated accordingly. The resistors are required to limit the capacitor discharge current when the motor is reversed. Resistor values can be calculated from the following:

$$R_X = 0.2 \frac{E}{I_R} \text{ ohms}$$

$$P = I_M^2 R_X \text{ watts (wattage rating of resistors)}$$

where: E = Peak line voltage
I_R = SSR current rating
I_M = Motor current

2.6.2 *Braking Control for Split Phase Motors (Fig. 2-16)*

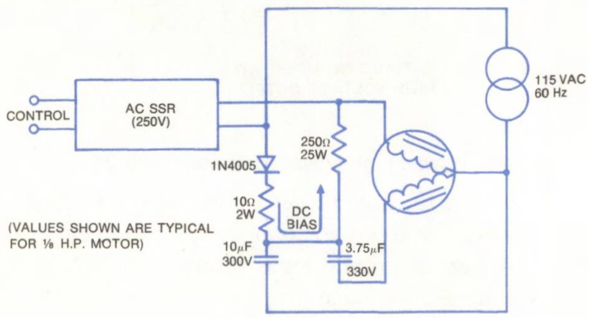


Fig. 2-16 Braking control for split phase motors.

A simple circuit is shown which will provide run and quick stop control of fractional horsepower split phase motors. This circuit provides a DC bias current to one winding to cause braking, yet provides proper AC relationships to exist during run conditions. Load voltage rating of the SSR should be twice line voltage due to the additive effect of the DC bias applied to the motor winding on turn-off.

2.6.3 *3-Phase AC Switching (Fig. 2-17)*

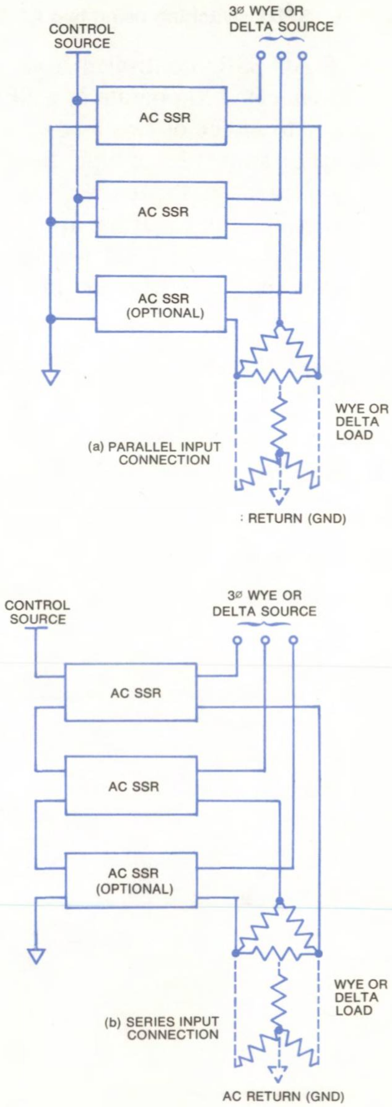


Fig. 2-17 3-Phase AC switching.

Three SPST AC SSRs can be used to control 3-phase loads from a single input control source. The SSR inputs may be connected in series or in parallel, and loads can either be wye or delta connected. In a 3-wire ungrounded wye or delta system, only two SSRs are required. In a 3-wire delta or ungrounded wye system, the SSR output voltage ratings must be high enough to safely handle line-to-line voltage levels.

2.6.4 *SPDT Switching (Fig. 2-18)*

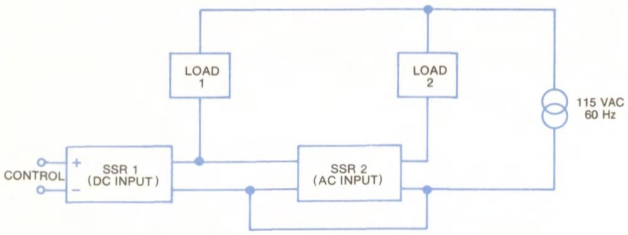


Fig. 2-18 SPDT switching using two AC SSRs.

Two SPST AC SSRs controlled from a single DC source, can be connected to operate as a SPDT relay to switch AC power to either of two loads. Note that one of the SSRs must be an AC input type. Because of overlap (make-before-break), the power source must be capable of supporting both loads for approximately two cycles. Offstate leakage in load #1 will be equal to the offstate leakage of relay #1 plus the input current for relay #2.

2.6.5 *Driving High Power Thyristors (Fig. 2-19)*

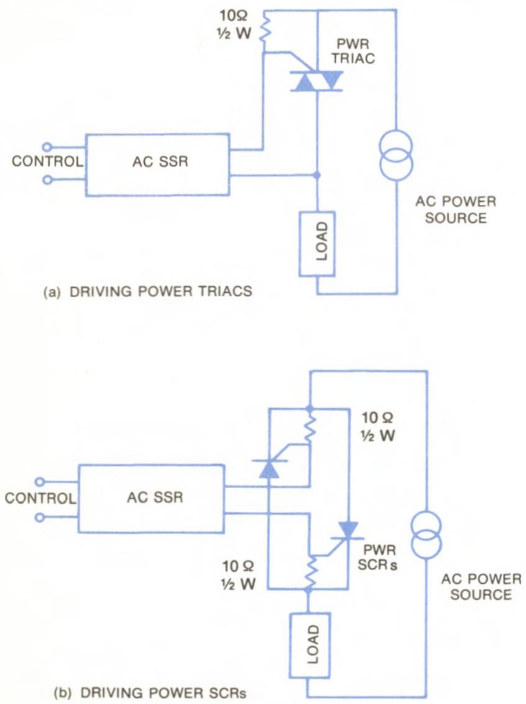


Fig. 2-19 Driving high power thyristors with low power AC SSRs.

Standard AC SSRs are available in maximum steady state current ratings up to 40 amperes. For switching higher current levels, Teledyne AC Serendip® SSRs have sufficient output switching capacity to drive the gates of most large high power thyristors. Non-shorted gate type SCRs should have a reverse diode between gate and cathode to prevent damage from reverse voltage. Current limiting resistors may be required in series with the SSR outputs for extremely high current loads. If zero voltage turn-on is required, Teledyne 601 or 675 Series can be used. Here gate resistors are required to bias off the higher off-state leakage currents.

2.6.6 *Driving High Power Transistors (Fig. 2-20)*

In the same manner that AC SSRs can be used to drive high power thyristors, DC SSRs can be used to drive power transistors for switching higher current or higher voltage loads. Teledyne 603, 643, and 675 Series DC SSRs are all suitable for this type of application depending upon the load current and voltage requirements and mounting considerations.

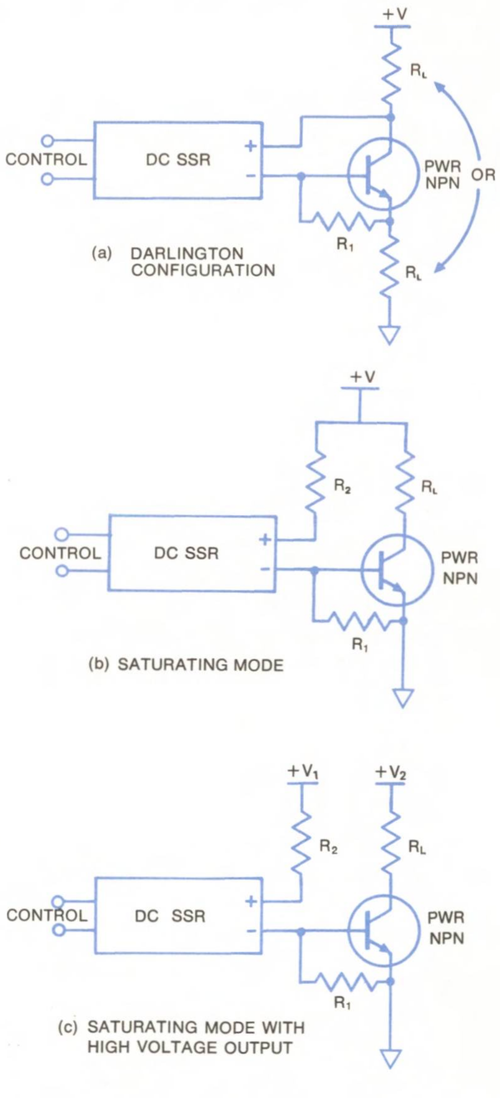


Fig. 2-20 Driving high power transistors with DC SSRs.

By driving the high power transistor in a Darlington configuration, the ability to connect the load in either the positive voltage or ground leg is retained, Fig. 2-20(a). For lower forward voltage drop resulting in lower dissipation, the output transistor is driven in the saturating mode, Fig. 2-20(b). In this configuration the load can only be connected in the collector leg (+), but if it is necessary that the load be in the ground leg a PNP transistor can be used (with the circuit reversed). Output voltages higher than the voltage rating of the SSR driver are permissible if a second supply is used, as shown in Fig. 2-20(c).

2.6.7 Latching AC SSR (Fig. 2-21)

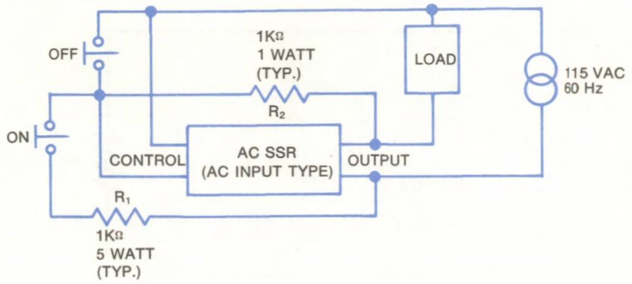


Fig. 2-21 Latching AC SSR.

An AC SSR can be made to self latch (at the sacrifice of input/output isolation), thus permitting the use of momentary action switches for on/off or stop/start operation. It may be necessary to insert an RC filter across the relay input to prevent the relay from turning on due to switching transients upon application of system power. Note that the SSR employed here must be an AC input type.

2.6.8 Switching AC Loads With DC SSRs (Fig. 2-22)

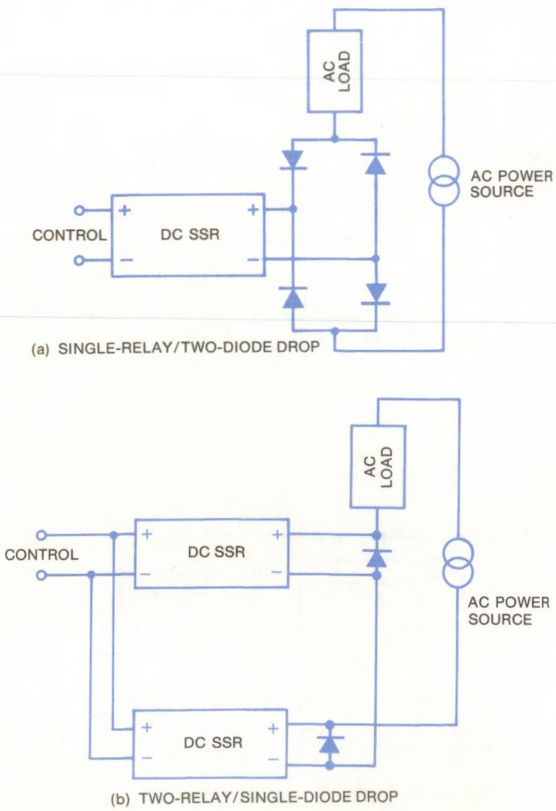


Fig. 2-22 Using DC SSR to switch AC loads in full-wave circuits.

AC loads can be switched using DC SSRs in a bridge configuration to achieve freedom from the effects of dv/dt. Another feature of this circuit is fast response (instantaneous on/off) as opposed to the delayed zero current turn-off inherent in thyristors. Teledyne 603, 643, and 675 Series DC SSRs can be used in this circuit depending upon the load current and voltage requirements and mounting considerations.

The full-wave bridge circuit of Figure 2-22(a) requires only a single relay, but adds a two diode drop to that of the relay, which could be a problem in lower voltage AC circuits. The circuit of Figure 2-22(b) has only one added diode drop but requires the use of two relays.

2.6.9 Circuit to Null Out Offset Voltage of Teledyne Serendip® Model 640-1 SSR (Fig. 2-23)

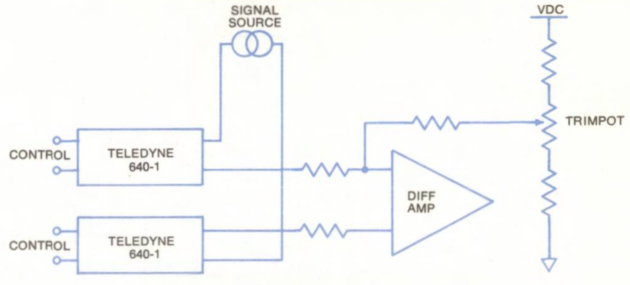


Fig. 2-23 Circuit to null out offset voltage of Teledyne 640-1.

This analog dual switching circuit shows a typical balanced differential amplifier input with a variable divider to null out offset voltage. The offset voltage can be nulled to zero at a given temperature, but may require adjustment for temperature changes. The same approach can be used with a single 640-1 SSR.

2.6.10 Bounce Suppression and Latch Circuit (Fig. 2-24)

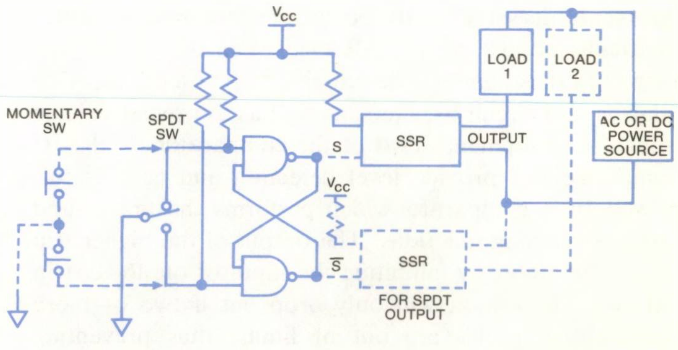


Fig. 2-24 Bounce suppression and latch circuit.

The dual latch is the simplest bounce suppression circuit, but requires double throw style contacts to operate. The circuit will trip on the leading edge of the input signal thus preventing bounce. By adding a second SSR to the inverted output a SPDT output is provided. Each SSR should have an individual load, rather than a single load switched between two sources because of possible overlap (make-before-break) .The bounce-free feature may be useful with DC SSRs (AC thyristor types are self latching). The flip-flop function may be applied to any SSRs, while observing the above precautions. The inputs can either be alternately pulsed with logic ground signals or by means of momentary action switches.

2.6.11 Over/Under Voltage Sensor (Fig. 2-25)

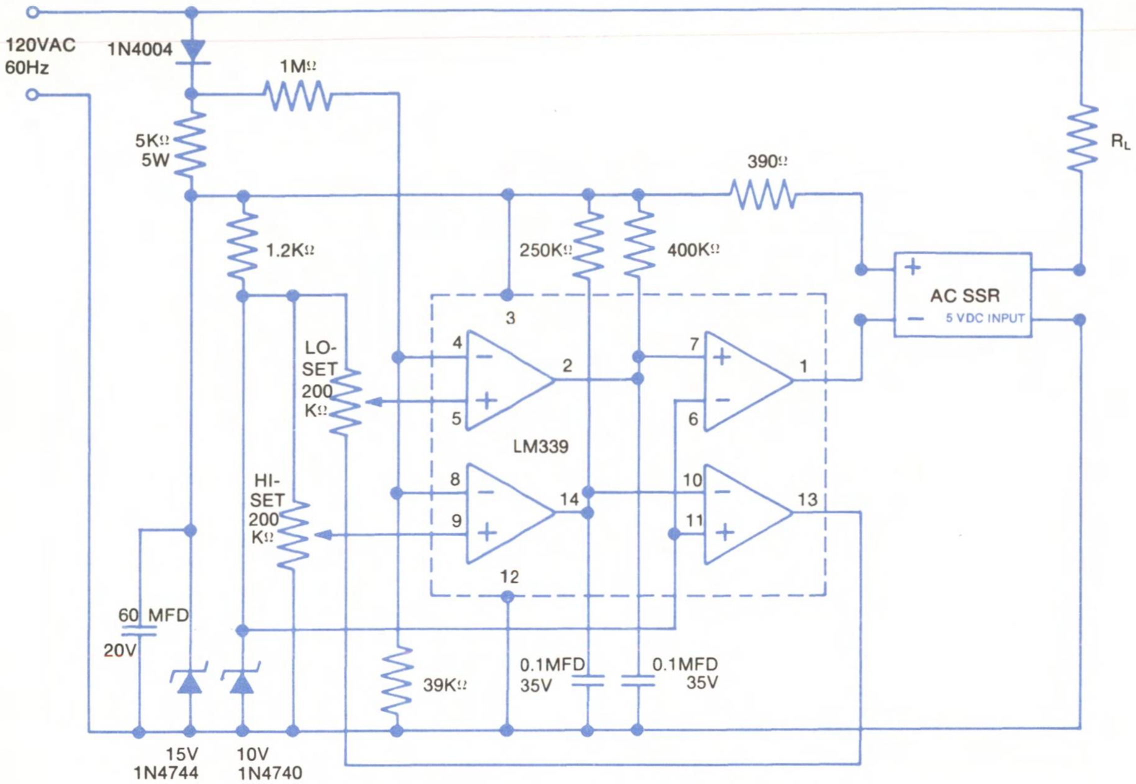


Fig. 2-25 Over/under voltage sensor.

The output SSR opens if line voltage exceeds the pre-set limits set up by the potentiometers. Power is automatically applied to the SSR load when the line voltage is within these limits. The circuit can be used to operate alarms and circuit breakers, as well as to protect voltage sensitive equipment. Two of the comparators in the IC quad package provide level detection and each is followed by a comparator which performs the timing and pulse stretching functions. The output of the higher trip circuit operates by inhibiting the input of the lower trip circuit. The output will only drop out if two or more consecutive cycles are out of limits, thus preventing "transient tripping." This period may be extended by increasing the timing capacitor values.

2.6.12 Multivibrator/Flasher Driver for SSRs (Fig. 2-26)

The IC timer provides a 50% duty cycle multivibrator drive for SSRs with DC inputs. The frequency of oscillation is determined by the RC time constant and may be adjusted by making R_1 variable. The timer output can be used to drive many SSRs in parallel, either in the source or sink mode, up to its 200 mA limit. An additional SSR connected as shown will provide alternating outputs.

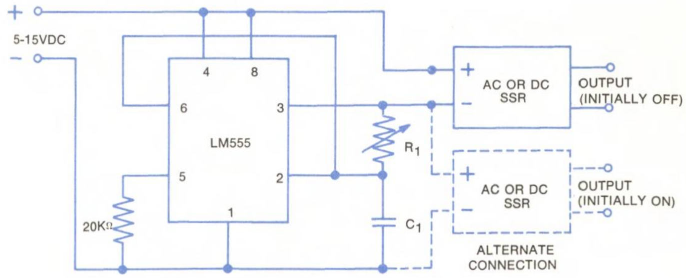


Fig. 2-26 Multivibrator/flasher driver for SSRs.

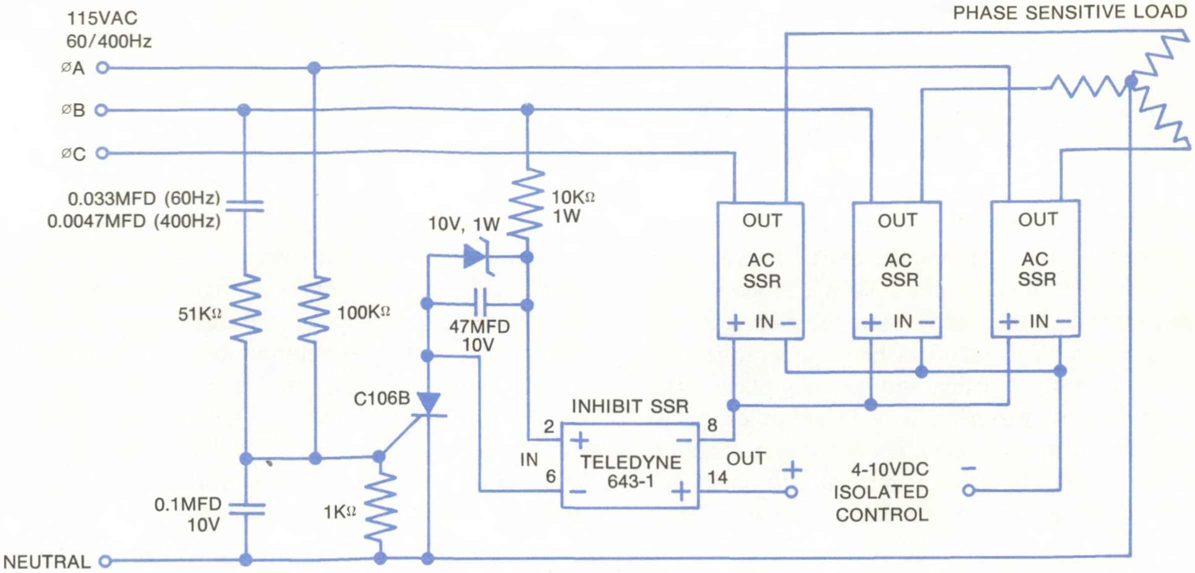


Fig. 2-27 Phase sequence detector.

2.6.13 Phase Sequence Detector (Fig. 2-27)

This circuit prevents damage to the load due to incorrect phasing. The three power SSRs are only permitted to turn-on for a phase sequence of phase A leading phase B. If phase A lags phase B the input currents will cancel, causing the SCR and the "inhibit" SSR to remain off until the sequence is reversed. This circuit illustrates how SSRs when controlling power lines may be gated at their inputs to provide additional logic functions. Voltage sensors, time delays, etc. may be similarly added. The inhibit SSR is included in this circuit to maintain isolation at the input for other control functions.

2.6.14 Time Delay Driver for SSRs (Fig. 2-28)

With input voltage applied, the IC timer provides a variable width "one-shot" output, for each momentary closure of SW1. The timing period is determined by the RC time constant of R_1 and C_1 and is independent of supply voltage. With SW1 permanently closed the circuit will function as a "time-delay-on-operate" for each application of input voltage. In either mode of operation, the "normally closed" SSR closes when the input voltage is applied.

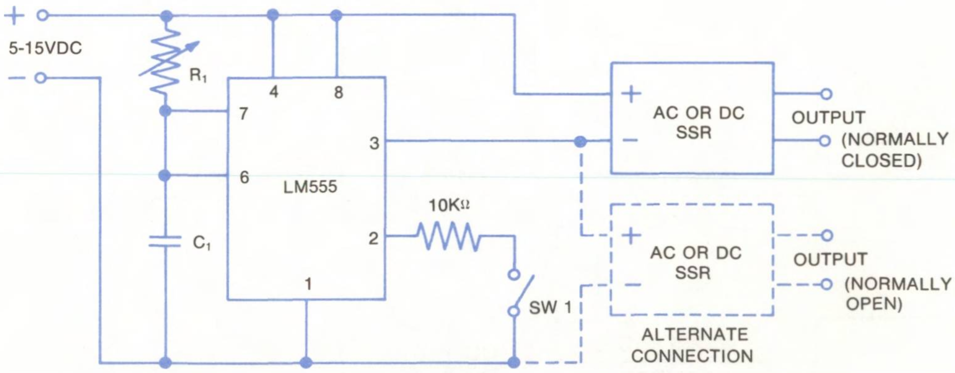


Fig. 2-28 Time delay driver for SSRs.

SECTION

3

3.0 I/O CONVERTER MODULES

Rapid advancements in computer technology in the last several years have brought about a virtual revolution in the field of industrial electronic systems. Process control systems, machine tool controls, and the more general purpose programmable controllers have undergone significant advancements in design and hence applicability. Today's new systems covering a wide range of complexity are available at lower cost, occupy less space, and provide higher reliability, greater immunity to harsh industrial environments, and substantially increased flexibility.

Solid state relay technology is proving to be a major contributor to the success of these systems. A prime example of this lies in the requirement for reliable, noise-free I/O interface switching circuits between the computer and the loads and sensing switches of the process being controlled. Typical programmable controllers, for example, utilize up to several hundred of these input/output circuits. Thus, the market has in effect defined a new class of solid state relay – the solid state I/O Module, also referred to as I/O Converter Interface.

There are two basic types of I/O converters – input converters and output converters – and both are available in AC and DC versions. Figure 3-1 describes the functional relationship of the input and output converters in a typical programmable controller. All I/O converter modules need only be single form A (to use conventional relay terminology), since multi-pole, multi-throw, and normally closed switching logic is performed by the computer, thus providing for module standardization with resultant cost advantages.

Output converters are functionally equivalent to conventional SSRs. They typically feature optical input/output coupling to provide electrical isolation between computer logic and power lines. Output load current ratings have been standardized at 3Amps maximum at room temperature (derated for higher ambient temperatures), which has proven to be sufficient load switching capacity for most standard solenoids, motor starters, etc. AC output converters, like most AC SSRs today, utilize triacs for the output switching stage; DC output converters utilize conventional power transistors in a

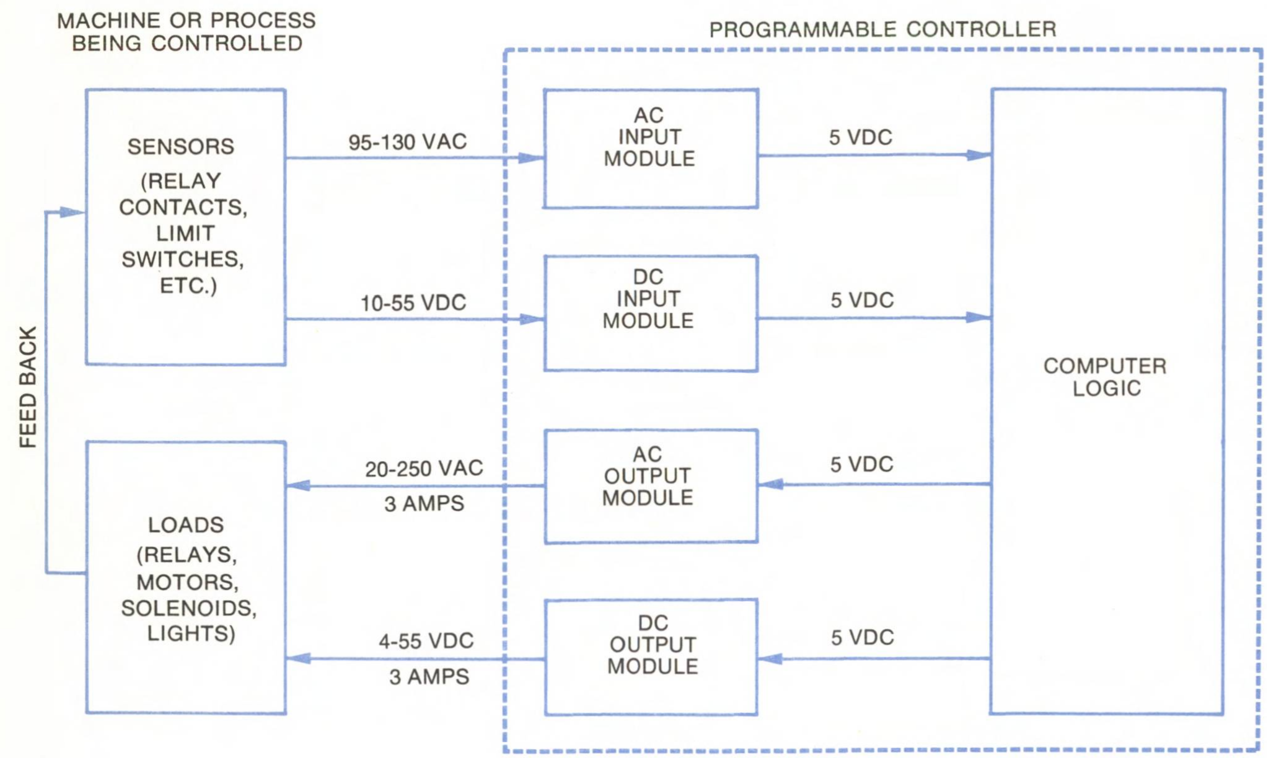


Fig. 3-1 Typical I/O Converter Module application.

three-stage complimentary Darlington configuration.

Input converters basically perform a reverse switching or conversion function compared to an output converter, i.e., they convert the high voltage AC or DC control power to 5-volt logic signals for use by the computer or microprocessor. For example, in a programmable controller the input converters sense switch closures from limit switches, pressure or flow switches, etc., and convert them through transient suppression and bounce elimination circuitry to "clean" 5VDC signals from which the controller's logic processor determines the appropriate sequence and timing of the machine or process being controlled. Input converters are also optically isolated, input to output, to protect the computer logic from the high voltage power control circuits.

Teledyne Relays' 673 Series I/O Modules are designed for side-by-side panel mounting, featuring barriered screw terminals for load connections such that when mounted in rows they eliminate the need for additional terminal strips and associated inter-connect wiring. Logic terminals are located on the rear of the modules, where they are physically isolated from the power wiring, and are designed to be plugged directly into a custom mounting panel available as an accessory. Logic circuit interconnections are provided within the panel, which carries no AC power circuits. Each 673 module contains an LED status indicator to facilitate fault location and quick surveillance of individual circuit status. Figure 3-2 shows 673 modules mounted on a Teledyne panel.

Utilizing the same circuit concepts as the 673, the Teledyne 675 Series converter modules feature a low profile package designed for direct mounting on pc boards (Fig. 3-3). Performance specifications and ratings are similar to the 673 series, but no LED status indicators are included.

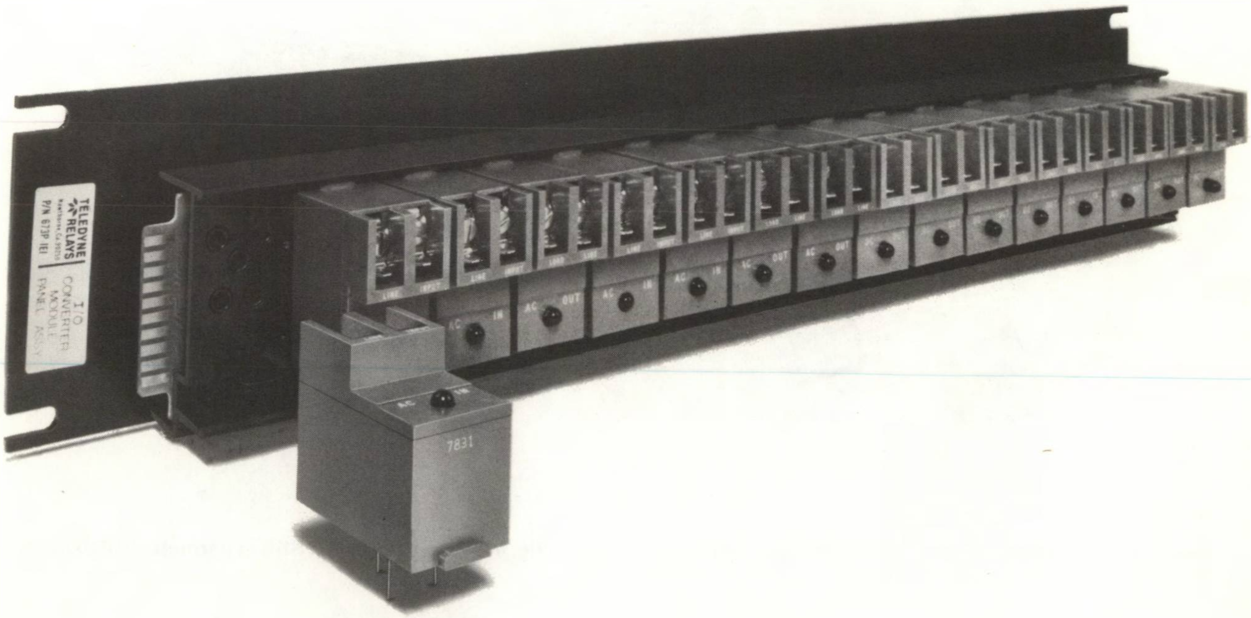


Fig. 3-2 Teledyne 673 Series I/O Converter Modules.

SECTION 4

4.0 MILITARY SOLID STATE RELAYS

While many areas of modern electronic technology were born out of the aerospace industry and subsequently found application in the consumer electronics and commercial/industrial markets, solid state relay technology had a reverse evolution. The first large scale uses of SSRs were in industrial control applications and computer peripherals, and the list of products and equipment now using SSRs in large quantities has grown to cover virtually every conceivable type of commercial and industrial equipment utilizing electronic circuits and controls. At the same time, military applications for SSRs have been in the minority. There appears, however, to be emerging an increasing interest in the aerospace community in SSRs for both military and space applications.

In 1970, a military specification covering solid state relays, MIL-R-28750, was published. Several "slash" sheets have been issued to this specification since then, and Teledyne Relays is the first to qualify to it with the following models:

Teledyne P/N	*Military P/N*
M640-1	M28750/5
M643-1	M28750/6
M643-2	M28750/7

These hermetically sealed devices are TO-5 packaged SSRs (Fig. 4-1) designed for switching low level analog signals (M640-1), and DC levels up to 300 mA/40 VDC (M643-1), and 100 mA/250 VDC (M643-2). More recent additions to the Teledyne line of military SSRs are the model 682-1 AC version rated at 1 amp/250 VRMS and the 683-1 DC version rated at .6 amp/50 VDC. These relays feature a low profile hermetic DIP configuration and, like the M640 Series, utilize hybrid microcircuit construction. Slash sheets to MIL-R-28750 have been assigned as follows:

682-1	M28750/9
683-1	M28750/8

and qualification is imminent.

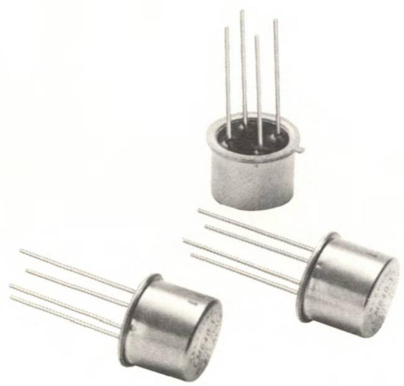


Fig. 4-1 Hermetically sealed TO-5 packaged SSRs.

Fig. 4-2 Low profile AC SSR in hermetic DIP package.

Fig. 4-3 shows the Teledyne 652 Series military power AC SSR designed to operate over a temperature range of $-55°$ to $+110°C$. Packaged in a thermally efficient hermetically sealed enclosure, its maximum load ratings are 25A/220 VRMS, 45-440 Hz. The 652 series SSRs are also slated for qualification to MIL-R-28750.

The foregoing applications engineering data, while it may primarily relate and make frequent reference to industrial and commercial equipment applications, is directly relevant to military/aerospace equipment from the standpoint of the basic technical details of SSR technology and applications. Inductive loads, high voltage transients, and current surges must be dealt with in the same way in military as in commercial equipment, and EMI considerations are even more critical in military applications. Thus, meaningful applications data can be of paramount concern to design and component engineers in selecting, specifying, and testing of SSRs for military and spacecraft applications.

Fig. 4-3 Military power AC SSR packaged in a thermal-efficient hermetic enclosure.

DOMESTIC SALES REPRESENTATIVES

ALABAMA, MISSISSIPPI TENNESSEE
M² 1
12021 So. Memorial Park
Huntsville, Alabama 35803
(205) 883-9901
TWX 810-776-2146

ARIZONA, SO. NEVADA
Arcom Sales
7300 E. Stetson Drive, Suite D
Scottsdale, Arizona 85251
(602) 947-5745
TWX 910-950-1158

CALIFORNIA (SOUTHERN)
Teledyne Relays
12525 Daphne Ave.
Hawthorne, California 90250
(213) 777-0077
TWX 910-321-4610

Teledyne Relays
1130 Camino Del Mar, Suite F
Del Mar, California 92014
(714) 481-6199

CALIFORNIA (NORTHERN)
Teledyne Relays
5581 Del Oro Place
San Jose, California 95124
(408) 356-6690

CANADA
A. Deskin Sales
290 Benjamin Hudson Street
St. Laurent, Quebec, H4N1J4
Canada
(514) 331-2860
TWX 610-421-3793

A. Deskin Sales
77D Steelcase Road, West
Markham, Ontario L3R2M4
Canada
(416) 495-1412
TWX 610-492-5113

A. Deskin Sales
272 S. W. Marine Drive
Vancouver, B.C. V5X2R5
Canada
(604) 324-6331
TWX 610-922-5036

COLORADO, UTAH, MONTANA, WYOMING
Quorum 3
5310 DTC Parkway, Suite H
Englewood, Colorado 80111
(303) 773-1903
TWX 510-950-7165

GEORGIA
M² 1
2457 Kingsley Dr.
Marietta, Georgia 30062
(404) 973-4855
TWX 810-766-2202

ILLINOIS (NORTHERN) WISCONSIN
Teledyne Relays
739 W. Roosevelt Road
Bldg. 8, Suite 309
Glen Ellyn, Illinois 60137
(312) 858-1090
TWX 910-651-3313

ILLINOIS (SOUTHERN) MISSOURI
Ensco Rep., Inc.
11714 Lackland Industrial Drive
St. Louis, Missouri 63141
(314) 567-3935
TWX 910-764-0856

INDIANA
Ihrig Associates
6410 Woodwind
Indianapolis, Indiana 46217
(317) 783-7630

IOWA
Esco Rep., Inc.
2615 West Central Park
Davenport, Iowa 52804
(319) 386-6600

KANSAS, NEBRASKA
Ensco Rep., Inc.
7939 Floyd Room L-12
Overland Park, Kansas 66204
(913) 381-7557
TWX 910-749-4066

MARYLAND, VIRGINIA DISTRICT OF COLUMBIA
Heller Sales
P.O. Box 293 2312 Killoran Road
Timonium, Maryland 21093
(301) 252-4780

MICHIGAN
J. C. Hofstetter Company
26847 Grand River Ave.
Detroit, Michigan 48240
(313) 533-7788
TWX 810-221-1201

MINNESOTA, NORTH & SOUTH DAKOTA
Stan Clothier Company
7423 Washington Avenue, South
Minneapolis, Minnesota 55435
(612) 944-3456
TWX 910-576-3415

NEW ENGLAND
Gerald Rosen Company, Inc.
271 Worcester Road
Framingham, Massachusetts 01701
(617) 879-5505
TWX 710-380-0466

Gerald Rosen Company, Inc.
2420 Main Street
Stratford, Connecticut 06497
(203) 375-5456

Gerald Rosen Company, Inc.
Wheeler Rd., P.O. Box 152
Hollis, New Hampshire 03049
(603) 465-7902
TWX 710-380-0466

NEW MEXICO
Reptronix
237 Eubank, Suite C
Albuquerque, New Mexico 87112
(505) 881-8001
TWX 910-989-1160

NEW YORK (METROPOLITAN) NO. JERSEY
Friedman-Smith Electronics
519 South Fifth Avenue
Mount Vernon, New York 10550
(914) 664-4866
TWX 710-562-0188

NEW YORK (UPSTATE)
I A Hotze
112 DeWitt Street
Syracuse, New York 13203
(315) 479-6641
TWX 710-541-1572

NORTH & SOUTH CAROLINA
M² 1
P.O. Box 520
1212 Lane Drive
Cary, North Carolina 27511
(919) 467-6319
TWX 510-920-0634

OHIO (NORTHERN) PENNSYLVANIA (WESTERN)
J. C. Hofstetter Company
7014 River Styx Road
Medina, Ohio 44256
(216) 241-4880
TLX 98-6494 - Hofstetter Mina

OHIO (SOUTHERN) KENTUCKY
J. C. Hofstetter Company
3300 So. Dixie Drive, Room 220
Dayton, Ohio 45439
(513) 296-1010

OREGON, WASHINGTON
B & P Sales, Inc.
Evergreen Bldg.,
15 South Grady Way,
Evergreen Building, Suite 931
Renton, Washington 98055
(206) 271-3733
TWX 910-423-0804

PENNSYLVANIA (EASTERN) SO. JERSEY, DELAWARE
Vantage Sales Company
21 Bala Avenue
Bala Cynwyd, Pennsylvania 19004
(215) 667-0990
TWX 510-662-5846

TEXAS, ARKANSAS OKLAHOMA, LOUISIANA
Kruvand Associates, Inc.
Northwest Office Park
8330 Burnet Rd., Suite 107
(512) 458-9204
Austin, Texas 78758

Kruvand Associates, Inc.
10300 North Central Expressway
Dallas, Texas 75231
(214) 691-4592
TWX 910-861-9016

Kruvand Associates, Inc.
7333 Harwin Drive, Suite 213
Houston, Texas 77036
(713) 780-9710
TWX 910-881-5054

REGIONAL OFFICES

EASTERN REGIONAL SALES OFFICE
Teledyne Relays
60 Monmouth Park Highway
West Long Branch, New Jersey 07764
(201) 229-5900
TWX 710-722-6668

FACTORY SALES OFFICE
Teledyne Relays
12525 Daphne Street
Hawthorne, California 90250
(213) 777-0077
TWX 910-321-4610

CENTRAL REGIONAL OFFICE
Teledyne Relays
739 W. Roosevelt Road, Bldg. 8, Suite 309
Glen Ellyn, Illinois 60137
(312) 858-1090
TWX 910-651-3313

DOMESTIC DISTRIBUTORS

ALABAMA
Pioneer Electronics
1207 Putnam Drive, N.W.
Huntsville, Alabama 35805
(205) 837-9300
TWX 810-726-2197

ARIZONA
Kierulff Electronics
4134 E. Wood Street
Phoenix, Arizona 85040
(602) 243-4101
TWX 910-951-1550

Wyle Distribution Group
8155 N. 24th Avenue
Phoenix, Arizona 85021
(602) 249-2232
TWX 910-951-4282

CALIFORNIA
Wyle Distribution Group
124 Maryland Street
El Segundo, California 90245
(213) 322-8100
TWX 910-348-7111

Kierulff Electronics
2585 Commerce Way
Los Angeles, California 90040
(213) 725-0325
TWX 910-580-3106

Kierulff Electronics
14101 Franklin Avenue
Tustin, California 92680
(714) 731-5711
TWX 910-595-2599

Wyle Distribution Group
3000 Bowers Avenue
Santa Clara, California 94052
(408) 727-2500
TWX 910-338-0541/910-338-0296

Kierulff Electronics
3969 E. Bayshore Road
Palo Alto, California 94303
(415) 968-6292
TWX 910-379-6437

Kierulff Electronics
8797 Balboa Avenue
San Diego, California 92123
(714) 278-2112
TWX 910-335-1182

Wyle Distribution Group
9515 Chesapeake Dr.
San Diego, California 92123
(714) 565-9171
TWX 910-335-1590

CANADA
A. Deskin Sales
290 Benjamin Hudson Street
St. Laurent, Quebec, H4N1J4
Canada
(514) 331-2860
TWX 610-421-3793

A. Deskin Sales
77B Steelcase Road, West
Markham, Ontario L3R2M4
Canada
(416) 495-1412
TWX 610-492-5113

A Deskin Sales
272 S.W. Marine Drive
Vancouver, BC V5X2R5
Canada (604) 324-6331
TWX 610-922-5036

COLORADO
Kierulff Electronics
10890 E. 47th Avenue
Denver, Colorado 80204
(303) 371-6500
TWX 910-932-0169

Wyle Distribution Group
6777 E. 50th Avenue
Commerce City, Colorado 80022
(303) 287-9611
TWX 910-936-0770

CONNECTICUT
Milgray/Connecticut
378 Boston Post Road
Orange, Connecticut 06477
(203) 795-0711
TWX 510-225-3673

FLORIDA
Milgray/Florida
1850 Lee Road, Suite 104
Winter Park, Florida 32789
(305) 647-5747
TWX 510-225-3673

Pioneer/Florida
6220 South Orange Blossom Trail
Suite 412
Orlando, Florida 32809
(305) 859-3600
TWX 810-850-0177

ILLINOIS
Kierulff Electronics
1536 Landmeier Road
Elk Grove Village, Illinois 60007
(312) 640-0200
TWX 910-222-0351

Pioneer/Chicago
1551 Carmen Drive
Elk Grove VIllage, Illinois 60007
(312) 437-9680
TWX 910-222-1834

INDIANA
Pioneer/Indianapolis
6408 Castle Place Drive
Indianapolis, Indiana 46250
(317) 849-7300
TWX 810-260-1794

KANSAS
Milgray/Kansas City
6901 W. 63rd Street
Overland Park, Kansas 66202
(913) 236-8800

MARYLAND
Milgray/Washington
9730 George Palmer Hwy.
Lanham, Maryland 20801
(301) 459-2222

Pioneer/Washington
9100 Gaither
Gaithersburg, Maryland 20760
(301) 948-0710
TWX 710-828-0545

MASSACHUSETTS
Future Electronics
12 Mercer Rd.
Natick, Massachusetts 01760
(617) 879-0860
TWX 710-386-1214

Kierulff Electronics
13 Fortune Drive
Billerica, Massachusetts 01821
(617) 667-8331
TWX 710-390-1449

Milgray/New England
79 Terrace Hall Avenue
Burlington, Massachusetts 01803
(617) 272-6800
TWX 710-332-6508

MICHIGAN
Pioneer/Michigan
13485 Stamford
Livonia, Michigan 48150
(313) 525-1800
TWX 810-242-3271

MINNESOTA
Kierulff Electronics
5280 W. 74th Street
Edina, Minnesota 55435
(612) 835-4388

Stark Electronics
401 Royalston Avenue North
Minneapolis, Minnesota 55405
(612) 333-3361
TWX 910-576-2714

NEW JERSEY
Milgray/Delaware Valley
1165 Marlkress Road
Cherry Hill, New Jersey 08034
New Jersey (609) 424-1300
Philadelphia (215) 228-2000
TWX 710-896-0405

Kierulff Electronics
3 Edison Place
Fairfield, New Jersey 07006
(201) 515-6750
TWX 710-734-4372

NEW YORK (UPSTATE)
Summit Distributors, Inc.
916 Main Street
Buffalo, New York 14203
(716) 884-3450
TWX 710-522-1692

Summit Distributors, Inc.
292 Commerce Drive
Rochester, New York 14623
(716) 334-8110

NEW YORK (METROPOLITAN)
Milgray Electronics
191 Hanse Avenue
Freeport, NY 11520
(516) 546-5600
Toll Free (800) 645-3992
TWX 510-225-3673

Kierulff Electronics
330 Motor Park Way
Hauppauge,LI., N.Y. 11787
(516) 273-8100

NORTH & SOUTH CAROLINA
Pioneer/Carolina
2906 Baltic Avenue
Greensboro, North Carolina 27406
(919) 273-4441
TWX 510-925-1114

OHIO
Milgray/Cleveland
6155 Rockside Road
Cleveland, Ohio 44131
TOLL FREE (800) 321-0006
(216) 447-1520

Pioneer/Cleveland
4800 E. 131st Street
Cleveland, Ohio 44105
(216) 587-3600
TWX 810-422-2211

Pioneer/Dayton
1900 Troy Street
Dayton, Ohio 45404
(513) 236-9900
TWX 810-459-1622

OREGON
Kierulff Electronics
10950 S. W. 5th St.
Suite #145
Beaverton, Oregon 97005

PENNSYLVANIA (EASTERN)
Pioneer/Delaware Valley
141 Gibraltar Road
Horsham, Pennsylvania 19044
(215) 674-4000
TWX 510-665-6778

PENNSYLVANIA (WESTERN)
Pioneer/Pittsburgh
560 Alpha Drive
Pittsburgh, Pennsylvania 15238
(412) 782-2300
TWX 710-795-3122

TEXAS
Solid State Electronics
P.O. Box 20299
Dallas, Texas 75220
(214) 438-5700

DOMESTIC DISTRIBUTORS (Continued)

Solid State Electronics
9519 Town Park
Houston, Texas 77036
(713) 772-8483
TWX 910-881-6289

Pioneer Standard Electronics, Inc.
13710 Omega Road
Dallas, Texas 75240
(214) 386-7300

Pioneer Houston
5853 Point West Drive
Houston, Texas 77036
(713) 988-5555

UTAH
Kierulff Electronics
3695 W. 1987 South
Salt Lake City, Utah 84104
(801) 973-6913

WASHINGTON
Kierulff Electronics
1005 Andover Park East
Tukwila, Washington 98188
(206) 575-4420
TWX 910-444-2034

Wyle Distribution Group
1750 132nd Avenue, N.E.
Bellevue, Washington 98005
(206) 453-8300
TWX 910-443-2526

WISCONSIN
Kierulff Electronics, Inc.
2212 East Moreland Blvd.
Waukesha, Wisc. 53186
414-784-8160

INTERNATIONAL SALES REPRESENTATIVES

ARGENTINA
Rayo Electronica S.R.L.
Belgrano 990
Pisos 6 Y 2
Buenos Aires, Argentina
37-9890/9476, 38-1779
TELEX 012-2153
AAB: 122153 AR RAYOX

AUSTRALIA
Austronic Engineering Labs
24 Lexton Road
Box Hill North
Victoria 3129
Melbourne, Australia
03-89-8900
TELEX 32595

AUSTRIA
Firma Paul Kugler
Veitingergasse 159 c
A1130 Wien 13
Austria
222-841346
TELEX 133075

BELGIUM
Simac Electronics S.P.R.L.
148, Blvd. du Triomphe
1160 Brussels, Belgium
6604428
TELEX 23662

BRAZIL
Productos Electronicos
METALTEX Ltda.
Caixa Postal - 9452
Sao Paulo - Brazil
240-212061-2714
CEP 01000

DENMARK
Nordisk Elektronik
Transformervej, 17
2730 Herlev
02/842000
TELEX 35200

FINLAND
Havulinna Oy
P.O. Box 68
SF-00811 Helsinki 81
Finland
358 0755 4144
TELEX 124426

FRANCE
Tekelec Airtonic
Cite des Bruyeres
Rue Carle Vernet
92310 Sevres
5347535
TELEX 204552

GERMANY
Teledyne Relays
A Division of Teledyne GmbH
Abraham Lincoln
Str 38-42
62 Wiesbaden
West Germany
6121-700811
04-186851 (TREL-D)

INDIA
Sujata Sales & Exports Ltd.
112 Bajaj Bhavan
Nariman Point
Bombay 400 021 India
234685
TELEX 011-3855

ISRAEL
STG International Ltd.
P.O. Box 1276
Tel Aviv
23-248231
TELEX 32229

ITALY
Tekelec Airtronic S.P.A.
Via G. Mameli 31
20129 Milano
7380641
TELEX 312402

JAPAN
Teledyne Relays
Nihon Seimei Akasaka Bldg.
8-1-19 Akasaka,
Minato-Ku
Tokyo 107
(03) 403-8141
TELEX 781-24439

NEW ZEALAND
Professional Electronics Ltd.
P.O. Box 31143
Milford
Auckland, New Zealand
493-029
TELEX NZ21084

NORWAY
Nordisk Electronik (Norge) A/S
Smedsvingen 4 - P.O. Box 122
1364 Hvalstad - Norway
2-78 62 10
TELEX 17546

SWEDEN
NAXAB
Box 4115
S17104 Solna
985140
TELEX 17912

SWITZERLAND
Jucker Relaisbau
Seefeldstr. 94
8008 Zeurich
01-476510
TELEX 58300

SOUTH AFRICA
Agatronics Components (PTY) Ltd
P.O. Box 10223
Johannesburg 2000
11-724-1591
TELEX 8-9539

TAIWAN
Industrial Electronics
P.O. Box 22423
Taipei
(02) 771-4257, 752-5060
TELEX 23612 LEOTRONX

THAILAND
Engineering Technic L.P.
528/1 Latphrao Rd.
Bangkok 9
511-1562, 511-0537

THE NETHERLANDS
Simac Electronics
Veenstraat 20
Veldhoven
040-533725
TELEX 51037

UNITED KINGDOM
Teledyne Relays
A Division of Teledyne Ltd.
Heathrow House,
Bath Rd, Cranford
Hounslow, Mx TW59QP
01-897-2501
TELEX 935008

INTERNATIONAL DISTRIBUTORS

UNITED KINGDOM
Macro-Marketing Ltd.
369 Bath Road
Slough, Bucks, England
Burham (Bucks) 63011
Slough (0753) 30211
06286-4422
TELEX 847945

GERMANY
Teledyne Relays
A Division of Teledyne GmbH
Str 38-42
62 Wiesbaden
West Germany
6121-700811
TELEX 04-186851 (TREL-D)

JAPAN
Hakuto Co., Ltd.
Foreign Division
C.P.O. Box 25
Tokyo 100-91
03-502-2211
TELEX J-22912A & B

SWITZERLAND
Dahms Elektronik A.G.
Mitteldorfstrasse 57
CH 5033 Buchs
Switzerland
64 227766
TELEX 68895

2/80 16M CREATIVE GRAPHICS

TELEDYNE RELAYS

12525 Daphne Avenue , Hawthorne, California 90250 • (213) 777-0077

Printed in USA

SMA 119 20M