



# FRONTGRADE

## DATASHEET

### UT63M147

MIL-STD-1553A/B + 5V-Tranceiver

7/1/2019

Version #: 1.0

## Features

- 5-volt only operation ( $\pm 10\%$ )
- Fit and functionally compatible to industry standard transceiver
- Idle low transmitter inputs and receiver outputs
- Dual-channel 50-mil center 24-lead Flatpack
- Dual-channel 100-mil center 36-pin DIP
- Full military operating temperature range,  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ , screened to QML Q or QML V requirements
- Radiation hardened to 1 Mrads(Si)
- Supports MIL-STD-1553 (UT63M147)
- Standard Microcircuit Drawing (SMD) 5962-93226 available
  - QML Q and QML V compliant part

## Introduction

The monolithic UT63M147 Transceivers are complete transmitter and receiver pairs for MIL-STD-1553A and 1553B applications. Encoder and decoder interfaces are idle low.

The receiver section of the UT63M147 series accepts biphase- modulated Manchester II bipolar data from a MIL- STD-1553 data bus and produces TTL-level signal data at its RXOUT and RXOUT outputs. An external RXEN input enables or disables the receiver outputs.

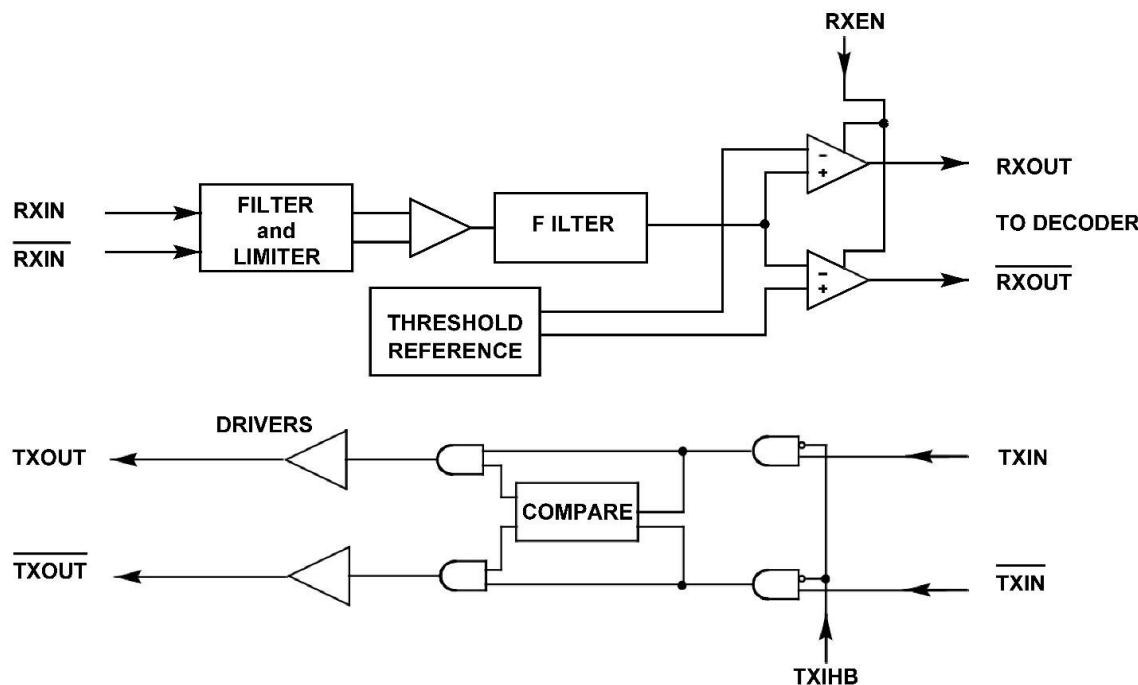


Figure 1. Functional Block Diagram

The transmitter section accepts biphasic TTL-level signal data at its TXIN and TXIN and produces MIL-STD-1553 data signals. The transmitter's output voltage is typically 12 V<sub>PP,L-L</sub>. Activating the TXIHB input or setting both data inputs to the same logic level disables the transmitter outputs.

The UT63M147 series offers complete transmitter and receiver pairs packaged in a dual-channel 36-pin DIP or 24-lead flatpack configurations designed for use in any MIL-STD-1553 application.

### Legend for TYPE field:

- TI = TTL input
- TO = TTL output
- DO = Differential output
- DI = Differential input
- DIO = Differential input/output
- ( ) = Channel designator
- [ ] = 24-lead flatpack

## Transmitter

Name	Pin Number	Type	Description
TXOUT <sup>1</sup> (A)	1 [1]	DO [DIO]	Transmitter outputs: TXOUT and TXOUT are differential data signals.
TXOUT (B)	10 [7]	DO [DIO]	
TXOUT <sup>1</sup> (A)	2 [2]	DO [DIO]	TXOUT is the half-cycle complement of TXOUT.
TXOUT (B)	11 [8]	DO [DIO]	
TXIHB (A)	34 [22]	TI	Transmitter inhibit: This is an active high input signal.
TXIHB (B)	25 [16]	TI	
TXIN (A)	35 [23]	TI	Transmitter input: TXIN and TXIN are complementary TTL- level Manchester II encoder inputs.
TXIN (B)	26 [17]	TI	
TXIN (A)	36 [24]	TI	TXIN is the complement of TXIN input
TXIN (B)	27 [18]	TI	

#### Note:

1. The 24-lead flatpack internally connects TXOUT to RXIN (CHA, CHB) and TXOUT to RXIN (CHA, CHB) for each channel.

## Receiver

Name	Pin Number	Type	Description
RXOUT (A)	5 [4]	TO	Receiver outputs: RXOUT and <u>RXOUT</u> are complementary Manchester II decoder outputs.
RXOUT (B)	14 [10]	TO	
<u>RXOUT</u> (A)	8 [6]	TO	
<u>RXOUT</u> (B)	17 [12]	TO	<u>RXOUT</u> is the complement of RXOUT output.
RXEN (A)	6 [5]	TI	Receiver enable/disable: This is an active high input signal.
RXEN (B)	15 [11]	TI	
RXIN <sup>1</sup> (A)	29 [1]	DI [DIO]	Receiver input: RXIN and <u>RXIN</u> are biphase-modulated Manchester II bipolar inputs from MIL-STD-1553 data bus.
RXIN (B)	20 [7]	DI [DIO]	
<u>RXIN</u> <sup>1</sup> (A)	30 [2]	DI [DIO]	<u>RXIN</u> is the half-cycle complement of RXIN input.
<u>RXIN</u> (B)	21 [8]	DI [DIO]	

**Note:**

1. The 24-lead flatpack internally connects TXOUT to RXIN (CHA, CHB) and TXOUT to RXIN (CHA, CHB) for each channel.

## Power and Ground

Name	Pin Number	Type	Description
V <sub>CC</sub> (A)	33 [20]	PWR	+5 V <sub>DC</sub> power ( $\pm 10\%$ ) Recommended decoupling capacitors: 1 $\mu$ F (tantalum) and 0.1 $\mu$ F (ceramic)
V <sub>CC</sub> (B)	24 [14]	PWR	
GND (A)	3, 7, 31 [3,19,21]	GND	
GND (B)	12, 16, 22 [9,13,15]	GND	Ground reference

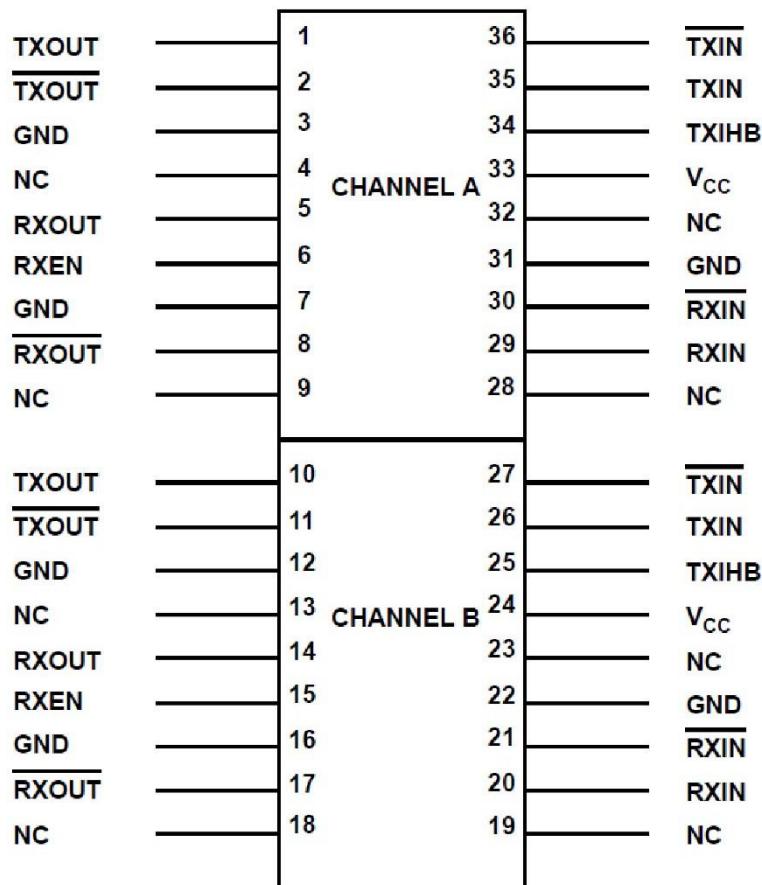


Figure 2a. Functional Pin Diagram -- Dual Channel (36)

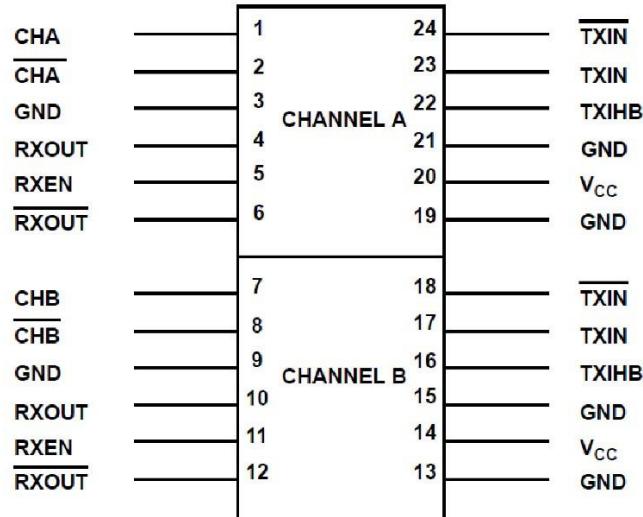


Figure 2b. Functional Pin Diagram -- Dual Channel (24) 1

**Note:**

1. The 24-lead flatpack internally connects TXOUT to RXIN (CHA, CHB) and TXOUT to RXIN (CHA, CHB) for each channel.

## Transmitter

The transmitter section accepts Manchester II biphase TTL data and converts this data into differential phase-modulated current drive. Transmitter current drivers are coupled to a MIL-STD-1553 data bus via a transformer driven from the TXOUT and TXOUT terminals. Transmitter output terminals' non-transmitting state is enabled by asserting TXIHB (logic "1"), or by placing both TXIN and TXIN at the same logic level. Table 1, Transmit Operating Mode, lists the functions for the output data in reference to the state of TXIHB. Figure 3 shows typical transmitter waveforms.

## Receiver

The receiver section accepts biphase differential data from a MILSTD-1553 data bus at its RXIN and RXIN inputs. The receiver converts input data to biphase Manchester II TTL format and is available for decoding at the RXOUT and RXOUT terminals. The outputs RXOUT and RXOUT represent positive and negative excursions (respectively) of the inputs RXIN and RXIN. Figure 4 shows typical receiver output waveforms.

## Table 1. Transmit Operating Mode

TXIN	TXIN	TXIHB	TXOUT
x <sup>1</sup>	x	1	Off
0	0	x	Off
0	1	0	On
1	0	0	On
1	1	x	Off <sup>3</sup>

**Notes:**

1. x = Don't care.
2. Transmitter output terminals are in the non-transmitting mode during Off-time.
3. Transmitter output terminals are in the non-transmitting mode during Off-time, independent of TXIHB status.

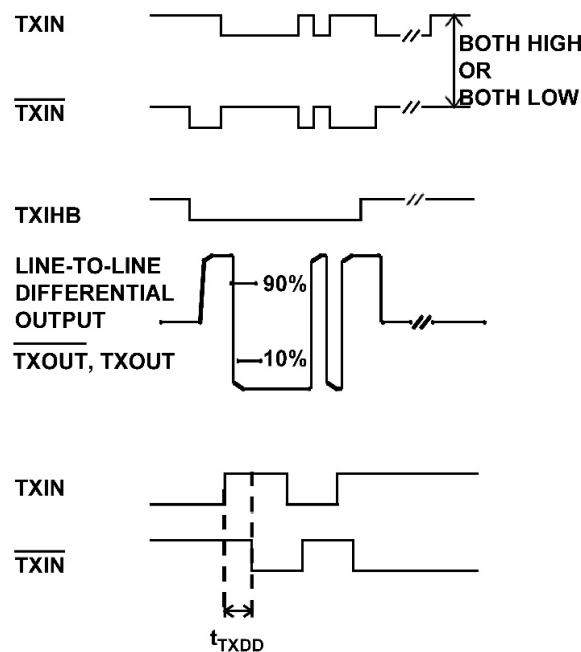


Figure 3. Typical Transmitter Wave

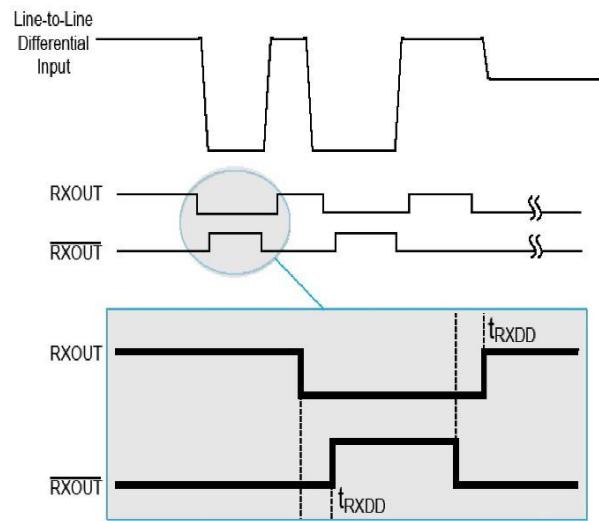


Figure 4. Typical Receiver Waveforms

## Data Bus Interface<sup>1</sup>

The designer can connect the UT63M147 to the data bus via a short-stub (direct-coupling) connection or a long-stub (transformer-coupling) connection. Use a short-stub connection when the distance from the isolation transformer to the data bus does not exceed a one-foot maximum. Use a long-stub connection when the distance from the isolation transformer exceeds the one foot maximum and is less than twenty feet. Figure 5 shows various examples of bus coupling configurations. The UT63M147 series transceivers are designed to function with MIL- STD-1553A and 1553B compatible transformers.

**Note:**

1. The 24-lead flatpack internally connects TXOUT to RXIN and TXOUT to RXIN for each channel.

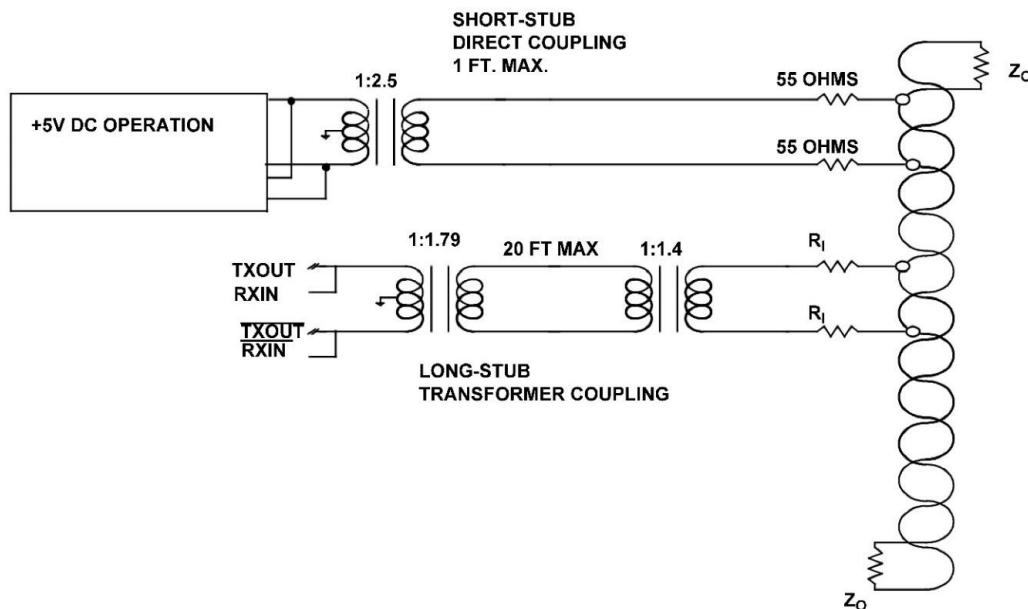


Figure 5. Bus Coupling Configuration

**Note:**

1. The isolation resistor ( $R_I$ ) is defined by MIL-STD-1553B, section 4.5.1.5.1.2 as equal to  $0.75 \times Z_0 \pm 2\%$ . Typically,  $0.75 \times 78\Omega = 58.5\Omega$ .  $Z_0$  is the selected nominal cable impedance.

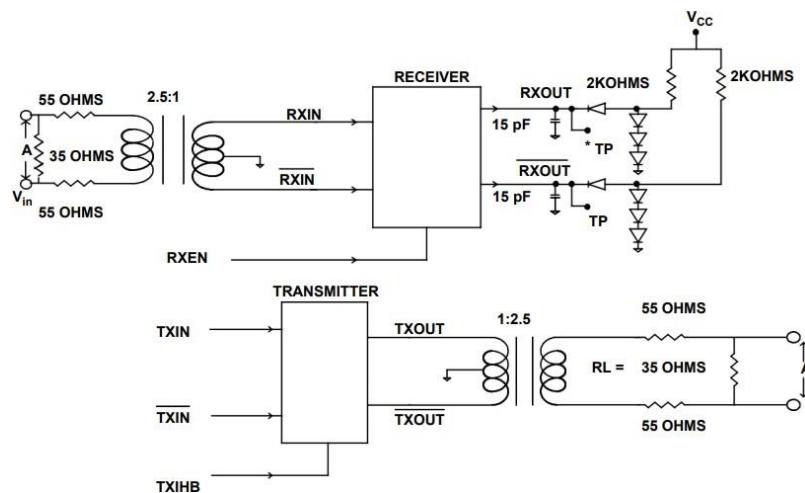


Figure 6. Direct Coupled Transceiver with Load

**Notes:**

1. TP = Test point.
2.  $R_I$  removed for terminal input impedance test.
3. TXOUT and RXIN tied together. TXOUT and RXIN tied together.

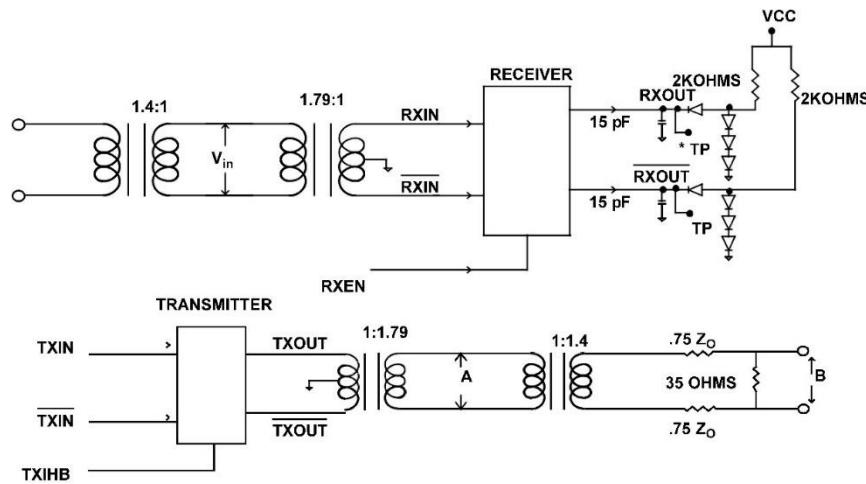


Figure 7. Transformer Coupled Transceiver with Load

**Notes:**

1. TP = Test point.
2.  $R_L$  removed for terminal impedance test.
3. TXOUT and RXIN tied together.  $\overline{\text{TXOUT}}$  and  $\overline{\text{RXIN}}$  tied together.

## Recommended Thermal Protection

All packages should mount to or contact a heat removal rail located in the printed circuit board. To insure proper heat transfer between the package and the heat removal rail, use a thermally-conductive material between the package and the heat removal rail. A MIL-STD-883 TM5011 certified thermal bonding material, like Al Technologies ME7159, is a common thermal interface material for space applications.

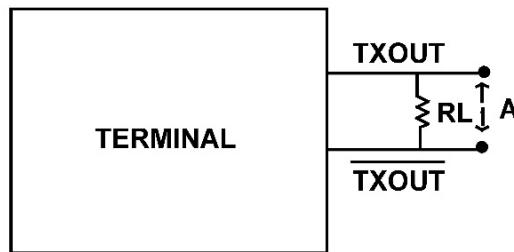


Figure 8. Transceiver Test Circuit MIL-STD-1553

**Notes:**

1. Transformer Coupled Stub: Terminal is defined as transceiver plus isolation transformer. Point A is defined in figure 7.
2. Direct Coupled Stub: Terminal is defined as transceiver plus isolation transformer and fault resistors. Point A is defined in figure 6.

## Table 2. Transformer Requirements

Coupling Technique	$\pm 5\text{VDC}$
DIRECT-COUPLED: Isolation Transformer Ratio	1:2.5
TRANSFORMER-COUPLED: Isolation Transformer Ratio	1:1.79
Coupling Transformer Ratio	1:1.4

## Absolute Maximum Ratings<sup>1</sup>

Parameter	Limits	Unit
$V_{CC}$	-0.3 to +7.0	V
Input voltage range (receiver) <sup>2</sup>	10	V <sub>PP</sub>
Logic input voltage range	-0.3 to +5.5	V
Power dissipation 100% duty cycle (per channel)	3.6	W
Thermal impedance junction to case <sup>3</sup>	6.0	°C/W
Maximum junction temperature	+175	°C
Storage temperature	-65 to +150	°C
Receiver common mode input voltage range	-5.0 to +5.0	V

**Notes:**

1. Stress outside the listed absolute maximum rating may cause permanent damage to the devices. This is a stress rating only, and functional operation of the device at these or any other conditions beyond limits indicated in the operational sections of this specification is not recommended. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.
2. Voltage measurement identified as  $V_{PP11}$  are differential measurements. Voltage measurements identified as  $V_{PP}$  are single ended measurements with a ground reference.
3. Mounting per MIL-STD-883, Method 1012.

## Recommended Operating Conditions

Parameter	Limits	Unit
Supply voltage range	+4.50 to +5.50	V
Logic input voltage range	0 to +5.0	V
Receiver differential voltage	8.0	V <sub>P-P</sub>

Parameter	Limits	Unit
Receiver common mode voltage range	±4.0	V
Driver peak output current	600	mA
Serial data rate	0.3 to 1	MHz
Case operating temperature range (T <sub>c</sub> )	-55 to +125	°C

## Operational Environment

Parameter	Limits	Unit
Total Ionizing Dose	1E6	rads(Si)
Single Event Latchup Immune (SEL)	≤35	MeV-cm <sup>2</sup> /mg
Single Event Upset Immune (SEU)	≤14	MeV-cm <sup>2</sup> /mg

## DC Electrical Characteristics <sup>1</sup>

**V<sub>CC</sub> = 5.0V ± 10%; -55°C ≤ T<sub>c</sub> ≤ +125°C**

Symbol	Parameter	Minimum	Maximum	Unit	Condition
V <sub>IL</sub>	Input low voltage		0.8	V	RXEN, TXIHB, TXIN, <u>TXIN</u>
V <sub>IH</sub>	Input high voltage	2.0		V	RXEN, TXIHB, TXIN, <u>TXIN</u>
I <sub>IL</sub>	Input low current	-0.1		mA	V <sub>IL</sub> = 0.4V; RXEN, TXIHB, TXIN, <u>TXIN</u>
I <sub>IH</sub>	Input high current	-40	40	μA	V <sub>IH</sub> = 2.7V; RXEN, TXIHB, TXIN, <u>TXIN</u>
V <sub>OL</sub>	Output low voltage		.55	V	I <sub>OL</sub> = 4mA; RXOUT, <u>RXOUT</u>
V <sub>OH</sub>	Output high voltage	2.4		V	I <sub>OH</sub> = 0.4mA; RXOUT, <u>RXOUT</u>
I <sub>CC</sub>	V <sub>CC</sub> supply currentss	22	mA	0% duty cycle (non-transmitting) 25% duty cycle (f = 1MHz)	
		200	mA		
		380	mA	50% duty cycle (f = 1MHz)	
		650	mA	87.5% duty cycle (f = 1MHz)	
		740	mA	100% duty cycle (f = 1MHz) <sup>2</sup>	

**Note:**

1. All tests guaranteed per test figure 6.
2. Guaranteed but not tested.

## Receiver Electrical Characteristics <sup>1</sup>

**V<sub>CC</sub> = 5.0V ±10%; -55°C ≤ T<sub>C</sub> ≤ +125°C**

Symbol	Parameter	Minimum	Maximum	Unit	Condition
C <sub>IN</sub> <sup>2</sup>	Input capacitance		15	pF	RXEN, TXIHB, TXIN, $\overline{\text{TXIN}}$ ; input f = 1MHz @ 0V
C <sub>OUT</sub> <sup>2</sup>	Output capacitance		20	pF	RXOUT, $\overline{\text{RXOUT}}$ ; f = 1MHz @ 0V
V <sub>IC</sub> <sup>5</sup>	Common mode input voltage	-5	5	V	Direct-coupled stub; input 1.2 VPP, 200ns rise/fall time ±25ns, f = 1MHz
V <sub>TH</sub>	Input threshold voltage <sup>4</sup> (no response)		0.20	V <sub>PP,L-L</sub>	Transformer-coupled stub; input at f = 1MHz, rise/fall time 200ns at (Receiver output 0 → 1 transition)
	Input threshold voltage (no response)		0.28	V <sub>PP,L-L</sub>	Direct-coupled stub; input at f = 1MHz, rise/fall time 200ns at (Receiver output 0 → 1 transition)
	Input threshold voltage <sup>4</sup> (response)	0.86	14.0	V <sub>PP,L-L</sub>	Transformer-coupled stub; input at f = 1MHz, rise/fall time 200ns at (Receiver output 0 → 1 transition)
	Input threshold voltage (response)	1.20	20.0 <sup>2</sup>	V <sub>PP,L-L</sub>	Direct-coupled stub; input at f = 1MHz, rise/fall time 200ns at (Receiver output 0 → 1 transition)
CMRR <sup>5</sup>	Common mode rejection ratio	Pass/Fail <sup>3</sup>		N/A	

### Notes:

1. All tests guaranteed per test figure 6.
2. Capacitance is measured only for initial qualification and after any process or design changes which may affect input or output capacitance.
3. Pass/fail criteria per the test method described in MIL-HDBK-1553 Appendix A, RT Validation Test Plan, Section 5.1.2.2, Common Mode Rejection.
4. Guaranteed by design.
5. Guaranteed to the limits specified if not tested.

## Transmitter Electrical Characteristics 1

**V<sub>CC</sub> = 5.0V ±10%; -55°C ≤ T<sub>C</sub> ≤ +125°C**

Symbol	Parameter	Minimum	Maximum	Unit	Condition
V <sub>O</sub>	Output voltage swing per MIL-STD-1553B 4 (see figure 9)	18	27	V <sub>PP,L-L</sub>	Transformer-coupled stub, Figure 8, Point A; input f = 1MHz, R <sub>L</sub> = 70 ohms
	per MIL-STD-1553B (see figure 9)	6.0	9.0	V <sub>PP,L-L</sub>	Direct-coupled stub, Figure 8, Point A; input f = 1MHz, R <sub>L</sub> = 35 ohms
	per MIL-STD-1553A 4 (see figure 9)	6.0	20	V <sub>PP,L-L</sub>	Figure 8, Point A; input f = 1MHz, R <sub>L</sub> = 35 ohms
V <sub>NS</sub> <sup>2</sup>	Output noise voltage differential (see figure 9)		14	mV-RMS L-L	Transformer-coupled stub, Figure 8, Point A; input f = DC to 10MHz, R <sub>L</sub> = 70 ohms
			5	mV-RMS L-L	Direct-coupled stub, Figure 8, Point A; input f = DC to 10MHz, R <sub>L</sub> = 35 ohms
V <sub>OS</sub> <sup>3</sup>	Output symmetry	-250	+250	mV <sub>PP,L-L</sub>	Transformer-coupled stub, Figure 8, Point A; R <sub>L</sub> = 140 ohms measurements taken 2.5 μs after end of transmission
		-90	+90	mV <sub>PP,L-L</sub>	Direct-coupled stub, Figure 8, Point A; R <sub>L</sub> = 35 ohms, measurements taken 2.5 μs after end of transmission
V <sub>DIS</sub>	Output voltage distortion (overshoot or ring) (see figure 9)	-900	+900	mV <sub>peak,L-L</sub>	Transformer-coupled stub, Figure 8, Point A; R <sub>L</sub> = 70 ohms
		-300	+300	mV <sub>peak,L-L</sub>	Direct-coupled stub, Figure 8, Point A; R <sub>L</sub> = 35 ohms
C <sub>IN</sub> <sup>2</sup>	Input capacitance		15	pF	RXEN, TXIHB, TXIN, <u>TXIN</u> ; input f = 1MHz @ 0V
T <sub>IZ</sub> <sup>4</sup>	Terminal input impedance	1		Kohm	Transformer-coupled stub, Figure 7, Point A; input f = 75KHz to 1MHZ (power on or power off; non-transmitting, R <sub>L</sub> removed from circuit).
		2		Kohm	Direct-coupled stub, Figure 6, Point A; input f = 75KHz to 1MHZ (power on or power off; non-transmitting, R <sub>L</sub> removed from circuit).

### Notes:

1. All tests guaranteed per test figure 6.
2. Guaranteed by device characterization. Capacitance is measured only for initial qualification and after any process or design changes which may affect
3. Test in accordance with the method described in MIL-STD-1553B output symmetry, section 4.5.2.1.1.4.
4. Guaranteed to the limits specified if not tested.

## AC Electrical Characteristics<sup>1</sup>

**V<sub>CC</sub> = 5.0V ±10%; -55°C ≤ T<sub>C</sub> ≤ +125°C**

Symbol	Parameter	Minimum	Maximum	Unit	Condition
t <sub>R</sub> , t <sub>F</sub>	Transmitter output rise/fall time (see figure 10)	100	300	ns	Input f = 1MHz 50% duty cycle: direct-coupled R <sub>L</sub> = 35 ohms output at 10% through 90% points TXOUT, $\overline{\text{TXOUT}}$ Figure 10.
t <sub>RXDD</sub>	RXOUT delay	-200	200	ns	RXOUT to $\overline{\text{RXOUT}}$ , Figure 4.
t <sub>TXDD</sub> <sup>3</sup>	TXIN skew	-25	25	ns	TXIN to $\overline{\text{TXIN}}$ , Figure 3.
t <sub>RZCD</sub>	Zero crossing distortion (see figure 11)	-150	150	ns	Direct-coupled stub; input f = 1MHz, 3 VPP (skew INPUT±150ns), rise/fall time 200ns.
t <sub>TZCS</sub>	Zero crossing stability (see figure 10)	-25	25	ns	Input TXIN and should $\overline{\text{TXIN}}$ create Transmitter output zero crossings at 500ns, 1000ns, 1500ns, and 2000ns. These zero crossings should not deviate more than ±25ns.
t <sub>DXOF</sub> <sup>3, 4</sup>	Transmitter off; delay from inhibit active		100	ns	TXIN and $\overline{\text{TXIN}}$ toggling @ 1MHz; TXIHB transitions from logic zero to one, see figure 12.
t <sub>DXON</sub> <sup>3, 5</sup>	Transmitter on; delay from inhibit inactive		150	ns	TXIN and $\overline{\text{TXIN}}$ toggling @ 1MHz; TXIHB transitions from logic one to zero, see figure 12.
t <sub>RCVOFF</sub> <sup>3</sup>	Receiver off		50	ns	Receiver turn off time, see figure 13.
t <sub>RCVON</sub> <sup>3</sup>	Receiver on		50	ns	Receiver turn on time, see figure 13.
t <sub>RCVPD</sub> <sup>3</sup>	Receiver propagation		450	ns	Receiver propagation delay, see figure 13.
t <sub>XMITPD</sub> <sup>3</sup>	Transmitter propagation		200	ns	Transmitter propagation delay, see figure 12.

### Notes:

1. All tests guaranteed per test figure 6.
2. Guaranteed by device characterization.
3. Supplied as a design limit but not guaranteed or tested.
4. Delay time from transmit inhibit (1.5V) rising to transmit off (280mV).
5. Delay time from not transmit inhibit (1.5V) falling to transmit on (1.2V).

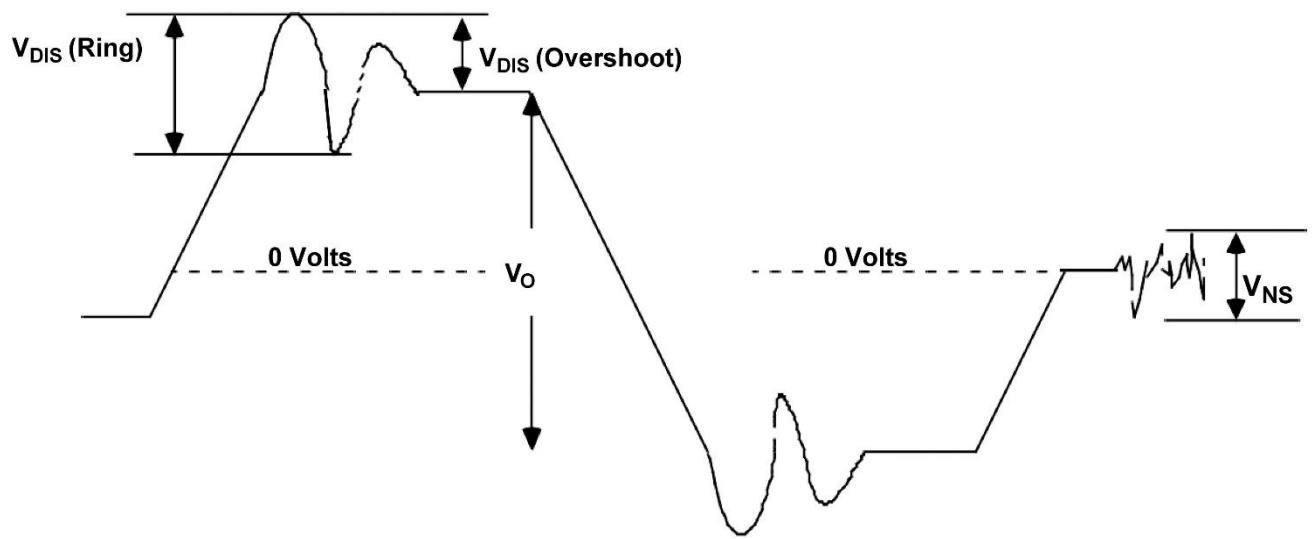


Figure 9. Transmitter Output Characteristics (VDIS, VNS, VO)

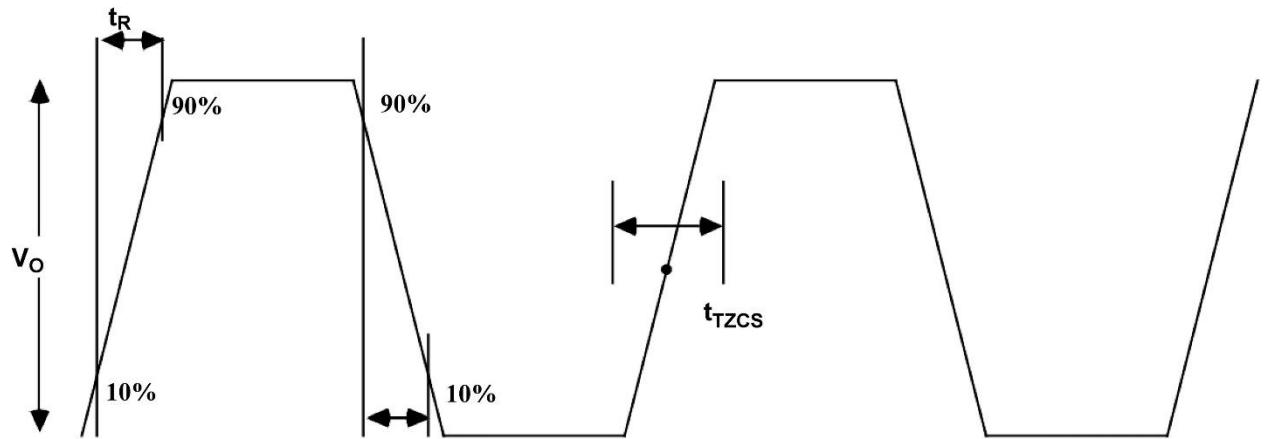


Figure 10. Transmitter Output Zero Crossing Stability, Rise Time, Fall Time (tTZCS, tR, tF)

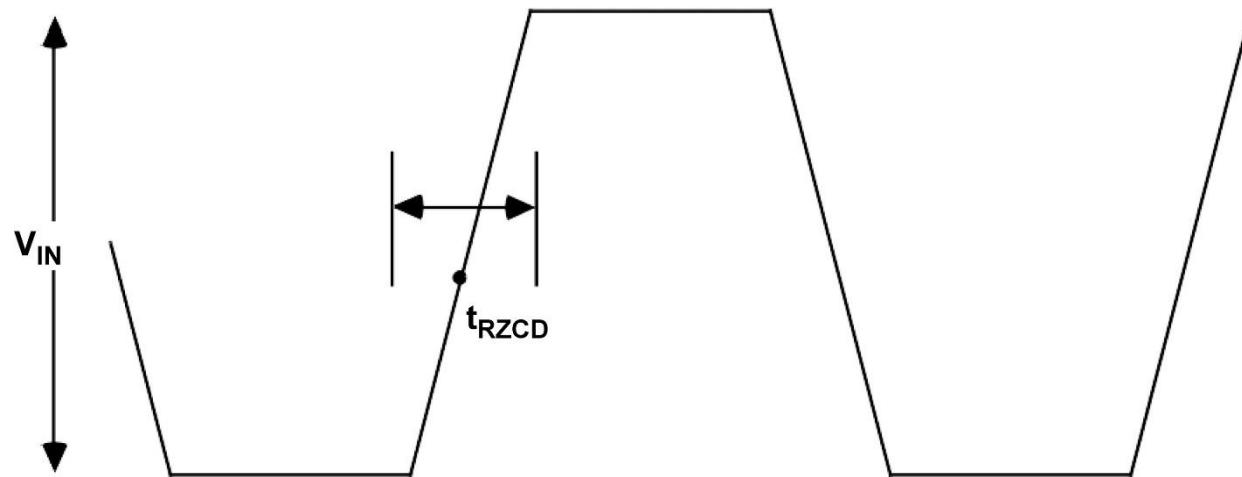


Figure 11

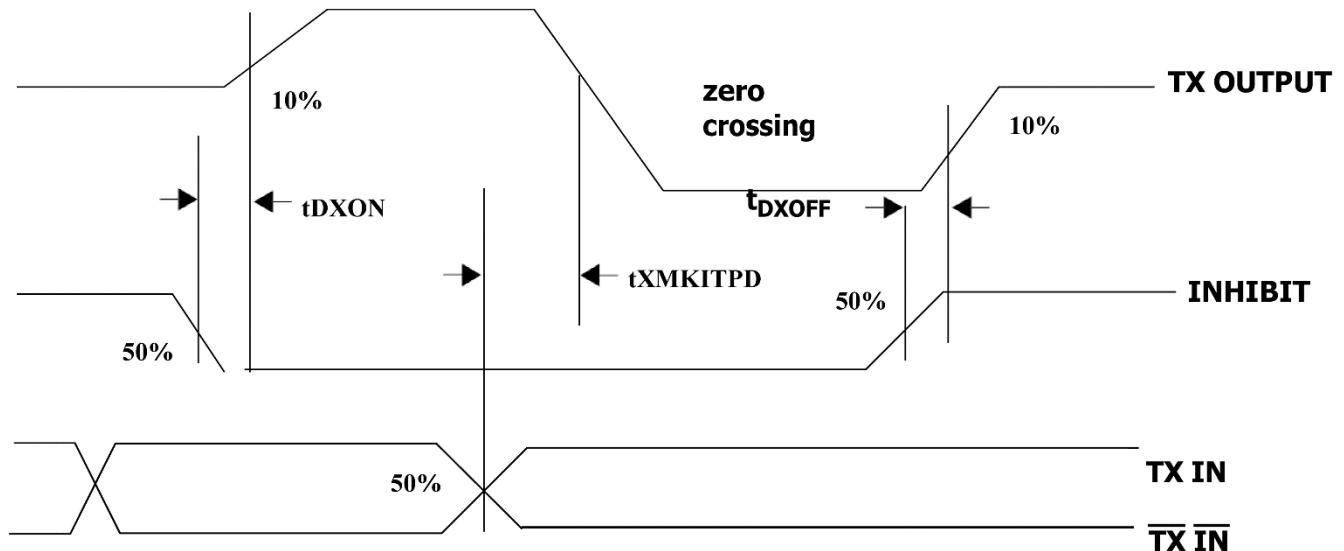


Figure 12. Transmitter Timing

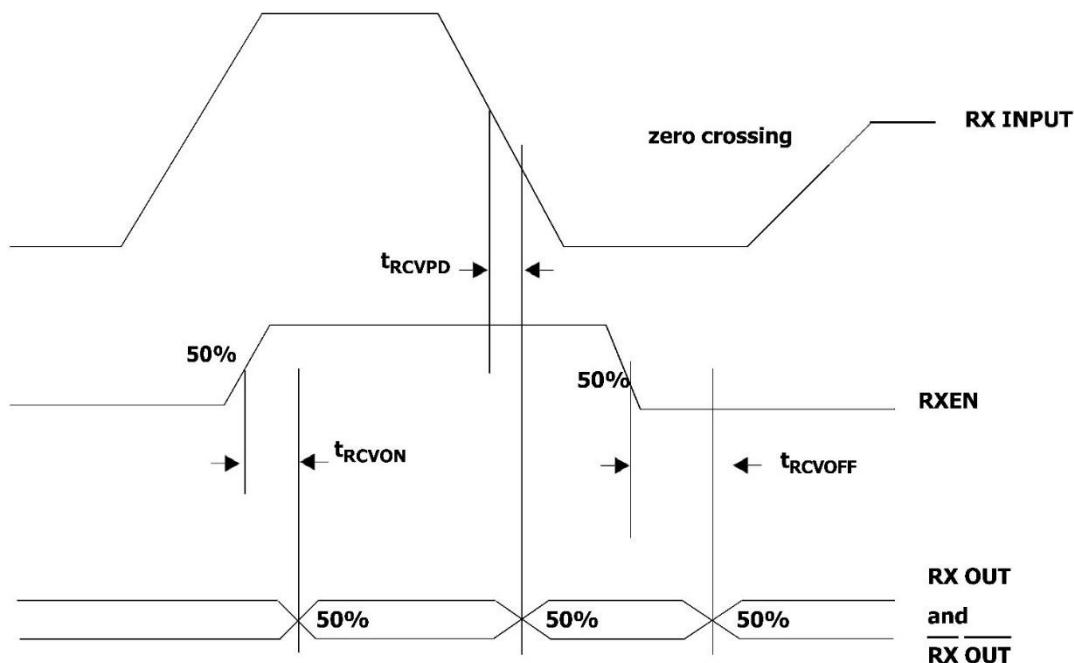


Figure 13. Receiving Timing

## Packaging

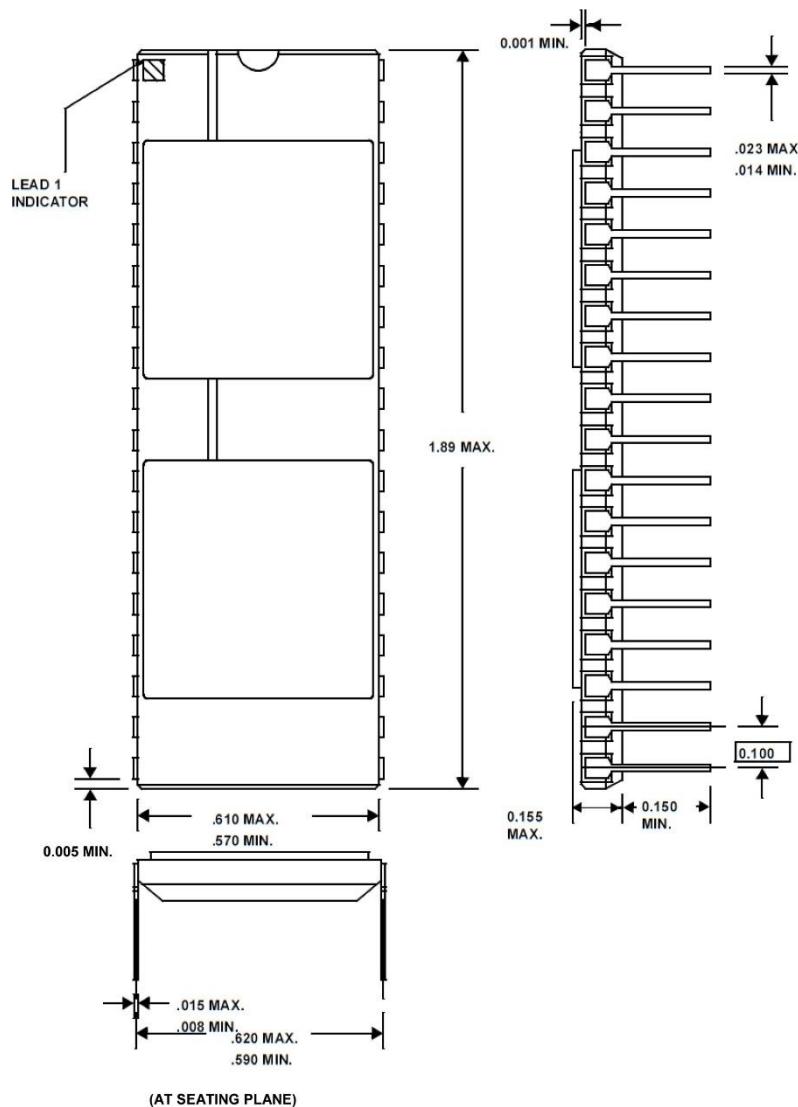


Figure 14. 36-Pin Side-Brazed DIP, Dual Cavity

**Notes:**

1. Package material: opaque ceramic.
2. All package finishes are per MIL-PRF-38535.
3. It is recommended that package ceramic be mounted on a heat removal rail in the printed circuit board. A thermally conductive material should be used.
4. Units are in inches.

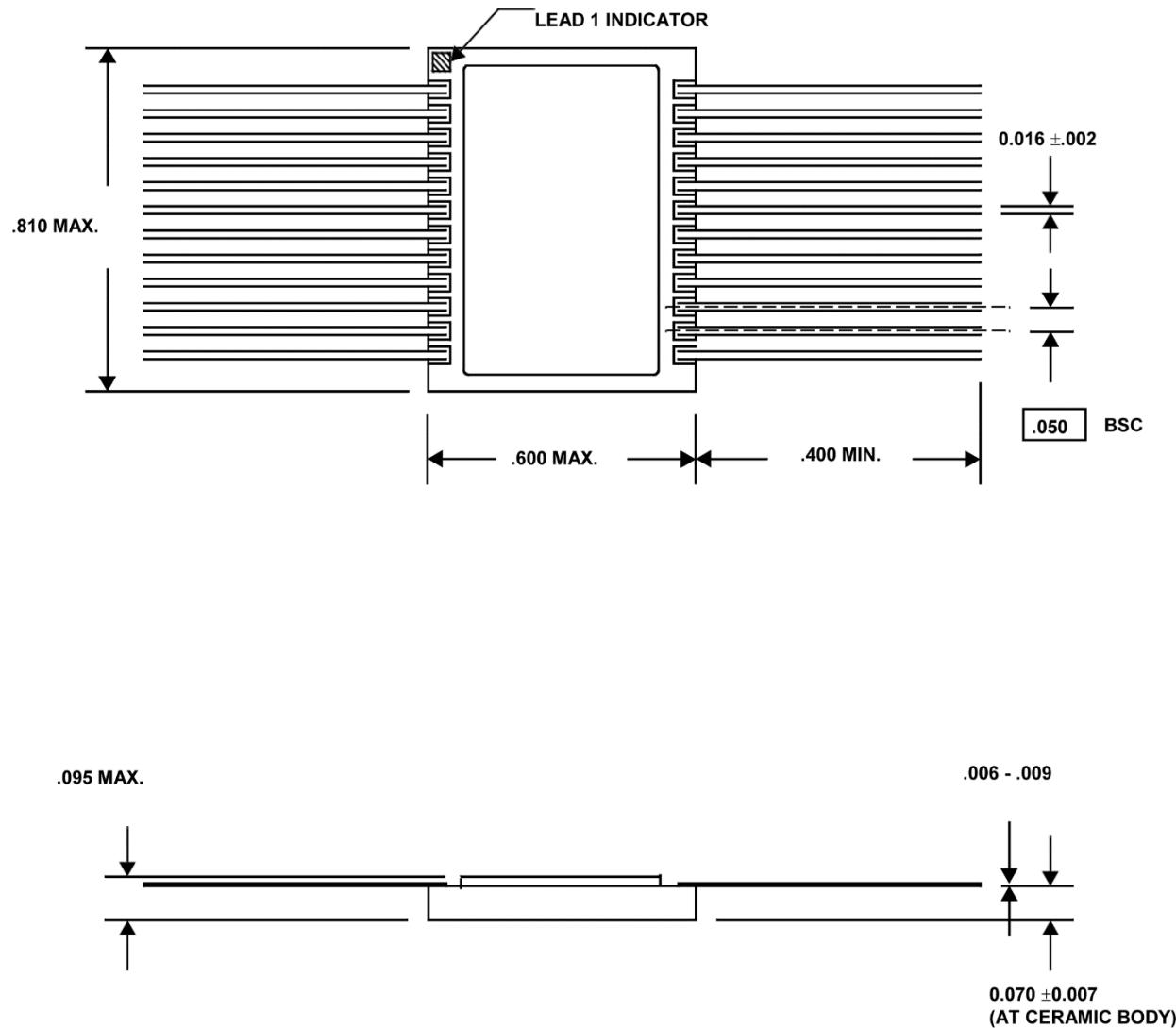
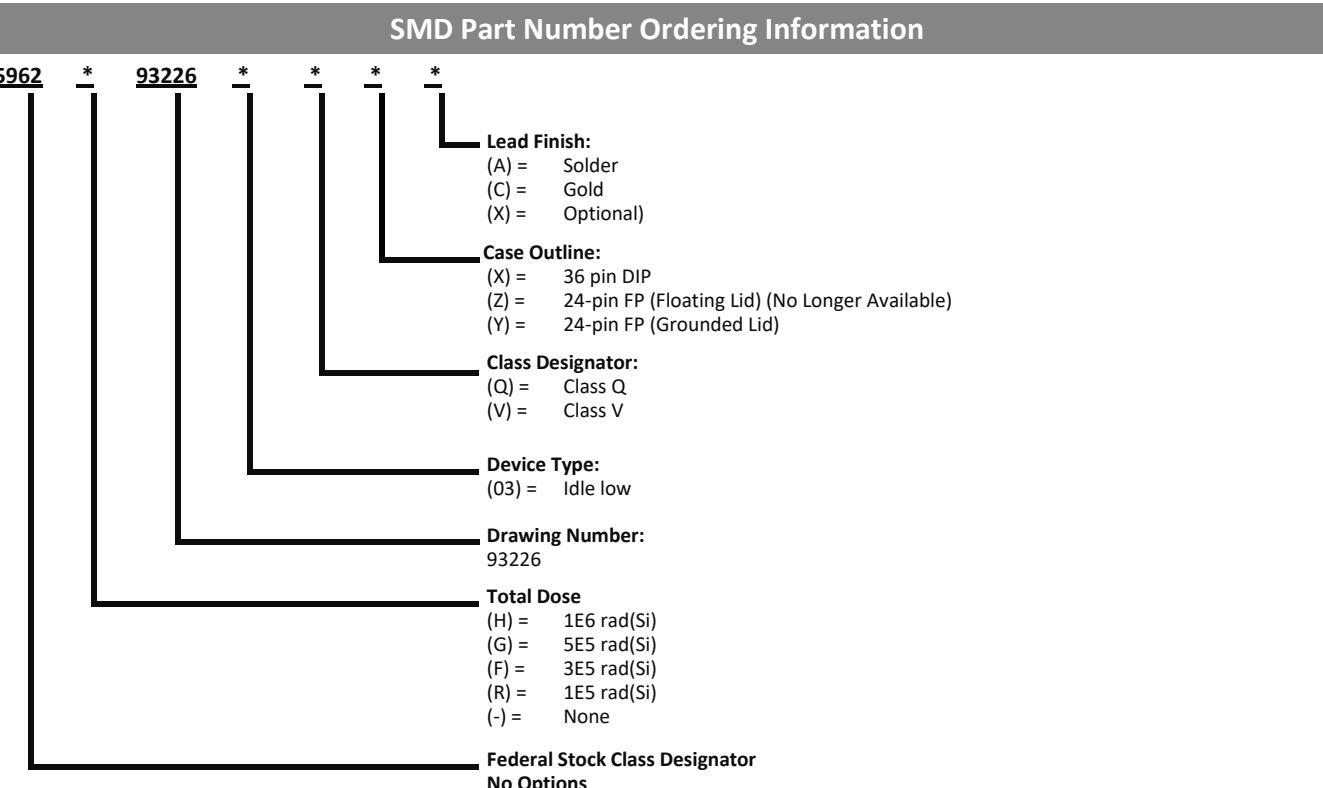


Figure 15. 24-Lead Flatpack, Dual Cavity (50-mil lead spacing)

**Notes:**

1. Package material: opaque ceramic.
2. All package plating finishes are per MIL-PRF-38535.
3. It is recommended that package ceramic be mounted to a heat removal rail located in the printed circuit board. A thermally conductive material should be used.
4. Units are in inches.

## Ordering Information



### Notes:

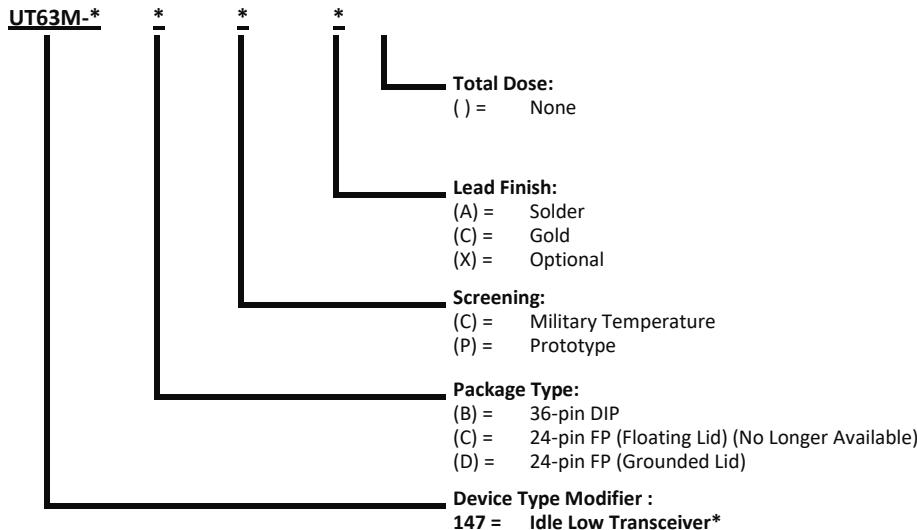
1. Lead finish (A, C, or X) must be specified.
2. If "X" is specified when ordering, part marking will match the lead finish and will be either "A" (solder) or "C" (gold).
3. Total dose must be specified for QML Q and QML V devices.
4. Neutron irradiation limits will be added when available.

## Ordering Information

### Notes:

1. Lead finish (A, C, or X) must be specified.
2. If an "X" is specified when ordering, part marking will match the lead finish and will be either "A" (solder) or "C" (gold).
3. Total dose must be specified for all QML Q and QML V devices.
4. Neutron irradiation limits will be added when available.

### Frontgrade Part Numbering Ordering Information



#### Notes:

1. Lead finish (A, C, or X) must be specified.
2. If an "X" is specified when ordering, part marking will match the lead finish and will be either "A" (solder) or "C" (gold).
3. Military Temperature range devices are burned-in and tested at -55°C, room temperature, and 125°C. Radiation characteristics are neither tested nor guaranteed and may not be specified.
4. Devices have prototype assembly and are tested at 25°C only. Radiation characteristics are neither tested nor guaranteed and may not be specified. Lead finish is GOLD only.

## Revision History

Date	Revision #	Author	Change Description	Page #
9-09		TS	Last official release	
11-15		TS	Edited Table 2 and Absolute Maximums Applied new Frontgrade Data Sheet template Page 6 clarified Figure 4 Timing Diagrams Page 7: Corrected note for Figure 5 Page 7 Added "Point A" notation to Figure 6	p. 6, 7
1-18		TM	Page 9 edit to Absolute Maximums Input Voltage Range	p. 9
7-19		RS	Added 24-pin FP package offering with grounded lid and obsoleted 24-pin FP package offering with floating lid.	

## Datasheet Definitions

Definition	
Advanced Datasheet	Frontgrade reserves the right to make changes to any products and services described herein at any time without notice. The product is still in the development stage and the <b>datasheet is subject to change</b> . Specifications can be <b>TBD</b> and the part package and pinout are <b>not final</b> .
Preliminary Datasheet	Frontgrade reserves the right to make changes to any products and services described herein at any time without notice. The product is in the characterization stage and prototypes are available.
Datasheet	Product is in production and any changes to the product and services described herein will follow a formal customer notification process for form, fit or function changes.

**Note: The following Commerce Statement should be used depending upon the ECCN classification.**

The following United States (U.S.) Department of Commerce statement shall be applicable if these commodities, technology, or software are exported from the U.S.: These commodities, technology, or software were exported from the United States in accordance with the Export Administration Regulations. Diversion contrary to U.S. law is prohibited.