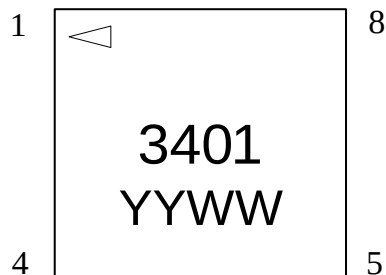


IRL3401FI**RS-485/422 Transceiver**

YY – Year of manufacture
WW – Week of manufacture

Key parameters:

- Power supply voltage from 3.0 to 5.5 V;
- The receiver's input impedance corresponds to 1/8 load unit, which allows up to 256 microchips to be connected in parallel.
- Common-mode voltage of the data bus from -7 to +12 V;
- Overheat protection;
- Short-circuit protection;
- Data transfer speed up to 30 Mbps;
- Weight not more than 0.12 g;
- MSL 2a
- Temperature range from - 40 °C to + 85 °C.

Package Type:

- DFN8 5x6x1.6 (1.27) plastic package.

General Description and Areas of Application

The IRL3401FI (hereinafter referred to as microcircuits) are designed to be used in equipment as a transceiver according to the RS-485/422 standard with a data transfer rate of up to 30 Mbps.

Usage as per RS-422 standard is possible when two IRL3401FI ICs are used. However, one microchip should be switched on only in transmission mode, and the other – only in reception mode.

Contents

1	Structural block diagram	3
2	Conventional graphic symbol.....	3
3	Pin description	4
4	Instructions for use and operation (IFU).....	5
5	Microcircuit operation.....	6
5.1	Transmitter mode. RS-485.....	6
5.2	Receiver mode. RS-485.....	6
5.3	Microhip in "Shutdown" mode	7
5.4	Maximum bus length.....	7
6	Timing diagrams	8
7	Standard connection diagrams.....	10
8	Electrical parameters.....	12
9	Maximum Permissible Parameter Limits.....	14
10	Reference parameters	15
11	Dimensional drawing	16
12	Order Information	17

1 Structural block diagram

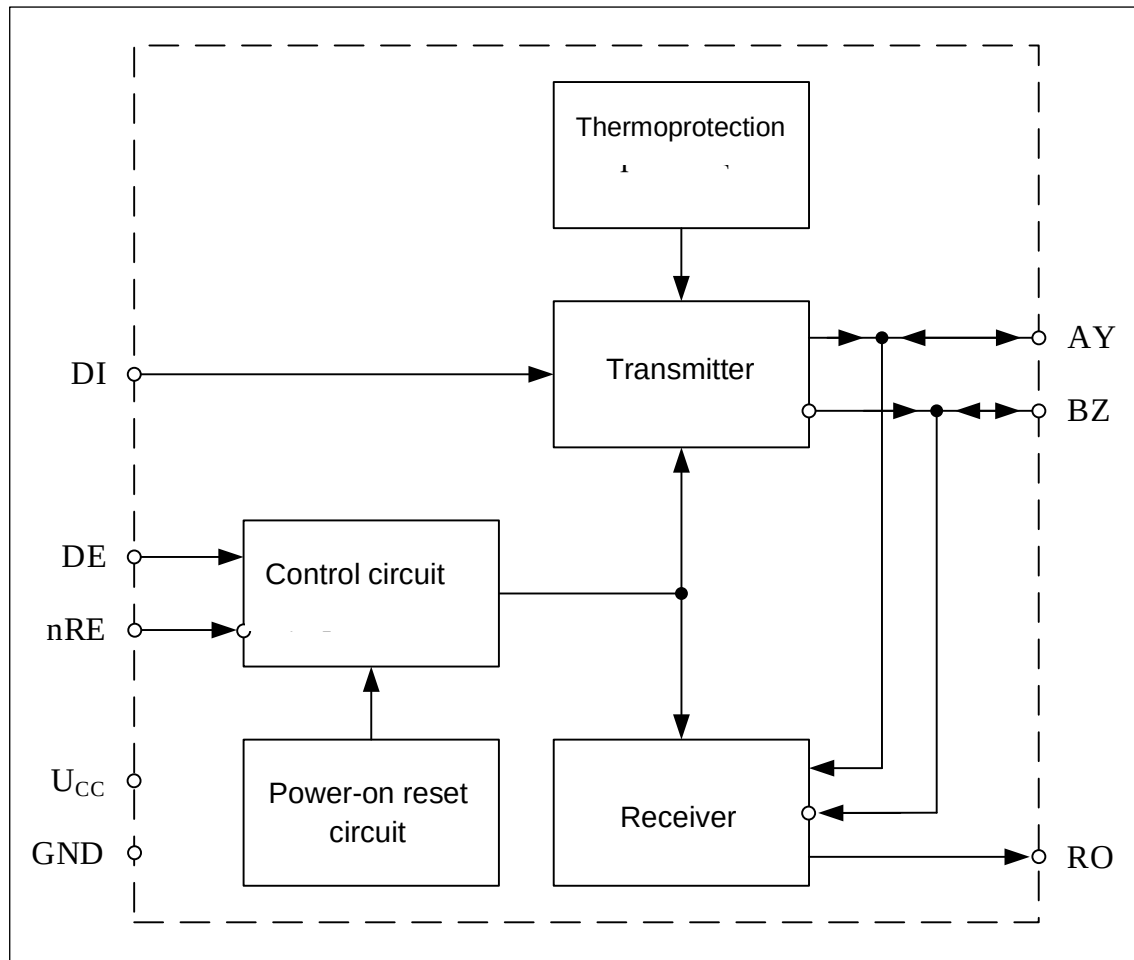


Figure 1 – Chip block diagram

2 Conventional graphic symbol

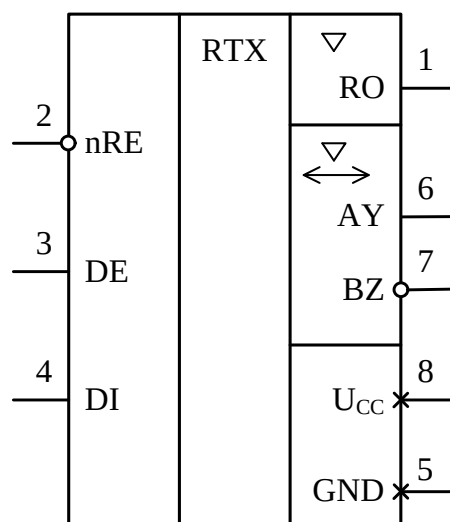


Figure 2 – Conventional graphic symbol

3 Pin description

Table 1 – IC Pin Description

Pin number	Pin designation	Pin functional purpose	
1	RO	Output	Receiver Output
2	nRE	Input	Receiver On/Off: "0" – receiver is on; "1" – receiver is off
3	DE	Input	Transmitter On/Off: "0" – transmitter is off; "1" – transmitter is on
4	DI	Input	Transmitter Input
5	GND	GND	General
6	AY	Input/Output	"Positive" transmitter output / receiver input
7	BZ	Input/Output	"Negative" transmitter output / receiver input
8	U _{CC}	PWR	Power supply

4 Instructions for use and operation (IFU)

During the repair of equipment and measurement of the parameters, microchips should only be replaced when the power sources are disconnected.

The soldering (welding) and assembly tool should not have a potential exceeding 0.3 V relative to the common bus.

It is forbidden to connect any electrical signals (including power and ground buses) to the RO output if it is not in use.

Unused logic inputs nRE, DE, and DI must be connected to ground or power supply bus according to the truth tables.

Capacitors connected to the power pin should be placed as close as possible to the IC package.

Order of applying and removing power supply voltages and input signals to the microchip:

- Supply (microchip enable): common, power, input signals or simultaneously;
- Removal (microchip deactivation): simultaneously or in reverse order.

It is allowed to apply Input voltages to the AY and BZ inputs/outputs when the supply voltage is disconnected.

Typical connection diagrams for the microcircuits are given in Paragraph 7 Standard connection diagrams.

5 Microcircuit operation

5.1 Transmitter mode. RS-485

The transmitter outputs have a slew rate limitation of the output signal to reduce the level of electromagnetic interference and reflections with an imperfectly matched bus. This ensures stable information transfer.

The circuit implements two transmitter output protection mechanisms:

- by maximum output current;
- by dissipated power.

Protection is activated in the cases of incorrect use of the transceiver circuit: shorting the transmitter outputs to the power and/or ground buses, as well as in conflict situations – attempts by multiple transceivers to transmit data simultaneously.

Thermal protection scheme activates at die temperature of at least 160°C and switches the transmitter circuit to the "Off" state.

The truth table for the operation of the transmitter IC is given in Table 2.

Table 2 – Transmitter operation truth table

Inputs			Outputs
nRE	DE	DI	AY – BZ
X	1	1	$\geq U_{O_D}$
X	1	0	$\leq -U_{O_D}$
0	0	X	Z
1	0	X	Z. "Off" mode
Note – Logical level at output: 1 – logical '1'; 0 – logical '0'; X – any value: logical '1' or logical '0'; Z – high impedance (high output resistance)			

5.2 Receiver mode. RS-485

The truth table for the operation of the receiver IC is given in Table 3.

Table 3 – Receiver operation truth table

Inputs			Outputs
nRE	DE	AY – BZ	RO
0	X	$\geq -30 \text{ mV}$	1
0	X	$\leq -200 \text{ mV}$	0
0	X	Open/short circuit	1
1	1	X	Z
1	0	X	Z. "Off" mode
Note – Logical level at output: 1 – logical '1'; 0 – logical '0'; X – any value: logical '1' or logical '0'; Z – high impedance (high output resistance)			

Description for RS-485/433 Transceiver

The IC receiver has built-in bias, so external resistors are not required to set the bias in the line.

The input impedance of an RS-485 receiver, as per the standard, must be at least 12 k Ω (one unit load), and a standard transmitter can operate up to 32 unit loads. The input impedance of the IRL3401FI is 1/8 load unit (not less than 96 k Ω), which allows up to 256 equivalent transceivers to be connected in parallel to the bus. Also, a combination on the chip bus with transceivers having a different input impedance is acceptable.

5.3 Microchip in "Shutdown" mode

Applying a logical '0' to the DE input while applying a logical '1' to the nRE input switches the microchip to the 'Off' mode with reduced current consumption. The microchip does not enter this mode if the hold time for the combination DE = "0" and nRE = "1" at the inputs is less than 50 ns. For guaranteed switching to the "Off" mode, the hold time for the DE = "0" and nRE = "1" combination at the inputs must be at least 700 ns.

5.4 Maximum bus length

The maximum bus length according to the RS-485 standard is 1200 m. In case of exceeding this length, repeaters should be used.

6 Timing diagrams



Figure 3 – Timing diagram for measuring t_{PLH_D} and t_{PHL_D}

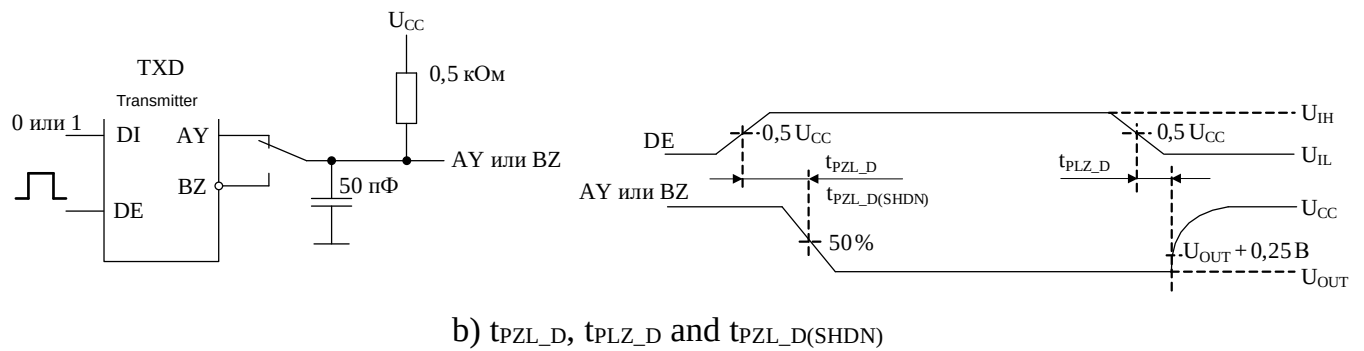
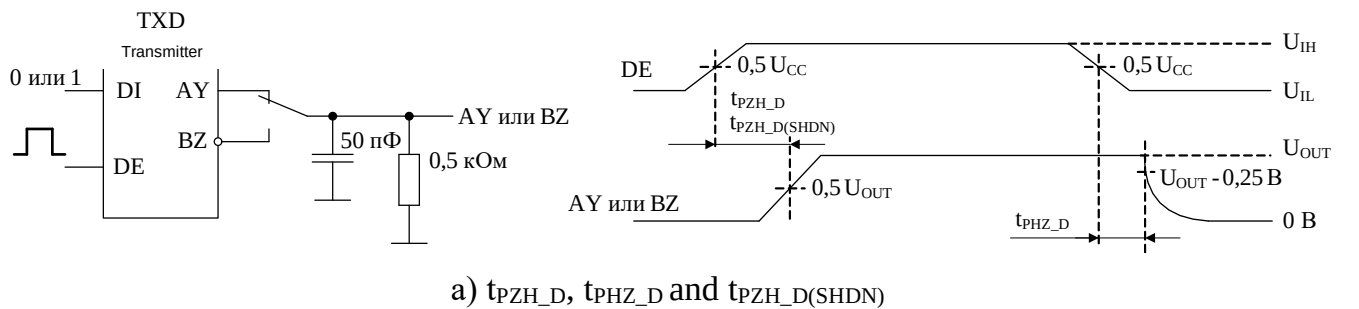


Figure 4 – Schematic diagrams of connection and timing diagrams during measurement

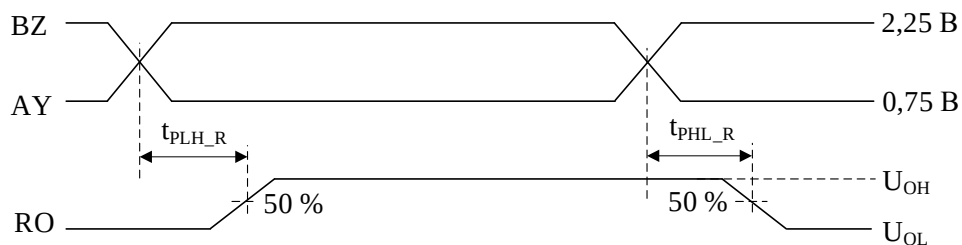
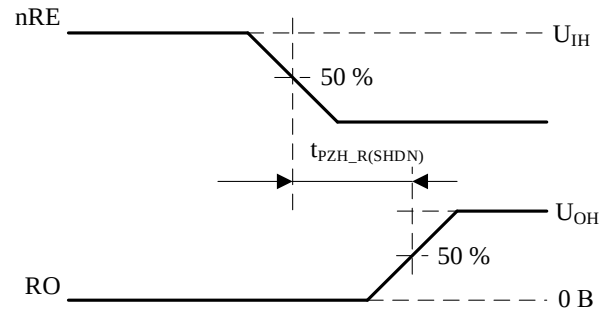
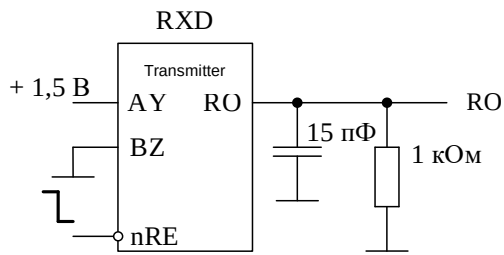
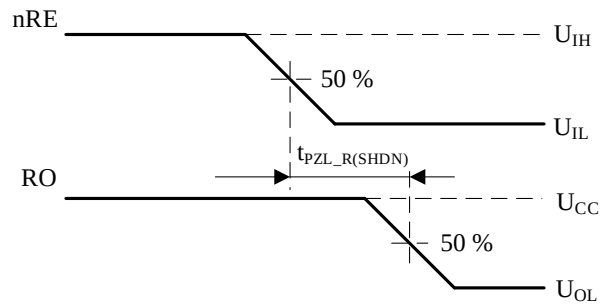
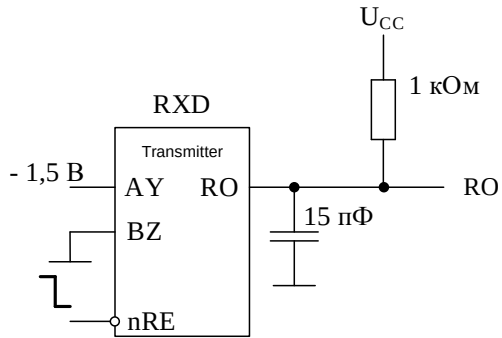


Figure 4 – Timing diagram for measuring t_{PLH_R} and t_{PHL_R}

Description for RS-485/433 Transceiver



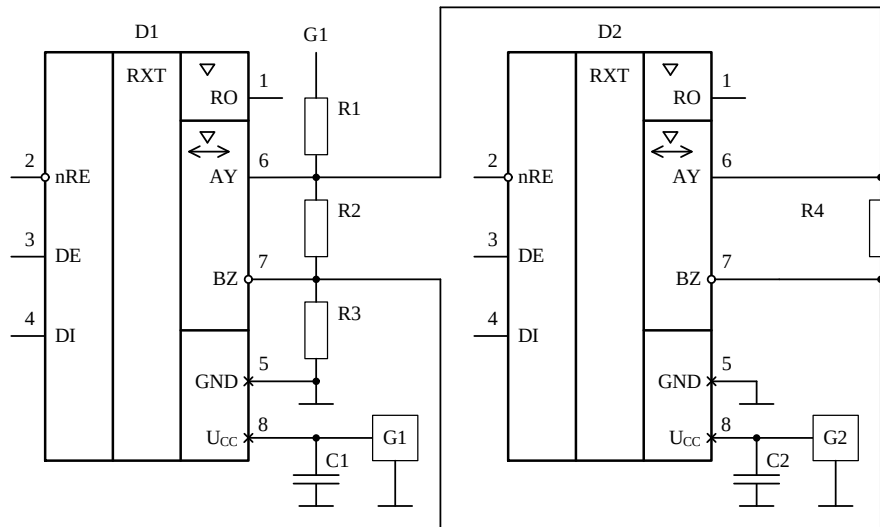
a) $t_{PZH_R(SHDN)}$



b) $t_{PZL_R(SHDN)}$

Figure 5 – Schematic diagrams of connection and timing diagrams during measurement

7 Standard connection diagrams



C1, C2 – capacitors with a capacitance of at least $0.1 \mu\text{F} \pm \pm 20\%$;

D1, D2 the IRL3401FI connected

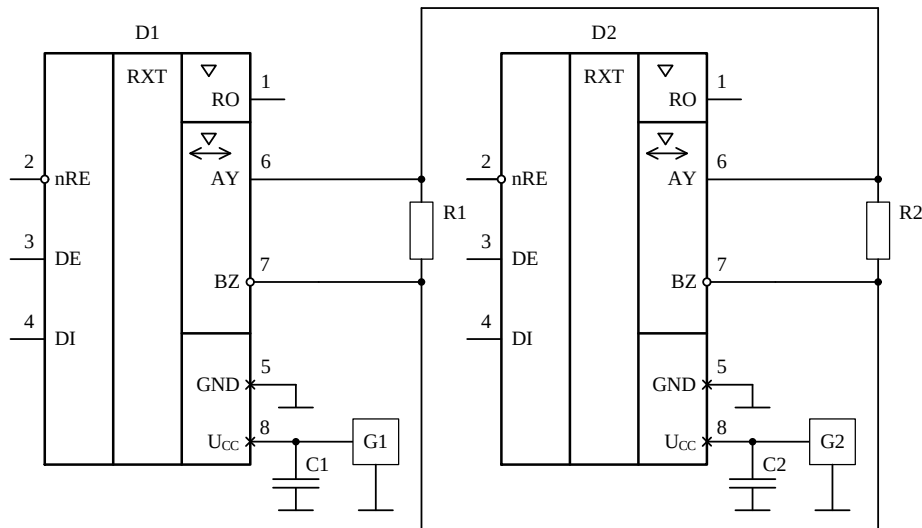
G1, G2 – power supply voltage sources 3.0 – 5.5 V;

R1 – R4 – resistors with a resistance of:

$R1 = R3 = 583 \text{ Ohms} \pm 0.5\%$,
 $R2 = 133 \text{ Ohm} \pm 0.5\%$
 $R4 = 120 \text{ Ohm} \pm 0.5\%$.

When using a transmission line with a characteristic impedance of 120 Ohms, the line must be matched at both ends with resistors of 120 Ohms.

Figure 6 – Typical connection diagram for microcircuits with external line biasing (RS-485)



C1, C2 – capacitors with a capacitance of at least $0.1 \mu\text{F} \pm \pm 20\%$;

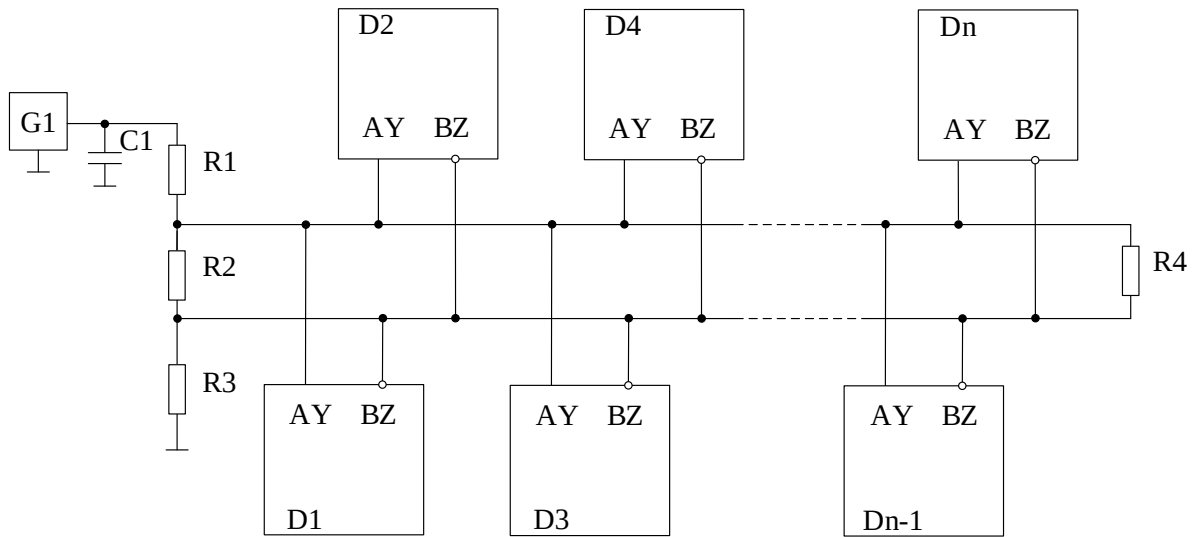
D1, D2 the IRL3401FI connected

G1, G2 – power supply voltage sources 3.0 – 5.5 V;

R1, R2 – resistors with a resistance of 120 Ohms.

The microchips should be used in a transmission line terminated at both ends with resistors of 120 Ohms.

Figure 8 – Typical connection diagram for microcircuits without external line biasing (RS-485)



- C1 – capacitor with a capacitance of at least $0.1 \mu\text{F} \pm \pm 20\%$;
 D1 – Dn the IRL3401FI
 G1 – power supply voltage source 3.0 – 5.5 V;
 R1 – R4 – resistors with a resistance of: $R1 = R3 = 583 \text{ Ohms} \pm 0.5\%$,
 $R2 = 133 \text{ Ohm} \pm 0.5\%$
 $R4 = 120 \text{ Ohm} \pm 0.5\%$.

Figure 7 – Typical resistor connection diagram for bias voltage in the line (RS-485)

The resistances of the resistors in figures 67, 9 7 are calculated for a supply voltage of 5.0 V and a bias voltage in the line of minus 250 mV.

For other supply voltages and bias voltages in the line, the calculation of the protective bias resistor values R1 – R3 is done using the formulas

$$R1 = R3 = \left(\frac{U_{CC}}{|U_{CM}|} + 1 \right) \cdot 27,8 \text{ (Om)} ; \quad (12)$$

$$R2 = \frac{1}{\frac{1}{R4} - \frac{1}{2 \cdot R3}} \text{ (Om)} , \quad (22)$$

where U_{SM} – bias voltage in the line, V;

R4 – matching resistor, Ohm. $R4 = 120 \text{ Ohms}$.

Resistors must be selected from preferred value series in accordance with the permissible deviation for the supply voltage.

8 Electrical parameters

Table 1 – Electrical parameters of the microcircuits

Parameter name, measurement unit, measurement mode	Letter identification of the parameter	Parameter standard		Ambient temperature,
		not less	not more	
Transmitter output differential voltage, V, at: $4,5 \leq U_{CC} \leq 5,5$ V, at: $R_L = 100$ Ohm; $R_L = 54$ Ohm at: $3.0 \leq U_{CC} < 4.5$ V, at: $R_L = 100$ Ohm, $R_L = 54$ Ohm	U_{OD}	2.5	U_{CC}	25, 85, – 40
		2.0		
		1.5		
Change in output differential voltage of the transmitter, V	ΔU_{OD}	–	0.2	
Transmitter output common-mode voltage, V, at: $R_L = 100$ Ohm, $R_L = 54$ Ohm	U_{OC}	–	3	
Change in transmitter output common-mode voltage, V, at: $R_L = 100$ Ohm; $R_L = 54$ Ohm	ΔU_{OC}	–	0.2	
Receiver high-level output voltage, V, at: $I_O = -1$ mA	U_{OH}	$U_{CC} - 0.6$	–	
Receiver low-level output voltage, V, at: $I_O = 1$ mA	U_{OL}	–	0.4	
Consumption current, mA, at: $U_{nRE} = 0$ V, $U_{DE} = U_{CC}$, no load $U_{nRE} = U_{CC}$, $U_{DE} = U_{CC}$, no load $U_{nRE} = 0$ V, $U_{DE} = 0$ V	I_{CC}	–	1.8	
Consumption current in the "Off" state, μ A (receiver and transmitter are off), at: $U_{nRE} = U_{CC}$, $U_{DE} = 0$ V	I_{SHDN}	–	20	
High/low level input current, μ A on the nRE, DE and DI outputs	I_{IH} I_{IL}	– 1	1	
Receiver input leakage current, μ A	I_{L_R}	– 100	125	
Transmitter output short-circuit current, mA, at: $U_{CC} \leq U_{AY}(U_{BZ}) \leq 12$ V at: -7 V $\leq U_{AY}(U_{BZ}) \leq 0$	I_{OS_D}	40	250	25, 85, – 40
		– 250	– 40	
Transmitter minimum short-circuit current, mA, at: $U_{CC} - 1 \leq U_{AY}(U_{BZ}) \leq 12$ V at: -7 V $\leq U_{AY}(U_{BZ}) \leq 1$ V	I_{OSF_D}	20	–	
		–	– 20	
Receiver output current in "Off" state, μ A	I_{OZ_R}	– 1	1	

Description for RS-485/433 Transceiver

Parameter name, measurement unit, measurement mode	Letter identification of the parameter	Parameter standard		Ambient temperature,
		not less	not more	
Receiver output short-circuit current, mA, at: $0\text{ V} \leq U_{RO} < U_{CC}$	I_{OS_R}	– 110	110	
Transmitter signal propagation delay time when switching on/off, ns at: $C_L = 50\text{ pF}$, $R_L = 54\text{ Ohms}$, at: $4.5\text{ V} \leq U_{CC} \leq 5.5\text{ V}$;	t_{PLH_D} t_{PHL_D}	–	15	
at: $3.0\text{ V} \leq U_{CC} < 4.5\text{ V}$			25	
Transmitter propagation delay time when switching from the "Off" state to the high/low level state, ns at: $U_{nRE} = 0\text{ V}$ (receiver ON)	t_{PZH_D} t_{PZL_D}	–	60	
Transmitter propagation delay time from high/low level to "Off" state, ns, at: $U_{nRE} = 0\text{ V}$ (receiver ON)	t_{PHZ_D} t_{PLZ_D}	–	100	
Transmitter propagation delay time when switching from "Off" to high/low level, μs , at: $U_{nRE} = U_{CC}$ (receiver off)	$t_{PZH_D}(SHDN)$ $t_{PZL_D}(SHDN)$	–	5.5	
Receiver signal propagation delay time when switching on/off, ns	t_{PLH_R} t_{PHL_R}	–	60	
Receiver signal propagation delay difference, ns, $ t_{PLH_R} - t_{PHL_R} $	t_{SKEW_R}	–	30	
Receiver signal propagation delay time when switching from the "Off" state to the high/low level state, μs , at: $U_{DE} = 0\text{ V}$ (transmitter off)	$t_{PZH_R}(SHDN)$ $t_{PZL_R}(SHDN)$	–	5.5	

The microchips must be resistant to static electricity with a potential of at least 2,000 V.

9 Maximum Permissible Parameter Limits

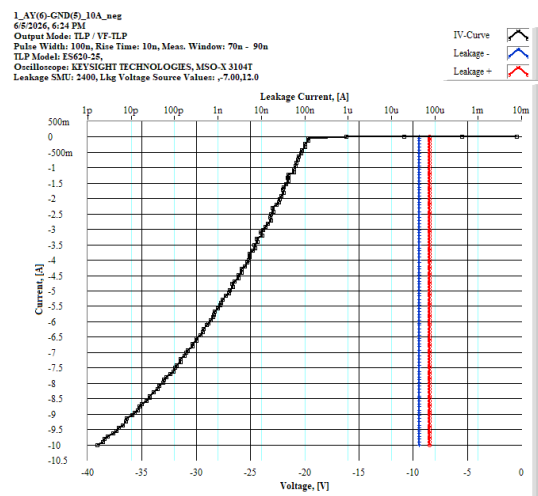
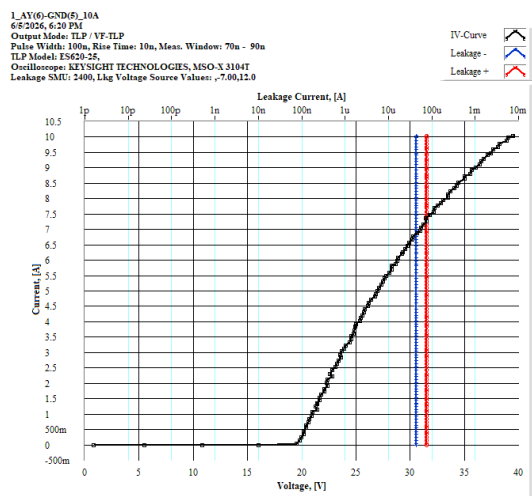
Table 2 – Maximum permissible and limit operating modes of the microchips

Parameter name, unit of measurement	Letter identification of the parameter	Parameter standard			
		Maximum permissible mode		Limit mode	
		at least	not more than	at least	not more than
Power supply voltage, V	U_{CC}	3.0	5.5	–	6.0
Low-level input voltage, V	U_{IL}	0	0.8	– 0,3	–
High-level input voltage, V	U_{IH}	2.4	U_{CC}	–	$U_{CC} + 0.3$
Receiver input voltage, V	U_{LR}	– 7	12	– 8	13
Receiver differential threshold voltage, mV, at: $-7V < U_{LR} < 12V$	U_{TH}	– 200	– 30	–	–
Data transfer rate, Mbps	f_{DR}	–	30	–	–
Note – Simultaneous exposure to several limit modes is not allowed					

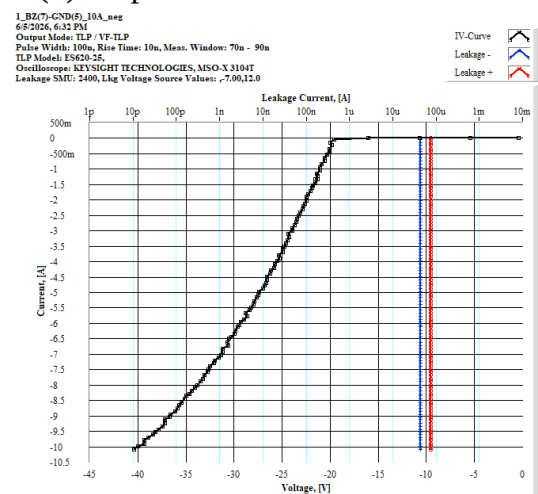
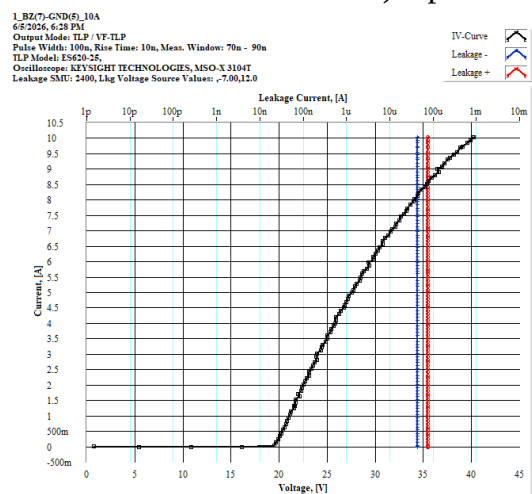
10 Reference parameters

Table 3 – Microchip Reference Parameters

Parameter name, unit of measurement	Letter identification of the parameter	Parameter standard		Environment Temperature, °C
		not less	not more	
Electrostatic discharge human body model (ESD HBM) resistance, kV, AY(6) – GND(5), BZ(7) – GND(5)	—	–15*	15*	—
* By TLP (Transmission-Line Pulse) method				



a) a pair of AY(6)-GND(5) outputs



b) a pair of BZ(6)-GND(5) outputs

Figure 108 – Results of the electrostatic discharge withstand test using the TLP method

11 Dimensional drawing

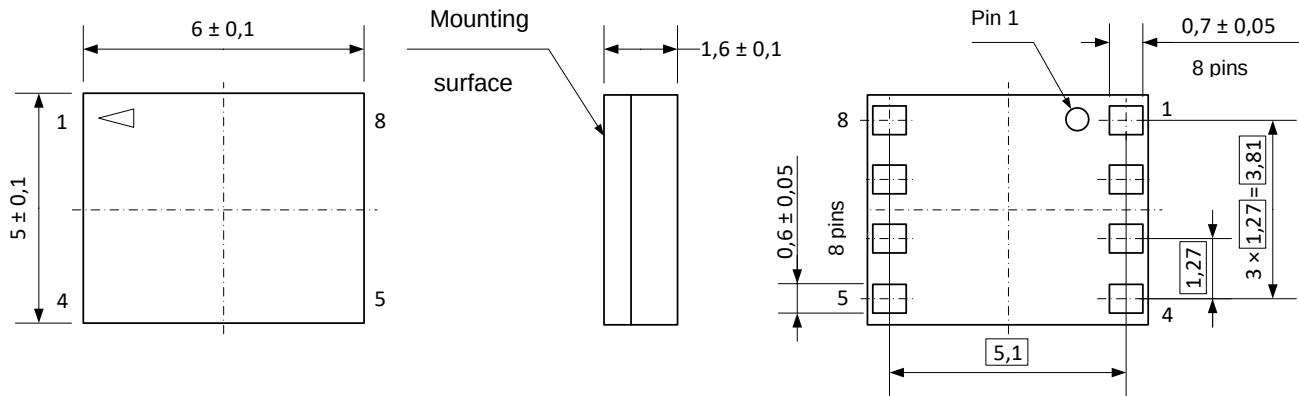


Figure 119 – Microcircuit in DFN8 5×6×1.6 (1.27) package

12 Order Information

Part number	Marking	Package Type:	Temperature range, °C
IRL3401FI	3401	DFN8 5×6×1.6 (1.27)	from – 40 to +85