Async/Sync Industrial Line Driver

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AND
CANADIAN DEPARTMENT OF COMMUNICATIONS
RADIO FREQUENCY INTERFERENCE STATEMENTS

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio communication. It has been tested and found to comply with the limits for a Class A computing device in accordance with the specifications in Subpart J of Part 15 of FCC rules, which are designed to provide reasonable protection against such interference when the equipment is operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference, in which case the user at his own expense will be required to take whatever measures may be necessary to correct the interference.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This digital apparatus does not exceed the Class A limits for radio noise emission from digital apparatus set out in the Radio Interference Regulation of Industry Canada.

Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de la classe A prescrites dans le Règlement sur le brouillage radioélectrique publié par Industrie Canada.

NORMAS OFICIALES MEXICANAS (NOM)
ELECTRICAL SAFETY STATEMENT

INSTRUCCIONES DE SEGURIDAD

1. Todas las instrucciones de seguridad y operación deberán ser leídas antes de que el aparato eléctrico sea operado.

2. Las instrucciones de seguridad y operación deberán ser guardadas para referencia futura.

3. Todas las advertencias en el aparato eléctrico y en sus instrucciones de operación deben ser respetadas.

4. Todas las instrucciones de operación y uso deben ser seguidas.

5. El aparato eléctrico no deberá ser usado cerca del agua—por ejemplo, cerca de la tina de baño, lavabo, sótano mojado o cerca de una alberca, etc..

6. El aparato eléctrico debe ser usado únicamente con carritos o pedestales que sean recomendados por el fabricante.

7. El aparato eléctrico debe ser montado a la pared o al techo sólo como sea recomendado por el fabricante.

8. Servicio—El usuario no debe intentar dar servicio al equipo eléctrico más allá a lo descrito en las instrucciones de operación. Todo otro servicio deberá ser referido a personal de servicio calificado.

9. El aparato eléctrico debe ser situado de tal manera que su posición no interfiera su uso. La colocación del aparato eléctrico sobre una cama, sofá, alfombra o superficie similar puede bloquea la ventilación, no se debe colocar en libreros o gabinetes que impidan el flujo de aire por los orificios de ventilación.

10. El equipo eléctrico deber ser situado fuera del alcance de fuentes de calor como radiadores, registros de calor, estufas u otros aparatos (incluyendo amplificadores) que producen calor.

11. El aparato eléctrico deberá ser connectado a una fuente de poder sólo del tipo descrito en el instructivo de operación, o como se indique en el aparato.

12. Precaución debe ser tomada de tal manera que la tierra fisica y la polarización del equipo no sea eliminada.

13. Los cables de la fuente de poder deben ser guiados de tal manera que no sean pisados ni pellizcados por objetos colocados sobre o contra ellos, poniendo particular atención a los contactos y receptáculos donde salen del aparato.

14. El equipo eléctrico debe ser limpiado únicamente de acuerdo a las recomendaciones del fabricante.

15. En caso de existir, una antena externa deberá ser localizada lejos de las lineas de energia.

16. El cable de corriente deberá ser desconectado del cuando el equipo no sea usado por un largo periodo de tiempo.

17. Cuidado debe ser tomado de tal manera que objectos liquidos no sean derramados sobre la cubierta u orificios de ventilación.

18. Servicio por personal calificado deberá ser provisto cuando:

    A: El cable de poder o el contacto ha sido dañado; u

    B: Objectos han caído o líquido ha sido derramado dentro del aparato; o

    C: El aparato ha sido expuesto a la lluvia; o

    D: El aparato parece no operar normalmente o muestra un cambio en su desempeño; o

    E: El aparato ha sido tirado o su cubierta ha sido dañada.

Contents

1. Specifications

Transmission Format —   Synchronous or asynchronous, 2-wire/half duplex or 4-wire/full or half duplex

Interface —   RS-232 (CCITT V.24) connection via DB25 female; Twisted-pair connection via RJ-45

Transmission Line —   2- or 4-wire UTP, 19 to 26 AWG

Data Rates —   Synchronous or asynchronous at 1.2, 1.8, 2.4, 3.6, 4.8, 7.2, 9.6, 14.4, 19.2, 28.8, 38.4, 57.6, and 64 kbps (switch-selectable)

Clocking —   Internal, external, or receive recover

Controls —   Carrier Constantly ON or Controlled by RTS; RTS/CTS delay set to no delay, 7 ms, or 53 ms

Applications —   Point-to-point or multipoint

Indicators —   Mono-color LEDs for TX, RX, RTS, and CD; Single LEDs for Power, Test, and Error

RTS Anti-Stream Timer —   12.5 sec., 50 sec., or disabled (switch-selectable); Tolerance: +50%, -0

Diagnostics —   V.52-compliant bit-error-rate pattern (511/511E pattern) generator and detector with error-injection mode; V.54 compliant—Local Analog Loopback and Remote Digital Loopback, activated by front-panel switch or via RS-232 interface

Transformer Isolation —   2000 V RMS

Surge Protection —   Immune to IEC-801-5 Level 2, 1kV

Temperature —   14 to 158°F (-10 to +70°C)

Power Supply —   157 to 242 VAC Universal Interface

Size —   1.6"H x 5.5"W x 7.5"D (4 x 14 x 19.1 cm)

2. Introduction

2.1 Description

The Async/Sync Industrial Line Driver operates 2-wire (half duplex) or 4-wire (full or half duplex), in synchronous or asynchronous modes, over unconditioned telephone lines. The Line Driver supports data rates up to 64 kbps. It operates in synchronous mode between the local and remote modems; when connected to an asynchronous RS-232 device, the Line Driver converts the asynchronous data to synchronous data.

To enhance overall performance, the Line Driver features equalization, anti-streaming timer, transformer isolation (to guard against data loss due to ground-potential differences), and Silicon Avalanche Diode surge protection (to guard against data-line transients).

The Async/Sync Industrial Line Driver features V.52-compliant bit-error-rate pattern tests and two V.54 test modes (local analog loopback and remote digital loopback). The operator at the local end can test both local and remote modems, plus the line, in the digital-loopback mode. Both RDL and LAL modes can be controlled by a manual switch or via the V.24/RS-232 interface.

2.2 Features

- Distances up to 12 miles (19.2 km).

- Point-to-point or multipoint.

- Internal, external, or received loopback clocking.

- 2000-VAC transformer isolation and high-speed surge protection.

- Internal power supply.

3. Configuration

3.1 Configuration Switches

The Async/Sync Industrial Line Driver uses 24 external mini DIP switches that allow configuration to an extremely wide range of applications. These 24 DIP switches are grouped into three eight-switch sets, and are externally accessible from the underside of the unit (see Figure 3-1). Since all configuration DIP switches are externally accessible, there is no need to open the case for configuration.

The configuration switches allow you to select data rates, clocking methods, V.52 and V.54 tests, word lengths, extended signaling rates, async or sync mode, 2- or 4-wire operation, anti-stream control, and input impedance. The information on the following pages describes all switch locations, positions, and functions.
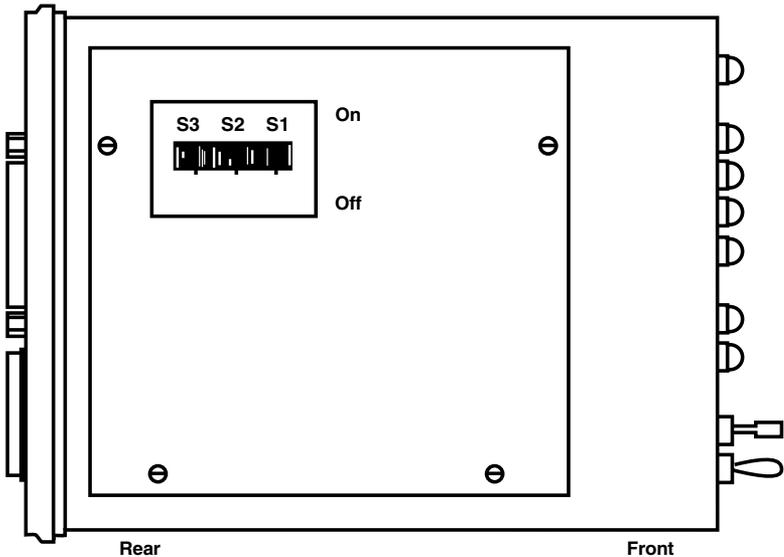
Figure 3-1. Bottom view of Async/Sync Industrial Line Driver.

The Line Driver has three sets of eight switches, yielding 24 total DIP switches. The three sets will be referred to as switch sets S1, S2, and S3. As Figure 3-2 shows, the orientation of all DIP switches is the same with respect to ON and OFF positions.
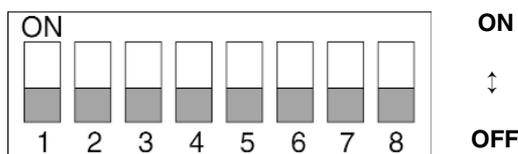
Figure 3-2. Close-up of DIP switches showing ON and OFF positions.

3.2 Configuration Switch Set S1

The DIP switches on S1 set data rate, clock source, async/sync mode, and carrier-control method. The default settings are shown in the table below.

Table 3-1. S1 switches

Position	Function	Factory Default	
S1-1	Data Rate	On	
S1-2	Data Rate	Off	9600 bps
S1-3	Data Rate	Off	
S1-4	Data Rate	On	
S1-5	Clock Source	On	
S1-6	Clock Source	On	Internal
S1-7	Async/Sync	On	Async
S1-8	Carrier Control	Off	Constantly On

All the possible configuration settings are described in detail beginning on the next page.

Switches S1-1 through S1-4 and S3-3: Data-Rate Setting
Switches S1-1 through S1-4 and S3-3 are set in combination to determine the asynchronous and synchronous data rate for the Async/Sync Industrial Line Driver.

Table 3-2. Data-Rate Settings

S1-1	S1-2	S1-3	S1-4	S3-3	Setting (kbps)
On	On	On	On	Off	1.2
Off	On	On	On	Off	1.8
On	Off	On	On	Off	2.4
Off	Off	On	On	Off	3.6
On	On	Off	On	Off	4.8
Off	On	Off	On	Off	7.2
On	Off	Off	On	Off	9.6
Off	Off	Off	On	Off	14.4
Off	On	Off	On	On	16*
On	On	On	Off	Off	19.2
Off	On	On	Off	Off	28.8
Off	Off	Off	On	On	32*
On	On	Off	Off	Off	38.4
Off	On	Off	Off	Off	57.6
Off	On	On	Off	On	64*

*Must have switch 3-3 On.

Switches S1-5 and S1-6: Clock Source
Switches S1-5 and S1-6 are set in combination to determine the transmit clock source for the Async/Sync Industrial Line Driver.

S1-5	S1-6	Setting
On	On	Internal transmit clock
Off	On	Receive recover clock
On	Off	External transmit clock

Switch S1-7: Asynchronous/Synchronous Mode
The setting for switch S1-7 determines whether the Async/Sync Industrial Line Driver is in asynchronous or synchronous operating mode.

S1-7	**Setting**
On	Asynchronous
Off	Synchronous

Switch S1-8: Carrier-Control Method
The setting for switch S1-8 determines whether the carrier is Constantly On or Controlled by RTS. This setting allows for operation in switched carrier, multipoint, and/or hardware-handshaking applications.

S1-8	**Setting**
Off	Constantly On
On	Controlled by RTS

3.3 Configuration Switch Set S2

The DIP switches on S2 set word length, extended signaling rate, RTS/CTS delay, V.52 and V.54 diagnostic test, and 2- and 4-wire operation.

Table 3-3. S2 switches

Position	Function	Factory Default	
S2-1	Word Length	Off	
S2-2	Word Length	Off	10 bits
S2-3	Extended Signaling Rate	Off	-2.5% to 1%
S2-4	RTS/CTS Delay	On	
S2-5	RTS/CTS Delay	On	7 ms
S2-6	2-Wire/4-Wire	On	
S2-7	2-Wire/4-Wire	Off	(4-Wire) FDX
S2-8	V.54	Off	V.54 Enabled

Switches S2-1 and S2-2: Word Length
Switches S2-1 and S2-2 are set in combination to determine the word length for asynchronous data, including the start and stop bits.

S2-1	S2-2	Setting
Off	On	8 bits
On	On	9 bits
Off	Off	10 bits
On	Off	11 bits

Switch S2-3: Extended Signaling Rate
The setting for switch S2-3 determines the range of variability the Async/Sync Industrial Line Driver "looks for" in asynchronous data rates (that is, the actual variance from a given frequency level the Line Driver will tolerate).

S2-3	Setting
Off	-2.5% to +1%
On	-2.5% to +2.3%

Switches S2-4 and S2-5: RTS/CTS Delay
The combined settings for switches S2-4 and S2-5 determine the amount of delay between the time the Line Driver "sees" RTS and when it sends CTS. Options are no delay, 7 ms, and 53 ms.

S2-4	S2-5	Setting
On	On	7 ms
Off	On	53 ms
On	Off	No delay
Off	Off	No delay

Switch S2-6 and S2-7: 2-Wire/4-Wire Mode Selection
The setting for switch S2-6 and S2-7 determines whether the Async/Sync Industrial Line Driver is operating in 2-wire or 4-wire mode.

S2-6	S2-7	Setting
On	On	4-wire (half duplex)
On	Off	4-wire (full duplex)
Off	On	2-wire (half duplex)

Switch S2-8: V.54 Loopback Test Enable
This switch enables or disables V.54 looping in the Async/Sync Industrial Line
Driver.

S2-8	Setting
Off	V.54 Normal Operation Enabled
On	V.54 Testing Disabled

3.4 Configuration Switch Set S3

The DIP switches on S3 set the anti-stream control, timing mode, topology, local
loopback enable, remote loopback enable, and input impedance levels for the
Async/Sync Industrial Line Driver. Factory-default positions are shown in the table
below.

Table 3-4. S3 switches

Position	Function	Factory Default	
S3-1	Input Impedance	On	
S3-2	Input Impedance	Off	200 ohms
S3-3	Timing Mode	Off	
S3-4	Topology	On	Point-to-point
S3-5	Local Loopback	Off	Disabled
S3-6	Remote Loopback	Off	Disabled
S3-7	Anti-Stream Control	Off	
S3-8	Anti-Stream Control	Off	Disabled

Switches S3-1 and S3-2: Input Impedance
The setting for Switches S3-1 and S3-2 determines the Line Driver's input impedance. This allows you to choose the optimum impedance setting for your application. In long-distance applications, the impedance of the cable must match the impedance of the load (or resistor) of the Async/Sync Industrial Line Driver. Thicker-gauge cables require a lower-ohm setting, while a thinner-gauge cable should receive a higher-ohm setting. If you are using higher speeds, you will need a lower-ohm setting and a higher-ohm setting for the slower speeds. Refer to Table 3-5 for assistance in selecting a setting.

S3-1	S3-2	Setting
On	On	130 ohms
On	Off	200 ohms
Off	On	320 ohms
Off	Off	High impedance (minimum 2k ohms)

Table 3-5. Speed Selection

Cable Gauge	Data Rates (kbps)							
	1.2	1.8	2.4	3.6	4.8	7.2	9.6	14.4
19 AWG/0.9 mm	320	320	200	200	200	200	200	130
22 AWG/0.6 mm	320	320	320	200	200	200	200	200
24 AWG/0.5 mm	320	320	320	320	200	200	200	200
26 AWG/0.4 mm	320	320	320	320	320	200	200	200

Cable Gauge	Data Rates (kbps)						
	16	19.2	28.8	32	38.4	57.6	64
19 AWG/0.9 mm	130	130	130	130	130	High	High
22 AWG/0.6 mm	200	130	130	130	130	High	High
24 AWG/0.5 mm	200	200	130	130	130	High	High
26 AWG/0.4 mm	200	200	200	200	130	High	High

Switch S3-3: Timing-Mode Selection
Use Switch S3-3 to select the Line Driver's timing mode. To operate the Line Driver at 16, 32, or 64 kbps, set S3-3 to the On position. To select any other DTE rate, set Switch S3-3 Off.

S3-3	Setting
On	16, 32, or 64 kbps
Off	1.2 through 57 kbps, excluding 16 and 32 kbps

Switch S3-4: Topology
Use switch S3-4 to select the topology of the Async/Sync Industrial Line Driver.

S3-4	Setting
On	Point-to-point
On	Master multipoint
Off	Slave multipoint

Switch S3-5: RS-232 Initiation of Local Loopback Test
The setting for switch S3-5 determines whether or not the Async/Sync Industrial Line Driver local analog loopback test can be initiated by raising pin 18 on the RS-232 interface.

S3-5	Setting
On	RS-232 initiation enabled
Off	RS-232 initiation disabled

Switch S3-6: RS-232 Initiation of Remote Loopback Test
The setting for switch S3-6 determines whether or not the Async/Sync Industrial Line Driver remote digital loopback test can be initiated by raising pin 21 on the RS-232 interface.

S3-6	Setting
On	RS-232 initiation enabled
Off	RS-232 initiation disabled

Switches S3-7 and S3-8: Anti-Stream Control
Switches S3-7 and S3-8 are set in combination to determine the time-out period for the Line Driver's anti-stream control timer.

S3-7	S3-8	Setting
Off	Off	Disabled
Off	On	12.5 seconds
On	Off	50 seconds
On	On	12.5 seconds

4. Installation

The Async/Sync Industrial Line Driver operates in four twisted-pair topologies: 2-wire/point-to-point, 2-wire/multipoint, 4-wire/point-to-point, and 4-wire/multipoint. In each of these topologies, the twisted-pair wire must be 19 to 26 AWG dry, unconditioned metallic wire (see the **Appendix** for wire recommendations). Dial-up analog circuits, such as those used with a standard Hayes-type modem, are not acceptable. The twisted pair may be shielded or unshielded. (Both types work well.)

The Async/Sync Industrial Line Driver has an RJ-45 jack for its twisted-pair line connection. Figure 4-1 shows the location of the RJ-45 jack on the Line Driver's rear panel. Connect the wire to each Line Driver as described in the instructions that follow the illustration.
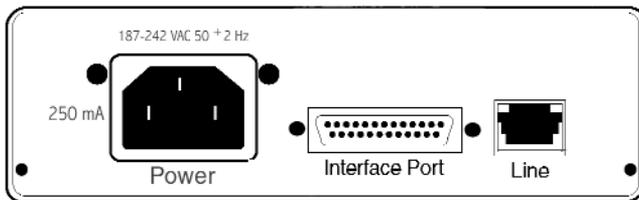

Figure 4-1. The Line Driver's rear panel.

4.1 Two-Wire Installation

When communicating over a single twisted-pair circuit, the Async/Sync Industrial Line Driver operates half duplex (that is, it transmits in only one direction at a time). This is effective for both point-to-point and multipoint applications.

In single-pair point-to-point applications, you will need a pair of Async/Sync Industrial Line Drivers for each circuit (one at each end of the single-pair wire). In single-pair multipoint applications you'll need three or more Async/Sync Industrial Line Drivers. These can be connected using a daisychain or star topology.

4.1.1 TWO-WIRE CABLE CONNECTION VIA RJ-45

The RJ-45 jack on an Async/Sync Industrial Line Driver is prewired for a standard telco wiring environment. To be sure you have the right wiring, use the table below as a guide.

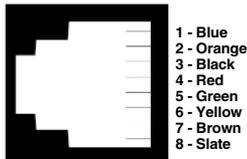| RJ-45	Signal
1	NC
2	GND†
3	RCV
4	XMT
5	XMT
6	RCV
7	GND
8	NC

†Connection to ground is optional.

Proper wiring of pairs between the two Line Drivers is as follows:

Signal	Pin#	Color*	Color	Pin#	Signal
XMT	4	Green	Green	4	XMT
XMT	5	Red	Red	5	XMT

*Standard color codes—yours may be different.

AT&T standard modular color codes are:

1 - Blue
2 - Orange
3 - Black
4 - Red
5 - Green
6 - Yellow
7 - Brown
8 - Slate

4.2 Four-Wire Installation

When communicating over a two-twisted-pair circuit, the Async/Sync Industrial Line Driver can operate full or half duplex, point-to-point or multipoint. In two-pair point-to-point applications, you'll need a pair of Line Drivers for each circuit (one at each end of the two-pair cable). In two-pair multipoint applications you'll need three or more Async/Sync Industrial Line Drivers. These can be connected using a daisychain or star topology.

4.2.1 FOUR-WIRE CABLE CONNECTION VIA RJ-45

The RJ-45 jack on an Async/Sync Industrial Line Driver is prewired for a standard telco wiring environment. To be sure you have the right wiring, use the table below as a guide.

RJ-45	Signal
1	NC
2	GND†
3	RCV
4	XMT
5	XMT
6	RCV
7	GND
8	NC

†Connection to ground is optional.

Proper crossing of pairs between the two Line Drivers is as follows:

Signal	Pin#	Color*	Color	Pin#	Signal
GND†	2	Orange	Brown	7	GND
RCV	3	Black	Green	5	XMT
XMT	4	Red	Yellow	6	RCV
XMT	5	Green	Black	3	RCV
RCV	6	Yellow	Red	4	XMT
GND	7	Brown	Orange	2	GND

*Standard color codes—yours may be different.
†Connection to ground is optional.

AT&T standard modular color codes are:


```
1 - Blue
2 - Orange
3 - Black
4 - Red
5 - Green
6 - Yellow
7 - Brown
8 - Slate
```
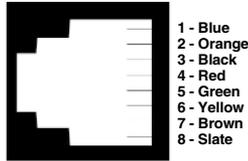
4.3 Four-Wire, Multipoint Installation

Multipoint operation involves the connection of several terminals to one host port. In such an application, one local Async/Sync Industrial Line Driver is used as a master unit, and it is connected to several remote Async/Sync Industrial Line Drivers that are acting as slaves.

In a multipoint environment, the master Async/Sync Industrial Line Driver transmits continually. Initiation of two-way communication is RTS-controlled by each slave Async/Sync Industrial Line Driver. To facilitate multipoint communication, the master Async/Sync Industrial Line Driver should have its carrier-control DIP switch set to Constantly ON (S1-8=OFF). Each slave Line Driver should have its carrier-control DIP switch set to Controlled by RTS (S1-8=ON). Figure 4-2 shows a typical Line Driver multipoint application.
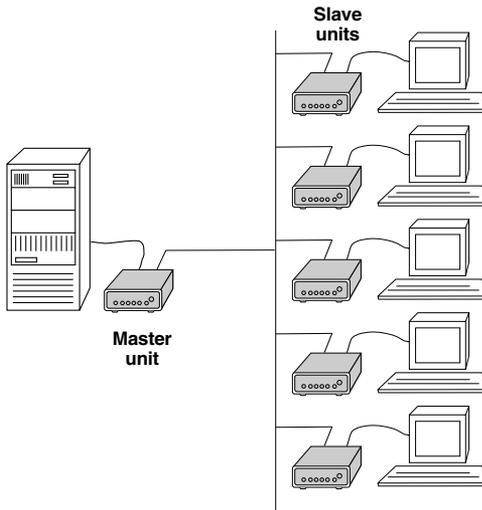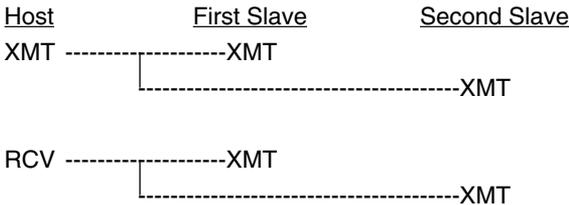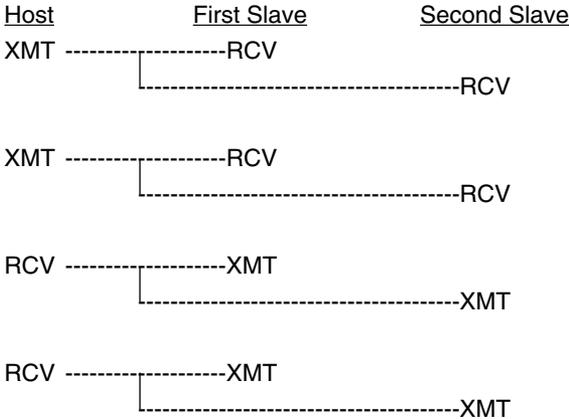

Figure 4-2. Typical multipoint setup.

4.3.1 MULTIPOINT TWISTED-PAIR CONNECTION

The Async/Sync Industrial Line Driver supports multipoint applications using a star topology. Maximum distance between the Line Drivers will vary based on the number of drops, data rate, wire gauge, etc. Call Technical Support for specific distance estimates. The illustration below shows how to wire the one-pair and two-pair cables properly for a star topology. Note that the ground connection is not needed.

```
Host                First Slave        Second Slave
XMT --------------------RCV
                  └------------------------------------RCV


XMT --------------------RCV
                  └------------------------------------RCV


RCV --------------------XMT
                  └------------------------------------XMT


RCV --------------------XMT
                  └------------------------------------XMT



Host                First Slave        Second Slave
XMT --------------------XMT
                  └------------------------------------XMT


RCV --------------------XMT
                  └------------------------------------XMT
```

4.4 RS-232 Connection

Connect the synchronous or asynchronous output of your RS-232 device to the DB25 interface on the Line Driver's rear panel.

NOTE

The Async/Sync Industrial Line Driver is wired to connect to a DTE. If your RS-232 output device is DCE, call Technical Support for specific installation instructions.

5. Operation

Once you've configured each Async/Sync Industrial Line Driver and connected the twisted-pair and RS-232 cables (see **Chapter 4**), you're ready to operate the Line Drivers.

5.1 LED Status Monitors

The Async/Sync Industrial Line Driver has seven front-panel status LEDs that indicate the condition of the Line Driver and communication link. Figure 5-1 shows the LED's location. Following the illustration is a description of each LED's function.
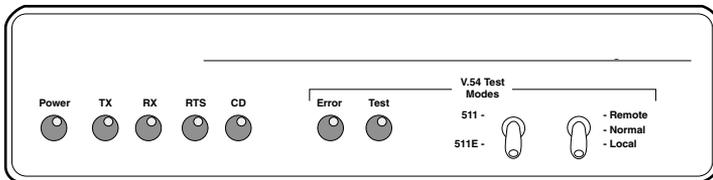

Figure 5-1. Front panel.

5.1.1 THE POWER, TX, AND RX INDICATORS

The Power LED lights green to signal that power is present. The TX and RX indicators blink green with data activity. Off indicates a low RS-232 logic level, solid green indicates a high RS-232 logic level.

NOTE

RS-232 devices idle in a low state, so the LED will be off if the connections are correct and the RS-232 device is in an idle state.

5.1.2 THE RTS AND CD INDICATORS

These indicators will be off for a low signal or green for a high signal. RTS lights for an incoming signal on RS-232 pin 4. CD lights for an incoming signal on the line side, and the resulting output signal on RS-232 pin 8.

5.1.3 THE TEST INDICATOR

The yellow Test LED indicates that V.52 or V.54 tests are running.

5.1.4 THE ERROR INDICATORS

The Error indicator LED has two functions:

- When the Async/Sync Industrial Line Driver is in test mode (green Test LED is lit), the Error LED glows red when bit errors occur.

- When not in test mode (green Test LED is off), the Error LED indicates an RTS streaming condition. (See **Section 5.2** for information on the anti-streaming circuitry.)

5.2 Anti-Streaming Error Indicator

When not in test mode (green Test LED is off), the Error LED indicates a streaming error. When the Async/Sync Industrial Line Driver's anti-streaming circuitry is enabled, the RTS signal from the DTE is timer controlled. The timer begins to count when the DTE raises RTS. If the time period that RTS remains high exceeds the preset time-out period, the anti-stream circuit will force RTS low. The Error LED will light red, indicating a streaming condition (RTS continually on). This prevents a malfunctioning terminal from tying up a computer port in a multi-drop or polling environment. When the DTE drops RTS, the anti-streaming timer is automatically reset and the Error LED turns off. The time-out period is DIP-switch selectable for 12.5 or 50 seconds.

5.3 Power-Up

Apply AC power to the Line Driver by plugging the separate AC power cable first into the Line Driver's rear panel and then into an acceptable AC power outlet. The Remote/Normal/Local switch should be set to Normal. When the local and remote Async/Sync Industrial Line Drivers are powered up and passing data normally, these LED conditions will exist:

- TX and RX = flashing on and off

- RTS and CD = green

- TEST = off

5.4 V.54 Test Modes

The Async/Sync Industrial Line Driver offers two V.54 test modes to evaluate the condition of the modems and the communication link. These tests can be activated physically from the front panel or via the RS-232 interface.

NOTE

V.54 test modes are available for point-to-point applications only.

5.4.1 LOCAL ANALOG LOOPBACK (LAL)

The Local Analog Loopback (LAL) test checks the operation of the local Async/Sync Industrial Line Driver and is performed separately on each unit. In this test mode, any data sent to the local Line Driver will be echoed back (returned) to the user device. For example, characters typed on the keyboard of a terminal will appear on the terminal screen.

To perform a LAL test:

1. Activate LAL. You can do this in one of two ways: by moving the front-panel toggle switch to Local or by raising pin 18 on the RS-232 interface (Make sure DIP-switch S2-6 is OFF, and DIP-switch S3-5 is ON). Once LAL is activated, the Line Driver's transmit output is connected to its own receiver. The Test LED should be lit.

2. Verify that the data terminal equipment is operating properly and can be used for a test. If a fault is indicated, call Technical Support.

3. Perform a BER (bit error rate) or 511/511E test on each Line Driver. If the BER-test equipment indicates no faults, but the data terminal indicates a fault, follow the manufacturer's checkout procedures for the data terminal. Also, check the RS-232 interface cable between the terminal and the Line Driver.

5.4.2 REMOTE DIGITAL LOOPBACK (RDL)

The Remote Digital Loopback (RDL) test checks the performance of both the local and remote Line Drivers and the communication link between them. In this test mode, any characters sent to the remote Async/Sync Industrial Line Driver will be returned back to the originating device. For example, characters typed on the keyboard of the local terminal will appear on the local terminal screen after having been passed to the remote Line Driver and looped back.

To perform an RDL test:

1. Activate RDL. You can do this in one of two ways: By moving the front-panel toggle switch to Remote or by raising pin 21 on the RS-232 interface (make sure DIP-switch S3-6 is ON and DIP-switch S2-6 is OFF).

2. Perform a BER-test (bit error rate) 511/511E test on the system. If the BER-test equipment indicates a fault, and the Local Analog Loopback test was successful for both Line Drivers, you may have a problem with the twisted-pair line between the Line Drivers. Test the twisted-pair line for proper connections and continuity.

5.4.3 USING THE V.52 BER TEST INDEPENDENTLY

The V.52 BER test can be used independently of the V.54 loopback tests. This requires two operators: one to initiate and monitor the test at the local Line Driver, and one at the remote Line Driver.

To use the V.52 BER test by itself, both operators should simultaneously follow these steps:

1. Locate the 511/511E toggle switch on the front panel and move it UP. This activates the V.52 BER test mode and transmits a 511 test pattern to the other Line Driver. If any errors are present, the receiving Line Driver's red ERROR LED will blink sporadically.

NOTE
For this test to work, the 511 switch on both Line Drivers must be on.

2. If the test indicates no errors are present, move the V.52 toggle switch DOWN, activating the 511/E test with periodic errors present. If the test is working properly, the receiving Line Driver's yellow ERROR LED will blink regularly. A successful 511/E test will confirm that the link is in place, and that the Line Driver's built-in 511 generator and detector are working properly.

5.5 Power-Down

To turn off the Async/Sync Industrial Line Driver, simply unplug the AC power cord from the wall. There is no power switch.

Appendix. Cable Recommendations

This Line Driver was tested on twisted-pair cable with these characteristics:

Wire Gauge	Capacitance	Resistance
19 AWG (0.9 mm)	83 nF/mi. or 15.72 pF/ft.	0.0163 ohms/ft.
22 AWG (0.6 mm)	83 nF/mi. or 15.72 pF/ft.	0.0326 ohms/ft.
24 AWG (0.5 mm)	83 nF/mi. or 15.72 pF/ft.	0.05165 ohms/ft.
26 AWG (0.4 mm)	83 nF/mi. or 15.72 pF/ft.	0.08235 ohms/ft.

The Line Driver should operate on lines with specifications different from those tested, but to reduce the potential difficulties in the field, make sure that the cable being used has similar or better characteristics (lower capacitance or lower resistance).

Table A-1. Distance in miles (km)

Data Rate (kbps)	Wire Gauge (AWG/mm)		
	22 (0.6 mm)	24 (0.5 mm)	26 (0.4 mm)
1.2	11.9 (19.2)	9.8 (15.8)	7.2 (11.6)
1.8	11.6 (18.6)	8.7 (14)	7 (11.3)
2.4	11.1 (18)	8 (12.8)	6.6 (10.7)
3.6	10.4 (16.8)	7.6 (12.2)	6.25 (10.1)
4.8	9.7 (15.5)	6.9 (11.1)	5.9 (9.4)
7.2	9.1 (14.6)	6.6 (10.7)	4.9 (7.9)
9.6	7.6 (12.2)	6.25 (10.1)	4.5 (7.3)
14.4	7.4 (11.9)	5.2 (8.4)	4 (6.4)
16	7.2 (11.6)	5.1 (8.2)	3.8 (6.1)
19.2	6.8 (11)	4.9 (7.9)	3.6 (5.8)
28.8	6 (9.6)	3.8 (6.1)	3 (4.9)
32	5.7 (9.1)	3.6 (5.8)	2.8 (4.6)
38.4	4.7 (7.6)	3.2 (5.2)	2.2 (3.7)
57.6	3.4 (5.5)	2.7 (4.3)	1.9 (3)
64	2.5 (4)	2.3 (3.7)	1.3 (2.1)

Wire with capacitance of 20 pF/ft. or less is suitable; however, distances may vary. Resistance will also affect distance but not functionality. Wire should be 26 AWG (0.4 mm) or larger (smaller AWG#).

This Line Driver is designed to withstand normal environmental noise and conditions; however, other environmental factors may affect proper operation.

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